



Cisco Nexus 3600 Switch NX-OS Security Configuration Guide, Release 10.5(x)

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Preface

This preface includes the following sections:

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- [Document Conventions, on page xv](#)
- [Related Documentation for Cisco Nexus 3000 Series Switches, on page xvi](#)
- [Documentation Feedback, on page xvi](#)
- [Communications, Services, and Additional Information, on page xvi](#)

Audience

This publication is for network administrators who install, configure, and maintain Cisco Nexus switches.

Document Conventions

Command descriptions use the following conventions:

Convention	Description
bold	Bold text indicates the commands and keywords that you enter literally as shown.
<i>Italic</i>	Italic text indicates arguments for which the user supplies the values.
[x]	Square brackets enclose an optional element (keyword or argument).
[x y]	Square brackets enclosing keywords or arguments separated by a vertical bar indicate an optional choice.
{x y}	Braces enclosing keywords or arguments separated by a vertical bar indicate a required choice.
[x {y z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.

Convention	Description
<i>variable</i>	Indicates a variable for which you supply values, in context where italics cannot be used.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.

Examples use the following conventions:

Convention	Description
<code>screen font</code>	Terminal sessions and information the switch displays are in screen font.
boldface screen font	Information you must enter is in boldface screen font.
<i>italic screen font</i>	Arguments for which you supply values are in italic screen font.
<>	Nonprinting characters, such as passwords, are in angle brackets.
[]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Related Documentation for Cisco Nexus 3000 Series Switches

The entire Cisco Nexus 3000 Series switch documentation set is available at the following URL:

<https://www.cisco.com/c/en/us/support/switches/nexus-3000-series-switches/tsd-products-support-series-home.html>

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CHAPTER 1

New and Changed Information

- [New and Changed Information](#), on page 1

New and Changed Information

Table 1: New and Changed Features

Feature	Description	Changed in Release	Where Documented
NA	No feature updates for this release.	10.5(1)F	NA



CHAPTER 2

Overview

The Cisco NX-OS software supports security features that can protect your network against degradation or failure and also against data loss or compromise resulting from intentional attacks and from unintended but damaging mistakes by well-meaning network users.

- [Licensing Requirements, on page 3](#)
- [Authentication, Authorization, and Accounting, on page 3](#)
- [RADIUS and TACACS+ Security Protocols, on page 4](#)
- [SSH and Telnet, on page 4](#)
- [IP ACLs, on page 4](#)

Licensing Requirements

For a complete explanation of Cisco NX-OS licensing recommendations and how to obtain and apply licenses, see the [Cisco NX-OS Licensing Guide](#) and the [Cisco NX-OS Licensing Options Guide](#).

Authentication, Authorization, and Accounting

Authentication, authorization, and accounting (AAA) is an architectural framework for configuring a set of three independent security functions in a consistent, modular manner.

Authentication

Provides the method of identifying users, including login and password dialog, challenge and response, messaging support, and, depending on the security protocol that you select, encryption. Authentication is the way a user is identified prior to being allowed access to the network and network services. You configure AAA authentication by defining a named list of authentication methods and then applying that list to various interfaces.

Authorization

Provides the method for remote access control, including one-time authorization or authorization for each service, per-user account list and profile, user group support, and support of IP, IPX, ARA, and Telnet.

Remote security servers, such as RADIUS and TACACS+, authorize users for specific rights by associating attribute-value (AV) pairs, which define those rights, with the appropriate user. AAA authorization works by assembling a set of attributes that describe what the user is authorized to perform. These attributes are compared with the information contained in a database for a given user, and the result is returned to AAA to determine the user's actual capabilities and restrictions.

Accounting

Provides the method for collecting and sending security server information used for billing, auditing, and reporting, such as user identities, start and stop times, executed commands (such as PPP), number of packets, and number of bytes. Accounting enables you to track the services that users are accessing, as well as the amount of network resources that they are consuming.



Note You can configure authentication outside of AAA. However, you must configure AAA if you want to use RADIUS or TACACS+, or if you want to configure a backup authentication method.

RADIUS and TACACS+ Security Protocols

AAA uses security protocols to administer its security functions. If your router or access server is acting as a network access server, AAA is the means through which you establish communication between your network access server and your RADIUS or TACACS+ security server.

The chapters in this guide describe how to configure the following security server protocols:

RADIUS

A distributed client/server system implemented through AAA that secures networks against unauthorized access. In the Cisco implementation, RADIUS clients run on Cisco routers and send authentication requests to a central RADIUS server that contains all user authentication and network service access information.

TACACS+

A security application implemented through AAA that provides a centralized validation of users who are attempting to gain access to a router or network access server. TACACS+ services are maintained in a database on a TACACS+ daemon running, typically, on a UNIX or Windows NT workstation. TACACS+ provides for separate and modular authentication, authorization, and accounting facilities.

SSH and Telnet

You can use the Secure Shell (SSH) server to enable an SSH client to make a secure, encrypted connection to a Cisco NX-OS device. SSH uses strong encryption for authentication. The SSH server in the Cisco NX-OS software can interoperate with publicly and commercially available SSH clients.

The SSH client in the Cisco NX-OS software works with publicly and commercially available SSH servers.

The Telnet protocol enables TCP/IP connections to a host. Telnet allows a user at one site to establish a TCP connection to a login server at another site and then passes the keystrokes from one device to the other. Telnet can accept either an IP address or a domain name as the remote device address.

IP ACLs

IP ACLs are ordered sets of rules that you can use to filter traffic based on IPv4 information in the Layer 3 header of packets. Each rule specifies a set of conditions that a packet must satisfy to match the rule. When the Cisco NX-OS software determines that an IP ACL applies to a packet, it tests the packet against the conditions of all rules. The first match determines whether a packet is permitted or denied, or if there is no

match, the Cisco NX-OS software applies the applicable default rule. The Cisco NX-OS software continues processing packets that are permitted and drops packets that are denied.



CHAPTER 3

Configuring AAA

This chapter describes how to configure authentication, authorization, and accounting (AAA) on Cisco NX-OS devices.

- [Information About AAA, on page 7](#)
- [Prerequisites for Remote AAA, on page 11](#)
- [Guidelines and Limitations for AAA, on page 11](#)
- [Configuring AAA, on page 11](#)
- [Monitoring and Clearing the Local AAA Accounting Log , on page 29](#)
- [Verifying the AAA Configuration, on page 29](#)
- [Configuration Examples for AAA, on page 30](#)
- [Default AAA Settings, on page 31](#)

Information About AAA

AAA Security Services

The authentication, authorization, and accounting (AAA) features allows you to verify the identity of, grant access to, and track the actions of users who manage Cisco Nexus devices. The Cisco Nexus device supports Remote Access Dial-In User Service (RADIUS) or Terminal Access Controller Access Control device Plus (TACACS+) protocols.

Based on the user ID and password that you provide, the switches perform local authentication or authorization using the local database or remote authentication or authorization using one or more AAA servers. A preshared secret key provides security for communication between the switch and AAA servers. You can configure a common secret key for all AAA servers or for only a specific AAA server.

AAA security provides the following services:

- **Authentication**—Identifies users, including login and password dialog, challenge and response, messaging support, and, encryption depending on the security protocol that you select.
- **Authorization**—Provides access control.

Authorization to access a Cisco Nexus device is provided by attributes that are downloaded from AAA servers. Remote security servers, such as RADIUS and TACACS+, authorize users for specific rights by associating attribute-value (AV) pairs, which define those rights with the appropriate user.

- Accounting—Provides the method for collecting information, logging the information locally, and sending the information to the AAA server for billing, auditing, and reporting.



Note The Cisco NX-OS software supports authentication, authorization, and accounting independently. For example, you can configure authentication and authorization without configuring accounting.

Benefits of Using AAA

AAA provides the following benefits:

- Increased flexibility and control of access configuration
- Scalability
- Standardized authentication methods, such as RADIUS and TACACS+
- Multiple backup devices

Remote AAA Services

Remote AAA services provided through RADIUS and TACACS+ protocols have the following advantages over local AAA services:

- User password lists for each switch in the fabric are easier to manage.
- AAA servers are already deployed widely across enterprises and can be easily used for AAA services.
- The accounting log for all switches in the fabric can be centrally managed.
- User attributes for each switch in the fabric are easier to manage than using the local databases on the switches.

AAA Server Groups

You can specify remote AAA servers for authentication, authorization, and accounting using server groups. A server group is a set of remote AAA servers that implement the same AAA protocol. A server group provides for failover servers if a remote AAA server fails to respond. If the first remote server in the group fails to respond, the next remote server in the group is tried until one of the servers sends a response. If all the AAA servers in the server group fail to respond, that server group option is considered a failure. If required, you can specify multiple server groups. If a switch encounters errors from the servers in the first group, it tries the servers in the next server group.

AAA Service Configuration Options

On Cisco Nexus devices, you can have separate AAA configurations for the following services:

- User Telnet or Secure Shell (SSH) login authentication
- Console login authentication

- User management session accounting

The following table lists the CLI commands for each AAA service configuration option.

Table 2: AAA Service Configuration Commands

AAA Service Configuration Option	Related Command
Telnet or SSH login	aaa authentication login default
Console login	aaa authentication login console
User session accounting	aaa accounting default

You can specify the following authentication methods for the AAA services:

- RADIUS server groups—Uses the global pool of RADIUS servers for authentication.
- Specified server groups—Uses specified RADIUS or TACACS+ server groups for authentication.
- Local—Uses the local username or password database for authentication.
- None—Uses only the username.



Note If the method is for all RADIUS servers, instead of a specific server group, the Cisco Nexus devices choose the RADIUS server from the global pool of configured RADIUS servers in the order of configuration. Servers from this global pool are the servers that can be selectively configured in a RADIUS server group on the Cisco Nexus devices.

The following table describes the AAA authentication methods that you can configure for the AAA services.

Table 3: AAA Authentication Methods for AAA Services

AAA Service	AAA Methods
Console login authentication	Server groups, local, and none
User login authentication	Server groups, local, and none
User management session accounting	Server groups and local



Note For console login authentication, user login authentication, and user management session accounting, the Cisco Nexus devices try each option in the order specified. The local option is the default method when other configured options fail.

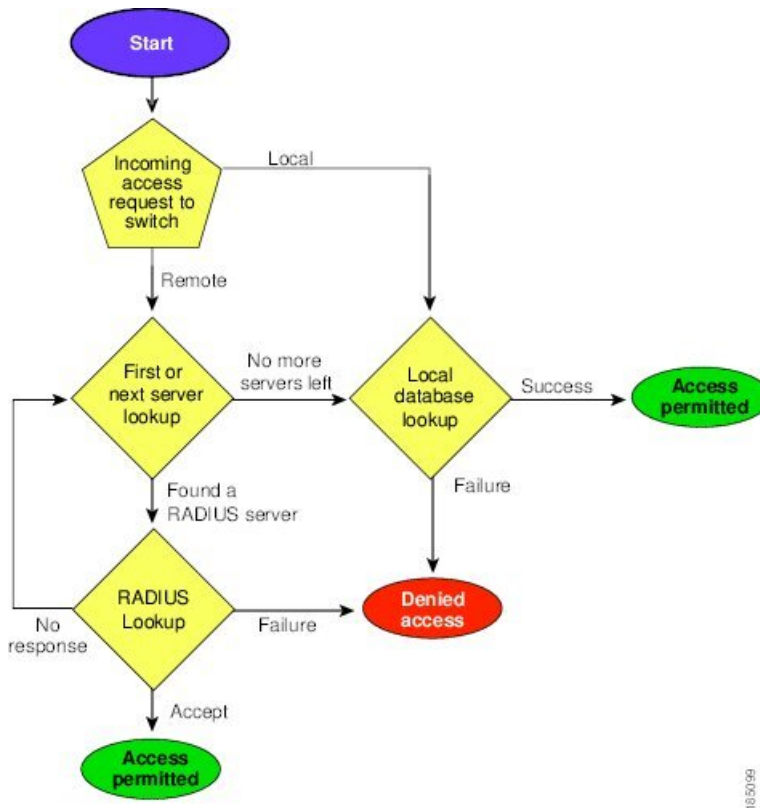
Authentication and Authorization Process for User Logins

The authentication and authorization process for user login is as occurs:

- When you log in to the required Cisco Nexus device, you can use the Telnet, SSH, Fabric Manager or Device Manager, or console login options.
- When you have configured the AAA server groups using the server group authentication method, the Cisco Nexus device sends an authentication request to the first AAA server in the group as follows:
If the AAA server fails to respond, then the next AAA server is tried and so on until the remote server responds to the authentication request.
If all AAA servers in the server group fail to respond, the servers in the next server group are tried.
If all configured methods fail, the local database is used for authentication.
- If a Cisco Nexus device successfully authenticates you through a remote AAA server, the following conditions apply:
If the AAA server protocol is RADIUS, user roles specified in the cisco-av-pair attribute are downloaded with an authentication response.
If the AAA server protocol is TACACS+, another request is sent to the same server to get the user roles specified as custom attributes for the shell.
- If your username and password are successfully authenticated locally, the Cisco Nexus device logs you in and assigns you the roles configured in the local database.

The following figure shows a flowchart of the authentication and authorization process.

Figure 1: Authentication and Authorization Flow for User Login





Note This figure is applicable only to username password SSH authentication. It does not apply to public key SSH authentication. All username password SSH authentication goes through AAA.

In the figure, "No more servers left" means that there is no response from any server within this server group.

Prerequisites for Remote AAA

Remote AAA servers have the following prerequisites:

- At least one RADIUS or TACACS+ server must be IP reachable.
- The Cisco Nexus device is configured as a client of the AAA servers.
- The preshared secret key is configured on the Cisco Nexus device and on the remote AAA servers.
- The remote server responds to AAA requests from the Cisco Nexus device.

Guidelines and Limitations for AAA

The Cisco Nexus devices do not support all numeric usernames, whether created with TACACS+ or RADIUS, or created locally. If an all numeric username exists on an AAA server and is entered during a login, the Cisco Nexus device still logs in the user.

If you configure the AAA login authentication default group, TACACS-SERVER-GROUP, it also overrides the login for the console. This override occurs even if **aaa authentication login console local** is a default command on the switch. To prevent this, you must configure **aaa authentication login console local**.



Caution You should not create user accounts with usernames that are all numeric.

Configuring AAA

Configuring Console Login Authentication Methods

The authentication methods include the following:

- Global pool of RADIUS servers
- Named subset of RADIUS or TACACS+ servers
- Local database on the Cisco Nexus device.
- Username only **none**

The default method is local.



Note The **group radius** and **group server-name** forms of the **aaa authentication** command are used for a set of previously defined RADIUS servers. Use the **radius server-host** command to configure the host servers. Use the **aaa group server radius** command to create a named group of servers.



Note If you configure the AAA login authentication default group, TACACS-SERVER-GROUP, it also overrides the login for the console. This override occurs even if **aaa authentication login console local** is a default command on the switch. To prevent this, you must configure **aaa authentication login console local**.

Before you configure console login authentication methods, configure RADIUS or TACACS+ server groups as needed.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aaa authentication login console {group group-list [none] | local | none}**
3. switch(config)# **exit**
4. (Optional) switch# **show aaa authentication**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aaa authentication login console {group group-list [none] local none}	<p>Configures login authentication methods for the console.</p> <p>The <i>group-list</i> argument consists of a space-delimited list of group names. The group names are the following:</p> <ul style="list-style-type: none"> • radius —Uses the global pool of RADIUS servers for authentication. • <i>named-group</i> —Uses a named subset of TACACS+ or RADIUS servers for authentication. <p>The local method uses the local database for authentication. The none method uses the username only.</p> <p>The default console login method is local, which is used when no methods are configured or when all of the configured methods fail to respond.</p>
Step 3	switch(config)# exit	Exits global configuration mode.
Step 4	(Optional) switch# show aaa authentication	Displays the configuration of the console login authentication methods.

	Command or Action	Purpose
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

This example shows how to configure authentication methods for the console login:

```
switch# configure terminal
switch(config)# aaa authentication login console group radius
switch(config)# exit
switch# show aaa authentication
switch# copy running-config startup-config
```

Configuring Default Login Authentication Methods

The default method is local.

Before you configure default login authentication methods, configure RADIUS or TACACS+ server groups as needed.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aaa authentication login default {group group-list [none] | local | none}**
3. switch(config)# **exit**
4. (Optional) switch# **show aaa authentication**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aaa authentication login default {group group-list [none] local none}	<p>Configures the default authentication methods.</p> <p>The <i>group-list</i> argument consists of a space-delimited list of group names. The group names are the following:</p> <ul style="list-style-type: none"> • radius —Uses the global pool of RADIUS servers for authentication. • named-group —Uses a named subset of TACACS+ or RADIUS servers for authentication. <p>The local method uses the local database for authentication. The none method uses the username only.</p>

	Command or Action	Purpose
		The default login method is local , which is used when no methods are configured or when all of the configured methods do not respond.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show aaa authentication	Displays the configuration of the default login authentication methods.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Enabling Login Authentication Failure Messages

When you log in, the login is processed by the local user database if the remote AAA servers do not respond. If you have enabled the displaying of login failure messages, the following message is displayed:

```
Remote AAA servers unreachable; local authentication done.
Remote AAA servers unreachable; local authentication failed.
```

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aaa authentication login error-enable**
3. switch(config)# **exit**
4. (Optional) switch# **show aaa authentication**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aaa authentication login error-enable	Enables login authentication failure messages. The default is disabled.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show aaa authentication	Displays the login failure message configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Logging Successful and Failed Login Attempts

You can configure the switch to log all successful and failed login attempts to the configured syslog server.

SUMMARY STEPS

1. **configure terminal**
2. **[no] login on-failure log**
3. **[no] login on-success log**
4. (Optional) **show login on-failure log**
5. (Optional) **show login on-successful log**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal	Enters global configuration mode.
Step 2	Required: [no] login on-failure log Example: switch(config)# login on-failure log	Logs all failed authentication messages to the configured syslog server. With this configuration, the following syslog message appears after the failed login: AUTHPRIV-3-SYSTEM_MSG: pam_aaa:Authentication failed for user admin from 172.22.00.00 Note When logging level authpriv is 6, additional Linux kernel authentication messages appear along with the previous message. If these additional messages need to be ignored, the authpriv value should be set to 3.
Step 3	Required: [no] login on-success log Example: switch(config)# login on-success log	Logs all successful authentication messages to the configured syslog server. With this configuration, the following syslog message appears after the successful login: AUTHPRIV-6-SYSTEM_MSG: pam_aaa:Authentication success for user admin from 172.22.00.00 Note When logging level authpriv is 6, additional Linux kernel authentication messages appear along with the previous message.
Step 4	(Optional) show login on-failure log Example: switch(config)# show login on-failure log	Displays whether the switch is configured to log failed authentication messages to the syslog server.
Step 5	(Optional) show login on-successful log Example: switch(config)# show login on-successful log	Displays whether the switch is configured to log successful authentication messages to the syslog server.
Step 6	(Optional) copy running-config startup-config Example:	Copies the running configuration to the startup configuration.

Command or Action	Purpose
<code>switch(config)# copy running-config startup-config</code>	

Configuring AAA Command Authorization

When a TACACS+ server authorization method is configured, you can authorize every command that a user executes with the TACACS+ server which includes all EXEC mode commands and all configuration mode commands.

The authorization methods include the following:

- Group—TACACS+ server group
- Local—Local role-based authorization
- None—No authorization is performed

The default method is Local.



Note There is no authorization on the console session.

Before you begin

You must enable TACACS+ before configuring AAA command authorization.

SUMMARY STEPS

1. **configure terminal**
2. **aaa authorization** {**commands** | **config-commands**} {**default**} {{{**group** *group-name* | [**local**] | {{{**group** *group-name* | [**none**]}}}}

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	aaa authorization { commands config-commands } { default } {{{ group <i>group-name</i> [local] {{{ group <i>group-name</i> [none]}}}} Example: <pre>switch(config)# aaa authorization config-commands default group tac1</pre> Example:	Configures authorization parameters. Use the commands keyword to authorize EXEC mode commands. Use the config-commands keyword to authorize configuration mode commands. Use the group , local , or none keywords to identify the authorization method.

	Command or Action	Purpose
	switch# <code>aaa authorization commands default group tac1</code>	

Example

The following example shows how to authorize EXEC mode commands with TACACS+ server group *tac1*:

```
switch# aaa authorization commands default group tac1
```

The following example shows how to authorize configuration mode commands with TACACS+ server group *tac1*:

```
switch(config)# aaa authorization config-commands default group tac1
```

The following example shows how to authorize configuration mode commands with TACACS+ server group *tac1*:

- If the server is reachable, the command is allowed or not allowed based on the server response.
- If there is an error reaching the server, the command is authorized based on the user's *local* role.

```
switch(config)# aaa authorization config-commands default group tac1 local
```

The following example shows how to authorize configuration mode commands with TACACS+ server group *tac1*:

- If the server is reachable, the command is allowed or not allowed based on the server response.
- If there is an error reaching the server, allow the command regardless of the local role.

```
switch# aaa authorization commands default group tac1 none
```

The following example shows how to authorize EXEC mode commands regardless of the local role:

```
switch# aaa authorization commands default none
```

The following example shows how to authorize EXEC mode commands using the local role for authorization:

```
switch# aaa authorization commands default local
```

Enabling MSCHAP Authentication

Microsoft Challenge Handshake Authentication Protocol (MSCHAP) is the Microsoft version of CHAP. You can use MSCHAP for user logins to a Cisco Nexus device through a remote authentication server (RADIUS or TACACS+).

By default, the Cisco Nexus device uses Password Authentication Protocol (PAP) authentication between the switch and the remote server. If you enable MSCHAP, you must configure your RADIUS server to recognize the MSCHAP vendor-specific attributes (VSAs).

The following table describes the RADIUS VSAs required for MSCHAP.

Table 4: MSCHAP RADIUS VSAs

Vendor-ID Number	Vendor-Type Number	VSA	Description
311	11	MSCHAP-Challenge	Contains the challenge sent by an AAA server to an MSCHAP user. It can be used in both Access-Request and Access-Challenge packets.
211	11	MSCHAP-Response	Contains the response value provided by an MSCHAP user in response to the challenge. It is only used in Access-Request packets.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aaa authentication login mschap enable**
3. switch(config)# **exit**
4. (Optional) switch# **show aaa authentication login mschap**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aaa authentication login mschap enable	Enables MS-CHAP authentication. The default is disabled.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show aaa authentication login mschap	Displays the MS-CHAP configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring AAA Authorization on LDAP Servers

You can configure the default AAA authorization method for LDAP servers.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **aaa authorization ssh-certificate default {group *group-list* [none] | local | none}**
3. **exit**
4. (Optional) **show aaa authorization [all]**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	aaa authorization ssh-certificate default {group <i>group-list</i> [none] local none} Example: <pre>switch(config)# aaa authorization ssh-certificate default group ldap1 ldap2</pre>	<p>Configures the default AAA authorization method for the LDAP servers.</p> <p>The ssh-certificate keyword configures LDAP or local authorization with certificate authentication. The default authorization is local authorization, which is the list of authorized commands for the user's assigned role.</p> <p>The <i>group-list</i> argument consists of a space-delimited list of LDAP server group names. Servers belonging to this group are contacted for AAA authorization. The local method uses the local database for authorization, and the none method specifies that no AAA authorization be used.</p>
Step 3	exit Example: <pre>switch(config)# exit switch#</pre>	Exits global configuration mode.
Step 4	(Optional) show aaa authorization [all] Example: <pre>switch# show aaa authorization</pre>	Displays the AAA authorization configuration. The all keyword displays the default values.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Configuring AAA SSH-Cert-Authorization on TACACS Servers

To configure AAA SSH-Cert-Authorization on TACACS Servers, follow these steps:

SUMMARY STEPS

1. **configure terminal**
2. **aaa authorization ssh-certificate default {group group-list [none] | local | none}**
3. **exit**
4. (Optional) **show aaa authorization [all]**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	aaa authorization ssh-certificate default {group group-list [none] local none} Example: <pre>switch(config)# aaa authorization ssh-certificate default group tac1</pre>	<p>Configures the default AAA authorization-method for SSH request having X509 certificate as TACACS server-group(s).</p> <p>The ssh-certificate keyword configures TACACS or local authorization with certificate authentication. The default authorization is local authorization, which is the list of authorized commands for the user's assigned role.</p> <p>The <i>group-list</i> argument consists of a space-delimited list of TACACS server group names. Servers belonging to this group are contacted for AAA authorization. The local method uses the local database for authorization, and the none method specifies that no AAA authorization be used.</p>
Step 3	exit Example: <pre>switch(config)# exit switch#</pre>	Exits global configuration mode.
Step 4	(Optional) show aaa authorization [all] Example: <pre>switch# show aaa authorization</pre>	Displays the AAA authorization configuration. The all keyword displays the default values.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Configuring AAA Accounting Default Methods

The Cisco Nexus device supports TACACS+ and RADIUS methods for accounting. The switches report user activity to TACACS+ or RADIUS security servers in the form of accounting records. Each accounting record contains accounting attribute-value (AV) pairs and is stored on the AAA server.

When you activate AAA accounting, the Cisco Nexus device reports these attributes as accounting records, which are then stored in an accounting log on the security server.

You can create default method lists defining specific accounting methods, which include the following:

- RADIUS server group—Uses the global pool of RADIUS servers for accounting.
- Specified server group—Uses a specified RADIUS or TACACS+ server group for accounting.
- Local—Uses the local username or password database for accounting.



Note If you have configured server groups and the server groups do not respond, by default, the local database is used for authentication.

Before you begin

Before you configure AAA accounting default methods, configure RADIUS or TACACS+ server groups as needed.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aaa accounting default {group group-list | local}**
3. switch(config)# **exit**
4. (Optional) switch# **show aaa accounting**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aaa accounting default {group group-list local}	Configures the default accounting method. One or more server group names can be specified in a space-separated list. The <i>group-list</i> argument consists of a space-delimited list of group names. The group names are the following: <ul style="list-style-type: none"> • radius —Uses the global pool of RADIUS servers for accounting. • named-group —Uses a named subset of TACACS+ or RADIUS servers for accounting.

	Command or Action	Purpose
		The local method uses the local database for accounting. The default method is local , which is used when no server groups are configured or when all the configured server group do not respond.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show aaa accounting	Displays the configuration AAA accounting default methods.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

About No Service Password-Recovery

The No Service Password-Recovery feature enables anyone with console access, the ability to access the router and its network.

Enabling No Service Password-Recovery

If the no service password-recovery feature is enabled, then none except the administrator with network privileges will be able to modify the administrator password.

Before you begin

If you plan to enter the no service password-recovery command, Cisco recommends that you save a copy of the system configuration file in a location away from the device.

SUMMARY STEPS

1. **configure terminal**
2. **no service password-recovery**
3. (Optional) **copy running-config startup-config**
4. **Reload**
5. **exit**
6. (Optional) **show user-account**
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.

	Command or Action	Purpose
Step 2	<p>no service password-recovery</p> <p>Example:</p> <pre>switch(config)# no service password-recovery WARNING: Executing this command will disable the password recovery mechanism. Do not execute this command without another plan for password recovery. Are you sure you want to continue? (y/n) : [y] y switch(config)# copy run start [#####] 100% Copy complete, now saving to disk (please wait)... Copy complete.</pre>	Disables the password recovery mechanism.
Step 3	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.
Step 4	<p>Reload</p> <p>Example:</p> <pre>switch(config)# Reload This command will reboot the system. (y/n)? [n] y 2018 Jun 26 16:23:19 BAR %\$ VDC-1 %\$ %PLATFORM-2-PFM_SYSTEM_RESET: Manual system restart from Command Line Interface CISCO SWITCH Ver 8.34 CISCO SWITCH Ver 8.34 Manual system restart from Command Line Interface writing reset reason 9, switch(boot)# config t Enter configuration commands, one per line. End with CNTL/Z. switch(boot) (config)# admin-password Abcd!123\$ ERROR: service password-recovery disabled. Cannot change password! switch(boot) (config)#</pre>	
Step 5	<p>exit</p> <p>Example:</p> <pre>switch(config)# exit switch#</pre>	Exits global configuration mode.
Step 6	<p>(Optional) show user-account</p> <p>Example:</p> <pre>switch# show user-account</pre>	Displays the role configuration.
Step 7	<p>(Optional) copy running-config startup-config</p> <p>Example:</p>	Copies the running configuration to the startup configuration.

	Command or Action	Purpose
	switch# copy running-config startup-config	

Using AAA Server VSAs

VSAs

You can use vendor-specific attributes (VSAs) to specify the Cisco Nexus device user roles and SNMPv3 parameters on AAA servers.

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating VSAs between the network access server and the RADIUS server. The IETF uses attribute 26. VSAs allow vendors to support their own extended attributes that are not suitable for general use. The Cisco RADIUS implementation supports one vendor-specific option using the format recommended in the specification. The Cisco vendor ID is 9, and the supported option is vendor type 1, which is named `cisco-av-pair`. The value is a string with the following format:

```
protocol : attribute separator value *
```

The protocol is a Cisco attribute for a particular type of authorization, separator is an equal sign (=) for mandatory attributes, and an asterisk (*) indicates optional attributes.

When you use RADIUS servers for authentication on a Cisco Nexus device, the RADIUS protocol directs the RADIUS server to return user attributes, such as authorization information, with authentication results. This authorization information is specified through VSAs.

VSA Format

The following VSA protocol options are supported by the Cisco Nexus device:

- Shell—Used in access-accept packets to provide user profile information.
- Accounting—Used in accounting-request packets. If a value contains any white spaces, put it within double quotation marks.

The following attributes are supported by the Cisco Nexus device:

- roles—Lists all the roles assigned to the user. The value field is a string that stores the list of group names delimited by white space.
- accountinginfo—Stores additional accounting information in addition to the attributes covered by a standard RADIUS accounting protocol. This attribute is sent only in the VSA portion of the Account-Request frames from the RADIUS client on the switch, and it can only be used with the accounting protocol-related PDUs.

Specifying Switch User Roles and SNMPv3 Parameters on AAA Servers

You can use the VSA `cisco-av-pair` on AAA servers to specify user role mapping for the Cisco Nexus device using this format:

```
shell:roles="roleA roleB ..."
```

If you do not specify the role option in the `cisco-av-pair` attribute, the default user role is `network-operator`.



Note For information on Cisco Unified Wireless Network TACACS+ configurations and to change the user roles, see [Cisco Unified Wireless Network TACACS+ Configuration](#).

You can also specify your SNMPv3 authentication and privacy protocol attributes as follows:

```
shell:roles="roleA roleB..." snmpv3:auth=SHA priv=AES-128
```

The SNMPv3 authentication protocol options are SHA and MD5. The privacy protocol options are AES-128 and DES. If you do not specify these options in the `cisco-av-pair` attribute, MD5 and DES are the default authentication protocols.

For additional information, see the Configuring User Accounts and RBAC chapter in the System Management Configuration Guide for your Cisco Nexus device.

Secure Login Enhancements

Secure Login Enhancements

The following secure login enhancements are supported in Cisco NX-OS:

- Configuring Login Parameters
- Configuration Examples for Login Parameters
- Restricting Sessions Per User—Per User Per Login
- Enabling the Password Prompt for User Name
- Configuring Share Key Value for using RADIUS/TACACS+

Configuring Login Parameters

Use this task to configure your Cisco NX-OS device for login parameters that help detect suspected DoS attacks and slow down dictionary attacks.

All login parameters are disabled by default. You must enter the **login block-for** command, which enables default login functionality, before using any other login commands. After the **login block-for** command is enabled, the following default is enforced:

- All login attempts made through Telnet or SSH are denied during the quiet period; that is, no ACLs are exempt from the login period until the **login quiet-mode access-class** command is entered.

SUMMARY STEPS

1. **configure terminal**
2. **[no] login block-for** *seconds* **attempts** *tries* **within** *seconds*
3. **[no] login quiet-mode access-class** {*acl-name* | *acl-number*}
4. **exit**
5. **show login failures**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Switch# configure terminal	Enters global configuration mode.
Step 2	[no] login block-for <i>seconds</i> attempts <i>tries</i> within <i>seconds</i> Example: Switch(config)# login block-for 100 attempts 2 within 100	Configures your Cisco NX-OS device for login parameters that help provide DoS detection. Note This command must be issued before any other login command can be used.
Step 3	[no] login quiet-mode access-class {<i>acl-name</i> <i>acl-number</i>} Example: Switch(config)# login quiet-mode access-class myacl	(Optional) Although this command is optional, it is recommended that it be configured to specify an ACL that is to be applied to the device when the device switches to quiet mode. When the device is in quiet mode, all login requests are denied and the only available connection is through the console.
Step 4	exit Example: Switch(config)# exit	Exits to privileged EXEC mode.
Step 5	show login failures Example: Switch# show login	Displays login parameters. • failures --Displays information related only to failed login attempts.

Configuration Examples for Login Parameters

Setting Login Parameters Example

The following example shows how to configure your switch to enter a 100 second quiet period if 15 failed login attempts is exceeded within 100 seconds; all login requests are denied during the quiet period except hosts from the ACL "myacl."

```
Switch(config)# login block-for 100 attempts 15 within 100
Switch(config)# login quiet-mode access-class myacl
```

Showing Login Parameters Example

The following sample output from the **show login** command verifies that no login parameters have been specified:

```
Switch# show login
```

No Quiet-Mode access list has been configured, default ACL will be applied.

Switch is enabled to watch for login Attacks.

If more than 2 login failures occur in 45 seconds or less, logins will be disabled for 70 seconds.

Switch presently in Normal-Mode.

Current Watch Window remaining time 10 seconds.

Present login failure count 0.

The following sample output from the **show login failures** command shows all failed login attempts on the switch:

```
Switch# show login failures
```

```
Information about last 20 login failures with the device.
```

```
-----
Username                               Line   Source                               Appname
TimeStamp
-----
admin                                   pts/0  bgl-ads-728.cisco.com               login
Wed Jun 10 04:56:16 2015
admin                                   pts/0  bgl-ads-728.cisco.com               login
Wed Jun 10 04:56:19 2015
-----
```

The following sample output from the **show login failures** command verifies that no information is presently logged:

```
Switch# show login failures
```

```
*** No logged failed login attempts with the device.***
```

Restricting Sessions Per User—Per User Per Login

Use this task to restrict the maximum sessions per user.

SUMMARY STEPS

1. **configure terminal**
2. **[no] user max-logins *max-logins***
3. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Switch# configure terminal	Enters global configuration mode.
Step 2	[no] user max-logins <i>max-logins</i> Example: Switch(config)# user max-logins 1	Restricts the maximum sessions per user. The range is from 1 to 7. If you set the maximum login limit as 1, then only one session (telnet/SSH) is allowed per user.

	Command or Action	Purpose
Step 3	exit Example: Switch(config)# exit	Exits to privileged EXEC mode.

Enabling the Password Prompt for User Name

SUMMARY STEPS

1. `configure terminal`
2. `[no] password prompt username`
3. `exit`

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Switch# configure terminal	Enters global configuration mode.
Step 2	[no] password prompt username Example: Switch(config)# password prompt username	Enables the login knob. If this command is enabled and the user enters the username command without the password option, then the password is prompted. The password accepts hidden characters. Use the no form of this command to disable the login knob.
Step 3	exit Example: Switch(config)# exit	Exits to privileged EXEC mode.

Configuring Share Key Value for using RADIUS/TACACS+

The shared secret you configure for remote authentication and accounting must be hidden. For the **radius-server key** and **tacacs-server key** commands, a separate command to generate encrypted shared secret can be used.

SUMMARY STEPS

1. `configure terminal`
2. `generate type7_encrypted_secret`
3. `exit`

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: Switch# configure terminal	Enters global configuration mode.
Step 2	generate type7_encrypted_secret Example: Switch(config)# generate type7_encrypted_secret	Configures RADIUS and TACACS shared secret with key type 7. While generating an encrypted shared secret, user input is hidden. Note You can generate encrypted equivalent of plain text separately and can configure the encrypted shared secret later.
Step 3	exit Example: Switch(config)# exit	Exits to privileged EXEC mode.

Monitoring and Clearing the Local AAA Accounting Log

The Cisco Nexus device maintains a local log for the AAA accounting activity.

SUMMARY STEPS

1. switch# **show accounting log** [*size*] [**start-time** *year month day hh : mm : ss*]
2. (Optional) switch# **clear accounting log**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show accounting log [<i>size</i>] [start-time <i>year month day hh : mm : ss</i>]	Displays the accounting log contents. By default, the command output contains up to 250,000 bytes of the accounting log. You can use the size argument to limit command output. The range is from 0 to 250000 bytes. You can also specify a start time for the log output.
Step 2	(Optional) switch# clear accounting log	Clears the accounting log contents.

Verifying the AAA Configuration

To display AAA configuration information, perform one of the following tasks:

Command	Purpose
<code>show aaa accounting</code>	Displays AAA accounting configuration.
<code>show aaa authentication [login {error-enable mschap}]</code>	Displays AAA authentication information.
<code>show aaa authorization</code>	Displays AAA authorization information.
<code>show aaa groups</code>	Displays the AAA server group configuration.
<code>show login [failures]</code>	Displays the login parameters. The failures option displays information related only to failed login attempts. Note The clear login failures command clears the login failures in the current watch period.
<code>show login on-failure log</code>	Displays whether the switch is configured to log failed authentication messages to the syslog server.
<code>show login on-successful log</code>	Displays whether the switch is configured to log successful authentication messages to the syslog server.
<code>show running-config aaa [all]</code>	Displays the AAA configuration in the running configuration.
<code>show running-config aaa [all]</code>	Displays the AAA configuration in the running configuration.
<code>show running-config all i max-login</code>	Displays the maximum number of login sessions allowed per user.
<code>show startup-config aaa</code>	Displays the AAA configuration in the startup configuration.
<code>show userpassphrase {length max-length min-length}</code>	Displays the minimum and maximum length of the user password.

Configuration Examples for AAA

The following example shows how to configure AAA:

```
switch(config)# aaa authentication login default group radius
switch(config)# aaa authentication login console group radius
switch(config)# aaa accounting default group radius
```


Default AAA Settings

The following table lists the default settings for AAA parameters.

Table 5: Default AAA Parameters

Parameters	Default
Console authentication method	local
Default authentication method	local
Login authentication failure messages	Disabled
MSCHAP authentication	Disabled
Default accounting method	local
Accounting log display length	250 KB



CHAPTER 4

Configuring RADIUS

This chapter contains the following sections:

- [Information About RADIUS](#), on page 33
- [Prerequisites for RADIUS](#), on page 36
- [Guidelines and Limitations for RADIUS](#), on page 36
- [Guidelines and Limitations for RadSec](#), on page 36
- [Configuring RADIUS Servers](#), on page 37
- [Verifying the RADIUS Configuration](#), on page 51
- [Displaying RADIUS Server Statistics](#), on page 52
- [Clearing RADIUS Server Statistics](#), on page 52
- [Configuration Examples for RADIUS](#), on page 53
- [Default Settings for RADIUS](#), on page 53
- [Feature History for RADIUS](#), on page 53

Information About RADIUS

The Remote Access Dial-In User Service (RADIUS) distributed client/server system allows you to secure networks against unauthorized access. In the Cisco implementation, RADIUS clients run on Cisco Nexus device and send authentication and accounting requests to a central RADIUS server that contains all user authentication and network service access information.

RADIUS Network Environments

RADIUS can be implemented in a variety of network environments that require high levels of security while maintaining network access for remote users.

You can use RADIUS in the following network environments that require access security:

- Networks with multiple-vendor network devices, each supporting RADIUS.

For example, network devices from several vendors can use a single RADIUS server-based security database.

- Networks already using RADIUS.

You can add a Cisco Nexus device with RADIUS to the network. This action might be the first step when you make a transition to an AAA server.

- Networks that require resource accounting.

You can use RADIUS accounting independent of RADIUS authentication or authorization. The RADIUS accounting functions allow data to be sent at the start and end of services, indicating the amount of resources (such as time, packets, bytes, and so on) used during the session. An Internet service provider (ISP) might use a freeware-based version of the RADIUS access control and accounting software to meet special security and billing needs.

- Networks that support authentication profiles.

Using the RADIUS server in your network, you can configure AAA authentication and set up per-user profiles. Per-user profiles enable the Cisco Nexus device to manage ports using their existing RADIUS solutions and to efficiently manage shared resources to offer different service-level agreements.

Information About RADIUS Operations

When a user attempts to log in and authenticate to a Cisco Nexus device using RADIUS, the following process occurs:

1. The user is prompted for and enters 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 the following responses from the RADIUS server:
 - ACCEPT—The user is authenticated.
 - REJECT—The user is not authenticated and is prompted to reenter the username and password, or access is denied.
 - CHALLENGE—A challenge is issued by the RADIUS server. The challenge collects additional data from the user.
 - CHANGE PASSWORD—A request is issued by the RADIUS server, asking the user to select a new password.

The ACCEPT or REJECT response is bundled with additional data that is used for EXEC or network authorization. You must first complete RADIUS authentication before using RADIUS authorization. The additional data included with the ACCEPT or REJECT packets consists of the following:

- Services that the user can access, including Telnet, rlogin, or local-area transport (LAT) connections, and Point-to-Point Protocol (PPP), Serial Line Internet Protocol (SLIP), or EXEC services.
- Connection parameters, including the host or client IPv4 address, access list, and user timeouts.

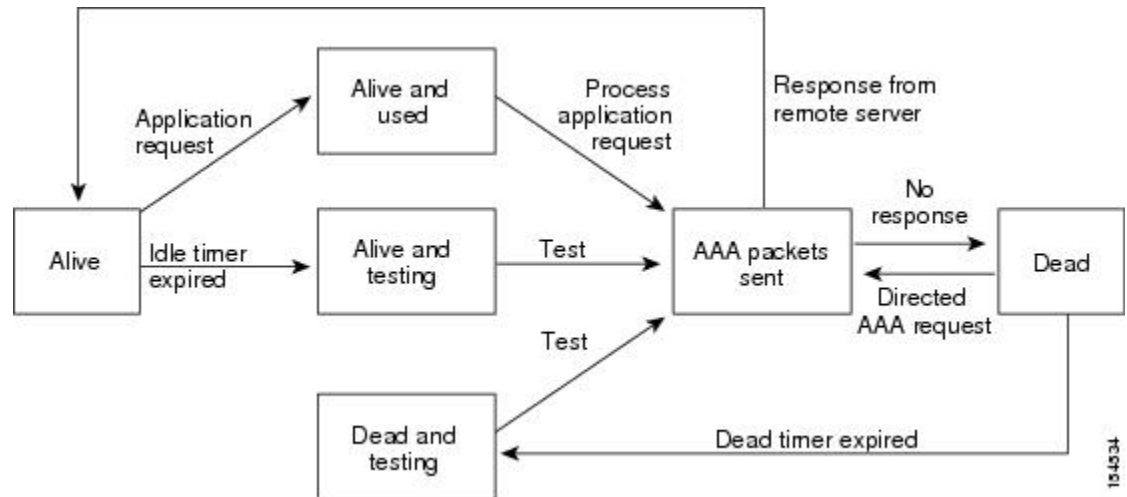
RADIUS Server Monitoring

An unresponsive RADIUS server can cause delay in processing of AAA requests. You can configure the switch to periodically monitor a RADIUS server to check whether it is responding (or alive) to save time in processing AAA requests. The switch marks unresponsive RADIUS servers as dead and does not send AAA requests to any dead RADIUS servers. The switch periodically monitors the dead RADIUS servers and brings them to the alive state once they respond. This process verifies that a RADIUS server is in a working state before real AAA requests are sent to the server. Whenever a RADIUS server changes to the dead or alive

state, a Simple Network Management Protocol (SNMP) trap is generated and the switch displays an error message that a failure is taking place.

The following figure shows the different RADIUS server states:

Figure 2: RADIUS Server States



Note The monitoring interval for alive servers and dead servers are different and can be configured by the user. The RADIUS server monitoring is performed by sending a test authentication request to the RADIUS server.

Vendor-Specific Attributes

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating vendor-specific attributes (VSAs) between the network access server and the RADIUS server. The IETF uses attribute 26. VSAs allow vendors to support their own extended attributes that are not suitable for general use. The Cisco RADIUS implementation supports one vendor-specific option using the format recommended in the specification. The Cisco vendor ID is 9, and the supported option is vendor type 1, which is named cisco-av-pair. The value is a string with the following format:

```
protocol : attribute separator value *
```

The protocol is a Cisco attribute for a particular type of authorization, the separator is an equal sign (=) for mandatory attributes, and an asterisk (*) indicates optional attributes.

When you use RADIUS servers for authentication on a Cisco Nexus device, the RADIUS protocol directs the RADIUS server to return user attributes, such as authorization information, with authentication results. This authorization information is specified through VSAs.

The following VSA protocol options are supported by the Cisco Nexus device:

- Shell— Used in access-accept packets to provide user profile information.
- Accounting— Used in accounting-request packets. If a value contains any white spaces, you should enclose the value within double quotation marks.

The Cisco Nexus device supports the following attributes:

- **roles**—Lists all the roles to which the user belongs. The value field is a string that lists the role names delimited by white spaces.
- **accountinginfo**—Stores accounting information in addition to the attributes covered by a standard RADIUS accounting protocol. This attribute is sent only in the VSA portion of the Account-Request frames from the RADIUS client on the switch. It can be used only with the accounting protocol data units (PDUs).

Prerequisites for RADIUS

RADIUS has the following prerequisites:

- You must obtain IPv4 addresses or hostnames for the RADIUS servers.
- You must obtain preshared keys from the RADIUS servers.
- Ensure that the Cisco Nexus device is configured as a RADIUS client of the AAA servers.

Guidelines and Limitations for RADIUS

RADIUS has the following configuration guidelines and limitations:

- You can configure a maximum of 64 RADIUS servers on the device.

Guidelines and Limitations for RadSec

RadSec has the following guidelines and limitations:

- Beginning with Cisco NX-OS Release 10.3(1)F, the RADIUS Secure (RadSec) support is provided on Cisco Nexus switches to secure the communication between RADIUS/TCP peers at the transport layer.
- RadSec must be enabled/disabled at the switch level, as the combination of servers having different transport protocols (i.e. UDP and TCP-with-TLS) is not possible.
- **radius-server directed-request** command is not supported along with the RadSec feature.
- **test aaa server radius** command is not supported for the RadSec servers, only **test aaa group** command is supported with the RadSec.
- Dot1x is not officially supported with RadSec.
- RADIUS server monitoring is not supported along with the RadSec servers.
- RADIUS server re-transmit and timeout are applicable to UDP based RADIUS mode and not supported for RadSec servers.
- Beginning with Cisco NX-OS Release 10.4(3)F, TLS version 1.3 and 1.2 is supported on Cisco Nexus switches. TLS v1.1 is deprecated.

Configuring RADIUS Servers

This section describes how to configure RADIUS servers.

SUMMARY STEPS

1. Establish the RADIUS server connections to the Cisco Nexus device.
2. Configure the preshared secret keys for the RADIUS servers.
3. If needed, configure RADIUS server groups with subsets of the RADIUS servers for AAA authentication methods.
4. If needed, configure any of the following optional parameters:
5. If needed, configure periodic RADIUS server monitoring.

DETAILED STEPS

-
- Step 1** Establish the RADIUS server connections to the Cisco Nexus device.
See [Configuring RADIUS Server Hosts, on page 37](#).
- Step 2** Configure the preshared secret keys for the RADIUS servers.
See [Configuring RADIUS Global Preshared Keys, on page 38](#).
- Step 3** If needed, configure RADIUS server groups with subsets of the RADIUS servers for AAA authentication methods.
See [Allowing Users to Specify a RADIUS Server at Login, on page 46](#) and [Configuring Accounting and Authentication Attributes for RADIUS Servers, on page 47](#).
- Step 4** If needed, configure any of the following optional parameters:
- Dead-time interval. See [Configuring the Dead-Time Interval, on page 50](#).
 - Allow specification of a RADIUS server at login. See [Allowing Users to Specify a RADIUS Server at Login, on page 46](#)
 - Transmission retry count and timeout interval. See [Configuring the Global RADIUS Transmission Retry Count and Timeout Interval, on page 46](#).
 - Accounting and authentication attributes. See [Configuring Accounting and Authentication Attributes for RADIUS Servers, on page 47](#).
- Step 5** If needed, configure periodic RADIUS server monitoring.
See [Configuring Periodic RADIUS Server Monitoring, on page 49](#).
-

Configuring RADIUS Server Hosts

Configure the IPv4 address or the hostname for each RADIUS server that you want to use for authentication. All RADIUS server hosts are added to the default RADIUS server group. You can configure up to 64 RADIUS servers.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server host** {*ipv4-address* | *host-name*}
3. switch(config)# **exit**
4. (Optional) switch# **show radius-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> }	Specifies the IPv4 address or hostname for a RADIUS server.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show radius-server	Displays the RADIUS server configuration.
Step 5	(Optional) switch# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

The following example shows how to configure host 10.10.1.1 as a RADIUS server:

```
switch# configure terminal
switch(config)# radius-server host 10.10.1.1
switch(config)# exit
switch# copy running-config startup-config
```

Configuring RADIUS Global Preshared Keys

You can configure preshared keys at the global level for all servers used by the Cisco Nexus device. A preshared key is a shared secret text string between the switch and the RADIUS server hosts.

Before you begin

Obtain the preshared key values for the remote RADIUS servers

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server key** [0 | 7] *key-value*
3. switch(config)# **exit**
4. (Optional) switch# **show radius-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server key [0 7] key-value	Specifies a preshared key for all RADIUS servers. You can specify a clear text (0) or encrypted (7) preshared key. The default format is clear text. The maximum length is 63 characters. By default, no preshared key is configured.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show radius-server	Displays the RADIUS server configuration. Note The preshared keys are saved in encrypted form in the running configuration. Use the show running-config command to display the encrypted preshared keys.
Step 5	(Optional) switch# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to configure preshared keys at the global level for all servers used by the device:

```
switch# configure terminal
switch(config)# radius-server key 0 QsEfThUkO
switch(config)# exit
switch# copy running-config startup-config
```

Configuring RADIUS Server Preshared Keys

A preshared key is a shared secret text string between the Cisco Nexus device and the RADIUS server host.

Before you begin

Obtain the preshared key values for the remote RADIUS servers.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server host {ipv4-address | host-name} key [0 | 7] key-value**
3. switch(config)# **exit**
4. (Optional) switch# **show radius-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> } key [0 7] <i>key-value</i>	Specifies a preshared key for a specific RADIUS server. You can specify a clear text (0) or encrypted (7) preshared key. The default format is clear text. The maximum length is 63 characters. This preshared key is used instead of the global preshared key.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show radius-server	Displays the RADIUS server configuration. Note The preshared keys are saved in encrypted form in the running configuration. Use the show running-config command to display the encrypted preshared keys.
Step 5	(Optional) switch# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to configure RADIUS preshared keys:

```
switch# configure terminal
switch(config)# radius-server host 10.10.1.1 key 0 P1IjUhYg
switch(config)# exit
switch# show radius-server
switch# copy running-config startup-config
```

Configuring RadSec

RadSec is a protocol for transporting RADIUS datagrams over TLS.

This procedure describes how to enable/disable the RadSec on a switch.

Before you begin

- Ensure that the client identity certificate and CA certificate of the server are installed on the switch.
- Ensure that the subject name in the server certificate is matching with the server host name/IP address that is configured on the switch.
- Before configuring AAA authentication and accounting to use RadSec servers, use **test aaa group** command and ensure RadSec authentication is success.

- Configure TLS idle-timeout to maximum value on RadSec server to avoid frequent TLS sessions retries from switch.

SUMMARY STEPS

1. **configure terminal**
2. **radius-server secure tls**
3. **radius-server host t {ipv4-address | ipv6-address | hostname} key {key} auth-port 2083 acct-port 2083 authentication accounting**
4. **radius-server host {ipv4-address | ipv6-address | hostname} tls client-trustpoint trustpoint**
5. **radius-server host {ipv4-address | ipv6-address | hostname} tls idle-timeout value**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# <code>configure terminal</code>	Enters configuration mode.
Step 2	radius-server secure tls Example: switch# <code>radius-server secure tls</code>	Enables the RadSec at global level. Note This CLI will not change or affect the port numbers that is used for RadSec.
Step 3	radius-server host t {ipv4-address ipv6-address hostname} key {key} auth-port 2083 acct-port 2083 authentication accounting Example: switch# <code>radius-server host 10.105.222.161 key radsec auth-port 2083 acct-port 2083 authentication accounting</code>	Configures the RadSec server with shared secret key along with the authentication and accounting ports. Note For server, the default RadSec port for authentication and accounting is "2083" and the key is "radsec". For switch, there is no default configuration for RadSec port and key, please add this configuration explicitly as defined on server.
Step 4	radius-server host {ipv4-address ipv6-address hostname} tls client-trustpoint trustpoint Example: switch# <code>radius-server host 10.105.222.161 tls client-trustpoint rad1</code>	Configures the TLS client trustpoint where the client identity certificate is installed.
Step 5	radius-server host {ipv4-address ipv6-address hostname} tls idle-timeout value Example: switch# <code>radius-server host 10.105.222.161 tls idle-timeout 80</code>	Configures the TLS idle-timeout. The default value is 600 seconds. Note If there are no transactions from the RadSec client, server can close the connection based on its timeout value. The TLS idle-timeout on the client is not supported in this release. Client does not close connections on its own.



Note When remote user logs-in, you can notice delay in login for approximately 20 seconds i.e when TLS session establishment is happening for the first time between switch and RadSec server, Once TLS sessions are up no delay will be seen for consecutive remote log-ins.



Note When a RadSec client is facing certificate related issues such as no certificate or invalid certificates are being exchanged with the server, you may experience delay in `show run` commands.

About RadSec with DTLS

From Cisco NX-OS Release 10.4(1)F, RadSec with DTLS protocol is introduced. This protocol is for transporting RADIUS datagrams over a secure channel using UDP.

RadSec with DTLS provides secure communication between RADIUS peers at the transport layer. This protocol helps secure RADIUS packets transfer through different administrative domains and suspicious, and unsafe networks.

Configuring RadSec with DTLS

Before you begin

- Ensure that you create client identity certificate with subject and alternative name same as the IP address/DNS hostname of the switch. Install the client identity certificate on the switch using a trustpoint.
- Enusre that the server certificate of ISE server used for DTLS/RADIUS is installed on the switch.
- Make sure that the CA certificate used to sign client identity certificate is installed in trusted certificate store of ISE server.
- Ensure that the subject name in the server certificate is same as the server hostname/IP address that is configured on the switch.
- Before configuring AAA authentication and accounting groups to use RadSec servers, check with `test aaa group` command and ensure that the RadSec authentication is successful.
- You must enable RadSec with DTLS protocol at the switch level.
- Configuring combination of RadSec servers to use different transports protocols such as DTLS and TLS is not supported. You can configure one protocol at an instant.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters configuration mode.

	Command or Action	Purpose
Step 2	radius-server secure dtls Example: <pre>switch(config)# radius-server secure dtls</pre>	Enables the RadSec with DTLS protocol on the switch.
Step 3	radius-server host {ipv4-address ipv6-address hostname} key {radius/dtls} auth-port 2083 acct-port 2083 authentication accounting Example: <pre>switch(config)# radius-server host 10.105.222.161 key radius/dtls auth-port 2083 acct-port 2083 authentication accounting</pre>	Configures the RadSec server with shared secret key along with the authentication and accounting ports. Note The default destination DTLS port for authentication and accounting is UDP/2083 . There is no default server key for DTLS as per RFC. Ensure that you add this configuration explicitly as defined on server. The ISE server must be pre-set with the "radius/dtls" key at that instant. Check and add the key on the Nexus switch while configuring DTLS with an ISE server.
Step 4	radius-server host {ipv4-address ipv6-address hostname} dtls client-trustpoint trustpoint Example: <pre>switch(config)# radius-server host 10.105.222.161 dtls client-trustpoint radl</pre>	Configures the DTLS client-trustpoint parameter with a trustpoint where the switch identity certificate is installed. The <i>radl</i> is a trustpoint on the switch which must have the client identity certificate.
Step 5	radius-server host {ipv4-address ipv6-address hostname} dtls idle-timeout value Example: <pre>switch# radius-server host 10.105.222.161 dtls idle-timeout 80</pre>	Configures the DTLS idle-timeout. The default value is 600 seconds. Note If there are no transactions from the RadSec client, server can close the connection as per defined timeout value. The DTLS idle-timeout on the client is not supported in this release. Client does not close connections on its own.



Note When remote user logs-in, you can notice delay in login for approximately 20 seconds i.e when TLS session establishment is happening for the first time between switch and RadSec server, Once TLS sessions are up no delay will be seen for consecutive remote log-ins.



Note When a RadSec client is facing certificate related issues such as no certificate or invalid certificates are being exchanged with the server, we may experience delay in `show run` commands.

Configuring RADIUS Server Groups

You can specify one or more remote AAA servers for authentication using server groups. All members of a group must belong to the RADIUS protocol. The servers are tried in the same order in which you configure them.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch (config)# **aaa group server radius** *group-name*
3. switch (config-radius)# **server** {*ipv4-address* |*server-name*}
4. (Optional) switch (config-radius)# **deadtime** *minutes*
5. (Optional) switch(config-radius)# **source-interface** *interface*
6. switch(config-radius)# **exit**
7. (Optional) switch(config)# **show radius-server group** [*group-name*]
8. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch (config)# aaa group server radius <i>group-name</i>	Creates a RADIUS server group and enters the RADIUS server group configuration submode for that group. The <i>group-name</i> argument is a case-sensitive, alphanumeric string with a maximum of 127 characters.
Step 3	switch (config-radius)# server { <i>ipv4-address</i> <i>server-name</i> }	Configures the RADIUS server as a member of the RADIUS server group. If the specified RADIUS server is not found, configure it using the radius-server host command and retry this command.
Step 4	(Optional) switch (config-radius)# deadtime <i>minutes</i>	Configures the monitoring dead time. The default is 0 minutes. The range is from 1 through 1440. Note If the dead-time interval for a RADIUS server group is greater than zero (0), that value takes precedence over the global dead-time value.
Step 5	(Optional) switch(config-radius)# source-interface <i>interface</i>	Assigns a source interface for a specific RADIUS server group. The supported interface types are management and VLAN. Note Use the source-interface command to override the global source interface assigned by the ip radius source-interface command.
Step 6	switch(config-radius)# exit	Exits configuration mode.
Step 7	(Optional) switch(config)# show radius-server group [<i>group-name</i>]	Displays the RADIUS server group configuration.
Step 8	(Optional) switch(config)# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

The following example shows how to configure a RADIUS server group:

```

switch# configure terminal
switch (config)# aaa group server radius RadServer
switch (config-radius)# server 10.10.1.1
switch (config-radius)# deadtime 30
switch (config-radius)# use-vrf management
switch (config-radius)# exit
switch (config)# show radius-server group
switch (config)# copy running-config startup-config

```

What to do next

Apply the RADIUS server groups to an AAA service.

Configuring the Global Source Interface for RADIUS Server Groups

You can configure a global source interface for RADIUS server groups to use when accessing RADIUS servers. You can also configure a different source interface for a specific RADIUS server group.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **ip radius source-interface** *interface*
3. switch(config)# **exit**
4. (Optional) switch# **show radius-server**
5. (Optional) switch# **copy running-config startup config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# ip radius source-interface <i>interface</i>	Configures the global source interface for all RADIUS server groups configured on the device. The source interface can be the management or the VLAN interface.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show radius-server	Displays the RADIUS server configuration information.
Step 5	(Optional) switch# copy running-config startup config	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the mgmt 0 interface as the global source interface for RADIUS server groups:

```
switch# configure terminal
switch(config)# ip radius source-interface mgmt 0
switch(config)# exit
switch# copy running-config startup-config
```

Allowing Users to Specify a RADIUS Server at Login

You can allow users to specify a RADIUS server at login.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server directed-request**
3. switch(config)# **exit**
4. (Optional) switch# **show radius-server directed-request**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server directed-request	Allows users to specify a RADIUS server to send the authentication request when logging in. The default is disabled.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show radius-server directed-request	Displays the directed request configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

This example shows how to allow users to select a RADIUS server when logging in to a network:

```
switch# configure terminal
switch(config)# radius-server directed-request
switch# exit
switch# copy running-config startup-config
```

Configuring the Global RADIUS Transmission Retry Count and Timeout Interval

You can configure a global retransmission retry count and timeout interval for all RADIUS servers. By default, a switch retries transmission to a RADIUS server only once before reverting to local authentication. You can increase this number up to a maximum of five retries per server. The timeout interval determines how long the Cisco Nexus device waits for responses from RADIUS servers before declaring a timeout failure.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server retransmit** *count*
3. switch(config)# **radius-server timeout** *seconds*
4. switch(config)# **exit**
5. (Optional) switch# **show radius-server**
6. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server retransmit <i>count</i>	Specifies the retransmission count for all RADIUS servers. The default retransmission count is 1 and the range is from 0 to 5.
Step 3	switch(config)# radius-server timeout <i>seconds</i>	Specifies the transmission timeout interval for RADIUS servers. The default timeout interval is 5 seconds and the range is from 1 to 60 seconds.
Step 4	switch(config)# exit	Exits global configuration mode.
Step 5	(Optional) switch# show radius-server	Displays the RADIUS server configuration.
Step 6	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

This example shows how to set the retry count to 3 and the transmission timeout interval to 5 seconds for RADIUS servers:

```
switch# configure terminal
switch(config)# radius-server retransmit 3
switch(config)# radius-server timeout 5
switch(config)# exit
switch# copy running-config startup-config
```

Configuring Accounting and Authentication Attributes for RADIUS Servers

You can specify that a RADIUS server is to be used only for accounting purposes or only for authentication purposes. By default, RADIUS servers are used for both accounting and authentication. You can also specify the destination UDP port numbers where RADIUS accounting and authentication messages should be sent.

SUMMARY STEPS

1. switch# **configure terminal**
2. (Optional) switch(config)# **radius-server host** *{ipv4-address || host-name}* **acct-port** *udp-port*

3. (Optional) switch(config)# **radius-server host** {*ipv4-address* | *host-name*} **accounting**
4. (Optional) switch(config)# **radius-server host** {*ipv4-address* | *host-name*} **auth-port** *udp-port*
5. (Optional) switch(config)# **radius-server host** {*ipv4-address* | *host-name*} **authentication**
6. switch(config)# **exit**
7. (Optional) switch(config)# **show radius-server**
8. switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	(Optional) switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> } acct-port <i>udp-port</i>	Specifies a UDP port to use for RADIUS accounting messages. The default UDP port is 1812. The range is from 0 to 65535.
Step 3	(Optional) switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> } accounting	Specifies that the specified RADIUS server is to be used only for accounting purposes. The default is both accounting and authentication.
Step 4	(Optional) switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> } auth-port <i>udp-port</i>	Specifies a UDP port to use for RADIUS authentication messages. The default UDP port is 1812. The range is from 0 to 65535.
Step 5	(Optional) switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> } authentication	Specifies that the specified RADIUS server only be used for authentication purposes. The default is both accounting and authentication.
Step 6	switch(config)# exit	Exits configuration mode.
Step 7	(Optional) switch(config)# show radius-server	Displays the RADIUS server configuration.
Step 8	switch(config)# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to configure accounting and authentication attributes for a RADIUS server:

```
switch# configure terminal
switch(config)# radius-server host 10.10.1.1 acct-port 2004
switch(config)# radius-server host 10.10.1.1 accounting
switch(config)# radius-server host 10.10.2.2 auth-port 2005
switch(config)# radius-server host 10.10.2.2 authentication
switch # exit
switch # copy running-config startup-config
switch #
```

Configuring Periodic RADIUS Server Monitoring

You can monitor the availability of RADIUS servers. These parameters include the username and password to use for the server and an idle timer. The idle timer specifies the interval during which a RADIUS server receives no requests before the switch sends out a test packet. You can configure this option to test servers periodically.



Note For security reasons, we recommend that you do not configure a test username that is the same as an existing user in the RADIUS database.

The test idle timer specifies the interval during which a RADIUS server receives no requests before the switch sends out a test packet.

The default idle timer value is 0 minutes. When the idle time interval is 0 minutes, the switch does not perform periodic RADIUS server monitoring.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server host** {*ipv4-address* | *host-name*} **test** {*idle-time minutes* | **password** *password* [*idle-time minutes*] | **username** *name* [**password** *password* [*idle-time minutes*]]}
3. switch(config)# **radius-server** **deadtime** *minutes*
4. switch(config)# **exit**
5. (Optional) switch# **show radius-server**
6. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server host { <i>ipv4-address</i> <i>host-name</i> } test { <i>idle-time minutes</i> password <i>password</i> [<i>idle-time minutes</i>] username <i>name</i> [password <i>password</i> [<i>idle-time minutes</i>]]}	Specifies parameters for server monitoring. The default username is test and the default password is test. The default value for the idle timer is 0 minutes. The valid range is from 0 to 1440 minutes. Note For periodic RADIUS server monitoring, you must set the idle timer to a value greater than 0.
Step 3	switch(config)# radius-server deadtime <i>minutes</i>	Specifies the number of minutes before the switch checks a RADIUS server that was previously unresponsive. The default value is 0 minutes. The valid range is 1 to 1440 minutes.
Step 4	switch(config)# exit	Exits configuration mode.
Step 5	(Optional) switch# show radius-server	Displays the RADIUS server configuration.

	Command or Action	Purpose
Step 6	(Optional) switch# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to configure RADIUS server host 10.10.1.1 with a username (user1) and password (Ur2Gd2BH) and with an idle timer of 3 minutes and a deadtime of 5 minutes:

```
switch# configure terminal
switch(config)# radius-server host 10.10.1.1 test username user1 password Ur2Gd2BH idle-time
3
switch(config)# radius-server deadtime 5
switch(config)# exit
switch# copy running-config startup-config
```

Configuring the Dead-Time Interval

You can configure the dead-time interval for all RADIUS servers. The dead-time interval specifies the time that the Cisco Nexus device waits after declaring a RADIUS server is dead, before sending out a test packet to determine if the server is now alive. The default value is 0 minutes.



Note When the dead-time interval is 0 minutes, RADIUS servers are not marked as dead even if they are not responding. You can configure the dead-time interval for a RADIUS server group. See [Configuring RADIUS Server Groups, on page 43](#).

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **radius-server deadtime**
3. switch(config)# **exit**
4. (Optional) switch# **show radius-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# radius-server deadtime	Configures the dead-time interval. The default value is 0 minutes. The range is from 1 to 1440 minutes.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show radius-server	Displays the RADIUS server configuration.

	Command or Action	Purpose
Step 5	(Optional) <code>switch# copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

Example

This example shows how to configure a deadtime of 5 minutes for a radius server:

```
switch# configure terminal
switch(config)# radius-server deadtime 5
switch(config)# exit
switch# copy running-config startup-config
```

Manually Monitoring RADIUS Servers or Groups

SUMMARY STEPS

1. `switch# test aaa server radius {ipv4-address | server-name} [vrf vrf-name] username password test aaa server radius {ipv4-address | server-name} [vrf vrf-name] username password`
2. `switch# test aaa group group-name username password`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<code>switch# test aaa server radius {ipv4-address server-name} [vrf vrf-name] username password test aaa server radius {ipv4-address server-name} [vrf vrf-name] username password</code>	Sends a test message to a RADIUS server to confirm availability.
Step 2	<code>switch# test aaa group group-name username password</code>	Sends a test message to a RADIUS server group to confirm availability.

Example

This example shows how to send a test message to the RADIUS server and server group to confirm availability:

```
switch# test aaa server radius 10.10.1.1 user 1 Ur2Gd2BH
switch# test aaa group RadGroup user2 As3He3CI
```

Verifying the RADIUS Configuration

To display AAA information, perform one of the following tasks:

Command	Purpose
show running-config radius [all]	Displays the RADIUS configuration in the running configuration.
show startup-config radius	Displays the RADIUS configuration in the startup configuration.
show radius-server [<i>server-name</i> <i>ipv4-address</i> <i>ipv6-address</i>] [directed-request groups sorted statistics]	Displays all configured RADIUS server parameters.

Displaying RADIUS Server Statistics

SUMMARY STEPS

1. switch# **show radius-server statistics** {*hostname* | *ipv4-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show radius-server statistics { <i>hostname</i> <i>ipv4-address</i> }	Displays the RADIUS statistics.

Clearing RADIUS Server Statistics

You can display the statistics that the Cisco NX-OS device maintains for RADIUS server activity.

Before you begin

Configure RADIUS servers on the Cisco NX-OS device.

SUMMARY STEPS

1. (Optional) switch# **show radius-server statistics** {*hostname* | *ipv4-address*}
2. switch# **clear radius-server statistics** {*hostname* | *ipv4-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	(Optional) switch# show radius-server statistics { <i>hostname</i> <i>ipv4-address</i> }	Displays the RADIUS server statistics on the Cisco NX-OS device.
Step 2	switch# clear radius-server statistics { <i>hostname</i> <i>ipv4-address</i> }	Clears the RADIUS server statistics.

Configuration Examples for RADIUS

The following example shows how to configure RADIUS:

```
switch# configure terminal
switch(config)# radius-server key 7 "ToIkLhPpG"
switch(config)# radius-server host 10.10.1.1 key 7 "ShMoMhTl" authentication accounting
switch(config)# aaa group server radius RadServer
switch(config-radius)# server 10.10.1.1
switch(config-radius)# exit
switch(config-radius)# use-vrf management
```

Default Settings for RADIUS

The following table lists the default settings for RADIUS parameters.

Table 6: Default RADIUS Parameters

Parameters	Default
Server roles	Authentication and accounting
Dead timer interval	0 minutes
Retransmission count	1
Retransmission timer interval	5 seconds
Idle timer interval	0 minutes
Periodic server monitoring username	test
Periodic server monitoring password	test

Feature History for RADIUS

Table 7: Feature History for RADIUS

Feature Name	Releases	Feature Information
RADIUS	5.0(3)U1(1)	This feature was introduced.
IPv6	5.0(3)U3(1)	IPv6 support was introduced.



CHAPTER 5

Configuring TACACS+

This chapter contains the following sections:

- [Information About Configuring TACACS+, on page 55](#)
- [Prerequisites for TACACS+, on page 57](#)
- [Guidelines and Limitations for TACACS+, on page 58](#)
- [Configuring TACACS+, on page 58](#)

Information About Configuring TACACS+

The Terminal Access Controller Access Control System Plus (TACACS+) security protocol provides centralized validation of users attempting to gain access to a Cisco Nexus device. TACACS+ services are maintained in a database on a TACACS+ daemon typically running on a UNIX or Windows NT workstation. You must have access to and must configure a TACACS+ server before the configured TACACS+ features on your Cisco Nexus device are available.

TACACS+ provides for separate 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 is associated with 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 TACACS+ client/server protocol uses TCP (TCP port 49) for transport requirements. The Cisco Nexus device provides centralized authentication using the TACACS+ protocol.

Beginning with Cisco NX-OS release 10.4(3)F, SSH based authorization of X.509 certificates using TACACS+ server can be done using the **aaa authorization ssh-certificate default group** command on the Cisco Nexus 3600 Series platform switches. For configuration details, see [Configuring X.509 Certificate-Based SSH Authorization Using TACACS Server, on page 67](#)

TACACS+ Advantages

TACACS+ has the following advantages over RADIUS authentication:

- Provides independent AAA facilities. For example, the Cisco Nexus device can authorize access without authenticating.
- Uses the TCP transport protocol to send data between the AAA client and server, making reliable transfers with a connection-oriented protocol.

- Encrypts the entire protocol payload between the switch and the AAA server to ensure higher data confidentiality. The RADIUS protocol only encrypts passwords.

User Login with TACACS+

When a user attempts a Password Authentication Protocol (PAP) login to a Cisco Nexus device using TACACS+, the following actions occur:

1. When the Cisco Nexus device establishes a connection, it contacts the TACACS+ daemon to obtain the username and password.



Note TACACS+ allows an arbitrary conversation between the daemon and the user until the daemon receives enough information to authenticate the user. This action is done by prompting for a username and password combination, but may include prompts for other items, such as the user's mother's maiden name.

2. The Cisco Nexus device receives one of the following responses from the TACACS+ daemon:
 - **ACCEPT**—User authentication succeeds and service begins. If the Cisco Nexus device requires user authorization, authorization begins.
 - **REJECT**—User authentication failed. The TACACS+ daemon either denies further access to the user or prompts the user to retry the login sequence.
 - **ERROR**—An error occurred at some time during authentication either at the daemon or in the network connection between the daemon and the Cisco Nexus device. If the Cisco Nexus device receives an **ERROR** response, the switch tries to use an alternative method for authenticating the user.

The user also undergoes an additional authorization phase, if authorization has been enabled on the Cisco Nexus device. Users must first successfully complete TACACS+ authentication before proceeding to TACACS+ authorization.

3. If TACACS+ authorization is required, the Cisco Nexus device again contacts the TACACS+ daemon and it returns an **ACCEPT** or **REJECT** authorization response. An **ACCEPT** response contains attributes that are used to direct the **EXEC** or **NETWORK** session for that user and determines the services that the user can access.

Services include the following:

- Telnet, rlogin, Point-to-Point Protocol (PPP), Serial Line Internet Protocol (SLIP), or EXEC services
- Connection parameters, including the host or client IP address (IPv4), access list, and user timeouts

Default TACACS+ Server Encryption Type and Preshared Key

You must configure the TACACS+ that is preshared key to authenticate the switch to the TACACS+ server. A preshared key is a secret text string shared between the Cisco Nexus device and the TACACS+ server host. The length of the key is restricted to 63 characters and can include any printable ASCII characters (white spaces are not allowed). You can configure a global preshared secret key for all TACACS+ server configurations on the Cisco Nexus device to use.

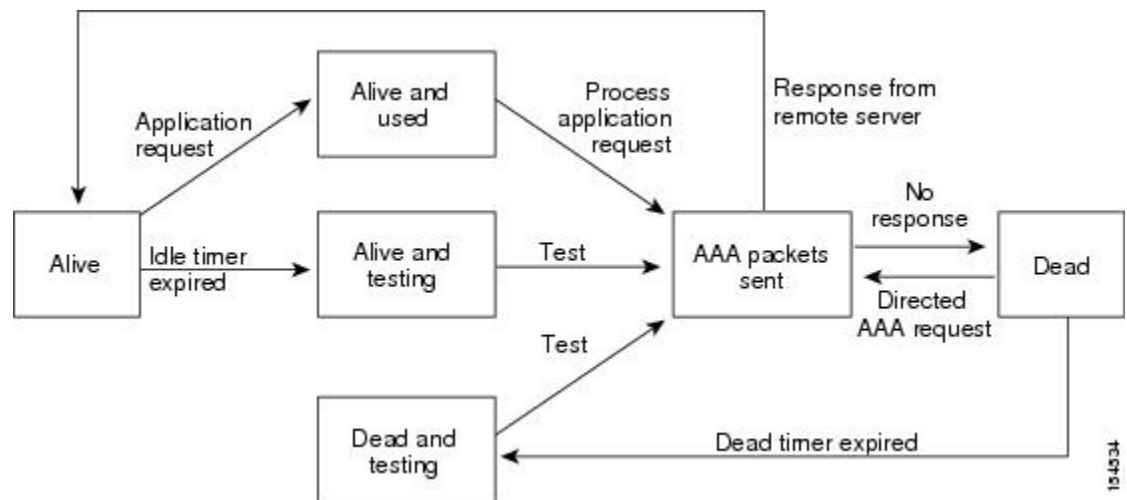
You can override the global preshared key assignment by using the **key** option when configuring an individual TACACS+ server.

TACACS+ Server Monitoring

An unresponsive TACACS+ server can delay the processing of AAA requests. A Cisco Nexus device can periodically monitor an TACACS+ server to check whether it is responding (or alive) to save time in processing AAA requests. The Cisco Nexus device marks unresponsive TACACS+ servers as dead and does not send AAA requests to any dead TACACS+ servers. The Cisco Nexus device periodically monitors dead TACACS+ servers and brings them to the alive state once they are responding. This process verifies that a TACACS+ server is in a working state before real AAA requests are sent to the server. Whenever an TACACS+ server changes to the dead or alive state, a Simple Network Management Protocol (SNMP) trap is generated and the Cisco Nexus device displays an error message that a failure is taking place before it can impact performance.

The following figure shows the different TACACS+ server states:

Figure 3: TACACS+ Server States



Note The monitoring interval for alive servers and dead servers are different and can be configured by the user. The TACACS+ server monitoring is performed by sending a test authentication request to the TACACS+ server.

Prerequisites for TACACS+

TACACS+ has the following prerequisites:

- You must obtain the IPv4 or IPv6 addresses or hostnames for the TACACS+ servers.
- You must obtain the preshared keys from the TACACS+ servers, if any.
- Ensure that the Cisco Nexus device is configured as a TACACS+ client of the AAA servers.

Guidelines and Limitations for TACACS+

TACACS+ has the following configuration guidelines and limitations:

- You can configure a maximum of 64 TACACS+ servers on the Cisco Nexus device.

Configuring TACACS+

TACACS+ Server Configuration Process

This section describes how to configure TACACS+ servers.

SUMMARY STEPS

1. Enable TACACS+.
2. Establish the TACACS+ server connections to the Cisco Nexus device.
3. Configure the preshared secret keys for the TACACS+ servers.
4. If needed, configure TACACS+ server groups with subsets of the TACACS+ servers for AAA authentication methods.
5. If needed, configure periodic TACACS+ server monitoring.

DETAILED STEPS

-
- | | |
|---------------|---|
| Step 1 | Enable TACACS+.
See Enabling TACACS+ , on page 58 . |
| Step 2 | Establish the TACACS+ server connections to the Cisco Nexus device.
Configuring TACACS+ Server Hosts, on page 59 |
| Step 3 | Configure the preshared secret keys for the TACACS+ servers.
Configuring TACACS+ Global Preshared Keys, on page 60 |
| Step 4 | If needed, configure TACACS+ server groups with subsets of the TACACS+ servers for AAA authentication methods.
Configuring TACACS+ Server Groups, on page 61 |
| Step 5 | If needed, configure periodic TACACS+ server monitoring.
Configuring Periodic TACACS+ Server Monitoring, on page 65 |
-

Enabling TACACS+

Although by default, the TACACS+ feature is disabled on the Cisco Nexus device. You can enable the TACACS+ feature to access the configuration and verification commands for authentication.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **feature tacacs+**
3. switch(config)# **exit**
4. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# feature tacacs+	Enables TACACS+.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring TACACS+ Server Hosts

To access a remote TACACS+ server, you must configure the IPv4 or IPv6 address or the hostname for the TACACS+ server on the Cisco Nexus device. All TACACS+ server hosts are added to the default TACACS+ server group. You can configure up to 64 TACACS+ servers.

If a preshared key is not configured for a configured TACACS+ server, a warning message is issued if a global key is not configured. If a TACACS+ server key is not configured, the global key (if configured) is used for that server.

(See [Configuring TACACS+ Global Preshared Keys](#) and [Configuring TACACS+ Server Preshared Keys](#) sections for more details.)

Before you configure TACACS+ server hosts, you should do the following:

- Enable TACACS+. See [Enabling TACACS+ , on page 58](#) for more information.
- Obtain the IPv4 or IPv6 addresses or the hostnames for the remote TACACS+ servers.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **tacacs-server host** {*ipv4-address* | *ipv6-address* | *host-name*}
3. switch(config)# **tacacs-server host** {*ipv4-address* | *host-name*}
4. switch(config)# **exit**
5. (Optional) switch# **show tacacs-server**
6. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# tacacs-server host { <i>ipv4-address</i> <i>ipv6-address</i> <i>host-name</i> }	Specifies the IPv4 or IPv6 address or hostname for a TACACS+ server.
Step 3	switch(config)# tacacs-server host { <i>ipv4-address</i> <i>host-name</i> }	Specifies the IPv4 address or hostname for a TACACS+ server.
Step 4	switch(config)# exit	Exits configuration mode.
Step 5	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration.
Step 6	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

You can delete a TACACS+ server host from a server group.

Configuring TACACS+ Global Preshared Keys

You can configure preshared keys at the global level for all servers used by the Cisco Nexus device. A preshared key is a shared secret text string between the Cisco Nexus device and the TACACS+ server hosts.

Before you configure preshared keys, you should do the following:

- Enable TACACS+.
- Obtain the preshared key values for the remote TACACS+ servers.

SUMMARY STEPS

1. switch# **configure terminal**
2. **tacacs-server key** [0 | 6 | 7] *key-value*
3. switch(config)# **exit**
4. (Optional) switch# **show tacacs-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	tacacs-server key [0 6 7] <i>key-value</i> Example: switch(config)# tacacs-server key 0 QsEfThUkO Example: switch(config)# tacacs-server key 7 "fewhg"	Specifies a TACACS+ key for all TACACS+ server. You can specify that the <i>key-value</i> is in clear text format (0), is type-6 encrypted (6), or is type-7 encrypted (7). The Cisco NX-OS software encrypts a clear text key before saving it to the running configuration. The default format is clear text. The maximum length is 63 characters. By default, no secret key is configured.

	Command or Action	Purpose
		Note If you already configured a shared secret using the <code>generate type7 encrypted secret</code> command, enter it in quotation marks, as shown in the second example.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration. Note The preshared keys are saved in encrypted form in the running configuration. Use the show running-config command to display the encrypted preshared keys.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to configure global preshared keys:

```
switch# configure terminal
switch(config)# tacacs-server key 0 QsEfThUkO
switch(config)# exit
switch# show tacacs-server
switch# copy running-config startup-config
```

Configuring TACACS+ Server Groups

You can specify one or more remote AAA servers to authenticate users using server groups. All members of a group must belong to the TACACS+ protocol. The servers are tried in the same order in which you configure them.

You can configure these server groups at any time but they only take effect when you apply them to an AAA service.

Before you begin

You must use the **feature tacacs+** command to enable TACACS+ before you configure TACACS+.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aaa group server tacacs+ group-name**
3. (Optional) switch(config-tacacs+)# **deadtime minutes**
4. (Optional) switch(config-tacacs+)# **source-interface interface**
5. switch(config-tacacs+)# **exit**
6. (Optional) switch(config)# **show tacacs-server groups**
7. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aaa group server tacacs+ group-name	Creates a TACACS+ server group and enters the TACACS+ server group configuration mode for that group.
Step 3	(Optional) switch(config-tacacs+)# deadtime minutes	Configures the monitoring dead time. The default is 0 minutes. The range is from 0 through 1440. Note If the dead-time interval for a TACACS+ server group is greater than zero (0), that value takes precedence over the global dead-time value.
Step 4	(Optional) switch(config-tacacs+)# source-interface interface	Assigns a source interface for a specific TACACS+ server group. The supported interface types are management and VLAN. Note Use the source-interface command to override the global source interface assigned by the ip tacacs source-interface command.
Step 5	switch(config-tacacs+)# exit	Exits configuration mode.
Step 6	(Optional) switch(config)# show tacacs-server groups	Displays the TACACS+ server group configuration.
Step 7	(Optional) switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to configure a TACACS+ server group:

```
switch# configure terminal
switch(config)# aaa group server tacacs+ TacServer
switch(config-tacacs+)# server 10.10.2.2
switch(config-tacacs+)# deadtime 30
switch(config-tacacs+)# exit
switch(config)# show tacacs-server groups
switch(config)# copy running-config startup-config
```

Configuring the Global Source Interface for TACACS+ Server Groups

You can configure a global source interface for TACACS+ server groups to use when accessing TACACS+ servers. You can also configure a different source interface for a specific TACACS+ server group.

SUMMARY STEPS

1. **configure terminal**
2. **ip tacacs source-interface** *interface*
3. **exit**
4. (Optional) **show tacacs-server**
5. (Optional) **copy running-config startup config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal	Enters global configuration mode.
Step 2	ip tacacs source-interface <i>interface</i> Example: switch(config)# ip tacacs source-interface mgmt 0	Configures the global source interface for all TACACS+ server groups configured on the device. The source interface can be the management or the VLAN interface.
Step 3	exit Example: switch(config)# exit switch#	Exits configuration mode.
Step 4	(Optional) show tacacs-server Example: switch# show tacacs-server	Displays the TACACS+ server configuration information.
Step 5	(Optional) copy running-config startup config Example: switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring the Global TACACS+ Timeout Interval

You can set a global timeout interval that the Cisco Nexus device waits for responses from all TACACS+ servers before declaring a timeout failure. The timeout interval determines how long the switch waits for responses from TACACS+ servers before declaring a timeout failure.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **tacacs-server timeout** *seconds*
3. switch(config)# **exit**
4. (Optional) switch# **show tacacs-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# tacacs-server timeout <i>seconds</i>	Specifies the timeout interval for TACACS+ servers. The default timeout interval is 5 second and the range is from 1 to 60 seconds.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring the Timeout Interval for a Server

You can set a timeout interval that the Cisco Nexus device waits for responses from a TACACS+ server before declaring a timeout failure. The timeout interval determines how long the switch waits for responses from a TACACS+ server before declaring a timeout failure.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **exit**
3. (Optional) switch# **show tacacs-server**
4. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# exit	Exits configuration mode.
Step 3	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration.
Step 4	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring TCP Ports

You can configure another TCP port for the TACACS+ servers if there are conflicts with another application. By default, the Cisco Nexus device uses port 49 for all TACACS+ requests.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **exit**
3. (Optional) switch# **show tacacs-server**
4. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# exit	Exits configuration mode.
Step 3	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration.
Step 4	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to configure TCP ports:

```
switch# configure terminal
switch(config)# tacacs-server host 10.10.1.1 port 2
switch(config)# exit
switch# show tacacs-server
switch# copy running-config startup-config
```

Configuring Periodic TACACS+ Server Monitoring

You can monitor the availability of TACACS+ servers. These parameters include the username and password to use for the server and an idle timer. The idle timer specifies the interval in which a TACACS+ server receives no requests before the Cisco Nexus device sends out a test packet. You can configure this option to test servers periodically, or you can run a one-time only test.



Note To protect network security, we recommend that you use a username that is not the same as an existing username in the TACACS+ database.

The test idle timer specifies the interval in which a TACACS+ server receives no requests before the Cisco Nexus device sends out a test packet.



Note The default idle timer value is 0 minutes. When the idle time interval is 0 minutes, periodic TACACS+ server monitoring is not performed.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **tacacs-server dead-time** *minutes*
3. switch(config)# **exit**
4. (Optional) switch# **show tacacs-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# tacacs-server dead-time <i>minutes</i>	Specifies the number minutes before the Cisco Nexus device checks a TACACS+ server that was previously unresponsive. The default value is 0 minutes and the valid range is 0 to 1440 minutes.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to configure periodic TACACS+ server monitoring:

```
switch# configure terminal
switch(config)# tacacs-server host 10.10.1.1 test username user1 password Ur2Gd2BH idle-time
3
switch(config)# tacacs-server dead-time 5
switch(config)# exit
switch# show tacacs-server
switch# copy running-config startup-config
```

Configuring the Dead-Time Interval

You can configure the dead-time interval for all TACACS+ servers. The dead-time interval specifies the time that the Cisco Nexus device waits, after declaring a TACACS+ server is dead, before sending out a test packet to determine if the server is now alive.



Note When the dead-time interval is 0 minutes, TACACS+ servers are not marked as dead even if they are not responding. You can configure the dead-time interval per group. See [Configuring TACACS+ Server Groups, on page 61](#)

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **tacacs-server deadtime** *minutes*
3. switch(config)# **exit**
4. (Optional) switch# **show tacacs-server**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# tacacs-server <i>deadtime minutes</i>	Configures the global dead-time interval. The default value is 0 minutes. The range is from 1 to 1440 minutes.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# show tacacs-server	Displays the TACACS+ server configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring X.509 Certificate-Based SSH Authorization Using TACACS Server

Beginning with Cisco NX-OS release 10.4(3)F, you can configure SSH-based authorization of x509v3-certificates using a TACAC+ server on the Cisco Nexus switches.

To configure X.509 certificate-based SSH-authorization using a TACAC+ server, follow these steps:

SUMMARY STEPS

1. **configure terminal**
2. **aaa authorization ssh-certificate default group** *tacacs-group-name*
3. **exit**
4. (Optional) **show aaa authorization [all]**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	aaa authorization ssh-certificate default group <i>tacacs-group-name</i> Example: switch(config)# aaa authorization ssh-certificate default group tac	Configures the default AAA authorization method for the TACAC+ servers. The ssh-certificate keyword configures TACACS or local authorization with certificate authentication. The default authorization is local authorization, which is the list of authorized commands for the user's assigned role.

	Command or Action	Purpose
		<p>Note</p> <ul style="list-style-type: none"> • Ensure that the <i>tacacs-group-name</i> is configured under the TACACS-server configuration using the aaa group server tacacs+ tacacs-group-name command. • To support SSH certificate-based authentication, configure a crypto trustpoint and install the root CA. For more details, see the Configuring PKI, on page 113 section.
Step 3	<p>exit</p> <p>Example:</p> <pre>switch(config)# exit switch#</pre>	Exits global configuration mode.
Step 4	<p>(Optional) show aaa authorization [all]</p> <p>Example:</p> <pre>switch# show aaa authorization</pre>	Displays the AAA authorization configuration. The all keyword displays the default values.
Step 5	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Manually Monitoring TACACS+ Servers or Groups

SUMMARY STEPS

1. switch# **test aaa server tacacs+ {ipv4-address | host-name} [vrf vrf-name] username password**
2. switch# **test aaa group group-name username password**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# test aaa server tacacs+ {ipv4-address host-name} [vrf vrf-name] username password	Sends a test message to a TACACS+ server to confirm availability.
Step 2	switch# test aaa group group-name username password	Sends a test message to a TACACS+ server group to confirm availability.

Example

The following example shows how to manually issue a test message:

```
switch# test aaa server tacacs+ 10.10.1.1 user1 Ur2Gd2BH
switch# test aaa group TacGroup user2 As3He3CI
```

Disabling TACACS+

You can disable TACACS+.



Caution When you disable TACACS+, all related configurations are automatically discarded.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **no feature tacacs+**
3. switch(config)# **exit**
4. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# no feature tacacs+	Disables TACACS+.
Step 3	switch(config)# exit	Exits configuration mode.
Step 4	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Displaying TACACS+ Statistics

To display the statistics, the switch maintains for TACACS+ activity, perform this task:

SUMMARY STEPS

1. switch# **show tacacs-server statistics** [*hostname* | *ipv4-address* | *ipv6-address*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show tacacs-server statistics [<i>hostname</i> <i>ipv4-address</i> <i>ipv6-address</i>]	Displays the TACACS+ statistics. Note <i>ipv6-address</i> parameter not supported on Nexus 3548.

Example

For detailed information about the fields in the output from this command, see the *Command Reference* for your Nexus switch.

Verifying the TACACS+ Configuration

To display TACACS+ information, perform one of the following tasks:

Command	Purpose
<code>show tacacs+ {status pending pending-diff}</code>	Displays the TACACS+ Cisco Fabric Services distribution status and other details.
<code>show running-config tacacs [all]</code>	Displays the TACACS+ configuration in the running configuration.
<code>show startup-config tacacs</code>	Displays the TACACS+ configuration in the startup configuration.
<code>show tacacs-serve [host-name ipv4-address ipv6-address] [directed-request groups sorted statistics]</code>	Displays all configured TACACS+ server parameters.

Configuration Examples for TACACS+

This example shows how to configure TACACS+:

```
switch# configure terminal
switch(config)# feature tacacs+
switch(config)# tacacs-server key 7 "ToIkLhPgG"
switch(config)# tacacs-server host 10.10.2.2 key 7 "ShMoMhT1"
switch(config)# aaa group server tacacs+ TacServer
switch(config-tacacs+)# server 10.10.2.2
switch(config-tacacs+)# use-vrf management
```

This example shows how to enable tacacs+ and how to configure the tacacs+ server preshared keys to specify remote AAA servers to authenticate server group TacServer1:

```
switch# configure terminal
switch(config)# feature tacacs+
switch(config)# tacacs-server key 7 "ikvhw10"
switch(config)# tacacs-server host 1.1.1.1
switch(config)# tacacs-server host 1.1.1.2

switch(config)# aaa group server tacacs+ TacServer1
switch(config-tacacs+)# server 1.1.1.1
switch(config-tacacs+)# server 1.1.1.2
```

Default Settings for TACACS+

The following table lists the default settings for TACACS+ parameters.

Table 8: Default TACACS+ Parameters

Parameters	Default
TACACS+	Disabled

Parameters	Default
Dead-time interval	0 minutes
Timeout interval	5 seconds
Idle timer interval	0 minutes
Periodic server monitoring username	test
Periodic server monitoring password	test



CHAPTER 6

Configuring LDAP

This chapter describes how to configure the Lightweight Directory Access Protocol (LDAP) on Cisco NX-OS devices and includes the following sections:

- [About LDAP, on page 73](#)
- [Prerequisites for LDAP, on page 76](#)
- [Guidelines and Limitations for LDAP, on page 76](#)
- [Default Settings for LDAP, on page 77](#)
- [Configuring LDAP, on page 77](#)
- [Monitoring LDAP Servers, on page 92](#)
- [Clearing LDAP Server Statistics, on page 92](#)
- [Verifying the LDAP Configuration, on page 93](#)
- [Configuration Examples for LDAP, on page 94](#)
- [Where to Go Next, on page 94](#)

About LDAP

The Lightweight Directory Access Protocol (LDAP) provides centralized validation of users attempting to gain access to a Cisco NX-OS device. LDAP services are maintained in a database on an LDAP daemon running typically on a UNIX or Windows NT workstation. You must have access to and must configure an LDAP server before the configured LDAP features on your Cisco NX-OS device are available.

LDAP provides for separate authentication and authorization facilities. LDAP allows for a single access control server (the LDAP daemon) to provide each service authentication and authorization 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 LDAP client/server protocol uses TCP (port 389) for transport requirements. Cisco NX-OS devices provide centralized authentication using the LDAP protocol.

LDAP Authentication and Authorization

Clients establish a TCP connection and authentication session with an LDAP server through a simple bind (username and password). As part of the authorization process, the LDAP server searches its database to retrieve the user profile and other information.

You can configure the bind operation to first bind and then search, where authentication is performed first and authorization next, or to first search and then bind. The default method is to first search and then bind.

The advantage of searching first and binding later is that the distinguished name (DN) received in the search result can be used as the user DN during binding rather than forming a DN by prepending the username (cn attribute) with the baseDN. This method is especially helpful when the user DN is different from the username plus the baseDN. For the user bind, the bindDN is constructed as baseDN + append-with-baseDN, where append-with-baseDN has a default value of cn=\$userid.



Note As an alternative to the bind method, you can establish LDAP authentication using the compare method, which compares the attribute values of a user entry at the server. For example, the user password attribute can be compared for authentication. The default password attribute type is userPassword.

LDAP Operation for User Login

When a user attempts a Password Authentication Protocol (PAP) login to a Cisco NX-OS device using LDAP, the following actions occur:

1. When the Cisco NX-OS device establishes a connection, it contacts the LDAP daemon to obtain the username and password.
2. The Cisco NX-OS device eventually receives one of the following responses from the LDAP daemon:
 - ACCEPT—User authentication succeeds and service begins. If the Cisco NX-OS device requires user authorization, authorization begins.
 - REJECT—User authentication fails. The LDAP daemon either denies further access to the user or prompts the user to retry the login sequence.
 - ERROR—An error occurs at some time during authentication either at the daemon or in the network connection between the daemon and the Cisco NX-OS device. If the Cisco NX-OS device receives an ERROR response, the Cisco NX-OS device tries to use an alternative method for authenticating the user.

After authentication, the user also undergoes an additional authorization phase if authorization has been enabled on the Cisco NX-OS device. Users must first successfully complete LDAP authentication before proceeding to LDAP authorization.

3. If LDAP authorization is required, the Cisco NX-OS device again contacts the LDAP daemon, and it returns an ACCEPT or REJECT authorization response. An ACCEPT response contains attributes that are used to direct the EXEC or NETWORK session for that user and determines the services that the user can access. Services include the following:
 - Telnet, rlogin, Point-to-Point Protocol (PPP), Serial Line Internet Protocol (SLIP), or EXEC services
 - Connection parameters, including the host or client IP address (IPv4 or IPv6), access list, and user timeouts



Note LDAP allows an arbitrary conversation between the daemon and the user until the daemon receives enough information to authenticate the user. This action is usually done by prompting for a username and password combination but may include prompts for other items.

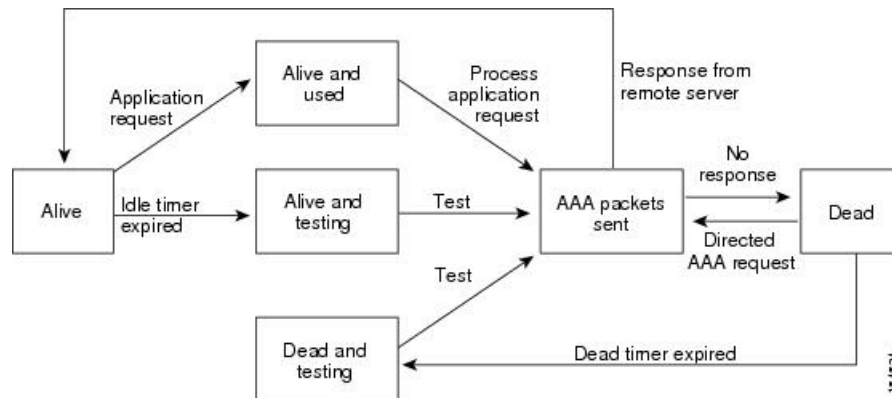


Note In LDAP, authorization can occur before authentication.

LDAP Server Monitoring

An unresponsive LDAP server can delay the processing of AAA requests. A Cisco NX-OS device can periodically monitor an LDAP server to check whether it is responding (or alive) to save time in processing AAA requests. The Cisco NX-OS device marks unresponsive LDAP servers as dead and does not send AAA requests to any dead LDAP servers. A Cisco NX-OS device periodically monitors dead LDAP servers and brings them to the alive state once they are responding. This process verifies that an LDAP server is in a working state before real AAA requests are sent its way. Whenever an LDAP server changes to the dead or alive state, a Simple Network Management Protocol (SNMP) trap is generated, and the Cisco NX-OS device displays an error message that a failure is taking place before it can impact performance. The following figure shows the server states for LDAP server monitoring.

Figure 4: LDAP Server States



Note The monitoring interval for alive servers and dead servers is different and can be configured by the user. The LDAP server monitoring is performed by sending a test authentication request to the LDAP server.

Vendor-Specific Attributes for LDAP

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating vendor-specific attributes (VSAs) between the network access server and the LDAP server. The IETF uses attribute 26. VSAs allow vendors to support their own extended attributes that are not suitable for general use.

Cisco VSA Format for LDAP

The Cisco LDAP implementation supports one vendor-specific option using the format recommended in the IETF specification. The Cisco vendor ID is 9, and the supported option is vendor type 1, which is named `cisco-av-pair`. The value is a string with the following format:

```
protocol : attribute separator value *
```

The protocol is a Cisco attribute for a particular type of authorization, the separator is an = (equal sign) for mandatory attributes, and an * (asterisk) indicates optional attributes. When you use LDAP servers for authentication on a Cisco NX-OS device, LDAP directs the LDAP server to return user attributes, such as authorization information, along with authentication results. This authorization information is specified through VSAs. The following VSA protocol option is supported by the Cisco NX-OS software:

- Shell—Protocol used in access-accept packets to provide user profile information.

The Cisco NX-OS software supports the following attribute:

- roles—Lists all the roles to which the user belongs. The value field is a string that lists the role names delimited by white space.

Virtualization Support for LDAP

The Cisco NX-OS device uses virtual routing and forwarding instances (VRFs) to access the LDAP servers. For more information on VRFs, see the *Cisco Nexus 3600 Switch NX-OS Unicast Routing Configuration Guide*.

Prerequisites for LDAP

LDAP has the following prerequisites:

- Obtain the IPv4 or IPv6 addresses or hostnames for the LDAP servers.
- Ensure that the Cisco NX-OS device is configured as an LDAP client of the AAA servers.

Guidelines and Limitations for LDAP

LDAP has the following guidelines and limitations:

- You can configure a maximum of 64 LDAP servers on the Cisco NX-OS device.
- Cisco NX-OS supports only LDAP version 3.
- Cisco NX-OS supports only these LDAP servers:
 - OpenLDAP
 - Microsoft Active Directory
- LDAP over Secure Sockets Layer (SSL) supports only SSL version 3 and Transport Layer Security (TLS) version 1.2.
- Beginning with Cisco NX-OS Release 10.4(3)F, LDAP over Secure Sockets Layer (SSL) supports TLS version 1.3 and 1.2 on Cisco Nexus switches. TLS v1.1 is deprecated.
- For LDAP over SSL, the LDAP client configuration must include the hostname as a subject in the LDAP server certificate.
- If you have a user account configured on the local Cisco NX-OS device that has the same name as a remote user account on a AAA server, the Cisco NX-OS software applies the user roles for the local user account to the remote user, not the user roles configured on the AAA server.

- Beginning with Cisco NX-OS Release 10.3(1)F, LDAP is supported on the Cisco Nexus 9808 switches.
 - Beginning with Cisco NX-OS Release 10.4(1)F, LDAP is supported on Cisco Nexus X98900CD-A and X9836DM-A line cards with Cisco Nexus 9808 switches.
- Beginning with Cisco NX-OS Release 10.4(1)F, LDAP is supported on the Cisco Nexus 9804 switches, and Cisco Nexus X98900CD-A and X9836DM-A line cards.
- Beginning from Cisco NX-OS Release 10.4(2)F, the configuration replace feature is supported for LDAP on Cisco NX-OS devices.

Default Settings for LDAP

This table lists the default settings for LDAP parameters.

Parameters	Default
LDAP	Disabled
LDAP authentication method	First search and then bind
LDAP authentication mechanism	Plain
Dead-time interval	0 minutes
Timeout interval	5 seconds
Idle timer interval	60 minutes
Periodic server monitoring username	test
Periodic server monitoring password	Cisco

Configuring LDAP

This section describes how to configure LDAP on a Cisco NX-OS device.

LDAP Server Configuration Process

You can configure LDAP servers by following this configuration process.

1. Enable LDAP.
2. Establish the LDAP server connections to the Cisco NX-OS device.
3. If needed, configure LDAP server groups with subsets of the LDAP servers for AAA authentication methods.
4. (Optional) Configure the TCP port.
5. (Optional) Configure the default AAA authorization method for the LDAP server.
6. (Optional) Configure an LDAP search map.
7. (Optional) If needed, configure periodic LDAP server monitoring.

Related Topics

- [Enabling or Disabling LDAP](#), on page 78
- [Configuring LDAP Server Hosts](#), on page 79
- [Configuring the RootDN for an LDAP Server](#), on page 80
- [Configuring LDAP Server Groups](#), on page 81
- [Configuring TCP Ports](#), on page 85
- [Configuring LDAP Search Maps](#), on page 86
- [Configuring Periodic LDAP Server Monitoring](#), on page 87

Enabling or Disabling LDAP

By default, the LDAP feature is disabled on the Cisco NX-OS device. You must explicitly enable the LDAP feature to access the configuration and verification commands for authentication.

SUMMARY STEPS

1. **configure terminal**
2. **[no] feature ldap**
3. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	Required: [no] feature ldap Example: <pre>switch(config)# feature ldap</pre>	Enables LDAP. Use the no form of this command to disable LDAP. Note When you disable LDAP, all related configurations are automatically discarded.
Step 3	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

- [LDAP Server Configuration Process](#), on page 77
- [Configuring LDAP Server Hosts](#), on page 79
- [Configuring the RootDN for an LDAP Server](#), on page 80
- [Configuring LDAP Server Groups](#), on page 81
- [Configuring the Global LDAP Timeout Interval](#), on page 83
- [Configuring the Timeout Interval for an LDAP Server](#), on page 84
- [Configuring TCP Ports](#), on page 85

- [Configuring LDAP Search Maps](#), on page 86
- [Configuring Periodic LDAP Server Monitoring](#), on page 87
- [Configuring the LDAP Dead-Time Interval](#), on page 88
- [Configuring AAA Authorization on LDAP Servers](#), on page 89

Configuring LDAP Server Hosts

To access a remote LDAP server, you must configure the IP address or the hostname for the LDAP server on the Cisco NX-OS device. You can configure up to 64 LDAP servers.



Note By default, when you configure an LDAP server IP address or hostname on the Cisco NX-OS device, the LDAP server is added to the default LDAP server group. You can also add the LDAP server to another LDAP server group.

Before you begin

Enable LDAP.

Obtain the IPv4 or IPv6 addresses or the hostnames for the remote LDAP servers.

If you plan to enable the Secure Sockets Layer (SSL) protocol, make sure that the LDAP server certificate is manually configured on the Cisco NX-OS device.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server host** {*ipv4-address* | *ipv6-address* | *host-name*} [**enable-ssl**] [**referral-disable**]
3. (Optional) **show ldap-server**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] ldap-server host { <i>ipv4-address</i> <i>ipv6-address</i> <i>host-name</i> } [enable-ssl] [referral-disable] Example: <pre>switch(config)# ldap-server host 10.10.2.2 enable-ssl</pre>	Specifies the IPv4 or IPv6 address or hostname for an LDAP server. The enable-ssl keyword ensures the integrity and confidentiality of the transferred data by causing the LDAP client to establish an SSL session prior to sending the bind or search request. The referral-disable keyword disables the unwanted referral links.

	Command or Action	Purpose
Step 3	(Optional) show ldap-server Example: switch(config)# show ldap-server	Displays the LDAP server configuration.
Step 4	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

- [LDAP Server Configuration Process](#), on page 77
- [Enabling or Disabling LDAP](#), on page 78
- [Configuring LDAP Server Groups](#), on page 81
- [Configuring the RootDN for an LDAP Server](#), on page 80
- [Configuring LDAP Server Groups](#), on page 81
- [Configuring Periodic LDAP Server Monitoring](#), on page 87
- [Monitoring LDAP Servers](#), on page 92
- [Clearing LDAP Server Statistics](#), on page 92

Configuring the RootDN for an LDAP Server

You can configure the root designated name (DN) for the LDAP server database. The rootDN is used to bind to the LDAP server to verify its state.

Before you begin

Enable LDAP.

Obtain the IPv4 or IPv6 addresses or the hostnames for the remote LDAP servers.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server host {ipv4-address | ipv6-address | hostname} rootDN root-name [password password [port tcp-port [timeout seconds] | timeout seconds]]**
3. (Optional) **show ldap-server**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.

	Command or Action	Purpose
Step 2	<p>[no] ldap-server host {<i>ipv4-address</i> <i>ipv6-address</i> <i>hostname</i>} rootDN <i>root-name</i> [password <i>password</i> [port <i>tcp-port</i> [timeout <i>seconds</i>] timeout <i>seconds</i>]]</p> <p>Example:</p> <pre>switch(config)# ldap-server host 10.10.1.1 rootDN cn=manager,dc=acme,dc=com password Ur2Gd2BH timeout 60</pre>	<p>Specifies the rootDN for the LDAP server database and the bind password for the root.</p> <p>Optionally specifies the TCP port to use for LDAP messages to the server. The range is from 1 to 65535, and the default TCP port is the global value or 389 if a global value is not configured. Also specifies the timeout interval for the server. The range is from 1 to 60 seconds, and the default timeout is the global value or 5 seconds if a global value is not configured.</p>
Step 3	<p>(Optional) show ldap-server</p> <p>Example:</p> <pre>switch(config)# show ldap-server</pre>	Displays the LDAP server configuration.
Step 4	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

[LDAP Server Configuration Process](#), on page 77

[Enabling or Disabling LDAP](#), on page 78

[Configuring LDAP Server Hosts](#), on page 79

Configuring LDAP Server Groups

You can specify one or more remote AAA servers to authenticate users using server groups. All members of a group must be configured to use LDAP. The servers are tried in the same order in which you configure them.

You can configure these server groups at any time, but they take effect only when you apply them to an AAA service.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] aaa group server ldap** *group-name*
3. **[no] server** {*ipv4-address* | *ipv6-address* | *host-name*}
4. (Optional) **[no] authentication** {**bind-first** [**append-with-baseDN** *DNstring*] | **compare** [**password-attribute** *password*]}
5. (Optional) **[no] enable user-server-group**
6. (Optional) **[no] enable Cert-DN-match**
7. (Optional) **[no] use-vrf** *vrf-name*
8. **exit**

9. (Optional) **show ldap-server groups**
10. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] aaa group server ldap group-name Example: <pre>switch(config)# aaa group server ldap LDAPServer1 switch(config-ldap)#</pre>	Creates an LDAP server group and enters the LDAP server group configuration mode for that group.
Step 3	[no] server {ipv4-address ipv6-address host-name} Example: <pre>switch(config-ldap)# server 10.10.2.2</pre>	<p>Configures the LDAP server as a member of the LDAP server group.</p> <p>If the specified LDAP server is not found, configure it using the ldap-server host command and retry this command.</p>
Step 4	(Optional) [no] authentication {bind-first [append-with-baseDN DNstring] compare [password-attribute password]} Example: <pre>switch(config-ldap)# authentication compare password-attribute TyuL8r</pre>	Performs LDAP authentication using the bind or compare method. The default LDAP authentication method is the bind method using first search and then bind.
Step 5	(Optional) [no] enable user-server-group Example: <pre>switch(config-ldap)# enable user-server-group</pre>	Enables group validation. The group name should be configured in the LDAP server. Users can login through public-key authentication only if the username is listed as a member of this configured group in the LDAP server.
Step 6	(Optional) [no] enable Cert-DN-match Example: <pre>switch(config-ldap)# enable Cert-DN-match</pre>	Enables users to login only if the user profile lists the subject-DN of the user certificate as authorized for login.
Step 7	(Optional) [no] use-vrf vrf-name Example: <pre>switch(config-ldap)# use-vrf vrf1</pre>	Specifies the VRF to use to contact the servers in the server group.
Step 8	exit Example: <pre>switch(config-ldap)# exit switch(config)#</pre>	Exits LDAP server group configuration mode.

	Command or Action	Purpose
Step 9	(Optional) show ldap-server groups Example: switch(config)# show ldap-server groups	Displays the LDAP server group configuration.
Step 10	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

- [LDAP Server Configuration Process](#), on page 77
- [Configuring LDAP Server Hosts](#), on page 79
- [Enabling or Disabling LDAP](#), on page 78
- [Configuring LDAP Server Hosts](#), on page 79

Configuring the Global LDAP Timeout Interval

You can set a global timeout interval that determines how long the Cisco NX-OS device waits for responses from all LDAP servers before declaring a timeout failure.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server timeout seconds**
3. (Optional) **show ldap-server**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	[no] ldap-server timeout seconds Example: switch(config)# ldap-server timeout 10	Specifies the timeout interval for LDAP servers. The default timeout interval is 5 seconds. The range is from 1 to 60 seconds.
Step 3	(Optional) show ldap-server Example: switch(config)# show ldap-server	Displays the LDAP server configuration.

	Command or Action	Purpose
Step 4	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

[Enabling or Disabling LDAP](#), on page 78

[Configuring the Timeout Interval for an LDAP Server](#), on page 84

[Configuring the Timeout Interval for an LDAP Server](#), on page 84

Configuring the Timeout Interval for an LDAP Server

You can set a timeout interval that determines how long the Cisco NX-OS device waits for responses from an LDAP server before declaring a timeout failure.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server host {ipv4-address | ipv6-address | hostname} timeout seconds**
3. (Optional) **show ldap-server**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	[no] ldap-server host {ipv4-address ipv6-address hostname} timeout seconds Example: switch(config)# ldap-server host server1 timeout 10	Specifies the timeout interval for a specific server. The default is the global value. Note The timeout interval value specified for an LDAP server overrides the global timeout interval value specified for all LDAP servers.
Step 3	(Optional) show ldap-server Example: switch(config)# show ldap-server	Displays the LDAP server configuration.
Step 4	(Optional) copy running-config startup-config Example:	Copies the running configuration to the startup configuration.

	Command or Action	Purpose
	<code>switch(config)# copy running-config startup-config</code>	

Related Topics

[Configuring the Global LDAP Timeout Interval](#), on page 83

[Enabling or Disabling LDAP](#), on page 78

[Configuring the Global LDAP Timeout Interval](#), on page 83

Configuring TCP Ports

You can configure another TCP port for the LDAP servers if there are conflicts with another application. By default, Cisco NX-OS devices use port 389 for all LDAP requests.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server host** {*ipv4-address* | *ipv6-address* | *hostname*} **port** *tcp-port* [**timeout** *seconds*]
3. (Optional) **show ldap-server**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] ldap-server host { <i>ipv4-address</i> <i>ipv6-address</i> <i>hostname</i> } port <i>tcp-port</i> [timeout <i>seconds</i>] Example: <pre>switch(config)# ldap-server host 10.10.1.1 port 200 timeout 5</pre>	<p>Specifies the TCP port to use for LDAP messages to the server. The default TCP port is 389. The range is from 1 to 65535.</p> <p>Optionally specifies the timeout interval for the server. The range is from 1 to 60 seconds, and the default timeout is the global value or 5 seconds if a global value is not configured.</p> <p>Note The timeout interval value specified for an LDAP server overrides the global timeout interval value specified for all LDAP servers.</p>
Step 3	(Optional) show ldap-server Example: <pre>switch(config)# show ldap-server</pre>	Displays the LDAP server configuration.

	Command or Action	Purpose
Step 4	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

[LDAP Server Configuration Process](#), on page 77

[Enabling or Disabling LDAP](#), on page 78

Configuring LDAP Search Maps

You can configure LDAP search maps to send a search query to the LDAP server. The server searches its database for data meeting the criteria specified in the search map.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **ldap search-map** *map-name*
3. (Optional) [**userprofile** | **trustedCert** | **CRLLookup** | **user-certdn-match** | **user-pubkey-match** | **user-switch-bind**] **attribute-name** *attribute-name* **search-filter** *filter* **base-DN** *base-DN-name*
4. (Optional) **exit**
5. (Optional) **show ldap-search-map**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	ldap search-map <i>map-name</i> Example: switch(config)# ldap search-map map1 switch(config-ldap-search-map)#	Configures an LDAP search map.
Step 3	(Optional) [userprofile trustedCert CRLLookup user-certdn-match user-pubkey-match user-switch-bind] attribute-name <i>attribute-name</i> search-filter <i>filter</i> base-DN <i>base-DN-name</i> Example:	Configures the attribute name, search filter, and base-DN for the user profile, trusted certificate, CRL, certificate DN match, public key match, or user-switchgroup lookup search operation. These values are used to send a search query to the LDAP server.

	Command or Action	Purpose
	<pre>switch(config-ldap-search-map)# userprofile attribute-name att-name search-filter (&(objectClass=inetOrgPerson)(cn=\$userid)) base-DN dc=acme,dc=com</pre>	The <i>attribute-name</i> argument is the name of the attribute in the LDAP server that contains the Nexus role definition.
Step 4	<p>(Optional) exit</p> <p>Example:</p> <pre>switch(config-ldap-search-map)# exit switch(config)#</pre>	Exits LDAP search map configuration mode.
Step 5	<p>(Optional) show ldap-search-map</p> <p>Example:</p> <pre>switch(config)# show ldap-search-map</pre>	Displays the configured LDAP search maps.
Step 6	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

[LDAP Server Configuration Process](#), on page 77

[Enabling or Disabling LDAP](#), on page 78

Configuring Periodic LDAP Server Monitoring

You can monitor the availability of LDAP servers. The configuration parameters include the username and password to use for the server, the rootDN to bind to the server to verify its state, and an idle timer. The idle timer specifies the interval in which an LDAP server receives no requests before the Cisco NX-OS device sends out a test packet. You can configure this option to test servers periodically, or you can run a one-time only test.



Note To protect network security, we recommend that you use a username that is not the same as an existing username in the LDAP database.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server host** {*ipv4-address* | *ipv6-address* | *hostname*} **test rootDN** *root-name* [**idle-time** *minutes* | **password** *password* [**idle-time** *minutes*]] | **username** *name* [**password** *password* [**idle-time** *minutes*]]]
3. **[no] ldap-server deadtime** *minutes*
4. (Optional) **show ldap-server**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	Required: [no] ldap-server host { <i>ipv4-address</i> <i>ipv6-address</i> <i>hostname</i> } test rootDN <i>root-name</i> [idle-time minutes password <i>password</i> [idle-time minutes] username <i>name</i> [password <i>password</i> [idle-time minutes]]] Example: <pre>switch(config)# ldap-server host 10.10.1.1 test rootDN root1 username user1 password Ur2Gd2BH idle-time 3</pre>	Specifies the parameters for server monitoring. The default username is test, and the default password is Cisco. The default value for the idle timer is 60 minutes, and the valid range is from 1 to 1440 minutes. Note We recommend that the user not be an existing user in the LDAP server database.
Step 3	[no] ldap-server deadtime <i>minutes</i> Example: <pre>switch(config)# ldap-server deadtime 5</pre>	Specifies the number of minutes before the Cisco NX-OS device checks an LDAP server that was previously unresponsive. The default value is 0 minutes, and the valid range is from 1 to 60 minutes.
Step 4	(Optional) show ldap-server Example: <pre>switch(config)# show ldap-server</pre>	Displays the LDAP server configuration.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

[LDAP Server Configuration Process](#), on page 77

[Enabling or Disabling LDAP](#), on page 78

[Configuring LDAP Server Hosts](#), on page 79

Configuring the LDAP Dead-Time Interval

You can configure the dead-time interval for all LDAP servers. The dead-time interval specifies the time that the Cisco NX-OS device waits, after declaring that an LDAP server is dead, before sending out a test packet to determine if the server is now alive.



Note When the dead-time interval is 0 minutes, LDAP servers are not marked as dead even if they are not responding. You can configure the dead-time interval per group.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **[no] ldap-server deadtime *minutes***
3. (Optional) **show ldap-server**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] ldap-server deadtime <i>minutes</i> Example: <pre>switch(config)# ldap-server deadtime 5</pre>	Configures the global dead-time interval. The default value is 0 minutes. The range is from 1 to 60 minutes.
Step 3	(Optional) show ldap-server Example: <pre>switch(config)# show ldap-server</pre>	Displays the LDAP server configuration.
Step 4	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

[Enabling or Disabling LDAP](#), on page 78

Configuring AAA Authorization on LDAP Servers

You can configure the default AAA authorization method for LDAP servers.

Before you begin

Enable LDAP.

SUMMARY STEPS

1. **configure terminal**
2. **aaa authorization {ssh-certificate | ssh-publickey} default {group *group-list* | local}**
3. (Optional) **show aaa authorization [all]**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	aaa authorization {ssh-certificate ssh-publickey} default {group group-list local} Example: <pre>switch(config)# aaa authorization ssh-certificate default group LDAPServer1 LDAPServer2</pre>	<p>Configures the default AAA authorization method for the LDAP servers.</p> <p>The ssh-certificate keyword configures LDAP or local authorization with certificate authentication, and the ssh-publickey keyword configures LDAP or local authorization with the SSH public key. The default authorization is local authorization, which is the list of authorized commands for the user's assigned role.</p> <p>The <i>group-list</i> argument consists of a space-delimited list of LDAP server group names. Servers that belong to this group are contacted for AAA authorization. The local method uses the local database for authorization.</p>
Step 3	(Optional) show aaa authorization [all] Example: <pre>switch(config)# show aaa authorization</pre>	Displays the AAA authorization configuration. The all keyword displays the default values.
Step 4	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

[Enabling or Disabling LDAP](#), on page 78

Configuring LDAP SSH Public Key Authorization

The AAA authorization is performed through LDAP servers with the public key of the user which is saved in the user entry of the LDAP server.

Before configuring LDAP SSH public key authorization, ensure that the following are taken care of:

- Save the public key of the user as a user attribute in the LDAP server.
- Sign-in using the private key from the SSH client.



Note The private key that is presented during SSH sign-in is verified with the public key which is saved in the LDAP server.

The following example shows the sample LDAP client configuration.

In the following example, the public key of the user is saved in the LDAP server under the attribute mentioned in **user-pubkey-match** configuration, ie, **sshPublicKeys** attribute in the below case:

```
ldap-server host fully qualified domain name.com rootDN
"CN=ucsadmin1,CN=Users,DC=PI-Sec-DT,DC=com" password 7 password1
ldap search-map Map1
  userprofile attribute-name "description" search-filter "(cn=$userid)" base-DN
  "DC=PI-Sec-DT,DC=com"
  user-pubkey-match attribute-name "sshPublicKeys" search-filter "(cn=$userid)" base-DN
  "DC=PI-Sec-DT,DC=com"
aaa group server ldap ldap1
  server fully qualified domain name.com
  use-vrf management
  ldap-search-map Map1

aaa authorization ssh-publickey default group ldap1
```

In the following example, the SSH client private key of the user is used to sign in to the switch management IP address:

```
ssh ldapuser@10.0.0.1 -i ldap_pub_key_test
```

Configuring LDAP SSH Certificate Authorization

AAA authorization is performed through an LDAP server with a certificate and the DN of the certificate which is saved in the user attribute of the LDAP server.

During LDAP SSH certificate authorization, following things are taken care of:

- Validation of the user certificate presented through the SSH client using the CA certificate installed in the switch.
- As the **enable cert-dn-match** configuration is enabled by default, the cert-DN-match with the DN stored in the LDAP server to validate the certificate is taken care automatically.

The following example shows the sample LDAP client configurations.

- The following example shows how to save the certificate DN in an LDAP server under any specific attribute that is mentioned in the **user-certdn-match** configuration.

The format is "x509v3-sign-rsa DN /DC=com, DC=PI-Sec-DT, CN=Users, CN=username1".

```
ldap-server host fully qualified domain name.com rootDN
"CN=ucsadmin1,CN=Users,DC=PI-Sec-DT,DC=com" password 7 password1
ldap search-map Map24
  userprofile attribute-name "description" search-filter "(cn=$userid)" base-DN
  "DC=PI-Sec-DT,DC=com"
  user-certdn-match attribute-name <attribute> search-filter "(cn=$userid)" base-DN
  "DC=PI-Sec-DT,DC=com"
aaa group server ldap ldap24
  server fully qualified domain name.com
  enable Cert-DN-match
  use-vrf management
  ldap-search-map Map24

aaa authorization ssh-certificate default group ldap24
```

- The following show command shows the details of the rootCA certificate installed on the box:

```
switch# show crypto ca certificates
Trustpoint: ldap
CA certificate 0:
```

```

subject=C = IN, ST = KAR, L = BGL, O = Cisco, OU = DCBG-Cert, CN = RootCA
issuer=C = IN, ST = KAR, L = BGL, O = Cisco, OU = DCBG-Cert, CN = RootCA
serial=82EE7603BF7E74A9
notBefore=May 29 07:12:30 2023 GMT
notAfter=May 26 07:12:30 2033 GMT
SHA1 Fingerprint=D5:AE:75:8E:A1:4F:79:1E:80:3E:5E:67:C5:42:44:10:13:C6:F7:1D
purposes: sslserver sslclient

```

```
n7700-DE#
```

- The following example shows how user sign-in is performed from the SSH client:
 - In the SSH client, the input certificate contains both private key and user certificate concatenated in a single file '<user>.cert'.
 - The rootCA.crt is the rootCA certificate file.
 - The IP Address is the switch management IP address.

```
ssh username1@10.0.0.1 -i username1.crt -vvv -oCACertificateFile=rootCA.crt
```

Monitoring LDAP Servers

You can monitor the statistics that the Cisco NX-OS device maintains for LDAP server activity.

Before you begin

Configure LDAP servers on the Cisco NX-OS device.

SUMMARY STEPS

1. **show ldap-server statistics** {*hostname* | *ipv4-address* | *ipv6-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	show ldap-server statistics { <i>hostname</i> <i>ipv4-address</i> <i>ipv6-address</i> } Example: switch# show ldap-server statistics 10.10.1.1	Displays the LDAP server statistics.

Related Topics

[Configuring LDAP Server Hosts](#), on page 79

[Clearing LDAP Server Statistics](#), on page 92

[Clearing LDAP Server Statistics](#), on page 92

Clearing LDAP Server Statistics

You can display the statistics that the Cisco NX-OS device maintains for LDAP server activity.

Before you begin

Configure LDAP servers on the Cisco NX-OS device.

SUMMARY STEPS

1. (Optional) **show ldap-server statistics** {*hostname* | *ipv4-address* | *ipv6-address*}
2. **clear ldap-server statistics** {*hostname* | *ipv4-address* | *ipv6-address*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	(Optional) show ldap-server statistics { <i>hostname</i> <i>ipv4-address</i> <i>ipv6-address</i> } Example: switch# show ldap-server statistics 10.10.1.1	Displays the LDAP server statistics.
Step 2	clear ldap-server statistics { <i>hostname</i> <i>ipv4-address</i> <i>ipv6-address</i> } Example: switch# clear ldap-server statistics 10.10.1.1	Clears the LDAP server statistics.

Related Topics

- [Monitoring LDAP Servers](#), on page 92
- [Configuring LDAP Server Hosts](#), on page 79
- [Monitoring LDAP Servers](#), on page 92

Verifying the LDAP Configuration

To display LDAP configuration information, perform one of the following tasks.

Command	Purpose
show running-config ldap [all]	Displays the LDAP configuration in the running configuration.
show startup-config ldap	Displays the LDAP configuration in the startup configuration.
show ldap-server	Displays LDAP configuration information.
show ldap-server groups	Displays LDAP server group configuration information.
show ldap-server statistics { <i>hostname</i> <i>ipv4-address</i> <i>ipv6-address</i> }	Displays LDAP statistics.
show ldap-search-map	Displays information about the configured LDAP attribute maps.

Configuration Examples for LDAP

The following example shows how to configure an LDAP server host and server group:

```
feature ldap
ldap-server host 10.10.2.2 enable-ssl
aaa group server ldap LdapServer
server 10.10.2.2
exit
show ldap-server
show ldap-server groups
```

The following example shows how to configure an LDAP search map:

```
ldap search-map s0
userprofile attribute-name att-name search-filter "
(&(objectClass=Person)(sAMAccountName=$userid))" base-DN dc=acme,dc=com
exit
show ldap-search-map
```

The following example shows how to configure AAA authorization with certificate authentication for an LDAP server:

```
aaa authorization ssh-certificate default group LDAPServer1 LDAPServer2
exit
show aaa authorization
```

The following example shows how you can validate the authentication:

```
failing
test aaa group LdapServer user <user-password>
user has failed authentication

! working
test aaa group LdapServer user <user-password>
user has been authenticated
```

Where to Go Next

You can now configure AAA authentication methods to include the server groups.



CHAPTER

7

Configuring SSH and Telnet

This chapter contains the following sections:

- [Information About SSH and Telnet, on page 95](#)
- [Guidelines and Limitations for SSH, on page 97](#)
- [Configuring SSH, on page 97](#)
- [Configuration Examples for SSH, on page 104](#)
- [Configuring X.509v3 Certificate-Based SSH Authentication, on page 105](#)
- [Configuration Example for X.509v3 Certificate-Based SSH Authentication, on page 107](#)
- [Configuring Telnet, on page 108](#)
- [Verifying the SSH and Telnet Configuration, on page 110](#)
- [Default Settings for SSH, on page 111](#)

Information About SSH and Telnet

SSH Server

The Secure Shell Protocol (SSH) server feature enables a SSH client to make a secure, encrypted connection to a Cisco Nexus device. SSH uses strong encryption for authentication. The SSH server in the Cisco Nexus device switch interoperates with publicly and commercially available SSH clients.

The user authentication mechanisms supported for SSH are RADIUS, TACACS+, and the use of locally stored user names and passwords.

SSH Client

The SSH client feature is an application running over the SSH protocol to provide device authentication and encryption. The SSH client enables a switch to make a secure, encrypted connection to another Cisco Nexus device or to any other device running an SSH server. This connection provides an outbound connection that is encrypted. With authentication and encryption, the SSH client allows for a secure communication over an insecure network.

The SSH client in the Cisco Nexus device works with publicly and commercially available SSH servers.

SSH Server Keys

SSH requires server keys for secure communications to the Cisco Nexus device. You can use SSH keys for the following SSH options:

- SSH version 2 using Rivest, Shamir, and Adelman (RSA) public-key cryptography
- SSH version 2 using the Digital System Algorithm (DSA)

Be sure to have an SSH server key-pair with the appropriate version before enabling the SSH service. You can generate the SSH server key-pair according to the SSH client version used. The SSH service accepts three types of key-pairs for use by SSH version 2:

- The `dsa` option generates the DSA key-pair for the SSH version 2 protocol.
- The `rsa` option generates the RSA key-pair for the SSH version 2 protocol.

By default, the Cisco Nexus device generates an RSA key using 1024 bits.

SSH supports the following public key formats:

- OpenSSH
- IETF Secure Shell (SECSH)



Caution If you delete all SSH keys, you can't start the SSH services.

SSH Authentication Using Digital Certificates

SSH authentication on CiscoNX-OS devices provide X.509 digital certificate support for host authentication. An X.509 digital certificate is a data item that ensures the origin and integrity of a message. It contains encryption keys for secured communications and is signed by a trusted certification authority (CA) to verify the identity of the presenter. The X.509 digital certificate support provides either DSA or RSA algorithms for authentication.

The certificate infrastructure uses the first certificate that supports the Secure Socket Layer (SSL) and is returned by the security infrastructure, either through a query or a notification. Verification of certificates is successful if the certificates are from any of the trusted CAs.

You can configure your device for SSH authentication using an X.509 certificate. If the authentication fails, you are prompted for a password.

You can configure SSH authentication using X.509v3 certificates (RFC 6187). X.509v3 certificate-based SSH authentication uses certificates combined with a smartcard to enable two-factor authentication for Cisco device access. The SSH client is provided by Cisco partner Pragma Systems.

Telnet Server

The Telnet protocol enables TCP/IP connections to a host. Telnet allows a user at one site to establish a TCP connection to a login server at another site, and then passes the keystrokes from one system to the other. Telnet can accept either an IP address or a domain name as the remote system address.

The Telnet server is enabled by default on the Cisco Nexus device.

Guidelines and Limitations for SSH

SSH has the following configuration guidelines and limitations:

- The Cisco Nexus device supports only SSH version 2 (SSHv2).
- SSH public and private keys imported into user accounts that are remotely authenticated through a AAA protocol (such as RADIUS or TACACS+) for the purpose of SSH Passwordless File Copy will not persist when the Nexus device is reloaded unless a local user account with the same name as the remote user account is configured on the device before the SSH keys are imported.

Configuring SSH

Generating SSH Server Keys

You can generate an SSH server key based on your security requirements. The default SSH server key is an RSA key that is generated using 1024 bits.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **ssh key {dsa [force] | rsa [bits [force]]}**
3. switch(config)# **exit**
4. (Optional) switch# **show ssh key [dsa | rsa] [md5]**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# ssh key {dsa [force] rsa [bits [force]]}	Generates the SSH server key. The <i>bits</i> argument is the number of bits used to generate the key. The range is from 768 to 2048 and the default value is 1024. Use the force keyword to replace an existing key.
Step 3	switch(config)# exit	Exits global configuration mode.
Step 4	(Optional) switch# show ssh key [dsa rsa] [md5]	Displays the SSH server keys. For Cisco NX-OS Release 7.0(3)I4(6) and any later 7.0(3)I4(x) release, this command displays the fingerprint in SHA256 format by default. SHA256 is more secure than the old default format of MD5. However, the md5 option

	Command or Action	Purpose
		has been added, if you want to see the fingerprint in MD5 format for backward compatibility.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to generate an SSH server key:

```
switch# configure terminal
switch(config)# ssh key rsa 2048
switch(config)# exit
switch# show ssh key
switch# copy running-config startup-config
```

Specifying the SSH Public Keys for User Accounts

You can configure an SSH public key to log in using an SSH client without being prompted for a password. You can specify the SSH public key in one of three different formats:

- Open SSH format
- IETF SECSH format
- Public Key Certificate in PEM format

Specifying the SSH Public Keys in Open SSH Format

You can specify the SSH public keys in SSH format for user accounts.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **username *username* sshkey *ssh-key***
3. switch(config)# **exit**
4. (Optional) switch# **show user-account**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# username <i>username</i> sshkey <i>ssh-key</i>	Configures the SSH public key in SSH format.
Step 3	switch(config)# exit	Exits global configuration mode.
Step 4	(Optional) switch# show user-account	Displays the user account configuration.

	Command or Action	Purpose
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to specify an SSH public key in open SSH format:

```
switch# configure terminal
switch(config)# username User1 sshkey ssh-rsa
AAAAB3NzaC1yc2EAAAABIwAAAIEAri3mQy4WlAV9Y2t2hrEWgbUEYz
CFTPO5B8LRkedn56BEy2N9ZcdpqE6aqJLZwfZcTFEzaAAZp9AS86dgBAjsKGs7UxnhGySr8ZELv+DQBsDQH6rzT0KR+2Da8hJD4Z
XIeccWk0gS1DQUNZ300xstQsYZUtqnxlbvm5Ninn0McNinn0Mc=
switch(config)# exit
switch# show user-account
switch# copy running-config startup-config
```



Note The **username** command in the example above is a single line that has been broken for legibility.

Specifying the SSH Public Keys in IETF SECSH Format

You can specify the SSH public keys in IETF SECSH format for user accounts.

SUMMARY STEPS

1. switch# **copy server-file bootflash: filename**
2. switch# **configure terminal**
3. switch(config)# **username username sshkey file filename**
4. switch(config)# **exit**
5. (Optional) switch# **show user-account**
6. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# copy server-file bootflash: filename	Downloads the file that contains the SSH key in IETF SECSH format from a server. The server can be FTP, SCP, SFTP, or TFTP.
Step 2	switch# configure terminal	Enters global configuration mode.
Step 3	switch(config)# username username sshkey file filename	Configures the SSH public key in SSH format.
Step 4	switch(config)# exit	Exits global configuration mode.
Step 5	(Optional) switch# show user-account	Displays the user account configuration.

	Command or Action	Purpose
Step 6	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to specify the SSH public key in the IETF SECSH format:

```
switch#copy tftp://10.10.1.1/secsh_file.pub bootflash:secsh_file.pub
switch# configure terminal
switch(config)# username User1 sshkey file bootflash:secsh_file.pub
switch(config)# exit
switch# show user-account
switch# copy running-config startup-config
```

Specifying the SSH Public Keys in PEM-Formatted Public Key Certificate Form

You can specify the SSH public keys in PEM-formatted Public Key Certificate form for user accounts.

SUMMARY STEPS

1. switch# **copy server-file bootflash: filename**
2. switch# **configure terminal**
3. (Optional) switch# **show user-account**
4. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# copy server-file bootflash: filename	Downloads the file that contains the SSH key in PEM-formatted Public Key Certificate form from a server. The server can be FTP, SCP, SFTP, or TFTP
Step 2	switch# configure terminal	Enters global configuration mode.
Step 3	(Optional) switch# show user-account	Displays the user account configuration.
Step 4	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to specify the SSH public keys in PEM-formatted public key certificate form:

```
switch# copy tftp://10.10.1.1/cert.pem bootflash:cert.pem
switch# configure terminal
switch# show user-account
switch# copy running-config startup-config
```

Configuring the SSH Source Interface

You can configure SSH to use a specific interface.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **ip ssh source-interface** *type slot/port*
3. switch(config)# **show ip ssh source-interface**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# ip ssh source-interface <i>type slot/port</i>	Configures the source interface for all SSH packets. The following list contains the valid values for <i>interface</i> . <ul style="list-style-type: none"> • ethernet • loopback • mgmt • port-channel • vlan
Step 3	switch(config)# show ip ssh source-interface	Displays the configured SSH source interface.

Example

This example shows how to configure the SSH source interface:

```
switch(config)# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# ip ssh source-interface ethernet 1/7
switch(config)# show ip ssh source-interface
VRF Name                Interface
default                  Ethernet1/7
```

Starting SSH Sessions to Remote Devices

You can start SSH sessions to connect to remote devices from your Cisco Nexus device.

SUMMARY STEPS

1. switch# **ssh** *{hostname | username@hostname}* [**vrf** *vrf-name*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# ssh {hostname username@hostname} [vrf vrf-name]	Creates an SSH session to a remote device. The <i>hostname</i> argument can be an IPv4 address or a hostname.

Clearing SSH Hosts

When you download a file from a server using SCP or SFTP, you establish a trusted SSH relationship with that server.

SUMMARY STEPS

1. switch# clear ssh hosts

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# clear ssh hosts	Clears the SSH host sessions.

Disabling the SSH Server

By default, the SSH server is enabled on the Cisco Nexus device.

SUMMARY STEPS

1. switch# configure terminal
2. switch(config)# [no] feature ssh
3. switch(config)# exit
4. (Optional) switch# show ssh server
5. (Optional) switch# copy running-config startup-config

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# [no] feature ssh	Enables/disables the SSH server. The default is enabled.
Step 3	switch(config)# exit	Exits global configuration mode.
Step 4	(Optional) switch# show ssh server	Displays the SSH server configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Deleting SSH Server Keys

You can delete SSH server keys after you disable the SSH server.



Note To reenble SSH, you must first generate an SSH server key.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **no feature ssh**
3. switch(config)# **no ssh key [dsa | rsa]**
4. switch(config)# **exit**
5. (Optional) switch# **show ssh key**
6. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# no feature ssh	Disables the SSH server.
Step 3	switch(config)# no ssh key [dsa rsa]	Deletes the SSH server key. The default is to delete all the SSH keys.
Step 4	switch(config)# exit	Exits global configuration mode.
Step 5	(Optional) switch# show ssh key	Displays the SSH server configuration.
Step 6	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Clearing SSH Sessions

You can clear SSH sessions from the Cisco Nexus device.

SUMMARY STEPS

1. switch# **show users**
2. switch# **clear line vty-line**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show users	Displays user session information.
Step 2	switch# clear line vty-line	Clears a user SSH session.

Configuration Examples for SSH

The following example shows how to configure SSH:

SUMMARY STEPS

1. Generate an SSH server key.
2. Enable the SSH server.
3. Display the SSH server key.
4. Specify the SSH public key in Open SSH format.
5. Save the configuration.

DETAILED STEPS

Step 1 Generate an SSH server key.

```
switch(config)# ssh key rsa
generating rsa key(1024 bits).....
.
generated rsa key
```

Step 2 Enable the SSH server.

```
switch# configure terminal
switch(config)# feature ssh
```

Note This step should not be required because the SSH server is enabled by default.

Step 3 Display the SSH server key.

```
switch(config)# show ssh key
rsa Keys generated:Fri May  8 22:09:47 2009

ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAIEAri3mQy4W1AV9Y2t2hrEWgbUEYzCfTPO5B8LRkedn56BEy2N9ZcdpqE6aqJLZwfZ/
cTFEzaAAZp9AS86dgBAjsKGS7UxnhGySr8ZELv+DQBsDQH6rZt0KR+2Da8hJD4ZXIeccWk0gS1DQUNZ300xstQsYZUtqnx1bvm5/
Ninn0Mc=

bitcount:1024
fingerprint:
4b:4d:f6:b9:42:e9:d9:71:3c:bd:09:94:4a:93:ac:ca
*****
could not retrieve dsa key information
*****
```

Step 4 Specify the SSH public key in Open SSH format.

```
switch(config)# username User1 sshkey ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAIEAri3mQy4W1AV9Y2t2hrEWgbUEYz
CfTPO5B8LRkedn56BEy2N9ZcdpqE6aqJLZwfZcTFEzaAAZp9AS86dgBAjsKGS7UxnhGySr8ZELv+DQBsDQH6rZt0KR+2Da8hJD4Z
XIeccWk0gS1DQUNZ300xstQsYZUtqnx1bvm5Ninn0McNinn0Mc=
```

Step 5 Save the configuration.

```
switch(config)# copy running-config startup-config
```

Configuring X.509v3 Certificate-Based SSH Authentication

You can configure SSH authentication using X.509v3 certificates.

Before you begin

Enable the SSH server on the remote device.

SUMMARY STEPS

1. **configure terminal**
2. **username** *user-id* [**password** [0 | 5] *password*]
3. **username** *user-id* **ssh-cert-dn** *dn-name* {**dsa** | **rsa**}
4. [**no**] **crypto ca trustpoint** *trustpoint*
5. [**no**] **crypto ca authentication** *trustpoint*
6. **crypto ca crl request** *trustpoint* **bootflash:static-crl.crl**
7. (Optional) **show crypto ca certificates**
8. (Optional) **show crypto ca crl** *trustpoint*
9. (Optional) **show user-account**
10. (Optional) **show users**
11. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	username <i>user-id</i> [password [0 5] <i>password</i>] Example: <pre>switch(config)# username jsmith password 4Ty18Rnt</pre>	Configures a user account. The <i>user-id</i> argument is a case-sensitive, alphanumeric character string with a maximum length of 28 characters. Valid characters are uppercase letters A through Z, lowercase letters a through z, numbers 0 through 9, hyphen (-), period (.), underscore (_), plus sign (+), and equal sign (=). The at symbol (@)

	Command or Action	Purpose
		<p>is supported in remote usernames but not in local usernames.</p> <p>Usernames must begin with an alphanumeric character.</p> <p>The default password is undefined. The 0 option indicates that the password is clear text, and the 5 option indicates that the password is encrypted. The default is 0 (clear text).</p> <p>Note If you do not specify a password, the user might not be able to log in to the Cisco NX-OS device.</p> <p>Note If you create a user account with the encrypted password option, the corresponding SNMP user will not be created.</p>
Step 3	<p>username <i>user-id</i> ssh-cert-dn <i>dn-name</i> {dsa rsa}</p> <p>Example:</p> <pre>switch(config)# username jsmith ssh-cert-dn "/O = ABCcompany, OU = ABC1, emailAddress = jsmith@ABCcompany.com, L = Metropolis, ST = New York, C = US, CN = jsmith" rsa</pre>	Specifies an SSH X.509 certificate distinguished name and DSA or RSA algorithm to use for authentication for an existing user account. The distinguished name can be up to 512 characters and must follow the format shown in the examples. Make sure the email address and state are configured as emailAddress and ST, respectively.
Step 4	<p>[no] crypto ca trustpoint <i>trustpoint</i></p> <p>Example:</p> <pre>switch(config)# crypto ca trustpoint winca</pre>	Configures a trustpoint.
Step 5	<p>[no] crypto ca authentication <i>trustpoint</i></p> <p>Example:</p> <pre>switch(config)# crypto ca authentication winca</pre>	Configures a certificate chain for the trustpoint.
Step 6	<p>crypto ca crl request <i>trustpoint</i> bootflash:static-crl.crl</p> <p>Example:</p> <pre>switch(config)# crypto ca crl request winca bootflash:crllist.crl</pre>	<p>Configures the certificate revocation list (CRL) for the trustpoint. The CRL file is a snapshot of the list of revoked certificates by the trustpoint. This static CRL list is manually copied to the device from the Certification Authority (CA).</p> <p>Note Static CRL is the only supported revocation check method.</p>
Step 7	<p>(Optional) show crypto ca certificates</p> <p>Example:</p> <pre>switch(config)# show crypto ca certificates</pre>	Displays the configured certificate chain and associated trustpoint.
Step 8	<p>(Optional) show crypto ca crl <i>trustpoint</i></p> <p>Example:</p> <pre>switch(config)# show crypto ca crl winca</pre>	Displays the contents of the CRL list of the specified trustpoint.

	Command or Action	Purpose
Step 9	(Optional) show user-account Example: switch(config)# show user-account	Displays configured user account details.
Step 10	(Optional) show users Example: switch(config)# show users	Displays the users logged into the device.
Step 11	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuration Example for X.509v3 Certificate-Based SSH Authentication

The following example shows how to configure SSH authentication using X.509v3 certificates:

```

configure terminal
username jsmith password 4Ty18Rnt
username jsmith ssh-cert-dn "/O = ABCcompany, OU = ABC1,
emailAddress = jsmith@ABCcompany.com, L = Metropolis, ST = New York, C = US, CN = jsmith"
rsa
crypto ca trustpoint tp1
crypto ca authentication tp1
crypto ca crl request tp1 bootflash:crl1.crl

show crypto ca certificates
Trustpoint: tp1
CA certificate 0:
subject= /CN=SecDevCA
issuer= /CN=SecDevCA
serial=01AB02CD03EF04GH05IJ06KL07MN
notBefore=Jun 29 12:36:26 2016 GMT
notAfter=Jun 29 12:46:23 2021 GMT
SHA1 Fingerprint=47:29:E3:00:C1:C1:47:F2:56:8B:AC:B2:1C:64:48:FC:F4:8D:53:AF
purposes: sslserver sslclient

show crypto ca crl tp1
Trustpoint: tp1 CRL: Certificate Revocation List (CRL):
Version 2 (0x1)
Signature Algorithm: sha1WithRSAEncryption
Issuer: /CN=SecDevCA
Last Update: Aug 8 20:03:15 2016 GMT
Next Update: Aug 16 08:23:15 2016 GMT
CRL extensions:
  X509v3 Authority Key Identifier:
    keyid:30:43:AA:80:10:FE:72:00:DE:2F:A2:17:E4:61:61:44:CE:78:FF:2A

show user-account
user:user1
  this user account has no expiry date
  roles:network-operator
  ssh cert DN : /C = US, ST = New York, L = Metropolis, O = cisco , OU = csg, CN =

```

```
user1; Algo: x509v3-sign-rsa
```

```
show users
NAME      LINE      TIME      IDLE      PID      COMMENT
user1     pts/1     Jul 27 18:43 00:03     18796    (10.10.10.1)  session=ssh
```

Configuring Telnet

Enabling the Telnet Server

By default, the Telnet server is enabled. You can disable the Telnet server on your Cisco Nexus device.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **[no] feature telnet**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# [no] feature telnet	Enables/disables the Telnet server. The default is enabled.

Reenabling the Telnet Server

If the Telnet server on your Cisco Nexus device has been disabled, you can reenabling it.

SUMMARY STEPS

1. switch(config)# **[no] feature telnet**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch(config)# [no] feature telnet	Reenables the Telnet server.

Configuring the Telnet Source Interface

You can configure Telnet to use a specific interface.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **ip telnet source-interface** *type slot/port*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# ip telnet source-interface <i>type slot/port</i>	Configures the source interface for all Telnet packets. The following list contains the valid values for <i>interface</i> . <ul style="list-style-type: none"> • ethernet • loopback • mgmt • port-channel • vlan

Example

This example shows how to configure the Telnet source interface:

```
switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# ip telnet source-interface ethernet 1/6
switch(config)# show ip telnet source-interface
VRF Name                               Interface
default                                Ethernet1/6
switch(config)#
```

Starting Telnet Sessions to Remote Devices

Before you start a Telnet session to connect to remote devices, you should do the following:

- Obtain the hostname for the remote device and, if needed, obtain the username on the remote device.
- Enable the Telnet server on the Cisco Nexus device.
- Enable the Telnet server on the remote device.

SUMMARY STEPS

1. switch# **telnet** *hostname*

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# telnet <i>hostname</i>	Creates a Telnet session to a remote device. The <i>hostname</i> argument can be an IPv4 address or a device name.

Example

The following example shows how to start a Telnet session to connect to a remote device:

```
switch# telnet 10.10.1.1
Trying 10.10.1.1...
Connected to 10.10.1.1.
Escape character is '^'.
switch login:
```

Clearing Telnet Sessions

You can clear Telnet sessions from the Cisco Nexus device.

SUMMARY STEPS

1. switch# **show users**
2. switch# **clear line vty-line**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show users	Displays user session information.
Step 2	switch# clear line vty-line	Clears a user Telnet session.

Verifying the SSH and Telnet Configuration

To display the SSH configuration information, perform one of the following tasks:

Command or Action	Purpose
switch# show ssh key [dsa rsa][md5]	Displays SSH server keys.
switch# show running-config security [all]	Displays the SSH and user account configuration in the running configuration. The all keyword displays the default values for the SSH and user accounts.
switch# show ssh server	Displays the SSH server configuration.
switch# show user-account	Displays user account information.
switch# show users	Displays the users logged into the device.
switch# show crypto ca certificates	Displays the configured certificate chain and associated trustpoint for X.509v3 certificate-based SSH authentication.
switch# show crypto ca crl trustpoint	Displays the contents of the CRL list of the specified trustpoint for X.509v3 certificate-based SSH authentication.

Default Settings for SSH

The following table lists the default settings for SSH parameters.

Table 9: Default SSH Parameters

Parameters	Default
SSH server	Enabled
SSH server key	RSA key generated with 1024 bits
RSA key bits for generation	1024
Telnet server	Enabled



CHAPTER 8

Configuring PKI

This chapter describes the Public Key Infrastructure (PKI) support on the Cisco NX-OS device. PKI allows the device to obtain and use digital certificates for secure communication in the network and provides manageability and scalability for Secure Shell (SSH).

This chapter includes the following sections:

- [Information About PKI, on page 113](#)
- [Guidelines and Limitations for PKI, on page 119](#)
- [Default Settings for PKI, on page 120](#)
- [Configuring CAs and Digital Certificates, on page 120](#)
- [Verifying the PKI Configuration, on page 139](#)
- [Configuration Examples for PKI, on page 139](#)
- [Resource Public Key Infrastructure \(RPKI\), on page 160](#)
- [RPKI Configuration, on page 160](#)
- [RPKI Show Commands, on page 162](#)
- [RPKI Clear Commands, on page 163](#)
- [RPKI Debug and Event History Commands, on page 163](#)

Information About PKI

This section provides information about PKI.

CAs and Digital Certificates

Certificate authorities (CAs) manage certificate requests and issue certificates to participating entities such as hosts, network devices, or users. The CAs provide centralized key management for the participating entities.

Digital signatures, based on public key cryptography, digitally authenticate devices and individual users. In public key cryptography, such as the RSA encryption system, each device or user has a key pair that contains both a private key and a public key. The private key is kept secret and is known only to the owning device or user only. However, the public key is known to everybody. Anything encrypted with one of the keys can be decrypted with the other. A signature is formed when data is encrypted with a sender's private key. The receiver verifies the signature by decrypting the message with the sender's public key. This process relies on the receiver having a copy of the sender's public key and knowing with a high degree of certainty that it really does belong to the sender and not to someone pretending to be the sender.

Digital certificates link the digital signature to the sender. A digital certificate contains information to identify a user or device, such as the name, serial number, company, department, or IP address. It also contains a copy of the entity's public key. The CA that signs the certificate is a third party that the receiver explicitly trusts to validate identities and to create digital certificates.

To validate the signature of the CA, the receiver must first know the CA's public key. Typically, this process is handled out of band or through an operation done at installation. For instance, most web browsers are configured with the public keys of several CAs by default.

Trust Model, Trust Points, and Identity CAs

The PKI trust model is hierarchical with multiple configurable trusted CAs. You can configure each participating device with a list of trusted CAs so that a peer certificate obtained during the security protocol exchanges can be authenticated if it was issued by one of the locally trusted CAs. The Cisco NX-OS software locally stores the self-signed root certificate of the trusted CA (or certificate chain for a subordinate CA). The process of securely obtaining a trusted CA's root certificate (or the entire chain in the case of a subordinate CA) and storing it locally is called *CA authentication*.

The information about a trusted CA that you have configured is called the *trust point* and the CA itself is called a *trust point CA*. This information consists of a CA certificate (or certificate chain in case of a subordinate CA) and certificate revocation checking information.

The Cisco NX-OS device can also enroll with a trust point to obtain an identity certificate to associate with a key pair. This trust point is called an *identity CA*.

CA Certificate Hierarchy

For secure services, you typically have multiple trusted CAs. The CAs are usually installed in all the hosts as a bundle. The NX-OS PKI infrastructure does support importing certificate chain. However, with the current CLIs, one chain at a time can be installed. This procedure can be cumbersome when there are several CA chains to be installed. This requires a facility to download CA bundles that could include several intermediate and root CAs.

Importing CA Bundle

The **crypto CA trustpoint** command binds the CA certificates, CRLs, identity certificates and key pairs to a named label. All files corresponding to each of these entities are stored in the NX-OS certstore directory (`/isan/etc/certstore`) and tagged with the trustpoint label.

To access the CA certificates, an SSL app only needs to point to the standard NX-OS cert-store and specify that as the CA path during SSL initialization. It does not need to be aware of the trustpoint label under which CAs are installed.

If clients need to bind to an identity certificate, the trustpoint label needs to be used as the binding point.

The `import pkcs` command is enhanced to install the CA certificates under a trustpoint label. This can be further enhanced to install a CA bundle. The import command structure is modified to add `pkcs7` option which is used for providing CA bundle file in `pkcs7` format.

Beginning with Cisco NX-OS Release 10.1(1), the `pkcs7` file format is supported to unpack the CA bundle and install each CA chain under its own label. The labels are formed by appending an index to the main trustpoint label.

Once installed, there is no logical binding of all CA chains to a bundle.

Import of the CA Certificate Bundle in PKCS7 Format

To support the import of the ca certificate bundle which consists of multiple independent certificate chains, the option of 'pkcs7' is introduced in the crypto import command.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca import** *<baselabel>* **pkcs7** *<uri0>* **force**
3. **crypto ca cabundle** *<bundle-name>*
4. **exit**
5. (Optional) **show crypto ca certificates**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto ca import <i><baselabel></i> pkcs7 <i><uri0></i> force	<p>There are two input arguments in the command. The source file which is the ca bundle file is given in the <i><uri0></i>, the input file has to be in pkcs7 format indicating that it is a cabundle file.</p> <p>Multiple certificate chains will be extracted out of the cabundle. The command will generate multiple trustpoints with ca certificate chain attached to each one. Import command generates two configurations which are global CA bundle configuration and CA bundle sub-configuration with each trustpoint generated.</p> <p>The force option removes the CA bundle and related trustpoint configurations, imports a new CA bundle with the same bundle name, and generates fresh trustpoint configurations related to the cabundle.</p>
Step 3	crypto ca cabundle <i><bundle-name></i>	<p>The bundle-name is same as baselabel for import case. You can use the no form of this command to delete the, CA bundle, trustpoints, and related certificate chains.</p> <p>After importing CA bundle under a particular baselabel name and generating all the trustpoints, if a user try to execute the import command again under the same baselabel name, it will throw error saying CA bundle already exists. The user can use force option to modify the existing CA bundle.</p> <p>Maximum number of Cabundles supported is 20.</p>

	Command or Action	Purpose
Step 4	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 5	(Optional) show crypto ca certificates Example: <pre>switch# show crypto ca certificates</pre>	Displays the CA certificates.
Step 6	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

RSA Key Pairs and Identity Certificates

You can obtain an identity certificate by generating one or more RSA key pairs and associating each RSA key pair with a trust point CA where the Cisco NX-OS device intends to enroll. The Cisco NX-OS device needs only one identity per CA, which consists of one key pair and one identity certificate per CA.

The Cisco NX-OS software allows you to generate RSA key pairs with a configurable key size (or modulus). The default key size is 512. You can also configure an RSA key-pair label. The default key label is the device fully qualified domain name (FQDN).

The following list summarizes the relationship between trust points, RSA key pairs, and identity certificates:

- A trust point corresponds to a specific CA that the Cisco NX-OS device trusts for peer certificate verification for any application (such as SSH).
- A Cisco NX-OS device can have many trust points and all applications on the device can trust a peer certificate issued by any of the trust point CAs.
- A trust point is not restricted to a specific application.
- A Cisco NX-OS device enrolls with the CA that corresponds to the trust point to obtain an identity certificate. You can enroll your device with multiple trust points which means that you can obtain a separate identity certificate from each trust point. The identity certificates are used by applications depending upon the purposes specified in the certificate by the issuing CA. The purpose of a certificate is stored in the certificate as a certificate extension.
- When enrolling with a trust point, you must specify an RSA key pair to be certified. This key pair must be generated and associated to the trust point before generating the enrollment request. The association between the trust point, key pair, and identity certificate is valid until it is explicitly removed by deleting the certificate, key pair, or trust point.
- The subject name in the identity certificate is the fully qualified domain name for the Cisco NX-OS device.
- You can generate one or more RSA key pairs on a device and each can be associated to one or more trust points. But no more than one key pair can be associated to a trust point, which means only one identity certificate is allowed from a CA.

- If the Cisco NX-OS device obtains multiple identity certificates (each from a distinct CA), the certificate that an application selects to use in a security protocol exchange with a peer is application specific.
- You do not need to designate one or more trust points for an application. Any application can use any certificate issued by any trust point as long as the certificate purpose satisfies the application requirements.
- You do not need more than one identity certificate from a trust point or more than one key pair to be associated to a trust point. A CA certifies a given identity (or name) only once and does not issue multiple certificates with the same name. If you need more than one identity certificate for a CA and if the CA allows multiple certificates with the same names, you must define another trust point for the same CA, associate another key pair to it, and have it certified.

Multiple Trusted CA Support

The Cisco NX-OS device can trust multiple CAs by configuring multiple trust points and associating each with a distinct CA. With multiple trusted CAs, you do not have to enroll a device with the specific CA that issued the certificate to a peer. Instead, you can configure the device with multiple trusted CAs that the peer trusts. The Cisco NX-OS device can then use a configured trusted CA to verify certificates received from a peer that were not issued by the same CA defined in the identity of the peer device.

PKI Enrollment Support

Enrollment is the process of obtaining an identity certificate for the device that is used for applications like SSH. It occurs between the device that requests the certificate and the certificate authority.

The Cisco NX-OS device performs the following steps when performing the PKI enrollment process:

- Generates an RSA private and public key pair on the device.
- Generates a certificate request in standard format and forwards it to the CA.



Note The CA administrator may be required to manually approve the enrollment request at the CA server, when the request is received by the CA.

- Receives the issued certificate back from the CA, signed with the CA's private key.
- Writes the certificate into a nonvolatile storage area on the device (bootflash).

Manual Enrollment Using Cut-and-Paste

The Cisco NX-OS software supports certificate retrieval and enrollment using manual cut-and-paste. Cut-and-paste enrollment means that you must cut and paste the certificate requests and resulting certificates between the device and the CA.

You must perform the following steps when using cut and paste in the manual enrollment process:

- Create an enrollment certificate request, which the Cisco NX-OS device displays in base64-encoded text form.
- Cut and paste the encoded certificate request text in an e-mail or in a web form and send it to the CA.

- Receive the issued certificate (in base64-encoded text form) from the CA in an e-mail or in a web browser download.
- Cut and paste the issued certificate to the device using the certificate import facility.

Multiple RSA Key Pair and Identity CA Support

Multiple identity CAs enable the device to enroll with more than one trust point, which results in multiple identity certificates, each from a distinct CA. With this feature, the Cisco NX-OS device can participate in SSH and other applications with many peers using certificates issued by CAs that are acceptable to those peers.

The multiple RSA key-pair feature allows the device to maintain a distinct key pair for each CA with which it is enrolled. It can match policy requirements for each CA without conflicting with the requirements specified by the other CAs, such as the key length. The device can generate multiple RSA key pairs and associate each key pair with a distinct trust point. Thereafter, when enrolling with a trust point, the associated key pair is used to construct the certificate request.

Peer Certificate Verification

The PKI support on a Cisco NX-OS device can verify peer certificates. The Cisco NX-OS software verifies certificates received from peers during security exchanges for applications, such as SSH. The applications verify the validity of the peer certificates. The Cisco NX-OS software performs the following steps when verifying peer certificates:

- Verifies that the peer certificate is issued by one of the locally trusted CAs.
- Verifies that the peer certificate is valid (not expired) with respect to current time.
- Verifies that the peer certificate is not yet revoked by the issuing CA.

For revocation checking, the Cisco NX-OS software supports the certificate revocation list (CRL). A trust point CA can use this method to verify that the peer certificate has not been revoked.

Certificate Revocation Checking

The Cisco NX-OS software can check the revocation status of CA certificates. The applications can use the revocation checking mechanisms in the order that you specify. The choices are CRL, NDCPP: OCSP for Syslog, none, or a combination of these methods.

CRL Support

The CAs maintain certificate revocation lists (CRLs) to provide information about certificates revoked prior to their expiration dates. The CAs publish the CRLs in a repository and provide the download public URL in all issued certificates. A client verifying a peer's certificate can obtain the latest CRL from the issuing CA and use it to determine if the certificate has been revoked. A client can cache the CRLs of some or all of its trusted CAs locally and use them later if necessary until the CRLs expire.

The Cisco NX-OS software allows the manual configuration of predownloaded CRLs for the trust points, and then caches them in the device bootflash (cert-store). During the verification of a peer certificate, the Cisco NX-OS software checks the CRL from the issuing CA only if the CRL has already been cached locally and the revocation checking is configured to use the CRL. Otherwise, the Cisco NX-OS software does not perform

CRL checking and considers the certificate to be not revoked unless you have configured other revocation checking methods.

NDcPP: OCSP for Syslog

Online Certificate Status Protocol (OCSP) is a method to check certificate revocation when a peer has to retrieve this revocation information and then validate it to check the certificate revocation status. In this method, the certification revocation status is limited by the peer's ability to reach an OCSP responder through the cloud or by the certificate sender's performance in retrieving the certificate revocation-information.

When the remote syslog server shares the certificate which has an OCSP responder URL, the client sends the server certificate to an external OCSP responder (CA) server. The CA server validates this certificate and confirms if it is a valid or a revoked certificate. In this case, the client does not have to maintain the revoked certificate list locally.

Import and Export Support for Certificates and Associated Key Pairs

As part of the CA authentication and enrollment process, the subordinate CA certificate (or certificate chain) and identity certificates can be imported in standard PEM (base64) format.

The complete identity information in a trust point can be exported to a file in the password-protected PKCS#12 standard format. It can be later imported to the same device (for example, after a system crash) or to a replacement device. The information in a PKCS#12 file consists of the RSA key pair, the identity certificate, and the CA certificate (or chain).

Guidelines and Limitations for PKI

PKI has the following configuration guidelines and limitations:

- The maximum number of key pairs you can configure on a Cisco NX-OS device is 16.
- The maximum number of trust points you can declare on a Cisco NX-OS device is 16.
- The maximum number of identity certificates that you can configure on a Cisco NX-OS device are 16.
- The maximum number of certificates in a CA certificate chain is 10.
- The maximum number of trust points you can authenticate to a specific CA is 10.
- Configuration rollbacks do not support the PKI configuration.
- Beginning with Cisco NX-OS Release 9.3(5), Cisco NX-OS software supports NDcPP: OCSP for Syslog.
- Beginning with Cisco NX-OS Release 10.3(3)F, Elliptic Curve Cryptography (ECC) key pair support is provided to generate and import the certificate on Cisco Nexus switches.



Note If you are familiar with the Cisco IOS CLI, be aware that the Cisco NX-OS commands for this feature might differ from the Cisco IOS commands that you would use.

Default Settings for PKI

This table lists the default settings for PKI parameters.

Table 10: Default PKI Parameters

Parameters	Default
Trust point	None
RSA key pair	None
RSA key-pair label	Device FQDN
RSA key-pair modulus	512
RSA key-pair exportable	Enabled
Revocation check method	CRL

Configuring CAs and Digital Certificates

This section describes the tasks that you must perform to allow CAs and digital certificates on your Cisco NX-OS device to interoperate.

Configuring the Hostname and IP Domain Name

You must configure the hostname and IP domain name of the device if you have not yet configured them because the Cisco NX-OS software uses the fully qualified domain name (FQDN) of the device as the subject in the identity certificate. Also, the Cisco NX-OS software uses the device FQDN as a default key label when you do not specify a label during key-pair generation. For example, a certificate named DeviceA.example.com is based on a device hostname of DeviceA and a device IP domain name of example.com.



Caution Changing the hostname or IP domain name after generating the certificate can invalidate the certificate.

SUMMARY STEPS

1. **configure terminal**
2. **hostname** *hostname*
3. **ip domain-name** *name* [**use-vrf** *vrf-name*]
4. **exit**
5. (Optional) **show hosts**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	hostname <i>hostname</i> Example: switch(config)# hostname DeviceA	Configures the hostname of the device.
Step 3	ip domain-name <i>name</i> [use-vrf <i>vrf-name</i>] Example: DeviceA(config)# ip domain-name example.com	Configures the IP domain name of the device. If you do not specify a VRF name, the command uses the default VRF.
Step 4	exit Example: switch(config)# exit switch#	Exits configuration mode.
Step 5	(Optional) show hosts Example: switch# show hosts	Displays the IP domain name.
Step 6	(Optional) copy running-config startup-config Example: switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Generating an RSA Key Pair

You can generate an RSA key pairs to sign and/or encrypt and decrypt the security payload during security protocol exchanges for applications. You must generate the RSA key pair before you can obtain a certificate for your device.

Beginning Cisco NX-OS Release 9.3(3), you must explicitly generate RSA key pairs before you associate the Cisco NX-OS device with a trust point CA. Prior to Cisco NX-OS Releases 9.3(3), if unavailable, the RSA key pairs would be auto generated.

SUMMARY STEPS

1. **configure terminal**
2. **crypto key generate rsa [label *label-string*] [exportable] [modulus *size*]**
3. **exit**
4. (Optional) **show crypto key mypubkey rsa**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto key generate rsa [label <i>label-string</i>] [exportable] [modulus <i>size</i>] Example: <pre>switch(config)# crypto key generate rsa exportable</pre>	<p>Generates an RSA key pair. The maximum number of key pairs on a device is 16.</p> <p>The label string is alphanumeric, case sensitive, and has a maximum length of 64 characters. The default label string is the hostname and the FQDN separated by a period character (.).</p> <p>Valid modulus values are 512, 768, 1024, 1536, and 2048. The default modulus size is 512.</p> <p>Note The security policy on the Cisco NX-OS device and on the CA (where enrollment is planned) should be considered when deciding the appropriate key modulus.</p> <p>By default, the key pair is not exportable. Only exportable key pairs can be exported in the PKCS#12 format.</p> <p>Caution You cannot change the exportability of a key pair.</p>
Step 3	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 4	(Optional) show crypto key mypubkey rsa Example: <pre>switch# show crypto key mypubkey rsa</pre>	Displays the generated key.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Generating an ECC Key Pair

You can generate an ECC key pair to sign and/or encrypt and decrypt the security payload during security protocol exchanges for applications. You must generate the ECC key pair before you can obtain a certificate for your device. The ECC keys are stronger compared to RSA keys for a given length.

Beginning Cisco NX-OS Release 10.3(3)F, you can generate an ECC key pair to associate the Cisco NX-OS device with a trust point CA.

SUMMARY STEPS

1. **configure terminal**
2. **crypto key generate ecc** [*label ecc-key-label*] [**exportable**] [*modulus size*]
3. **no crypto key generate ecc** [*label ecc-key-label*]
4. **exit**
5. (Optional) **show crypto key mypubkey ecc**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto key generate ecc [<i>label ecc-key-label</i>] [exportable] [<i>modulus size</i>] Example: <pre>switch(config)# crypto key generate ecc exportable modulus 224</pre>	<p>Generates an RSA key pair. The maximum number of key pairs on a device is 16.</p> <p>The label string is alphanumeric, case sensitive, and has maximum length of 64 characters. The default label string is the hostname and the FQDN separated by a period character (.).</p> <p>Valid modulus values are 224, 384, and 521. The default modulus size is 224.</p> <p>Note The security policy on the Cisco NX-OS device and on the CA (where enrollment is planned) should be considered when deciding the appropriate key modulus.</p> <p>By default, the key pair is not exportable. Only exportable key pairs can be exported in the PKCS#12 format.</p> <p>Caution You cannot change the exportability of a key pair.</p>
Step 3	no crypto key generate ecc [<i>label ecc-key-label</i>] Example: <pre>switch(config)# no crypto key generate ecc label label-name</pre>	Deletes the ECC key.
Step 4	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 5	(Optional) show crypto key mypubkey ecc Example: <pre>switch# show crypto key mypubkey ecc</pre>	Displays the generated ECC key.

	Command or Action	Purpose
Step 6	(Optional) copy running-config startup-config Example: switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Creating a Trust Point CA Association

You must associate the Cisco NX-OS device with a trust point CA.

Before you begin

Generate the RSA key pair.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca trustpoint** *name*
3. **cabundle** *baselabel*
4. **enrollment terminal**
5. **rsa** *label*
6. **exit**
7. (Optional) **show crypto ca trustpoints**
8. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	crypto ca trustpoint <i>name</i> Example: switch(config)# crypto ca trustpoint admin-ca switch(config-trustpoint)#	Declares a trust point CA that the device should trust and enters trust point configuration mode. Note The maximum number of trustpoints that can be configured is 50.
Step 3	cabundle <i>baselabel</i> Example: switch(config-trustpoint)# cabundle test	Groups the trustpoints under a specific CA bundle. The No form of this command detaches the trustpoints from the CA bundle. This command associates the trustpoints to an existing CA bundle and it does not configure any new CA bundle.
Step 4	enrollment terminal Example:	Enables manual cut-and-paste certificate enrollment. The default is enabled.

	Command or Action	Purpose
	<code>switch(config-trustpoint)# enrollment terminal</code>	Note The Cisco NX-OS software supports only the manual cut-and-paste method for certificate enrollment.
Step 5	rsa keypair <i>label</i> Example: <code>switch(config-trustpoint)# rsa keypair SwitchA</code>	Specifies the label of the RSA key pair to associate to this trust point for enrollment. Note You can specify only one RSA key pair per CA.
Step 6	exit Example: <code>switch(config-trustpoint)# exit</code> <code>switch(config)#</code>	Exits trust point configuration mode.
Step 7	(Optional) show crypto ca trustpoints Example: <code>switch(config)# show crypto ca trustpoints</code>	Displays trust point information.
Step 8	(Optional) copy running-config startup-config Example: <code>switch(config)# copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

Related Topics

[Generating an RSA Key Pair](#), on page 121

Configuring Certificate Mapping Filters

You can configure mapping filters to validate the CA certificates that are used for authentication. The mapping filters are used to match the CA certificate against a username.

Cisco NX-OS supports the following certificate mapping filters:

- `%username%`—Substitutes the user's login name.
- `%hostname%`—Substitutes the peer hostname.

Before you begin

Configure a cert-store for certificate authentication.

SUMMARY STEPS

1. **configure terminal**
2. **crypto certificatemap** *mapname* *map-name*
3. **filter** [**subject-name** *subject-name* | **altname-email** *e-mail-ID* | **altname-upn** *user-principal-name*]
4. **exit**
5. (Optional) **crypto cert ssh-authorize** [**default** | *issuer-CAname*] [**map** *map-name1* [*map-name2*]]
6. (Optional) **show crypto certificatemap**

7. (Optional) **show crypto ssh-auth-map**
8. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto certificatemap mapname map-name Example: <pre>switch(config)# crypto certificatemap mapname filtermap1</pre>	Creates a new filter map.
Step 3	filter [subject-name subject-name altname-email e-mail-ID altname-upn user-principal-name] Example: <pre>switch(config-certmap-filter)# filter altname-upn %username%@cisco.com</pre>	<p>Configures one or more certificate mapping filters within the filter map. These certificate field attributes are supported in the filters: The validation passes if the certificate passes all of the filters configured in the map.</p> <ul style="list-style-type: none"> • subject-name—The required subject name in the LDAP distinguished name (DN) string format. For example: <pre>filter subject-name CN=%username%</pre> <p>or</p> <pre>filter subject-name /C=IN/ST=KA/L=BLR/O=CISCO/OU=ABC/CN=%username%</pre> • altname-email—The e-mail address that must be present in the certificate as a subject alternative name. For example: <pre>filter altname-email %username%@cisco.com</pre> • altname-upn—The principal name that must be present in the certificate as a subject alternative name. For example: <pre>filter altname-upn %username%@%hostname%</pre> <p>The validation passes if the certificate passes all of the filters configured in the map.</p>
Step 4	exit Example: <pre>switch(config-certmap-filter)# exit switch(config)#</pre>	Exits certificate mapping filter configuration mode.
Step 5	(Optional) crypto cert ssh-authorize [default issuer-CAname] [map map-name1 [map-name2]] Example:	Configures a certificate mapping filter for the Secure Shell (SSH) protocol. You can use the default filter map for SSH authorization or specify the issuer of the CA certificate. If

	Command or Action	Purpose
	<code>switch(config)# crypto cert ssh-authorize default map filtermap1</code>	you do not use the default map, you can specify one or two filter maps for authorization. If you specify the issuer of the CA certificate, the certificate bound to the user account is validated as successful if it passes one of the configured maps.
Step 6	(Optional) show crypto certificatemap Example: <code>switch(config)# show crypto certificatemap</code>	Displays the certificate mapping filters.
Step 7	(Optional) show crypto ssh-auth-map Example: <code>switch(config)# show crypto ssh-auth-map</code>	Displays the mapping filters configured for SSH authentication.
Step 8	(Optional) copy running-config startup-config Example: <code>switch(config)# copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

Authenticating the CA

The configuration process of trusting a CA is complete only when the CA is authenticated to the Cisco NX-OS device. You must authenticate your Cisco NX-OS device to the CA by obtaining the self-signed certificate of the CA in PEM format, which contains the public key of the CA. Because the certificate of the CA is self-signed (the CA signs its own certificate) the public key of the CA should be manually authenticated by contacting the CA administrator to compare the fingerprint of the CA certificate.



Note The CA that you are authenticating is not a self-signed CA when it is a subordinate CA to another CA, which itself may be a subordinate to yet another CA, and so on, finally ending in a self-signed CA. This type of CA certificate is called the *CA certificate chain* of the CA being authenticated. In this case, you must input the full list of the CA certificates of all the CAs in the certification chain during the CA authentication. The maximum number of certificates in a CA certificate chain is 10.

Before you begin

Create an association with the CA.

Obtain the CA certificate or CA certificate chain.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca authenticate** *name pemfile uri0*
3. **exit**
4. (Optional) **show crypto ca trustpoints**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto ca authenticate name pemfile uri0 Example: <pre>switch(config)# crypto ca authenticate admin-ca input (cut & paste) CA certificate (chain) in PEM format; end the input with a line containing only END OF INPUT : -----BEGIN CERTIFICATE----- MIIC4jCCAyGAWIBAgIQBWDsiay0GZRP5Rl1jK0ZejaNEBgkqhkiG9w0BAQFADCB kDEMB4GCSqGSIb3DQEJARYRYWlhbmRrZUBjaXNjb20xZCZAJBgqNBAYTAkLO MRlWEAYDVQQIEw1LYXJuYXRha2ExEjAQBgnVBAClTCUUhcmdbG9yZTEOMAwGA1UE ChMFQ21zY28xezARBgnVBAsTCm5ldHN0b3JhZ2UxejAQBgnVBAMICUFWwYXJuYSBD QTAeFw0wNTA1MDMjMjQ2MzdaFw0wNzA1MDMjMjU1MTdaMIGQMSAwHgYJKoZIhvcN AQkBFhFhWfuzGt1QGncc2NvLmNvbTElMAkGA1UEBhMCSU4xejAQBgnVBAGTCUth cm5hdGFyYTESMBAGA1UEBjMjZ2Fsb3JlMjQ4wDAYDVQQKEwVDaXNjb2EIMBEG A1UECjMkMmV0c3RvcnFhZTESMBAGA1UEEjMjZ2Fsb3JlMjQ4wDAYDVQXQXBhcn5h IENEMFwwDQYJKoZIhvcNAQEBBQADSwAwSAJBAM/7b3+DXJPANBsIHHZluNocNM87ypyzwuoSNZXQmpeRXXI OzyBAGiXIT2ASFuUoWQliDM8r0/41jf8RrvYKvysCAwEAAsOBvzCBvDALBgNVHQ8E BAMCAcywDwYDR0TAQH/BAUwAwEB/zAcBgNVHQ4EFgQUUjyRqMbrCNMRU2OyRhQ GgsWbHedwawYDVR0fBGMwYjAucyYgKoYoahr0cDovL3NzZS0wOC9DZXJ0RW5yb2xs L0FwYXJuYXNjYmENBmNybDAwOC6GgLIYgZmlsZTovL1xccc3NLLTA4XENLcnRfbnJv bGxcQXBhcn5hJTITwQ0EuY3JsbGAgCSsGAQQBgjcVAQODAgaFAMA0GCSqGSIb3DQEB BQJUA0EAHv6UQ+8nE399Tww+KaGrOg0NLJaqNgLh0AFcT0rEyuyt/WYGPzksF9Ea NBG7E0oN66zex0EOEfg1Vs6mXp1//w== -----END CERTIFICATE----- END OF INPUT Fingerprint(s): MD5 Fingerprint=65:84:9A:27:D5:71:03:33:9C:12:23:92:38:6F:78:12 Do you accept this certificate? [yes/no]: yes</pre>	<p>Prompts you to cut and paste the certificate of the CA. Use the same name that you used when declaring the CA.</p> <p>Also validates and attaches the CA chain directly to the specified trust point.</p> <p>The maximum number of trust points that you can authenticate to a specific CA is 10.</p> <p>Note For subordinate CA authentication, the Cisco NX-OS software requires the full chain of CA certificates ending in a self-signed CA because the CA chain is needed for certificate verification as well as for PKCS#12 format export.</p>
Step 3	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 4	(Optional) show crypto ca trustpoints Example: <pre>switch# show crypto ca trustpoints</pre>	Displays the trust point CA information.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Related Topics

[Creating a Trust Point CA Association](#), on page 124

Configuring Certificate Revocation Checking Methods

During security exchanges with a client (for example, an SSH user), the Cisco NX-OS device performs the certificate verification of the peer certificate sent by the client. The verification process may involve certificate revocation status checking.

You can configure the device to check the CRL downloaded from the CA. Downloading the CRL and checking locally does not generate traffic in your network. However, certificates can be revoked between downloads and your device would not be aware of the revocation.

Before you begin

Authenticate the CA.

Ensure that you have configured the CRL if you want to use CRL checking.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca trustpoint** *name*
3. **revocation-check** {crl [none] | none}
4. **exit**
5. (Optional) **show crypto ca trustpoints**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	crypto ca trustpoint <i>name</i> Example: switch(config)# crypto ca trustpoint admin-ca switch(config-trustpoint)#	Specifies a trust point CA and enters trust point configuration mode.
Step 3	revocation-check {crl [none] none} Example: switch(config-trustpoint)# revocation-check none	Configures the certificate revocation checking methods. The default method is crl . The Cisco NX-OS software uses the certificate revocation methods in the order that you specify.
Step 4	exit Example: switch(config-trustpoint)# exit switch(config)#	Exits trust point configuration mode.
Step 5	(Optional) show crypto ca trustpoints Example:	Displays the trust point CA information.

	Command or Action	Purpose
	<code>switch(config)# show crypto ca trustpoints</code>	
Step 6	(Optional) copy running-config startup-config Example: <code>switch(config)# copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

Related Topics

[Authenticating the CA](#), on page 127

[Configuring a CRL](#), on page 135

Generating Certificate Requests

You must generate a request to obtain identity certificates from the associated trust point CA for each of your device's RSA key pairs. You must then cut and paste the displayed request into an e-mail or in a website form for the CA.

Before you begin

Create an association with the CA.

Obtain the CA certificate or CA certificate chain.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca enroll** *name*
3. **exit**
4. (Optional) **show crypto ca certificates**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <code>switch# configure terminal</code> <code>switch(config)#</code>	Enters global configuration mode.
Step 2	crypto ca enroll <i>name</i> Example: <code>switch(config)# crypto ca enroll admin-ca</code> Create the certificate request .. Create a challenge password. You will need to verbally provide this password to the CA Administrator in order to revoke your certificate. For security reasons your password will not be saved in the configuration. Please make a note of it.	Generates a certificate request for an authenticated CA. Note You must remember the challenge password. It is not saved with the configuration. You must enter this password if your certificate needs to be revoked.

	Command or Action	Purpose
	<pre> Password:nbv123 The subject name in the certificate will be: DeviceA.cisco.com Include the switch serial number in the subject name? [yes/no]: no Include an IP address in the subject name [yes/no]: yes ip address:172.22.31.162 The certificate request will be displayed... -----BEGIN CERTIFICATE REQUEST----- MIIBgzCCARQCAQAwHDEaMBGGA1UEAxMFvmtvYXNjby5jb20wZ8wDQYJ KoZlHvcNAQEEBQADgY0AMIGJAoGBAL8Y1UAJ2NC7jU1DVaSMqNIgJ2kt8r141KY 0JCQanNy4qdk8VeMXZSiLJ4JgTzKWdxLdKtTysnjuCXGvjb+wh0Ehv/y51T9y P2NJJ8omqShrvFZgC7ysN/PyMwKcgzhbVpj+rargZvHtGJ91XTq4WoVksCzXv8S VqyH0vEvAgMBAAGTzAVBgkqhkiG9w0BQCxCEM3mJ2MTIzMDYGCsGSIb3DQEJ DjEgMCcwJQYDRORAGH/BBswGYIRvmtvYXNjby5jb22HBKwWH6IwDQYJ KoZlHvcNAQEEBQADgYEAKT60KER6Qo8nj0sDXZVHSfJZh6K6JtDz3Gkd99GLFWgt PftzNcWUE/pw6HayfQl2T3ecgNwe12d15133YBF2bktExiI6U188nTOjg1XMjja8 8a23bNDpNsM8rklwA6hWkrVL8NUZEFJxcqbjfngPNTZacJCUS6ZqfCMetbKytUx0= -----END CERTIFICATE REQUEST----- </pre>	
Step 3	<pre> exit Example: switch(config-trustpoint)# exit switch(config)# </pre>	Exits trust point configuration mode.
Step 4	<pre> (Optional) show crypto ca certificates Example: switch(config)# show crypto ca certificates </pre>	Displays the CA certificates.
Step 5	<pre> (Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config </pre>	Copies the running configuration to the startup configuration.

Related Topics

[Creating a Trust Point CA Association](#), on page 124

Installing Identity Certificates

You can receive the identity certificate from the CA by e-mail or through a web browser in base64 encoded text form. You must install the identity certificate from the CA by cutting and pasting the encoded text.

Before you begin

Create an association with the CA.

Obtain the CA certificate or CA certificate chain.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca import *name* certificate**

Related Topics

[Creating a Trust Point CA Association](#), on page 124

Ensuring Trust Point Configurations Persist Across Reboots

You can ensure that the trustpoint configuration persists across Cisco NX-OS device reboots.

The trust point configuration is a normal Cisco NX-OS device configuration that persists across system reboots only if you copy it explicitly to the startup configuration. The certificates, key pairs, and CRL associated with a trust point are automatically persistent if you have already copied the trust point configuration in the startup configuration. Conversely, if the trust point configuration is not copied to the startup configuration, the certificates, key pairs, and CRL associated with it are not persistent since they require the corresponding trust point configuration after a reboot. Always copy the running configuration to the startup configuration to ensure that the configured certificates, key pairs, and CRLs are persistent. Also, save the running configuration after deleting a certificate or key pair to ensure that the deletions are permanent.

The certificates and CRL associated with a trust point automatically become persistent when imported (that is, without explicitly copying to the startup configuration) if the specific trust point is already saved in startup configuration.

We recommend that you create a password-protected backup of the identity certificates and save it to an external server.



Note Copying the configuration to an external server does include the certificates and key pairs.

Related Topics

[Exporting Identity Information in PKCS 12 Format](#), on page 133

Exporting Identity Information in PKCS 12 Format

You can export the identity certificate along with the RSA key pair and CA certificate (or the entire chain in the case of a subordinate CA) of a trust point to a PKCS#12 file for backup purposes. You can import the certificate and RSA key pair to recover from a system crash on your device or when you replace the supervisor modules.



Note You can use only the `bootflash:filename` format when specifying the export URL.

Before you begin

Authenticate the CA.

Install an identity certificate.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca export** *name* **pkcs12 bootflash:***filename* *password*
3. **exit**

4. copy bootflash:filename scheme://server/ [url /]filename

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto ca export name pkcs12 bootflash:filename password Example: <pre>switch(config)# crypto ca export admin-ca pkcs12 bootflash:adminid.p12 nbv123</pre>	Exports the identity certificate and associated key pair and CA certificates for a trust point CA. The password is alphanumeric, case sensitive, and has a maximum length of 128 characters.
Step 3	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 4	copy bootflash:filename scheme://server/ [url /]filename Example: <pre>switch# copy bootflash:adminid.p12 tftp:adminid.p12</pre>	<p>Copies the PKCS#12 format file to a remote server.</p> <p>For the <i>scheme</i> argument, you can enter tftp:, ftp:, scp:, or sftp:. The <i>server</i> argument is the address or name of the remote server, and the <i>url</i> argument is the path to the source file on the remote server.</p> <p>The <i>server</i>, <i>url</i>, and <i>filename</i> arguments are case sensitive.</p>

Related Topics

[Generating an RSA Key Pair](#), on page 121

[Authenticating the CA](#), on page 127

[Installing Identity Certificates](#), on page 131

Importing Identity Information in PKCS 12 or PKCS 7 Format

You can import the certificate and RSA key pair to recover from a system crash on your device or when you replace the supervisor modules.



Note You can use only the bootflash:filename format when specifying the import URL.

Before you begin

Ensure that the trust point is empty by checking that no RSA key pair is associated with it and no CA is associated with the trust point using CA authentication.

SUMMARY STEPS

1. **copy** *scheme:// server[/url /]filename bootflash:filename*
2. **configure terminal**
3. **crypto ca import** *name [pkcs12 | pkcs7] bootflash:filename*
4. **exit**
5. (Optional) **show crypto ca certificates**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	copy <i>scheme:// server[/url /]filename bootflash:filename</i> Example: <pre>switch# copy tftp:adminid.p12 bootflash:adminid.p12</pre>	Copies the PKCS#12 format file from the remote server. For the <i>scheme</i> argument, you can enter tftp: , ftp: , scp: , or sftp: . The <i>server</i> argument is the address or name of the remote server, and the <i>url</i> argument is the path to the source file on the remote server. The <i>server</i> , <i>url</i> , and <i>filename</i> arguments are case sensitive.
Step 2	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 3	crypto ca import <i>name [pkcs12 pkcs7] bootflash:filename</i> Example: <pre>switch(config)# crypto ca import admin-ca pkcs12 bootflash:adminid.p12 nbv123</pre>	Imports the identity certificate and associated key pair and CA certificates for trust point CA.
Step 4	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 5	(Optional) show crypto ca certificates Example: <pre>switch# show crypto ca certificates</pre>	Displays the CA certificates.
Step 6	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Configuring a CRL

You can manually configure CRLs that you have downloaded from the trust points. The Cisco NX-OS software caches the CRLs in the device bootflash (cert-store). During the verification of a peer certificate, the Cisco

NX-OS software checks the CRL from the issuing CA only if you have downloaded the CRL to the device and you have configured certificate revocation checking to use the CRL.

Before you begin

Ensure that you have enabled certificate revocation checking.

SUMMARY STEPS

1. **copy** *scheme:[//server/[url /]]filename bootflash:filename*
2. **configure terminal**
3. **crypto ca crl request** *name bootflash:filename*
4. **exit**
5. (Optional) **show crypto ca crl** *name*
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	copy <i>scheme:[//server/[url /]]filename bootflash:filename</i> Example: <pre>switch# copy tftp:adminca.crl bootflash:adminca.crl</pre>	Downloads the CRL from a remote server. For the <i>scheme</i> argument, you can enter tftp: , ftp: , scp: , or sftp: . The <i>server</i> argument is the address or name of the remote server, and the <i>url</i> argument is the path to the source file on the remote server. The <i>server</i> , <i>url</i> , and <i>filename</i> arguments are case sensitive.
Step 2	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 3	crypto ca crl request <i>name bootflash:filename</i> Example: <pre>switch(config)# crypto ca crl request admin-ca bootflash:adminca.crl</pre>	Configures or replaces the current CRL with the one specified in the file.
Step 4	exit Example: <pre>switch(config)# exit switch#</pre>	Exits configuration mode.
Step 5	(Optional) show crypto ca crl <i>name</i> Example: <pre>switch# show crypto ca crl admin-ca</pre>	Displays the CA CRL information.
Step 6	(Optional) copy running-config startup-config Example: <pre>switch# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Deleting Certificates from the CA Configuration

You can delete the identity certificates and CA certificates that are configured in a trust point. You must first delete the identity certificate, followed by the CA certificates. After deleting the identity certificate, you can disassociate the RSA key pair from a trust point. You must delete certificates to remove expired or revoked certificates, certificates that have compromised (or suspected to be compromised) key pairs, or CAs that are no longer trusted.

SUMMARY STEPS

1. **configure terminal**
2. **crypto ca trustpoint** *name*
3. **delete ca-certificate**
4. **delete certificate** [**force**]
5. **exit**
6. (Optional) **show crypto ca certificates** [*name*]
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	crypto ca trustpoint <i>name</i> Example: <pre>switch(config)# crypto ca trustpoint admin-ca switch(config-trustpoint)#</pre>	Specifies a trust point CA and enters trust point configuration mode.
Step 3	delete ca-certificate Example: <pre>switch(config-trustpoint)# delete ca-certificate</pre>	Deletes the CA certificate or certificate chain.
Step 4	delete certificate [force] Example: <pre>switch(config-trustpoint)# delete certificate</pre>	Deletes the identity certificate. You must use the force option if the identity certificate you want to delete is the last certificate in a certificate chain or only identity certificate in the device. This requirement ensures that you do not mistakenly delete the last certificate in a certificate chain or only the identity certificate and leave the applications (such as SSH) without a certificate to use.
Step 5	exit Example: <pre>switch(config-trustpoint)# exit switch(config)#</pre>	Exits trust point configuration mode.

	Command or Action	Purpose
Step 6	(Optional) show crypto ca certificates [<i>name</i>] Example: switch(config)# show crypto ca certificates admin-ca	Displays the CA certificate information.
Step 7	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Deleting RSA Key Pairs from a Cisco NX-OS Device

You can delete the RSA key pairs from a Cisco NX-OS device if you believe the RSA key pairs were compromised in some way and should no longer be used.



Note After you delete RSA key pairs from a device, ask the CA administrator to revoke your device's certificates at the CA. You must supply the challenge password that you created when you originally requested the certificates.

SUMMARY STEPS

1. **configure terminal**
2. **crypto key zeroize rsa** *label*
3. **exit**
4. (Optional) **show crypto key mypubkey rsa**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	crypto key zeroize rsa <i>label</i> Example: switch(config)# crypto key zeroize rsa MyKey	Deletes the RSA key pair.
Step 3	exit Example: switch(config)# exit switch#	Exits configuration mode.

	Command or Action	Purpose
Step 4	(Optional) show crypto key mypubkey rsa Example: switch# show crypto key mypubkey rsa	Displays the RSA key pair configuration.
Step 5	(Optional) copy running-config startup-config Example: switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

[Generating Certificate Requests](#), on page 130

Verifying the PKI Configuration

To display PKI configuration information, perform one of the following tasks:

Command	Purpose
show crypto key mypubkey rsa	Displays information about the RSA public keys generated on the Cisco NX-OS device.
show crypto ca certificates	Displays information about CA and identity certificates.
show crypto ca crl	Displays information about CA CRLs.
show crypto ca trustpoints	Displays information about CA trust points.

Configuration Examples for PKI

This section shows examples of the tasks that you can use to configure certificates and CRLs on Cisco NX-OS devices using a Microsoft Windows Certificate server.



Note You can use any type of certificate server to generate digital certificates. You are not limited to using the Microsoft Windows Certificate server.

Configuring Certificates on a Cisco NX-OS Device

To configure certificates on a Cisco NX-OS device, follow these steps:

Step 1 Configure the device FQDN.

```
switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# hostname Device-1
Device-1(config)#
```

Step 2 Configure the DNS domain name for the device.

```
Device-1(config)# ip domain-name cisco.com
```

Step 3 Create a trust point.

```
Device-1(config)# crypto ca trustpoint myCA
Device-1(config-trustpoint)# exit
Device-1(config)# show crypto ca trustpoints
trustpoint: myCA; key:
revokation methods: crl
```

Step 4 Create an RSA key pair for the device.

```
Device-1(config)# crypto key generate rsa label myKey exportable modulus 1024
Device-1(config)# show crypto key mypubkey rsa
key label: myKey
key size: 1024
exportable: yes
```

Step 5 Associate the RSA key pair to the trust point.

```
Device-1(config)# crypto ca trustpoint myCA
Device-1(config-trustpoint)# rsakeypair myKey
Device-1(config-trustpoint)# exit
Device-1(config)# show crypto ca trustpoints
trustpoint: myCA; key: myKey
revokation methods: crl
```

Step 6 Download the CA certificate from the Microsoft Certificate Service web interface.**Step 7** Authenticate the CA that you want to enroll to the trust point.

```
Device-1(config)# crypto ca authenticate myCA
input (cut & paste) CA certificate (chain) in PEM format;
end the input with a line containing only END OF INPUT :
-----BEGIN CERTIFICATE-----
MIIC4jCCAoygAwIBAgIQBWDSiay0GZRPSRI1jK0ZejanBkgqhkig9w0BAQUFADCB
kDEgMB4GCSqGSIb3DQEJARYRYW1hbmRrZUBjaXNjby5jb20xCzAJBgNVBAYTAk1O
MRIwEAYDVQQIEW1LYXJuYXRha2ExEjAQBGNVBACTCUJhbmdbG9yZTEOMAwGA1UE
ChMFQ21zY28xZzARBgNVBAsTCm5ldHN0b3JhZ2UxEjAQBGNVBAMTCUFwYXJuYSBD
QTAEFw0wNTA1MDMyMjQzMzdaFw0wNzA1MDMyMjU1MTdaMIGQMSAwHgYJKoZIhvcN
AQkBFhFhbWFuZGt1OGNpc2NvLmNvbTElMAkGA1UEBhMCSU4xEjAQBGNVBAGTCUth
cm5hdGFrYTESMBAGA1UEBxMJQmFuZ2Fsb3JlMQ4wDAYDVQQKEwVdaXNjby5jbzETMBEG
A1UECXMkNmV0c3RvcnFnZTESMBAGA1UEAxMjQXBhcm5hIENBMFwDQYJKoZIhvcN
AQEBBQADSwAwSAJBAMW/7b3+DXJPANBSIHHzluNccNM87ypyzwuoSNZXOMpeRXXI
OzyBAgiXT2ASFuUowQ1iDM8rO/41jf8RkxvYKvysCAwEAaA0BvzCBvDALBgNVHQ8E
BAMCAcYwDwYDVR0TAQH/BAUwAwEB/zAdBgNVHQ4EFgQUJyJyRoMbrCNMRU2OyRhQ
GgsWbHEwawYDVR0FBGQwYjAuoCygKoYoaHR0cDovL3NzZS0wOC9DZXJ0RW5yb2xs
L0FwYXJuYSUyMENBLmNybDAwOjC6gLIYqZmlsZTovL1xc3N1LTA4XEN1cnRFbnJv
bGxcQXBhcm5hJT1wQ0EuY3JsMBAGCSsGAQQBgjcVAQQDAgEAMA0GCSqGSIb3DQEB
```

```

BQUAA0EAHv6UQ+8nE399Tww+KaGr0gONIJaNgLh0AFcT0rEyuyt/WYGPzksF9Ea
NBG7E0oN66zex0EOEfG1Vs6mXp1//w==
-----END CERTIFICATE-----
END OF INPUT
Fingerprint(s): MD5 Fingerprint=65:84:9A:27:D5:71:03:33:9C:12:23:92:38:6F:78:12
Do you accept this certificate? [yes/no]:y

Device-1(config)# show crypto ca certificates
Trustpoint: myCA
CA certificate 0:
subject= /emailAddress=admin@yourcompany.com/C=IN/ST=Karnataka/
L=Bangalore/O=Yourcompany/OU=netstorage/CN=Aparna CA
issuer= /emailAddress=admin@yourcompany.com/C=IN/ST=Karnataka/
L=Bangalore/O=Yourcompany/OU=netstorage/CN=Aparna CA
serial=0560D289ACB419944F4912258CAD197A
notBefore=May  3 22:46:37 2005 GMT
notAfter=May  3 22:55:17 2007 GMT
MD5 Fingerprint=65:84:9A:27:D5:71:03:33:9C:12:23:92:38:6F:78:12
purposes: sslserver sslclient ike

```

Step 8 Generate a request certificate to use to enroll with a trust point.

```

Device-1(config)# crypto ca enroll myCA
Create the certificate request ..
Create a challenge password. You will need to verbally provide this
password to the CA Administrator in order to revoke your certificate.
For security reasons your password will not be saved in the configuration.
Please make a note of it.
Password: nbv123
The subject name in the certificate will be: Device-1.cisco.com
Include the switch serial number in the subject name? [yes/no]: no
Include an IP address in the subject name [yes/no]: yes
ip address: 10.10.1.1
The certificate request will be displayed...
-----BEGIN CERTIFICATE REQUEST-----
MIIBqzCCARQCAQAwHDEaMBGALUEAxMRVmVnYXNjby5jb20wgZ8wDQYJ
KoZIHvcNAQEBBQADgY0AMIGJAoGBAL8Y1UAJ2NC7jUJ1DVA5MqNIgJ2kt8r141KY
0JC6ManNy4qxk8VeMXZSiLJ4JgTzKWdxblDkTTysnjuCXGvjb+wj0hEhv/y51T9y
P2NJJ8ornqShrvFzgC7ysN/PyMwKcgzhhVpj+rargZvHtGJ91XTq4WoVksCzXv8S
VqyH0vEvAgMBAAGTzAVBqkqhkiG9w0BCQcxCBMGbmJ2MTIzMDYGCsGqIb3DQEJ
DjEpMCCwJQYDVR0RAQH/BBswGyIRVmVnYXNjby5jb22HBKwWH6IwDQYJ
KoZIHvcNAQEBBQADgYEAKT60KER6Qo8nj0sDXZVHsfJZh6K6JtDz3Gkd99G1FWgt
PfrNcWUE/pw6HayfQl2T3ecgNw12d15133YBF2bktExiI6U188nTOjg1XMjja8
8a23bNDpNsM8rklwA6hWkrVL8NUZEFJxqbjfngPNTZacJCUS6ZqKCMetbKytUx0=
-----END CERTIFICATE REQUEST-----

```

Step 9 Request an identity certificate from the Microsoft Certificate Service web interface.

Step 10 Import the identity certificate.

```

Device-1(config)# crypto ca import myCA certificate
input (cut & paste) certificate in PEM format:
-----BEGIN CERTIFICATE-----
MIIEADCCA6qgAwIBAgIKCj0OoQAAAAAdDANBgkqhkiG9w0BAQUFADCBkDEgMB4G
CSqGSIb3DQEJARYRYW1hbmRrZUBjaXNjby5jb20xCzAJBgNVBAYTAKlOMRIwEAYD
VQQIEwLLYXJuYXRha2ExEjAQBGNVBAcTCUJhbmdhbG9yZTEOMAwGALUEChMFQ2l2
Y28xZzARBGNVBAStCm51dHN0b3JhZ2UxEjAQBGNVBAMTCUFwYXJuY5BDQTAeFw0w
NTEeMTIwMzAyNDBaFw0wNjEeMTIwMzEyNDBaMBwGjAYBgNVBAMTEVZlZ2FzLTEu
Y2l2Y28uY29tIGFMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQC/GNVAcDjQu41C
dQ1WkjKjSICdpLfk5eJSmNCQujGpzcukSZPFxfJ2UoiyeCYE8y1ncWyy5E08rJ47
g1xr42/sI9IRIb/8udU/cj9jSSfKK56koa7xWYAu8rDfz8jMCnIM4W1aY/q2q4Gb
x7RifdV06uFqFZEgs17/Elash9LxLwIDAQABo4ICEzCCAq8wJQYDVR0RAQH/BBsw

```

```

GYIRVmVnYXmTMS5jaXnjby5jb22HBKwWH6IwHQYDVR0OBbYEFKCLi+2sspWEfgrR
bhWmlVyo9jngMIHMBGnVHSMEGcQwgcGAFCCo8kaDG6wjTEVNjskYUBoLFmxxoYGW
pIGTMIGQMSAwHgYJKoZIHvcNAQkBFhFhbWfFuZGt1QGNpc2NvLmNvbTElMAkGA1UE
BhMCSU4xEjAQBGNVBAgTCUthcm5hdGFryTESMBAGA1UEBxMJQmFuZ2Fsb3JlMQ4w
DAYDVQQKEwVDAxNjBzETMBEGA1UECXMkYmV0c3RvcnFnZTESMBAGA1UEAxMJQXBh
cm5hIENBghAFYnKJrLQZLE9JEiWMrR16MGsGA1UdHwRkMGiWlQAsocqGKGh0dHA6
Ly9zc2UtMDgvQ2VydeVucm9sbC9BcGFybmElmjBDQS5jcmwwMKAuoCygKmZpbGU6
Ly9cXHNzZS0wOFxDZXRJRW5yb2xsXEFwYXJuYSUyMENBLmNybDCBiGyIKwYBBQUH
AQEEfjB8MDSGCCsGAQUFBzAChi9odHRwOi8vc3NlLTA4L0NlcnRFbnJvbGwvc3Nl
LTA4X0FwYXJuYSUyMENBLmNydDA9BggrBgEFBQcwAoYxZmlsZTovL1xoc3NlLTA4
XENlcnRFbnJvbGwvc3NlLTA4X0FwYXJuYSUyMENBLmNydDANBgkqhkiG9w0BAQUF
AANBADbGBGsbe7GNLh9xeOTWBNbm24U69ZSuDDcOuzUUTgrpnTqVpPyejtsyflw
E36cIZu4WsExREqxbTk8ycx7V5o=
-----END CERTIFICATE-----
Device-1 (config) # exit
Device-1#

```

Step 11 Verify the certificate configuration.

Step 12 Save the certificate configuration to the startup configuration.

Related Topics

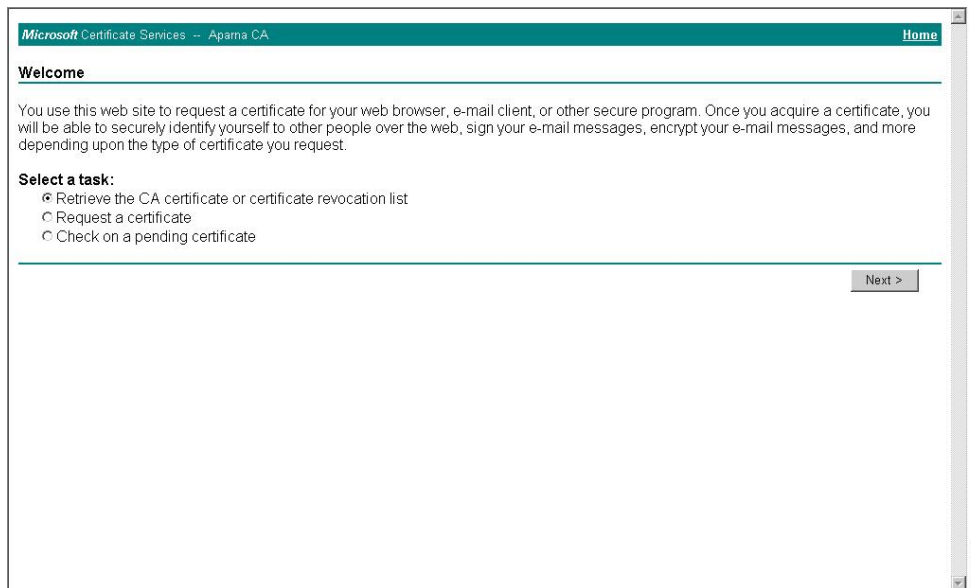
[Downloading a CA Certificate](#), on page 142

[Requesting an Identity Certificate](#), on page 145

Downloading a CA Certificate

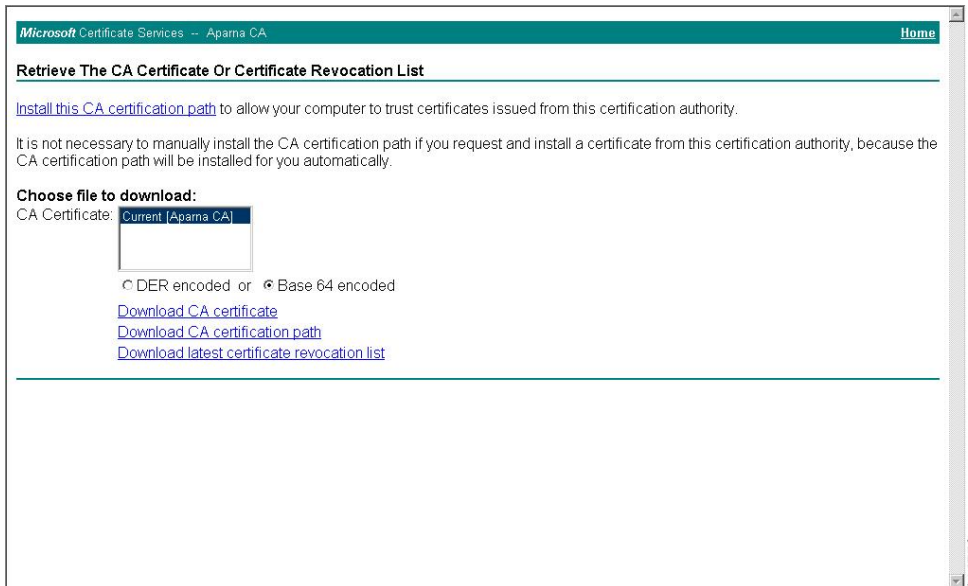
To download a CA certificate from the Microsoft Certificate Services web interface, follow these steps:

Step 1 From the Microsoft Certificate Services web interface, click **Retrieve the CA certificate or certificate revocation task**



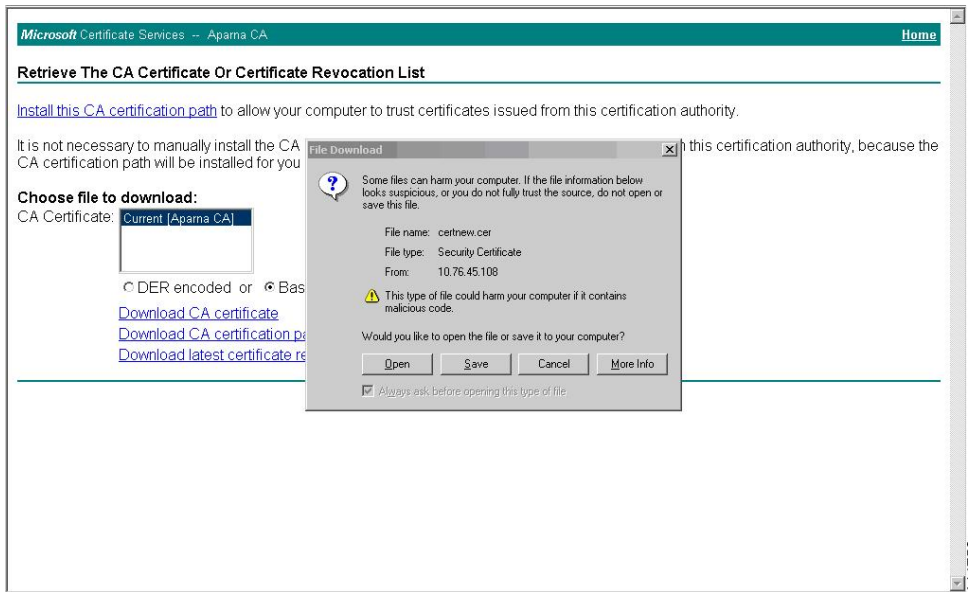
and click **Next**.

Step 2 From the display list, choose the CA certificate file to download from the displayed list. Then click **Base 64 encoded** and click **Download CA certificate**.



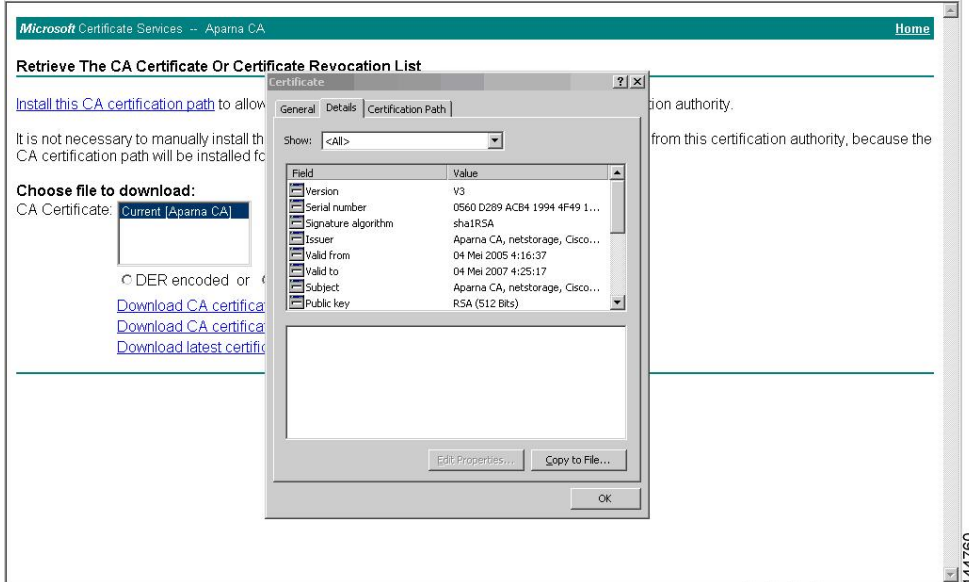
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Step 3 Click **Open** in the File Download dialog box.

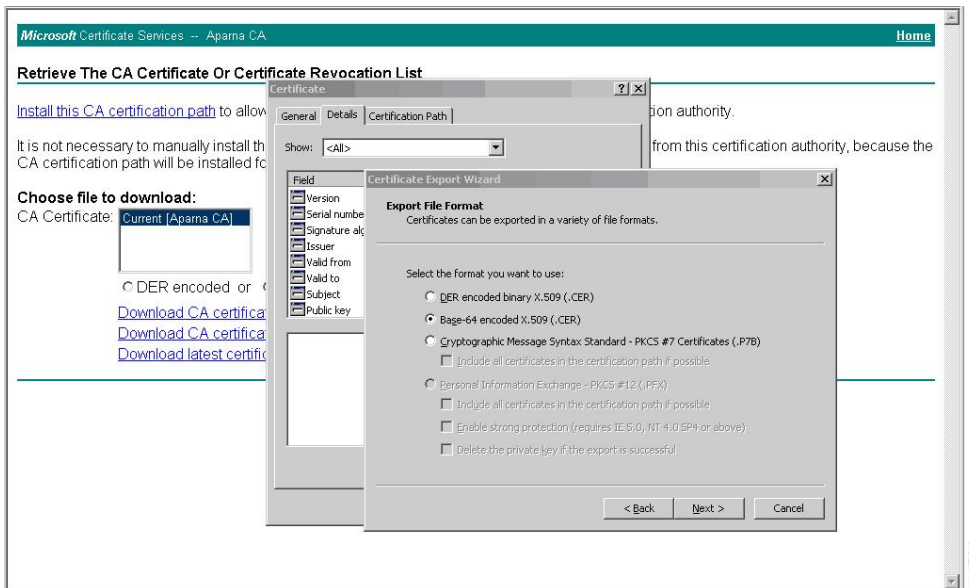


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Step 4 In the Certificate dialog box, click **Copy to File** and click **OK**.



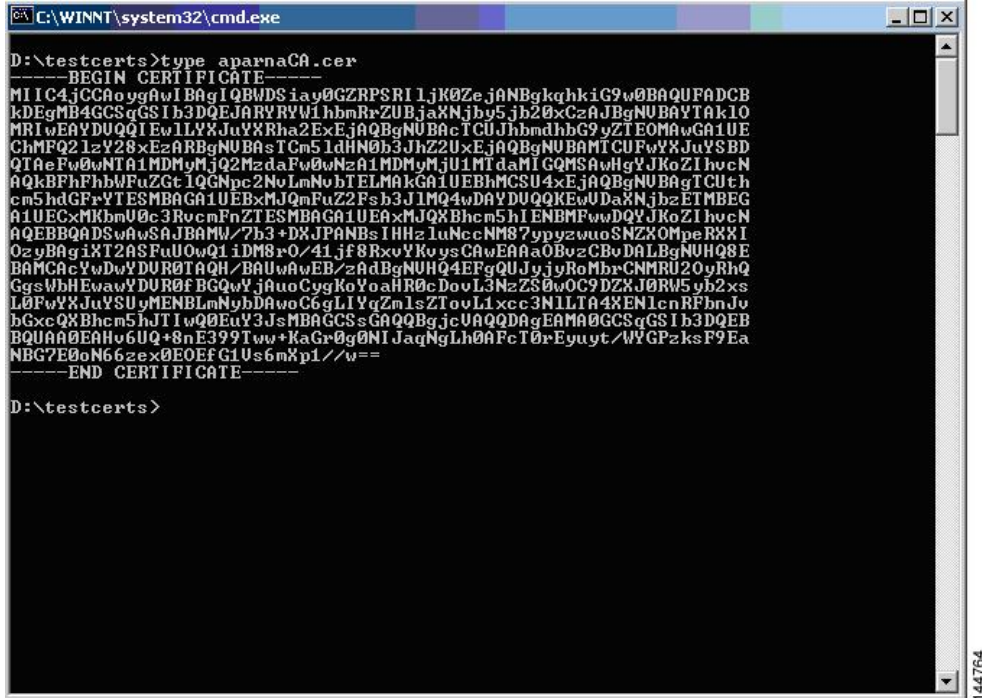
Step 5 From the Certificate Export Wizard dialog box, choose the **Base-64 encoded X.509 (CER)** and click **Next**.



Step 6 In the File name: text box on the Certificate Export Wizard dialog box, enter the destination file name and click **Next**.

Step 7 In the Certificate Export Wizard dialog box, click **Finish**.

Step 8 Enter the Microsoft Windows **type** command to display the CA certificate stored in Base-64 (PEM) format.



```

C:\WINNT\system32\cmd.exe
D:\testcerts>type aparnaCA.cer
-----BEGIN CERTIFICATE-----
MIIC4jCCAoygAwIBAgIQBwDSiaY0GZRPSRI1jk0ZeJANBgkqhkiG9w0BAQUFADCB
kDEgMB4GCSqGSIb3DQEJARYRYW1hbmRrZUBjaXNjb55jb20xCzAJBgNVBAYTAk10
MRIwEAYDUQIEdwLLYXJlbnRha2EjAQIBgNVBARTCUJhbmdhhG9vZTEOMAwGA1UE
ChMFQ21zY28xZzARBgNVBAstcm5ldHN0b3JhZ2UxEjAQIBgNVBAMTCUFWYXJlbnR5
QTAeFw0wNTA1MDMyMjQ2MzdaFw0wNTA1MDMyMjQ2MzdaMIQMSAwHgYJKoZIhvcN
AQkBFhFhbWVudG91LmNpb250b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3
cm5ldGFuYTESMBAQA1UEBxMjQ2MzdaFw0wNTA1MDMyMjQ2MzdaMIQMSAwHgYJKoZI
hvcNA1UECXMkbnV0c3RvcnR0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3
AQEBBQADSwAwSAJBAMl/7b3+DXJPANBSIHHZ1uNccNM87ppyzwuoSNZKOMpeRXXI
OzyBAgiXT2ASFuUOwQ1IDM8rO/41jF8RxyYKoyS CAwEAAa0BvzCBvDAlBgNUHQSE
BAMCAcYwDwYDUR0TAQH/BAUwAwEB/zAdBgNUHQ4EFGQUJyJyRoMbrCNMRU20yRhQ
GgsWbhEwawYDUR0FBGQwYjAuoCygKoYoaHR0cDovL3NzZS0wOC9DZXJ0RW5yb2xs
L0FwYXJlbnR0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3R0b3
bGxcQXhcm5hJT1wQ0EuY3JSMBAQCSGAQQBgjcuUQQDAgEAMAA0GCSqGSIb3DQEB
BQUAA0EAAHv6UQ+8nE399Tww+KaGr0g0NIJaNgLh0AFcT0rEyuyt/WYGPzksF9Ea
NBG7E0N6zeX0E0EFc1U56mXp1/w==
-----END CERTIFICATE-----
D:\testcerts>

```

Requesting an Identity Certificate

To request an identity certificate from a Microsoft Certificate server using a PKCS#12 certificate signing request (CSR), follow these steps:

Step 1

From the Microsoft Certificate Services web interface, click **Request a certificate** and click **Next**.

Microsoft Certificate Services -- Aparna CA Home

Welcome

You use this web site to request a certificate for your web browser, e-mail client, or other secure program. Once you acquire a certificate, you will be able to securely identify yourself to other people over the web, sign your e-mail messages, encrypt your e-mail messages, and more depending upon the type of certificate you request.

Select a task:

- Retrieve the CA certificate or certificate revocation list
- Request a certificate
- Check on a pending certificate

Next >

144765

Step 2

Click **Advanced request** and click **Next**.

Microsoft Certificate Services -- Aparna CA Home

Choose Request Type

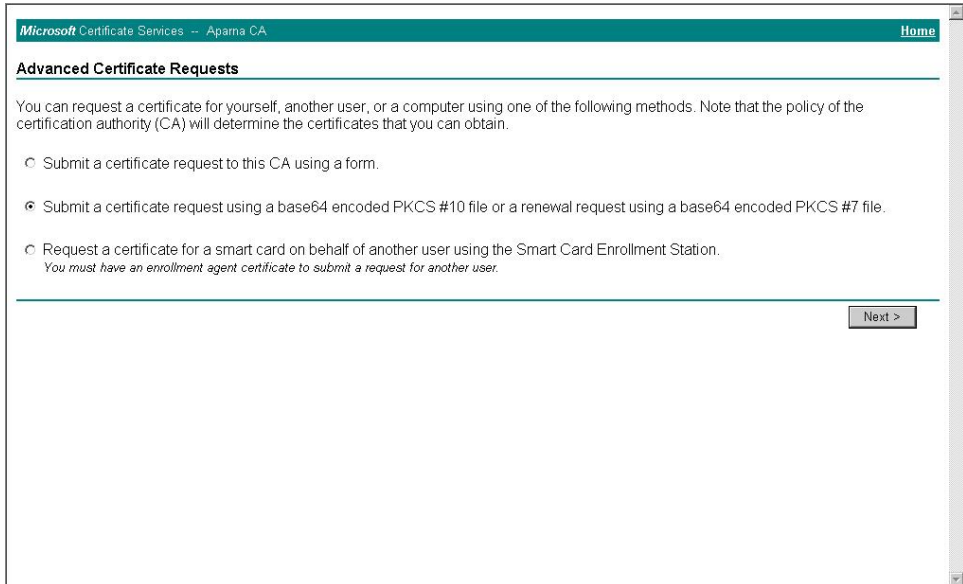
Please select the type of request you would like to make:

- User certificate request
 - Web Browser Certificate
 - E-Mail Protection Certificate
- Advanced request

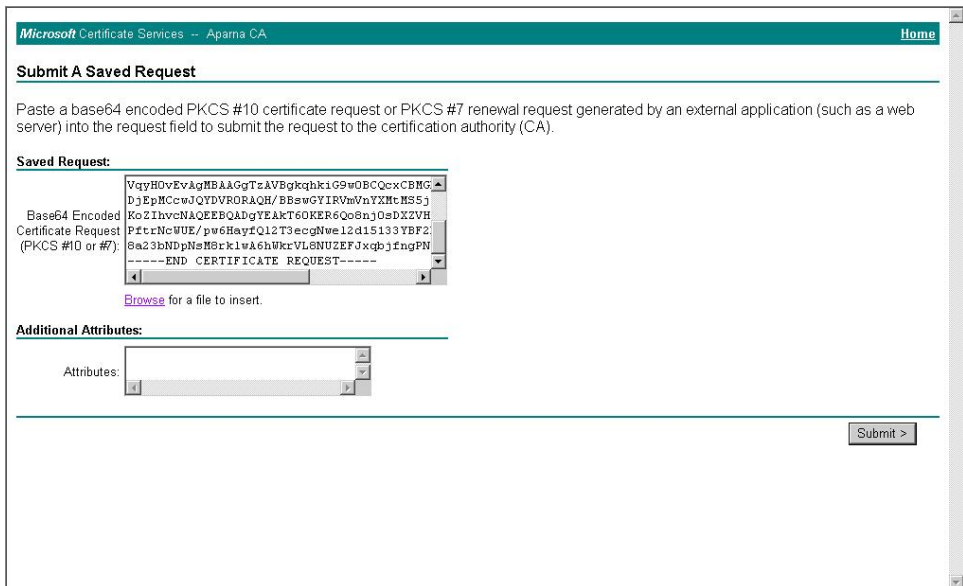
Next >

144766

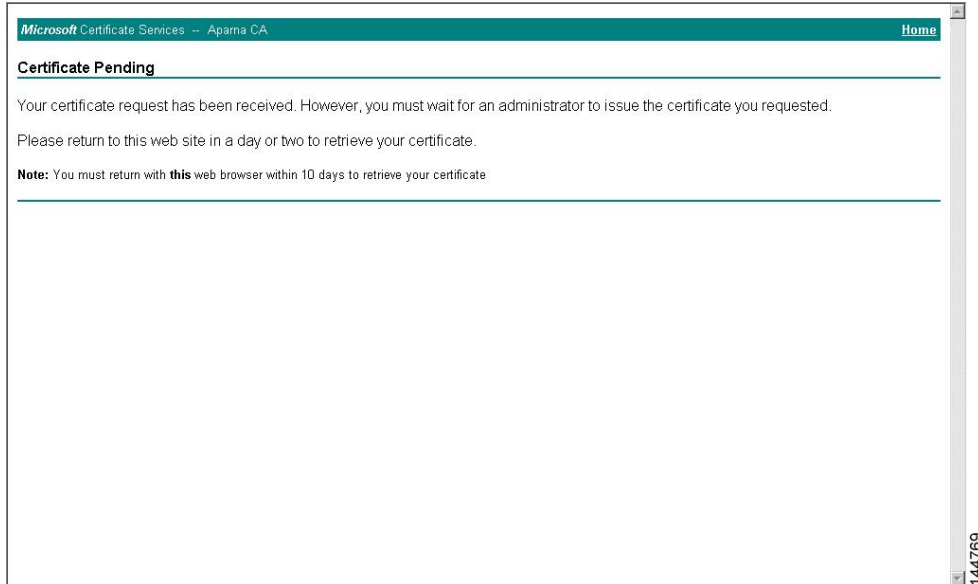
Step 3 Click **Submit a certificate request using a base64 encoded PKCS#10 file or a renewal request using a base64 encoded PKCS#7 file** and click **Next**.



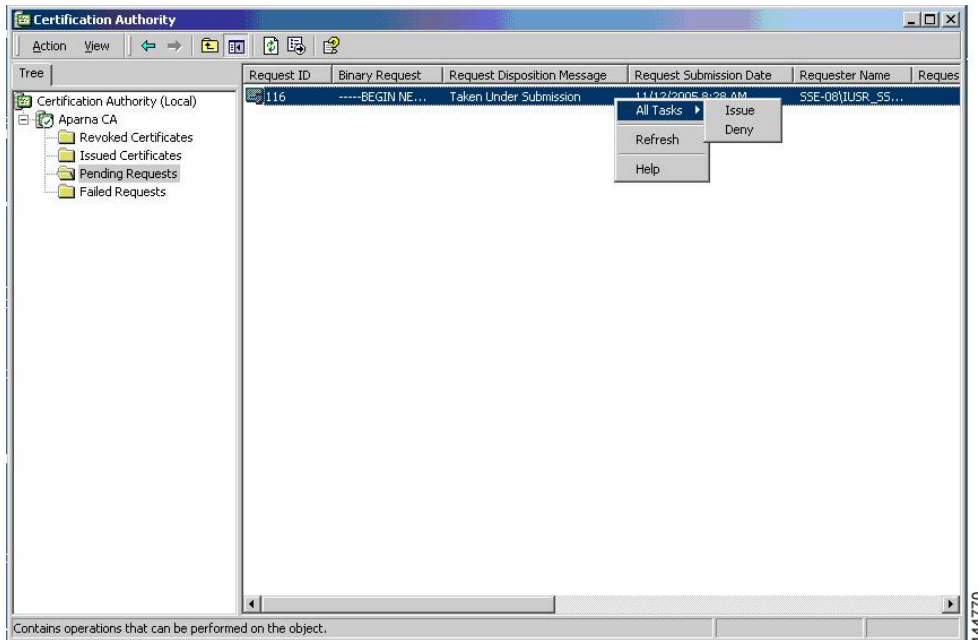
Step 4 In the Saved Request text box, paste the base64 PKCS#10 certificate request and click **Next**. The certificate request is copied from the Cisco NX-OS device console.



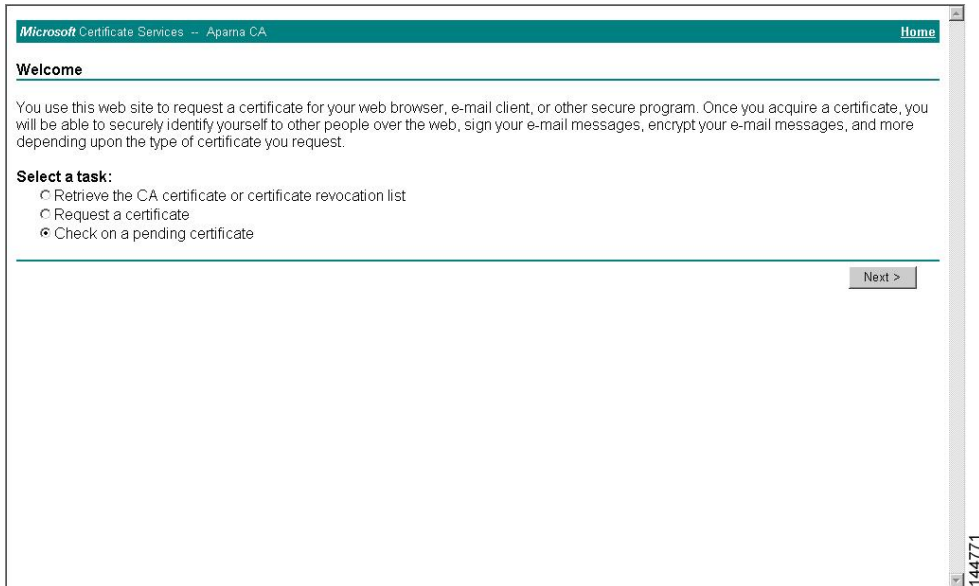
Step 5 Wait one or two days until the certificate is issued by the CA administrator.



Step 6 Note that the CA administrator approves the certificate request.

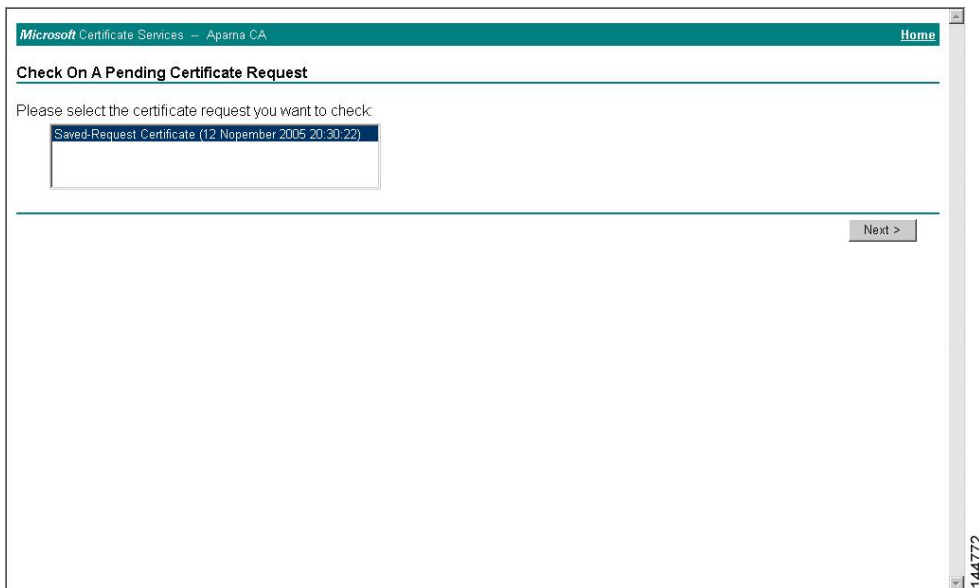


Step 7 From the Microsoft Certificate Services web interface, click **Check on a pending certificate** and click **Next**.



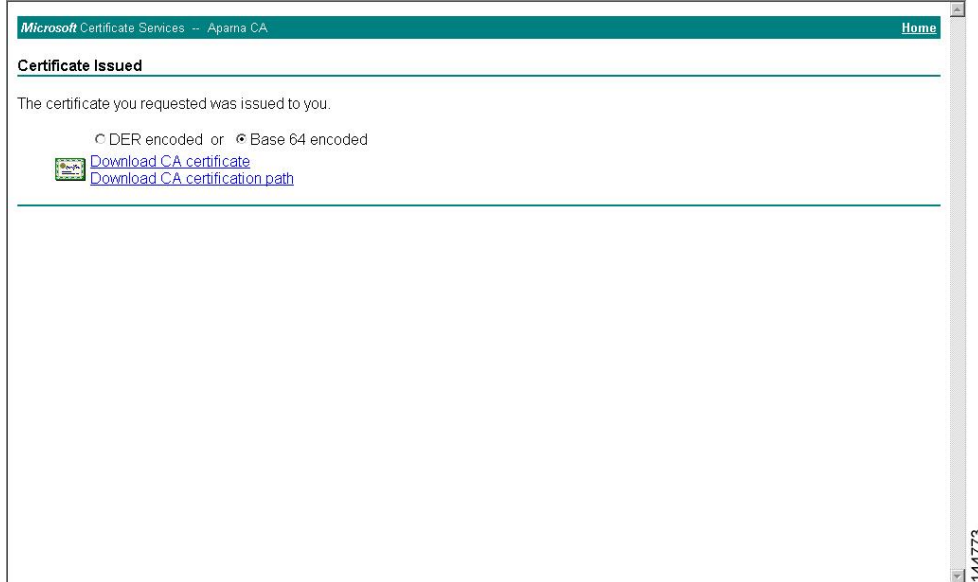
The screenshot shows the Microsoft Certificate Services web interface for the Apama CA. The page title is "Microsoft Certificate Services -- Apama CA" and there is a "Home" link in the top right. The main heading is "Welcome". Below this, there is a paragraph explaining the site's purpose: "You use this web site to request a certificate for your web browser, e-mail client, or other secure program. Once you acquire a certificate, you will be able to securely identify yourself to other people over the web, sign your e-mail messages, encrypt your e-mail messages, and more depending upon the type of certificate you request." Underneath, there is a section titled "Select a task:" with three radio button options: "Retrieve the CA certificate or certificate revocation list", "Request a certificate", and "Check on a pending certificate". The "Check on a pending certificate" option is selected. A "Next >" button is located at the bottom right of the form area. The page number "144771" is visible in the bottom right corner.

Step 8 Choose the certificate request that you want to check and click **Next**.

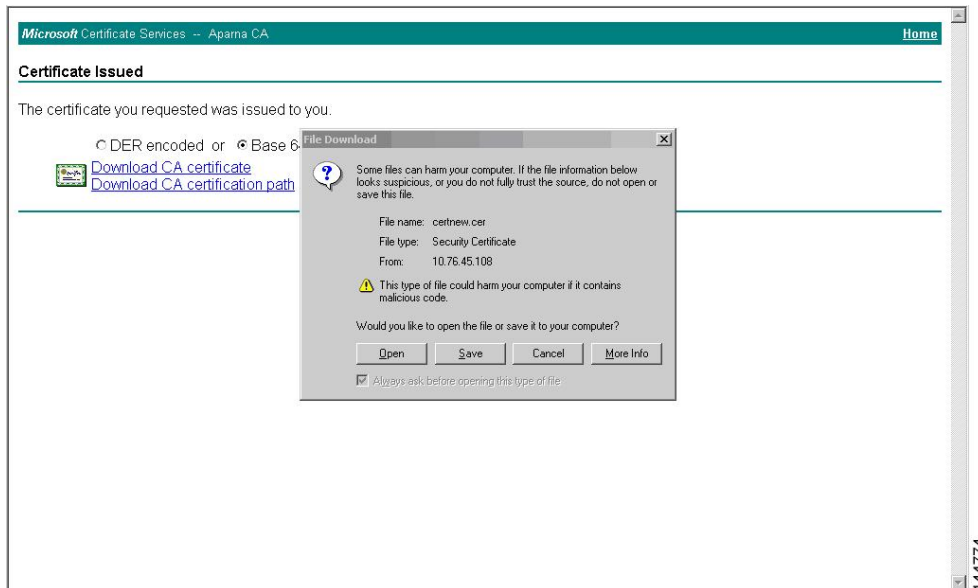


The screenshot shows the Microsoft Certificate Services web interface for the Apama CA, specifically the "Check On A Pending Certificate Request" page. The page title is "Microsoft Certificate Services -- Apama CA" and there is a "Home" link in the top right. The main heading is "Check On A Pending Certificate Request". Below this, there is a prompt: "Please select the certificate request you want to check:". A list box contains one entry: "Saved-Request Certificate (12 November 2005 20:30:22)". A "Next >" button is located at the bottom right of the form area. The page number "144772" is visible in the bottom right corner.

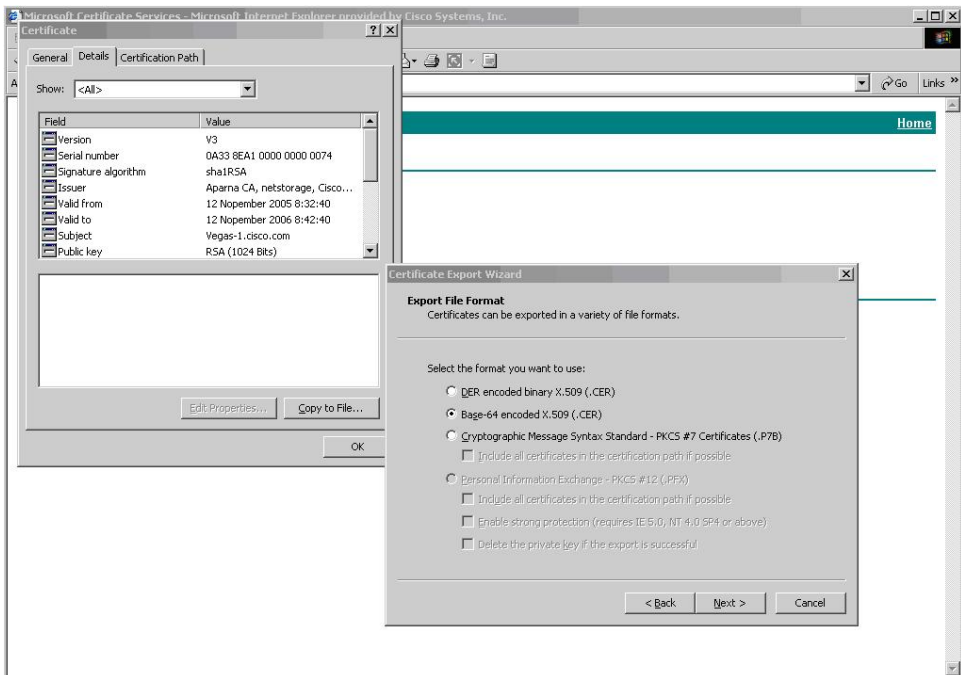
Step 9 Click **Base 64 encoded** and click **Download CA certificate**.



Step 10 In the File Download dialog box, click **Open**.

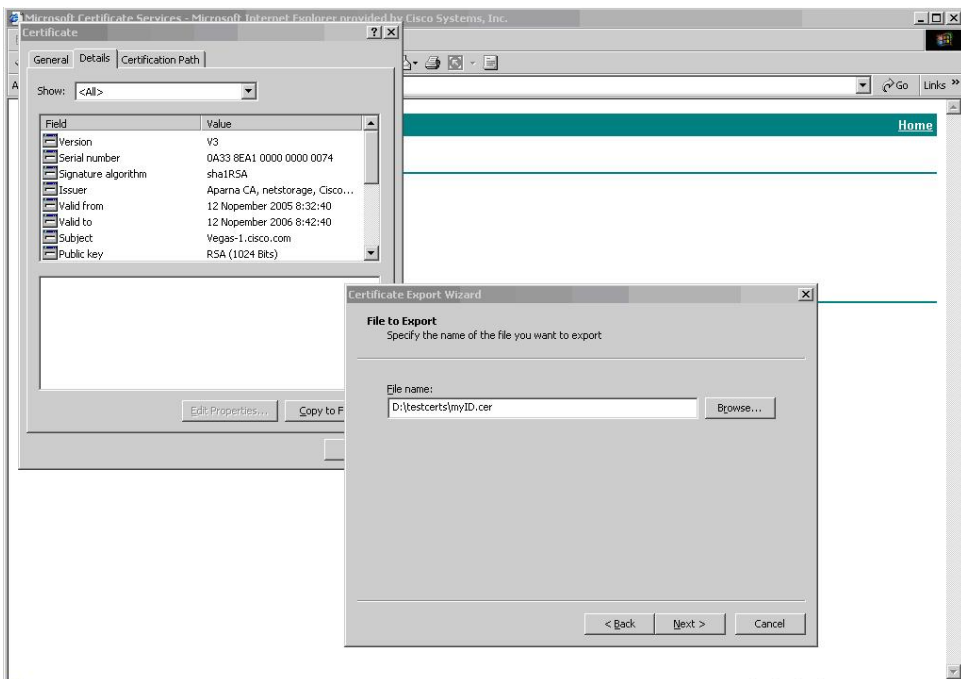


Step 11 In the Certificate box, click **Details** tab and click **Copy to File...**. In the Certificate Export Dialog box, click **Base-64 encoded X.509 (.CER)**, and click **Next**.

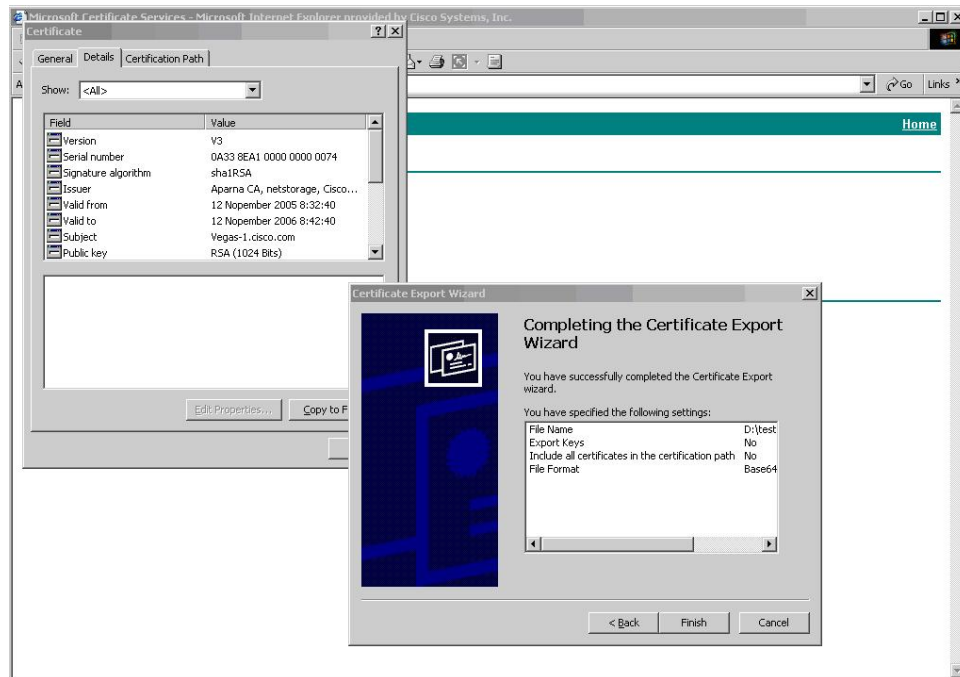


144776

Step 12 In the File name: text box on the Certificate Export Wizard dialog box, enter the destination file name and click **Next**.



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Step 13 Click **Finish**.

Step 14 Enter the Microsoft Windows **type** command to display the identity certificate in base64-encoded format.

```

C:\WINNT\system32\cmd.exe

D:\testcerts>type myID.cer
-----BEGIN CERTIFICATE-----
MIIEADCCA6ggAwIBAgIKCj00oQAAAAAAAAADANBgkqhkiG9w0BAQUFADCBkDEgMB4G
CSqGSIb3DQEJARYRYW1lbnRrZUBjaXNjb20xMjE0MzUwMzUwMzUwMzUwMzUwMzUw
UQ0IExLLYXJlbnRha2ExEjAQBgNUBACICUJhbmdhbG9yZTEOMAwGA1UEChMFQ2
Y28xZjY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2ZmY2Zm
NTExMTIwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUw
Y2IzY28uY29tMIIGMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBggQCNBAQDjQu41C
dQ1WkjkjKjIcdpLFK5eJSmNCQujGpzcukSZZPFjF2UoieCYE8y1ncUyW5E08rJ47
g1xr42/sI9IRIb/8udU/cj9jSSfKK56koa7xWYAu8rDfz8jMcnIM4W1aY/q2q4Gh
x7RifdU06uFgFZEgS17/Elash9LxLwIDAQABo4ICEzCCAq8wJQVUR0R0R0R0R0R0R0
CWIURmUnYXMS5jaXNjb20xMjE0MzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUw
bhMm1Uyo9jngMIHMBgNUHSMegcQwgcGAFCCo8kaDG6wjTEUNjskYUBoLFmxxoYGV
p1GTMIQQMSAwHgYJkoZ1hucNAQkBFhFhbWfuZGt1QGnpe2NuLmNubTELMAkGA1UE
BhMCSU4xEjAQBgNUBACICUthcm5hdGFyYTESMBAQGA1UEBxMjE0MzUwMzUwMzUw
dAYDUQQKEwUdaXNjb20xMjE0MzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUwMzUw
cm5hIENBghAFYFNKJrLQZ1E9JEiWMrR16MGsGA1UdHwRkMG1wLgAsQCgCKGh0dHA6
Ly9zc2UtdG9yZ2UydEUcm9sbC9BCEGFybmljBDQ55jcmwMKAuoCyGKmZpbGU6
Ly9cXHMzZS0wOFxjZXJ0R05yb2xsXEFwYXJlY29uY29uY29uY29uY29uY29uY29u
AQEEFjB8MdsGCCsGAQUFBzACh19odHRwOi8vc3NlLTA4L0N1cnRlbnJvbGwvc3Nl
LTA4L0N1cnRlbnJvbGwvc3NlLTA4L0N1cnRlbnJvbGwvc3NlLTA4L0N1cnRlbnJvbGw
XEN1cnRlbnJvbGwvc3NlLTA4L0N1cnRlbnJvbGwvc3NlLTA4L0N1cnRlbnJvbGwvc3
AANBA0BGBGbs7GNLh9xeOTWBNbm24U69ZSUDDCOcUZUUTgrpn1qUpPyejtsyf1w
E36cIzu4WsxREqxbtk8ycx7U5o=
-----END CERTIFICATE-----

D:\testcerts>

```

Related Topics

[Generating Certificate Requests](#), on page 130

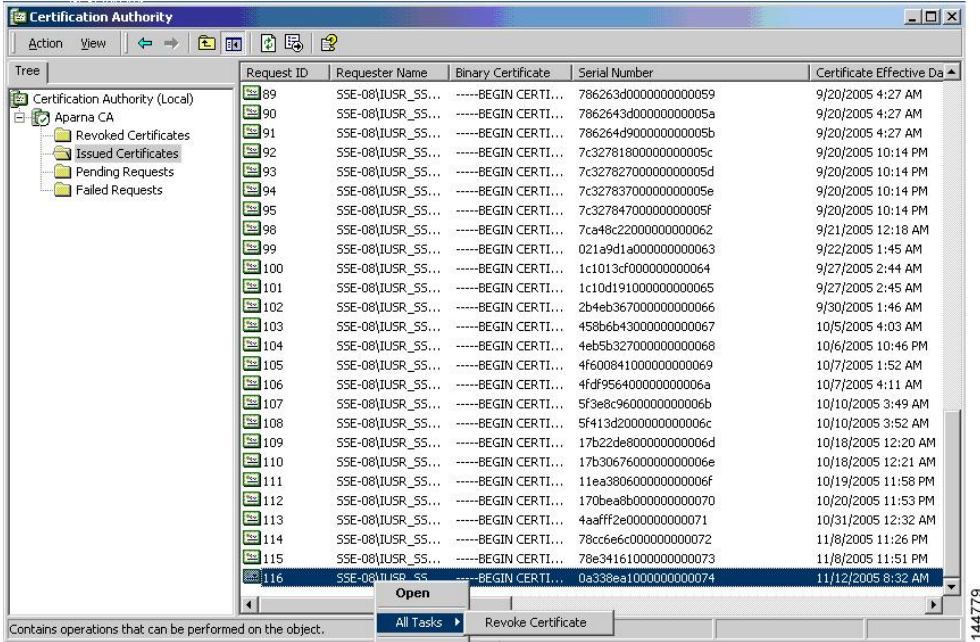
[Configuring Certificates on a Cisco NX-OS Device](#), on page 139

Revoking a Certificate

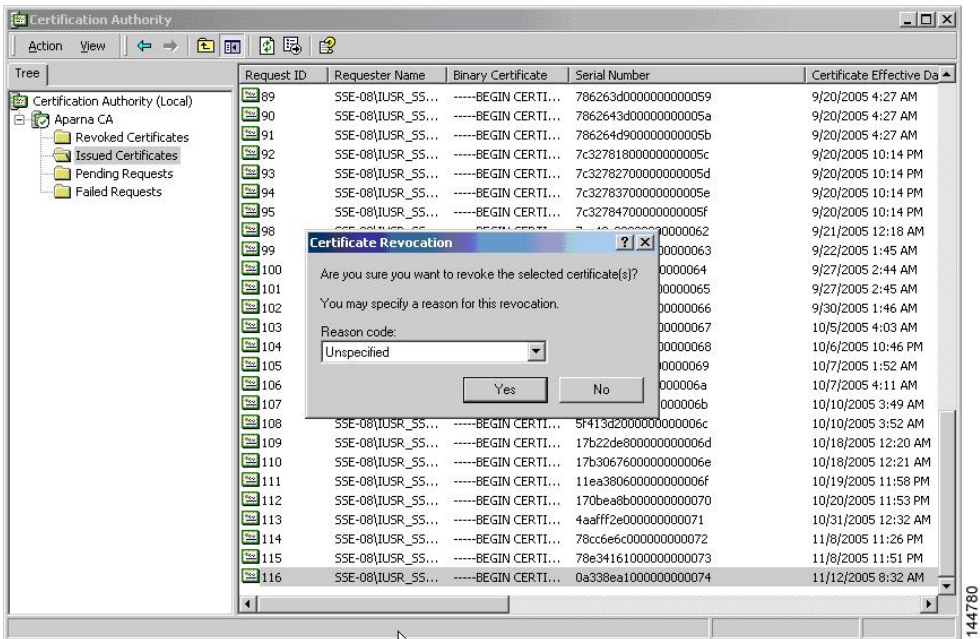
To revoke a certificate using the Microsoft CA administrator program, follow these steps:

Step 1 From the Certification Authority tree, click **Issued Certificates** folder. From the list, right-click the certificate that you want to revoke.

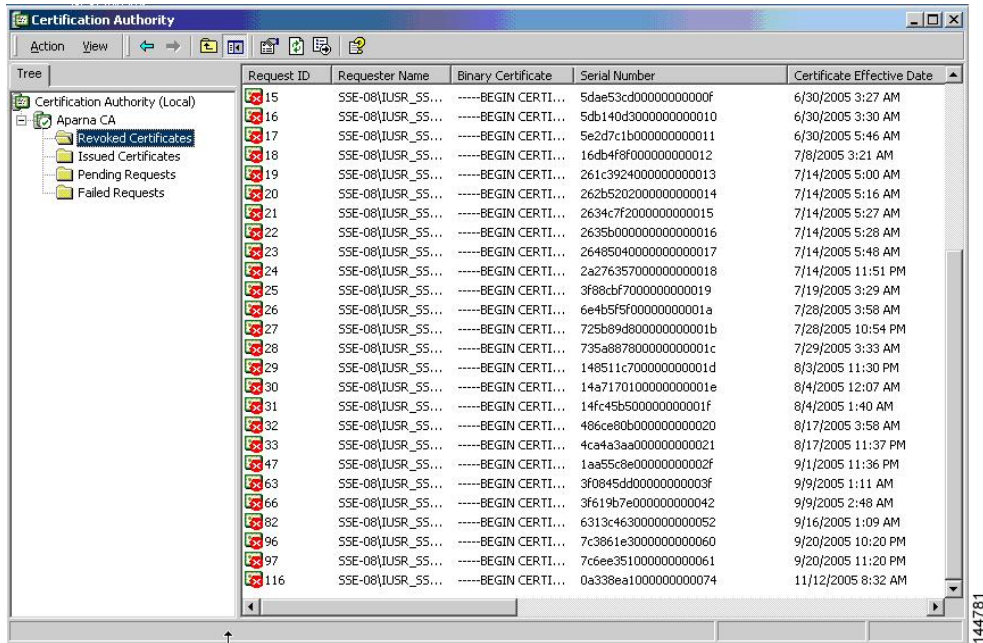
Step 2 Choose **All Tasks > Revoke Certificate**.



Step 3 From the Reason code drop-down list, choose a reason for the revocation and click **Yes**.



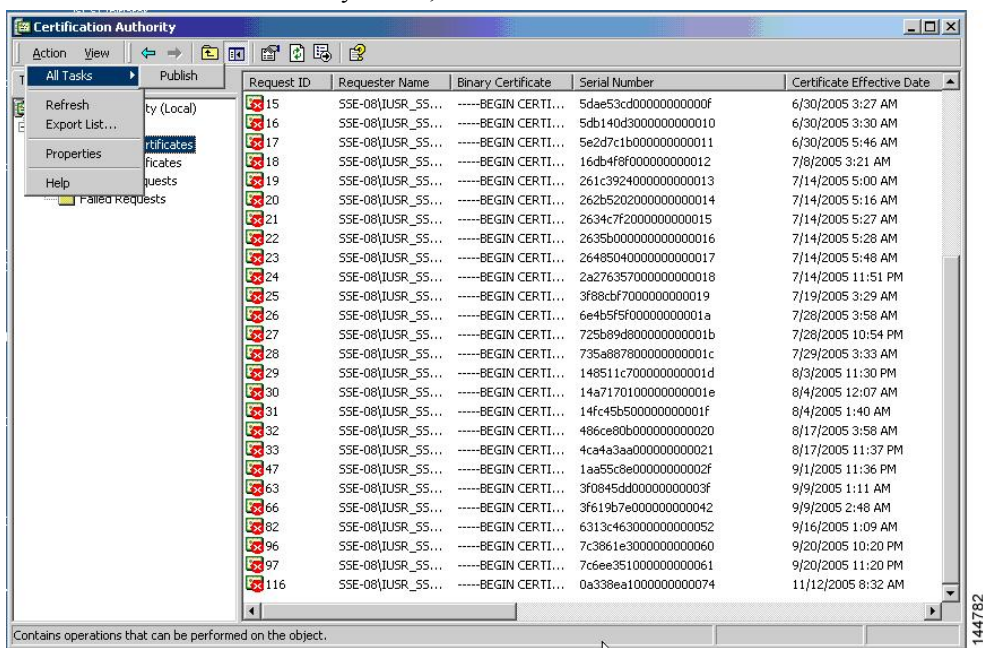
Step 4 Click the **Revoked Certificates** folder to list and verify the certificate revocation.



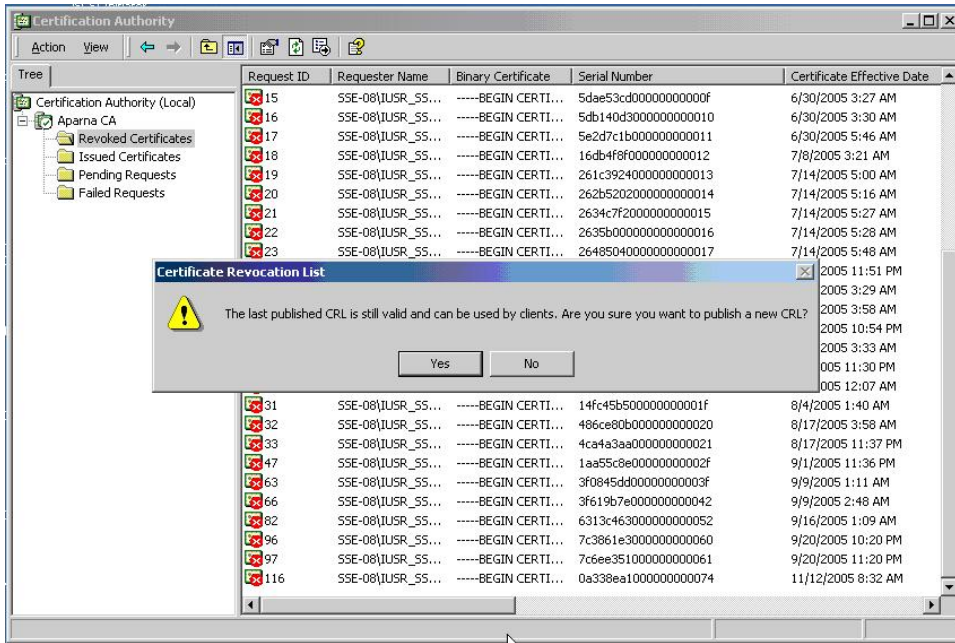
Generating and Publishing the CRL

To generate and publish the CRL using the Microsoft CA administrator program, follow these steps:

Step 1 From the Certification Authority screen, choose **Action > All Tasks > Publish**.



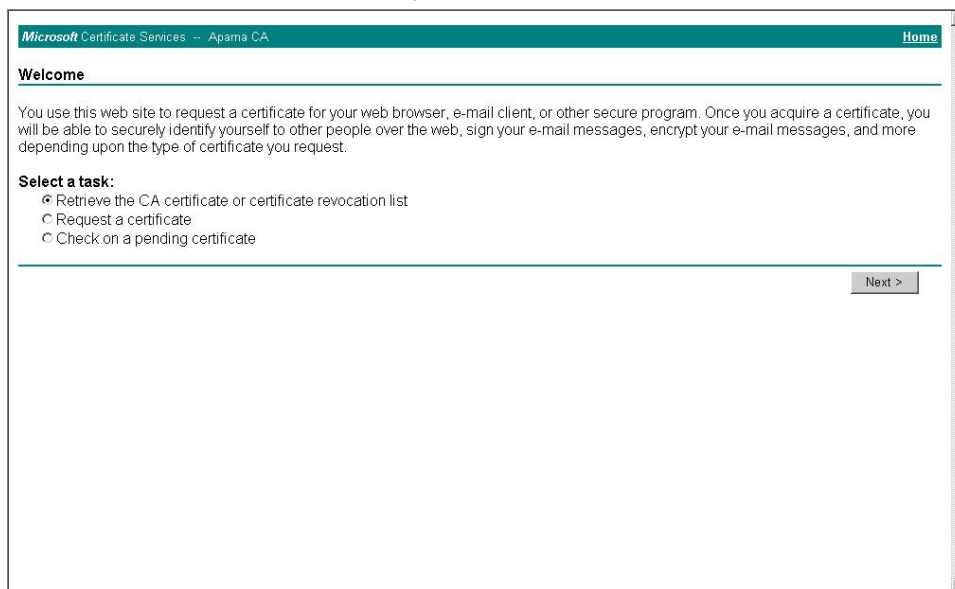
Step 2 In the Certificate Revocation List dialog box, click **Yes** to publish the latest CRL.



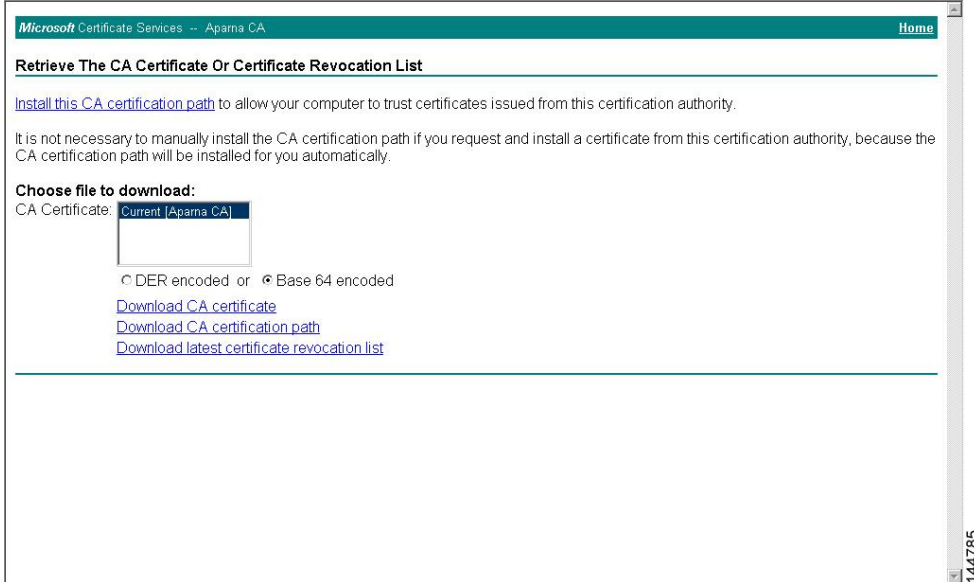
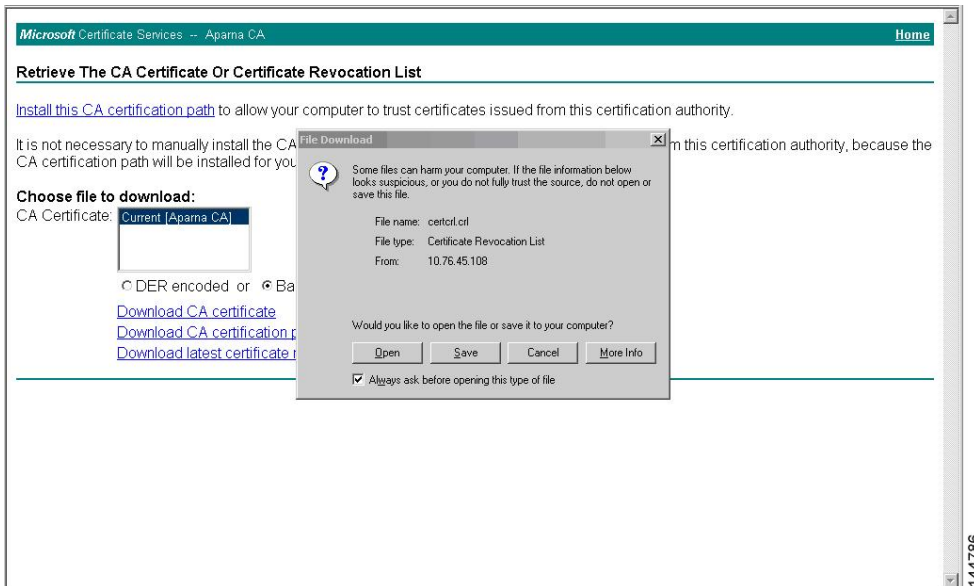
Downloading the CRL

To download the CRL from the Microsoft CA website, follow these steps:

Step 1 From the Microsoft Certificate Services web interface, click **Retrieve the CA certificate or certificate revocation list**



and click **Next**.

Step 2 Click **Download latest certificate revocation list**.**Step 3** In the File Download dialog box, click **Save**.

Importing the CRL

To import the CRL to the trust point corresponding to the CA, follow these steps:

Step 1 Copy the CRL file to the Cisco NX-OS device bootflash.

```
Device-1# copy tftp:apranaCA.crl bootflash:aparnaCA.crl
```

Step 2 Configure the CRL.

```
Device-1# configure terminal
Device-1(config)# crypto ca crl request myCA bootflash:aparnaCA.crl
Device-1(config)#
```

Step 3 Display the contents of the CRL.

```
Device-1(config)# show crypto ca crl myCA
Trustpoint: myCA
CRL:
Certificate Revocation List (CRL):
  Version 2 (0x1)
  Signature Algorithm: sha1WithRSAEncryption
  Issuer: /emailAddress=admin@yourcompany.com/C=IN/ST=Karnatak
Yourcompany/OU=netstorage/CN=Aparna CA
  Last Update: Nov 12 04:36:04 2005 GMT
  Next Update: Nov 19 16:56:04 2005 GMT
  CRL extensions:
    X509v3 Authority Key Identifier:
      keyid:27:28:F2:46:83:1B:AC:23:4C:45:4D:8E:C9:18:50:1
      1.3.6.1.4.1.311.21.1:
        ...
Revoked Certificates:
  Serial Number: 611B09A1000000000002
    Revocation Date: Aug 16 21:52:19 2005 GMT
  Serial Number: 4CDE464E000000000003
    Revocation Date: Aug 16 21:52:29 2005 GMT
  Serial Number: 4CFC2B42000000000004
    Revocation Date: Aug 16 21:52:41 2005 GMT
  Serial Number: 6C699EC2000000000005
    Revocation Date: Aug 16 21:52:52 2005 GMT
  Serial Number: 6CCF7DDC000000000006
    Revocation Date: Jun  8 00:12:04 2005 GMT
  Serial Number: 70CC4FFF000000000007
    Revocation Date: Aug 16 21:53:15 2005 GMT
  Serial Number: 4D9B1116000000000008
    Revocation Date: Aug 16 21:53:15 2005 GMT
  Serial Number: 52A80230000000000009
    Revocation Date: Jun 27 23:47:06 2005 GMT
  CRL entry extensions:
    X509v3 CRL Reason Code:
      CA Compromise
  Serial Number: 5349AD4600000000000A
    Revocation Date: Jun 27 23:47:22 2005 GMT
  CRL entry extensions:
    X509v3 CRL Reason Code:
      CA Compromise
  Serial Number: 53BD173C00000000000B
    Revocation Date: Jul  4 18:04:01 2005 GMT
```



```

CRL entry extensions:
  X509v3 CRL Reason Code:
    Certificate Hold
Serial Number: 591E7ACE000000000000C
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 5D3FD52E000000000000D
  Revocation Date: Jun 29 22:07:25 2005 GMT
CRL entry extensions:
  X509v3 CRL Reason Code:
    Key Compromise
Serial Number: 5DAB7713000000000000E
  Revocation Date: Jul 14 00:33:56 2005 GMT
Serial Number: 5DAE53CD000000000000F
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 5DB140D30000000000010
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 5E2D7C1B0000000000011
  Revocation Date: Jul 6 21:12:10 2005 GMT
CRL entry extensions:
  X509v3 CRL Reason Code:
    Cessation Of Operation
Serial Number: 16DB4F8F0000000000012
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 261C39240000000000013
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 262B52020000000000014
  Revocation Date: Jul 14 00:33:10 2005 GMT
Serial Number: 2634C7F20000000000015
  Revocation Date: Jul 14 00:32:45 2005 GMT
Serial Number: 2635B0000000000000016
  Revocation Date: Jul 14 00:31:51 2005 GMT
Serial Number: 264850400000000000017
  Revocation Date: Jul 14 00:32:25 2005 GMT
Serial Number: 2A2763570000000000018
Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 3F88CBF70000000000019
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 6E4B5F5F000000000001A
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 725B89D8000000000001B
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 735A8878000000000001C
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 148511C7000000000001D
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 14A71701000000000001E
  Revocation Date: Aug 16 21:53:15 2005 GMT
Serial Number: 14FC45B5000000000001F
  Revocation Date: Aug 17 18:30:42 2005 GMT
Serial Number: 486CE80B0000000000020
  Revocation Date: Aug 17 18:30:43 2005 GMT
Serial Number: 4CA4A3AA0000000000021
  Revocation Date: Aug 17 18:30:43 2005 GMT
Serial Number: 1AA55C8E000000000002F
  Revocation Date: Sep 5 17:07:06 2005 GMT
Serial Number: 3F0845DD000000000003F
  Revocation Date: Sep 8 20:24:32 2005 GMT
Serial Number: 3F619B7E0000000000042
  Revocation Date: Sep 8 21:40:48 2005 GMT
Serial Number: 6313C4630000000000052
  Revocation Date: Sep 19 17:37:18 2005 GMT
Serial Number: 7C3861E30000000000060
  Revocation Date: Sep 20 17:52:56 2005 GMT
Serial Number: 7C6EE3510000000000061

```

```

Revocation Date: Sep 20 18:52:30 2005 GMT
Serial Number: 0A338EA1000000000074 <-- Revoked identity certificate
Revocation Date: Nov 12 04:34:42 2005 GMT
Signature Algorithm: sha1WithRSAEncryption
0b:cb:dd:43:0a:b8:62:1e:80:95:06:6f:4d:ab:0c:d8:8e:32:
44:8e:a7:94:97:af:02:b9:a6:9c:14:fd:eb:90:cf:18:c9:96:
29:bb:57:37:d9:1f:d5:bd:4e:9a:4b:18:2b:00:2f:d2:6e:c1:
1a:9f:1a:49:b7:9c:58:24:d7:72

```

Note The identity certificate for the device that was revoked (serial number 0A338EA1000000000074) is listed at the end.

Resource Public Key Infrastructure (RPKI)

RPKI is a globally distributed database that contains information mapping BGP (internet) prefixes to their authorized origin-AS numbers. To validate the origin-AS of BGP paths, routers running BGP can connect to RPKI caches.

The RPKI-Cache-to-Router connectivity can be many-to-many, one RPKI cache can provide origin-AS validation data to multiple routers and one router can be connected to multiple RPKI caches. A router connects to RPKI caches to download information to build a special RPKI database that can be used by BGP to validate the origin-AS numbers for the internet routing table.

The RPKI database is a set of Route-Origin-Attestation (ROA) objects aggregated from the different RPKI caches to which BGP connects. ROA objects provide a mapping between a BGP prefix-block, and an AS number authorized to originate that block.

RPKI Configuration

RPKI configuration is categorized as:

- commands for connecting to RPKI Caches.
- commands for marking incoming prefixes with RPKI validation state.
- commands for using RPKI validation state in BGP best-path computation.
- commands for dropping out or manipulating prefixes with specific validation states using route-map.

Commands for connecting to RPKI caches

RPKI cache configuration is done in a new `rpki-cache` submode under the `router-bgp` submode. This is like configuring BGP peers under the default VRF. The submode is entered by using the `"rpki cache <IP address>"` command. When you enter the submode, various parameters for the RPKI cache can be configured.

```

router bgp 100
  rpki cache 147.28.0.11
    description          A description to identify the cache
    shutdown             Shutdown the cache
    transport tcp port   Transport port on which cache is listening

```

```

vrf                Vrf in which RPKI cache is reachable
refresh-interval   Specify periodic wait time between cache poll attempts
retry-interval     Specify wait time before retrying failed serial or reset query
expiry-interval    Specify how long to use current data while unable to perform successful
query

```



Note Unless transport TCP port is explicitly configured, BGP will connect to RPKI cache on RPKI-RTR port 323. Unless explicitly configured, all intervals will be determined as suggested by the RPKI Cache in End of Data PDU.

Commands for marking incoming prefixes with RPKI validation state

There are knobs that control the behavior of RPKI prefix validation processing. These knobs can be configured at the address-family level.

- **origin-as validate** - Configured at the address-family level enables eBGP path validation against ROA database. By default, this is disabled.



Note This command has no bearing on iBGP paths. The iBGP paths are not validated against ROA database. The only way to mark path validation state on iBGP paths is receiving the BGP Prefix Origin Validation State Extended Community, and is done by default without configuring any command.

- **origin-as validate signal ibgp** - Configured at the address-family level enables the iBGP signalling of validity state through BGP Prefix Origin Validation State Extended Community.

Commands for using RPKI validation state in BGP best-path-computation

There are commands to control the behavior of RPKI prefix validation processing. These commands can be configured at the address-family level.

- **bestpath origin-as use-validity** - Configured at the address-family level enables the validity states of BGP paths to affect the path's preference in the BGP bestpath process. By default, this is disabled.
- **bestpath origin-as allow invalid** - Configured at the address-family level allows all "invalid" paths to be considered for BGP bestpath computation (all such paths are not bestpath candidates if best-path origin-as validate is configured). By default, this is disabled.

Commands for dropping out or manipulating prefixes with specific validation states using route-map

The following is the command for dropping out or manipulating prefixes with specific validation states using route-map:

```

route-map sample1 permit 10
  match rpki {not-found | invalid | valid}

```

The parameters of the match rpk command are described as follows:

- `not-found` - This origin-AS is unknown in the RPKI database.
- `invalid` - This is an invalid origin-AS in the RPKI database.
- `valid` - This is a valid origin-AS in the RPKI database.

This match clause is relevant for inbound route-maps only.

For iBGP learnt paths, the incoming BGP Prefix Origin Validation State Extended Community in the update will be compared against this route-map clause.

For eBGP learnt paths, the validation state obtained by ROA database lookup will be compared against this route-map clause.

While prefixes marked as validation-state invalid are rendered ineffective by not being considered for best-path computation in BGP, an administrator may decide to drop such prefixes altogether to save system memory. The following inbound route-map is recommended for this purpose:

```
route-map sample deny 10
match rpk invalid
route-map sample permit 20
```

RPKI Show Commands

To display RPKI configuration information, perform one of the following tasks:

Command	Purpose
<code>show bgp rpk summary</code>	Displays an overview of RPKI statistics including the number of RPKI caches.
<code>show bgp rpk table {ipv4 ipv6} {IP address/masklength}</code>	<p>Displays information about the current RPKI ROA database. With no options specified, the command shows the IPv4 ROA database. With the IPv6 option (<code>show bgp rpk table ipv6</code>), the command shows the IPv6 ROA database. ROAs that are received from a cache that is temporarily down (due to connectivity issues, for example) are displayed with (*). These ROAs will be removed from the RPKI database if the cache session does not establish within the purge-time for that cache.</p> <p>If an ROA prefix-block is specified after the table show command (for example, <code>show bgp rpk table 67.21.36.0/24 max 24</code>), then that specific ROA entry is displayed in detail, if the ROA exists.</p> <p>Note One ROA (IP address/min-max) can have multiple origin ASs and can be sourced from multiple caches.</p>

Command	Purpose
show bgp rpki cache {IP address}	Displays a summary listing of all the caches that are configured and their parameters, such as show bgp summary . If a cache IP address is specified with the previous command, then detailed information is shown for that cache.
show bgp {ipv4 unicast ipv6 unicast} origin-as validity-state {valid invalid unknown}	Displays information about BGP. This command has new options to filter the BGP table output based on path (validation_state). Specify a validity state (valid, invalid, or unknown) with this command to filter the relevant information from the BGP table, and only the BGP paths matching that validity-state are displayed.

RPKI Clear Commands

The following is the RPKI Clear command:

- **clear bgp rpki cache *** - This command resets the transport sessions of all configured RPKI caches and immediately purges the RPKI database of all IPv4 and IPv6 ROAs received from all caches.

RPKI Debug and Event History Commands

The following are the RPKI Debug and Event History commands:

- **debug bgp rpki** - This command turns on debugging for all RPKI related operations excluding prefix-validation. This includes debugging events such as RPKI cache connectivity, protocol state-machine for the RPKI caches, and RPKI database events such as ROA insertion or deletion.
- **sh bgp event-history rpki** - This command dumps high level information about RPKI.



CHAPTER 9

Configuring IP ACLs

This chapter describes how to configure IP access control lists (ACLs) on Cisco NX-OS devices.

Unless otherwise specified, the term IP ACL refers to IPv4 and IPv6 ACLs.

- [Information About ACLs, on page 165](#)
- [Prerequisites for ACLs, on page 168](#)
- [Guidelines and Limitations for ACLs, on page 168](#)
- [Default ACL Settings, on page 170](#)
- [Configuring IP ACLs, on page 171](#)
- [About System ACLs, on page 185](#)
- [Configuring ACL Logging, on page 189](#)
- [Configuring ACL TCAM Region Sizes, on page 193](#)
- [Configuring ACLs on Virtual Terminal Lines, on page 196](#)

Information About ACLs

An access control list (ACL) is an ordered set of rules that you can use to filter traffic. Each rule specifies a set of conditions that a packet must satisfy to match the rule. When the switch determines that an ACL applies to a packet, it tests the packet against the conditions of all rules. The first match determines whether the packet is permitted or denied. If there is no match, the switch applies the applicable default rule. The switch continues processing packets that are permitted and drops packets that are denied.

You can use ACLs to protect networks and specific hosts from unnecessary or unwanted traffic. For example, you could use ACLs to disallow HTTP traffic from a high-security network to the Internet. You could also use ACLs to allow HTTP traffic but only to specific sites, using the IP address of the site to identify it in an IP ACL.

IP ACL Types and Applications

The Cisco Nexus device supports IPv4, IPv6, and MAC ACLs for security traffic filtering. The switch allows you to use IP access control lists (ACLs) as port ACLs, and Router ACLs as shown in the following table.

Table 11: Security ACL Applications

Application	Supported Interfaces	Types of ACLs Supported
Port ACL	An ACL is considered a port ACL when you apply it to one of the following: <ul style="list-style-type: none"> Ethernet interface Ethernet port-channel interface 	IPv4 ACLs IPv6 ACLs MAC ACLs
Router ACL	<ul style="list-style-type: none"> Physical Layer 3 interfaces Layer 3 Ethernet subinterfaces Layer 3 Ethernet port-channel interfaces Layer 3 Ethernet port-channel subinterfaces Management interfaces Switched Virtual Interfaces (SVIs) 	IPv4 ACLs IPv6 ACLs
VTY ACL	VTYs	IPv4 ACLs IPv6 ACLs

Application Order

When the device processes a packet, it determines the forwarding path of the packet. The path determines which ACLs that the device applies to the traffic. The device applies the ACLs in the following order:

1. Port ACL
2. Ingress Router ACL

Rules

You can create rules in access-list configuration mode by using the **permit** or **deny** command. The switch allows traffic that matches the criteria in a permit rule and blocks traffic that matches the criteria in a deny rule. You have many options for configuring the criteria that traffic must meet in order to match the rule.

Source and Destination

In each rule, you specify the source and the destination of the traffic that matches the rule. You can specify both the source and destination as a specific host, a network or group of hosts, or any host.

Protocols

IPv4 and MAC ACLs allow you to identify traffic by protocol. For your convenience, you can specify some protocols by name. For example, in an IPv4 ACL, you can specify ICMP by name.

You can specify any protocol by the integer that represents the Internet protocol number.

Implicit Rules

IP and MAC ACLs have implicit rules, which means that although these rules do not appear in the running configuration, the switch applies them to traffic when no other rules in an ACL match.

All IPv4 ACLs include the following implicit rule:

```
deny ip any any
```

This implicit rule ensures that the switch denies unmatched IP traffic.

All IPv6 ACLs include the following implicit rule:

```
deny ipv6 any any
```

All MAC ACLs include the following implicit rule:

```
deny any any protocol
```

This implicit rule ensures that the device denies the unmatched traffic, regardless of the protocol specified in the Layer 2 header of the traffic.

Additional Filtering Options

You can identify traffic by using additional options. IPv4 ACLs support the following additional filtering options:

- Layer 4 protocol
- TCP and UDP ports
- IGMP types
- Established TCP connections

Sequence Numbers

The Cisco Nexus device supports sequence numbers for rules. Every rule that you enter receives a sequence number, either assigned by you or assigned automatically by the device. Sequence numbers simplify the following ACL tasks:

- Adding new rules between existing rules—By specifying the sequence number, you specify where in the ACL a new rule should be positioned. For example, if you need to insert a rule between rules numbered 100 and 110, you could assign a sequence number of 105 to the new rule.
- Removing a rule—Without using a sequence number, removing a rule requires that you enter the whole rule, as follows:

```
switch(config-acl)# no permit tcp 10.0.0.0/8 any
```

However, if the same rule had a sequence number of 101, removing the rule requires only the following command:

```
switch(config-acl)# no 101
```

- Moving a rule—With sequence numbers, if you need to move a rule to a different position within an ACL, you can add a second instance of the rule using the sequence number that positions it correctly, and then you can remove the original instance of the rule. This action allows you to move the rule without disrupting traffic.

If you enter a rule without a sequence number, the device adds the rule to the end of the ACL and assigns a sequence number that is 10 greater than the sequence number of the preceding rule to the rule. For example, if the last rule in an ACL has a sequence number of 225 and you add a rule without a sequence number, the device assigns the sequence number 235 to the new rule.

In addition, the device allows you to reassign sequence numbers to rules in an ACL. Resequencing is useful when an ACL has rules numbered contiguously, such as 100 and 101, and you need to insert one or more rules between those rules.

Logical Operators and Logical Operation Units

IP ACL rules for TCP and UDP traffic can use logical operators to filter traffic based on port numbers.

The Cisco Nexus device stores operator-operand couples in registers called logical operation units (LOUs) to perform operations (greater than, less than, not equal to, and range) on the TCP and UDP ports specified in an IP ACL.

Prerequisites for ACLs

IP ACLs have the following prerequisites:

- You must be familiar with IP addressing and protocols to configure IP ACLs.
- You must be familiar with the interface types that you want to configure with ACLs.

Guidelines and Limitations for ACLs

IP ACLs have the following configuration guidelines and limitations:

- As an enhancement to HTTP method match, the `tcp-option-length` option has been added to the ACE syntax to specify the length of the TCP options header in the packets. You can configure up to four `tcp-option-lengths` in the ACEs, which include the TCP option length of 0. If you do not configure the `tcp-option-length` option, the length is considered as 0. It means that only the packets without the TCP options header can match this ACE. This feature gives more flexibility in such a way that the HTTP method can be matched even on the packets that have the variable length TCP options header.
- We recommend that you perform ACL configuration using the Session Manager. This feature allows you to verify ACL configuration and confirm that the resources that are required by the configuration are available before committing them to the running configuration. This is especially useful for ACLs that include more than about 1000 rules.
- You can configure any number of ACLs as long as TCAM space is available.
- Egress RAcls are not supported in Release 7.x, although the configuration may be allowed without an error or warning.
- Usually, ACL processing for IP packets occurs on the I/O modules, which use hardware that accelerates ACL processing. In some circumstances, processing occurs on the supervisor module, which can result in slower ACL processing, especially during processing that involves an ACL with many rules. Management interface traffic is always processed on the supervisor module. If IP packets in any of the following categories are exiting a Layer 3 interface, they are sent to the supervisor module for processing:

- Packets that fail the Layer 3 maximum transmission unit check and therefore require fragmenting.
- IPv4 packets that have IP options (additional IP packet header fields following the destination address field).
- IPv6 packets that have extended IPv6 header fields.
- When you apply an ACL that uses time ranges, the device updates the ACL entries whenever a time range that is referenced in an ACL entry starts or ends. Updates that are initiated by time ranges occur on a best-effort priority. If the device is especially busy when a time range causes an update, the device may delay the update by up to a few seconds. Make sure that the time range is valid and in an active state.
- To use the **match-local-traffic** option for all inbound and outbound traffic, you must first enable the ACL in the software.
- For a Cisco N3K-C36180YC-R switch with configured egress RACLs, before upgrading from a 7.x release to a 9.x release, follow these steps to ensure the RACLs are maintained and the upgrade is completed without issue:
 1. Add TCAM entries for egress RACL using the **hardware access-list tcam region e-racl** command.
 2. Save the configuration and reload.
 3. Upgrade to a 9.x release.

For more information about configuring TCAM regions, see [ACL TCAM Regions, on page 185](#) and [Configuring ACL TCAM Region Sizes, on page 193](#).

- Beginning Cisco NX-OS Release 9.3(2), you can configure a user-defined MAC address limit between the range of 16–256 for Cisco Nexus 36180YC-R and 3636C-R switches.
- In Cisco NX-OS Release 9.3(3), Cisco Nexus 3636C-R platform switches support the following for egress IPv6 RACLs:
 - Layer 4 Protocol
 - TCP flags
 - Fragment
 - ACL logs
- In Cisco NX-OS Release 9.3(3), Cisco Nexus 3636C-R platform switches do not support the following:
 - Egress atomic updates
 - Egress router ACL on external TCAM
 - Egress router ACL with UDF
 - Router ACL v6 counters for both egress and ingress
 - Egress and ingress router ACL IPv6 with I4 ops
 - Egress router ACL on subinterface
 - Egress and ingress router ACL with IPv6 ICMP Type and Code

- IPv6 ingress router ACL with tcp-flag
- IPv4 router ACL with extra option
- In Cisco NX-OS Release 9.3(3), Cisco Nexus 3636C-R platform switches support the following for egress IPv4 RAACLs:
 - TCP flags
 - ICMP Type and Code
 - ACL logs
- When you enable the counters for the ACL TCAM entries using the hardware profile `acl-stats module xx` command, the input discard field in the `show interface` is always zero. This limitation is applicable only to the Cisco Nexus 3600 platform switches with N3K-C3636C-R and N3K-C36180YC-R line cards.
- In Cisco NX-OS Release 9.3(5), IPv6 egress ACL supports the following on Cisco Nexus 3636C-R and 36180YC-R switches:
 - Layer 4 Protocol
 - TCP flags
 - Fragment
 - ACL logs
 - IPv6 header fields

Default ACL Settings

The following table lists the default settings for IP ACLs parameters.

Table 12: Default IP ACLs Parameters

Parameters	Default
IP ACLs	No IP ACLs exist by default.
ACL rules	Implicit rules apply to all ACLs

The following table lists the default settings for MAC ACLs parameters.

Table 13: Default MAC ACLs Parameters

Parameters	Default
MAC ACLs	No MAC ACLs exist by default.
ACL rules	Implicit rules apply to all ACLs

Configuring IP ACLs

Creating an IP ACL

You can create an IPv4 or IPv6 ACL on the device and add rules to it.

Before you begin

We recommend that you perform the ACL configuration using the Session Manager. This feature allows you to verify the ACL configuration and confirm that the resources that are required by the configuration are available before committing them to the running configuration. This feature is especially useful for ACLs that include more than about 1000 rules.

SUMMARY STEPS

1. **configure terminal**
2. Enter one of the following commands:
 - **ip access-list** *name*
 - **ipv6 access-list** *name*
3. [*sequence-number*] **{permit | deny}** *protocol* {*source-ip-prefix* | *source-ip-mask*} {*destination-ip-prefix* | *destination-ip-mask*}
4. **statistics per-entry**
5. **hardware profile acl-stats module** *xx*
6. **reload**
7. Enter one of the following commands:
 - **show ip access-lists** *name*
 - **show ipv6 access-lists** *name*
8. **copy running-config startup-config**
9. (Optional) **switch# copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	Enter one of the following commands: <ul style="list-style-type: none"> • ip access-list <i>name</i> • ipv6 access-list <i>name</i> Example: <pre>switch(config)# ip access-list acl-01 switch(config-acl)#</pre>	Creates the IP ACL and enters IP ACL configuration mode. The <i>name</i> argument can be up to 64 characters.

	Command or Action	Purpose
Step 3	<p>[<i>sequence-number</i>] {permit deny} <i>protocol</i> {<i>source-ip-prefix</i> <i>source-ip-mask</i>} {<i>destination-ip-prefix</i> <i>destination-ip-mask</i>}</p> <p>Example:</p> <pre>switch(config-acl)# 10 permit ipv6 1::1 2::2 3::3 4::4</pre>	<p>Creates a rule in the IP ACL. You can create many rules. The <i>sequence-number</i> argument can be a whole number between 1 and 4294967295.</p> <p>The permit and deny commands support many ways of identifying traffic. For more information, see the <i>Command Reference</i> for the specific Cisco Nexus device.</p>
Step 4	<p>statistics per-entry</p> <p>Example:</p> <pre>switch(config-acl)# statistics per-entry</pre>	Specifies that the device maintains global statistics for packets that match the rules in the ACL.
Step 5	<p>hardware profile acl-stats module <i>xx</i></p> <p>Example:</p> <pre>switch(config-acl)# hardware profile acl-stats module 1</pre>	<p>Enables counters for the ACL TCAM entries on both, the internal and external TCAM.</p> <p>Note This command is applicable only for Cisco Nexus 9500 platform switches with -R and -RX line cards and Cisco Nexus 3636C-R and 36180YC-R switches. VLAN and SVI statistics are lost when you enable the counters.</p>
Step 6	<p>reload</p> <p>Example:</p> <pre>switch(config)# reload</pre>	<p>Reloads the switch.</p> <p>Note The reload command is mandatory for the Cisco Nexus 3636C-R and 36180YC-R switches.</p>
Step 7	<p>Enter one of the following commands:</p> <ul style="list-style-type: none"> • show ip access-lists <i>name</i> • show ipv6 access-lists <i>name</i> <p>Example:</p> <pre>switch(config-acl)# show ip access-lists acl-01</pre>	Displays the IP ACL configuration.
Step 8	<p>copy running-config startup-config</p> <p>Example:</p> <pre>switch(config-acl)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.
Step 9	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

This example shows how to create an IPv4 ACL:

```
switch# configure terminal
switch(config)# ip access-list acl-01
switch(config-acl)# permit ip 192.168.2.0/24 any
```

This example shows how to create an IPv6 ACL:

```
switch# configure terminal
switch(config)# ipv6 access-list acl-01-ipv6
switch(config-ipv6-acl)# permit tcp 2001:0db8:85a3::/48 2001:0db8:be03:2112::/64
```

Configuring IPv4 ACL Logging

To configure the IPv4 ACL logging process, you first create the access list, then enable filtering of IPv4 traffic on an interface using the specified ACL, and finally configure the ACL logging process parameters.

SUMMARY STEPS

1. **configure terminal**
2. **ip access-list** *name*
3. **{permit | deny} ip** *source-address destination-address log*
4. **exit**
5. **interface ethernet** *slot/port*
6. **ip access-group** *name in*
7. **exit**
8. **logging ip access-list cache interval** *interval*
9. **logging ip access-list cache entries** *number-of-flows*
10. **logging ip access-list cache threshold** *threshold*
11. **logging ip access-list detailed**
12. **hardware rate-limiter access-list-log** *packets*
13. **aclog match-log-level** *severity-level*
14. (Optional) **show logging ip access-list cache** [*detail*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	ip access-list <i>name</i> Example: <pre>switch(config)# ip access-list logging-test switch(config-acl)#</pre>	Creates an IPv4 ACL and enters IP ACL configuration mode. The <i>name</i> argument can be up to 64 characters.
Step 3	{permit deny} ip <i>source-address destination-address log</i> Example: <pre>switch(config-acl)# permit ip any 10.30.30.0/24 log</pre>	<p>Creates an ACL rule that permits or denies IPv4 traffic matching its conditions. To enable the system to generate an informational logging message about each packet that matches the rule, you must include the log keyword.</p> <p>The <i>source-address</i> and <i>destination-address</i> arguments can be the IP address with a network wildcard, the IP address and variable-length subnet mask, the host address, or any to designate any address.</p>

	Command or Action	Purpose
Step 4	exit Example: switch(config-acl)# exit switch(config)#	Updates the configuration and exits IP ACL configuration mode.
Step 5	interface ethernet slot/port Example: switch(config)# interface ethernet 1/1 switch(config-if)#	Enters interface configuration mode.
Step 6	ip access-group name in Example: switch(config-if)# ip access-group logging-test in	Enables the filtering of IPv4 traffic on an interface using the specified ACL. You can apply an ACL to inbound traffic.
Step 7	exit Example: switch(config-if)# exit switch(config)#	Updates the configuration and exits interface configuration mode.
Step 8	logging ip access-list cache interval interval Example: switch(config)# logging ip access-list cache interval 490	Configures the log-update interval (in seconds) for the ACL logging process. The default value is 300 seconds. The range is from 5 to 86400 seconds.
Step 9	logging ip access-list cache entries number-of-flows Example: switch(config)# logging ip access-list cache entries 8001	Specifies the maximum number of flows to be monitored by the ACL logging process. The default value is 8000. The range of values supported is from 0 to 1048576.
Step 10	logging ip access-list cache threshold threshold Example: switch(config)# logging ip access-list cache threshold 490	If the specified number of packets is logged before the expiry of the alert interval, the system generates a syslog message.
Step 11	logging ip access-list detailed Example: switch(config)# logging ip access-list detailed	Enables the ACL name, the sequence number of ACE, action, ACL direction, ACL filter type, and the ACL applied interface are displayed in the output of the show logging ip access-list cache command.
Step 12	hardware rate-limiter access-list-log packets Example: switch(config)# hardware rate-limiter access-list-log 200	Configures rate limits in packets per second for packets copied to the supervisor module for ACL logging. The range is from 0 to 30000. Note Cisco Nexus NX-OS 7.0(3)F3(1) does not support the hardware rate-limiter access-list-log command.

	Command or Action	Purpose
Step 13	acllog match-log-level <i>severity-level</i> Example: switch(config)# acllog match-log-level 5	Specifies the minimum severity level to log ACL matches. The default is 6 (informational). The range is from 0 (emergency) to 7 (debugging).
Step 14	(Optional) show logging ip access-list cache [detail] Example: switch(config)# show logging ip access-list cache	Displays information on the active logged flows, such as source IP and destination IP addresses, source port and destination port information, source interfaces, and so on. If you entered the logging ip access-list detailed command, the output also includes the ACL name, the sequence number of ACE, action, ACL direction, ACL filter type, and the ACL applied interface .

Changing an IP ACL

You can add and remove rules in an existing IPv4 or IPv6 ACL. You cannot change existing rules. Instead, to change a rule, you can remove it and recreate it with the desired changes.

If you need to add more rules between existing rules than the current sequence numbering allows, you can use the **resequence** command to reassign sequence numbers.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **{ip | ipv6} ip access-list name**
3. switch(config)# **ip access-list name**
4. switch(config-acl)# [*sequence-number*] **{permit | deny} protocol source destination**
5. (Optional) switch(config-acl)# **no {sequence-number | {permit | deny} protocol source destination}**
6. (Optional) switch#**show ip access-lists name**
7. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# {ip ipv6} ip access-list name	Enters IP ACL configuration mode for the ACL that you specify by name.
Step 3	switch(config)# ip access-list name	Enters IP ACL configuration mode for the ACL that you specify by name.
Step 4	switch(config-acl)# [<i>sequence-number</i>] {permit deny} protocol source destination	Creates a rule in the IP ACL. Using a sequence number allows you to specify a position for the rule in the ACL. Without a sequence number, the rule is added to the end of the rules. The <i>sequence-number</i> argument can be a whole number between 1 and 4294967295.

	Command or Action	Purpose
		The permit and deny commands support many ways of identifying traffic. For more information, see the <i>Command Reference</i> for your Cisco Nexus device.
Step 5	(Optional) switch(config-acl)# no { <i>sequence-number</i> { permit deny } <i>protocol source destination</i> }	Removes the rule that you specified from the IP ACL. The permit and deny commands support many ways of identifying traffic. For more information, see the <i>Command Reference</i> for your Cisco Nexus device.
Step 6	(Optional) switch# show ip access-lists <i>name</i>	Displays the IP ACL configuration.
Step 7	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

[Changing Sequence Numbers in an IP ACL](#), on page 177

Removing an IP ACL

You can remove an IP ACL from the switch.

Before you remove an IP ACL from the switch, be sure that you know whether the ACL is applied to an interface. The switch allows you to remove ACLs that are currently applied. Removing an ACL does not affect the configuration of interfaces where you have applied the ACL. Instead, the switch considers the removed ACL to be empty.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **no ip access-list** *name*
3. switch(config)# **no ip access-list** *name*
4. (Optional) switch# **show running-config**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# no ip access-list <i>name</i>	Removes the IP ACL that you specified by name from the running configuration.
Step 3	switch(config)# no ip access-list <i>name</i>	Removes the IP ACL that you specified by name from the running configuration.
Step 4	(Optional) switch# show running-config	Displays the ACL configuration. The removed IP ACL should not appear.

	Command or Action	Purpose
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Changing Sequence Numbers in an IP ACL

You can change all the sequence numbers assigned to the rules in an IP ACL.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **resequence ip access-list** *name* *starting-sequence-number* *increment*
3. (Optional) switch# **show ip access-lists** *name*
4. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# resequence ip access-list <i>name</i> <i>starting-sequence-number</i> <i>increment</i>	Assigns sequence numbers to the rules contained in the ACL, where the first rule receives the starting sequence number that you specify. Each subsequent rule receives a number larger than the preceding rule. The difference in numbers is determined by the increment that you specify. The <i>starting-sequence-number</i> argument and the <i>increment</i> argument can be a whole number between 1 and 4294967295.
Step 3	(Optional) switch# show ip access-lists <i>name</i>	Displays the IP ACL configuration.
Step 4	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Applying an IP ACL to mgmt0

You can apply an IPv4 or IPv6 ACL to the management interface (mgmt0).

Before you begin

Ensure that the ACL that you want to apply exists and that it is configured to filter traffic in the manner that you need for this application.

SUMMARY STEPS

1. **configure terminal**
2. **ip access-group** *access-list* {**in** | **out**}
3. (Optional) **show running-config aclmgr**

4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	ip access-group <i>access-list</i> {in out} Example: switch(config-if)# ip access-group acl-120 out	Applies an IPv4 or IPv6 ACL to the Layer 3 interface for traffic flowing in the direction specified. You can apply one router ACL per direction.
Step 3	(Optional) show running-config aclmgr Example: switch(config-if)# show running-config aclmgr	Displays the ACL configuration.
Step 4	(Optional) copy running-config startup-config Example: switch(config-if)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Related Topics

- Creating an IP ACL

Applying an IP ACL as a Port ACL

You can apply an IPv4 ACL to a physical Ethernet interface or a PortChannel. ACLs applied to these interface types are considered port ACLs.



Note Some configuration parameters when applied to an PortChannel are not reflected on the configuration of the member ports.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **interface** {**ethernet** [*chassis*]/*slot*/*port* | **port-channel** *channel-number*}
3. switch(config-if)# **ip port access-group *access-list* in**
4. (Optional) switch# **show running-config**
5. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# interface { ethernet [<i>chassis</i>]/ <i>slot/port</i> port-channel <i>channel-number</i> }	Enters interface configuration mode for the specified interface.
Step 3	switch(config-if)# ip port access-group <i>access-list in</i>	Applies an IPv4 ACL to the interface or PortChannel. Only inbound filtering is supported with port ACLs. You can apply one port ACL to an interface.
Step 4	(Optional) switch# show running-config	Displays the ACL configuration.
Step 5	(Optional) switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Applying an IP ACL as a Router ACL

You can apply an IPv4 or IPv6 ACL to any of the following types of interfaces:

- Physical Layer 3 interfaces and subinterfaces
- Layer 3 Ethernet port-channel interfaces and subinterfaces
- Management interfaces

Before you begin

Ensure that the ACL you want to apply exists and that it is configured to filter traffic in the manner that you need for this application.

SUMMARY STEPS

1. switch# **configure terminal**
2. Enter one of the following commands:
 - switch(config)# **interface ethernet** *slot/port*[. *number*]
 - switch(config)# **interface port-channel** *channel-number*[. *number*]
 - switch(config)# **interface mgmt** *port*
3. Enter one of the following commands:
 - switch(config-if)# **ip access-group** *access-list* {*in*}
 - switch(config-if)# **ipv6 traffic-filter** *access-list* {*in*}
4. (Optional) switch(config-if)# **show running-config aclmgr**
5. (Optional) switch(config-if)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	Enter one of the following commands: <ul style="list-style-type: none"> switch(config)# interface ethernet <i>slot/port</i> [. <i>number</i>] switch(config)# interface port-channel <i>channel-number</i> [. <i>number</i>] switch(config)# interface mgmt <i>port</i> 	Enters configuration mode for the interface type that you specified.
Step 3	Enter one of the following commands: <ul style="list-style-type: none"> switch(config-if)# ip access-group <i>access-list</i> {<i>in</i>} switch(config-if)# ipv6 traffic-filter <i>access-list</i> {<i>in</i>} 	Applies an IPv4 or IPv6 ACL to the layer 3 interface for traffic in the ingress direction.
Step 4	(Optional) switch(config-if)# show running-config aclmgr	Displays the ACL configuration.
Step 5	(Optional) switch(config-if)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring an Interface MAC Address and Limit

You can configure a static MAC address on SVI, Layer 3 interfaces, port channels, Layer 3 subinterfaces, and tunnel interfaces. You can also configure static MAC addresses on a range of ports and port channels. However, all ports must be in Layer 3. Even if one port in the range of ports is in Layer 2, the command is rejected and an error message is displayed.

By default, the maximum MAC addresses that can be configured on a switch is 16. However, you can change this limit and set it to a range of MAC addresses between 16 to 256.

On vPC enabled switches, the configured limit includes both, the locally configured user-defined MAC addresses plus the synced user-defined MAC addresses from the vPC peer.

SUMMARY STEPS

- configure terminal**
- interface ethernet** *slot/port*
- [no] mac-address** *static router MAC address*
- (Optional) **show interface ethernet** *slot/port*
- mac address-table limit** *16-256 user-defined*
- (Optional) **show mac address-table limit** *user-defined*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# <code>configure terminal</code> switch(config)#	Enters global configuration mode.

	Command or Action	Purpose
Step 2	interface ethernet slot/port Example: <pre>switch(config)# interface ethernet 2/1 switch(config-if)#</pre>	Enters interface configuration mode.
Step 3	[no] mac-address static router MAC address Example: <pre>switch(config-if)# mac-address 0019.D2D0.00AE</pre>	Configures the interface MAC address. The no form of this command removes the configuration. You can enter the MAC address in any one of the four supported formats: <ul style="list-style-type: none"> • E.E.E • EE-EE-EE-EE-EE-EE • EE:EE:EE:EE:EE:EE • EEEE.EEEE.EEEE Note Do not enter any of the following invalid MAC addresses: <ul style="list-style-type: none"> • Null MAC address—0000.0000.0000 • Broadcast MAC address—FFFF.FFFF.FFFF • Multicast MAC address—0100.DAAA.ADDD
Step 4	(Optional) show interface ethernet slot/port Example: <pre>switch(config-if)# show interface ethernet 2/1 switch(config)#</pre>	Displays all information for the interface.
Step 5	mac address-table limit 16-256 user-defined Example: <pre>switch(config)# mac address-table limit 200 user-defined switch(config)#</pre>	Configures the maximum number of MAC addresses that can be configured on a switch.
Step 6	(Optional) show mac address-table limit user-defined Example: <pre>switch(config)# show mac address-table limit user-defined</pre>	Displays the maximum number of MAC-addresses that can be configured on a switch.

Example

The following example shows how to configure an interface MAC address:

```
switch# configure terminal
switch(config)# interface ethernet 3/3
switch(config-if)# mac-address aaaa.bbbb.dddd
switch(config-if)# show interface ethernet 3/3
switch(config-if)#
```

```

switch(config)# mac address-table limit 100 user-defined
Warning: Configure the same User-Defined Mac Limit on the peer.
Warning: New Fhrp max group limit is 390
switch# show mac address-table limit user-defined
User Defined Mac Limit: 100
FHRP Mac Limit: 390
=====

```

Configuring a UDF-Based MAC ACL

This feature enables the device to match on user-defined fields (UDFs) and to apply the matching packets to MAC ACLs.

Beginning Cisco NX-OS Release 9.3(2), you can configure UDF-based MAC access lists (ACLs) for Cisco Nexus 36180YC-R and 3636C-R platform switches.

SUMMARY STEPS

1. **configure terminal**
2. **udf** *udf-name* *offset-base* *offset* *length*
3. **hardware access-list** *tcam region* *ing-ifacl* **qualify** {*udf* *udf-name* }
4. **copy running-config startup-config**
5. **reload**
6. **mac access-list** *udf-acl*
7. **permit mac** *source* *destination* **udf** *udf-name* *value* *mask*
8. **interface port-channel** *channel-number*
9. **mac port access-group** *udf-access-list*
10. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	udf <i>udf-name</i> <i>offset-base</i> <i>offset</i> <i>length</i> Example: <pre>switch(config)# udf pkttofl0 packet-start 10 2</pre>	Defines the UDF as follows: <ul style="list-style-type: none"> • <i>udf-name</i>—Specifies the name of the UDF. You can enter up to 16 alphanumeric characters for the name. • <i>offset-base</i>—Specifies the UDF offset base as follows: {packet-start}. • <i>offset</i>—Specifies the number of bytes offset from the offset base. • <i>length</i>—Specifies the number of bytes from the offset. Only 1 or 2 bytes are supported. To match additional bytes, you must define multiple UDFs.

	Command or Action	Purpose
		You can define multiple UDFs, but Cisco recommends defining only required UDFs.
Step 3	<p>hardware access-list tcam region ing-ifacl qualify {udf udf-name }</p> <p>Example:</p> <pre>switch(config)# hardware access-list tcam region ing-ifacl qualify udf pkttoff10</pre>	<p>Attaches the UDFs to the ing-ifacl TCAM region, which applies to IPv4 or IPv6 port ACLs.</p> <p>Up to 18 UDFs are supported.</p> <p>Note When the UDF qualifier is added, the TCAM region goes from single wide to double wide. Make sure that enough free space is available; otherwise, this command will be rejected. If necessary, you can reduce the TCAM space from unused regions and then re-enter this command. For more information, see Configuring ACL TCAM Region Sizes, on page 193.</p> <p>Note The no form of this command detaches the UDFs from the TCAM region and returns the region to single wide.</p>
Step 4	<p>Required: copy running-config startup-config</p> <p>Example:</p> <pre>switch(config)# copy running-config startup-config</pre>	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.
Step 5	<p>Required: reload</p> <p>Example:</p> <pre>switch(config)# reload</pre>	<p>Reloads the device.</p> <p>Note Your UDF configuration is effective only after you enter copy running-config startup-config + reload.</p>
Step 6	<p>mac access-list udf-acl</p> <p>Example:</p> <pre>switch(config)# mac access-list udfacl switch(config-acl)#</pre>	Creates a MAC access control list (ACL) and enters MAC ACL configuration mode.
Step 7	<p>permit mac source destination udf udf-name value mask</p> <p>Example:</p> <pre>switch(config-acl)# permit mac any any udf pkttoff10 0x1234 0xffff</pre>	<p>Configures the MAC ACL to match on UDFs along with the current access control entries (ACEs) for the outer packet fields (example 2). The range for the <i>value</i> and <i>mask</i> arguments is from 0x0 to 0xffff.</p> <p>A single ACL can have ACEs with and without UDFs together. Each ACE can have different UDF fields to match, or all ACEs can match for the same list of UDFs.</p>
Step 8	<p>interface port-channel channel-number</p> <p>Example:</p> <pre>switch(config)# interface port-channel 5 switch(config-if)#</pre>	Enters interface configuration mode for a Layer 2 port-channel interface.

	Command or Action	Purpose
Step 9	mac port access-group <i>udf-access-list</i> Example: <pre>switch(config-if)# mac port access-group udf-acl-01</pre>	Applies the UDF-based MAC ACL to the interface.
Step 10	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Configuring an ACL for IPv6 Extension Headers

This procedure applies only to the following devices:

- Cisco Nexus 9504 and 9508 modular chassis with these line cards: N9K-X9636C-R, N9K-X9636Q-R, N9K-X9636C-RX, and N9K-X96136YC-R
- Cisco Nexus 3600 Platform Switches (N3K-C36180YC-R and N3K-C3636C-R)

Beginning with Cisco NX-OS Release 9.3(7), if you configure an IPv6 ACL on the devices listed here, you must include a new rule for the disposition of IPv6 packets that include extension headers. For more information about IPv6 extension headers, see "Simplified IPv6 Packet Header" in NX-OS Release 9.3(x) or later of the *Cisco Nexus 3600 NX-OS Unicast Routing Configuration Guide*.



Note The permit or deny rule that you choose in this procedure is applied to any IPv6 packet with at least one extension header regardless of any other ACL rule that matches the packet's other fields.

SUMMARY STEPS

1. **configure terminal**
2. **ipv6 access-list** *name*
3. **extension-header** {**permit-all** | **deny-all**}

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	ipv6 access-list <i>name</i> Example: <pre>switch(config)# ipv6 access-list acl-01 switch(config-acl)#</pre>	Creates the IPv6 ACL and enters ACL configuration mode.

	Command or Action	Purpose
Step 3	extension-header {permit-all deny-all} Example: <pre>switch(config-acl)# extension-header permit-all switch(config-acl)#</pre>	Choose the desired action for matched packets: <ul style="list-style-type: none"> • permit-all — Any IPv6 packet with at least one extension header is permitted. • deny-all — Any IPv6 packet with at least one extension header is dropped.

About System ACLs

You can configure system ACLs on Cisco Nexus 36180YC-R and C3636C-R switches. With system ACLs, you can now configure a Layer 2 port ACL (PACL) on all the ports with the same access-list in the switch. Configuring system ACLs reduces the TCAM usage and also brings down the time and memory usage while the policy is being applied or modified.

See the following guidelines and limitations for configuring system ACLs:

- The system PAACL is supported for Layer 2 interface only.
- ACE statistics are not yet supported for the system ACLs.
- IPv6 is not yet supported in the system ACLs.
- System ACLs are not supported on the breakout port.
- For quality of service, ACL, or TCAM carving configuration on Cisco Nexus 3600 platform switches, see the [Cisco Nexus 3600 NX-OS Quality of Service Configuration Guide](#) for more information.

ACL TCAM Regions

You can change the size of the ACL ternary content addressable memory (TCAM) regions in the hardware.

The IPv4 TCAMs are single wide.

You can create IPv6 port ACLs, router ACLs, and you can match IPv6 addresses for QoS. Cisco NX-OS provides simultaneous support for all three TCAMs. You must remove or reduce the size of the existing TCAMs to enable these new IPv6 TCAMs.

TCAM region sizes have the following guidelines and limitations:

- To revert to the default ACL TCAM size, use the **no hardware access list tcam region** command. You need to reload the modules when you revert to default sizes.
- Depending upon the platform, each TCAM region might have a different minimum/maximum/aggregate size restriction.
- The total number of TCAMs is 16.
 - There are 12 large TCAMs—Each has 2048 entries that are 160 bit key size.
 - There are 4 small TCAMs—Each has 256 entries that are 160 bit key size.
- The TCAM regions RACL v6, QoS, CoPP, and Multicast cannot be set to 0.

- Redirect_v6, RACL v4 cannot share TCAM with any other features.
- After TCAM carving, you must reload the switch.
- RACL v6, CoPP, and multicast have default TCAM sizes and these TCAM sizes must be non-zero on the following Cisco 3600 line cards to avoid line card failure during reload:
 - N3K-C3636C-R
 - N3K-C36180YC-R
- You can partially use IPv6 RACL with IPv6 IFCAL. This is applicable Cisco Nexus N3K-C36180YC-R and N3K-C3636C-R line cards.

Table 14: TCAM Sizes by ACL Region

TCAM ACL Region	Default Size
PACL_IPv4 [ifacl]	1024
PACL_IPV6 [ipv6-ifacl]	1024
PACL_MAC [mac-ifacl]	2048
IPv4 Port QOS [qos]	640
IPv6 Port QOS [ipv6-qos]	256
IPv4 RACL [racl]	1024
IPv6 RACL [ipv6-racl]	1024
IPv4 L3 QoS [l3qos]	640
IPv6 L3 QoS [ipv6-l3qos]	256
SPAN [span]	96
Ingress COPP [copp]	128
Redirect v4	1024
Redirect v6	2048

Carving a TCAM Region

Before configuring the system ACLs, carve the TCAM region first. Note that for configuring the ACLs less than 1k, you do not need to carve the TCAM region. See the [Configuring ACL TCAM Region Sizes, on page 193](#) section for more information.



Note You can configure PACL IPv4, RACL IPv4, and RACL IPv6 beyond 12k.

Configuring System ACLs

After an IPv4 ACL is created, configure the system ACL.

Before you begin

Create an IPv4 ACL on the device. See [Creating an IP ACL, on page 171](#) for more information.

SUMMARY STEPS

1. `config t`
2. `system acl`
3. `ip port access-group <pacl name> in`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<code>config t</code>	Enters the configuration mode.
Step 2	<code>system acl</code>	Configures the system ACL.
Step 3	<code>ip port access-group <pacl name> in</code>	Applies a Layer 2 PACL to the interface. Only inbound filtering is supported with port ACLs. You can apply one port ACL to an interface.

Configuration and Show Command Examples for the System ACLs

See the following configuration examples for the system ACL show commands.

Configuring system PACL with 1K scale [using default TCAM]

See the following example for configuring system PACL with 1K scale [Using default TCAM].

Step 1: Create PACL.

```

config t
ip access-list PACL-DNA
  10 permit ip 1.1.1.1/32 any
  20 permit tcp 3.0.0.0/8 255.0.0.0 eq 1500
  25 deny udp any any eq 500
  26 deny tcp any eq 490 any
  ....
  1000 deny any any

```

Step 2: Apply PACL into system level.

```

configuration terminal
system acl
  ip port access-group PACL-DNA in

```

To validate the system ACLs that are configured on the switch, use the `sh run aclmgr | sec system` command:

```
switch# sh run aclmgr | sec system
system acl
 ip port access-group test in
switch#
```

To validate the PACLs that are configured on the switch, use the **sh ip access-lists <name> [summary]** command:

```
switch# sh ip access-lists test

IP access list test
 10 deny udp any any eq 27
 20 permit ip 1.1.1.1/32 100.100.100.100/32
 30 permit ip 1.2.1.1/32 100.100.100.100/32
 40 permit ip 1.3.1.1/32 100.100.100.100/32
 50 permit ip 1.4.1.1/32 100.100.100.100/32
 60 permit ip 1.5.1.1/32 100.100.100.100/32
 70 permit ip 1.6.1.1/32 100.100.100.100/32
 80 permit ip 1.7.1.1/32 100.100.100.100/32
 90 permit ip 1.8.1.1/32 100.100.100.100/32

switch# sh ip access-lists test summary
IPV4 ACL test
Total ACEs Configured: 12279
Configured on interfaces:
Active on interfaces:
  - ingress
  - ingress

switch#
```

To validate PACL IPv4 (ifacl) TCAM region size, use the **show hardware access-list tcam region** command:

```
switch# show hardware access-list tcam region
*****WARNING*****
*****The output shows NFE tcam region info*****
***Please refer to 'show hardware access-list tcam template' for NFE2***
*****

          IPV4 PACL [ifacl] size = 12280
          IPV6 PACL [ipv6-ifacl] size = 0
            MAC PACL [mac-ifacl] size = 0
              IPV4 Port QoS [qos] size = 640
                IPV6 Port QoS [ipv6-qos] size = 256
                  MAC Port QoS [mac-qos] size = 0
                    FEX IPV4 PACL [fex-ifacl] size = 0
                      FEX IPV6 PACL [fex-ipv6-ifacl] size = 0
                        FEX MAC PACL [fex-mac-ifacl] size = 0
                          FEX IPV4 Port QoS [fex-qos] size = 0
                            FEX IPV6 Port QoS [fex-ipv6-qos] size = 0
                              FEX MAC Port QoS [fex-mac-qos] size = 0
                                IPV4 VACL [vacl] size = 0
                                  IPV6 VACL [ipv6-vacl] size = 0
                                    MAC VACL [mac-vacl] size = 0
                                      IPV4 VLAN QoS [vqos] size = 0
                                        IPV6 VLAN QoS [ipv6-vqos] size = 0
                                          MAC VLAN QoS [mac-vqos] size = 0
                                            IPV4 RAACL [racl] size = 0
                                              IPV6 RAACL [ipv6-racl] size = 128
                                                IPV4 Port QoS Lite [qos-lite] size = 0
                                                  FEX IPV4 Port QoS Lite [fex-qos-lite] size = 0
```

```

IPV4 VLAN QoS Lite [vqos-lite] size = 0
IPV4 L3 QoS Lite [l3qos-lite] size = 0
  Egress IPV4 QoS [e-qos] size = 0
  Egress IPV6 QoS [e-ipv6-qos] size = 0
    Egress MAC QoS [e-mac-qos] size = 0
    Egress IPV4 VACL [vacl] size = 0
    Egress IPV6 VACL [ipv6-vacl] size = 0
    Egress MAC VACL [mac-vacl] size = 0
    Egress IPV4 RAACL [e-racl] size = 0
    Egress IPV6 RAACL [e-ipv6-racl] size = 0
  Egress IPV4 QoS Lite [e-qos-lite] size = 0
    IPV4 L3 QoS [l3qos] size = 640
    IPV6 L3 QoS [ipv6-l3qos] size = 256
    MAC L3 QoS [mac-l3qos] size = 0
    Ingress System size = 0
    Egress System size = 0
    SPAN [span] size = 96
    Ingress COPP [copp] size = 128
  Ingress Flow Counters [flow] size = 0
switch#

```

To view ACL related tech support information, use the **show tech-support aclmgr** and **show tech-support aclqos** commands.

```

show tech-support aclmgr
show tech-support aclqos

```

Configuring ACL Logging

ACL Logging

The Cisco Nexus device supports ACL logging, which allows you to monitor flows that hit specific access control lists (ACLs). To enable the feature for the ACL entry, configure specific ACEs with the optional **log** keyword.

Configuring the ACL Logging Cache

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **logging ip access-list cache entries** *num_entries*
3. switch(config)# **logging ip access-list cache interval** *seconds*
4. switch(config)# **logging ip access-list cache threshold** *num_packets*
5. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 2	switch(config)# logging ip access-list cache entries <i>num_entries</i>	Sets the maximum number of log entries cached in the software. The range is from 0 to 1000000 entries. The default value is 8000 entries.
Step 3	switch(config)# logging ip access-list cache interval <i>seconds</i>	Sets the number of seconds between log updates. If an entry is inactive for this duration, it is removed from the cache. The range is from 5 to 86400 seconds. The default value is 300 seconds.
Step 4	switch(config)# logging ip access-list cache threshold <i>num_packets</i>	Sets the number of packet matches before an entry is logged. The range is from 0 to 1000000 packets. The default value is 0 packets, which means that logging is not triggered by the number of packet matches.
Step 5	(Optional) switch(config)# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

The following example show how to set the maximum number of log entries to 5000, the interval to 120 seconds, and the threshold to 500000:

```
switch# configure terminal
switch(config)# logging ip access-list cache entries 5000
switch(config)# logging ip access-list cache interval 120
switch(config)# logging ip access-list cache threshold 500000
switch(config)# copy running-config startup-config
```

Applying ACL Logging to an Interface

You can apply ACL logging to Ethernet interfaces and port channels.

Before you begin

- Create an ACL.
- Create an IP access list with at least one access control entry (ACE) configured for logging.
- Configure the ACL logging cache.
- Configure the ACL log match level.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **interface ethernet slot/port**
3. switch(config-if)# **ip access-group name in**
4. (Optional) switch(config-if)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# interface ethernet <i>slot/port</i>	Specifies the Ethernet interface.
Step 3	switch(config-if)# ip access-group <i>name</i> in	Attaches an ACL with a log to the specified interface. ACL logging is enabled when the ACL is applied to the interface on the hardware.
Step 4	(Optional) switch(config-if)# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

The following example shows how to apply the Ethernet interface with the logging specified in `acl1` for all ingress traffic:

```
switch# configure terminal
switch(config)# interface ethernet 1/2
switch(config-if)# ip access-group acl1 in
switch(config-if)# copy running-config startup-config
```

Applying the ACL Log Match Level

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **aclog match-log-level** *number*
3. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# aclog match-log-level <i>number</i>	Specifies the logging level to match for entries to be logged in the ACL log (aclog). The number is a value from 0 to 7. The default is 6. Note Log messages are entered into the log if the logging level for the ACL log facility (aclog) and the logging severity level for the log file are greater than or equal to the ACL log match log level setting.

	Command or Action	Purpose
Step 3	(Optional) switch(config)# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

The following example shows how to apply the log match level for entries to be logged in the ACL log:

```
switch# configure terminal
switch(config)# acllog match-log-level 3
switch(config)# copy running-config startup-config
```

Clearing Log Files

You can clear messages in the log file and the NVRAM.

SUMMARY STEPS

1. switch# **clear logging ip access-list cache**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# clear logging ip access-list cache	Clears the access control list (ACL) cache.

Verifying the ACL Logging Configuration

To display ACL logging configuration information, perform one of the following tasks:

Command	Purpose
switch# show hardware access-list tcam region	Displays the TCAM sizes that will be applicable on the next reload of the device.
switch# show ip access-lists	Displays the IPv4 ACL configuration.
switch# show ipv6 access-lists	Displays the IPv6 ACL configuration.
switch# show logging ip access-list cache [detail]	Displays information on the active logged flows, such as source IP and destination IP addresses, source port and destination port information, and source interfaces.
switch# show logging ip access-list status	Displays the deny maximum flow count, the current effective log interval, and the current effective threshold value..

Command	Purpose
switch# show startup-config acllog	Displays the access control list (ACL) log file in the startup configuration.
switch# show startup-config aclmgr [all]	Displays the access control list (ACL) log file in the startup configuration. Note This command displays the user-configured ACLs in the startup configuration. The all option displays both the default (CoPP-configured) and the user-configured ACLs in the startup configuration.
switch# show running-config acllog	Displays the access control list (ACL) log file in the running configuration.
switch# show running-config aclmgr [all]	Displays the access control list (ACL) log file in the running configuration including the IP ACL configuration and the interfaces where you have applied IP ACLs. Note This command displays the user-configured ACLs in the running configuration. The all option displays both the default (CoPP-configured) and the user-configured ACLs in the startup configuration.

Configuring ACL TCAM Region Sizes

You can change the size of the ACL ternary content addressable memory (TCAM) regions in the hardware.



Note You cannot change the size of the small TCAMs (TCAM 12 through 15)

SUMMARY STEPS

1. switch# **configure terminal**
2. **hardware access-list tcam region** { ifacl | {ipv6-qos | qos} | {ipv6-racl | racl} tcam_size
3. **copy running-config startup-config**
4. switch(config)# **show hardware access-list tcam region**
5. switch(config)# **reload**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 2	hardware access-list tcam region { ifacl {ipv6-qos qos} {ipv6-racl racl} tcam_size	Changes the ACL TCAM region size. <ul style="list-style-type: none"> • ifacl—Configures the size of the interface ACL (ifacl) TCAM region. The maximum number of entries is 1500. • qos—Configures the size of the quality of service (QoS) TCAM region. • racl—Configures the size of the router ACL (RACL) TCAM region. • tcam_size—TCAM size. The range is from 0 to 256, 512, (multiples of 256) entries.
Step 3	copy running-config startup-config Example: switch(config)# copy running-config startup-config	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.
Step 4	switch(config)# show hardware access-list tcam region Example: switch(config)# show hardware access-list tcam region	Displays the TCAM sizes that will be applicable on the next reload of the switch.
Step 5	switch(config)# reload Example: switch(config)# reload	Copies the running configuration to the startup configuration. Note The new size values are effective only upon the next reload after saving the copy running-config to startup-config .

Example

The following example shows how to change the size of the RACL TCAM region:

```
switch(config)# hardware access-list tcam region racl 256
[SUCCESS] New tcam size will be applicable only at boot time.
You need to 'copy run start' and 'reload'
```

```
switch(config)# copy running-config startup-config
switch(config)# reload
WARNING: This command will reboot the system
Do you want to continue? (y/n) [n] y
```

This example shows how to display the TCAM region sizes to verify your changes:

```
switch(config)# show hardware accesslist tcam region | exclude "0"
```

```
IPV4 PACL [ifacl] size = 1024
```

```

IPV6 PACL [ipv6-ifacl] size = 1024
MAC PACL [mac-ifacl] size = 2048
IPV4 Port QoS [qos] size = 640
IPV6 Port QoS [ipv6-qos] size = 256
IPV4 RACL [racl] size = 2048
IPV6 RACL [ipv6-racl] size = 1024
IPV4 L3 QoS [l3qos] size = 640
IPV6 L3 QoS [ipv6-l3qos] size = 256
SPAN [span] size = 96
Ingress COPP [copp] size = 128
Redirect v4 size = 1024
Redirect v6 size = 2048

```

Reverting to the Default TCAM Region Sizes

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **no hardware profile tcam region {arpacl | e-racl} | ifacl | | nat | qos} | qoslbl | racl} | vacl } tcam_size**
3. (Optional) switch(config)# **copy running-config startup-config**
4. switch(config)# **reload**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# no hardware profile tcam region {arpacl e-racl} ifacl nat qos} qoslbl racl} vacl } tcam_size	Reverts the configuration to the default ACL TCAM size.
Step 3	(Optional) switch(config)# copy running-config startup-config	Saves the changes persistently through reboots and restarts by copying the running configuration to the startup configuration.
Step 4	switch(config)# reload	Reloads the switch.

Example

The following example shows how to revert to the default RACL TCAM region sizes:

```

switch(config)# no hardware profile tcam region racl 256
[SUCCESS] New tcam size will be applicable only at boot time.
You need to 'copy run start' and 'reload'

switch(config)# copy running-config startup-config
switch(config)# reload
WARNING: This command will reboot the system
Do you want to continue? (y/n) [n] y

```

Configuring ACLs on Virtual Terminal Lines

To restrict incoming and outgoing connections for IPv4 between a Virtual Terminal (VTY) line and the addresses in an access list, use the **access-class** command in line configuration mode. To remove access restrictions, use the **no** form of this command.

Follow these guidelines when configuring ACLs on VTY lines:

- Set identical restrictions on all VTY lines because a user can connect to any of them.
- Statistics per entry is not supported for ACLs on VTY lines.

Before you begin

Be sure that the ACL that you want to apply exists and is configured to filter traffic for this application.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **line vty**
3. switch(config-line)# **access-class access-list-number {in | out}**
4. (Optional) switch(config-line)# **no access-class access-list-number {in | out}**
5. switch(config-line)# **exit**
6. (Optional) switch# **show running-config aclmgr**
7. (Optional) switch# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# configure terminal	Enters global configuration mode.
Step 2	switch(config)# line vty Example: switch(config)# line vty switch(config-line)#	Enters line configuration mode.
Step 3	switch(config-line)# access-class access-list-number {in out} Example: switch(config-line)# access-class ozi2 in switch(config-line)#access-class ozi3 out switch(config)#	Specifies inbound or outbound access restrictions.
Step 4	(Optional) switch(config-line)# no access-class access-list-number {in out} Example: switch(config-line)# no access-class ozi2 in switch(config-line)# no access-class ozi3 out switch(config)#	Removes inbound or outbound access restrictions.

	Command or Action	Purpose
Step 5	switch(config-line)# exit Example: switch(config-line)# exit switch#	Exits line configuration mode.
Step 6	(Optional) switch# show running-config aclmgr Example: switch# show running-config aclmgr	Displays the running configuration of the ACLs on the switch.
Step 7	(Optional) switch# copy running-config startup-config Example: switch# copy running-config startup-config	Copies the running configuration to the startup configuration.

Example

The following example shows how to apply the access-class ozi2 command to the in-direction of the vty line.

```
switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# line vty
switch(config-line)# access-class ozi2 in
switch(config-line)# exit
switch#
```

Verifying ACLs on VTY Lines

To display the ACL configurations on VTY lines, perform one of the following tasks:

Command	Purpose
show running-config aclmgr	Displays the running configuration of the ACLs configured on the switch.
show users	Displays the users that are connected.
show access-lists <i>access-list-name</i>	Display the statistics per entry.

Configuration Examples for ACLs on VTY Lines

The following example shows the connected users on the console line (ttyS0) and the VTY lines (pts/0 and pts/1).

```
switch# show users
NAME      LINE      TIME      IDLE      PID COMMENT
admin    ttyS0     Aug 27 20:45 .         14425 *
admin    pts/0     Aug 27 20:06 00:46    14176 (172.18.217.82) session=ssh
admin    pts/1     Aug 27 20:52 .         14584 (10.55.144.118)
```

The following example shows how to allow vty connections to all IPv4 hosts except 172.18.217.82 and how to deny vty connections to any IPv4 host except 10.55.144.118, 172.18.217.79, 172.18.217.82, 172.18.217.92:

```
switch# show running-config aclmgr
!Time: Fri Aug 27 22:01:09 2010
version 5.0(2)N1(1)
ip access-list ozi
  10 deny ip 172.18.217.82/32 any
  20 permit ip any any
ip access-list ozi2
  10 permit ip 10.55.144.118/32 any
  20 permit ip 172.18.217.79/32 any
  30 permit ip 172.18.217.82/32 any
  40 permit ip 172.18.217.92/32 any

line vty
  access-class ozi in
  access-class ozi2 out
```

The following example shows how to configure the IP access list by enabling per-entry statistics for the ACL:

```
switch# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
switch(config)# ip access-list ozi2
switch(config-acl)# statistics per-entry
switch(config-acl)# deny tcp 172.18.217.83/32 any
switch(config-acl)# exit

switch(config)# ip access-list ozi
switch(config-acl)# statistics per-entry
switch(config-acl)# permit ip 172.18.217.20/24 any
switch(config-acl)# exit
switch#
```

The following example shows how to apply the ACLs on VTY in and out directions:

```
switch(config)# line vty
switch(config-line)# ip access-class ozi in
switch(config-line)# access-class ozi2 out
switch(config-line)# exit
switch#
```

The following example shows how to remove the access restrictions on the VTY line:

```
switch# configure terminal
Enter configuration commands, one per line. End
with CNTL/Z.
switch(config)# line vty
switch(config-line)# no access-class ozi2 in
switch(config-line)# no ip access-class ozi2 in
switch(config-line)# exit
switch#
```




CHAPTER 10

Configuring Unicast RPF

This chapter contains the following sections:

- [Information About Unicast RPF, on page 199](#)
- [Guidelines and Limitations for Unicast RPF, on page 200](#)
- [Default Settings for Unicast RPF, on page 202](#)
- [Configuring Unicast RPF, on page 202](#)
- [Configuration Examples for Unicast RPF, on page 203](#)
- [Verifying the Unicast RPF Configuration, on page 204](#)
- [Additional References for Unicast RPF, on page 204](#)

Information About Unicast RPF

The Unicast RPF feature reduces problems that are caused by the introduction of malformed or forged (spoofed) IPv4 source addresses into a network by discarding IPv4 packets that lack a verifiable IP source address. For example, a number of common types of Denial-of-Service (DoS) attacks, including Smurf and Tribal Flood Network (TFN) attacks, can take advantage of forged or rapidly changing source IPv4 or IPv6 addresses to allow attackers to thwart efforts to locate or filter the attacks. Unicast RPF deflects attacks by forwarding only the packets that have source addresses that are valid and consistent with the IP routing table.

When you enable Unicast RPF on an interface, the examines all ingress packets received on that interface to ensure that the source address and source interface appear in the routing table and match the interface on which the packet was received. This examination of source addresses relies on the Forwarding Information Base (FIB).

Unicast RPF verifies that any packet received at a interface arrives on the best return path (return route) to the source of the packet by doing a reverse lookup in the FIB. If the packet was received from one of the best reverse path routes, the packet is forwarded as normal. If there is no reverse path route on the same interface from which the packet was received, the source address might have been modified by the attacker. If Unicast RPF does not find a reverse path for the packet, the packet is dropped.



Note With Unicast RPF, all equal-cost “best” return paths are considered valid, which means that Unicast RPF works where multiple return paths exist, if each path is equal to the others in terms of the routing cost (number of hops, weights, and so on) and as long as the route is in the FIB. Unicast RPF also functions where Enhanced Interior Gateway Routing Protocol (EIGRP) variants are being used and unequal candidate paths back to the source IP address exist.

Unicast RPF Process

Unicast RPF has several key implementation principles:

- The packet must be received at an interface that has the best return path (route) to the packet source (a process called *symmetric routing*). There must be a route in the FIB that matches the route to the receiving interface. Static routes, network statements, and dynamic routing add routes to the FIB.
- IP source addresses at the receiving interface must match the routing entry for the interface.
- Unicast RPF is an input function and is applied only on the input interface of a device at the upstream end of a connection.

You can use Unicast RPF for downstream networks, even if the downstream network has other connections to the Internet.



Caution Be careful when using optional BGP attributes, such as weight and local preference, because an attacker can modify the best path back to the source address. Modification would affect the operation of Unicast RPF.

When a packet is received at the interface where you have configured Unicast RPF and ACLs, the Cisco NX-OS software performs the following actions:

-
- Step 1** Checks the input ACLs on the inbound interface.
 - Step 2** Uses Unicast RPF to verify that the packet has arrived on the best return path to the source, which it does by doing a reverse lookup in the FIB table.
 - Step 3** Conducts a FIB lookup for packet forwarding.
 - Step 4** Checks the output ACLs on the outbound interface.
 - Step 5** Forwards the packet.
-

Global Statistics

Each time the Cisco NX-OS device drops a packet at an interface due to a failed unicast RPF check, that information is counted globally on the device on a per-forwarding engine (FE) basis. Global statistics on dropped packets provide information about potential attacks on the network, but they do not specify which interface is the source of the attack. Per-interface statistics on packets dropped due to a failed unicast RPF check are not available.

Guidelines and Limitations for Unicast RPF

Unicast RPF (uRPF) has the following configuration guidelines and limitations:

- You must apply uRPF at the interface downstream from the larger portion of the network, preferably at the edges of your network.
- The further downstream that you apply uRPF, the finer the granularity you have in mitigating address spoofing and in identifying the sources of spoofed addresses. For example, applying uRPF on an

aggregation device helps to mitigate attacks from many downstream networks or clients and is simple to administer, but it does not help identify the source of the attack. Applying uRPF at the network access server helps limit the scope of the attack and trace the source of the attack; however, deploying uRPF across many sites does add to the administration cost of operating the network.

- The more entities that deploy uRPF across Internet, intranet, and extranet resources, means that the better the chances are of mitigating large-scale network disruptions throughout the Internet community, and the better the chances are of tracing the source of an attack.
- uRPF will not inspect IP packets that are encapsulated in tunnels, such as generic routing encapsulation (GRE) tunnels. You must configure uRPF at a home gateway so that uRPF processes network traffic only after the tunneling and encryption layers have been stripped off the packets.
- You can use uRPF in any “single-homed” environment where there is only one access point out of the network or one upstream connection. Networks that have one access point provide symmetric routing, which means that the interface where a packet enters the network is also the best return path to the source of the IP packet.
- Do not use uRPF on interfaces that are internal to the network. Internal interfaces are likely to have routing asymmetry, which means that multiple routes to the source of a packet exist. You should configure uRPF only where there is natural or configured symmetry. Do not configure strict uRPF.
- uRPF allows packets with 0.0.0.0 source and 255.255.255.255 destination to pass so that the Bootstrap Protocol (BOOTP) and the Dynamic Host Configuration Protocol (DHCP) can operate correctly.
- When uRPF is enabled, loose mode is applied for both IPv4 and IPv6. However, strict mode can be applied per protocol.
- For strict uRPF to work, you must enable it on both the ingress interface and the interface where the source IP address is learned.
- The switch hardware does not implement strict uRPF per the configured routing interface.
- Strict uRPF is implemented per learned route on strict uRPF-enabled interfaces.
- If a route is resolved as ECMP, strict uRPF will fall back to loose mode.
- Because of the hardware limitation on the trap resolution, uRPF might not be applied on supervisor-bound packets via inband.
- For IP traffic, both IPv4 and IPv6 configurations should be enabled simultaneously.
- Due to hardware limitations, the Cisco Nexus 3600 Series switches support only the following combinations:

uRPF Configuration		Applied Traffic Check on Source IP Address		
IPv4	IPv6	IP Unipath	IP ECMP	MPLS Encap/VPN/ECMP
Disable	Disable	Allow	Allow	Allow
Loose	Loose	uRPF loose	uRPF loose	uRPF loose
Strict	Strict	uRPF strict	uRPF loose	uRPF loose

Default Settings for Unicast RPF

This table lists the default settings for Unicast RPF parameters.

Table 15: Default Unicast RPF Parameter Settings

Parameters	Default
Unicast RPF	Disabled

Configuring Unicast RPF

You can configure the Strict Unicast RPF mode or the Loose Unicast RPF mode on the ingress interface. For Strict Unicast mode, apply the configuration to interfaces where the source IP is attached. This allows you to configure the allowed list of specific sources.

Strict Unicast RPF mode

A strict mode check is successful when Unicast RPF finds a match in the FIB for the packet source address and the ingress interface through which the packet is received matches one of the Unicast RPF interfaces in the FIB match. If this check fails, the packet is discarded. You can use this type of Unicast RPF check where packet flows are expected to be symmetrical.

Loose Unicast RPF mode

A loose mode check is successful when a lookup of a packet source address in the FIB returns a match and the FIB result indicates that the source is reachable through at least one real interface. The ingress interface through which the packet is received isn't required to match any of the interfaces in the FIB result.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet *slot/port***
3. **{ip | ipv6} verify unicast source reachable-via any**
4. **exit**
5. (Optional) **show ip interface ethernet *slot/port***
6. (Optional) **show running-config interface ethernet *slot/port***
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	interface ethernet <i>slot/port</i> Example:	Specifies an ethernet interface and enters interface configuration mode.

	Command or Action	Purpose
	<pre>switch(config)# interface ethernet 2/3 switch(config-if)#</pre>	
Step 3	<p>{ip ipv6} verify unicast source reachable-via any</p> <p>Example:</p> <pre>switch(config-if)# ip verify unicast source reachable-via any</pre>	<p>Configures unicast RPF on the interface for both IPv4 and IPv6.</p> <p>Note Configure unicast RPF on each interface, since it's disabled by default. The configuration is shared across both IPv4 and IPv6. If you enable or disable on either IPv4 and IPv6, it affects all protocols on that interface.</p> <p>Note When you enable uRPF for IPv4 or IPv6 (using the ip or ipv6 keywords), unicast RPF is enabled for both IPv4 and IPv6.</p> <p>Note You can configure only one version of the available IPv4 and IPv6 Unicast RPF command on an interface. When you configure one version, all the mode changes must be done by this version. The interface blocks all the other versions.</p>
Step 4	<p>exit</p> <p>Example:</p> <pre>switch(config-cmap)# exit switch(config)#</pre>	Exits class map configuration mode.
Step 5	<p>(Optional) show ip interface ethernet slot/port</p> <p>Example:</p> <pre>switch(config)# show ip interface ethernet 2/3</pre>	Displays the IP information for an interface and verifies if the unicast RPF is enabled.
Step 6	<p>(Optional) show running-config interface ethernet slot/port</p> <p>Example:</p> <pre>switch(config)# show running-config interface ethernet 2/3</pre>	Displays the configuration for an interface in the running configuration.
Step 7	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Configuration Examples for Unicast RPF

The following examples show how to configure loose Unicast RPF for IPv4/IPv6 packets:

```
•
  interface Ethernet2/3
```

```
ip address 172.23.231.240/23
ip verify unicast source reachable-via any
```

- interface Ethernet2/3


```
ipv6 address 2001:0DB8:c18:1::3/64
ipv6 verify unicast source reachable-via any
```

The following examples show how to configure strict Unicast RPF for IPv4/IPv6 packets:

- ```
interface Ethernet2/2
ip address 172.23.231.240/23
ip verify unicast source reachable-via rx
```
- ```
interface Ethernet2/2
ipv6 address 2001:0DB8:c18:1::3/64
ipv6 verify unicast source reachable-via rx
```

Verifying the Unicast RPF Configuration

To display Unicast RPF configuration information, perform one of the following tasks:

Command	Purpose
show running-config interface ethernet <i>slot/port</i>	Displays the interface configuration in the running configuration.
show running-config ip [all]	Displays the IPv4 configuration in the running configuration.
show running-config ipv6 [all]	Displays the IPv6 configuration in the running configuration.
show startup-config interface ethernet <i>slot/port</i>	Displays the interface configuration in the startup configuration.
show ip interface ethernet <i>slot/port</i>	Displays the IP information for an interface and verifies if the unicast RPF is enabled or disabled.
show startup-config ip	Displays the IP configuration in the startup configuration.

Additional References for Unicast RPF

This section includes additional information related to implementing unicast RPF.

Related Documents

Related Topic	Document Title
MPLS VPN	Cisco Nexus 3600 Series NX-OS Label Switching Configuration Guide



CHAPTER 11

Configuring Control Plane Policing

This chapter contains the following sections:

- [About CoPP, on page 205](#)
- [Guidelines and Limitations for CoPP, on page 222](#)
- [Default Settings for CoPP, on page 224](#)
- [Configuring CoPP, on page 224](#)
- [Verifying the CoPP Configuration, on page 232](#)
- [Displaying the CoPP Configuration Status, on page 234](#)
- [Monitoring CoPP, on page 234](#)
- [Clearing the CoPP Statistics, on page 235](#)
- [Configuration Examples for CoPP, on page 235](#)
- [Additional References for CoPP, on page 237](#)

About CoPP

Control Plane Policing (CoPP) protects the control plane and separates it from the data plane, which ensures network stability, reachability, and packet delivery.

This feature allows a policy map to be applied to the control plane. This policy map looks like a normal QoS policy and is applied to all traffic entering the switch from a non-management port. A common attack vector for network devices is the denial-of-service (DoS) attack, where excessive traffic is directed at the device interfaces.

The Cisco NX-OS device provides CoPP to prevent DoS attacks from impacting performance. Such attacks, which can be perpetrated either inadvertently or maliciously, typically involve high rates of traffic destined to the supervisor module or CPU itself.

The supervisor module divides the traffic that it manages into three functional components or planes:

Data plane

Handles all the data traffic. The basic functionality of a Cisco NX-OS device is to forward packets from one interface to another. The packets that are not meant for the switch itself are called the transit packets. These packets are handled by the data plane.

Control plane

Handles all routing protocol control traffic. These protocols, such as the Border Gateway Protocol (BGP) and the Open Shortest Path First (OSPF) Protocol, send control packets between devices. These packets are destined to router addresses and are called control plane packets.

Management plane

Runs the components meant for Cisco NX-OS device management purposes such as the command-line interface (CLI) and Simple Network Management Protocol (SNMP).

The supervisor module has both the management plane and control plane and is critical to the operation of the network. Any disruption or attacks to the supervisor module will result in serious network outages. For example, excessive traffic to the supervisor module could overload and slow down the performance of the entire Cisco NX-OS device. For example, a DoS attack on the supervisor module could generate IP traffic streams to the control plane at a very high rate, forcing the control plane to spend a large amount of time in handling these packets and preventing the control plane from processing genuine traffic.

Examples of DoS attacks include:

- Internet Control Message Protocol (ICMP) echo requests
- IP fragments
- TCP SYN flooding

These attacks can impact the device performance and have the following negative effects:

- Reduced service quality (such as poor voice, video, or critical applications traffic)
- High route processor or switch processor CPU utilization
- Route flaps due to loss of routing protocol updates or keepalives
- Unstable Layer 2 topology
- Slow or unresponsive interactive sessions with the CLI
- Processor resource exhaustion, such as the memory and buffers
- Indiscriminate drops of incoming packets



Caution It is important to ensure that you protect the supervisor module from accidental or malicious attacks by configuring control plane protection.

Control Plane Protection

To protect the control plane, the Cisco NX-OS device segregates different packets destined for the control plane into different classes. Once these classes are identified, the Cisco NX-OS device polices the packets, which ensures that the supervisor module is not overwhelmed.

Control Plane Packet Types

Different types of packets can reach the control plane:

Receive packets

Packets that have the destination address of a router. The destination address can be a Layer 2 address (such as a router MAC address) or a Layer 3 address (such as the IP address of a router interface). These packets include router updates and keepalive messages. Multicast packets can also be in this category where packets are sent to multicast addresses that are used by a router.

Exception packets

Packets that need special handling by the supervisor module. For example, if a destination address is not present in the Forwarding Information Base (FIB) and results in a miss, the supervisor module sends an ICMP unreachable packet back to the sender. Another example is a packet with IP options set.

The following exceptions are possible from line cards only:

- match exception ip option
- match exception ipv6 option
- match exception ttl-failure

The following exceptions are possible from fabric modules only:

- match exception ipv6 icmp unreachable
- match exception ip icmp unreachable

The following exceptions are possible from line cards and fabric modules:

- match exception mtu-failure

Redirected packets

Packets that are redirected to the supervisor module.

Glean packets

If a Layer 2 MAC address for a destination IP address is not present in the FIB, the supervisor module receives the packet and sends an ARP request to the host.

All of these different packets could be maliciously used to attack the control plane and overwhelm the Cisco NX-OS device. CoPP classifies these packets to different classes and provides a mechanism to individually control the rate at which the supervisor module receives these packets.

Classification for CoPP

For effective protection, the Cisco NX-OS device classifies the packets that reach the supervisor modules to allow you to apply different rate controlling policies based on the type of the packet. For example, you might want to be less strict with a protocol packet such as Hello messages but more strict with a packet that is sent to the supervisor module because the IP option is set. You configure packet classifications and rate controlling policies using class maps and policy maps.

Rate Controlling Mechanisms

Once the packets are classified, the Cisco NX-OS device has different mechanisms to control the rate at which packets arrive at the supervisor module. Two mechanisms control the rate of traffic to the supervisor module. One is called policing and the other is called rate limiting.

Using hardware policers, you can define separate actions for traffic that conforms to or violates certain conditions. The actions can transmit the packet, mark down the packet, or drop the packet.

You can configure the following parameters for policing:

Committed information rate (CIR)

Desired bandwidth, specified as a bit rate or a percentage of the link rate.

Committed burst (BC)

Size of a traffic burst that can exceed the CIR within a given unit of time and not impact scheduling

In addition, you can set separate actions such as transmit or drop for conform and violate traffic.

For more information on policing parameters, see the *Cisco Nexus 9000 Series NX-OS Quality of Service Configuration Guide*.

Dynamic and Static CoPP ACLs

CoPP access control lists (ACLs) are classified as either dynamic or static. Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches use only dynamic CoPP ACLs. Cisco Nexus 9200 Series switches use both dynamic and static CoPP ACLs.

Dynamic CoPP ACLs work only for Forwarding Information Base (FIB)-based supervisor redirected packets, and static CoPP ACLs work for ACL-based supervisor redirected packets. Dynamic CoPP ACLs are supported for myIP and link-local multicast traffic, and static CoPP ACLs are supported for all other types of traffic.

Static CoPP ACLs are identified by a substring. Any ACL that has one of these substrings is categorized as a static CoPP ACL.

- MAC-based static CoPP ACL substrings:
 - acl-mac-cdp-udld-vtp
 - acl-mac-cfsoe
 - acl-mac-dot1x
 - acl-mac-l2-tunnel
 - acl-mac-l3-isis
 - acl-mac-lacp
 - acl-mac-lldp
 - acl-mac-sdp-srp
 - acl-mac-stp
 - acl-mac-undesirable
- Protocol-based static CoPP ACL substrings:
 - acl-dhcp
 - acl-dhcp-relay-response
 - acl-dhcp6
 - acl-dhcp6-relay-response
 - acl-ntp
- Multicast-based static CoPP ACL substrings:
 - acl-igmp

For more information on static CoPP ACLs, see [Guidelines and Limitations for CoPP, on page 222](#).

Default Policing Policies

When you bring up your Cisco NX-OS device for the first time, the Cisco NX-OS software installs the default copp-system-p-policy-strict policy to protect the supervisor module from DoS attacks. You can set the level of protection by choosing one of the following CoPP policy options from the initial setup utility:

- **Strict**—This policy is 1 rate and 2 color.
- **Moderate**—This policy is 1 rate and 2 color. The important class burst size is greater than the strict policy but less than the lenient policy.
- **Lenient**—This policy is 1 rate and 2 color. The important class burst size is greater than the moderate policy but less than the dense policy.
- **Dense**—This policy is 1 rate and 2 color. The policer CIR values are less than the strict policy.
- **Skip**—No control plane policy is applied. (Cisco does not recommend using the Skip option because it will impact the control plane of the network.)

If you do not select an option or choose not to execute the setup utility, the software applies strict policing. We recommend that you start with the strict policy and later modify the CoPP policies as required.



Note Strict policing is not applied by default when using POAP, so you must configure a CoPP policy.

The `copp-system-p-policy` policy has optimized values suitable for basic device operations. You must add specific class and access-control list (ACL) rules that meet your DoS protection requirements. The default CoPP policy does not change when you upgrade the software.



Caution Selecting the skip option and not subsequently configuring CoPP protection can leave your Cisco NX-OS device vulnerable to DoS attacks.

You can reassign the CoPP default policy by entering the setup utility again using the **setup** command from the CLI prompt or by using the **copp profile** command.

Default Class Maps

The `copp-system-class-critical` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-critical
  match access-group name copp-system-p-acl-bgp
  match access-group name copp-system-p-acl-rip
  match access-group name copp-system-p-acl-vpc
  match access-group name copp-system-p-acl-bgp6
  match access-group name copp-system-p-acl-ospf
  match access-group name copp-system-p-acl-rip6
  match access-group name copp-system-p-acl-eigrp
  match access-group name copp-system-p-acl-ospf6
  match access-group name copp-system-p-acl-eigrp6
  match access-group name copp-system-p-acl-auto-rp
  match access-group name copp-system-p-acl-mac-13-isis
```

The `copp-system-class-exception` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-exception
  match exception ip option
  match exception ip icmp unreachable
  match exception ipv6 option
  match exception ipv6 icmp unreachable
```

The `copp-system-class-exception-diag` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-exception-diag
  match exception ttl-failure
  match exception mtu-failure
```

The `copp-system-class-important` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-important
  match access-group name copp-system-p-acl-hsrp
  match access-group name copp-system-p-acl-vrrp
  match access-group name copp-system-p-acl-hsrp6
  match access-group name copp-system-p-acl-vrrp6
  match access-group name copp-system-p-acl-mac-lldp
```

The `copp-system-class-l2-default` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-l2-default
  match access-group name copp-system-p-acl-mac-undesirable
```

The `copp-system-class-l2-unpoliced` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-l2-unpoliced
  match access-group name copp-system-p-acl-mac-stp
  match access-group name copp-system-p-acl-mac-lacp
  match access-group name copp-system-p-acl-mac-cfsoe
  match access-group name copp-system-p-acl-mac-sdp-srp
  match access-group name copp-system-p-acl-mac-l2-tunnel
  match access-group name copp-system-p-acl-mac-cdp-udld-vtp
```

The `copp-system-class-l3mc-data` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-l3mc-data
  match exception multicast rpf-failure
  match exception multicast dest-miss
```

The `copp-system-class-l3uc-data` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-l3uc-data
  match exception glean
```

The `copp-system-class-management` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-management
  match access-group name copp-system-p-acl-ftp
  match access-group name copp-system-p-acl-ntp
  match access-group name copp-system-p-acl-ssh
  match access-group name copp-system-p-acl-http
  match access-group name copp-system-p-acl-ntp6
  match access-group name copp-system-p-acl-sftp
  match access-group name copp-system-p-acl-snmp
  match access-group name copp-system-p-acl-ssh6
  match access-group name copp-system-p-acl-tftp
  match access-group name copp-system-p-acl-https
  match access-group name copp-system-p-acl-snmp6
  match access-group name copp-system-p-acl-tftp6
  match access-group name copp-system-p-acl-radius
  match access-group name copp-system-p-acl-tacacs
  match access-group name copp-system-p-acl-telnet
  match access-group name copp-system-p-acl-radius6
  match access-group name copp-system-p-acl-tacacs6
  match access-group name copp-system-p-acl-telnet6
```

The `copp-system-class-monitoring` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-monitoring
  match access-group name copp-system-p-acl-icmp
  match access-group name copp-system-p-acl-icmp6
  match access-group name copp-system-p-acl-traceroute
```

The `copp-system-class-multicast-host` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-multicast-host
  match access-group name copp-system-p-acl-mlld
```

The `copp-system-class-multicast-router` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-multicast-router
  match access-group name copp-system-p-acl-pim
  match access-group name copp-system-p-acl-msdp
  match access-group name copp-system-p-acl-pim6
  match access-group name copp-system-p-acl-pim-reg
  match access-group name copp-system-p-acl-pim6-reg
  match access-group name copp-system-p-acl-pim-mdt-join
```

The `copp-system-class-nat-flow` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-nat-flow
  match exception nat-flow
```

The `copp-system-class-ndp` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-ndp
  match access-group name copp-system-p-acl-ndp
```

The `copp-system-class-normal` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-normal
  match access-group name copp-system-p-acl-mac-dot1x
  match protocol arp
```

The `copp-system-class-normal-dhcp` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-normal-dhcp
  match access-group name copp-system-p-acl-dhcp
  match access-group name copp-system-p-acl-dhcp6
```

The `copp-system-class-normal-dhcp-relay-response` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-normal-dhcp-relay-response
  match access-group name copp-system-p-acl-dhcp-relay-response
  match access-group name copp-system-p-acl-dhcp6-relay-response
```

The `copp-system-class-normal-igmp` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-normal-igmp
  match access-group name copp-system-p-acl-igmp
```

The `copp-system-class-redirect` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-redirect
  match access-group name copp-system-p-acl-ntp
```

The `copp-system-class-undesirable` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-undesirable
  match access-group name copp-system-p-acl-undesirable
  match exception multicast sg-rpf-failure
```

The `copp-system-class-fcoe` class has the following configuration:

```
class-map type control-plane match-any copp-system-p-class-fcoe
  match access-group name copp-system-p-acl-mac-fcoe
```



Note The `copp-system-class-fcoe` class is not supported for Cisco Nexus 9200 Series switches.

Strict Default CoPP Policy

On Cisco Nexus 9200 Series switches, the strict CoPP policy has the following configuration:

```
policy-map type control-plane copp-system-p-policy-strict
  class copp-system-p-class-l3uc-data
    set cos 1
    police cir 800 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-critical
    set cos 7
    police cir 36000 kbps bc 1280000 bytes conform transmit violate drop
  class copp-system-p-class-important
    set cos 6
    police cir 2500 kbps bc 1280000 bytes conform transmit violate drop
  class copp-system-p-class-multicast-router
    set cos 6
    police cir 2600 kbps bc 128000 bytes conform transmit violate drop
  class copp-system-p-class-management
    set cos 2
    police cir 10000 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-multicast-host
    set cos 1
    police cir 1000 kbps bc 128000 bytes conform transmit violate drop
  class copp-system-p-class-l3mc-data
    set cos 1
    police cir 2400 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-normal
    set cos 1
    police cir 1400 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-ndp
    set cos 6
    police cir 1400 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-normal-dhcp
    set cos 1
    police cir 1300 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-normal-dhcp-relay-response
    set cos 1
    police cir 1500 kbps bc 64000 bytes conform transmit violate drop
  class copp-system-p-class-normal-igmp
    set cos 3
    police cir 3000 kbps bc 64000 bytes conform transmit violate drop
  class copp-system-p-class-redirect
    set cos 1
    police cir 280 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-exception
    set cos 1
```

```

    police cir 150 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-exception-diag
    set cos 1
    police cir 150 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-monitoring
    set cos 1
    police cir 150 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-l2-unpoliced
    set cos 7
    police cir 50 mbps bc 8192000 bytes conform transmit violate drop
class copp-system-p-class-undesirable
    set cos 0
    police cir 200 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-nat-flow
    set cos 7
    police cir 800 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-l2-default
    set cos 0
    police cir 400 kbps bc 32000 bytes conform transmit violate drop
class class-default
    set cos 0
    police cir 400 kbps bc 32000 bytes conform transmit violate drop

```

On Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches, the strict CoPP policy has the following configuration:

```

policy-map type control-plane copp-system-p-policy-strict
  class copp-system-p-class-l3uc-data
    set cos 1
    police cir 250 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-critical
    set cos 7
    police cir 19000 pps bc 128 packets conform transmit violate drop
  class copp-system-p-class-important
    set cos 6
    police cir 3000 pps bc 128 packets conform transmit violate drop
  class copp-system-p-class-multicast-router
    set cos 6
    police cir 3000 pps bc 128 packets conform transmit violate drop
  class copp-system-p-class-management
    set cos 2
    police cir 3000 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-multicast-host
    set cos 1
    police cir 2000 pps bc 128 packets conform transmit violate drop
  class copp-system-p-class-l3mc-data
    set cos 1
    police cir 3000 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-normal
    set cos 1
    police cir 1500 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-ndp
    set cos 6
    police cir 1500 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-normal-dhcp
    set cos 1
    police cir 300 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-normal-dhcp-relay-response
    set cos 1
    police cir 400 pps bc 64 packets conform transmit violate drop
  class copp-system-p-class-normal-igmp
    set cos 3
    police cir 6000 pps bc 64 packets conform transmit violate drop
  class copp-system-p-class-redirect

```

```

    set cos 1
    police cir 1500 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-exception
    set cos 1
    police cir 50 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-exception-diag
    set cos 1
    police cir 50 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-monitoring
    set cos 1
    police cir 300 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-l2-unpoliced
    set cos 7
    police cir 20000 pps bc 8192 packets conform transmit violate drop
class copp-system-p-class-undesirable
    set cos 0
    police cir 15 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-fcoe
    set cos 6
    police cir 1500 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-nat-flow
    set cos 7
    police cir 100 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-l2-default
    set cos 0
    police cir 50 pps bc 32 packets conform transmit violate drop
class class-default
    set cos 0
    police cir 50 pps bc 32 packets conform transmit violate drop

```

Moderate Default CoPP Policy

On Cisco Nexus 9200 Series switches, the moderate CoPP policy has the following configuration:

```

policy-map type control-plane copp-system-p-policy-moderate
class copp-system-p-class-l3uc-data
    set cos 1
    police cir 800 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-critical
    set cos 7
    police cir 36000 kbps bc 1920000 bytes conform transmit violate drop
class copp-system-p-class-important
    set cos 6
    police cir 2500 kbps bc 1920000 bytes conform transmit violate drop
class copp-system-p-class-multicast-router
    set cos 6
    police cir 2600 kbps bc 192000 bytes conform transmit violate drop
class copp-system-p-class-management
    set cos 2
    police cir 10000 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-multicast-host
    set cos 1
    police cir 1000 kbps bc 192000 bytes conform transmit violate drop
class copp-system-p-class-l3mc-data
    set cos 1
    police cir 2400 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-normal
    set cos 1
    police cir 1400 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-ndp
    set cos 6
    police cir 1400 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-normal-dhcp

```



```

    set cos 1
    police cir 1300 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-normal-dhcp-relay-response
    set cos 1
    police cir 1500 kbps bc 96000 bytes conform transmit violate drop
class copp-system-p-class-normal-igmp
    set cos 3
    police cir 3000 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-redirect
    set cos 1
    police cir 280 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-exception
    set cos 1
    police cir 150 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-exception-diag
    set cos 1
    police cir 150 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-monitoring
    set cos 1
    police cir 150 kbps bc 192000 bytes conform transmit violate drop
class copp-system-p-class-l2-unpoliced
    set cos 7
    police cir 50 mbps bc 8192000 bytes conform transmit violate drop
class copp-system-p-class-undesirable
    set cos 0
    police cir 200 kbps bc 48000 bytes conform transmit violate drop
class copp-system-p-class-nat-flow
    set cos 7
    police cir 800 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-l2-default
    set cos 0
    police cir 400 kbps bc 48000 bytes conform transmit violate drop
class class-default
    set cos 0
    police cir 400 kbps bc 48000 bytes conform transmit violate drop

```

On Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches, the moderate CoPP policy has the following configuration:

```

policy-map type control-plane copp-system-p-policy-moderate
class copp-system-p-class-l3uc-data
    set cos 1
    police cir 250 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-critical
    set cos 7
    police cir 19000 pps bc 192 packets conform transmit violate drop
class copp-system-p-class-important
    set cos 6
    police cir 3000 pps bc 192 packets conform transmit violate drop
class copp-system-p-class-multicast-router
    set cos 6
    police cir 3000 pps bc 192 packets conform transmit violate drop
class copp-system-p-class-management
    set cos 2
    police cir 3000 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-multicast-host
    set cos 1
    police cir 2000 pps bc 192 packets conform transmit violate drop
class copp-system-p-class-l3mc-data
    set cos 1
    police cir 3000 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-normal
    set cos 1
    police cir 1500 pps bc 48 packets conform transmit violate drop

```

```

class copp-system-p-class-ndp
  set cos 6
  police cir 1500 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-normal-dhcp
  set cos 1
  police cir 300 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-normal-dhcp-relay-response
  set cos 1
  police cir 400 pps bc 96 packets conform transmit violate drop
class copp-system-p-class-normal-igmp
  set cos 3
  police cir 6000 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-redirect
  set cos 1
  police cir 1500 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-exception
  set cos 1
  police cir 50 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-exception-diag
  set cos 1
  police cir 50 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-monitoring
  set cos 1
  police cir 300 pps bc 192 packets conform transmit violate drop
class copp-system-p-class-l2-unpoliced
  set cos 7
  police cir 20000 pps bc 8192 packets conform transmit violate drop
class copp-system-p-class-undesirable
  set cos 0
  police cir 15 pps bc 48 packets conform transmit violate drop
class copp-system-p-class-fcoe
  set cos 6
  police cir 1500 pps bc 192 packets conform transmit violate drop
class copp-system-p-class-nat-flow
  set cos 7
  police cir 100 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-l2-default
  set cos 0
  police cir 50 pps bc 48 packets conform transmit violate drop
class class-default
  set cos 0
  police cir 50 pps bc 48 packets conform transmit violate drop

```

Lenient Default CoPP Policy)

On Cisco Nexus 9200 Series switches, the lenient CoPP policy has the following configuration:

```

policy-map type control-plane copp-system-p-policy-lenient
  class copp-system-p-class-l3uc-data
    set cos 1
    police cir 800 kbps bc 32000 bytes conform transmit violate drop
  class copp-system-p-class-critical
    set cos 7
    police cir 36000 kbps bc 2560000 bytes conform transmit violate drop
  class copp-system-p-class-important
    set cos 6
    police cir 2500 kbps bc 2560000 bytes conform transmit violate drop
  class copp-system-p-class-multicast-router
    set cos 6
    police cir 2600 kbps bc 256000 bytes conform transmit violate drop
  class copp-system-p-class-management
    set cos 2
    police cir 10000 kbps bc 64000 bytes conform transmit violate drop

```

```

class copp-system-p-class-multicast-host
  set cos 1
  police cir 1000 kbps bc 256000 bytes conform transmit violate drop
class copp-system-p-class-l3mc-data
  set cos 1
  police cir 2400 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-normal
  set cos 1
  police cir 1400 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-ndp
  set cos 6
  police cir 1400 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-normal-dhcp
  set cos 1
  police cir 1300 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-normal-dhcp-relay-response
  set cos 1
  police cir 1500 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-normal-igmp
  set cos 3
  police cir 3000 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-redirect
  set cos 1
  police cir 280 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-exception
  set cos 1
  police cir 150 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-exception-diag
  set cos 1
  police cir 150 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-monitoring
  set cos 1
  police cir 150 kbps bc 256000 bytes conform transmit violate drop
class copp-system-p-class-l2-unpoliced
  set cos 7
  police cir 50 mbps bc 8192000 bytes conform transmit violate drop
class copp-system-p-class-undesirable
  set cos 0
  police cir 200 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-nat-flow
  set cos 7
  police cir 800 kbps bc 64000 bytes conform transmit violate drop
class copp-system-p-class-l2-default
  set cos 0
  police cir 400 kbps bc 64000 bytes conform transmit violate drop
class class-default
  set cos 0
  police cir 400 kbps bc 64000 bytes conform transmit violate drop

```

On Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches, the lenient CoPP policy has the following configuration:

```

policy-map type control-plane copp-system-p-policy-lenient
  class copp-system-p-class-l3uc-data
    set cos 1
    police cir 250 pps bc 32 packets conform transmit violate drop
  class copp-system-p-class-critical
    set cos 7
    police cir 19000 pps bc 256 packets conform transmit violate drop
  class copp-system-p-class-important
    set cos 6
    police cir 3000 pps bc 256 packets conform transmit violate drop
  class copp-system-p-class-multicast-router
    set cos 6

```

```

    police cir 3000 pps bc 256 packets conform transmit violate drop
class copp-system-p-class-management
  set cos 2
  police cir 3000 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-multicast-host
  set cos 1
  police cir 2000 pps bc 256 packets conform transmit violate drop
class copp-system-p-class-l3mc-data
  set cos 1
  police cir 3000 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-normal
  set cos 1
  police cir 1500 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-ndp
  set cos 6
  police cir 1500 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-normal-dhcp
  set cos 1
  police cir 300 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-normal-dhcp-relay-response
  set cos 1
  police cir 400 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-normal-igmp
  set cos 3
  police cir 6000 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-redirect
  set cos 1
  police cir 1500 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-exception
  set cos 1
  police cir 50 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-exception-diag
  set cos 1
  police cir 50 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-monitoring
  set cos 1
  police cir 300 pps bc 256 packets conform transmit violate drop
class copp-system-p-class-l2-unpoliced
  set cos 7
  police cir 20000 pps bc 8192 packets conform transmit violate drop
class copp-system-p-class-undesirable
  set cos 0
  police cir 15 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-fcoe
  set cos 6
  police cir 1500 pps bc 256 packets conform transmit violate drop
class copp-system-p-class-nat-flow
  set cos 7
  police cir 100 pps bc 64 packets conform transmit violate drop
class copp-system-p-class-l2-default
  set cos 0
  police cir 50 pps bc 64 packets conform transmit violate drop
class class-default
  set cos 0
  police cir 50 pps bc 64 packets conform transmit violate drop

```

Dense Default CoPP Policy

On Cisco Nexus 9200 Series switches, the dense CoPP policy has the following configuration:

```

policy-map type control-plane copp-system-p-policy-dense
  class copp-system-p-class-l3uc-data
    set cos 1

```

```
    police cir 800 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-critical
  set cos 7
  police cir 4500 kbps bc 1280000 bytes conform transmit violate drop
class copp-system-p-class-important
  set cos 6
  police cir 2500 kbps bc 1280000 bytes conform transmit violate drop
class copp-system-p-class-multicast-router
  set cos 6
  police cir 370 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-management
  set cos 2
  police cir 2500 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-multicast-host
  set cos 2
  police cir 300 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-l3mc-data
  set cos 1
  police cir 600 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-normal
  set cos 1
  police cir 1400 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-ndp
  set cos 1
  police cir 350 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-normal-dhcp
  set cos 1
  police cir 750 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-normal-dhcp-relay-response
  set cos 1
  police cir 750 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-normal-igmp
  set cos 3
  police cir 1400 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-redirect
  set cos 1
  police cir 200 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-exception
  set cos 1
  police cir 200 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-exception-diag
  set cos 1
  police cir 200 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-monitoring
  set cos 1
  police cir 150 kbps bc 128000 bytes conform transmit violate drop
class copp-system-p-class-l2-unpoliced
  set cos 7
  police cir 50 mbps bc 8192000 bytes conform transmit violate drop
class copp-system-p-class-undesirable
  set cos 0
  police cir 100 kbps bc 32000 bytes conform transmit violate drop
class copp-system-p-class-l2-default
  set cos 0
  police cir 200 kbps bc 32000 bytes conform transmit violate drop
class class-default
  set cos 0
  police cir 200 kbps bc 32000 bytes conform transmit violate drop
```

On Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches, the dense CoPP policy has the following configuration:

```
policy-map type control-plane copp-system-p-policy-dense
  class copp-system-p-class-l3uc-data
```

```

    set cos 1
    police cir 250 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-critical
    set cos 7
    police cir 2500 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-important
    set cos 6
    police cir 1200 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-multicast-router
    set cos 6
    police cir 1200 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-management
    set cos 2
    police cir 1200 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-multicast-host
    set cos 2
    police cir 1000 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-l3mc-data
    set cos 1
    police cir 1200 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-normal
    set cos 1
    police cir 750 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-ndp
    set cos 1
    police cir 750 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-normal-dhcp
    set cos 1
    police cir 150 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-normal-dhcp-relay-response
    set cos 1
    police cir 200 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-normal-igmp
    set cos 3
    police cir 2500 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-redirect
    set cos 1
    police cir 1500 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-exception
    set cos 1
    police cir 50 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-exception-diag
    set cos 1
    police cir 50 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-monitoring
    set cos 1
    police cir 50 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-l2-unpoliced
    set cos 7
    police cir 20000 pps bc 8192 packets conform transmit violate drop
class copp-system-p-class-undesirable
    set cos 0
    police cir 15 pps bc 32 packets conform transmit violate drop
class copp-system-p-class-fcoe
    set cos 6
    police cir 750 pps bc 128 packets conform transmit violate drop
class copp-system-p-class-l2-default
    set cos 0
    police cir 25 pps bc 32 packets conform transmit violate drop
class class-default
    set cos 0
    police cir 25 pps bc 32 packets conform transmit violate drop

```

Packets Per Second Credit Limit

The aggregate packets per second (PPS) for a given policy (sum of PPS of each class part of the policy) is capped by an upper PPS Credit Limit (PCL). If an increase in PPS of a given class causes a PCL exceed, the configuration is rejected. To increase the desired PPS, the additional PPS beyond PCL should be decreased from other class(es).

Modular QoS Command-Line Interface

CoPP uses the Modular Quality of Service Command-Line Interface (MQC). MQC is a CLI structure that allows you to define a traffic class, create a traffic policy (policy map), and attach the traffic policy to an interface. The traffic policy contains the CoPP feature that will be applied to the traffic class.

SUMMARY STEPS

1. Define a traffic class using the **class-map** command. A traffic class is used to classify traffic.
2. Create a traffic policy using the **policy-map** command. A traffic policy (policy map) contains a traffic class and one or more CoPP features that will be applied to the traffic class. The CoPP features in the traffic policy determine how to treat the classified traffic.
3. Attach the traffic policy (policy map) to the control plane using the **control-plane** and **service-policy** commands.

DETAILED STEPS

Step 1 Define a traffic class using the **class-map** command. A traffic class is used to classify traffic.

This example shows how to create a new class-map called copp-sample-class:

```
class-map type control-plane copp-sample-class
```

Step 2 Create a traffic policy using the **policy-map** command. A traffic policy (policy map) contains a traffic class and one or more CoPP features that will be applied to the traffic class. The CoPP features in the traffic policy determine how to treat the classified traffic.

Step 3 Attach the traffic policy (policy map) to the control plane using the **control-plane** and **service-policy** commands.

This example shows how to attach the policy map to the control plane:

```
control-plane
service-policy input copp-system-policy
```

Note The copp-system-policy is always configured and applied. There is no need to use this command explicitly.

CoPP and the Management Interface

The Cisco NX-OS device supports only hardware-based CoPP, which does not support the management interface (mgmt0). The out-of-band mgmt0 interface connects directly to the CPU and does not pass through the in-band traffic hardware where CoPP is implemented.

On the mgmt0 interface, ACLs can be configured to give or deny access to a particular type of traffic.

Guidelines and Limitations for CoPP

CoPP has the following configuration guidelines and limitations:

- Before you upgrade to Release 9.3(7), set the scale factor to 1 using the **scale-factor 1 module multiple-module-range** command.
- We recommend that you use the strict default CoPP policy initially and then later modify the CoPP policies based on the data center and application requirements.
- Customizing CoPP is an ongoing process. CoPP must be configured according to the protocols and features used in your specific environment as well as the supervisor features that are required by the server environment. As these protocols and features change, CoPP must be modified.
- We recommend that you continuously monitor CoPP. If drops occur, determine if CoPP dropped traffic unintentionally or in response to a malfunction or attack. In either event, analyze the situation and evaluate the need to modify the CoPP policies.
- All the traffic that you do not specify in the other class maps is put into the last class, the default class. Monitor the drops in this class and investigate if these drops are based on traffic that you do not want or the result of a feature that was not configured and you need to add.
- All broadcast traffic is sent through CoPP logic in order to determine which packets (for example, ARP and DHCP) need to be redirected through an access control list (ACL) to the router processor. Broadcast traffic that does not need to be redirected is matched against the CoPP logic, and both conforming and violated packets are counted in the hardware but not sent to the CPU. Broadcast traffic that needs to be sent to the CPU and broadcast traffic that does not need to be sent to the CPU must be separated into different classes.
- After you have configured CoPP, delete anything that is not being used, such as old class maps and unused routing protocols.
- You must ensure that the CoPP policy does not filter critical traffic such as routing protocols or interactive access to the device. Filtering this traffic could prevent remote access to the Cisco NX-OS device and require a console connection.
- The Cisco NX-OS software does not support egress CoPP or silent mode. CoPP is supported only on ingress (you cannot use the **service-policy output copp** command to the control plane interface).
- You can use the access control entry (ACE) hit counters in the hardware only for ACL logic. Use the software ACE hit counters and the **show access-lists** and **show policy-map type control-plane** commands to evaluate CPU traffic.
- The Cisco NX-OS device hardware performs CoPP on a per-forwarding-engine basis. CoPP does not support distributed policing. Therefore, you should choose rates so that the aggregate traffic does not overwhelm the supervisor module.
- If multiple flows map to the same class, individual flow statistics will not be available.
- If you upgrade from a Cisco NX-OS release that supports the CoPP feature to a Cisco NX-OS release that supports the CoPP feature with additional classes for new protocols, you must either run the setup utility using the **setup** command or use the **copp profile** command for the new CoPP classes to be available.

- Before you downgrade from a Cisco NX-OS release that supports the CoPP feature to an earlier Cisco NX-OS release that supports the CoPP feature, you should verify compatibility using the **show incompatibility nxos bootflash:filename** command. If an incompatibility exists, disable any features that are incompatible with the downgrade image before downgrading the software.
- You cannot disable CoPP. If you attempt to disable it, packets are rate limited at 50 packets per seconds [for releases prior to Cisco NX-OS Release 7.0(3)I2(1)], or an error message appears [starting with Cisco NX-OS Release 7.0(3)I2(1)].
- Cisco Nexus 9200 Series switches support CoPP policer rates only in multiples of 10 kbps. If a rate is configured that is not a multiple of 10 kbps, the rate is rounded down. For example, the switch will use 50 kbps if a rate of 55 kbps is configured. (The **show policy-map type control-plane** command shows the user configured rate. See [Verifying the CoPP Configuration, on page 232](#) for more information.)
- For Cisco Nexus 9200 Series switches, ip icmp redirect, ipv6 icmp redirect, ip icmp unreachable, ipv6 icmp unreachable, and mtu-failure use the same TCAM entry, and they will all be classified to the class map where the first exception is present in the policy. In the CoPP strict profile, they are classified to the class-exception class map. In a different CoPP policy, if the first exception is in a different class map (for example, class-exception-diag), the rest of the exceptions will be classified to the same class map.
- The copp-system-class-foe class is not supported for Cisco Nexus 9200 Series switches.
- The following guidelines and limitations apply to static CoPP ACLs:
 - Only Cisco Nexus 9200 Series switches use static CoPP ACLs.
 - Static CoPP ACLs can be remapped to a different CoPP class.
 - Access control entries (ACEs) cannot be modified or removed for static CoPP ACLs.
 - If a CoPP ACL has a static ACL substring, it will be mapped to that type of traffic. For example, if the ACL includes the acl-mac-stp substring, STP traffic will be classified to the class map for that ACL.
 - Static CoPP ACLs take priority over dynamic CoPP ACLs, regardless of their position in the CoPP policy, the order in which they are configured, and how they appear in the output of the **show policy-map type control-plane** command.
 - You must have static CoPP ACLs in the CoPP policy. Otherwise, the CoPP policy will be rejected.
- Beginning with Cisco NX-OS Release 10.3(2)F, source IP based filtering in CoPP is supported on Cisco Nexus 3600 platform switches (N3K-C36180YC-R and N3K-C3636C-R).



Note For IPv6, source IP based filtering is supported up to 24b MSB.



Note If you are familiar with the Cisco IOS CLI, be aware that the Cisco NX-OS commands for this feature might differ from the Cisco IOS commands that you would use.

Default Settings for CoPP

This table lists the default settings for CoPP parameters.

Table 16: Default CoPP Parameters Settings

Parameters	Default
Default policy	Strict
Default policy	9 policy entries Note The maximum number of supported policies with associated class maps is 128.
Scale factor value	1.00

Configuring CoPP

This section describes how to configure CoPP.

Configuring a Control Plane Class Map

You must configure control plane class maps for control plane policies.

You can classify traffic by matching packets based on existing ACLs. The permit and deny ACL keywords are ignored in the matching.

You can configure policies for IP version 4 (IPv4) and IP version 6 (IPv6) packets.

Before you begin

Ensure that you have configured the IP ACLs if you want to use ACE hit counters in the class maps.

SUMMARY STEPS

1. **configure terminal**
2. **class-map type control-plane [match-all | match-any] class-map-name**
3. (Optional) **match access-group name access-list-name**
4. (Optional) **match exception {ip | ipv6} icmp redirect**
5. (Optional) **match exception {ip | ipv6} icmp unreachable**
6. (Optional) **match exception {ip | ipv6} option**
7. **match protocol arp**
8. **exit**
9. (Optional) **show class-map type control-plane [class-map-name]**
10. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	class-map type control-plane [match-all match-any] class-map-name Example: <pre>switch(config)# class-map type control-plane ClassMapA switch(config-cmap)#</pre>	Specifies a control plane class map and enters class map configuration mode. The default class matching is match-any. The name can be a maximum of 64 characters long and is case sensitive. Note You cannot use class-default, match-all, or match-any as class map names.
Step 3	(Optional) match access-group name access-list-name Example: <pre>switch(config-cmap)# match access-group name MyAccessList</pre>	Specifies matching for an IP ACL. Note The permit and deny ACL keywords are ignored in the CoPP matching.
Step 4	(Optional) match exception {ip ipv6} icmp redirect Example: <pre>switch(config-cmap)# match exception ip icmp redirect</pre>	Specifies matching for IPv4 or IPv6 ICMP redirect exception packets.
Step 5	(Optional) match exception {ip ipv6} icmp unreachable Example: <pre>switch(config-cmap)# match exception ip icmp unreachable</pre>	Specifies matching for IPv4 or IPv6 ICMP unreachable exception packets.
Step 6	(Optional) match exception {ip ipv6} option Example: <pre>switch(config-cmap)# match exception ip option</pre>	Specifies matching for IPv4 or IPv6 option exception packets.
Step 7	match protocol arp Example: <pre>switch(config-cmap)# match protocol arp</pre>	Specifies matching for IP Address Resolution Protocol (ARP) and Reverse Address Resolution Protocol (RARP) packets.
Step 8	exit Example: <pre>switch(config-cmap)# exit switch(config)#</pre>	Exits class map configuration mode.
Step 9	(Optional) show class-map type control-plane [class-map-name] Example: <pre>switch(config)# show class-map type control-plane</pre>	Displays the control plane class map configuration.

	Command or Action	Purpose
Step 10	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring a Control Plane Policy Map

You must configure a policy map for CoPP, which includes policing parameters. If you do not configure a policer for a class, the following default is configured:

- 50 packets per second (pps) with a burst of 32 packets (for Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches)
- 150 kilobits per second (kbps) with a burst of 32,000 bytes (for Cisco Nexus 9200 Series switches)

Before you begin

Ensure that you have configured a control plane class map.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map type control-plane** *policy-map-name*
3. **class** {*class-map-name* [**insert-before** *class-map-name2*] | **class-default**}
4. Enter one of the following commands:
 - **police** [**cir**] {*cir-rate* [*rate-type*]}
 - **police** [**cir**] {*cir-rate* [*rate-type*] } [**bc**] *burst-size* [*burst-size-type*]
 - **police** [**cir**] {*cir-rate* [*rate-type*] } **conform transmit** [**violate drop**]
5. (Optional) **logging drop threshold** [*drop-count* [**level** *syslog-level*]]
6. (Optional) **set cos** *cos-value*
7. **exit**
8. **exit**
9. (Optional) **show policy-map type control-plane** [**expand**] [**name** *class-map-name*]
10. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.

	Command or Action	Purpose
Step 2	<p>policy-map type control-plane <i>policy-map-name</i></p> <p>Example:</p> <pre>switch(config)# policy-map type control-plane ClassMapA switch(config-pmap)#</pre>	Specifies a control plane policy map and enters policy map configuration mode. The policy map name can have a maximum of 64 characters and is case sensitive.
Step 3	<p>class {<i>class-map-name</i> [insert-before <i>class-map-name2</i>] class-default}</p> <p>Example:</p> <pre>switch(config-pmap)# class ClassMapA switch(config-pmap-c)#</pre>	Specifies a control plane class map name or the class default and enters control plane class configuration mode. The class-default class map is always at the end of the class map list for a policy map.
Step 4	<p>Enter one of the following commands:</p> <ul style="list-style-type: none"> • police [cir] {<i>cir-rate</i> [<i>rate-type</i>]} • police [cir] {<i>cir-rate</i> [<i>rate-type</i>] [bc] <i>burst-size</i> [<i>burst-size-type</i>]} • police [cir] {<i>cir-rate</i> [<i>rate-type</i>] [conform transmit] [violate drop]} <p>Example:</p> <pre>switch(config-pmap-c)# police cir 52000 bc 1000 packets</pre> <p>Example:</p> <pre>switch(config-pmap-c)# police cir 3400 kbps bc 200 kbytes</pre>	<p>Specifies the committed information rate (CIR). The rate range is as follows:</p> <ul style="list-style-type: none"> • 01 to 268435456 pps (for Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches) • 0 to 80000000000 bps/gbps/kbps/mbps (for Cisco Nexus 9200 Series switches) <p>Note The CIR rate range starts with 0. In previous releases, the CIR rate range starts with 1. A value of 0 drops the packet.</p> <p>The committed burst (BC) range is as follows:</p> <ul style="list-style-type: none"> • 1 to 1073741 packets (for Cisco Nexus 9300 and 9500 Series and 3164Q, 31128PQ, 3232C, and 3264Q switches) • 1 to 512000000 bytes/kbytes/mbytes (for Cisco Nexus 9200 Series switches) <p>The conform transmit action transmits the packet.</p> <p>Note You can specify the BC and conform action for the same CIR.</p>
Step 5	<p>(Optional) logging drop threshold [<i>drop-count</i> [level <i>syslog-level</i>]]</p> <p>Example:</p> <pre>switch(config-pmap-c)# logging drop threshold 100</pre>	Specifies the threshold value for dropped packets and generates a syslog if the drop count exceeds the configured threshold. The range for the <i>drop-count</i> argument is from 1 to 8000000000 bytes. The range for the <i>syslog-level</i> argument is from 1 to 7, and the default level is 4.
Step 6	<p>(Optional) set cos <i>cos-value</i></p> <p>Example:</p> <pre>switch(config-pmap-c)# set cos 1</pre>	Specifies the 802.1Q class of service (CoS) value. The range is from 0 to 7. The default value is 0.

	Command or Action	Purpose
Step 7	exit Example: switch(config-pmap-c) # exit switch(config-pmap) #	Exits policy map class configuration mode.
Step 8	exit Example: switch(config-pmap) # exit switch(config) #	Exits policy map configuration mode.
Step 9	(Optional) show policy-map type control-plane [expand] [name class-map-name] Example: switch(config) # show policy-map type control-plane	Displays the control plane policy map configuration.
Step 10	(Optional) copy running-config startup-config Example: switch(config) # copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring the Control Plane Service Policy

You can configure one or more policy maps for the CoPP service policy.



Note When you try to change the CoPP policy and apply a custom CoPP policy, it is configured in the hardware as non-atomic, and the following system message appears:

```
This operation can cause disruption of control traffic. Proceed (y/n)? [no] y
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT24-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT23-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT21-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT25-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT26-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT22-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
2013 Nov 13 23:16:46 switch %ACLQOS-SLOT4-5-ACLQOS_NON_ATOMIC: Non atomic ACL/QoS policy
update done for CoPP
```

Before you begin

Ensure that you have configured a control plane policy map.

SUMMARY STEPS

1. **configure terminal**
2. **control-plane**
3. **[no] service-policy input** *policy-map-name*
4. **exit**
5. (Optional) **show running-config copp** [all]
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	control-plane Example: switch(config)# control-plane switch(config-cp)#	Enters control plane configuration mode.
Step 3	[no] service-policy input <i>policy-map-name</i> Example: switch(config-cp)# service-policy input PolicyMapA	Specifies a policy map for the input traffic. Repeat this step if you have more than one policy map. You cannot disable CoPP. If you enter the no form of this command, packets are rate limited at 50 packets per seconds.
Step 4	exit Example: switch(config-cp)# exit switch(config)#	Exits control plane configuration mode.
Step 5	(Optional) show running-config copp [all] Example: switch(config)# show running-config copp	Displays the CoPP configuration.
Step 6	(Optional) copy running-config startup-config Example: switch(config)# copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring the CoPP Scale Factor Per Line Card

You can configure the CoPP scale factor per line card.

The scale factor configuration is used to scale the policer rate of the applied CoPP policy for a particular line card. The accepted value is from 0.10 to 2.00. You can increase or reduce the policer rate for a particular line card without changing the current CoPP policy. The changes are effective immediately, so you do not need to reapply the CoPP policy.

SUMMARY STEPS

1. **configure terminal**
2. **control-plane**
3. **scale-factor** *value* **module** *multiple-module-range*
4. (Optional) **show policy-map interface control-plane**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	control-plane Example: <pre>switch(config)# control-plane switch(config-cp)#</pre>	Enters control plane configuration mode.
Step 3	scale-factor <i>value</i> module <i>multiple-module-range</i> Example: <pre>switch(config-cp)# scale-factor 1.10 module 1-2</pre>	<p>Configures the policer rate per line card. The allowed scale factor value is from 0.10 to 2.00. When the scale factor value is configured, the policing values are multiplied by the corresponding scale factor value of the module, and it is programmed in the particular module.</p> <p>To revert to the default scale factor value of 1.00, use the no scale-factor <i>value</i> module <i>multiple-module-range</i> command, or explicitly set the default scale factor value to 1.00 using the scale-factor 1 module <i>multiple-module-range</i> command.</p>
Step 4	(Optional) show policy-map interface control-plane Example: <pre>switch(config-cp)# show policy-map interface control-plane</pre>	Displays the applied scale factor values when a CoPP policy is applied.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Changing or Reapplying the Default CoPP Policy

You can change to a different default CoPP policy, or you can reapply the same default CoPP policy.

SUMMARY STEPS

1. **[no] copp profile** [**strict** | **moderate** | **lenient** | **dense**]

2. (Optional) **show copp status**
3. (Optional) **show running-config copp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	[no] copp profile [strict moderate lenient dense] Example: switch(config)# copp profile moderate	Applies the CoPP best practice policy. You cannot disable CoPP. If you enter the no form of this command, packets are rate limited at 50 packets per seconds.
Step 2	(Optional) show copp status Example: switch(config)# show copp status	Displays the CoPP status, including the last configuration operation and its status. This command also enables you to verify that the CoPP best practice policy is attached to the control plane.
Step 3	(Optional) show running-config copp Example: switch(config)# show running-config copp	Displays the CoPP configuration in the running configuration.

Copying the CoPP Best Practice Policy

The CoPP best practice policy is read-only. If you want to modify its configuration, you must copy it.

SUMMARY STEPS

1. **copp copy profile {strict | moderate | lenient | dense} {prefix | suffix} string**
2. (Optional) **show copp status**
3. (Optional) **show running-config copp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	copp copy profile {strict moderate lenient dense} {prefix suffix} string Example: switch# copp copy profile strict prefix abc	Creates a copy of the CoPP best practice policy. CoPP renames all class maps and policy maps with the specified prefix or suffix.
Step 2	(Optional) show copp status Example: switch# show copp status	Displays the CoPP status, including the last configuration operation and its status. This command also enables you to verify that the copied policy is not attached to the control plane.
Step 3	(Optional) show running-config copp Example: switch# show running-config copp	Displays the CoPP configuration in the running configuration, including the copied policy configuration.

Verifying the CoPP Configuration

To display CoPP configuration information, perform one of the following tasks:

Command	Purpose
show policy-map type control-plane [expand] [name <i>policy-map-name</i>]	Displays the control plane policy map with associated class maps and CIR and BC values.
show policy-map interface control-plane	Displays the policy values with associated class maps and drops per policy or class map. It also displays the scale factor values when a CoPP policy is applied. When the scale factor value is the default (1.00), it is not displayed. Note The scale factor changes the CIR and BC values internally on each module, but the display shows the configured CIR and BC values only. The actual applied value on a module is the scale factor multiplied by the configured value.
show class-map type control-plane [<i>class-map-name</i>]	Displays the control plane class map configuration, including the ACLs that are bound to this class map.

Command	Purpose
show copp diff profile {strict moderate lenient dense} [prior-ver] profile {strict moderate lenient dense} show copp diff profile	<p>Displays the difference between two CoPP best practice policies.</p> <p>When you do not include the prior-ver option, this command displays the difference between two currently applied default CoPP best practice policies (such as the currently applied strict and currently applied moderate policies).</p> <p>When you include the prior-ver option, this command displays the difference between a currently applied default CoPP best practice policy and a previously applied default CoPP best practice policy (such as the currently applied strict and the previously applied lenient policies).</p>
show copp profile {strict moderate lenient dense}	<p>Displays the details of the CoPP best practice policy, along with the classes and policer values.</p>
show running-config aclmgr [all]	<p>Displays the user-configured access control lists (ACLs) in the running configuration. The all option displays both the default (CoPP-configured) and user-configured ACLs in the running configuration.</p>
show running-config copp [all]	<p>Displays the CoPP configuration in the running configuration.</p>
show startup-config aclmgr [all]	<p>Displays the user-configured access control lists (ACLs) in the startup configuration. The all option displays both the default (CoPP-configured) and user-configured ACLs in the startup configuration.</p>

Displaying the CoPP Configuration Status

SUMMARY STEPS

1. switch# **show copp status**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show copp status	Displays the configuration status for the CoPP feature.

Example

This example shows how to display the CoPP configuration status:

```
switch# show copp status
```

Monitoring CoPP

SUMMARY STEPS

1. switch# **show policy-map interface control-plane**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# show policy-map interface control-plane	Displays packet-level statistics for all classes that are part of the applied CoPP policy. Statistics are specified in terms of OutPackets (packets admitted to the control plane) and DropPackets (packets dropped because of rate limiting).

Example

This example shows how to monitor CoPP:

```
switch# show policy-map interface control-plane
Control Plane

Service-policy input: copp-system-p-policy-strict

class-map copp-system-p-class-critical (match-any)
  set cos 7
  police cir 19000 pps , bc 128 packets
module 4 :
  transmitted 373977 packets;
```

```
dropped 0 packets;
```

Clearing the CoPP Statistics

SUMMARY STEPS

1. (Optional) switch# **show policy-map interface control-plane**
2. switch# **clear copp statistics**

DETAILED STEPS

	Command or Action	Purpose
Step 1	(Optional) switch# show policy-map interface control-plane	Displays the currently applied CoPP policy and per-class statistics.
Step 2	switch# clear copp statistics	Clears the CoPP statistics.

Example

This example shows how to clear the CoPP statistics for your installation:

```
switch# show policy-map interface control-plane
switch# clear copp statistics
```

Configuration Examples for CoPP

This section includes example CoPP configurations.

CoPP Configuration Example

The following example shows how to configure CoPP using IP ACLs and MAC ACLs:

```
configure terminal
ip access-list copp-system-p-acl-igmp
permit igmp any 10.0.0.0/24

ip access-list copp-system-p-acl-msdp
permit tcp any any eq 639

mac access-list copp-system-p-acl-arp
permit any any 0x0806

ip access-list copp-system-p-acl-tacas
permit udp any any eq 49

ip access-list copp-system-p-acl-ntp
permit udp any 10.0.1.1/23 eq 123
```

```

ip access-list copp-system-p-acl-icmp
permit icmp any any

class-map type control-plane match-any copp-system-p-class-critical
match access-group name copp-system-p-acl-igmp
match access-group name copp-system-p-acl-msdp

class-map type control-plane match-any copp-system-p-class-normal
match access-group name copp-system-p-acl-icmp
match exception ip icmp redirect
match exception ip icmp unreachable
match exception ip option

policy-map type control-plane copp-system-p-policy

class copp-system-p-class-critical
police cir 19000 pps bc 128 packets conform transmit violate drop

class copp-system-p-class-important
police cir 500 pps bc 128 packets conform transmit violate drop

class copp-system-p-class-normal
police cir 300 pps bc 32 packets conform transmit violate drop

class class-default
police cir 50 pps bc 32 packets conform transmit violate drop

control-plane
service-policy input copp-system-p-policy

```

Create CoPP class and associate ACL:

```

class-map type control-plane copp-arp-class
match access-group name copp-arp-acl

```

Add the class to the CoPP policy:

```

policy-map type control-plane copp-system-policy
class copp-arp-class
police pps 500

```

Changing or Reapplying the Default CoPP Policy Using the Setup Utility

The following example shows how to change or reapply the default CoPP policy using the setup utility.

```
switch# setup
```

```
----- Basic System Configuration Dialog -----
```

```
This setup utility will guide you through the basic configuration of
the system. Setup configures only enough connectivity for management
of the system.
```

```
*Note: setup is mainly used for configuring the system initially,
when no configuration is present. So setup always assumes system
defaults and not the current system configuration values.
```

```
Press Enter at anytime to skip a dialog. Use ctrl-c at anytime
to skip the remaining dialogs.
```

```

Would you like to enter the basic configuration dialog (yes/no): yes
Do you want to enforce secure password standard (yes/no) [y]: <CR>
  Create another login account (yes/no) [n]: n
  Configure read-only SNMP community string (yes/no) [n]: n
  Configure read-write SNMP community string (yes/no) [n]: n
Enter the switch name : <CR>
Enable license grace period? (yes/no) [n]: n
Continue with Out-of-band (mgmt0) management configuration? (yes/no) [y]: n
Configure the default gateway? (yes/no) [y]: n
Configure advanced IP options? (yes/no) [n]: <CR>
Enable the telnet service? (yes/no) [n]: y
Enable the ssh service? (yes/no) [y]: <CR>
  Type of ssh key you would like to generate (dsa/rsa) : <CR>
Configure the ntp server? (yes/no) [n]: n
Configure default interface layer (L3/L2) [L3]: <CR>
Configure default switchport interface state (shut/noshut) [shut]: <CR>
Configure best practices CoPP profile (strict/moderate/lenient/dense/skip) [strict]:
strict

The following configuration will be applied:
password strength-check
no license grace-period
no telnet server enable
no system default switchport
system default switchport shutdown
policy-map type control-plane copp-system-p-policy

Would you like to edit the configuration? (yes/no) [n]: <CR>
Use this configuration and save it? (yes/no) [y]: y
switch#

```

Additional References for CoPP

This section provides additional information related to implementing CoPP.

Related Documents

Related Topic	Document Title
Licensing	<i>Cisco NX-OS Licensing Guide</i>

Standards

Standards	Title
RFC 2698	A Two Rate Three Color Marker



CHAPTER 12

Configuring MACsec

This document describes how to configure MACsec on Cisco NX-OS devices.

- [Configuring MACsec, on page 239](#)

Configuring MACsec

This document describes how to configure MACsec on Cisco NX-OS devices.

About MACsec

Media Access Control Security (MACsec) an IEEE 802.1AE along with MACsec Key Agreement (MKA) protocol provide secure communications on Ethernet links. It offers the following :

- Provides line rate encryption capabilities.
- Helps to ensure data confidentiality by providing strong encryption at Layer 2.
- Provides integrity checking to help ensure that data cannot be modified in transit.
- Can be selectively enabled using a centralized policy to help ensure that it is enforced where required while allowing non-MACsec-capable components to access the network.
- Encrypts packets on a hop-by-hop basis at Layer 2, allowing the network to inspect, monitor, mark, and forward traffic according to your existing policies, unlike end-to-end Layer 3 encryption techniques that hide the contents of packets from the network devices they cross.

Key Lifetime and Hitless Key Rollover

A MACsec keychain can have multiple pre-shared keys (PSKs), each configured with a key ID and an optional lifetime. A key lifetime specifies at which time the key activates and expires. In the absence of a lifetime configuration, the default lifetime is unlimited. When a lifetime is configured, MKA rolls over to the next configured pre-shared key in the keychain after the lifetime expires. The time zone of the key can be local or UTC. The default time zone is UTC.

To configure a MACsec keychain, see [Configuring a MACsec Keychain and Keys, on page 243](#).

A key can roll over to a second key within the same keychain by configuring the second key and a lifetime for the first key. When the lifetime of the first key expires, it automatically rolls over to the next key in the

list. If the same key is configured on both sides of the link at the same time, then the key rollover is hitless, that is, the key rolls over without traffic interruption.

Fallback Key

A MACsec session can fail due to a key/key name (CKN) mismatch or a finite key duration between the switch and a peer. If a MACsec session does fail, a fallback session can take over if a fallback key is configured. A fallback session prevents downtime due to primary session failure and allows a user time to fix the key issue causing the failure. A fallback key also provides a backup session if the primary session fails to start. This feature is optional.

To configure a MACsec fallback key, see [Configuring MACsec Fallback Key, on page 245](#).

Guidelines and Limitations for MACsec

MACsec has the following guidelines and limitations:

- MACsec is supported on the following interface types:
 - Layer 2 switch ports (access and trunk)
 - Layer 3 routed interfaces (no subinterfaces)



Note Enabling MACsec on the Layer 3 routed interface also enables encryption on all the subinterfaces that are defined under that interface. However, selectively enabling MACsec on a subset of subinterfaces of the same Layer 3 routed interface is not supported.

- Individual Layer 2 and Layer 3-port channel members (no subinterfaces)
- Secure Channel Identified (SCI) encoding cannot be disabled on Cisco Nexus 3600 Series switches.
- Support for MACsec is not available for Cisco Nexus ToR switches when you downgrade from Release 10.x.
- MKA is the only supported key exchange protocol for MACsec. The Security Association Protocol (SAP) is not supported.
- Link-level flow control (LLFC) and priority flow control (PFC) are not supported with MACsec.
- Multiple MACsec peers (different SCI values) for the same interface are not supported.
- You can retain the MACsec configuration when you disable MACsec using the **macsec shutdown** command.
- MACsec sessions are liberal in accepting packets from a key server whose latest Rx and latest Tx flags have been retired after Tx SA installation for the first time. The MACsec session then converges into a secure state.
- Beginning with Cisco NX-OS Release 10.1(1), you can modify MACSec policy while the policy is referenced by an interface.
- Beginning with Cisco Nexus Release 10.1(1), MACsec is supported on the Cisco Nexus N3KC3636C-R platform switches.

- N3K-C3636C-R—MACsec is supported on the following eight ports of N3K-C3636C-R, marked in green [Ports 29–36].



Note On the Cisco N3K-C3636C-R platform switches, when MACsec is either configured or unconfigured on a port, there will be a port-flap occurrence irrespective of MACsec security-policy type.

- Cisco Nexus 3600 Series switches do not support MACsec on any of the MACsec capable ports when QSA is being used.
- MACsec is not supported on breakout ports, and breakout is not supported on the following eight ports, from Port 29 to Port 36, of N3K-C3636C-R when MACsec is configured.
- Packet drops for a short period when the conf-offset parameter is changed dynamically for a MACsec policy. Change the conf-offset parameter only in static configuration when the policy is not active on the port.
- Beginning with Cisco Nexus Release 10.3(3)F, MACsec is supported on Cisco N3K-C36180YC-R switches with the following limitations:
 - MACsec is supported only on the Eth1/49, Eth1/51, Eth1/52, Eth1/53, and Eth1/54 ports.
 - MACsec must not be configured on the Eth1/50 port, as it brings the link down.

Keychain Restrictions:

- You cannot overwrite the octet string for a MACsec key. Instead, you must create a new key or a new keychain.
- A new key in the keychain is configured when you enter end or exit. The default timeout for editor mode is 6 seconds. If the key is not configured with the key octet string or/and the send lifetime within the 6-second window, incomplete information may be used to bring up the MACsec session and could result in the session being stuck in an Authorization Pending state. If the MACsec sessions are not converged after the configuration is complete, you might be advised to shut/no shut the ports.
- For a given keychain, key activation times should overlap to avoid any period of time when no key is activated. If a time period occurs during which no key is activated, session negotiation fails and traffic drops can occur. The key with the latest start time among the currently active keys takes precedence for a MACsec key rollover.

Fallback Restrictions:

- If a MACsec session is secured on an old primary key, it does not go to a fallback session in case of mismatched latest active primary key. So the session remains secured on the old primary key and will show as rekeying on the old CA under status. And the MACsec session on the new key on primary PSK will be in init state.
- Use only one key with infinite lifetime in the fallback key chain. Multiple keys are not supported.
- The key ID (CKN) used in the fallback key chain must not match any of the key IDs (CKNs) used in the primary key chain.

- Once configured, fallback configuration on an interface cannot be removed, unless the complete MACsec configuration on the interface is removed.

MACsec Policy Restrictions:

- BPDU packets can be transmitted before a MACsec session becomes secure.

Layer 2 Tunneling Protocol (L2TP) Restrictions:

- MACsec is not supported on ports configured for dot1q tunneling or L2TP.
- L2TP does not work if STP is enabled on trunk ports for non-native VLANs.

Statistics Restrictions:

- Few CRC errors should occur during the transition between MACsec and non-MACsec mode (regular port shut/no shut).
- The IEEE8021-SECY-MIB OIDs `secyRxSASStatsOKPkts`, `secyTxSASStatsProtectedPkts`, and `secyTxSASStatsEncryptedPkts` can carry only up to 32 bits of counter values, but the traffic may exceed 32 bits.

Enabling MACsec

Before you can access the MACsec and MKA commands, you must enable the MACsec feature.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <code>switch# configure terminal</code> <code>switch(config)#</code>	Enters global configuration mode.
Step 2	feature macsec Example: <code>switch(config)# feature macsec</code>	Enables MACsec and MKA on the device.
Step 3	(Optional) copy running-config startup-config Example: <code>switch(config)# copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

Disabling MACsec

Beginning with Cisco NX-OS Release 10.1(1), disabling the MACsec feature only deactivates this feature and does not remove the associated MACsec configurations.

Disabling MACsec has the following conditions:

- MACsec shutdown is global command and is not available at the interface level.
- The macsec shutdown, show macsec mka session/summary, show macsec mka session detail, and show macsec mka/secy statistics commands will display the 'Macsec is shutdown' message. However, the show macsec policy and show key chain commands will display the output.
- Consecutive MACsec status changes from macsec shutdown to no macsec shutdown and vice versa needs a 30 seconds time interval in between the status change.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	macsec shutdown Example: <pre>switch(config)# macsec shutdown</pre>	Disables the MACsec configuration on the device. The no option restores the MACsec feature.
Step 3	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration. This step is required only if you want to retain the MACsec in the shutdown state after the switch reload. Note You can also disable the MACsec feature using the no feature macsec command.

Configuring a MACsec Keychain and Keys

You can create a MACsec keychain and keys on the device.



Note Only MACsec keychains will result in converged MKA sessions.

Before you begin

Make sure that MACsec is enabled.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.

	Command or Action	Purpose
Step 2	(Optional) <code>[no] key-chain macsec-psk no-show</code> Example: <pre>switch(config)# key-chain macsec-psk no-show</pre>	Hides the encrypted key octet string in the output of the show running-config and show startup-config by replacing the string with a wildcard character. By default, PSK keys are displayed in encrypted format and can be easily decrypted. This command applies only to MACsec keychains. Note The octet string is also hidden when you save the configuration to a file.
Step 3	<code>key chain name macsec</code> Example: <pre>switch(config)# key chain 1 macsec switch(config-macseckeychain)#</pre>	Creates a MACsec keychain to hold a set of MACsec keys and enters MACsec keychain configuration mode.
Step 4	<code>key key-id</code> Example: <pre>switch(config-macseckeychain)# key 1000 switch(config-macseckeychain-macseckey)#</pre>	Creates a MACsec key and enters MACsec key configuration mode. The range is from 1 to 32 octets, and the maximum size is 64. Note The key must consist of an even number of characters.
Step 5	<code>key-octet-string octet-string cryptographic-algorithm {AES_128_CMAC AES_256_CMAC}</code> Example: <pre>switch(config-macseckeychain-macseckey)# key-octet-string abcdef0123456789abcdef0123456789abcdef0123456789abcdef0123456789 cryptographic-algorithm AES_256_CMAC</pre>	Configures the octet string for the key. The octet-string argument can contain up to 64 hexadecimal characters. The octet key is encoded internally, so the key in clear text does not appear in the output of the show running-config macsec command. The key octet string includes the following: <ul style="list-style-type: none"> • 0 Encryption Type - No encryption (default) • 6 Encryption Type - Proprietary (Type-6 encrypted). For more information, see <i>Enabling Type-6 Encryption on MACsec Keys</i>. • 7 Encryption Type - Proprietary WORD key octet string with maximum 64 characters Note MACsec peers must run the same Cisco NX-OS release in order to use the AES_128_CMAC cryptographic algorithm. To interoperate between previous releases and Cisco NX-OS Release 7.0(3)I7(2) or a later release, you must use keys with the AES_256_CMAC cryptographic algorithm.
Step 6	<code>send-lifetime start-time duration duration</code> Example: <pre>switch(config-macseckeychain-macseckey)# send-lifetime 00:00:00 Oct 04 2016 duration 100000</pre>	Configures a send lifetime for the key. By default, the device treats the start time as UTC. The <i>start-time</i> argument is the time of day and date that the key becomes active. The <i>duration</i> argument is the length

	Command or Action	Purpose
		of the lifetime in seconds. The maximum length is 2147483646 seconds (approximately 68 years).
Step 7	(Optional) show key chain <i>name</i> Example: switch(config-macseckeychain-macseckey) # show key chain 1	Displays the keychain configuration.
Step 8	(Optional) copy running-config startup-config Example: switch(config-macseckeychain-macseckey) # copy running-config startup-config	Copies the running configuration to the startup configuration.

Configuring MACsec Fallback Key

Beginning with Cisco NX-OS Release 10.1(1), you can configure a fallback key on the device to initiate a backup session if the primary session fails as a result of a key/key name (CKN) mismatch or a finite key duration between the switch and peer.

Before you begin

Make sure that MACsec is enabled and a primary and fallback keychain and key ID are configured. See [Configuring a MACsec Keychain and Keys, on page 243](#).

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	interface <i>name</i> Example: switch(config)# interface ethernet 1/29 switch(config-if)#	Specifies the interface that you are configuring. You can specify the interface type and identity. For an Ethernet port, use ethernet slot/port.
Step 3	macsec keychain <i>keychain-name</i> policy <i>policy-name</i> fallback-keychain <i>keychain-name</i> Example: switch(config-if)# macsec keychain kc2 policy abc fallback-keychain fb_kc2	Specifies the fallback keychain to use after a MACsec session failure due to a key/key ID mismatch or a key expiration. The fallback key ID should not match any key ID from a primary keychain. Fallback keychain configuration for each interface can be changed on the corresponding interface, without removing the MACsec configuration, by reissuing the same command with the fallback keychain name changed.

	Command or Action	Purpose
		<p>Note The command must be entered exactly the same as the existing configuration command for the interface, except for the fallback keychain name.</p> <p>See Configuring a MACsec Keychain and Keys, on page 243.</p>
Step 4	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch(config-if)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

Configuring a MACsec Policy

You can create multiple MACsec policies with different parameters. However, only one policy can be active on an interface.

Before you begin

Make sure that MACsec is enabled.

Procedure

	Command or Action	Purpose
Step 1	<p>configure terminal</p> <p>Example:</p> <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	<p>macsec policy name</p> <p>Example:</p> <pre>switch(config)# macsec policy abc switch(config-macsec-policy)#</pre>	Creates a MACsec policy.
Step 3	<p>cipher-suite name</p> <p>Example:</p> <pre>switch(config-macsec-policy)# cipher-suite GCM-AES-256</pre>	Configures one of the following ciphers: GCM-AES-128, GCM-AES-256, GCM-AES-XPN-128, or GCM-AES-XPN-256.
Step 4	<p>key-server-priority number</p> <p>Example:</p> <pre>switch(config-macsec-policy)# key-server-priority 0</pre>	Configures the key server priority to break the tie between peers during a key exchange. The range is from 0 (highest) and 255 (lowest), and the default value is 16.
Step 5	<p>security-policy name</p> <p>Example:</p>	Configures one of the following security policies to define the handling of data and control packets:

	Command or Action	Purpose
	<code>switch(config-macsec-policy) # security-policy should-secure</code>	<ul style="list-style-type: none"> • must-secure—Packets not carrying MACsec headers will be dropped. • should-secure—Packets not carrying MACsec headers will be permitted. This is the default value.
Step 6	window-size <i>number</i> Example: <code>switch(config-macsec-policy) # window-size 512</code>	Configures the replay protection window such that the secured interface will not accept any packet that is less than the configured window size. The range is from 0 to 596000000.
Step 7	sak-expiry-time <i>time</i> Example: <code>switch(config-macsec-policy) # sak-expiry-time 100</code>	Configures the time in seconds to force an SAK rekey. This command can be used to change the session key to a predictable time interval. The default is 0.
Step 8	conf-offset <i>name</i> Example: <code>switch(config-macsec-policy) # conf-offset CONF-OFFSET-0</code>	<p>Configures one of the following confidentiality offsets in the Layer 2 frame, where encryption begins: CONF-OFFSET-0, CONF-OFFSET-30, or CONF-OFFSET-50.</p> <p>This command might be necessary for intermediate switches to use packet headers {dmac, smac, etype} like MPLS tags.</p>
Step 9	(Optional) show macsec policy Example: <code>switch(config-macsec-policy) # show macsec policy</code>	Displays the MACsec policy configuration.
Step 10	(Optional) copy running-config startup-config Example: <code>switch(config-macsec-policy) # copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

Rotating PSKs

Follow this procedure to rotate PSKs when the SAK expiry time is configured for 60 seconds in the MACsec policy.

-
- Step 1** Use the **no sak-expiry-time** command to remove the SAK expiry timer from the MACsec policy.
- You need to remove the SAK expiry timer only for the number of policies in the configuration. You do not need to remove it for each interface. If you have defined only one policy and applied it to all interfaces, you need to remove the SAK expiry timer only from this policy.
- Step 2** Wait for 2 minutes.
- Step 3** Use the **key key-id** command to program the new key under the keychain.
- Step 4** Once the session with the new key is secured, use the **no key key-id** command to delete the old key.
- Step 5** Wait for 2 minutes.

Step 6 Use the `sak-expiry-timer 60` command to add the SAK rekey timer to the MACsec policy.

Verifying the MACsec Configuration

To display MACsec configuration information, perform one of the following tasks:

Command	Purpose
<code>show key chain <i>name</i></code>	Displays the keychain configuration.
<code>show macsec mka session [interface <i>type slot/port</i>] [detail]</code>	Displays information about the MACsec MKA session for a specific interface or for all interfaces.
<code>show macsec mka session details</code>	Displays information about the MAC address.
<code>show macsec mka summary</code>	Displays the MACsec MKA configuration.
<code>show macsec policy [policy-name]</code>	Displays the configuration for a specific MACsec policy or for all MACsec policies.
<code>show running-config macsec</code>	Displays the running configuration information for MACsec.

The following example displays information about the MACsec MKA session for all interfaces.

```
switch(config)# show macsec mka session
Interface          Local-TxSCI          # Peers      Status
Key-Server        Auth Mode
-----
Ethernet1/29      6c8b.d3db.e968/0001  1            Secured
No                PRIMARY-PSK
Ethernet1/30      6c8b.d3db.e96c/0001  1            Secured
No                PRIMARY-PSK
Ethernet1/31      6c8b.d3db.e970/0001  1            Secured
Yes              PRIMARY-PSK
Ethernet1/32      6c8b.d3db.e974/0001  1            Secured
Yes              PRIMARY-PSK
Ethernet1/33      6c8b.d3db.e978/0001  1            Secured
Yes              PRIMARY-PSK
Ethernet1/34      6c8b.d3db.e97c/0001  1            Secured
Yes              PRIMARY-PSK
Ethernet1/35      6c8b.d3db.e980/0001  1            Secured
Yes              PRIMARY-PSK
Ethernet1/36      6c8b.d3db.e984/0001  1            Secured
No                PRIMARY-PSK
-----
Total Number of Sessions : 8
    Secured Sessions : 8
    Pending Sessions : 0
switch(config)#
```

The following example displays information about the MACsec MKA session for a specific interface. In addition to the common elements of the table as described in the previous example, the following also identifies the authentication mode which defines the current MACsec session type.

```
switch(config)# show macsec mka session interface e1/35
Interface          Local-TxSCI          # Peers          Status
Key-Server        Auth Mode
-----
Ethernet1/35      6c8b.d3db.e980/0001 1                  Secured
Yes               PRIMARY-PSK
switch(config)#
```

The following example displays detailed information about the MACsec MKA session for a specific Ethernet interface:

```
switch(config)# show macsec mka session interface e1/35 details
Detailed Status for MKA Session
-----
Interface Name          : Ethernet1/35
Session Status          : SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : 6c8b.d3db.e980/0001
Local Tx-SSCI           : 2
MKA Port Identifier     : 2
CAK Name (CKN)          : 2006
CA Authentication Mode  : PRIMARY-PSK
Member Identifier (MI)  : 50BE8367F1C6D0AB1C442229
Message Number (MN)    : 1048
MKA Policy Name         : mpsr1
Key Server Priority     : 1
Key Server              : Yes
Include ICV             : Yes
SAK Cipher Suite        : GCM-AES-128
SAK Cipher Suite (Operational) : GCM-AES-128
Replay Window Size     : 148809600
Confidentiality Offset : CONF-OFFSET-30
Confidentiality Offset (Operational) : CONF-OFFSET-30
Latest SAK Status      : Rx & TX
Latest SAK AN          : 0
Latest SAK KI          : 50BE8367F1C6D0AB1C44222900000021
Latest SAK KN          : 33
Last SAK key time      : 11:23:53 pst Tue Dec 15 2020
CA Peer Count          : 1
Eapol dest mac         : 0180.c200.0003
Ether-type              : 0x888e
Peer Status:
Peer MI                 : 37AFE73EC8617FD32F70E21A
RxSCI                   : 6c8b.d3db.e984/0001
Peer CAK                : Match
Latest Rx MKPDU        : 11:24:52 pst Tue Dec 15 2020
Fallback Data:
Fallback CKN            : FB2004
Fallback MI             : 849D72D5F6A900F5B0718C78
Fallback MN             : 0x3d6
Fallback Peer:
Peer MI                 : 8DCE8CBE67B474D2C2955F58
RxSCI                   : 6c8b.d3db.e984/0001
Peer CAK                : Match
Latest Rx MKPDU        : 11:24:52 pst Tue Dec 15 2020
switch(config)#
```

The following example displays the MACsec MKA configuration:

```
switch# show macsec mka summary
Interface          MACSEC-policy          Keychain
-----
Ethernet2/13      1                      1/100000000000000000
Ethernet2/14      1                      1/100000000000000000
switch#
```

The following example displays the configuration for all MACsec policies:

```
switch# show macsec policy
MACSec Policy Cipher Pri Window Offset Security SAK Rekey time ICV Indicator
-----
system-default-macsec-policy GCM-AES-XPN-256 16 148809600 0 should-secure
pn-rollover FALSE
tests1 GCM-AES-XPN-256 16 148809600 0 should-secure
pn-rollover FALSE
tests2 GCM-AES-XPN-256 16 148809600 0 should-secure
pn-rollover FALSE
tests3 GCM-AES-256 16 148809600 0 should-secure
pn-rollover FALSE
```

The following example displays the key octet string in the output of the **show running-config** and **show startup-config** commands when the **key-chain macsec-psk no-show** command is not configured:

```
key chain KC256-1 macsec
  key 2000
    key-octet-string 7
075e701e1c5a4a5143475e5a527d7c7c706a6c724306170103555a5c57510b051e47080
a05000101005e0e50510f005c4b5f5d0b5b070e234e4d0a1d0112175b5e cryptographic-algorithm
AES_256_CMAC
```

The following example displays the key octet string in the output of the **show running-config** and **show startup-config** commands when the **key-chain macsec-psk no-show** command is configured:

```
key chain KC256-1 macsec
  key 2000
    key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
```

Displaying MACsec Statistics

You can display MACsec statistics using the following commands.

Command	Purpose
show macsec mka statistics [<i>interface type slot/port</i>]	Displays MACsec MKA statistics.
show macsec secy statistics [<i>interface type slot/port</i>]	Displays MACsec security statistics.

The following example shows the MACsec MKA statistics for a specific Ethernet interface:

```
switch# show macsec mka statistics interface ethernet 1/29
MKA Statistics for Session on interface (Ethernet1/29)
=====
CA Statistics
  Pairwise CAK Rekeys..... 0

SA Statistics
  SAKs Generated..... 0
  SAKs Rekeyed..... 0
  SAKs Received..... 0
  SAK Responses Received.. 0

MKPDU Statistics
  MKPDUs Transmitted..... 41
  "Distributed SAK".. 0
  MKPDUs Validated & Rx... 41
  "Distributed SAK".. 0

MKA IDB Statistics
```

```

MKPDUs Tx Success..... 82
MKPDUs Tx Fail..... 0
MKPDUs Tx Pkt build fail... 0
MKPDUs No Tx on intf down.. 0
MKPDUs No Rx on intf down.. 0
MKPDUs Rx CA Not found..... 0
MKPDUs Rx Error..... 0
MKPDUs Rx Success..... 82

MKPDU Failures
MKPDU Rx Validation ..... 0
MKPDU Rx Bad Peer MN..... 0
MKPDU Rx Non-recent Peerlist MN..... 0
MKPDU Rx Drop SAKUSE, KN mismatch..... 0
MKPDU Rx Drop SAKUSE, Rx Not Set..... 0
MKPDU Rx Drop SAKUSE, Key MI mismatch.... 0
MKPDU Rx Drop SAKUSE, AN Not in Use..... 0
MKPDU Rx Drop SAKUSE, KS Rx/Tx Not Set... 0
MKPDU Rx Drop Packet, Ethertype Mismatch. 0
MKPDU Rx Drop Packet, DestMAC Mismatch... 0

SAK Failures
SAK Generation..... 0
Hash Key Generation..... 0
SAK Encryption/Wrap..... 0
SAK Decryption/Unwrap..... 0

CA Failures
ICK Derivation..... 0
KEK Derivation..... 0
Invalid Peer MACsec Capability... 0

MACsec Failures
Rx SA Installation..... 0
Tx SA Installation..... 0

switch(config)#

```

The following example shows the MACsec security statistics for a specific Ethernet interface.



Note The following differences exist for uncontrolled and controlled packets in Rx and Tx statistics:

- Rx statistics:
 - Uncontrolled = Encrypted and unencrypted
 - Controlled = Decrypted
- Tx statistics:
 - Uncontrolled = Unencrypted
 - Controlled = Encrypted
 - Common = Encrypted and unencrypted

```

switch(config)# show macsec secy statistics interface e1/29
Interface Ethernet1/29 MACSEC SecY Statistics:
-----
Interface Rx Statistics:

```

```

Unicast Uncontrolled Pkts: 8067779
Multicast Uncontrolled Pkts: 14
Broadcast Uncontrolled Pkts: 0
Uncontrolled Pkts - Rx Drop: 0
Uncontrolled Pkts - Rx Error: 0
Unicast Controlled Pkts: N/A (N3K-C3636C-R not supported)
Multicast Controlled Pkts: N/A (N3K-C3636C-R not supported)
Broadcast Controlled Pkts: N/A (N3K-C3636C-R not supported)
Controlled Pkts: 8056748
Controlled Pkts - Rx Drop: N/A (N3K-C3636C-R not supported)
Controlled Pkts - Rx Error: N/A (N3K-C3636C-R not supported)
In-Octets Uncontrolled: 37641828280 bytes
In-Octets Controlled: 37324295914 bytes
Input rate for Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Input rate for Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Input rate for Controlled Pkts: N/A (N3K-C3636C-R not supported)
Input rate for Controlled Pkts: N/A (N3K-C3636C-R not supported)

```

Interface Tx Statistics:

```

Unicast Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Multicast Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Broadcast Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Uncontrolled Pkts - Rx Drop: N/A (N3K-C3636C-R not supported)
Uncontrolled Pkts - Rx Error: N/A (N3K-C3636C-R not supported)
Unicast Controlled Pkts: N/A (N3K-C3636C-R not supported)
Multicast Controlled Pkts: N/A (N3K-C3636C-R not supported)
Broadcast Controlled Pkts: N/A (N3K-C3636C-R not supported)
Controlled Pkts: 8049279
Controlled Pkts - Rx Drop: N/A (N3K-C3636C-R not supported)
Controlled Pkts - Rx Error: N/A (N3K-C3636C-R not supported)
Out-Octets Uncontrolled: N/A (N3K-C3636C-R not supported)
Out-Octets Controlled: 37262189352 bytes
Out-Octets Common: 37699748491 bytes
Output rate for Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Output rate for Uncontrolled Pkts: N/A (N3K-C3636C-R not supported)
Output rate for Controlled Pkts: N/A (N3K-C3636C-R not supported)
Output rate for Controlled Pkts: N/A (N3K-C3636C-R not supported)

```

SECY Rx Statistics:

```

Transform Error Pkts: N/A (N3K-C3636C-R not supported)
Control Pkts: 0
Untagged Pkts: N/A (N3K-C3636C-R not supported)
No Tag Pkts: 0
Bad Tag Pkts: 0
No SCI Pkts: 0
Unknown SCI Pkts: 0
Tagged Control Pkts: N/A (N3K-C3636C-R not supported)

```

SECY Tx Statistics:

```

Transform Error Pkts: N/A (N3K-C3636C-R not supported)
Control Pkts: 0
Untagged Pkts: N/A (N3K-C3636C-R not supported)

```

SAK Rx Statistics for AN [0]:

```

Unchecked Pkts: 0
Delayed Pkts: 0
Late Pkts: 0
OK Pkts: 8056748
Invalid Pkts: 0
Not Valid Pkts: 0
Not-Using-SA Pkts: 0
Unused-SA Pkts: 0
Decrypted In-Octets: 36952542946 bytes
Validated In-Octets: 0 bytes

```

```
SAK Tx Statistics for AN [0]:
  Encrypted Protected Pkts: 8049279
  Too Long Pkts: N/A (N3K-C3636C-R not supported)
  SA-not-in-use Pkts: N/A (N3K-C3636C-R not supported)
  Encrypted Protected Out-Octets: 36909704659 bytes
```

```
switch(config)#
```

Configuration Example for MACsec

The following example shows how to configure a user-defined MACsec policy and then apply the policy to interfaces:

```
switch(config)# macsec policy mpsr1
switch(config-macsec-policy)# cipher-suite GCM-AES-128
switch(config-macsec-policy)# key-server-priority 1
switch(config-macsec-policy)# window-size 1000
switch(config-macsec-policy)# conf-offset CONF-OFFSET-30
switch(config-macsec-policy)# security-policy must-secure
switch(config-macsec-policy)# sak-expiry-time 60
switch(config-macsec-policy)# include-icv-indicator

switch(config-macsec-policy)# interface e1/35-36
switch(config-if-range)# macsec keychain ksr policy mpsr1
switch(config-if-range)# show macsec mka session
```

Interface	Local-TxSCI	# Peers	Status
Key-Server	Auth Mode		

Ethernet1/35	6c8b.d3db.e980/0001	1	Secured
Yes	PRIMARY-PSK		
Ethernet1/36	6c8b.d3db.e984/0001	1	Secured
No	PRIMARY-PSK		

```
switch(config-if-range)# show macsec mka summary
```

Interface	Status	Cipher (Operational)	Key-Server	MACSEC-policy
Keychain			Fallback-keychain	

Ethernet1/35	Secured	GCM-AES-128	Yes	mpsrl
ksr			no keychain	
Ethernet1/36	Secured	GCM-AES-128	No	mpsrl
ksr			no keychain	

```
switch(config-if-range)# show running-config macsec
!Command: show running-config macsec
!Running configuration last done at: Tue Dec 15 11:41:53 2020
!Time: Tue Dec 15 11:45:06 2020

version 10.1(1) Bios:version 01.14
feature macsec

macsec policy mpsr1
  cipher-suite GCM-AES-128
  key-server-priority 1
  window-size 1000
  conf-offset CONF-OFFSET-30
  sak-expiry-time 60
  include-icv-indicator
```

```
interface Ethernet1/35
  macsec keychain ksr policy mpsr1

interface Ethernet1/36
  macsec keychain ksr policy mpsr1
```

The following example shows how to configure a MACsec keychain and then add the system default MACsec policy to the interfaces:

```
switch(config)# key chain ksr macsec
switch(config-macseckeychain)# key 2006
switch(config-macseckeychain-macseckey)# key-octet-string
1234567890abcdef1234567890abcdef1234567890abcdef1234567890abcdef cryptographic-algorithm
AES_256_CMAC
switch(config-macseckeychain-macseckey)# interface e1/35-36
switch(config-if-range)# macsec keychain ksr

switch(config-if-range)# show running-config macsec
!Command: show running-config macsec
!Running configuration last done at: Tue Dec 15 11:53:10 2020
!Time: Tue Dec 15 11:54:40 2020

version 10.1(1) Bios:version 01.14
feature macsec

interface Ethernet1/35
  macsec keychain ksr policy system-default-macsec-policy

interface Ethernet1/36
  macsec keychain ksr policy system-default-macsec-policy

switch(config-if-range)# show macsec mka summary
Interface          Status  Cipher (Operational)  Key-Server  MACSEC-policy
  Keychain          Fallback-keychain
-----
Ethernet1/35      Secured  GCM-AES-XPB-256      Yes          system-default-macsec-policy
  ksr              no keychain
Ethernet1/36      Secured  GCM-AES-XPB-256      No           system-default-macsec-policy
  ksr              no keychain

switch(config-if-range)# show macsec mka session
Interface          Local-TxSCI          # Peers          Status
Key-Server        Auth Mode
-----
Ethernet1/35      6c8b.d3db.e980/0001  1                Secured
Yes               PRIMARY-PSK
Ethernet1/36      6c8b.d3db.e984/0001  1                Secured
No                PRIMARY-PSK

Total Number of Sessions : 2
  Secured Sessions : 2
  Pending Sessions : 0

switch(config-if-range)#
```


XML Examples

MACsec supports XML output for the following **show** commands for scripting purposes using **| xml**:

- **show key chain *name* | xml**
- **show macsec mka session *interface interface slot/port details* |xml**
- **show macsec mka statistics *interface interface slot/port* |xml**
- **show macsec mka summary |xml**
- **show macsec policy *name* |xml**
- **show macsec secy statistics *interface interface slot/port* |xml**
- **show running-config macsec |xml**

The following are example outputs for each of the preceding **show** commands:

Example 1: Displays the keychain configuration

```
switch(config)# show key chain "ksr" | xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<nf:rpc-reply xmlns="http://www.cisco.com/nxos:1.0:rpm"
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0">
<nf:data>
  <show>
    <key>
      <chain>
        <__XML__OPT_Cmd_rpm_show_keychain_cmd_keychain>
          <keychain>ksr</keychain>
          <__XML__OPT_Cmd_rpm_show_keychain_cmd__readonly__>
            <__readonly__>
              <TABLE_keychain>
                <ROW_keychain>
                  <chain_name>ksr</chain_name>
                  <TABLE_key>
                    <ROW_key>
                      <key_id>2006</key_id>
                      <key_string>075e731fa5c4524f4800d6292f21e62677147524054590f09595157a061e47000030604020520b07058b5301155756085f535976141759180714160e0a</key_string>
                      <crypto_algo>AES_256_CMAC</crypto_algo>
                      <send_valid>true</send_valid>
                    </ROW_key>
                  </TABLE_key>
                </ROW_keychain>
              </TABLE_keychain>
            </__readonly__>
          </__XML__OPT_Cmd_rpm_show_keychain_cmd__readonly__>
        </__XML__OPT_Cmd_rpm_show_keychain_cmd_keychain>
      </chain>
    </key>
  </show>
</nf:data>
</nf:rpc-reply>
]]>]]>
switch(config)#
```

Example 2: Displays information about the MACsec MKA session for a specific interface

```

switch(config)# show macsec mka session interface e1/35 details | xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<nf:rpc-reply xmlns="http://www.cisco.com/nxos:1.0:cts"
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0">
<nf:data>
  <show>
    <macsec>
      <mka>
        <session>
          <__XML_OPT_Cmd_show_macsec_mka_session_interface>
            <interface>
              <__XML_INTF_ifname>
                <__XML_PARAM_value>
                  <__XML_INTF_output>Ethernet1/35</__XML_INTF_output>
                </__XML_PARAM_value>
              </__XML_INTF_ifname>
            </interface>
          <__XML_OPT_Cmd_show_macsec_mka_session_details>
            <details/>
            <__XML_OPT_Cmd_show_macsec_mka_session__readonly__>
              <__readonly__>
                <TABLE_mka_session_details>
                  <ROW_mka_session_details>
                    <ifname>Ethernet1/35</ifname>
                    <status>SECURED - Secured MKA Session with MACsec</status>
                    <sci>6c8b.d3db.e980/0001</sci>
                    <ssci>2</ssci>
                    <port_id>2</port_id>
                    <ckn>2006</ckn>
                    <ca_auth_mode>PRIMARY-PSK</ca_auth_mode>
                    <mi>5AABE0AB9CC867AB0FF40F7D</mi>
                    <mn>3550</mn>
                    <policy>system-default-macsec-policy</policy>
                    <ks_prio>16</ks_prio>
                    <keyserver>Yes</keyserver>
                    <include_icv_indicator>No</include_icv_indicator>
                    <cipher>GCM-AES-XPN-256</cipher>
                    <cipher_operational>GCM-AES-XPN-256</cipher_operational>
                    <window>148809600</window>
                    <conf_offset>CONF-OFFSET-0</conf_offset>
                    <conf_offset_operational>CONF-OFFSET-0</conf_offset_operational>
                    <sak_status>Rx &amp; TX</sak_status>
                    <sak_an>0</sak_an>
                    <sak_ki>5AABE0AB9CC867AB0FF40F7D00000001</sak_ki>
                    <sak_kn>1</sak_kn>
                    <last_sak_rekey_time>11:53:25 pst Tue Dec 15 2020</last_sak_rekey_time>
                    <peer_count>1</peer_count>
                    <mac_addr>0180.c200.0003</mac_addr>
                    <ether_type>0x888e</ether_type>
                    <TABLE_mka_peer_status>
                      <ROW_mka_peer_status>
                        <peer_mi>27FC36C2BFAFBDBC65419A40</peer_mi>
                        <rxsci>6c8b.d3db.e984/0001</rxsci>
                        <icv_status>Match</icv_status>
                        <last_rx_time>13:51:39 pst Tue Dec 15 2020</last_rx_time>
                      </ROW_mka_peer_status>
                    </TABLE_mka_peer_status>
                  </ROW_mka_session_details>
                </TABLE_mka_session_details>
              </__readonly__>
            </__XML_OPT_Cmd_show_macsec_mka_session__readonly__>
          </__XML_OPT_Cmd_show_macsec_mka_session_details>
        </session>
      </mka>
    </macsec>
  </show>
</nf:data>

```

```

    </__XML__OPT_Cmd_show_macsec_mka_session_interface>
  </session>
</mka>
</macsec>
</show>
</nf:data>
</nf:rpc-reply>
]]>]]>
switch(config)#

```

Example 3: Displays MACsec MKA statistics

```

switch(config)# show macsec mka statistics interface e1/29 | xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<nf:rpc-reply xmlns="http://www.cisco.com/nxos:1.0:cts"
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0">
<nf:data>
  <show>
    <macsec>
      <mka>
        <statistics>
          <__XML__OPT_Cmd_some_macsec_mka_statistics_interface>
            <interface>
              <__XML__INTF_ifname>
                <__XML__PARAM_value>
                  <__XML__INTF_output>Ethernet1/29</__XML__INTF_output>
                </__XML__PARAM_value>
              </__XML__INTF_ifname>
            </interface>
            <__XML__OPT_Cmd_some_macsec_mka_statistics__readonly__>
              <__readonly__>
                <TABLE_mka_intf_stats>
                  <ROW_mka_intf_stats>
                    <ifname2>Ethernet1/29</ifname2>
                    <TABLE_ca_stats>
                      <ROW_ca_stats>
                        <ca_stat_ckn>2002</ca_stat_ckn>
                        <ca_stat_pairwise_cak_rekey>0</ca_stat_pairwise_cak_rekey>
                        <sa_stat_sak_generated>0</sa_stat_sak_generated>
                        <sa_stat_sak_rekey>0</sa_stat_sak_rekey>
                        <sa_stat_sak_received>2</sa_stat_sak_received>
                        <sa_stat_sak_response_rx>0</sa_stat_sak_response_rx>
                        <mkpdu_stat_mkpdu_tx>4335</mkpdu_stat_mkpdu_tx>
                        <mkpdu_stat_mkpdu_tx_distsak>0</mkpdu_stat_mkpdu_tx_distsak>
                        <mkpdu_stat_mkpdu_rx>4335</mkpdu_stat_mkpdu_rx>
                        <mkpdu_stat_mkpdu_rx_distsak>2</mkpdu_stat_mkpdu_rx_distsak>
                      </ROW_ca_stats>
                    </TABLE_ca_stats>
                    <TABLE_idb_stats>
                      <ROW_idb_stats>
                        <ca_stat_pairwise_cak_rekey>0</ca_stat_pairwise_cak_rekey>
                        <sa_stat_sak_generated>0</sa_stat_sak_generated>
                        <sa_stat_sak_rekey>0</sa_stat_sak_rekey>
                        <sa_stat_sak_received>2</sa_stat_sak_received>
                        <sa_stat_sak_response_rx>0</sa_stat_sak_response_rx>
                        <mkpdu_stat_mkpdu_tx>4335</mkpdu_stat_mkpdu_tx>
                        <mkpdu_stat_mkpdu_tx_distsak>0</mkpdu_stat_mkpdu_tx_distsak>
                        <mkpdu_stat_mkpdu_rx>4335</mkpdu_stat_mkpdu_rx>
                        <mkpdu_stat_mkpdu_rx_distsak>2</mkpdu_stat_mkpdu_rx_distsak>
                        <idb_stat_mkpdu_tx_success>8666</idb_stat_mkpdu_tx_success>
                        <idb_stat_mkpdu_tx_fail>0</idb_stat_mkpdu_tx_fail>
                        <idb_stat_mkpdu_tx_pkt_build_fail>0</idb_stat_mkpdu_tx_pkt_build_fail>
                        <idb_stat_mkpdu_no_tx_on_intf_down>0</idb_stat_mkpdu_no_tx_on_intf_down>
                        <idb_stat_mkpdu_no_rx_on_intf_down>0</idb_stat_mkpdu_no_rx_on_intf_down>
                      </ROW_idb_stats>
                    </TABLE_idb_stats>
                  </ROW_mka_intf_stats>
                </TABLE_mka_intf_stats>
              </__readonly__>
            </__XML__OPT_Cmd_some_macsec_mka_statistics__readonly__>
          </__XML__OPT_Cmd_some_macsec_mka_statistics_interface>
        </statistics>
      </mka>
    </macsec>
  </show>
</nf:data>
</nf:rpc-reply>
]]>]]>
switch(config)#

```

```

        <idb_stat_mkpdu_rx_ca_notfound>0</idb_stat_mkpdu_rx_ca_notfound>
        <idb_stat_mkpdu_rx_error>0</idb_stat_mkpdu_rx_error>
        <idb_stat_mkpdu_rx_success>8666</idb_stat_mkpdu_rx_success>

<idb_stat_mkpdu_failure_rx_integrity_check_error>0</idb_stat_mkpdu_failure_rx_integrity_check_error>

<idb_stat_mkpdu_failure_invalid_peer_mn_error>0</idb_stat_mkpdu_failure_invalid_peer_mn_error>

<idb_stat_mkpdu_failure_nonrecent_peerlist_mn_error>0</idb_stat_mkpdu_failure_nonrecent_peerlist_mn_error>

<idb_stat_mkpdu_failure_sakuse_kn_mismatch_error>0</idb_stat_mkpdu_failure_sakuse_kn_mismatch_error>

<idb_stat_mkpdu_failure_sakuse_rx_not_set_error>0</idb_stat_mkpdu_failure_sakuse_rx_not_set_error>

<idb_stat_mkpdu_failure_sakuse_key_mi_mismatch_error>0</idb_stat_mkpdu_failure_sakuse_key_mi_mismatch_error>

<idb_stat_mkpdu_failure_sakuse_an_not_in_use_error>0</idb_stat_mkpdu_failure_sakuse_an_not_in_use_error>

<idb_stat_mkpdu_failure_sakuse_ks_rx_tx_not_set_error>0</idb_stat_mkpdu_failure_sakuse_ks_rx_tx_not_set_error>

<idb_stat_mkpdu_failure_sakuse_eapol_etherstype_mismatch_error>0</idb_stat_mkpdu_failure_sakuse_eapol_etherstype_mismatch_error>

<idb_stat_mkpdu_failure_sakuse_eapol_destmac_mismatch_error>0</idb_stat_mkpdu_failure_sakuse_eapol_destmac_mismatch_error>

<idb_stat_sak_failure_sak_generate_error>0</idb_stat_sak_failure_sak_generate_error>

<idb_stat_sak_failure_hash_generate_error>0</idb_stat_sak_failure_hash_generate_error>

<idb_stat_sak_failure_sak_encryption_error>0</idb_stat_sak_failure_sak_encryption_error>

<idb_stat_sak_failure_sak_decryption_error>0</idb_stat_sak_failure_sak_decryption_error>

<idb_stat_sak_failure_ick_derivation_error>0</idb_stat_sak_failure_ick_derivation_error>

<idb_stat_sak_failure_kek_derivation_error>0</idb_stat_sak_failure_kek_derivation_error>

<idb_stat_sak_failure_invalid_macsec_capability_error>0</idb_stat_sak_failure_invalid_macsec_capability_error>

<idb_stat_macsec_failure_rx_sa_create_error>0</idb_stat_macsec_failure_rx_sa_create_error>

<idb_stat_macsec_failure_tx_sa_create_error>0</idb_stat_macsec_failure_tx_sa_create_error>
    </ROW_idb_stats>
  </TABLE_idb_stats>
  </ROW_mka_intf_stats>
</TABLE_mka_intf_stats>
</__readonly__>
</__XML_OPT_Cmd_some_macsec_mka_statistics__readonly__>
</__XML_OPT_Cmd_some_macsec_mka_statistics_interface>
</statistics>
</mka>
</macsec>
</show>
</nf:data>

```

```

</nf:rpc-reply>
]]>]]>
switch(config)#

```

Example 4: Displays the MACsec MKA configuration

```

switch(config)# show macsec mka summary | xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<nf:rpc-reply xmlns="http://www.cisco.com/nxos:1.0:cts"
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0">
<nf:data>
  <show>
    <macsec>
      <mka>
        <_XML_OPT_Cmd_some_macsec_summary>
          <_XML_OPT_Cmd_some_macsec__readonly__>
            <_readonly__>
              <TABLE_mka_summary>
                <ROW_mka_summary>
                  <ifname>Ethernet1/29</ifname>
                  <status>Secured</status>
                  <cipher>GCM-AES-128</cipher>
                  <keyserver>No</keyserver>
                  <policy>mpd1</policy>
                  <keychain>kd</keychain>
                  <fallback_keychain>fbkd</fallback_keychain>
                </ROW_mka_summary>
                <ROW_mka_summary>
                  <ifname>Ethernet1/30</ifname>
                  <status>Secured</status>
                  <cipher>GCM-AES-128</cipher>
                  <keyserver>No</keyserver>
                  <policy>mpd2</policy>
                  <keychain>kd</keychain>
                  <fallback_keychain>fbkd</fallback_keychain>
                </ROW_mka_summary>
                <ROW_mka_summary>
                  <ifname>Ethernet1/31</ifname>
                  <status>Secured</status>
                  <cipher>GCM-AES-128</cipher>
                  <keyserver>Yes</keyserver>
                  <policy>mps1</policy>
                  <keychain>ks</keychain>
                  <fallback_keychain>fbks</fallback_keychain>
                </ROW_mka_summary>
                <ROW_mka_summary>
                  <ifname>Ethernet1/32</ifname>
                  <status>Secured</status>
                  <cipher>GCM-AES-128</cipher>
                  <keyserver>Yes</keyserver>
                  <policy>mps2</policy>
                  <keychain>ks</keychain>
                  <fallback_keychain>fbks</fallback_keychain>
                </ROW_mka_summary>
                <ROW_mka_summary>
                  <ifname>Ethernet1/33</ifname>
                  <status>Secured</status>
                  <cipher>GCM-AES-128</cipher>
                  <keyserver>Yes</keyserver>
                  <policy>mpsrl</policy>
                  <keychain>ksr</keychain>
                  <fallback_keychain>fbksr</fallback_keychain>
                </ROW_mka_summary>
              </TABLE_mka_summary>
            </_readonly__>
          </_XML_OPT_Cmd_some_macsec__readonly__>
        </_XML_OPT_Cmd_some_macsec_summary>
      </mka>
    </macsec>
  </show>
</nf:data>
</nf:rpc-reply>

```

```

        <ifname>Ethernet1/34</ifname>
        <status>Secured</status>
        <cipher>GCM-AES-128</cipher>
        <keyserver>Yes</keyserver>
        <policy>mpsr2</policy>
        <keychain>ksr</keychain>
        <fallback_keychain>fbksr</fallback_keychain>
    </ROW_mka_summary>
    <ROW_mka_summary>
        <ifname>Ethernet1/35</ifname>
        <status>Secured</status>
        <cipher>GCM-AES-XPN-256</cipher>
        <keyserver>Yes</keyserver>
        <policy>system-default-macsec-policy</policy>
        <keychain>ksr</keychain>
        <fallback_keychain>no keychain</fallback_keychain>
    </ROW_mka_summary>
    <ROW_mka_summary>
        <ifname>Ethernet1/36</ifname>
        <status>Secured</status>
        <cipher>GCM-AES-XPN-256</cipher>
        <keyserver>No</keyserver>
        <policy>system-default-macsec-policy</policy>
        <keychain>ksr</keychain>
        <fallback_keychain>no keychain</fallback_keychain>
    </ROW_mka_summary>
</TABLE_mka_summary>
</__readonly__>
</__XML__OPT_Cmd_some_macsec__readonly__>
</__XML__OPT_Cmd_some_macsec_summary__>
</mka>
</macsec>
</show>
</nf:data>
</nf:rpc-reply>
]]>]]>
switch(config)#

```

Example 5: Displays the configuration for a specific MACsec policy

```

switch(config)# show macsec policy mpsr1 | xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<nf:rpc-reply xmlns="http://www.cisco.com/nxos:1.0:cts"
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0">
<nf:data>
  <show>
    <macsec>
      <policy>
        <__XML__OPT_Cmd_show_macsec_policy_policy_name>
        <policy_name>mpsr1</policy_name>
        <__XML__OPT_Cmd_show_macsec_policy__readonly__>
        <__readonly__>
          <TABLE_macsec_policy>
            <ROW_macsec_policy>
              <name>mpsr1</name>
              <cipher_suite>GCM-AES-128</cipher_suite>
              <keyserver_priority>1</keyserver_priority>
              <window_size>1000</window_size>
              <conf_offset>30</conf_offset>
              <security_policy>should-secure</security_policy>
              <sak-expiry-time>60</sak-expiry-time>
              <include_icv_indicator>TRUE</include_icv_indicator>
            </ROW_macsec_policy>
          </TABLE_macsec_policy>

```

```

        </__readonly__>
        </__XML__OPT_Cmd_show_macsec_policy__readonly__>
        </__XML__OPT_Cmd_show_macsec_policy_policy_name>
    </policy>
</macsec>
</show>
</nf:data>
</nf:rpc-reply>
]]>]]>
switch(config)#

```

Example 6: Displays MACsec Security statistics

```

switch(config)# show macsec secy statistics interface e1/29 | xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<nf:rpc-reply xmlns="http://www.cisco.com/nxos:1.0:cts"
xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0">
<nf:data>
  <show>
    <macsec>
      <secy>
        <statistics>
          <__XML__OPT_Cmd_some_macsec_secy_statistics_interface>
            <interface>
              <__XML__INTF_ifname>
                <__XML__PARAM_value>
                  <__XML__INTF_output>Ethernet1/29</__XML__INTF_output>
                </__XML__PARAM_value>
              </__XML__INTF_ifname>
            </interface>
            <__XML__OPT_Cmd_some_macsec_secy_statistics__readonly__>
              <__readonly__>
                <TABLE_statistics>
                  <ROW_statistics>
                    <ifname2>Ethernet1/29</ifname2>
                    <in_pkts_unicast_uncontrolled>6536205587</in_pkts_unicast_uncontrolled>
                    <in_pkts_multicast_uncontrolled>10775</in_pkts_multicast_uncontrolled>
                    <in_pkts_broadcast_uncontrolled>0</in_pkts_broadcast_uncontrolled>
                    <in_rx_drop_pkts_uncontrolled>0</in_rx_drop_pkts_uncontrolled>
                    <in_rx_err_pkts_uncontrolled>0</in_rx_err_pkts_uncontrolled>
                    <in_pkts_unicast_controlled>N/A (N3K-C3636C-R not
supported)</in_pkts_unicast_controlled>
                    <in_pkts_multicast_controlled>N/A (N3K-C3636C-R not
supported)</in_pkts_multicast_controlled>
                    <in_pkts_broadcast_controlled>N/A (N3K-C3636C-R not
supported)</in_pkts_broadcast_controlled>
                    <in_pkts_controlled>5173107800</in_pkts_controlled>
                    <in_rx_drop_pkts_controlled>N/A (N3K-C3636C-R not
supported)</in_rx_drop_pkts_controlled>
                    <in_rx_err_pkts_controlled>N/A (N3K-C3636C-R not
supported)</in_rx_err_pkts_controlled>
                    <in_octets_uncontrolled>30491280431357</in_octets_uncontrolled>
                    <in_octets_controlled>23935220809548</in_octets_controlled>
                    <input_rate_uncontrolled_pps>N/A (N3K-C3636C-R not
supported)</input_rate_uncontrolled_pps>
                    <input_rate_uncontrolled_bps>N/A (N3K-C3636C-R not
supported)</input_rate_uncontrolled_bps>
                    <input_rate_controlled_pps>N/A (N3K-C3636C-R not
supported)</input_rate_controlled_pps>
                    <input_rate_controlled_bps>N/A (N3K-C3636C-R not
supported)</input_rate_controlled_bps>
                    <out_pkts_unicast_uncontrolled>N/A (N3K-C3636C-R not
supported)</out_pkts_unicast_uncontrolled>
                    <out_pkts_multicast_uncontrolled>N/A (N3K-C3636C-R not

```

```

supported)</out_pkts_multicast_uncontrolled>
  <out_pkts_broadcast_uncontrolled>N/A (N3K-C3636C-R not
supported)</out_pkts_broadcast_uncontrolled>
  <out_rx_drop_pkts_uncontrolled>N/A (N3K-C3636C-R not
supported)</out_rx_drop_pkts_uncontrolled>
  <out_rx_err_pkts_uncontrolled>N/A (N3K-C3636C-R not
supported)</out_rx_err_pkts_uncontrolled>
  <out_pkts_unicast_controlled>N/A (N3K-C3636C-R not
supported)</out_pkts_unicast_controlled>
  <out_pkts_multicast_controlled>N/A (N3K-C3636C-R not
supported)</out_pkts_multicast_controlled>
  <out_pkts_broadcast_controlled>N/A (N3K-C3636C-R not
supported)</out_pkts_broadcast_controlled>
  <out_pkts_controlled>5173113173</out_pkts_controlled>
  <out_rx_drop_pkts_controlled>N/A (N3K-C3636C-R not
supported)</out_rx_drop_pkts_controlled>
  <out_rx_err_pkts_controlled>N/A (N3K-C3636C-R not
supported)</out_rx_err_pkts_controlled>
  <out_octets_uncontrolled>N/A (N3K-C3636C-R not supported)</out_octets_uncontrolled>

  <out_octets_controlled>23946219872208</out_octets_controlled>
  <out_octets_common>30664229104600</out_octets_common>
  <output_rate_uncontrolled_pps>N/A (N3K-C3636C-R not
supported)</output_rate_uncontrolled_pps>
  <output_rate_uncontrolled_bps>N/A (N3K-C3636C-R not
supported)</output_rate_uncontrolled_bps>
  <output_rate_controlled_pps>N/A (N3K-C3636C-R not
supported)</output_rate_controlled_pps>
  <output_rate_controlled_bps>N/A (N3K-C3636C-R not
supported)</output_rate_controlled_bps>
  <in_pkts_transform_error>N/A (N3K-C3636C-R not supported)</in_pkts_transform_error>

  <in_pkts_control>0</in_pkts_control>
  <in_pkts_untagged>N/A (N3K-C3636C-R not supported)</in_pkts_untagged>
  <in_pkts_no_tag>0</in_pkts_no_tag>
  <in_pkts_badtag>0</in_pkts_badtag>
  <in_pkts_no_sci>0</in_pkts_no_sci>
  <in_pkts_unknown_sci>0</in_pkts_unknown_sci>
  <in_pkts_tagged_ctrl>N/A (N3K-C3636C-R not supported)</in_pkts_tagged_ctrl>
  <out_pkts_transform_error>N/A (N3K-C3636C-R not
supported)</out_pkts_transform_error>
  <out_pkts_control>0</out_pkts_control>
  <out_pkts_untagged>N/A (N3K-C3636C-R not supported)</out_pkts_untagged>
  <TABLE_rx_sa_an>
  <ROW_rx_sa_an>
  <rx_sa_an>2</rx_sa_an>
  <in_pkts_unchecked>0</in_pkts_unchecked>
  <in_pkts_delayed>0</in_pkts_delayed>
  <in_pkts_late>0</in_pkts_late>
  <in_pkts_ok>1951781408</in_pkts_ok>
  <in_pkts_invalid>0</in_pkts_invalid>
  <in_pkts_not_valid>0</in_pkts_not_valid>
  <in_pkts_not_using_sa>0</in_pkts_not_using_sa>
  <in_pkts_unused_sa>0</in_pkts_unused_sa>
  <in_octets_decrypted>8952613134278</in_octets_decrypted>
  <in_octets_validated>0</in_octets_validated>
  </ROW_rx_sa_an>
  </TABLE_rx_sa_an>
  <TABLE_tx_sa_an>
  <ROW_tx_sa_an>
  <tx_sa_an>2</tx_sa_an>
  <out_pkts_encrypted_protected>1951773387</out_pkts_encrypted_protected>
  <out_pkts_too_long>N/A (N3K-C3636C-R not supported)</out_pkts_too_long>
  <out_pkts_sa_not_inuse>N/A (N3K-C3636C-R not supported)</out_pkts_sa_not_inuse>

```



```

        <out_octets_encrypted_protected>8952606203313</out_octets_encrypted_protected>
    </ROW_tx_sa_an>
</TABLE_tx_sa_an>
</ROW_statistics>
</TABLE_statistics>
</__readonly__>
</__XML__OPT_Cmd_some_macsec_secy_statistics__readonly__>
</__XML__OPT_Cmd_some_macsec_secy_statistics_interface>
</statistics>
</secy>
</macsec>
</show>
</nf:data>
</nf:rpc-reply>
]]>]]>
switch(config)#

```

Example 7: Displays the running configuration information for MACsec

```

switch(config)# show running-config macsec | xml

!Command: show running-config macsec
!Running configuration last done at: Tue Dec 15 11:53:10 2020
!Time: Tue Dec 15 13:58:58 2020

version 10.1(1) Bios:version 01.14
*****
This may take time. Please be patient.
*****
<?xml version="1.0"?>
<nf:rpc xmlns:nf="urn:ietf:params:xml:ns:netconf:base:1.0"
xmlns="http://www.cisco.com/nxos:10.1.1.:configure_"
xmlns:m="http://www.cisco.com/nxos:10.1.1.:_exec"
xmlns:m1="http://www.cisco.com/nxos:10.1.1.:configure__macsec-policy"
xmlns:m2="http://www.cisco.com/nxos:10.1.1.:configure__if-ethernet-all" message-id="1">
  <nf:get-config>
    <nf:source>
      <nf:running/>
    </nf:source>
    <nf:filter>
      <m:configure>
        <m:terminal>
          <feature>
            <macsec/>
          </feature>
          <macsec>
            <policy>
              <__XML__PARAM__policy_name>
                <__XML__value>mpd1</__XML__value>
                <m1:cipher-suite>
                  <m1:__XML__PARAM__suite>
                    <m1:__XML__value>GCM-AES-128</m1:__XML__value>
                  </m1:__XML__PARAM__suite>
                </m1:cipher-suite>
                <m1:conf-offset>
                  <m1:__XML__PARAM__offset>
                    <m1:__XML__value>CONF-OFFSET-30</m1:__XML__value>
                  </m1:__XML__PARAM__offset>
                </m1:conf-offset>
              </__XML__PARAM__policy_name>
            </policy>
          </macsec>

```

```

<macsec>
  <policy>
    <__XML_PARAM_policy_name>
      <__XML_value>mpd2</__XML_value>
      <ml:cipher-suite>
        <ml:__XML_PARAM_suite>
          <ml:__XML_value>GCM-AES-128</ml:__XML_value>
        </ml:__XML_PARAM_suite>
      </ml:cipher-suite>
      <ml:conf-offset>
        <ml:__XML_PARAM_offset>
          <ml:__XML_value>CONF-OFFSET-30</ml:__XML_value>
        </ml:__XML_PARAM_offset>
      </ml:conf-offset>
      <ml:security-policy>
        <ml:__XML_PARAM_policy>
          <ml:__XML_value>must-secure</ml:__XML_value>
        </ml:__XML_PARAM_policy>
      </ml:security-policy>
    </__XML_PARAM_policy_name>
  </policy>
</macsec>
<macsec>
  <policy>
    <__XML_PARAM_policy_name>
      <__XML_value>mps1</__XML_value>
      <ml:cipher-suite>
        <ml:__XML_PARAM_suite>
          <ml:__XML_value>GCM-AES-128</ml:__XML_value>
        </ml:__XML_PARAM_suite>
      </ml:cipher-suite>
      <ml:key-server-priority>
        <ml:__XML_PARAM_pri>
          <ml:__XML_value>1</ml:__XML_value>
        </ml:__XML_PARAM_pri>
      </ml:key-server-priority>
      <ml:conf-offset>
        <ml:__XML_PARAM_offset>
          <ml:__XML_value>CONF-OFFSET-30</ml:__XML_value>
        </ml:__XML_PARAM_offset>
      </ml:conf-offset>
      <ml:sak-expiry-time>
        <ml:__XML_PARAM_ts>
          <ml:__XML_value>60</ml:__XML_value>
        </ml:__XML_PARAM_ts>
      </ml:sak-expiry-time>
      <ml:include-icv-indicator/>
    </__XML_PARAM_policy_name>
  </policy>
</macsec>
<macsec>
  <policy>
    <__XML_PARAM_policy_name>
      <__XML_value>mps2</__XML_value>
      <ml:cipher-suite>
        <ml:__XML_PARAM_suite>
          <ml:__XML_value>GCM-AES-128</ml:__XML_value>
        </ml:__XML_PARAM_suite>
      </ml:cipher-suite>
      <ml:key-server-priority>
        <ml:__XML_PARAM_pri>
          <ml:__XML_value>1</ml:__XML_value>
        </ml:__XML_PARAM_pri>
      </ml:key-server-priority>
    </__XML_PARAM_policy_name>
  </policy>
</macsec>

```

```

    <ml:window-size>
      <ml:XML_PARAM_size>
        <ml:XML_value>1000</ml:XML_value>
      </ml:XML_PARAM_size>
    </ml:window-size>
  <ml:conf-offset>
    <ml:XML_PARAM_offset>
      <ml:XML_value>CONF-OFFSET-30</ml:XML_value>
    </ml:XML_PARAM_offset>
  </ml:conf-offset>
  <ml:security-policy>
    <ml:XML_PARAM_policy>
      <ml:XML_value>must-secure</ml:XML_value>
    </ml:XML_PARAM_policy>
  </ml:security-policy>
  <ml:sak-expiry-time>
    <ml:XML_PARAM_ts>
      <ml:XML_value>60</ml:XML_value>
    </ml:XML_PARAM_ts>
  </ml:sak-expiry-time>
  <ml:include-icv-indicator/>
</XML_PARAM_policy_name>
</policy>
</macsec>
<macsec>
  <policy>
    <XML_PARAM_policy_name>
      <XML_value>mpsr1</XML_value>
    <ml:cipher-suite>
      <ml:XML_PARAM_suite>
        <ml:XML_value>GCM-AES-128</ml:XML_value>
      </ml:XML_PARAM_suite>
    </ml:cipher-suite>
    <ml:key-server-priority>
      <ml:XML_PARAM_pri>
        <ml:XML_value>1</ml:XML_value>
      </ml:XML_PARAM_pri>
    </ml:key-server-priority>
    <ml:window-size>
      <ml:XML_PARAM_size>
        <ml:XML_value>1000</ml:XML_value>
      </ml:XML_PARAM_size>
    </ml:window-size>
    <ml:conf-offset>
      <ml:XML_PARAM_offset>
        <ml:XML_value>CONF-OFFSET-30</ml:XML_value>
      </ml:XML_PARAM_offset>
    </ml:conf-offset>
    <ml:sak-expiry-time>
      <ml:XML_PARAM_ts>
        <ml:XML_value>60</ml:XML_value>
      </ml:XML_PARAM_ts>
    </ml:sak-expiry-time>
    <ml:include-icv-indicator/>
  </XML_PARAM_policy_name>
</policy>
</macsec>
<macsec>
  <policy>
    <XML_PARAM_policy_name>
      <XML_value>mpsr2</XML_value>
    <ml:cipher-suite>
      <ml:XML_PARAM_suite>
        <ml:XML_value>GCM-AES-128</ml:XML_value>

```

```

        </m1:__XML__PARAM__suite>
    </m1:cipher-suite>
    <m1:key-server-priority>
        <m1:__XML__PARAM__pri>
            <m1:__XML__value>1</m1:__XML__value>
        </m1:__XML__PARAM__pri>
    </m1:key-server-priority>
    <m1>window-size>
        <m1:__XML__PARAM__size>
            <m1:__XML__value>1000</m1:__XML__value>
        </m1:__XML__PARAM__size>
    </m1>window-size>
    <m1:conf-offset>
        <m1:__XML__PARAM__offset>
            <m1:__XML__value>CONF-OFFSET-30</m1:__XML__value>
        </m1:__XML__PARAM__offset>
    </m1:conf-offset>
    <m1:security-policy>
        <m1:__XML__PARAM__policy>
            <m1:__XML__value>must-secure</m1:__XML__value>
        </m1:__XML__PARAM__policy>
    </m1:security-policy>
    <m1:sak-expiry-time>
        <m1:__XML__PARAM__ts>
            <m1:__XML__value>60</m1:__XML__value>
        </m1:__XML__PARAM__ts>
    </m1:sak-expiry-time>
    <m1:include-icv-indicator/>
</__XML__PARAM__policy_name>
</policy>
</macsec>
<interface>
    <__XML__PARAM__interface>
        <__XML__value>Ethernet1/29</__XML__value>
    <m2:macsec>
        <m2:keychain>
            <m2:__XML__PARAM__keychain_name>
                <m2:__XML__value>kd</m2:__XML__value>
            <m2:policy>
                <m2:__XML__PARAM__policy_name>
                    <m2:__XML__value>mpd1</m2:__XML__value>
                <m2:fallback-keychain>
                    <m2:__XML__PARAM__fallback_kc_name>
                        <m2:__XML__value>fbkd</m2:__XML__value>
                    </m2:__XML__PARAM__fallback_kc_name>
                </m2:fallback-keychain>
            </m2:__XML__PARAM__policy_name>
        </m2:policy>
    </m2:__XML__PARAM__keychain_name>
    </m2:keychain>
    </m2:macsec>
    </__XML__PARAM__interface>
</interface>
<interface>
    <__XML__PARAM__interface>
        <__XML__value>Ethernet1/30</__XML__value>
    <m2:macsec>
        <m2:keychain>
            <m2:__XML__PARAM__keychain_name>
                <m2:__XML__value>kd</m2:__XML__value>
            <m2:policy>
                <m2:__XML__PARAM__policy_name>
                    <m2:__XML__value>mpd2</m2:__XML__value>
                <m2:fallback-keychain>

```

```

        <m2: __XML_PARAM_fallback_kc_name>
        <m2: __XML_value>fbkd</m2: __XML_value>
    </m2: __XML_PARAM_fallback_kc_name>
    </m2: fallback-keychain>
</m2: __XML_PARAM_policy_name>
</m2: policy>
</m2: __XML_PARAM_keychain_name>
</m2: keychain>
</m2: macsec>
</ __XML_PARAM_interface>
</interface>
<interface>
  < __XML_PARAM_interface>
    < __XML_value>Ethernet1/31</ __XML_value>
    <m2: macsec>
      <m2: keychain>
        <m2: __XML_PARAM_keychain_name>
        <m2: __XML_value>ks</m2: __XML_value>
        <m2: policy>
          <m2: __XML_PARAM_policy_name>
          <m2: __XML_value>mps1</m2: __XML_value>
          <m2: fallback-keychain>
            <m2: __XML_PARAM_fallback_kc_name>
            <m2: __XML_value>fbks</m2: __XML_value>
            </m2: __XML_PARAM_fallback_kc_name>
          </m2: fallback-keychain>
          </m2: __XML_PARAM_policy_name>
        </m2: policy>
      </m2: __XML_PARAM_keychain_name>
    </m2: keychain>
  </m2: macsec>
</ __XML_PARAM_interface>
</interface>
<interface>
  < __XML_PARAM_interface>
    < __XML_value>Ethernet1/32</ __XML_value>
    <m2: macsec>
      <m2: keychain>
        <m2: __XML_PARAM_keychain_name>
        <m2: __XML_value>ks</m2: __XML_value>
        <m2: policy>
          <m2: __XML_PARAM_policy_name>
          <m2: __XML_value>mps2</m2: __XML_value>
          <m2: fallback-keychain>
            <m2: __XML_PARAM_fallback_kc_name>
            <m2: __XML_value>fbks</m2: __XML_value>
            </m2: __XML_PARAM_fallback_kc_name>
          </m2: fallback-keychain>
          </m2: __XML_PARAM_policy_name>
        </m2: policy>
      </m2: __XML_PARAM_keychain_name>
    </m2: keychain>
  </m2: macsec>
</ __XML_PARAM_interface>
</interface>
<interface>
  < __XML_PARAM_interface>
    < __XML_value>Ethernet1/33</ __XML_value>
    <m2: macsec>
      <m2: keychain>
        <m2: __XML_PARAM_keychain_name>
        <m2: __XML_value>ksr</m2: __XML_value>
        <m2: policy>
          <m2: __XML_PARAM_policy_name>

```

```

        <m2:__XML__value>mpsrl</m2:__XML__value>
        <m2:fallback-keychain>
            <m2:__XML__PARAM__fallback_kc_name>
                <m2:__XML__value>fbksr</m2:__XML__value>
            </m2:__XML__PARAM__fallback_kc_name>
        </m2:fallback-keychain>
        </m2:__XML__PARAM__policy_name>
    </m2:policy>
    </m2:__XML__PARAM__keychain_name>
</m2:keychain>
</m2:macsec>
</__XML__PARAM__interface>
</interface>
<interface>
    <__XML__PARAM__interface>
        <__XML__value>Ethernet1/34</__XML__value>
        <m2:macsec>
            <m2:keychain>
                <m2:__XML__PARAM__keychain_name>
                    <m2:__XML__value>ksr</m2:__XML__value>
                <m2:policy>
                    <m2:__XML__PARAM__policy_name>
                        <m2:__XML__value>mpsrl2</m2:__XML__value>
                    <m2:fallback-keychain>
                        <m2:__XML__PARAM__fallback_kc_name>
                            <m2:__XML__value>fbksr</m2:__XML__value>
                        </m2:__XML__PARAM__fallback_kc_name>
                    </m2:fallback-keychain>
                </m2:__XML__PARAM__policy_name>
            </m2:policy>
        </m2:__XML__PARAM__keychain_name>
    </m2:keychain>
</m2:macsec>
</__XML__PARAM__interface>
</interface>
<interface>
    <__XML__PARAM__interface>
        <__XML__value>Ethernet1/35</__XML__value>
        <m2:macsec>
            <m2:keychain>
                <m2:__XML__PARAM__keychain_name>
                    <m2:__XML__value>ksr</m2:__XML__value>
                <m2:policy>
                    <m2:__XML__PARAM__policy_name>
                        <m2:__XML__value>system-default-macsec-policy</m2:__XML__value>
                    </m2:__XML__PARAM__policy_name>
                </m2:policy>
            </m2:__XML__PARAM__keychain_name>
        </m2:keychain>
</m2:macsec>
</__XML__PARAM__interface>
</interface>
<interface>
    <__XML__PARAM__interface>
        <__XML__value>Ethernet1/36</__XML__value>
        <m2:macsec>
            <m2:keychain>
                <m2:__XML__PARAM__keychain_name>
                    <m2:__XML__value>ksr</m2:__XML__value>
                <m2:policy>
                    <m2:__XML__PARAM__policy_name>
                        <m2:__XML__value>system-default-macsec-policy</m2:__XML__value>
                    </m2:__XML__PARAM__policy_name>
                </m2:policy>
            </m2:keychain>
        </m2:macsec>
    </__XML__PARAM__interface>
</interface>

```

```

        </m2:__XML__PARAM__keychain_name>
    </m2:keychain>
</m2:macsec>
</__XML__PARAM__interface>
</interface>
</m:terminal>
</m:configure>
</nf:filter>
</nf:get-config>
</nf:rpc>
]]>]]>

switch(config)#

```

MIBs

MACsec supports the following MIBs:

- IEEE8021-SECY-MIB
- CISCO-SECY-EXT-MIB

Related Documentation

Related Topic	Document Title
Keychain management	Cisco Nexus 3600 Series NX-OS Security Configuration Guide
System messages	Cisco Nexus 3600 Series NX-OS System Messages References



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