CONFIGURATION GUIDE

Extreme Network OS Security Configuration Guide, 7.3.0

Supporting Network OS 7.3.0

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Contents

Preface

Document conventions

The document conventions describe text formatting conventions, command syntax conventions, and important notice formats used in Extreme technical documentation.

Notes, cautions, and warnings

Notes, cautions, and warning statements may be used in this document. They are listed in the order of increasing severity of potential hazards.

NOTE
A Note provides a tip, guidance, or advice, emphasizes important information, or provides a reference to related information.

ATTENTION
An Attention statement indicates a stronger note, for example, to alert you when traffic might be interrupted or the device might reboot.

CAUTION
A Caution statement alerts you to situations that can be potentially hazardous to you or cause damage to hardware, firmware, software, or data.

DANGER
A Danger statement indicates conditions or situations that can be potentially lethal or extremely hazardous to you. Safety labels are also attached directly to products to warn of these conditions or situations.

Text formatting conventions

Text formatting conventions such as boldface, italic, or Courier font may be used to highlight specific words or phrases.

Format	Description
bold text	Identifies command names.
	Identifies keywords and operands.
	Identifies the names of GUI elements.
	Identifies text to enter in the GUI.
italic text	Identifies emphasis.
	Identifies variables.
	Identifies document titles.
`Courier font`	Identifies CLI output.

Format	Description
	Identifies command syntax examples.

Command syntax conventions

Bold and italic text identify command syntax components. Delimiters and operators define groupings of parameters and their logical relationships.

Convention	Description
bold text	Identifies command names, keywords, and command options.
italic text	Identifies a variable.
[ ]	Syntax components displayed within square brackets are optional. Default responses to system prompts are enclosed in square brackets.
{ **x** | **y** | **z** }	A choice of required parameters is enclosed in curly brackets separated by vertical bars. You must select one of the options.
x | **y**	A vertical bar separates mutually exclusive elements.
< >	Nonprinting characters, for example, passwords, are enclosed in angle brackets.
...	Repeat the previous element, for example, *member*[*member*...].
\	Indicates a "soft" line break in command examples. If a backslash separates two lines of a command input, enter the entire command at the prompt without the backslash.

Extreme resources

Visit the Extreme website to locate related documentation for your product and additional Extreme resources.

White papers, data sheets, and the most recent versions of Extreme software and hardware manuals are available at www.extremenetworks.com. Product documentation for all supported releases is available to registered users at www.extremenetworks.com/support/documentation.

Document feedback

Quality is our first concern at Extreme, and we have made every effort to ensure the accuracy and completeness of this document. However, if you find an error or an omission, or you think that a topic needs further development, we want to hear from you.

You can provide feedback in two ways:

- Use our short online feedback form at http://www.extremenetworks.com/documentation-feedback-pdf/
- Email us at internalinfodev@extremenetworks.com

Provide the publication title, part number, and as much detail as possible, including the topic heading and page number if applicable, as well as your suggestions for improvement.

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- GTAC (Global Technical Assistance Center) for immediate support
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  - Email: support@extremenetworks.com. To expedite your message, enter the product name or model number in the subject line.
- GTAC Knowledge - Get on-demand and tested resolutions from the GTAC Knowledgebase, or create a help case if you need more guidance.
- The Hub - A forum for Extreme customers to connect with one another, get questions answered, share ideas and feedback, and get problems solved. This community is monitored by Extreme Networks employees, but is not intended to replace specific guidance from GTAC.
- Support Portal - Manage cases, downloads, service contracts, product licensing, and training and certifications.

Before contacting Extreme Networks for technical support, have the following information ready:

- Your Extreme Networks service contract number and/or serial numbers for all involved Extreme Networks products
- A description of the failure
- A description of any action(s) already taken to resolve the problem
- A description of your network environment (such as layout, cable type, other relevant environmental information)
- Network load at the time of trouble (if known)
- The device history (for example, if you have returned the device before, or if this is a recurring problem)
- Any related RMA (Return Material Authorization) numbers

About this document

Supported hardware and software

In those instances in which procedures or parts of procedures documented here apply to some devices but not to others, this guide identifies exactly which devices are supported and which are not.

Although many different software and hardware configurations are tested and supported by Extreme Networks, Inc. for Network OS, documenting all possible configurations and scenarios is beyond the scope of this document.

The following hardware platforms are supported by this release of Network OS:

- ExtremeSwitching VDX 2746
- ExtremeSwitching VDX 6740
  - ExtremeSwitching VDX 6740-48
  - ExtremeSwitching VDX 6740-64
- ExtremeSwitching VDX 6740T
  - ExtremeSwitching VDX 6740T-48
  - ExtremeSwitching VDX 6740T-64
  - ExtremeSwitching VDX 6740T-1G
- ExtremeSwitching VDX 6940-36Q
- ExtremeSwitching VDX 6940-144S
- ExtremeSwitching VDX 8770
  - ExtremeSwitching VDX 8770-4
  - ExtremeSwitching VDX 8770-8

To obtain information about a Network OS version other than this release, refer to the documentation specific to that version.

Using the Network OS CLI

For complete instructions and support for using the Extreme Network OS command line interface (CLI), refer to the *Extreme Network OS Command Reference*.

What's new in this document

NOTE

On October 30, 2017, Extreme Networks, Inc. acquired the data center networking business from Brocade Communications Systems, Inc. This document has been updated to remove or replace references to Brocade Communications, Inc. with Extreme Networks., Inc., as appropriate.

This document supports the following features introduced in Network OS v7.3.0:

- Importing TLS certificate and keys without trust point
- Configuring user-level aliases

For complete information, refer to the *Network OS Release Notes*.

User Accounts and Passwords

User account overview

A user account specifies that user's level of access to the device CLI.

The software uses role-based access control (RBAC) as the authorization mechanism. A *role* is a container for rules, which specify which commands can be executed and with which permissions. When you create a user account you need to specify a role for that account. In general, *user* (as opposed to *user-level*) refers to any account—to which any role can be assigned—user, admin, or a non-default role.

Default accounts and roles

The software ships with two default accounts—admin and user—and two corresponding default roles:

- **admin**—Accounts with admin permissions can execute all commands supported on the device. (For the initial admin login, refer to the relevant *Hardware Installation Guide*.)
- **user**—Accounts with user-level permissions can execute all **show** commands supported on the device. User-level accounts can also execute the following operational commands: **exit**, **ping**, **ssh**, **telnet**, **timestamp**, **rasman**, and **traceroute**.

  NOTE
  For details on non-default roles (also known as *user-defined roles*), refer to User-defined roles on page 18.

Account guidelines and limitations

Be aware of the following guidelines and limitations:

- Extreme recommends that every user access the CLI through a unique account: After logging in as admin, create a unique account for yourself, specifying **role admin**.
- You cannot modify rules for the admin or the user default accounts.
- You cannot modify rules for the admin or the user default roles.
- By default, all account information is stored in the device-local user database.
- By default, user authentication and tracking of logins to the device is local.
- The maximum number of accounts—including the two default accounts—is 64. For more than 64 users, you can implement an authentication, authorization, and accounting (AAA) service. For details, refer to the External Server Authentication section.
- The maximum number of roles—including the two default roles—is 64. If needed, refer to Role and rule limits on page 18.
- Role configuration is applied to all VCS nodes.

Basic account management

These topics enable you to create and manage basic admin and user accounts.

Creating an admin-role account

An admin-role account can execute all supported CLI commands.

The required parameters for creating an account are **name**, **role**, and **password**. In this example, the optional **desc** parameter is also utilized.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **username** command, with the specified parameters.

```
device(config)# username jsmith role admin password Tijd1spw desc "Has access to all commands"
```

Creating a user-role account

A user-role account can execute **show** and other basic CLI commands.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **username** command, with the specified parameters.

```
device(config)# username jdoe role user password iKt1Sas*p
```

Modifying an account

Use this topic to modify a user account.

The only required parameter for modifying an account is **username** *username*. In this example, the role is changed to admin.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **username** command, with the needed parameters.

```
device(config)# username jdoe role admin
```

Disabling an account

Use this topic to disable a user account.

NOTE
If you disable an account, all active sessions for that user are immediately terminated.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **username** command, with the **enable false** parameters.

```
device(config)# username testUser enable false
```

Unlocking an account

Use this topic to unlock a user account.

A user account is automatically locked by the system when the configured threshold for repeated failed login attempts has been reached. The account lockout threshold is a configurable parameter. Refer to Account lockout policy on page 26 for more information.

If a user account is locked out of a device, that user can still try to log in on another device in the fabric. However, the unlocking is done on the given RBridge IDs, irrespective of whether the user is locked or not on one or more devices.

NOTE
The **username** and **no username** commands are global configuration commands, but the **unlock username** command is a privileged EXEC command.

1. In privileged EXEC mode, enter the **show users** command to display currently active sessions and locked out users.

```
device# show users
 rbridge-id
 all
**USER SESSIONS**
ID  Username    Role    Host IP       Method    Time Logged In          TTY
2   jsmith      user    192.0.2.0     cli       2016-04-30 01:59:35     pts/2
1   jdoe        admin   192.0.2.1     cli       2016-05-30 01:57:41     tty80

**LOCKED USERS**
RBridge ID      Username
1               testUser
```

2. For each account that you want to unlock, enter the **unlock username** command.

```
device#  unlock username testUser
Result: Unlocking the user account is successful
```

3. Enter the **show users** command to verify that the account is unlocked.

```
device# show users
 rbridge-id
 all
**USER SESSIONS**
ID  Username    Role    Host Ip       Method    Time Logged In          TTY
2   jsmith      user    192.0.2.0     cli       2016-04-30 01:59:35     pts/2
1   jdoe        admin   192.0.2.1     cli       2016-05-30 01:57:41     tty80

**LOCKED USERS**
RBridge ID      Username
no locked users
```

Deleting an account

Use this topic to delete a user account.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **no username** command.

```
device(config)# no username testUser
```

When an account is deleted, all active login sessions for that user are terminated

User-defined roles

In addition to the default roles—admin and user—the software supports the creation of user-defined roles.

User-defined-role overview

User-defined roles enable you to fine-tune CLI access.

A user-defined role starts from a basic set of privileges which are then refined by adding rules. You assign a name to the role and then associate the role to one or more user accounts.

The following tools are available for managing user-defined roles:

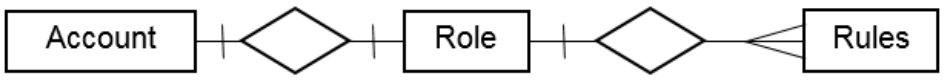
- The **role** command defines new roles and deletes user-defined roles.
- The **rule** command allows you to specify access rules for specific operations and assign these rules to a given role.
- The **username** command associates a given user-defined role with a specific user account.

Role and rule limits

At any given time, an account is associated with one role. A role is associated with one or more rules. A rule is associated with only one role.

This relationship among accounts, roles, and rules is illustrated by the following entity-relationship diagram:

FIGURE 1 Accounts, roles, and rules



The number of supported accounts, roles, and rules is as follows:

- The maximum number of accounts is 64, including the default admin and user accounts. For more than 64 users, you can implement an authentication, authorization, and accounting (AAA) service.
- The maximum number of roles is 64, including the default admin and user roles.
- The maximum number of rules is 512, which you can allocate among your roles as you see fit.

Creating or modifying a role

Use this topic to create a role or to modify its Description.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **role** command, specifying the role name and (optionally) a description.

```
device(config)# role name NetworkAdmin desc "Manages security CLIs"
```

Deleting a role

Use this topic to delete a role.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **no role** command with the specified parameters.

```
device(config)# no role name NetworkAdmin
```

Commonly used roles

The following examples illustrate the creation and configuration of two frequently-used administrative roles and accounts: Extreme VCS Fabric security administrator, and FCoE Fabric administrator.

Creating a VCS Fabric security administrator role and account

The following steps create and configure a typical Extreme VCS Fabric security administrator role.

1. Create a role for an Extreme VCS Fabric security administrator.

```
device(config)# role name NetworkSecurityAdmin desc "Manages security CLIs"
```

2. Create a user account associated with the newly created role.

```
device(config)# username SecAdminUser role NetworkSecurityAdmin password testpassword
```

3. Create the rules to specify the RBAC permissions for the NetworkSecurityAdmin role.

```
device(config)# rule 30 action accept operation read-write role NetworkSecurityAdmin command role
device(config-rule-30)# exit
device(config)# rule 31 action accept operation read-write role NetworkSecurityAdmin command rule
device(config-rule-31)# exit
device(config)# rule 32 action accept operation read-write role NetworkSecurityAdmin command username
device(config-rule-32)# exit
device(config)# rule 33 action accept operation read-write role    NetworkSecurityAdmin command aaa
device(config-rule-33)# exit
device(config)# rule 34 action accept operation read-write role    NetworkSecurityAdmin command
radius-server
device(config-rule-34)# exit
device(config)# rule 35 action accept operation read-write role    NetworkSecurityAdmin command
config
device(config-rule-35)# exit
```

The SecAdminUser account has been granted operational access to the configuration-level commands **role**, **rule**, **username**, **aaa**, and **radius-server**. Any account associated with the NetworkSecurityAdmin role can now create and modify user accounts, manage roles, and define rules. In addition, the role permits configuring a RADIUS server and set the login sequence.

Creating an FCoE administrator role and account

The following steps create and configure a typical FCoE administrator role.

1. Create an FCoE administrator role.

```
device(config)# role name FCOEAdmin desc "Manages FCOE"
```

2. Create an FCoE admin user account.

```
device(config)# username FCOEAdmUser role FCOEAdmin password testpassword
```

3. Create the rules defining the access permissions for the FCoE administrator role.

```
device(config)# rule 40 action accept operation read-write role FCOEAdmin    command interface fcoe
```

The FCOEAdmUser account that is associated with the FCoEAdmin role can now perform the FCoE operations.

Command-access rules

Command authorization is defined in terms of rules that you associate with a user-defined role.

Rules define and restrict a role to access modes (*read-only* or *read-write* access), and beyond that can define permit or reject on specified command groups or individual commands. You can associate multiple rules with a given user-defined role, but you can associate only one role with any given user account.

The following rule parameters are mandatory:

- **index**—a unique index number
- **role**—the unique role with which you are associating the rule
- **command**—the command to which the rule applies

The following rule parameters are optional:

- **operation**—specifies the type of operation permitted (**read-only** or **read-write**). The default is **read-write**.
- **action**—specifies whether the user is accepted or rejected while attempting to execute the specified command. The default value is **accept**.

The following example creates and assigns four rules to a role named "NetworkAdmin".

```
device(config)# rule 70 action accept operation read-write role NetworkAdmin command configure
device(config)# rule 71 action accept operation read-write role NetworkAdmin command copy running-config
device(config)# rule 72 action accept operation read-write role NetworkAdmin command interface management
device(config)# rule 73 action accept operation read-write role NetworkAdmin command clear logging
```

NOTE

Rules cannot be added for commands that are not at the top level of the command hierarchy. For a list of eligible commands, type **?** after the **command** keyword.

Rules for configuration commands

The following rules govern configuration commands:

- If a role has a rule with a **read-write** operation and the **accept** action for a configuration command, the user associated with this role can execute the command and read the configuration data.
- If a role has a rule with a **read-only** operation and the **accept** action for a configuration command, the user associated with this role can only read the configuration data of the command.
- If a role has a rule with a **read-only** or **read-write** operation and the **reject** action for a configuration command, the user associated with this role cannot execute the command and can read the configuration data of the command.

Rules for operational commands

Rules can be created for the specified operational commands. By default, every role can display all the operational commands but cannot execute them. The **show** commands can be accessed by all the roles.

The following rules govern operational commands:

- If a role has a rule with a **read-write** operation and the **accept** action for an operational command, the user associated with this role can execute the command.
- If a role has a rule with a **read-only** operation and the **accept** action for an operational command, the user associated with this role can access but cannot execute the command.
- If a role has a rule with a **read-only** or **read-write** operation and the **reject** action for an operational command, the user associated with this role can neither access nor execute the command.

Rules for interface commands

Rules can be created for a specific instance of the interface-related configuration commands.

By default, every role has the permission to read the configuration data related to all the instances of the interfaces using the **show running-config interface** command.

The following rules govern interface commands:

- If a role has a rule with a **read-write** operation and the **accept** action for only a particular instance of the interface, users associated with this role can only modify the attributes of that instance.
- If a role has a rule with a **read-only** operation and the **accept** action for only a particular instance of the interface, users associated with this role can only read (using the **show running-config** command) the data related to that instance of the interface.
- If a role has a rule with a **read-write** operation and the **reject** action for only a particular instance of the interface, users associated with this role cannot execute and read the configuration data for that interface instance.

In the following example, the rules are applicable only to a particular instance of the specified interface.

```
device(config)# rule 60 action accept operation read-write role NetworkAdmin command interface
tengigabitethernet 1/0/4
device(config)# rule 65 action accept operation read-write role NetworkAdmin command interface fcoe
1/0/4
device(config)# rule 68 role NetworkAdmin action reject command interface fortygigabitethernet 1/2/4
```

- If a role has a rule with a **read-only** or **read-write** operation and the **reject** action for an interface or an instance of the interface, users associated with this role cannot perform **clear** and **show** operations related to those interfaces or interface instances. To perform **clear** and **show** operations, the user's role must have at least **read-only** and the **accept** permission. By default, every role has the **read-only** and **accept** permission for all interface instances.

  In the following example, NetworkAdmin users cannot perform **clear** and **show** operations related to all **tengigabitethernet** instances.

  ```
  device(config)# rule 30 action accept operation read-write role NetworkAdmin command interface
  tengigabitethernet
  ```

- If a role has a rule with **read-only** or **read-write** operation, and the **reject** action for an interface **tengigabitethernet** and **fcoe** instances, users associated with this role cannot perform **clear** and **show** operations related to those instances. To perform **clear** and **show** operations related to **interface tengigabitethernet** and **fcoe** instances, the role should have at least **read-only** and **accept** permission. By default, every role has the **read-only** or **accept** permission for all interface instances.

  In the following example, users associated with the NetworkAdmin role cannot perform some of the **clear** and **show** operations related to all **tengigabitethernet** instances.

  ```
  device(config)# rule 30 role NetworkAdmin action reject command interface tengigabitethernet
  ```

- The **dot1x** option under the **interface** instance submode can only be configured if the role has the **read-write** and **accept** permissions for both the **dot1x** command and **interface te** instances.

  In the following example, users associated with the CfgAdmin role can access and execute the **dot1x** command in **tengigabitethernet** instances.

  ```
  device(config)# rule 16 action accept operation read-write role cfgadmin command interface
  tengigabitethernet
  device(config)# rule 17 action accept operation read-write role cfgadmin command dot1x
  ```

- To execute the **no vlan** and **no spanning-tree** commands under the submode of **interface tengigabitethernet** instances, a user must have **read-write** and **accept** permissions for both the **vlan** and the **protocol spanning-tree** commands. If a user has **read-write** and **accept** permissions for the **vlan** and **spanning-tree** commands and **read-write** and **accept** permissions for at least one interface instance, users can perform the **no vlan** and **no spanning-tree** operations on the other **interface** instances for which users have only default permissions (**read-only** and **accept**).

Configuring a placeholder rule

A rule created with the **no-operation** command does not enforce any authorization rules. Instead, you can use the **no-operation** instance as a placeholder for a valid command that is added later, as shown in the following example.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

   ```
   device# configure terminal
   ```

2. Enter the **rule** command with the specified parameters and the **no-operation** keyword as a placeholder.

   ```
   device(config)# rule 75 action reject operation read-write role NetworkAdmin command no-operation
   ```

3. Enter the **rule** command with the specified command to replace the placeholder.

```
device(config)# rule 75 role NetworkAdmin command firmware
```

Rule-processing order

When a user executes a command, rules are searched in ascending order by index for a match and the action of the first matching rule is applied. If none of the rules match, command execution is blocked. If there are conflicting permissions for a role in different indices, the rule with lowest index number is applied.

As an exception, when a match is found for a rule with the **read-only** operation and the **accept** action, the system seeks to determine whether there are any rules with the **read-write** operation and the **accept** action. If such rules are found, the rule with the **read-write** permission is applied.

In the following example, two rules with action accept are present and rule 11 is applied.

```
device(config)# rule 9 operation read-only action accept role NetworkAdmin command aaa
device(config)# rule 11 operation read-write action accept role NetworkAdmin command aaa
```

Adding a rule

You add a rule to a role by entering the **rule** command with appropriate options. Any updates to the authorization rules will not apply to the active sessions of the users. The changes are applied only when users log out from the current session and log in to a new session.

The following example creates the rules that authorize the security administrator role to create and manage user accounts.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
```

2. Create a rule specifying read-write access to the global configuration mode.

```
device(config)# rule 150 action accept operation read-write role SecAdminUser command config
```

3. Create a second rule specifying read-write access to the **username** command. Enter the **rule** command with the specified parameters.

```
device(config)# rule 155 action accept operation read-write role SecAdminUser command username
```

4. "SecAdminUser" users can create or modify user accounts.

```
device# configure terminal
Entering configuration mode terminal
Current configuration users:
admin console (cli from 127.0.0.1) on since 2010-08-16 18:35:05 terminal mode

device(config)# username testuser role user password (<string>): ********
```

Changing a rule

The following example changes the previously created rule (index number 155) so that the **username** command is replaced by the **role** command.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
```

2. Enter the **rule** command, specifying an existing rule (index 155) and the role; and changing the **command** attribute to the **role** command.

```
device(config)# rule 155 role SecAdminUser command role
```

After changing rule 155, "SecAdminUser" users can execute the **role** command, but not the **username** command.

Deleting a rule

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **no rule** command followed by the index number of the rule you wish to delete.

```
device(config)# no rule 155
```

After rule 155 is deleted, the SecAdminUser can no longer access the **role** command.

Advanced account management

These topics enable you to create non-default accounts and to configure advanced settings.

Creating a non-default account

The permissions for a non-default account are determined by the role assigned to it.

The required parameters for creating an account are **name**, **role**, and **password**. In this example, the optional **desc** parameter is also utilized.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **username** command, with the name, role, initial password, and optional parameters.

```
device(config)# username mlopez role NetworkAdmin password xL*84qt desc "Has access to all network
admin commands."
```

Creating an account with clock-restricted access

When defining or editing an account, you can specify permitted access hours.

By default, users can log in 24 hours a day. The **access-time** parameter enables you to limit access to defined hours, as per the system time defined for the operating system. For the current system time, enter **show clock**.

1. In privileged EXEC mode, enter the **configure terminal** command.

```
device# configure terminal
```

2. Enter the **username** command, with the **access-time** parameter.

```
device(config)# username aming role user password Tijd1spw access-time 0800 to 1800
```

Password policies

Password policies define and enforce a set of rules that make passwords more secure by subjecting all new passwords to global restrictions.

Password policies overview

You can configure password strength policy, password encryption policy, and account lockout policy.

The password policies described in this section apply to the device-local user database only.

Configured password policies (and all user account attributes and password state data) are synchronized across management modules and remain unchanged after an HA failover.

Password configuration is applied to all nodes in the fabric.

> NOTE
> For recovering the root password, refer to the *Extreme Network OS Troubleshooting Guide*.

Password strength policy

The following table lists configurable password policy parameters.

TABLE 1 Password policy parameters

Parameter	Description
character-restriction lower	Specifies the minimum number of lowercase alphabetic characters that must occur in the password. The maximum value must be less than or equal to the minimum length value. The default value is zero, which means there is no restriction of lowercase characters.
character-restriction upper	Specifies the minimum number of uppercase alphabetic characters that must occur in the password. The maximum value must be less than or equal to the Minimum Length value. The default value is zero, which means there is no restriction of uppercase characters.
character-restriction numeric	Specifies the minimum number of numeric characters that must occur in the password. The maximum value must be less than or equal to the Minimum Length value. The default value is zero, which means there is no restriction of numeric characters.
character-restriction special-char	Specifies the minimum number of punctuation characters that must occur in the password. All printable, non-alphanumeric punctuation characters except the colon (:) are allowed. The value must be less than or equal to the Minimum Length value. The default value is zero, which means there is no restriction of punctuation characters. Special characters, such as backslash (\) and question mark (?), are not counted as characters in a password unless the password is specified within quotes.
min-length	Specifies the minimum length of the password. Passwords must be from 8 through 32 characters in length. The default value is 8. The total of the previous four parameters (lowercase, uppercase, digits, and punctuation) must be less than or equal to the Minimum Length value.
max-retry	Specifies the number of failed password logins permitted before a user is locked out. The lockout threshold can range from 0 through 16. The default value is 0. When a password fails more than one of the strength attributes, an error is reported for only one of the attributes at a time.

NOTE
Passwords can have a maximum of 40 characters.

Password encryption policy

The software supports encrypting the passwords of all existing user accounts by enabling password encryption at the device level. By default, the encryption service is enabled.

The following rules apply to password encryption:

- When you enable password encryption, all existing clear-text passwords will be encrypted, and any passwords that are added subsequently in clear-text are stored in encrypted format.

  In the following example, the testuser account password is created in clear text after password encryption has been enabled. The global encryption policy overrides command-level encryption settings. The password is stored as encrypted.

```
device(config)# service password-encryption

device(config)# do show running-config service password-encryption
service password-encryption

device(config)# username testuser role testrole desc "Test User" encryption-level 0 password hellothere

device(config)# do show running-config username
username admin password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role admin desc Administrator
username testuser password "cONW1RQ0nTV9Az42/9uCQg==\n" encryption-level 7 role testrole desc "Test User"
username user password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role user desc User
```

- When you disable the password encryption service, any new passwords added in clear text will be stored as clear text on the device. Existing encrypted passwords remain encrypted.

  In the following example, the testuser account password is stored in clear text after password encryption has been disabled. The default accounts, "user" and admin" remain encrypted.

```
device(config)# no service password-encryption

device(config)# do show running-config service password-encryption
no service password-encryption

device(config)# username testuser role testrole desc "Test User" encryption-level 0 password hellothere enable
true

device(config)# do show running-config username
username admin password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role admin desc Administrator
username testuser password hellothere encryption-level 0 role testrole desc "Test User"
username user password "BwrsDbB+tABWGWpINOVKoQ==\n" encryptionlevel 7 role user desc User
```

Account lockout policy

The account lockout policy disables a user account when the user exceeds a configurable number of failed login attempts. A user whose account has been locked cannot log in. SSH login attempts that use locked user credentials are denied without the user being notified of the reason for denial.

The account remains locked until explicit administrative action is taken to unlock the account. A user account cannot be locked manually. An account that is not locked cannot be unlocked.

Failed login attempts are tracked on the local device only. In VCS mode, the user account is locked only on the device where the lockout occurred; the same user can still try to log in on another device in the fabric.

The account lockout policy is enforced across all user accounts except for the root account and accounts with the admin role.

Denial of service implications

The account lockout mechanism may be used to create a denial of service (DOS) condition when a user repeatedly attempts to log in to an account by using an incorrect password. Selected privileged accounts, such as root and admin, are exempted from the account lockout policy to prevent these accounts from being locked out by a DOS attack. However these privileged accounts may then become the target of password-guessing attacks.

ATTENTION
Extreme advises that you periodically examine the Security Audit logs to determine if such attacks are attempted. Refer to Security-event logs on page 28.

Configuring password policies

Use the **password-attributes** command with specified parameters to define or modify existing password policies.

Configuring the account lockout threshold

You can configure the lockout threshold with the **password-attributes max-retry** *maxretry* command. The value of the *maxretry* specifies the number of times a user can attempt to log in with an incorrect password before the account is locked. The number of failed login attempts is counted from the last successful login. The *maxretry* can be set to a value from 0 through 16. A value of 0 disables the lockout mechanism (default).

The following example sets the lockout threshold to 5.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter the **password-attributes** command with the specified parameter.

```
device# configure terminal
Entering configuration mode terminal
device(config)# password-attributes max-retry 4
```

When a user account is locked, it can be unlocked using the procedure described in Unlocking an account on page 17.

Creating a password policy

The following example defines a password policy that places restrictions on minimum length and enforces character restrictions and account lockout.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.
2. Enter the **password-attributes** command with the specified parameters.

```
device# configure terminal
Entering configuration mode terminal
device(config)# password-attributes min-length 8 max-retry 4 character-restriction lower 2 upper 1
numeric 1 special-char 1  max-lockout-duration 5000
```

Restoring the default password policy

Entering the **no** form of the **password-attributes** command resets all password attributes to their default values. If you specify a specific attribute, only that attribute is reset to the default. If you enter **no password-attributes** without operands, all password attributes are reset to their default values.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

2. Enter the **password-attributes** command with the specified parameters.

```
device# configure terminal
Entering configuration mode terminal
device(config)# no password-attributes min-length
device(config)# password-attributes max-retry 4
device(config)# no password-attributes numeric
```

Displaying password attributes

To display configured password attributes, change to privileged EXEC mode and enter **show running-config password-attributes**. Refer to the password-attributes command in the command reference for details on modifying password attributes.

```
device# show running-config password-attributes
password-attributes max-retry 4
password-attributes character-restriction upper 1
password-attributes character-restriction lower 2
password-attributes character-restriction numeric 1
password-attributes character-restriction special-char 1
password-attributes max-lockout-duration 5000
```

Password interaction with remote AAA servers

The password policies apply to local device authentication only. External AAA servers such as RADIUS, TACACS+, or LDAP provide server-specific password-enforcement mechanisms. The password management commands operate on the device-local password database only, even when the device is configured to use an external AAA service for authentication. When so configured, authentication through remote servers is applied to the login only.

When remote AAA server authentication is enabled, an administrator can still perform user and password management functions on the local password database.

Security-event logs

Security event logging utilizes the RASLog audit infrastructure to record security-related audit events.

Any user-initiated security event generates an auditable event. Audited events are generated for all Management interfaces.

In Extreme VCS Fabric mode, for fabric-wide events, the audit is generated on all devices of the fabric. Refer to the *Extreme Network OS Message Reference* for information on how to configure, monitor, and analyze security audit logging.

User accounts and passwords show commands

There are **show** commands that display user account and password information, listed here with descriptions.

TABLE 2 User account and password show commands in the *Command Reference*

Command	Description
show running-config password-attributes	Displays global password attributes.
show running-config role	Displays name and description of the configured roles.
show running-config rule	Displays configured access rules.
show running-config username	Displays the user accounts on the device.
show users	Displays the users logged in to the system and locked user accounts.

Configuring Remote Server Authentication

Remote server authentication overview

The software supports various protocols to provide external Authentication, Authorization, and Accounting (AAA) services for devices. Supported protocols include the following:

- RADIUS — Remote authentication dial-in user service
- LDAP/AD — Lightweight Directory Access Protocol using Microsoft Active Directory (AD) in Windows
- TACACS+ — Terminal access controller access-control system plus

When configured to use a remote AAA service, the device acts as a network access server client. The device sends all authentication, authorization, and accounting (AAA) service requests to the remote RADIUS, LDAP, or TACACS+ server. The remote AAA server receives the request, validates the request, and sends a response back to the device.

The supported management access channels that integrate with RADIUS, TACACS+, or LDAP include serial port, Telnet, or SSH.

When configured to use a remote RADIUS, TACACS+, or LDAP server for authentication, a device becomes a RADIUS, TACACS+, or LDAP client. In either of these configurations, authentication records are stored in the remote host server database. Login and logout account name, assigned permissions, and time-accounting records are also stored on the AAA server for each user.

Extreme recommends that you configure at least two remote AAA servers to provide redundancy in the event of failure. For each of the supported AAA protocols, you can configure up to five external servers on the device. Each device maintains its own server configuration.

Login authentication mode

The authentication mode is defined as the order in which AAA services are used on the device for user authentication during the login process. The software supports two sources of authentication: primary and secondary. The secondary source of authentication is used in the event of primary source failover and is optional for configuration. You can configure four possible sources for authentication:

- Local — Use the default device-local database (default)
- RADIUS — Use an external RADIUS server
- LDAP — Use an external LDAP server
- TACACS+ — Use an external TACACS+ server

By default, external AAA services are disabled, and AAA services default to the device-local user database. Any environment requiring more than 64 users should adopt AAA servers for user management.

When the authentication, authorization, and accounting (AAA) mode is changed, an appropriate message is broadcast to all logged-in users, and the active login sessions end. If the primary source is set to an external AAA service (RADIUS, LDAP, or TACACS+) and the secondary source is not configured, the following events occur:

- For Telnet-based and SSH connections-based logins, the login authentication fails if none of the configured (primary source) AAA servers respond or if an AAA server rejects the login.
- For a serial port (console) connection-based login, if a user's login fails for any reason with the primary source, failover occurs and the same user credentials are used for login through the local source. This failover is not explicit.

- If the primary source is set to an external AAA service, and the secondary source is configured to be local (for example, by means of the **aaa authentication login radius local** command), then, if login fails through the primary source either because none of the configured servers is responding or the login is rejected by a server, failover occurs and authentication occurs again through the secondary source (local) for releases earlier than Network OS 4.0.

In Network OS 4.0 and later, when **local** is specified as the secondary authentication service, failover to local does not occur if login is rejected by a server. In addition, when the authentication service is changed, the user sessions are not logged out. If a user wants to log out all connected user sessions, the **clear sessions** command should be used.

- In Network OS 4.0 and later, when **local** is specified as the secondary authentication service, local authentication is tried only when the primary AAA authentication service (TACACS+, RADIUS, or LDAP) is either unreachable or not available. Local authentication will not be attempted if authentication with the primary service fails.
- In Network OS 4.0 and later, you can specify to use the local device database if prior authentication methods on a RADIUS or TACACS+ server are not active or if authentication fails. To specify this option, use the **local-auth-failback** command. In the following example, the local device database will be used if the RADIUS server is unavailable.

```
device(config)# aaa authentication login radius local-auth-fallback
```

Conditions for conformance

Consider the following conditions for remote server authentication:

- If the first source is specified as **default**, do not specify a second source. A second source signals a request to set the login authentication mode to its default value, which is **local**. If the first source is **local**, the second source cannot be set to any value, because the failover will never occur.
- The source of authentication (except **local**) and the corresponding server type configuration are dependent on each other. Therefore, at least one server should be configured before that server type can be specified as a source.
- If the source is configured to be a server type, you cannot delete a server of that type if it is the only server in the list. For example, if there are no entries in the TACACS+ server list, the authentication mode cannot be set to **tacacs+** or **tacacs+ local**. Similarly, when the authentication mode is **radius** or **radius local**, a RADIUS server cannot be deleted if it is the only one in the list.

Configuring remote server authentication

This section introduces the basics of configuring remote server authentication using RADIUS and TACACS+ in a simple manner.

For detailed configuration information on remote server authentication, refer to the following topics:

- RADIUS security on page 41
- Understanding and configuring TACACS+ on page 57
- Understanding and configuring LDAP on page 33

Setting and verifying the login authentication mode

The following procedure configures TACACS+ as the primary source of authentication and the device-local user database as the secondary source. For complete information on login authentication mode, refer to the **aaa authentication login** command in the *Network OS Command Reference*.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **aaa authentication login** command with the specified parameters.

```
device(config)# aaa authentication login tacacs+ local

Broadcast message from root (pts/0) Tue Apr 5 16:34:12 2016...
AAA Server Configuration Change: all accounts will be logged out
```

3. Enter the **do show running-config aaa** command to display the configuration.

```
device(config)# do show running-config aaa
aaa authentication login tacacs+ local
```

4. Log in to the device using an account with TACACS+-only credentials to verify that TACACS+ is being used to authenticate the user.

Resetting the login authentication mode

The following procedure resets the login configuration mode to the default value using the **no aaa authentication login** command.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **no aaa authentication login** command to remove the configured authentication sequence and to restore the default value (Local only).

```
device(config)# no aaa authentication login
```

3. Verify the configuration with the **do show running-config aaa** command.

```
device(config)# do show running-config aaa
aaa authentication login local
```

4. Log in to the device using an account with TACACS+-only credentials. The login should fail with an "access denied" error.
5. Log in to the device using an account with local-only credentials. The login should succeed.

Changing the login authentication mode

You can set the authentication mode with the **aaa authentication login** command.

You can reset the configuration to the default value using the **no aaa authentication login** command.

NOTE

In a configuration with primary and secondary sources of authentication, the primary mode cannot be modified alone. First remove the existing configuration and then configure it to the required configuration.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **aaa authentication login** command and specify the desired authentication mode.

```
device(config)# aaa authentication login radius local
Broadcast message from root (pts/0) Tue Apr 5 16:34:12 2016...
AAA Server Configuration Change: all accounts will be logged out
```

3. Verify the configuration with the **do show running-config aaa** command.

```
device(config)# do show running-config aaa
aaa authentication login radius local
```

4. Log in to the device using an account with TACACS+ credentials. The login should fail with an "access denied" error.
5. Log in to the device using an account with RADIUS credentials. The login should succeed.

Lightweight Directory Access Protocol

Understanding and configuring LDAP

Lightweight Directory Access Protocol (LDAP) is an open-source protocol for accessing distributed directory services that act in accordance with X.500 data and service models. LDAP assumes that one or more servers jointly provide access to a Directory Information Tree (DIT) where data is stored and organized as entries in a hierarchical fashion. Each entry has a name called the distinguished name that uniquely identifies it.

LDAP can also be used for centralized authentication through directory service.

Active Directory (AD) is a directory service that supports a number of standardized protocols such as LDAP, Kerberos authentication, and Domain Name Server (DNS), to provide various network services. AD uses a structured data store as the basis for a logical, hierarchical organization of directory information. AD includes user profiles and groups as part of directory information, so it can be used as a centralized database for authenticating third-party resources.

If you are in logical chassis fabric mode, the configuration is applied to all nodes in the fabric.

User authentication

A device can be configured as an LDAP client for authentication with an Active Directory (AD) server, supporting authentication with a clear text password over the Transport Layer Security (TLS) channel. Optionally, the device supports server authentication during the TLS handshake. Only the user principal name from the AD server is supported for LDAP authentication on the device. The common name (CN) based authentication is not supported. When you log in from the device, the complete user principal name, including domain, should be entered (for example, "testuser@sec.example.com").

LDAP supports alternative user principal names, such as:

- username
- username@AD.com
- username@ADsuffix.com
- username@newUPN.com

Network OS supports LDAP authentication with the following AD servers:

- Windows 2000
- Windows 2003
- Windows 2008 AD

A device configured to perform LDAP-based authentication supports access through a serial port, Telnet, and SSH. These access channels require that you know the device IP address or name to connect to the device.

A maximum of five AD servers can be configured on a device.

If you are in logical chassis mode, all LDAP server and map role configurations (except "show certutil" and "certutil") are applied to all devices in the fabric.

Server authentication

As a part of user authentication using LDAP, the device can be configured to support server certificate authentication. To enable server authentication (server certificate verification), follow these guidelines:

- While configuring the LDAP server, the Fully Qualified Domain Name (FQDN) of the AD server must be added as the host parameter, instead of the IP address. An FQDN is needed to validate the server identity as mentioned in the common name of the server certificate.
- The DNS server must be configured on the device prior to adding AD server with a domain name or a hostname. Without a DNS server, the name resolution of the server fails, and then the add operation fails. Use the **ip dns** command to configure DNS.
- The CA certificate of the AD server's certificate must be installed on the device. Currently, only PEM-formatted CA certificates can be imported into the device.

If more than one server is configured and an LDAP CA certificate is imported for one server on the device, the device performs the server certificate verification on all servers. Thus, either CA certificates for all servers must be imported, or CA certificates must not be imported for any of the servers. After the CA certificate is imported, it is retained even if the device is set back to its default configuration. If the CA certificate is not required, you must explicitly delete it.

Server authorization

The Active Directory (AD) server is used only for authentication. Command authorization of the AD users is not supported in the AD server. Instead, the access control of AD users is enforced locally by role-based access control (RBAC) on the device.

A user on an AD server must be assigned a nonprimary group, and that group name must be either matched or mapped to one of the existing roles on the device; otherwise, authentication will fail. After successful authentication, the device receives the nonprimary group of the user from the AD server and finds the corresponding user role for the group based on the matched or mapped roles.

If the device fails to get the group from the AD server, or the LDAP user is not a member of any matching AD group, the user authentication fails. Groups that match with the existing device roles have higher priority than the groups that are mapped with the device roles. Thereafter, the role obtained from the AD server (or default role) is used for RBAC.

If multiple nonprimary groups are associated to the AD user, only one of the groups must be mapped or matched to the device role. If multiple AD groups of AD users are mapped or matched to the device roles, authentication of the user is successful, but there is no guarantee as to which role the AD user gets among those multiple roles. After successful authentication, the device gets the nonprimary group of the user from the AD server and finds the corresponding user role for the group based on the matched or mapped roles. Thereafter, the role obtained from the AD server (or default role) will be used for RBAC.

A maximum of 16 AD groups can be mapped to the device roles.

FIPS compliance

To support FIPS compliance, the CA certificate of the AD server's certificate must be installed on the device, and the FIPS-compliant TLS ciphers for LDAP must be used.

Configuring LDAP

Configuring support for LDAP requires configuring both the client and the server. This following major tasks are sorted by client-side and server-side activities:

Client-side tasks:

- Configuring an Active Directory server on the client side on page 36
- Configuring Active Directory groups on the client side on page 37

Server-side tasks:

- Creating a user account on an LDAP/AD server on page 38
- Verifying the user account on a device on page 39
- Configuring LDAP users on a Windows AD server on page 39

Importing an LDAP CA certificate

The following example imports the LDAP CA certificate from a remote server to a device using secure copy (SCP).

1. In privileged EXEC mode, enter **configure terminal** to change to global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter **certutil import ldapca** with the specified parameters.

```
device# certutil import ldapca directory /usr/ldapcacert file cacert.pem protocol SCP host
10.23.24.56 user admin password *****
```

3. Verify the import by entering **show cert-util ldapcacert**.

```
device# show cert-util ldapcacert
List of ldap ca certificate files:
swLdapca.pem
```

Deleting LDAP CA certificates

The **no certutil ldapca** command deletes the LDAP CA certificates of all Active Directory servers. You must confirm that you want to delete the certificates.

```
device# no certutil ldapca
Do you want to delete LDAP CA certificate? [y/n]:y
```

Viewing the LDAP CA certificate

The following procedure allows you to view the LDAP CA certificate that has been imported on the device.

1. Connect to the device and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **show cert-util ldapcert** command.

```
device# show cert-util ldapcacert
```

Logical chassis fabric mode

To view the output in logical chassis fabric mode, enter the **show cert-util ldapcacert** command, followed by the desired RBridge ID. This example displays the certificate for RBridge ID 3.

```
device# show cert-util ldapcacert rbridge-id 3
```

Configuring an Active Directory server on the client side

Each device client must be individually configured to use Active Directory servers. You can configure a maximum of five Active Directory servers on a device for AAA service.

You use the **ldap-server** command to specify the host server, authentication protocols, and other parameters.

The parameters in the following table are associated with an Active Directory server that is configured on the device.

TABLE 3 Active Directory parameters

Parameter	Description
host	IPv4 or Fully Qualified Domain Name of the AD server. IPv6 is supported for Windows 2008 AD server only. The maximum supported length for the host name is 40 characters.
port	TCP port used to connect the AD server for authentication. The valid port range is 1024 through 65535. The default port is 389.
timeout	Time to wait for a server to respond. The range is 1 through 60 seconds. The default value is 5 seconds.
retries	Number of unsuccessful attempts to be made to connect to an AD server before quitting. The valid range is 1 through 100. The default value is 5.
domain	Base domain name.
use-vrf	Specifies a VRF though which to communicate with the Active Directory server.

Adding an LDAP server to the client server list

The following procedure configures an LDAP server on an LDAP client device.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

   ```
   device# configure terminal
   Entering configuration mode terminal
   ```

2. Use the **ldap-server-host** command to set the parameters for the LDAP server.

   This command places you into the LDAP server configuration submode where you can modify the server default settings.

   ```
   device(config)# ldap-server host 10.24.65.6
   device(config-ldap-server-10.24.65.6)#
   ```

3. Modify any settings, such as the domain name or retry limit, in this configuration mode (refer to the table in Configuring an Active Directory server on the client side on page 36).

   ```
   device(config-ldap-server 10.24.65.6)# basedn security.brocade.com
   device(config-ldap-server 10.24.65.6)# timeout 8
   device(config-host-10.24.65.6)# retries 3
   ```

4. Confirm the LDAP settings with the **do show running-config ldap-server** command.

   Attributes holding default values are not displayed.

```
device(config-ldap-server-10.24.65.6)# do show running-config ldap-server host 10.24.65.6
ldap-server host 10.24.65.6
port 3890
basedn security.brocade.com
retries 3
timeout 8
!
```

5. Use the **exit** command to return to global configuration mode.

```
device(config-ldap-server-10.24.65.6)# exit
```

Changing LDAP server parameters

Changing the LDAP server parameters follows the same procedure as that noted for adding an LDAP server to the client server list. Enter the host IP address or host name, and then enter the new values as required.

Refer to Adding an LDAP server to the client server list on page 36.

```
device# configure terminal
Entering configuration mode terminal
device(config)# ldap-server host 10.24.65.6
device(config-host-10.24.65.6/mgmt-vrf)# basedn security.brocade.com
```

Removing an LDAP server

The following procedure deletes an LDAP server entry from the device LDAP server list.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode

```
device# configure terminal
Entering configuration mode terminal
```

2. Use the **no ldap-server** command to delete the LDAP server.

```
device(config)# no ldap-server host 10.24.65.6
```

Configuring Active Directory groups on the client side

An Active Directory (AD) group defines access permissions for the LDAP server similar to Extreme roles. You can map an Active Directory group to an Extreme role with the **ldap-server maprole** command. The command confers all access privileges defined by the Active Directory group to the Extreme role to which it is mapped.

A user on an AD server must be assigned a nonprimary group, and that group name must be either matched or mapped to one of the existing roles on the device.

After successful authentication, the user is assigned a role from a nonprimary group (defined on the AD server) based on the matched or mapped device role.

A user logging in to the device that is configured to use LDAP and has a valid LDAP user name and password will be assigned LDAP user privileges if the user is not assigned a role from any nonprimary group.

Mapping an Active Directory group to a device role

In the following example, a user with the admin role inherits all privileges associated with the Active Directory (AD) Administrator group.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Use the **ldap-server maprole** command to set the group information.

   A maximum of 16 AD groups can be mapped to the device roles.

```
device(config)# ldap-server maprole group Administrator role admin
```

Removing the mapping of an Active Directory to a device role

The following example removes the mapping between the Extreme admin role and the Active Directory (AD) Administrator group. A user with the admin role can no longer perform the operations associated with the AD Administrator group.

To unmap an AD group to a device role, perform the following steps.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Use the **no ldap-server maprole** command to set the group information.

```
device(config)# no ldap-server maprole group Administrator
```

Configuring the client to use LDAP/AD for login authentication

After you configure the device LDAP server list, you must set the authentication mode so that LDAP is used as the primary source of authentication.

Refer to Login authentication mode on page 29 for information on how to configure the login authentication mode.

Configuring an Active Directory server on the server side

The following high-level overview of server-side configuration for LDAP/AD servers indicates the steps needed to set up a user account. This overview is provided for your convenience only. All instructions involving Microsoft Active Directory can be obtained from www.microsoft.com or from your Microsoft documentation. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

Creating a user account on an LDAP/AD server

The following procedure configures a user account on an LDAP/AD server.

1. Create a user on the Microsoft Active Directory server.
2. Create a group. The group should match with the user's Extremedevice role.

3. Optional: You can map the role to the Extreme device role with the **ldap-server maprole** command.
4. Associate the user with the group by adding the user to the group.
   The user account configuration is complete.

Verifying the user account on a device

The following procedure verifies a user account on a device.

1. Log in to the device as a user with admin privileges.
2. Verify that the LDAP/AD server has an entry in the device LDAP server list.

```
device# show running-config ldap-server
```

3. In global configuration mode, set the login authentication mode on the device to use LDAP only and verify the change.

```
device# configure terminal
Entering configuration mode terminal
device(config)# no aaa authentication login
device(config)# aaa authentication login ldap
device(config)# do
 show running-config aaa
aaa authentication login ldap
```

4. Log in to the device using an account with valid LDAP/AD only credentials to verify that LDAP/AD is being used to authenticate the user.
5. Log in to the device using an account with device-local only credentials. The login should fail with an access denied message.

Configuring LDAP users on a Windows AD server

The following procedure configures a user account on a Windows AD server.

1. Create a user in Windows.
   a) Open **Programs** > **Administrative Tools** > **Active directory Users and Computers**.
   b) Add a user by completing the **Active directory Users and Computers** dialog box.
   c) Save the account information.
   d) From a command prompt, log in using the new user name and enter a password when prompted.
2. Create a group in Windows.
   a) Go to **Programs** > **Administrative Tools** > **Active directory Users and Computers**.
   b) Add a new group.
   c) Save the group information.
3. Assign the group to the user.
   a) Click on the user name.
   b) From the **Properties** dialog box, click the **Member Of** tab and update the field with the group name. This group should either match the device role or it must be mapped with the device role on the device. In this instance, Domain Users is the primary group and therefore should not be mapped with the device role.

RADIUS Server Authentication

RADIUS security

The remote authentication dial-in user service (RADIUS) protocol manages authentication, authorization, and accounting (AAA) services centrally.

You can use a Remote Authentication Dial In User Service (RADIUS) server to secure the following types of access to the Layer-2 device or Layer-3 device:

- Telnet access
- SSH access
- Web management access
- Access to the Privileged EXEC level and CONFIG levels of the CLI, using roles pre-defined on the device and sent as attribute in Radius Response.

If you are in logical chassis mode, the configuration is applied to all nodes in the fabric.

RADIUS Authentication

When RADIUS authentication is implemented, the device consults a RADIUS server to verify user names and passwords.

During the user authentication process, the device sends its IP address. When the device also has a Virtual IP address (in Extreme VCS Fabric mode), it still sends only the unique IP address of the node that you are logging in to, to the RADIUS server.

RADIUS Authorization

User authorization through the RADIUS protocol is not supported. The access control of RADIUS users is enforced by the Extreme role-based access control (RBAC) protocol at the device level. A RADIUS user should therefore be assigned a role that is present on the device using the Vendor Specific Attribute (VSA) *Brocade-Auth-Role*. After the successful authentication of the RADIUS user, the role of the user configured on the server is obtained. If the role cannot be obtained or if the obtained role is not present on the device, the user will be assigned the "user" role and a session is granted to the user with "user" authorization.

Account password changes

All existing mechanisms for managing device-local user accounts and passwords remain functional when the device is configured to use RADIUS. Changes made to the device-local database do not propagate to the RADIUS server, nor do the changes affect any account on the RADIUS server; therefore, changes to a RADIUS user password must be done on the RADIUS server.

RADIUS authentication through management interfaces

You can access the device through Telnet or SSH from either the Management interface or the data ports (Ethernet interface or in-band). The device goes through the same RADIUS-based authentication with either access method.

Configuring server-side RADIUS support

With RADIUS servers, you should set up user accounts by their true network-wide identity, rather than by the account names created on a device. Along with each account name, you must assign appropriate device access roles. A user account can exist on a RADIUS server with the same name as a user on the device at the same time.

When logging in to a device configured with RADIUS, users enter their assigned RADIUS account names and passwords when prompted. Once the RADIUS server authenticates a user, it responds with the assigned device role and information associated with the user account information using an Extreme Vendor-Specific Attribute (VSA). An Authentication-Accept response without the role assignment automatically grants the "user" role.

NOTE
RADIUS Server must be configured to support Vendor-Specific-Attribute (VSA) in addition to configuring RADIUS Server support on the device.

Configuring a RADIUS server with Linux

FreeRADIUS is an open source RADIUS server that runs on all versions of Linux (FreeBSD, NetBSD, and Solaris).

Perform the following steps to configure a RADIUS server with Linux.

1. Download the package from www.freeradius.org and follow the installation instructions at the FreeRADIUS website.
2. Refer to the RADIUS product documentation for information on configuring and starting up a RADIUS server.
3. Determine where vendor-specific dictionaries are located on the server.

```
user@Linux:$ locate dictionary.*

/usr/share/freeradius/dictionary.3com
/usr/share/freeradius/dictionary.3gpp
/usr/share/freeradius/dictionary.3gpp2
/usr/share/freeradius/dictionary.acc
/usr/share/freeradius/dictionary.acme
```

4. Change to the vendor-specific dictionaries directory.

```
user@Linux:$ cd /usr/share/freeradius/
user@Linux:/usr/share/freeradius$
```

5. Verify that the `dictionary.brocade` file exists in this directory.

```
user@Linux:/usr/share/freeradius$ ls dictionary.brocade

dictionary. brocade
```

When the `dictionary.brocade` file does not exist, proceed to Step 7.

6. Check that the contents of the `dictionary.brocade` file are correct. The following example shows the correct information.

```
user@Linux:/usr/share/freeradius$ more dictionary.brocade

# -*- text -*-
# Copyright (C) 2013 The FreeRADIUS Server project and contributors
#
VENDOR          Brocade                         1588
BEGIN-VENDOR    Brocade

ATTRIBUTE       Brocade-Auth-Role                       1       string

END-VENDOR      Brocade
```

When the `dictionary.brocade` file exists and holds the correct information, proceed to Step 10.

7. When the `dictionary.brocade` file does not exist or holds incorrect information, you need to create a `dictionary.brocade` file with the correct information.
   a) Log in as the root user.
   b) In the vendor-specific dictionaries directory, create a file named `dictionary.brocade` with the below content.

```
# -*- text -*-
# Copyright (C) 2013 The FreeRADIUS Server project and contributors
#
VENDOR          Brocade                         1588
BEGIN-VENDOR    Brocade

ATTRIBUTE       Brocade-Auth-Role                       1       string

END-VENDOR      Brocade
```

8. To import the `dictionary.brocade` file, add the following line to the dictionary file.

```
$INCLUDE dictionary.brocade
```

9. To ensure that the dictionary is loaded, restart the FreeRADIUS server.

```
user@Linux:/usr/share/freeradius$ sudo service freeradius restart
```

10. Configure an Extreme user account.
    a) Open the `/etc/raddb/users` file in a text editor (the location of the FreeRADIUS users configuration file depends on the Linux distribution).
    b) Add the user name and associated the permissions. You must log in as rootadmin using admin permissions specified with Brocade-Auth-Role. The following example shows how to configure the rootadmin user account with a password "passadmin", a Service-Type of Framed-User, and admin permissions.

```
rootadmin Cleartext-Password := "passadmin"
          Service-Type = Framed-User,
          Brocade-Auth-Role = "admin"
```

NOTE
You must use double quotation marks around the password and role.

11. To ensure that the changes take effect, restart the FreeRADIUS server.

```
user@Linux:/usr/share/freeradius$ sudo service freeradius restart
```

NOTE
When you use network information service (NIS) for authentication, the only way to enable authentication with the password file is to force the device to authenticate using password authentication protocol (PAP); this requires the setting the **pap** option with the **radius-server host** command.

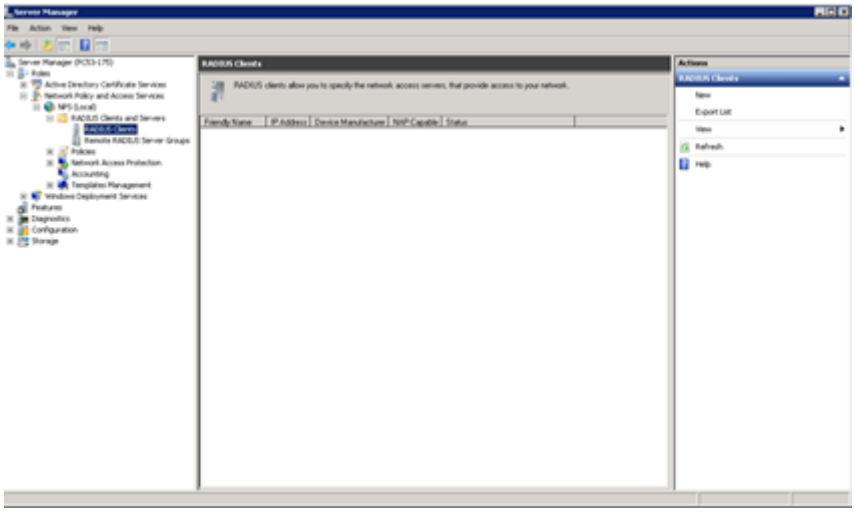
Configuring a Windows NPS-based RADIUS server

Step-by-step instructions for installing and configuring Network Policy Server (NPS) with Microsoft Windows server 2008 (or later; for example Windows 2012) can be obtained from www.microsoft.com or your Microsoft documentation. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

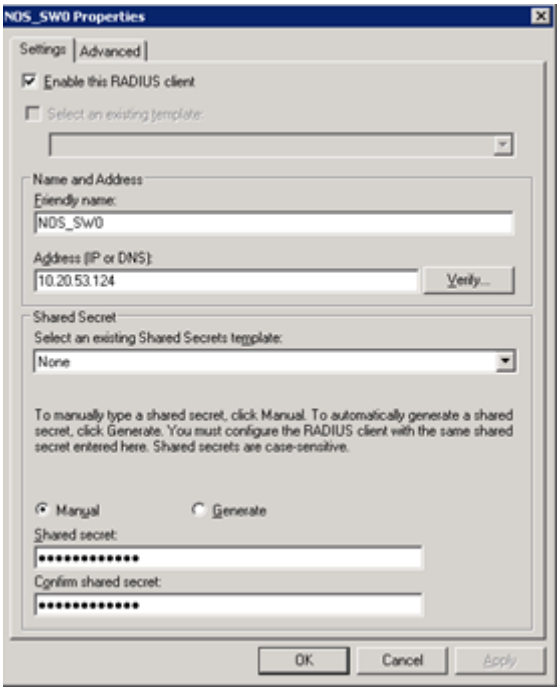
Use the following information to configure the Network Policy Server for a device.

NOTE
This is not a complete presentation of steps.

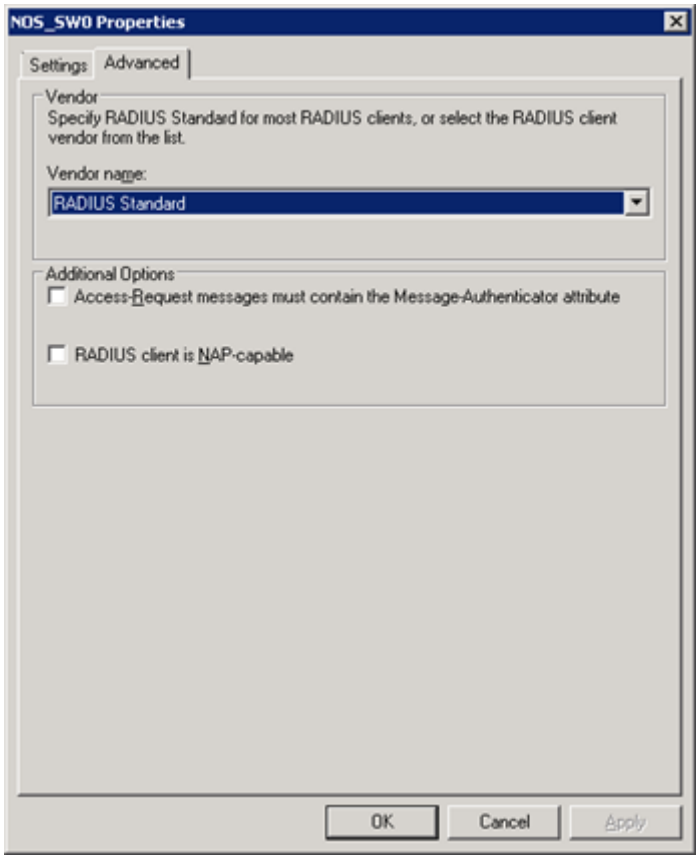
1. Configure a new RADIUS client.
   a) Open **Server Manager**, expand **Roles**, expand **Network Policy and Access Services**, expand **NPS**, expand **RADIUS Clients and Servers** and click on **RADIUS Clients**. Then, on the **Actions** panel, click **New**.



   b) On the **Settings** tab, select **Enable this RADIUS client** and configure the **Friendly name**, **Address (IP or DNS)**, and **Shared Secret** for the RADIUS client.



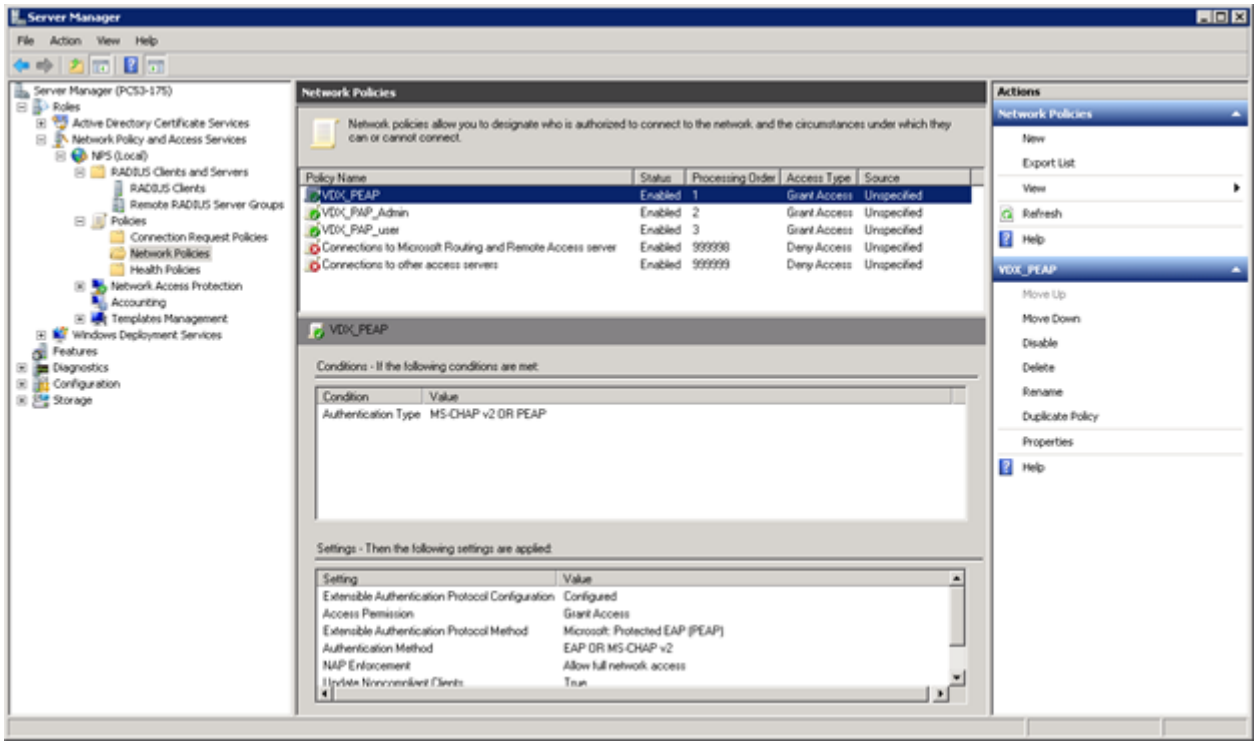
   c) On the **Advanced** tab, check that the **Vendor name** is set to RADIUS Standard. Leave **Additional Options** blank (unless you have configured your network polices to support these). Then, click **OK**.


NOS_SW0 Properties
Settings
Advanced
Vendor
Specify RADIUS Standard for most RADIUS clients, or select the RADIUS client vendor from the list.
Vendor name:
RADIUS Standard
Additional Options
Access-Request messages must contain the Message-Authenticator attribute
RADIUS client is NAP-capable
OK
Cancel
Apply

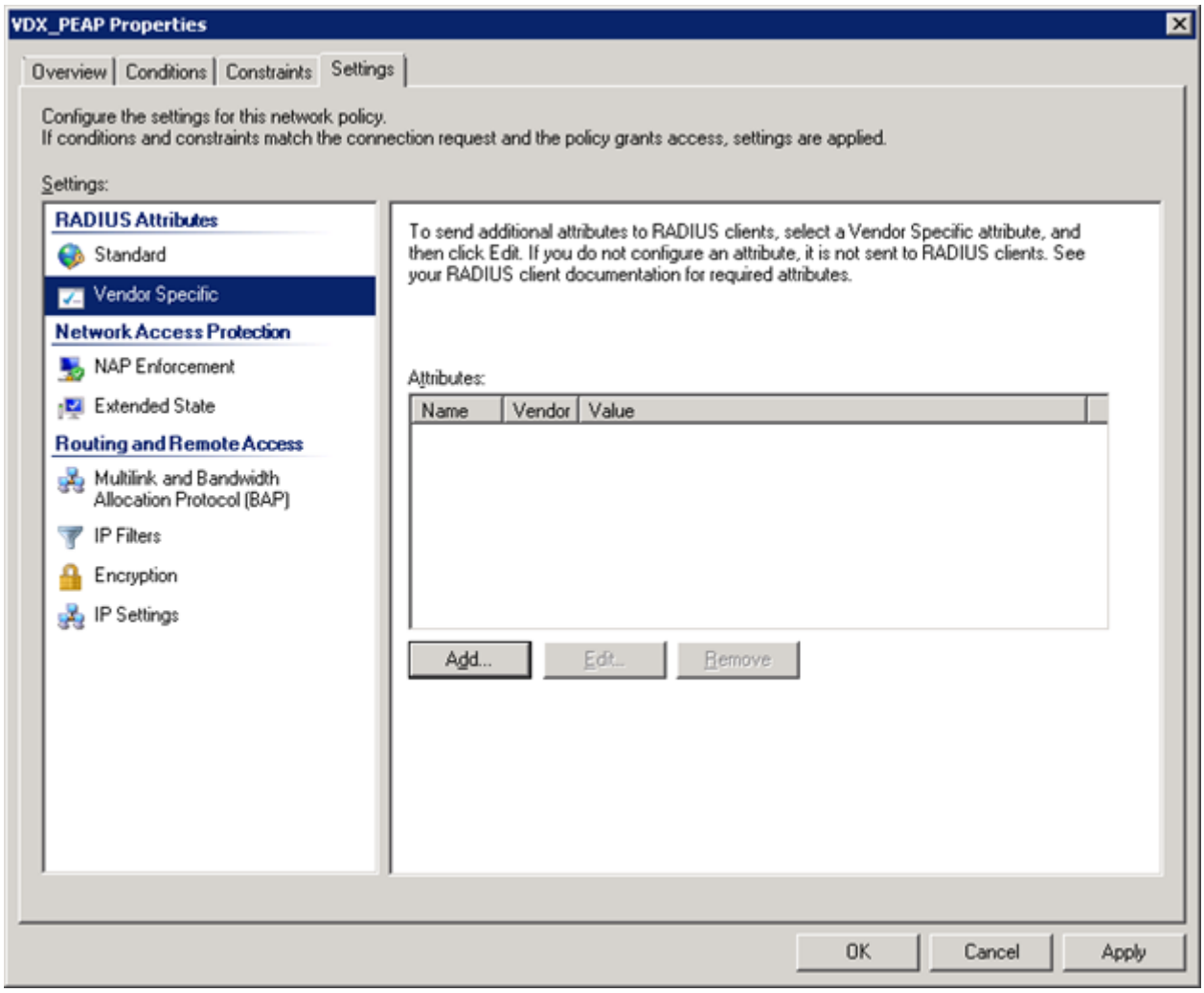
2. Configure Vendor Specific Attributes (VSA) in Network Policies.

   The following steps describe how to add the VSA for a NOS device to your network policy; for further information about creating network policies, refer to www.microsoft.com or your Microsoft documentation.

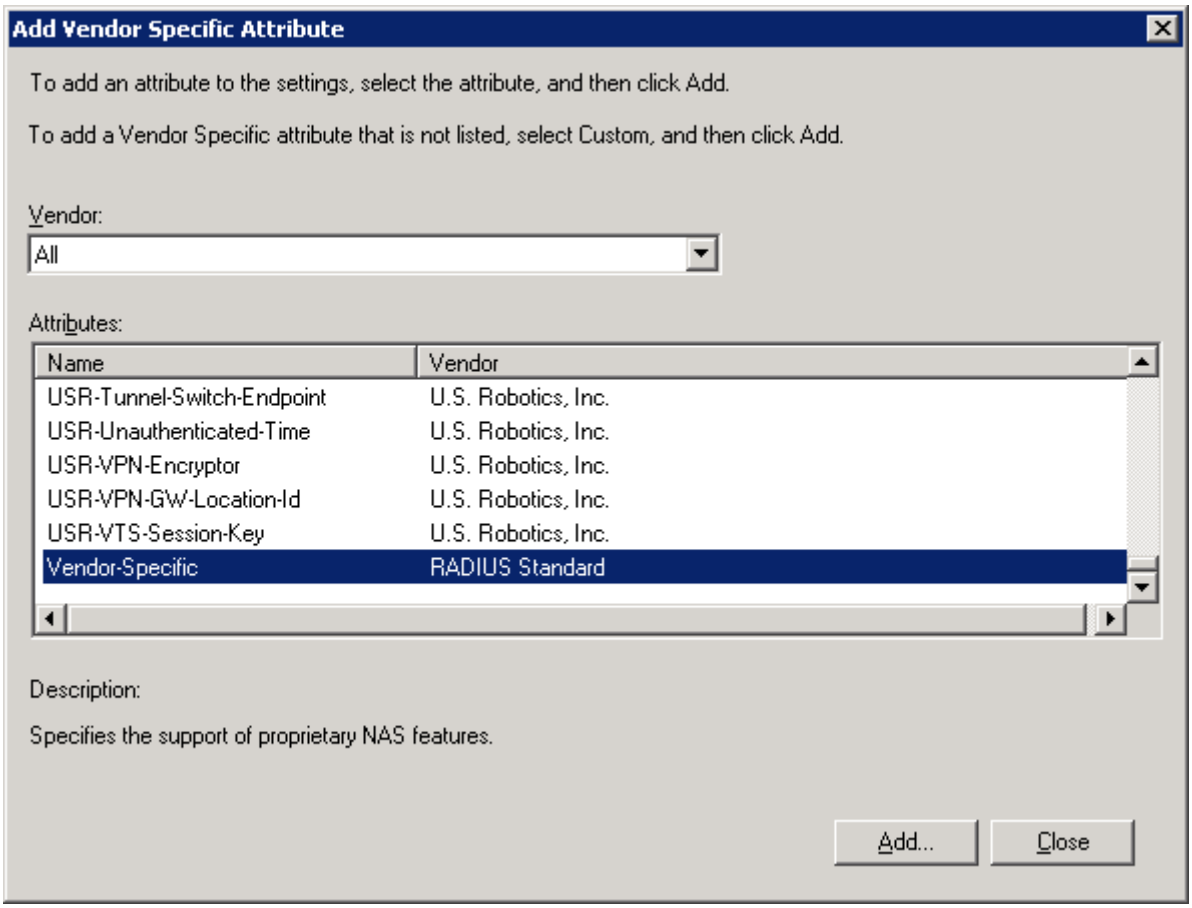
   a) In **Server Manager**, expand **Roles**, **Network Policy and Access Services**, **NPS**, and **Policies**. Then click on **Network Policies** and select the authorization policy that you created. On the **Actions** panel, click **Properties**.



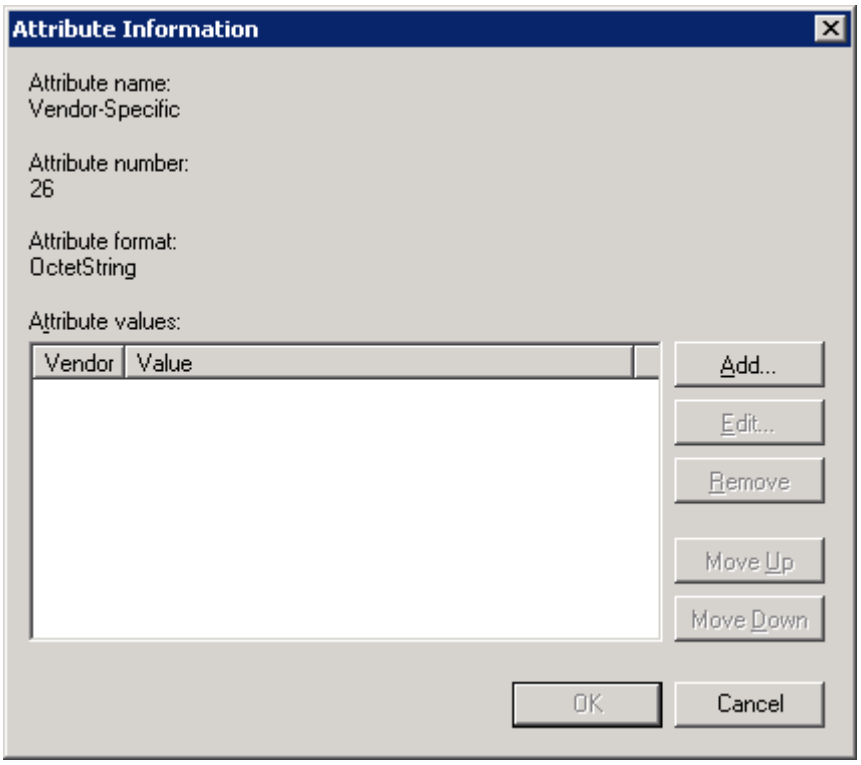
   b) On the **Settings** tab, select **Vendor Specific** and click **Add**.



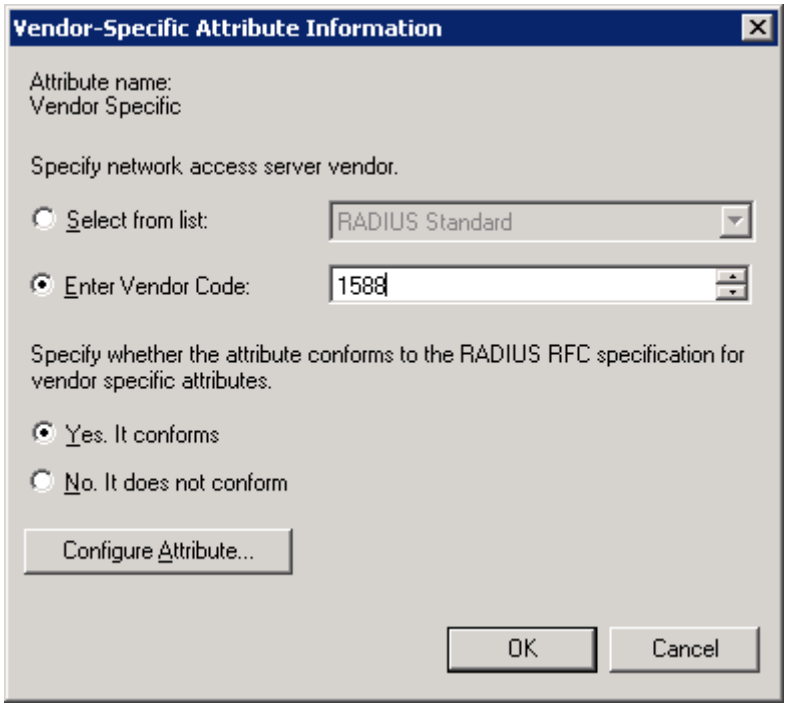
c) Scroll down through the **Attributes** and select **Vendor Specific**. Then click **Add**.



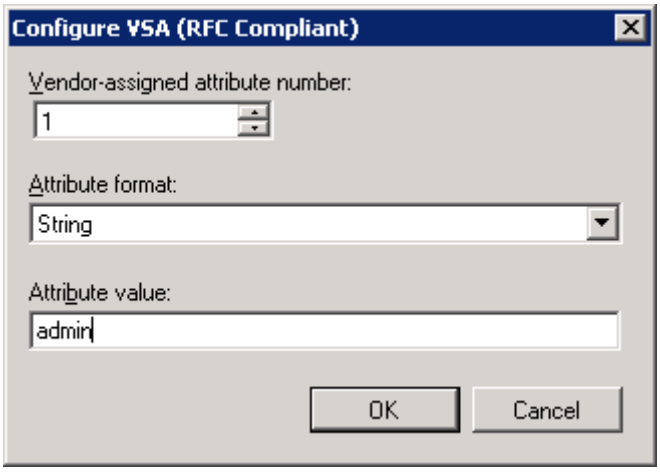
d) On the **Attribute Information** screen, click **Add**.



e) On the **Vendor-Specific Attribute Information** screen, configure the **Vendor Code** as 1588 and check **Yes: It conforms**. Then, click **Configure Attribute**.



f) On the **Configure VSA (RFC Compliant)** screen, set **Vendor-assigned attribute number** to 1, **Attribute format** to String, and **Attribute value** to admin (for admin user) or user (for default user).



g) Click **OK** on each screen until you return to the **Add Vendor Specific Attribute** screen. Then click **Close** and **Close** again on the network policy properties screen.

Configuring a Windows IAS-based RADIUS server

Step-by-step instructions for installing and configuring Internet Authentication Service (IAS) with Microsoft Windows server 2008 (or earlier versions, Windows 2003 or 2000) can be obtained from www.microsoft.com or your Microsoft documentation. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

Use the following information to configure the Internet Authentication Service for a device.

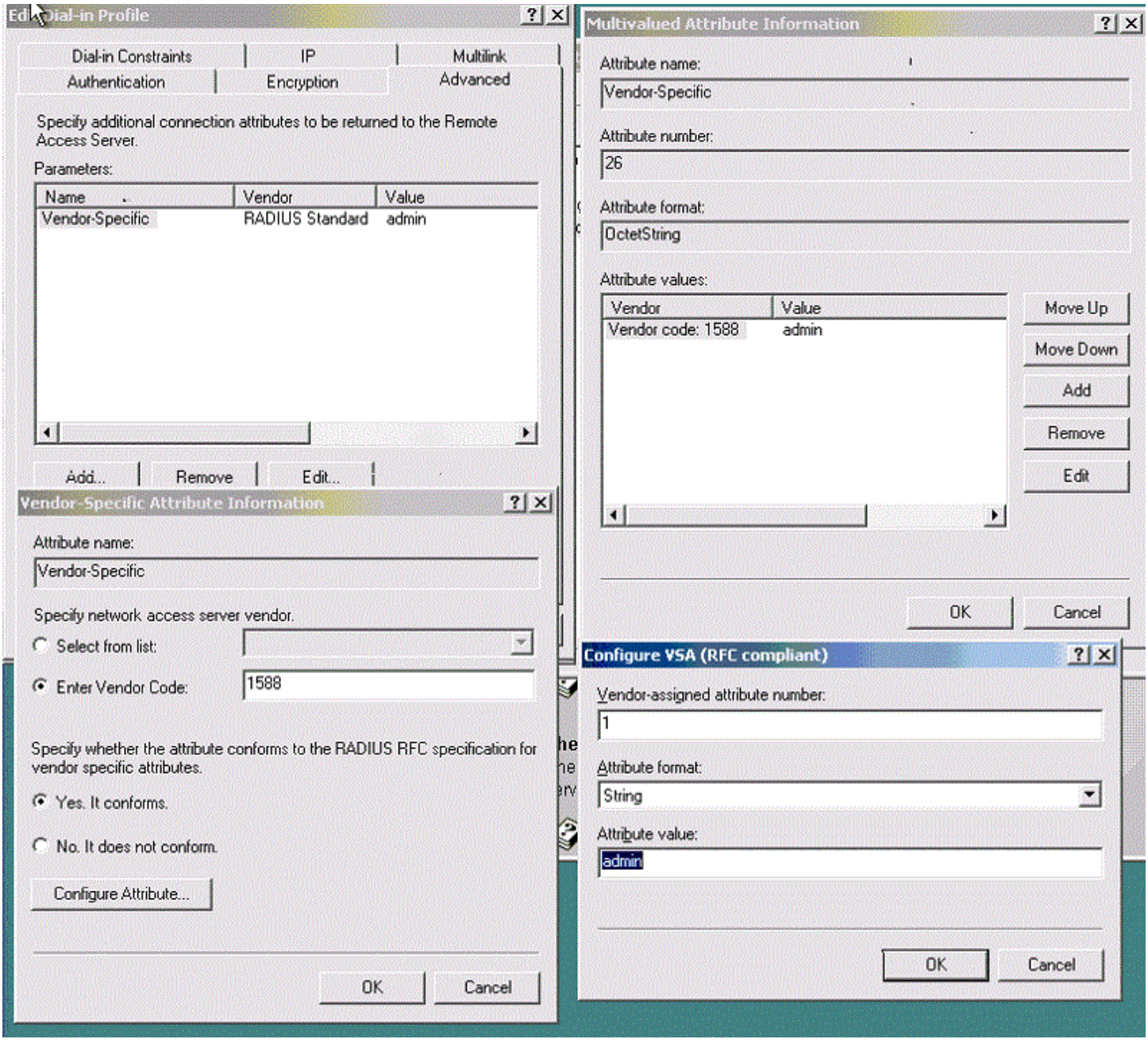
NOTE
This is not a complete presentation of steps.

1. In the **New RADIUS Client** window, choose **RADIUS Standard** from the **Client-Vendor** menu.
2. Configure the **Dial-in Profile** dialog box as follows:
   a) Select the **Advanced** tab.
   b) Scroll to the bottom of the RADIUS Standard list, select **Vendor-Specific**, and click **Add**.
   The **Multivalued Attribute Information** dialog box appears.
   c) Click **Add** in the **Multivalued Attribute Information** dialog box.
   The **Vendor-Specific Attribute Information** dialog box appears.
   d) Enter the Extreme vendor code value.
   e) Select **Yes. It conforms.** and then click **Configure Attribute**.
   The **Configure VSA (RFC compliant)** dialog box appears.
   f) In the **Configure VSA (RFC compliant)** dialog box, enter the following values and click **OK**:
      - Vendor-assigned attribute number—Enter the value **1**.
      - Attribute format—Enter the value **String**.

   The RADIUS server is now configured.

The following image shows the different screens configured in this task.

FIGURE 2 Windows server VSA configuration



Configuring RADIUS Server on a device

Each device client must be individually configured to use RADIUS servers.

You use the **radius-server host** command to specify the server IP address, authentication protocols, and other parameters.

You can configure a maximum of 5 RADIUS servers on a device for AAA service.

NOTE
RADIUS Server must be configured to support Vendor-Specific-Attribute (VSA) in addition to configuring RADIUS Server support on the device.

The following table describes the parameters associated with a RADIUS server that are configured on the device.

TABLE 4 RADIUS server parameters

Parameter	Description
host	IP address (IPv4 or IPv6) or host name of the RADIUS server. Host name requires prior DNS configuration. The maximum supported length for the host name is 255 characters.
auth-port	The user datagram protocol (UDP) port used to connect the RADIUS server for authentication. The port range is 0 through 65535; the default port is 1812.
protocol	The authentication protocol to be used. Options include CHAP, PAP, and PEAP. The default protocol is CHAP. IPv6 hosts are not supported if PEAP is the configured protocol.
key	The shared secret between the device and the RADIUS server. The default value is "sharedsecret." The key cannot contain spaces and must be from 8 through 40 characters in length. Empty keys are not supported.
retries	The number of attempts permitted to connect to a RADIUS server. The range is 0 through 100, and the default value is 5.
timeout	Time to wait for a server to respond. The range is 1 through 60 seconds. The default value is 5 seconds.
encryption-level	Whether the encryption key should be stored in clear-text or in encrypted format. Default is 7 (encrypted). Possible values are 0 or 7, where 0 represents store the key in clear-text format and 7 represents encrypted format.
use-vrf	Specifies a VRF though which to communicate with the RADIUS server.

NOTE
If you do not configure the **key** attribute, the authentication session will not be encrypted. The value of the **key** attribute must match the value configured in the RADIUS configuration file; otherwise, the communication between the server and the device fails.

Refer also to:

- Adding a RADIUS server on page 52
- Modifying the RADIUS server configuration on page 53
- Configuring the client to use RADIUS for login authentication on page 54

Adding a RADIUS server

You can configure up to five RADIUS servers on a device.

Prior to configuring a RADIUS server by specifying a domain or host name, you must configure the Domain Name System (DNS) server on the device by using the **ip dns** command. The host name cannot be resolved unless the DNS server is configured.

NOTE
When a list of servers is configured on the device, failover from one server to another server only happens when a RADIUS server fails to respond; it does not happen when user authentication fails.

Perform the following task to add a RADIUS server to a device.

1. From privileged EXEC mode, enter global configuration mode.

```
device# configure terminal

Entering configuration mode terminal
```

2. When the default configuration values for communication with the RADIUS server are not acceptable, use the **radius-server host** command specifying the **use-vrf** parameter to enter RADIUS server host VRF configuration mode.

```
device(config)# radius-server host 10.38.37.180 use-vrf mgmt-vrf
device(config-host-10.38.37.180/mgmt-vrf)#
```

3. The following examples show how to configure some parameters for communication with the RADIUS server using the mgmt-vrf.
   - (Optional) Configure the authentication protocol to use for communication with the RADIUS server.

```
device(config-host-10.38.37.180/mgmt-vrf)# protocol pap
```

   - (Optional) Specify a text string to be used as a shared secret between the device and the RADIUS server.

```
device(config-host-10.38.37.180/mgmt-vrf)# key "new#vertigo*secret"
```

   - (Optional) Specify the wait time (in seconds) allowed for a RADIUS server response.

```
device(config-host-10.38.37.180/mgmt-vrf)# timeout 10
```

4. Return to Privileged EXEC mode.

```
device(config-host-10.38.37.180/mgmt-vrf)# end
```

5. Verify the configuration.

```
device# show running-config radius-server host 10.38.37.180

radius-server host 10.38.37.180 use-vrf mgmt-vrf
protocol pap key "60/2cBziRKSGWM6jyUagFdsJ+KICcgECAZGURh0GQSI=\n" encryption-level 7 timeout 10
```

Modifying the RADIUS server configuration

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **radius-server host** command with the help option (**?**) to display the configured RADIUS servers.

```
device(config)# radius-server host ?

Possible completions:
  INETADDRESS   Domain name or IP Address of this RADIUS server
```

3. Enter the **radius-server host** command with the IP address of the server you want to modify and the **use-vrf** option.

```
device(config)# radius-server host 10.38.37.180 use-vrf mgmt-vrf
```

   After you run this command you are placed into the RADIUS server host VRF configuration mode where you can specify the parameters you want to modify.

4. Configure the values that you want to change.
   - (Optional) The following example shows how to configure a new key.

     ```
     device(config-host-10.38.37.180/mgmt-vrf)# key "changedsec"
     ```

   - (Optional) The following example shows how configure a timeout value of 3 seconds.

     ```
     device(config-host-10.38.37.180/mgmt-vrf)# timeout 3
     ```

5. Return to Privileged EXEC mode.

   ```
   device(config-host-10.38.37.180/mgmt-vrf)# end
   ```

6. NOTE
   This command does not display default values.

   Verify the new configuration.

   ```
   device# show running-config radius-server host 10.38.37.180
   radius-server host 10.38.37.180 use-vrf mgmt-vrf
    protocol pap key "h8mcoUf2LZF+P+AjaYnO1Q==\n" encryption-level 7 timeout 3
   !
   ```

   NOTE
   To remove a server from the list of configured RADIUS servers, use the **no radius-server host** command specifying the IP address or hostname of the RADIUS server that is to be removed.

   When used with a specified parameter, the command sets the default value of that parameter.

Configuring the client to use RADIUS for login authentication

After you configured the client-side RADIUS server list, you must set the authentication mode so that RADIUS is used as the primary source of authentication. Refer to the Login authentication mode section for information on how to configure the login authentication mode.

RADIUS two factor authentication support

Traditional password-based authentication methods are based on “one-factor” authentication, where a user confirms an identity using a memorized password. Reliance on one-factor authentication exposes enterprises to increased security risks; passwords may be stolen, guessed, cracked, replayed, or compromised in other ways by unsolicited users by using Man in the Middle Attack.

Two factor authentication increases the security by adding an additional step to the basic log-in procedure which requires the user to have both the password and RSA Secure ID credentials from a hardware token before being able to access a device. The authentication proceeds as four basic steps:

First, each hardware token is assigned to a user. It generates an authentication code every 60 seconds using built-in clock and the card’s random key (seed). This seed is 128 bits long, is different for each hardware-token, and is loaded into the RSA Secure ID server (RSA Authentication Manager). The token hardware is designed to be tamper-resistant to deter reverse engineering of the token. Network OS only supports an RSA ID key fob as a secondary authentication token.

Secondly, the RSA Authentication Manager authenticates the user’s password or PIN and token’s combination. It takes the clock time as the input value for the encryption process and it is encrypted with the seed record. The resulting value is the token.

Third, the RSA Agent receives authentication requests and forwards them to the RSA Authentication Manager through a secure channel. Based on the response from the Authentication Manager, agents either allow or deny user access.

Finally, the RSA RADIUS Server forwards the user's user ID and passes code to the RSA Authentication Manager, which verifies that the user ID exists and that the pass code is correct for that user at that specific time.

Each RSA Secure ID token holder must have a user record in the RSA Authentication Manager database. The user records must be synchronized in order to operate. These are the options for creating these records:

- Adding data for individual users in the Add User dialog box.
- Copy and edit an existing user record to make a template with group membership and Agent Host activation lists that can be used for many new users.
- Import user data from Security Accounts Manager (SAM) database on a Windows NT system to the Authentication Manager using dumpsamusers.exe and loadsamusers.exe tools.
- Import user data from an LDAP directory.

When synchronizing LDAP user records, the Database Administration application provides LDAP synchronization tools those can be used to populate the Authentication Manager's user database and keep it synchronized with LDAP directory server. The RSA Authentication Manager supports the following LDAP directory servers; Microsoft Active Directory, Sun ONE Directory Server, and Novell NDS eDirectory.

Using commands in Database Administration, you can add, edit, copy, list, delete, and run synchronization jobs to automatically maintain LDAP user records in the RSA Authentication Manager Database. Refer the RSA ACE/Server documentation for detailed info on adding the users and other configurations.

In order to support two factor authentication install RSA Authentication Manager on your Radius Server and set it to accept two-factor authentication input. When the user logs in, the password or token code works automatically without any changes to the device, as shown in the following example.

```
      Welcome to Console Server Management Server

HQ1-4E23-TS1 login: muser34
Password: ****************  <-----For example password/8675309

device#
```

TACACS+ Server Authentication

Understanding and configuring TACACS+

Terminal Access Controller Access-Control System Plus (TACACS+) is an AAA server protocol that uses a centralized authentication server and multiple network access servers or clients. With TACACS+ support, management of devices seamlessly integrates into network fabric environments. Once configured to use TACACS+, a device becomes a network access server.

If you are in logical chassis mode, the configuration is applied to all nodes in the fabric.

TACACS+ authorization

The TACACS+ server is used only for authentication and accounting. Authorization is enforced by the Extreme Role-Based Access Control (RBAC) protocol at the device level. Extreme recommends that the same role be assigned to a user configured on the TACACS+ server and configured on the device. If the device fails to get the user's role from the TACACS+ server after successful authentication, or if the role does not match any of the roles present on the device, the **user** role is assigned by default. Thereafter, the **brcd-role** is the key used to set the role from the TACACS+ server.

TACACS+ authentication through management interfaces

You can access the device through the serial port, or through Telnet or SSH, from either the management interface or the data ports (Ethernet interface or in-band). The device goes through the same TACACS+-based authentication with either access method.

Supported TACACS+ packages and protocols

Extreme supports the following TACACS+ packages for running the TACACS+ daemon on remote AAA servers:

- Free TACACS+ daemon. You can download the latest package from www.shrubbery.net/tac_plus.
- ACS 5.3
- ACS 4.2

The TACACS+ protocol v1.78 is used for AAA services between the device client and the TACACS+ server.

The authentication protocols supported for user authentication are Password Authentication Protocol (PAP) and Challenge Handshake Authentication Protocol (CHAP).

TACACS+ configuration components

Configuring TACACS+ requires configuring TACACS+ support on the client (including optional accounting), as well as configuring TACACS+ on the server. Support for mixed environments may also be required.

Configuring the client for TACACS+ support

Each device client must be individually configured to use TACACS+ servers. You use the **tacacs-server** command to specify the server IP address, authentication protocols, and other parameters. You can configure a maximum of five TACACS+ servers on a device for AAA service.

The parameters in the following table are associated with a TACACS+ server that is configured on the device.

TABLE 5 TACACS+ server parameters

Parameter	Description
host	IP address (IPv4 or IPv6) or domain/host name of the TACACS+ server. Host name requires prior DNS configuration. The maximum supported length for the host name is 40 characters.
port	The TCP port used to connect the TACACS+ server for authentication. The port range is 1 through 65535; the default port is 49.
protocol	The authentication protocol to be used. Options include CHAP and PAP. The default protocol is CHAP.
key	Specifies the text string that is used as the shared secret between the device and the TACACS+ server to make the message exchange secure. The key must be between 1 and 40 characters in length. The default key is **sharedsecret** . The exclamation mark (!) is supported both in RADIUS and TACACS+ servers, and you can specify the password in either double quotes or the escape character (\), for example **"secret!key"** or **secret\!key**. The only other valid characters are alphanumeric characters (such as a-z and 0-9) and underscores. No other special characters are allowed.
retries	The number of attempts permitted to connect to a TACACS+ server. The range is 0 through 100, and the default value is 5.
timeout	The maximum amount of time to wait for a server to respond. Options are from 1 through 60 seconds, and the default value is 5 seconds.
encryption-level	Whether the encryption key should be stored in clear-text or in encrypted format. Possible values are 0 or 7, where 0 represents store the key in clear-text format and 7 represents encrypted format. Default is 7 (encrypted).
use-vrf	Specifies a VRF though which to communicate with the TACACS+ server.

NOTE

If you do not configure the **key** attribute, the authentication session will not be encrypted. The value of **key** must match with the value configured in the TACACS+ configuration file; otherwise, the communication between the server and the device fails.

Adding a TACACS+ server to the client server list

Prior to adding the TACACS+ server with a domain name or a host name, you must configure the Domain Name System (DNS) server on the device. Without the DNS server, the TACACS+ server name resolution fails and therefore the add operation fails. Use the **ip dns** command to configure the DNS server.

NOTE

When a list of servers is configured, failover from one server to another server happens only if a TACACS+ server fails to respond; it does not happen when user authentication fails.

The following procedure adds a TACACS+ server host in IPv6 format.

1. In privileged EXEC mode, enter **configure terminal** to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter **tacacs-server** and specify the server IP address.

```
device(config)# tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
```

   Upon execution of the command you are placed into the TACACS server configuration submode where you can specify additional parameters.

3. Specify the additional parameters.
   This example specifies the CHAP protocol key.

```
device(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# protocol chap key
"new#hercules*secret"
device(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# exit
device(config)# do show running-config tacacs-server fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010 key new# Hercules*secret
```

4. Enter **exit** to return to global configuration mode.

```
device(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# exit
```

5. Enter **do show running-config tacacs-server host** *server_address* to verify the configuration.

```
device(config)# do show running-config tacacs-server fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
key new# Hercules*secret
```

Modifying the client-side TACACS+ server configuration

1. In privileged EXEC mode, enter **configure terminal** to change to global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter **tacacs-server host** with the help option (**?**) to display the configured server IP addresses.

```
device(config)# tacacs-server host ?
fec0:60:69bc:94:211:25ff:fec4:6010
```

3. Enter **tacacs-server host** followed by the address of the server you wish to modify.

```
device(config)# tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
```

   Upon execution of the command you are placed into the TACACS server configuration submode where you can specify the parameters you want to modify.

4. Specify the additional parameters.

```
device(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# key "changedsec" retries 100
```

5. Enter **exit** to return to global configuration mode.

```
device(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010)# exit
```

6. Enter **do show running-config tacacs-server** *server_address* to verify the configuration.

   This command does not display default values.

```
device(config)# do show running-config tacacs-server fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
key       changedesc
retries   100!
```

   The **no tacacs-server host** command removes the server configuration from the list of configured TACACS servers. If the TACACS+ server being deleted is the last one in the list and authentication mode is set to **tacacs**, deletion of the server from the device configuration is denied. When used with a specified parameter, the command sets the default value of that parameter.

Configuring the client to use TACACS+ for login authentication

After you configure the client-side TACACS+ server list, you must set the authentication mode so that TACACS+ is used as the primary source of authentication.

Configuring TACACS+ accounting on the client side

Once the fundamentals of TACACS+ authentication support are configured on the client, a variety of options are available for tracking user activity.

Client-side TACACS+ accounting overview

The TACACS+ protocol supports accounting as a function distinctly separate from authentication. You can use TACACS+ for authentication only, for accounting only, or for both. With a TACACS+ server you can track user logins and the commands users execute during a login session by enabling login accounting, command accounting, or both.

If you are in logical chassis mode, the configuration is applied to all nodes in the fabric.

- When login accounting is enabled, the device sends a TACACS+ start accounting packet with relevant attributes to the configured TACACS+ server when the user logs in, and a stop accounting packet when the session terminates.
- When command accounting is enabled, the device sends a TACACS+ stop accounting packet to the server when the command execution completes. No TACACS+ start accounting packet is sent for command accounting. Most configuration commands, **show** commands and non-configuration commands such as **firmware download** will be tracked.
- Commands received through the NetConf interface are tracked.

Regardless if a TACACS+ server is used for either authentication or accounting, the device first attempts to connect to the first TACACS+ server configured in the list. If the TACACS+ server cannot be reached, the device attempts to send the packets to the next server on the list.

> NOTE
> There is no fail back in this case. When the first TACACS+ server becomes reachable again, the accounting packets continue to be sent to the second TACACS+ server.

If authentication is performed through some other mechanism, such as the device-local database or RADIUS, the device will attempt to send the accounting packets to the first configured TACACS+ server. If that server is unreachable, the device will attempt to send the accounting packets to subsequent servers in the order in which they are configured.

Conditions for conformance

- Only login and command accounting is supported. System event accounting is not supported.

- You can use a TACACS+ server for accounting regardless of whether authentication is performed through RADIUS, TACACS+, or the device-local user database. The only precondition is the presence of one or more TACACS+ servers configured on the device.
- No accounting can be performed if authentication fails.
- In command accounting, commands with a partial timestamp cannot be logged. For example, a **firmware download** command issued with the **reboot** option will not be accounted for, because there is no timestamp available for completion of this command.

Firmware downgrade considerations

Before downgrading to a version that does not support TACACS+ accounting, you must disable both login and command accounting or the firmware download will fail with an appropriate error message.

Configuring TACACS+ accounting on the client

By default, accounting is disabled on the TACACS+ client (the device) and you must explicitly enable TACACS+. Enabling command accounting and login accounting on the TACACS+ client are two distinct operations. To enable login or command accounting, at least one TACACS+ server must be configured. Similarly, if either login or command accounting is enabled, you cannot remove a TACACS+ server if it is the only server in the list.

Enabling login accounting

The following procedure enables login accounting on a device where accounting is disabled.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **aaa accounting exec default start-stop tacacs+** command to enable login accounting.

```
device(config)# aaa accounting exec default start-stop tacacs+
```

3. Enter **exit** to return to privileged EXEC mode.

```
device(config)# exit
```

4. Enter the **show running-config aaa accounting** command to verify the configuration.

```
device(config)# show running-config aaa accounting
aaa accounting exec default start-stop tacacs+
aaa accounting commands default start-stop tacacs+
```

Enabling command accounting

The following procedure enables command accounting on a device where login accounting is enabled and command accounting is disabled.

1. In privileged EXEC mode, enter **configure terminal** to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter **aaa accounting command default start-stop tacacs+** to enable command accounting.

```
device(config)# aaa accounting command default start-stop tacacs+
```

3. Enter **exit** to return to privileged EXEC mode.

```
device(config)# exit
```

4. Enter **show running-config aaa accounting** to verify the configuration.

```
device# show running-config aaa accounting
aaa accounting exec default start-stop none
aaa accounting commands default start-stop tacacs+
```

Disabling accounting

You have two options to disable accounting: either by using the **aaa accounting** command with the **none** option or by using the **no** form of the command. Both variants are functionally equivalent. You must perform the disable operation separately for login accounting and for command accounting. The operation is performed in global configuration mode.

The following examples show two ways of disabling command accounting. The commands are executed in global configuration mode.

```
device(config)# aaa accounting commands default start-stop none
device(config)# no aaa accounting commands default start-stop
```

The following examples show two ways of disabling login accounting.

```
device(config)# aaa accounting exec default start-stop none
device(config)# no aaa accounting exec default start-stop
```

Viewing the TACACS+ accounting logs

The following excerpts from TACACS+ accounting logs exemplify typical success and failure cases for command and login accounting.

The following examples were taken from the free TACACS+ server. The order of the attributes may vary depending on the server package, but the values are the same. The location of the accounting logs depends on the server configuration.

Command accounting examples

The following example shows a successful execution of the **shutdown** command by the admin user, followed by a **no shutdown** command.

```
Wed Oct 14 10:40:40 2015        10.18.245.157   admin1  /dev/pts/0      10.70.7.36      stop
task_id=1       timezone=Etc/GMT        service=shell   priv-lvl=0      Cmd="operational top configure
terminal" Stop_time=Wed Oct 14 17:39:49 2015

        Status=Succeeded

Wed Oct 14 10:42:14 2015        10.18.245.157   admin1  /dev/pts/0      10.70.7.36      stop
task_id=1       timezone=Etc/GMT        service=shell   priv-lvl=0      Cmd="configure conf-if-te-157/0/5
shutdown"      Stop_time=Wed Oct 14 17:41:24 2015

        Status=Succeeded

Wed Oct 14 10:42:23 2015        10.18.245.157   admin1  /dev/pts/0      10.70.7.36      stop
task_id=1       timezone=Etc/GMT        service=shell   priv-lvl=0      Cmd="configure conf-if-te-157/0/5
no shutdown"   Stop_time=Wed Oct 14 17:41:33 2015
```

The following example shows a successful execution of the **username** command by the admin user.

```
<102> 2012-04-09 15:21:43 4/9/2012 3:21:43 PM NAS_IP=10.17.37.150 Port=0 rem_addr=Console User=admin
Flags=Stop task_id=1 timezone=Etc/GMT+0 service=shell priv-lvl=0 Cmd=username Stop_time=Mon Apr 9 09:43:56
```

```
2012
 Status=Succeeded
```

The following example shows a failed execution of the **radius-server** command by the admin user due to an invalid host name or server IP address.

```
<102> 2012-04-09 14:19:42 4/9/2016 2:19:42 PM NAS_IP=10.17.37.150 Port=0 rem_addr=Console User=admin
Flags=Stop task_id=1 timezone=Etc/GMT+0 service=shell priv-lvl=0 Cmd=radius-server Stop_time=Mon Apr 9
08:41:56 2012
 Status=%% Error: Invalid host name or IP address
```

Login (EXEC) accounting examples

The following example shows a successful login of the trial user.

```
<102> 2012-05-14 11:47:49 5/14/2016 11:47:49 AM NAS_IP=10.17.46.42 Port=/dev/ttyS0 rem_addr=Console
User=trial Flags=Start task_id=1 timezone=Asia/Kolkata service=shell
```

The following example shows a successful logout of the trial user.

```
<102>2012-05-14 11:49:52 5/14/2016 11:49:52 AM NAS_IP=10.17.46.42 Port=/dev/ttyS0 rem_addr=console
User=trial Flags=Stop task_id=1 timezone=Asia/Kolkata service=shell elapsed_time=123 reason=admin reset
```

Configuring TACACS+ on the server side

Step-by-step instructions for installing and configuring can be obtained from your server manufacturer. Confer with your system or network administrator prior to configuration for any special needs your network environment may have.

Server-side user account administration overview

With TACACS+ servers, you should set up user accounts by their true network-wide identity, rather than by the account names created on a device. Along with each account name, you must assign appropriate device access roles. A user account can exist on TACACS+ servers with the same name as a user on the device at the same time.

When logging in to a device configured with a TACACS+ server, users enter their assigned TACACS+ account names and passwords when prompted. Once the TACACS+ server authenticates a user, it responds with the assigned device role and information associated with the user account information using an Extreme Vendor-Specific Attribute (VSA). An Authentication-Accept response without the role assignment automatically grants the "user" role.

User accounts, protocols passwords, and related settings are configured by editing the server configuration files.

Establishing a server-side user account

The following example assigns the user "Mary" the Extreme role of "vlanadmin" and different passwords depending on whether CHAP or PAP is used. In the following example, which works in an environment with only devices supported by this guide, the brcd-role attribute is mandatory. In a mixed-vendor environment, the brcd-role attribute must be set to optional. Refer to Configuring TACACS+ for a mixed-vendor environment on page 65 for more information.

```
user = Mary {
chap = cleartext "chap password"
pap = cleartext "pap password"
service = exec {
brcd-role = vlanadmin;
}
}
```

The following example assigns the user "Agnes" a single password for all types of login authentication.

```
user = Agnes {
global = cleartext "Agnes global password"
}
```

Alternatively, a user can be authenticated using the /etc/passwd file. The following example allows the user "fred" to be authenticated using the /etc/passwd file.

```
user = fred {
login = file /etc/passwd
}
```

Changing a server-side TACACS+ account password

Changing a TACACS+ user password is done on the server by editing the TACACS+ server configuration file.

Defining a server-side TACACS+ group

A TACACS+ group or role can contain the same attributes as the users. By inference, all the attributes of a group can be assigned to any user to whom the group is assigned. The TACACS+ group, while functionally similar to the Extreme role concept, has no relation with the value of the "brcd-role" attribute.

The following example defines a TACACS+ group.

```
group = admin {
# group admin has a cleartext password which all members share
# unless they have their own password defined
chap = cleartext "my$parent$chap$password"
}
```

The following example assigns the user "Extreme" with the group "admin".

```
user = Extreme {
member = admin
pap = cleartext "pap password"
}
```

Setting a server-side account expiration date

You can set an expiration date for an account by using the "expires" attribute in the TACACS+ server configuration file. The expiration date has the format "*MMM DD YYYY* ".

```
user = Extreme {
member = admin
expires = "Jan 01 2017"
pap = cleartext "pap password"
}
```

Configuring a TACACS+ server key

The TACACS+ server key is the shared secret used to secure the messages exchanged between the device and the TACACS+ server. The TACACS+ server key must be configured on both the TACACS+ server and the client device. Only one key is defined per server in the TACACS+ server configuration file. The key is defined as follows:

```
key = "vcs shared secret text"
```

Configuring TACACS+ for the AAA user role

Allows the AAA user role to access configuration commands.

At least one TACACS+ server must be configured on the device using the **tacacs-server host** command.

You must configure a server-side user role on the TACACS+ server. Refer to Configuring TACACS+ for a mixed-vendor environment on page 65 for more information. The following example assigns the user "Agnes" a single password for all types of login authentication.

```
user = Agnes {
global = cleartext "Agnes global password"
}
```

Command authorization can be enabled only if at least one TACACS+ server host is configured. Similarly, if command authorization is enabled, then the last TACACS+ server cannot be removed if it is the only server in the list.

Whenever a command is executed, an authorization request is sent to the configured TACACS+ server in a round-robin fashion. The TACACS+ server responds with an accept or reject based on the configuration. If server responds with a reject, the authorization fails and the command is not executed.

If the 'local' option is not selected and if all the configured TACACS+ servers are unreachable, or TACACS+ server responds with an error, then the command is not executed.

If the 'local' option is selected and if all the configured TACACS+ servers are unreachable, or TACACS+ server responds with an error, then the command is executed, but is based on the local role.

NOTE

Use the **aaa authorization commands none** command to disable command authorization.

1. Enter global configuration mode with the **configure terminal** command.

```
device# configure terminal
```

2. Activate AAA command authorization with **aaa authorization commands**.

```
device(config)# aaa authorization commands tacacs+
```

3. Use **show running-config aaa authorization commands** with the do option to verify the status.

```
device(config)# do show running-config aaa authorization
aaa authorization commands tacacs+
```

Configuring TACACS+ for a mixed-vendor environment

Extreme uses Role-Based Access Control (RBAC) to authorize access to system objects by authenticated users. In AAA environments, users may need to be authorized across platforms supported by this guide and other platforms. You can use TACACS+ to provide centralized AAA services to multiple network access servers or clients. To use TACACS+ services in mixed-vendor environments, you must configure the Attribute-Value Pair (AVP) argument to be optional, as shown in the following example.

```
brcd-role*admin
```

The device sends the optional argument **brcd-role** in the authorization request to the TACACS+ server. Most TACACS+ servers are programmed to return the same argument in response to the authorization request, If "brcd-role" is configured as an optional argument, it is sent in the authorization request and Extreme users are able to successfully authorize with all TACACS+ servers in a mixed-vendor environment.

Configuring optional arguments in tac_plus

The following example is specific to the tac_plus package. The syntax for other packages may differ.

In the example, the mandatory attribute priv-lvl=15 is set to allow the server to authenticate. The optional brcd-role = admin argument is added to the tac_plus.conf file and allows devices to authenticate.

The following example configures a user with the optional AVP, brcd-role = admin. An Extreme user must match both the *username* and *usergroup* to authenticate successfully.

```
user = <username> {
    default service = permit
    service = exec {
     priv-lvl=15
  optional brcd-role = admin
  }
}
```

or

```
group = <usergroup> {
    default service = permit
    service = exec {
     priv-lvl=15
     optional brcd-role = admin
  }
}
user = <username> {
   Member = <usergroup>
}
```

HTTPS Certificates

HTTPS certificate overview

In public key cryptography each device has a pair of keys: a public key and a private key. These are typically numbers that are chosen to have a specific mathematical relationship.

The private key can be used to create a digital signature for any piece of data using a digital signature algorithm. This typically involves taking a cryptographic hash of the data and operating on it mathematically using the private key. Any device with the public key can check that this signature was created using the private key and the appropriate signature validation algorithm.

Network OS supports DSA, RSA and ECDSA encryption keys for HTTPS cryptography. You can generate key pairs, create trust points, and then authenticate and enroll the key pairs into the trust points to obtain the identity certificates.

Configuring HTTPS certificates

In order to support HTTPS, the device needs to be configured with an Identity certificate. This task generates the key pair, then configures the trust points and certificates required for HTTPS security.

When the Apache (web server) boots. it enables HTTPS service only in the presence of HTTPS crypto certificates.

HTTP and HTTPS are mutually exclusive.

The labels for the trust point and the key pair have to be consistent throughout this process.

1. Enter configure terminal mode.

```
device#configure terminal
```

2. Enter RBridge ID mode.

```
device(config)#rbridge-id 1
```

3. Generate a key pair (either RSA, ECDSA, or DSA) to sign and encrypt the security payload during the security protocol exchanges with the **crypto key** command.

```
device(config-rbridge-id-1)# crypto key label k1 rsa modulus 2048
```

4. Configure a trusted Certificate Authority (CA) so that the imported identity certificate can be verified that it was issued by one of the locally trusted CAs with the **crypto ca** command.

```
device(config-rbridge-id-1)# crypto ca trustpoint t1
device(config-ca-t1)#
```

5. Associate the key pair to the trust point with the **keypair** command. 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.

```
device(config-ca-t1)# keypair k1
```

6. Return to privileged EXEC mode with the **end** command.

```
device(config-ca-t1)# end
```

7. You must authenticate the device to the CA by obtaining the self-signed certificate of the CA with the **crypto ca authenticate** command. Because the certificate of the CA is self-signed, the public key of the CA should be manually authenticated by contacting the CA administrator to compare the fingerprint of the CA certificate.

```
device# crypto ca authenticate t1 protocol SCP host 10.70.12.102 user fvt directory /users/home/
crypto file cacert.pem
Password: **********
```

8. Export the enrollment certificate to the location specified for the remote host with the **crypto ca enroll** command.

```
device# crypto ca enroll t1 country US state CA locality SJ organization BRC orgunit SFI common
myhost.brocade.com protocol SCP host 10.70.12.102 user fvt directory /users/home/crypto
Password: **********
```

9. Import the identity certificate from the trust point CA with the **crypto ca import** command. This installs the identity certificate on the device.

```
device# crypto ca import t1 certificate protocol SCP host 10.70.12.102 user fvt directory /users/
home/crypto file swcert.pem
Password: **********
```

10. Confirm the configuration with the **show** commands in the example below.

```
device# show crypto key mypubkey
rbridge-id:1
key type: rsa
key label: k1
key size: 2048

device#  show crypto ca certificates
rbridge-id:1
trustpoint: t1; key-pair: k1
certificate: none
CA certificate:
SHA1 Fingerprint=76:5B:D4:2C:CB:54:FE:6B:C5:E0:E3:FD:11:B0:88:70:80:12:C6:63
Subject: C=US, ST=CA, L=SJ, O=BR, OU=SF, CN=SOUND/emailAddress=sravi
Issuer: C=US, ST=CA, L=SJ, O=BR, OU=SF, CN=SOUND/emailAddress=sravi
Not Before: Sep 19 20:56:49 2014 GMT
Not After : Oct 19 20:56:49 2014 GMT
purposes: sslserver

device# show running-config rbridge-id crypto
rbridge-id 1
crypto key label k1 rsa modulus 2048
crypto ca trustpoint t1
keypair k1
```

11. The HTTP server (either web server or apache server) must be restarted to activate the HTTPS service. Use only one of the following methods:
    - If HTTP is in an enabled state (by default HTTP is enabled), then execute the **http server** command to shutdown the service, followed by **no http server** command to enable HTTPS.
    - If HTTP is in a disabled state, then execute the **no http server** command to enable HTTPS.
    - Reboot the device.
    - Force an HA failover.

Disabling HTTPS certificates

Disables key pairs and trust points for HTTPS cryptography certificates, which disables the HTTPS security protocol.

To shutdown the HTTPS service without disabling the HTTPS certificates, execute the **http server shutdown** command.

When the Apache (web server) boots. it enables HTTPS service only in the presence of HTTPS crypto certificates.

HTTP and HTTPS are mutually exclusive.

NOTE
HTTPS certificates must be configured and enabled for web service to function on the device.

1. Delete the identity device certificate with the **no crypto ca import** command.

```
device# no crypto ca import t1 certificate

device# show crypto ca certificates
rbridge-id:1
Trustpoint: t1
certificate: none
CA certificate:
SHA1 Fingerprint=76:5B:D4:2C:CB:54:FE:6B:C5:E0:E3:FD:11:B0:88:70:80:12:C6:63
Subject: C=US, ST=CA, L=SJ, O=BR, OU=SF, CN=SOUND/emailAddress=sravi
Issuer: C=US, ST=CA, L=SJ, O=BR, OU=SF, CN=SOUND/emailAddress=sravi
Not Before: Sep 19 20:56:49 2014 GMT
Not After : Oct 19 20:56:49 2014 GMT
purposes: sslserver
```

2. Unauthenticate the trust point with the **no crypto ca authenticate** command.

```
device# no crypto ca authenticate t1
device# show crypto ca certificates
rbridge-id:1
Trustpoint: t1
certificate: none
CA certificate: none
```

3. Enter configure terminal mode.

```
device#configure terminal
```

4. Enter RBridge ID mode.

```
device(config)#rbridge-id 1
```

5. Disassociate the trust point from the key pair with the **no keypair** command.

```
device(config-rbridge-id-1)# crypto ca trustpoint t1
device(config-ca-t1)#no keypair
device(config-ca-t1)# do show running-config rbridge-id crypto
rbridge-id 1
 crypto key label k1 rsa modulus 2048
 crypto ca trustpoint t1
  !
!
device(config-ca-t1)# do show crypto ca trustpoint
rbridge-id:1
trustpoint: t1; key-pair: none
```

6. Delete the trust point with the **no crypto ca trustpoint** command.

```
device(config-rbridge-id-1)# no crypto ca trustpoint t1
device(config-ca-t1)# do show running-config rbridge-id crypto
rbridge-id 1
 crypto key label k1 rsa modulus 2048
!
device# show crypto ca trustpoint
rbridge-id:1
trustpoint: none; key-pair: none
```

7. Delete the key pair with the **no crypto key** command.

```
device(config-ca-t1)# exit
device(config-rbridge-id-1)#no crypto key label k1
device(config-rbridge-id-1)# do show running-config rbridge-id crypto
% No entries found.

device(config-rbridge-id-1)# do show crypto key mypubkey
rbridge-id:1
key type: none
key label: none
key size: none
```

8. Return to privileged EXEC mode with the **exit** command.

```
device(config-ca-t1)# exit
```

Enabling HTTPS service

After installing the HTTPS certificates, the web server (also known as the apache server) must be restarted to configure the HTTPS service. By default, the web service is running when the device boots.

The HTTPS certificates must be installed.

The web service can be started using one of the following mechanisms:

- Restart the web service with the **http server shutdown** command, followed by the **no http server shutdown** command. Refer to the *Extreme Network OS Command Reference*.
- Reboot the entire device.
- Commit an HA failover, if that option is available.

Disabling HTTPS service

The HTTPS service is disabled by using the **http server shutdown** command.

Refer to the *Extreme Network OS Command Reference*.

Importing TLS certificate and keys without trust point

This feature allows TLS server certificates (third party CA certificate) and keys to be directly imported without any trust point support.

The SSL/TLS protocol uses a pair of keys – one private, one public – to authenticate, secure and manage secure connections. These keys are created together as a pair and work together during the TLS handshake process to set up a secure session.

As part of the TLS handshake, the protocol also allows both peers to authenticate their identity. Finally, with encryption and authentication in place, the TLS protocol also provides its own message framing mechanism and signs each message with a message authentication code (MAC). Combined, all three mechanisms serve as a foundation for secure communication.

You must create a username named "scpuser" with admin privileges before you import the certificate or key.

Both the certificate and the key is used to establish secure connection over TLS by restarting the http server with the **http server use-vrf <VRF name> shutdown** and **no http server use-vrf <VRF name> shutdown** commands.

1. Enter configure terminal mode.

```
device#configure terminal
```

2. Enter RBridge ID mode.

```
device(config)#rbridge-id 1
```

3. Create a user account called "scpuser" that is assigned the admin role, using the **username** command.

```
device(config)# username scpuser role admin password 123456
```

4. Import the certificate file using the standard Linux **scp** command from any Linux machine.

```
# scp certificatefile scpuser@10.16.0.112:flash-tlscert
```

5. Import the key file using the standard Linux **scp** command from any Linux machine.

```
# scp keyfile scpuser@10.16.0.112:flash-tlsprivkey
```

6. Reboot the HTTP service on the device with the **http server use-vrf <VRF name> shutdown** and **no http server use-vrf <VRF name> shutdown** commands.

```
device(config)# http server use-vrf myvrf shutdown
device(config)# no http server use-vrf myvrf shutdown
```

7. Confirm the configuration with the **show** commands in the example below.

```
device# show http server status
rbridge-id 1:
VRF-Name: mgmt-vrf       Status: HTTP Enabled and HTTPS Disabled
VRF-Name: default-vrf    Status: HTTP Enabled and HTTPS Disabled

device# show http server status
rbridge-id 1:
VRF-Name: mgmt-vrf       Status: HTTP Disabled and HTTPS Enabled
VRF-Name: default-vrf    Status: HTTP Enabled and HTTPS Disabled

device# show cert-util tlsprivkey
%%Info: RSA Private key is already installed on the device.

device# show cert-util tlscert
Displaying contents of tlscert.pem
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number: 8209 (0x2011)
    Signature Algorithm: sha256WithRSAEncryption
        Issuer: C=IN, ST=Karnataka, L=Bangalore, O=Brocade, OU=NI, CN=Brocade/
emailAddress=gperakam@brocade.com
        Validity
            Not Before: Oct  3 05:26:25 2017 GMT
            Not After : Oct 13 05:26:25 2018 GMT
        Subject: C=US, ST=CA, L=SJ, O=Brocade, OU=Eng, CN=brocade
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (2048 bit)
                Modulus:
                    00:a2:34:c7:52:13:61:32:70:79:62:da:65:be:c6:
                    46:ff:3c:e7:04:c8:c4:73:e7:47:62:91:9a:77:48:
                    db:ab:43:ea:23:e8:97:b4:3f:95:f1:cf:7b:7a:8a:
                    4c:e2:2c:26:fe:17:5e:14:d2:e9:cc:3b:39:2d:65:
                    f7:80:dc:45:c0:24:d2:40:3e:71:6b:4f:22:ef:cd:
                    c8:ac:00:c1:14:ff:e6:54:98:17:46:a5:0f:d6:17:
                    7e:18:6f:fd:5d:e9:67:6b:fa:dd:3d:df:26:08:46:
                    3b:4b:ba:38:ed:43:f0:d8:d9:db:62:1a:17:c4:5a:
                    6e:d6:ac:4b:e4:3d:06:ae:61:8f:e4:fa:63:27:08:
                    48:27:39:86:24:cf:f9:26:2c:6e:07:f5:0a:4e:d7:
                    4f:ff:b9:c8:f2:93:96:b8:3d:5f:d5:63:4e:3d:1f:
                    44:f2:c9:f6:3a:cf:12:00:fc:fb:cc:b3:d9:3a:7f:
                    92:ab:e5:f2:47:b0:1e:3e:6e:da:e0:c5:dd:88:38:
                    89:93:8c:75:af:8e:e5:10:6e:47:98:d9:86:81:8c:
                    3d:1d:a1:b5:78:99:48:4e:49:e8:4a:7e:b8:21:07:
                    c5:00:5f:3f:44:61:d3:85:44:e3:20:21:45:68:dd:
                    64:db:4b:70:98:c5:f4:53:86:e4:27:40:67:a1:3b:
                    1b:79
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Basic Constraints:
                CA:FALSE
            Netscape Cert Type:
                SSL Server
            Netscape Comment:
                OpenSSL Generated Server Certificate
            X509v3 Subject Key Identifier:
                66:EB:24:45:03:05:7D:A6:9D:30:77:E0:07:5A:A7:24:DA:8A:1D:7A
            X509v3 Authority Key Identifier:
                keyid:1F:7D:8D:B0:DB:BA:F6:41:8F:8C:6B:85:55:C6:4B:C2:54:3A:77:80
                DirName:/C=IN/ST=Karnataka/L=Bangalore/O=Brocade/OU=NI/CN=Brocade/
emailAddress=gperakam@brocade.com
                serial:DF:A7:C9:93:BF:C9:23:37

            X509v3 Key Usage: critical
                Digital Signature, Key Encipherment
            X509v3 Extended Key Usage:
                TLS Web Server Authentication
    Signature Algorithm: sha256WithRSAEncryption
```

```
b4:b4:af:9f:18:aa:d0:82:2c:15:0f:e8:5f:2b:5a:65:6e:2e:
b3:be:57:9f:b1:4a:e6:21:27:20:8b:e2:dc:66:99:98:5a:35:
32:8b:72:4c:2a:29:62:d6:a3:11:4c:bb:46:65:71:de:ac:45:
57:e7:c0:a5:51:80:04:a0:63:9d:26:bc:86:8f:df:86:d5:fa:
1b:b3:ad:bc:3d:ce:23:2f:4a:05:51:6b:c0:45:f0:90:73:fa:
70:7c:7f:5e:50:a2:bd:d8:48:d6:85:08:c2:e0:c7:b7:dd:75:
55:fa:11:c9:e9:6e:c2:db:01:c0:60:f0:63:2a:ee:95:22:f9:
f8:e8:44:9b:d4:02:b5:66:7a:aa:44:9d:5c:08:d8:c7:1f:23:
46:bc:e9:8b:d6:08:23:f5:c5:68:68:b1:bd:96:ac:c4:cc:4a:
25:36:34:95:0c:c6:c0:04:ca:d6:8e:31:f5:9c:0e:1a:3d:b4:
7d:4f:3c:c0:dd:47:5b:b5:1f:74:41:49:59:f8:dd:7d:a6:7a:
50:1e:aa:d0:49:77:f8:bc:10:91:cf:90:12:28:df:72:f2:f0:
fb:d6:df:da:6e:1f:c8:65:99:e5:07:4a:b6:dd:db:1c:b0:33:
18:64:a2:b6:f2:ef:84:62:24:07:84:2d:38:ba:6e:58:fe:98:
df:c6:0f:f4
```

ACLs

ACL overview

An access control list (ACL) is a container for rules that permit or deny network traffic based on criteria that you specify.

When a frame or packet is received or sent, the device compares its header fields against the rules in applied ACLs. This comparison is done according to a rule sequence, which you can specify. Based on the comparison, the device either forwards or drops the frame or packet.

The benefits of ACLs include the following:

- Provide security and traffic management.
- Monitor network and user traffic.
- Save network resources by classifying traffic.
- Protect against denial of service (DOS) attacks.
- Reduce debug output.

Regarding the range of filtering options, there are two types of ACL:

- *Standard ACLs* — Permit, deny, or hard-drop traffic according to source address only.
- *Extended ACLs* — Permit, deny, or hard-drop traffic according to source and destination addresses, as well as other parameters. For example, in an extended ACL, you can also filter by one or more of the following:
  - Port name or number
  - Protocol, for example TCP/UDP port name or number
  - TCP flags

Regarding layer and protocol, ACL types are as follows:

- Layer 2
  - MAC ACLs
- Layer 3
  - IPv4 ACLs
  - IPv6 ACLs

ACL application-targets

ACLs that you apply to interfaces, to overlay gateways, or at RBridge-level are summarized in a table. Additional ACL types, not discussed in the current unit, are described in a separate table.

The following table summarizes details of the ACL application-target types discussed in the current unit. You create all of these ACL types using the { **mac** | **ip** | **ipv6** } **access-list** command.

TABLE 6 ACLs applied to interfaces, overlay gateways, or RBridges

Target/type	Description	Applied from	Applied with	Types supported	Reference
Interface	Filters all traffic entering or exiting an interface.	Interface configuration sub-modes	{ **mac** | **ip** | **ipv6** } **access-group** { **in** | **out** }	MAC, IPv4, IPv6 Standard, extended	Layer 2 (MAC) ACLs on page 78 Layer 3 (IPv4 and IPv6) ACLs on page 84
Overlay gateway	Filters all traffic entering an overlay gateway.	Overlay-gateway configuration mode	{ **mac** | **ip** | **ipv6** } **access-group in**	MAC, IPv4, IPv6 Standard, extended	Layer 2 (MAC) ACLs on page 78 Layer 3 (IPv4 and IPv6) ACLs on page 84 *Extreme Network OS Layer 2 Switching Configuration Guide* > "VXLAN Overlay Gateways for NSX Controller Deployments"
Receive-path	Receive-path ACLs (rACLs) are applied at RBridge-level. Their primary function is to filter traffic to the route-processor CPU.	RBridge-ID configuration mode	{ **ip** | **ipv6** } **receive access-group in**	IPv4, IPv6 Standard, extended	Implementation flow for rACLs and interface ACLs on page 84

The following table summarizes details of ACL types not discussed in the current unit, as they differ significantly from ACLs applied to interfaces, overlay gateways, and RBridges.

TABLE 7 Other ACL types

Target/type	Description	Created with	Applied with	Types supported	Reference
SNMP	Restricts access to a device by IP addresses associated with an SNMP-server community or user.	{ **ip** | **ipv6** } **access-list**	(IPv4) **snmp-server community** (IPv6) **snmp-server user**	IPv4, IPv6 Standard	*Extreme Network OS Management Configuration Guide* > "SNMP" > "Managing SNMP access rights using ACLs"
ARP	Address-resolution protocol (ARP) ACLs, applied to untrusted VLAN/VE ports to permit only ARP packets with specified IP/MAC address bindings.	**arp access-list**	**ip arp inspection filter**	There is only one type of ARP ACL.	*Extreme Network OS Security Configuration Guide* > "Configuring Dynamic ARP Inspection (DAI)" > "Implementing ARP ACLs for DAI"

NOTE

Both Layer 2 and Layer 3 ACLs are supported under flow-based QoS. For more information, refer to the "QoS" > "Flow-based QoS" section of the *Network OS Layer 2 Switching Configuration Guide*.

Interface ACLs and rACLs

Layer 3 ACLs applied at RBridge-level to filter route-processor CPU traffic are called *receive-path ACLs* or *rACLs*. All other ACLs discussed in the current document are applied to an interface or to an overlay gateway. They can be referred to an *interface ACLs*.

Traffic entering an RBridge can be divided into two categories:

- Datapath traffic
- Traffic for the route-processor CPU

Rules in an ACL applied to an interface filter all traffic entering or exiting that interface—datapath traffic and route-processor traffic.

Rules in an rACL, applied at RBridge level, primarily filter traffic destined for the route-processor CPU. Implementing rACLs offers the following advantages:

- Shields the route-processor CPU from unnecessary and potentially harmful traffic.
- Mitigates denial of service (DoS) attacks.
- Protects the CPU by a single application, rather than needing to apply ACLs on multiple interfaces.

rACLs also support filtering multicast datapath traffic, which offers an alternative to applying ACLs containing multicast rules to all device interfaces.

To implement rACLs, refer to Implementation flow for rACLs and interface ACLs on page 84.

Otherwise, continue with ACLs applied to interfaces on page 77.

ACLs applied to interfaces

This topic describes interfaces and overlay gateways that support ACLs.

Layer 2 (MAC) ACLs are supported on the following user-interface types:

- Physical interfaces (<*N*>-gigabit Ethernet)—in switchport mode
- Port-channel interfaces—in switchport mode
- VLANs
- Overlay gateways

Layer 3 (IPv4 and IPv6) ACLs are supported on the following interface types:

- User interfaces
  - Physical interfaces (<*N*>-gigabit Ethernet)
  - Port-channel interfaces
  - Virtual Ethernet (VE) interfaces
- Management interfaces
- Overlay gateways

ACL and rule limits

There are limits to the number of ACLs and rules supported.

The following table lists ACL and rule limits for supported devices and ACL types:

TABLE 8 ACL and rule limits

Resource	VDX 6740 VDX 6940 VDX 2741 VDX 2746	VDX 8770
Maximum total MAC ACLs (standard and extended)	512	2048
Maximum rules per MAC ACL	Total rules: 256 Maximum **count** rules: 256	Total rules: 2048 Maximum **count** rules: 2048

TABLE 8 ACL and rule limits (continued)

Resource	VDX 6740 VDX 6940 VDX 2741 VDX 2746	VDX 8770
Maximum total IPv4 ACLs (standard and extended)	512	2048
Maximum rules per IPv4 ACL	Total rules: 256 Maximum **count** rules: 256	Total rules: 12288 Maximum **count** rules: 6144
Maximum total IPv6 ACLs (standard and extended)	512	2048
Maximum rules per IPv6 ACL	Total rules: 256 Maximum **count** rules: 256	Total rules: 2048 Maximum **count** rules: 2048
Maximum total rules supported (All ACL rules on device)	200K	200K

NOTE
The hardware profile configured on the VDX device defines the number of supported ACLs. Consult the Release Notes for the ACL limits for each hardware profile.

The following limits apply to every ACL:

- An ACL name can be 1 through 63 characters long, and must begin with a–z, A–Z or 0–9. You can also use underscore (_) or hyphen (-) in an ACL name, but not as the first character.
- Sequence numbers can range from 0 through 4294967290.

Layer 2 (MAC) ACLs

Layer 2 access control lists (ACLs) filter traffic based on MAC header fields.

MAC ACL configuration guidelines

Follow these guidelines and restrictions when configuring MAC ACLs.

- On any given device, an ACL name must be unique among all ACL types (MAC/IPv4/IPv6; standard or extended).
- The order of the rules in an ACL is critical. The first rule that matches the traffic stops further processing of the frames. For example, following an **apply** match, subsequent **deny** or **hard-drop** rules do not override the **apply**.
- When you add rules to an ACL, you have the option of specifying the rule sequence number. If you create a rule without a sequence number, it is automatically assigned a sequence number incremented above the previous last rule.
- There is an implicit "permit" rule at the end of every Layer 2 rules list. This permits all Layer 2 streams that do not match any of the "deny" rules in the ACL.
- If an ACL includes a rule that denies a specific host or range, the device still responds to the **ping** command, unless there is also a relevant rule with the **hard drop** option.
- A hard-drop rule overrides control packet trap entries. As a result, it may interfere with normal operations of the protocols.

- Existing ACL rules cannot be changed, or updated with elements like **count** and **log**. You need to delete the rule and recreate it with the changed elements.
- You can apply up to six ACLs to each user interface, as follows:
  - One ingress MAC ACL—if the interface is in switchport mode
  - One egress MAC ACL—if the interface is in switchport mode
  - One ingress IPv4 ACL
  - One egress IPv4 ACL
  - One ingress IPv6 ACL
  - One egress IPv6 ACL

  NOTE
  You can apply a specific ACL to one or more interfaces, for ingress or egress, or for both.

Guidelines for ACLs applied to overlay gateways

In addition to the general guidelines, the following additional guidelines are relevant for ACLs applied to overlay gateways:

- There is an implicit "deny" rule at the end of every ACL applied to an overlay gateway. This denies all streams that do not match any of the "permit" rules in the ACL.
- You can apply a maximum of three ACLs to an overlay gateway, as follows:
  - One ingress MAC ACL
  - One ingress IPv4 ACL
  - One ingress IPv6 ACL

Creating a standard MAC ACL

A standard ACL permits or denies traffic according to source address only.

1. Enter **configure terminal** to access global configuration mode.

```
device# configure terminal
```

2. Enter the **mac access-list standard** command to create the ACL.

```
device(config)# mac access-list standard test_01
device(conf-macl-std)#
```

3. For each ACL rule that you need to create, enter a permit or deny command, specifying the needed parameters.

```
device(conf-macl-std)# seq 100 deny host 0011.2222.3333 count
device(conf-macl-std)# seq 110 permit host 0022.1111.2222 ffff.ffff.00ff count
device(conf-macl-std)# deny host 0022.3333.4444 count
device(conf-macl-std)# permit host 0022.5555.3333 count
```

4. Apply the ACL that you created to the appropriate interface.

Creating an extended MAC ACL

An extended ACL permits or denies traffic according to one or more of the following parameters: source address, destination address, port, ethertype, VLAN.

1. Enter **configure** to access global configuration mode.

```
device# configure
```

2. Enter the **mac access-list extended** command to create the access list.

```
device(config)# mac access-list extended test_02
```

3. Create a rule in the MAC ACL to **permit** traffic with the source MAC address and the destination MAC address.

```
device(conf-macl-ext)# permit host 0022.3333.4444 host 0022.3333.5555
```

4. (Optional) Use the **seq** command to insert the rule anywhere in the MAC ACL.

```
device(conf-macl-ext)# seq 5 permit host 0022.3333.4444 host 0022.3333.5555
```

5. Apply the ACL that you created to the appropriate interface.

Applying Layer 2 ACLs to interfaces

An ACL affects network traffic only after you apply it to an interface, using an **access-group** command. Use these procedures to apply MAC standard or extended ACLs to interfaces.

Applying a MAC ACL to a physical interface

Use this procedure to apply a Layer 2 ACL to any physical interface.

1. Enter the **configure** command to access global configuration mode.

```
device# configure
```

2. Enter the **interface** command, specifying the interface type and the rbridge-id/slot/port number.

```
device(config)# interface tengigabitethernet 2/2/1
```

3. If needed, to configure the interface as a Layer 2 switch port, enter the **switchport** command.
4. Enter the **mac access-group** command, specifying the ACL that you are applying to the interface, the in/out direction, and (optionally) **routed** or **switched**.

```
device(conf-if-te-2/2/1)# mac access-group test_02 in
```

Applying a MAC ACL to a LAG interface

Use this procedure to apply a Layer 2 ACL to a LAG (logical) interface, in switchport mode.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **interface port-channel** command, specifying the port-channel number.

```
device(config)# interface port-channel 10
```

3. Enter the **mac access-group** command, specifying the ACL that you are applying to the interface, the in/out direction, and (optionally) routed or switched.

```
device(config-Port-channel-10)# mac access-group test_02 in
```

Applying a MAC ACL to a VLAN interface

Use this procedure to apply a Layer 2 ACL to a VLAN interface.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **interface vlan** command, specifying the *vlan-id*.

```
device(config)# interface vlan 50
```

3. Enter the **mac access-group** command, specifying the ACL that you are applying to the interface, the in/out direction, and (optionally) routed or switched.

```
device(config-Vlan-50)# mac access-group test_02 in
```

Applying a MAC ACL to an overlay gateway

Use this procedure for applying a Layer 2 ACL to a VXLAN overlay gateway.

1. Enter the **configure** command to access global configuration mode.

```
device# configure
```

2. Enter the **overlay-gateway** command to access VXLAN overlay-gateway configuration mode for a gateway that you configure.

```
device(config)# overlay-gateway gw121
```

3. Enter the **mac access-group** command, specifying the ACL and **in**.

```
device(config-overlay-gw-gw121)# mac access-group stdmacaclin in
```

Removing a MAC ACL

To suspend ACL rules, you can remove the ACL containing those rules from the interface to which it was applied. After removing it, you can also delete the ACL.

1. Enter the **configure** command to access global configuration mode.

```
device# configure
```

2. Enter the **interface** command, specifying the interface type and identifying number.

```
device(config)# interface tengigabitethernet 178/0/9
```

3. Enter the **no access-group** command.

```
device(conf-if-te-178/0/9)# no mac access-group macacl2 in
```

Modifying MAC ACL rules

To modify an ACL rule, delete the original rule and replace it with a new rule.

1. To display MAC ACL rule details, in privileged EXEC mode enter the **show running-config mac access-list** command.

```
device# show running-config mac access-list standard ACL1
mac access-list standard ACL1
  seq 100 deny host 0022.3333.4444 count
  seq 110 permit host 0011.3333.5555 count
```

   Note the **seq** number of the rule that you need to modify.

2. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

3. Enter the **mac access-list** command, specifying the ACL you need to modify.

```
device(config)# mac access-list standard ACL1
```

4. Delete the original rule, doing one of the following:
   - Enter the **no seq** command, specifying the sequence number of the rule that you are deleting.

```
device(conf-macl-std)# no seq 100
```

   - Enter the exact rule that you are deleting, preceded by **no**.

```
no deny host 0022.3333.4444 count
```

5. Enter the replacement rule.

```
device(conf-macl-ext)# seq 100 permit host 0022.3333.6666 count
```

Reordering the sequence numbers in a MAC ACL

Reordering ACL-rule sequence numbers is helpful if you need to insert new rules into an ACL in which there are not enough available sequence numbers.

Note the following regarding sequence numbers and their reordering parameters:

- The default initial sequence number is 10 and the default increment is 10.
- For reordering the sequence numbers, you need to specify the following:
  - The new starting sequence number
  - The increment between sequence numbers

The first rule receives the number of 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 number that you specify. The starting-sequence number can range from 0 through 4294967290, and the increment number can range from 1 through 4294967290.

For example: In the command below, the **resequence access-list** command assigns a sequence number of 50 to the first rule, 55 to the second rule, 60 to the third rule, and so forth.

```
device# resequence access-list mac test_02 50 5
```

Creating MAC ACL rules enabled for counter statistics

When you create ACL rules, the **count** parameter enables you to display counter statistics.

1. Enter the **configure terminal** command to access global configuration mode.

   ```
   device# configure terminal
   ```

2. Enter the **mac access-list** command to create or modify an access list.

   ```
   device(config)# mac access-list standard mac_acl_1
   ```

3. In each rule for which you need to display statistics, include the **count** keyword.

   ```
   device(conf-mac1-std)# seq 100 deny 0022.3333.4444 count
   ```

4. If you have not yet applied the ACL to the appropriate interface, do so now.
5. (Optional) To display ACL counter statistics, enter the **show statistics access-list** command.

ACL logs

ACL logs can provide insight into permitted and denied network traffic.

ACL logs maintain the following properties:

- Supported for all ACL types (MAC, IPv4, and IPv6)
- Supported for incoming and outgoing network traffic
- Supported for all user interfaces (but not on management interfaces) on which ACLs can be applied
- May be CPU-intensive

Enabling and configuring the ACL log buffer

Among the conditions required for ACL logging is that the ACL log buffer be enabled and configured.

1. Enter the **debug access-list-log buffer** command to enable and configure ACL log buffering.

   ```
   device# debug access-list-log buffer circular packet count 1600
   ```

2. (Optional) To display the current ACL log buffer configuration, enter the **show access-list-log buffer config** command.

   ```
   device# show access-list-log buffer config
   ACL Logging Enabled.
   ACL logging Buffer configuration: Buffer type is circular and Buffer size is 1600.
   ```

Creating a MAC ACL rule enabled for logging

When you create ACL rules for which you want to enable logging, you must include the **log** keyword.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **mac access-list** command to create or modify an access list.

```
device(config)# mac access-list standard mac_1
```

3. In each rule for which you need logging, include the **log** keyword.

```
device(conf-mac1-std)# seq 100 deny 0022.3333.4444 log
```

4. If you have not yet applied the ACL to the appropriate interface, do so now.
5. (Optional) To display ACL logs, enter the **show access-list log buffer** command.

Layer 3 (IPv4 and IPv6) ACLs

Layer 3 access control lists (ACLs) filter traffic based on IPv4 or IPv6 header fields.

Implementation flow for rACLs and interface ACLs

The implementation flows for Layer 3 interface ACLs (including ACLs applied to overlay gateways) and receive-path ACLs (rACLs) are similar.

> NOTE
> For a comparison of rACLs and interface ACLs, refer to Interface ACLs and rACLs on page 76.

The following table displays the differential flows of implementation topics for interface ACLs and rACLs:

Interface ACLs	All ACLs	rACLs
	Layer 3 ACL configuration guidelines on page 85	
	One of the following procedures: • Creating a standard IPv4 ACL on page 87 • Creating a standard IPv6 ACL on page 87 • Creating an extended IPv4 ACL on page 88 • Creating an extended IPv6 ACL on page 88	
Applying Layer 3 ACLs to interfaces on page 89		Applying Layer 3 rACLs to RBridges on page 91

The above table indicates that there are no structural differences between Layer 3 interface ACLs and rACLs; you use identical procedures for all types. The implementation differences are as follows:

- You apply interface ACLs from an interface configuration mode, and overlay-gateway ACLs from overlay-gateway mode, all using the { **ip** | **ipv6** } **access-group** { **in** | **out** } command.

- You apply rACLs from rbridge-id configuration mode, using the { **ip** | **ipv6** } **receive access-group in** command.

All of the following topics apply both to interface ACLs and to rACLs:

- Modifying Layer 3 ACL rules on page 92
- Reordering the sequence numbers in a Layer 3 ACL on page 93
- ACL counter statistics (Layer 3) on page 93
- ACL logs on page 83
- ACL Show and Clear commands on page 95

Layer 3 ACL configuration guidelines

We present guidelines for all Layer 3 ACLs, followed by guidelines for ACLs applied to a user interface, applied to a management interface, applied to an overlay gateway, and then guidelines for receive-path ACLs (rACLs).

The following are guidelines for all Layer 3 ACLs:

- An ACL name can be up to 63 characters long, and must begin with a–z, A–Z or 0–9. You can also use underscore (_) or hyphen (-) in an ACL name, but not as the first character.
- On any given device, an ACL name must be unique among all ACL types (MAC/IPv4/IPv6, standard or extended, general or receive).
- The order of the rules in an ACL is critical. The first rule that matches the traffic stops further processing of the frames. For example, following an **apply** match, subsequent **deny** or **hard-drop** rules do not override the **apply**.
- When you create an ACL rule, you have the option of specifying the rule sequence number. If you create a rule without a sequence number, it is automatically assigned a sequence number incremented above the previous last rule.
- Existing ACL rules cannot be changed, or updated with elements like **count** and **log**. You need to delete the rule and recreate it with the changed elements.
- If an ACL includes a rule that denies a specific host or range (for example: "seq 2 deny host 10.9.106.120"), the device still responds to the **ping** command, unless there is also a relevant rule with the **hard drop** option (such as `seq 20 hard-drop icmp any any`).
- A hard-drop rule overrides control packet trap entries. As a result, it may interfere with normal operations of the protocols.
- If—under IPv6—RA-Guard is enabled on an interface, there is an internal rule that takes precedence over user-configured rules applied to that interface. For example:

```
seq 10 hard-drop IPv6-ICMP any any icmp-type 134 icmp-code 0
```

Guidelines for Layer 3 ACLs applied to user interfaces

In addition to the general guidelines, the following additional guidelines are relevant for Layer 3 ACLs applied to user interfaces:

- There is an implicit "deny" rule at the end of every Layer 3 ACL applied to a user interface. This denies all L3 streams that do not match any of the "permit" rules in the ACL.
- You can apply a maximum of six ACLs to a user interface, as follows:
  - One ingress MAC ACL—if the interface is in switchport mode
  - One egress MAC ACL—if the interface is in switchport mode
  - One ingress IPv4 ACL
  - One egress IPv4 ACL
  - One ingress IPv6 ACL
  - One egress IPv6 ACL

NOTE
You can apply a specific ACL to one or more interfaces, for ingress or egress, or for both.

Guidelines for ACLs applied to a management interface

In addition to the general guidelines, the following additional guidelines are relevant for Layer 3 ACLs applied to a management interface:

- For an ACL applied to a management interface, Layer 3 streams that do not match any of the "deny" rules in the ACL are permitted.
- For an ACL applied to a management interface, **hard-drop** parameters are interpreted as **deny** parameters.
- (Extended ACLs) Applying a permit or deny UDP ACL to the management interface enacts an implicit deny for TCP; however, a ping will succeed.
- (Extended ACLs) Applying a permit or deny ACL for a specific UDP port enacts an implicit deny for all other UDP ports.
- (Extended ACLs) Applying a permit or deny ACL for a specific TCP port enacts an implicit deny for all other TCP ports.
- ACLs in a route-map are not used by the Open Shortest Path First (OSPF) or Border Gateway Protocol (BGP) protocols.
- You can apply a maximum of two ACLs to a management interface, as follows:
  - One ingress IPv4 ACL
  - One ingress IPv6 ACL
- Before downgrading firmware, unbind any ACLs on the management interface.

If no ACLs are applied to the device management interface, the following default rules are effective:

- seq 0 permit tcp any any eq 22
- seq 1 permit tcp any any eq 23
- seq 2 permit tcp any any eq 80
- seq 3 permit tcp any any eq 443
- seq 4 permit udp any any eq 161
- seq 5 permit udp any any eq 123
- seq 6 permit tcp any any range 600-65535
- seq 7 permit udp any any range 600-65535

Guidelines for ACLs applied to overlay gateways

In addition to the general guidelines, the following additional guidelines are relevant for ACLs applied to overlay gateways:

- There is an implicit "deny" rule at the end of every ACL applied to an overlay gateway. This denies all streams that do not match any of the "permit" rules in the ACL.
- You can apply a maximum of three ACLs to an overlay gateway, as follows:
  - One ingress MAC ACL
  - One ingress IPv4 ACL
  - One ingress IPv6 ACL

Guidelines for receive-path ACLs (rACLs)

In addition to the general guidelines, the following additional guidelines are relevant for rACLs:

- Interface ACLs and rACLs share the same resource (database-table).

- To drop CPU-bound traffic, specify the **hard-drop** option. **Permit** and **deny** both allow CPU-bound traffic.
- IPv4 rACLs apply to multicast datapath traffic only if multicast destination-IPs are explicitly specified in rules.
- In an IPv4 rACL rule, if a destination IP or **any** is not specified, *my-ip* (IP addresses configured on any Layer 3 interface) is interpreted as the destination IP. Such rules do not filter multicast traffic.
- By default, IPv6 rACLs apply both to route-processor CPU traffic and to multicast datapath traffic. Unicast datapath traffic is not affected by rACLs.
- If in an IPv6 rACL rule a destination IP is not specified, the destination IP is interpreted both as *my-ip* and as multicast IP.
- Multicast traffic is first filtered by rACLs, then by interface ACLs.
- In all rACLs, explicit and implicit rules are processed in the following order:
  1. Explicit rules, in an order determined by their **seq** numbers.
  2. An implicit **permit** rule for all Layer 3 control protocols.
  3. An implicit **hard-drop any** *my-ip* rule that affects all other CPU-bound traffic.
- Under inband management, you need to include permit rules for your telnet/SSH access to the device.

Creating a standard IPv4 ACL

A standard ACL permits or denies traffic according to source address only.

1. Enter **configure** to access global configuration mode.

```
device# configure
```

2. Enter the **ip access-list standard** command to create the access list.

```
device(config)# ip access-list standard stdACL3
```

3. For each ACL rule, enter a **seq** command, specifying the needed parameters.

```
device(config-ipacl-std)# seq 5 permit host 10.20.33.4
device(config-ipacl-std)# seq 15 deny any
```

4. Apply the ACL that you created to the appropriate interface.

The following example shows how to create a standard IPv4 ACL, define a rule for it, and apply the ACL to an interface.

```
device# configure
device(config)# ip access-list standard stdACL3
device(config-ipacl-std)# seq 5 permit host 10.20.33.4
device(config-ipacl-std)# seq 15 deny any
device(config-ipacl-std)# exit
device(config)# interface tengigabitethernet 122/5/22
device(conf-if-te-122/5/22)# ip access-group stdACL3 in
```

Creating a standard IPv6 ACL

A standard ACL permits or denies traffic according to source address only.

1. Enter **configure** to access global configuration mode.

```
device# configure
```

2. Enter the **ipv6 access-list standard** command to create the access list.

```
device(config)# ipv6 access-list standard std_V6_ACL4
```

3. For each ACL rule, enter a **[seq] {permit | deny | hard-drop}** command, specifying the needed parameters.

```
device(config-ip6acl-std)# seq 5 permit host 2001:db8::1:2
device(config-ip6acl-std)# seq 15 deny any
```

4. Apply the ACL that you created to the appropriate interface.

Creating an extended IPv4 ACL

An extended ACL permits or denies traffic according to one or more of the following parameters: source address, destination address, port, protocol (TCP or UDP), TCP flags.

1. Enter **configure** to access global configuration mode.

```
device# configure
```

2. Enter the **ip access-list extended** command to create the access list.

```
device(config)# ip access-list extended extdACL5
```

3. For each ACL rule, enter a **[seq] {permit | deny | hard-drop}** command—specifying the needed parameters.

```
device(config-ipacl-ext)# seq 5 deny tcp host 10.24.26.145 any eq 23
device(config-ipacl-ext)# seq 7 deny tcp any any eq 80
device(config-ipacl-ext)# seq 10 deny udp any any range 10 25
device(config-ipacl-ext)# seq 15 permit tcp any any
```

4. Apply the ACL that you created to the appropriate interface.

The following example creates an IPv4 extended ACL, defines rules in the ACL, and applies it as a receive-path ACL to an RBridge.

```
device(config)# ip access-list extended ipv4-receive-acl-example
device(conf-ipacl-ext)# hard-drop tcp host 10.0.0.1 any count
device(conf-ipacl-ext)# hard-drop udp any host 20.0.0.1 count
device(conf-ipacl-ext)# permit tcp host 10.0.0.2 any eq telnet count
device(conf-ipacl-ext)# permit tcp host 10.0.0.2 any eq bgp count
device(conf-ipacl-ext)# hard-drop tcp host 10.0.0.3 host 224.0.0.1 count

device(conf-ipacl-ext)# rb 1
device(config-rbridge-id-1)# ip receive access-group ipv4-receive-acl-example in
```

Creating an extended IPv6 ACL

An extended ACL permits or denies traffic according to one or more of the following parameters: source address, destination address, port, protocol (TCP or UDP), TCP flags.

1. Enter **configure** to access global configuration mode.

```
device# configure
```

2. Enter the **ipv6 access-list extended** command to create the access list.

```
device(config)# ipv6 access-list extended ip_acl_1
```

3. For each ACL rule, enter a **[seq] {permit | deny | hard-drop}** command—specifying the needed parameters.

```
device(conf-ip6acl-ext)# seq 10 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 count
```

4. Apply the ACL that you created to the appropriate interface.

The following example shows how to create an extended IPv6 ACL, define rules for it (including a rule that filters by DSCP ID), and apply the ACL to an interface.

```
device# configure
device(config)# ipv6 access-list extended ip_acl_1
device(conf-ip6acl-ext)# seq 10 deny ipv6 any any dscp 3
device(conf-ip6acl-ext)# seq 20 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 count
device(conf-ip6acl-ext)# exit
device(config)# interface ten 122/5/22
device(conf-if-te-122/5/22)# ipv6 access-group ip_acl_1 in
```

The following example creates an IPv6 extended ACL, defines rules in the ACL, and applies it as a receive-path ACL to an RBridge.

```
device(config)# ipv6 access-list extended ipv6-receive-acl-example
device(conf-ipacl-ext)# hard-drop tcp host 10::1 any count
device(conf-ipacl-ext)# hard-drop udp any host 20::1 count
device(conf-ipacl-ext)# permit tcp host 10::2 any eq telnet count
device(conf-ipacl-ext)# permit tcp host 10::2 any eq bgp count
device(conf-ipacl-ext)# hard-drop tcp host 10::3 host ff02::1 count

device(conf-ipacl-ext)# rb 1
device(config-rbridge-id-1)# ipv6 receive access-group ipv6-receive-acl-example in
```

Applying Layer 3 ACLs to interfaces

An ACL affects network traffic only after you apply it to an interface, using one of the **access-group** commands. Use these procedures to apply standard or extended IPv4 and IPv6 ACLs to interfaces or to remove them from the interfaces.

Applying a Layer 3 ACL to a physical interface

Use this procedure for applying an IPv4 or IPv6 ACL to a physical interface, using the **access-group** command.

1. Enter **configure** to change to global configuration mode.

   ```
   device# configure
   ```

2. Enter the **interface** command, specifying the interface type and the rbridge-id/slot/port number.

   ```
   device(config)# interface ten 122/5/22
   ```

3. Enter the **ip/ipv6 access-group** command, specifying the ACL that you are applying to the interface, the in/out direction, and (optionally) **routed** or **switched**.

   ```
   device(conf-if-te-122/5/22)# ipv6 access-group ip_acl_1 in
   ```

4. (Optional) To display updated ACL details, enter the **show access-list** command.

   ```
   device(conf-if-te-122/5/22)# do show access-list ipv6 ip_acl_1 in
   ipv6 access-list ip_acl_1 on TenGigabitEthernet 122/5/22 at Ingress (From User)
       seq 10 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 count (Active)
   ```

The following example shows how to apply an IPv6 ACL to a physical interface.

```
device# configure
device(config)# interface ten 122/5/22
device(conf-if-te-122/5/22)# ipv6 access-group ip_acl_1 in

device(conf-if-te-122/5/22)# do show access-list ipv6 ip_acl_1 in
ipv6 access-list ip_acl_1 on TenGigabitEthernet 122/5/22 at Ingress (From User)
    seq 10 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 count (Active)
```

Applying a Layer 3 ACL to a LAG interface

Use this procedure to apply an IPv4 or IPv6 ACL to a LAG (logical) interface.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **interface port-channel** command, specifying the port-channel number.

```
device(config)# interface port-channel 10
```

3. Enter the **ip/ipv6 access-group** command, specifying the ACL that you are applying to the interface, the in/out direction, and (optionally) **routed** or **switched**.

```
device(config-Port-channel-10)# ip access-group test_02 in
```

Applying a Layer 3 ACL to a VE interface

Use this procedure to apply an IPv4 or IPv6 ACL to a VE interface.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **interface ve** command, specifying the *vlan-id*.

```
device(config)# interface ve 50
```

3. Enter the **ip/ipv6 access-group** command, specifying the ACL that you are applying to the VE, the in/out direction, and (optionally) routed or switched.

```
device(config-ve-50)# ip access-group test_02 in
```

Applying a Layer 3 ACL to an overlay gateway

Use this procedure for applying a Layer 3 ACL to a VXLAN overlay gateway.

1. Enter the **configure** command to access global configuration mode.

```
device# configure
```

2. Enter the **overlay-gateway** command to access VXLAN overlay-gateway configuration mode for a gateway that you configure.

```
device(config)# overlay-gateway gw121
```

3. Enter one or both of the following commands, specifying network protocol (**ip** or **ipv6**), the ACL, and **in**.

```
device(config-overlay-gw-gw121)# ip access-group stdipaclin in
device(config-overlay-gw-gw121)# ipv6 access-group stdipv6aclin in
```

Applying a Layer 3 ACL to a management interface

Use this procedure for applying a Layer 3 ACL to a management interface, using the **access-group** command.

NOTE

In VCS mode, you can apply an ACL to any fabric node, specifying its RBridge ID and port.

NOTE
If an explicit "deny ip any any" IP rule is applied to the management interface, that IP rule has priority over any TCP or UDP rules. Any incoming TCP packets that match that IP rule are dropped because the TCP packet has an IP header.

1. Enter **configure** to access global configuration mode.

```
device# configure
```

2. Use the **interface management** command to enter configuration mode for the management interface, specifying RBridge ID/port.

```
device(config)# interface management 3/1
```

3. To apply an IPv4 ACL to the management interface, enter the **ip access-group** command, specifying the ACL that you are applying to the interface, and **in**

```
device(config-Management-3/1)# ip access-group stdACL3 in
```

4. To apply an IPv6 ACL to the management interface, enter the **ipv6 access-group** command, specifying the ACL that you are applying to the interface, and **in**.

```
device(config-Management-3/1)# ipv6 access-group stdV6ACL1 in
```

5. Use the **exit** command to return to global configuration mode. Your changes are automatically saved.

```
device(config-Management-3/1)# exit
```

Removing a Layer 3 ACL from an interface

To suspend ACL rules, you can remove the ACL containing those rules from the interface to which it was applied. After removal, you can also delete the ACL.

1. Enter the **configure** command to access global configuration mode.

```
device# configure
```

2. Enter the **interface** command, specifying the interface type and name.

```
device(config)# interface tengigabitethernet 122/5/22
```

3. Enter the **no access-group** command.

```
device(conf-if-te-122/5/22)# no ipv6 access-group ip_acl_1 in
```

Applying Layer 3 rACLs to RBridges

A receive-path ACL (rACL) affects traffic only after you apply it at RBridge-level. Use these procedures to apply standard or extended IPv4 and IPv6 ACLs to RBridges or to remove them from the RBridges.

Applying an rACL to an RBridge

Use this procedure for applying an IPv4 or IPv6 receive-path ACL (rACL) at RBridge-level, using one of the **receive access-group** commands.

1. Enter **configure terminal** to change to global configuration mode.

```
device# configure terminal
```

2. Enter the **rbridge-id** command, specifying the RBridge ID.

```
device(config)# rbridge-id 1
```

3. Enter the { **ip** | **ipv6** } **receive access-group** command, specifying the ACL that you are applying to the RBridge and the **in** direction.

```
device(config-rbridge-id-1)# ip receive access-group ipv4-receive-acl-example in
```

The following example shows how to create an IPv6 ACL, define rules needed for an rACL, and apply the ACL to an RBridge.

```
device# configure terminal
device(config)# ipv6 access-list extended ipv6-receive-acl-example
device(conf-ipacl-ext)# hard-drop tcp host 10::1 any count
device(conf-ipacl-ext)# hard-drop udp any host 20::1 count
device(conf-ipacl-ext)# permit tcp host 10::2 any eq telnet count
device(conf-ipacl-ext)# permit tcp host 10::2 any eq bgp count
device(conf-ipacl-ext)# rbridge-id 1
device(config-rbridge-id-1)# ipv6 receive access-group ipv6-receive-acl-example in
```

Removing an rACL from an RBridge

To suspend rACL rules, you can remove the ACL containing those rules from the RBridge to which it was applied. After removal, you can also delete the ACL.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **rbridge-id** command, specifying the RBridge ID.

```
device(config)# rbridge-id 1
```

3. Enter the **no** { **ip** | **ipv6** } **receive access-group** command, specifying the ACL name and the **in** direction.

```
device(config-rbridge-id-1)# no ip receive access-group ipv4-receive-acl-example in
```

Modifying Layer 3 ACL rules

To modify an ACL rule, delete the original rule and replace it with a new rule.

1. To display the rules of all ACLs of a given IP type and standard/extended specification, in global configuration mode enter the **show running-config** command.

```
device# show running-config ip access-list standard
ip access-list standard a1
 seq 10 permit host 10.1.1.1 count
```

Note the **seq** number of the rule that you need to delete or modify.

2. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

3. Enter the **{ip | ipv6} access-list** command, specifying the ACL you need to modify.

```
device(config)# ip access-list standard a1
```

4. Delete the original rule, doing one of the following:
   - Enter the **no seq** command, specifying the sequence number of the rule that you are deleting.

```
device(conf-ipacl-std)# no seq 10
```

   - Enter the exact rule that you are deleting, preceded by **no**.

```
no permit host 10.1.1.1 count
```

5. Enter the replacement rule.

```
device(conf-ipacl-std)# seq 10 permit host 10.1.1.1 log
```

Reordering the sequence numbers in a Layer 3 ACL

Reordering ACL-rule sequence numbers is helpful if you need to insert new rules into an ACL in which there are not enough available sequence numbers.

NOTE
Although you can use this procedure for IPv4 or IPv6 ACLs, the example is for IPv4.

Note the following regarding sequence numbers and their reordering parameters:

- The default initial sequence number is 10 and the default increment is 10.
- For reordering the sequence numbers, you need to specify the following:
  - The new starting sequence number
  - The increment between sequence numbers

The first rule receives the number of 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 number that you specify. The starting-sequence number can range from 0 through 4294967290, and the increment number can range from 1 through 4294967290.

For example: In the command below, for the IPv4 ACL "a1", the **resequence access-list** command assigns a sequence number of 5 to the first rule, 10 to the second rule, 15 to the third rule, and so forth.

```
device# resequence access-list ip a1 5 5
```

ACL counter statistics (Layer 3)

If an ACL rule contains the **count** parameter, you can access statistics for the rule, including the number of frames permitted or denied by that rule. If needed, you can also clear ACL statistics.

NOTE
If an ACL with rules that contain the **count** keyword is applied to a management interface, statistics are not recorded for that ACL.

Creating an IPv4 ACL rule enabled for counter statistics

When you create ACL rules, the **count** parameter enables you to display counter statistics.

1. Enter **configure terminal** to access global configuration mode.

```
device# configure terminal
```

2. Enter the **ip access-list** command to create or modify an access list.

```
device(config)# ip access-list standard stdACL3
```

3. For each ACL rule for which you need to display statistics, include the **count** keyword.

```
device(config-ipacl-std)# seq 5 permit host 10.20.33.4 count
device(config-ipacl-std)# seq 15 deny any count
```

4. If you have not yet applied the ACL to the appropriate interface, do so now.

Creating an IPv6 ACL rule enabled for counter statistics

When you create ACL rules, the **count** parameter enables you to display counter statistics.

1. Enter the **configure terminal** command to access global configuration mode.

```
device# configure terminal
```

2. Enter the **ipv6 access-list** command to create or modify an access list.

```
device(config)# ipv6 access-list extended ip_acl_1
```

3. For each ACL rule for which you need to display statistics, include the **count** keyword.

```
device(conf-ip6acl-ext)# seq 20 deny ipv6 2002:2003:1234:1::/64 2001:3001:1234:1::/64 count
```

4. If you have not yet applied the ACL to the appropriate interface, do so now.
5. (Optional) To display ACL counter statistics, enter the **show statistics access-list** command.

The following example shows how to create an IPv6 extended ACL and define a counter-enabled rule for it.

```
device# configure terminal
device(config)# ipv6 access-list extended ip_acl_1
device(conf-ip6acl-ext)# seq 10 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 count
```

ACL logs

ACL logs can provide insight into permitted and denied network traffic.

ACL logs maintain the following properties:

- Supported for all ACL types (MAC, IPv4, and IPv6)
- Supported for incoming and outgoing network traffic
- Supported for all user interfaces (but not on management interfaces) on which ACLs can be applied
- May be CPU-intensive

Enabling and configuring the ACL log buffer

Among the conditions required for ACL logging is that the ACL log buffer be enabled and configured.

1. Enter the **debug access-list-log buffer** command to enable and configure ACL log buffering.

```
device# debug access-list-log buffer circular packet count 1600
```

2. (Optional) To display the current ACL log buffer configuration, enter the **show access-list-log buffer config** command.

```
device# show access-list-log buffer config
ACL Logging Enabled.
ACL logging Buffer configuration: Buffer type is circular and Buffer size is 1600.
```

Enabling IPv6 ACL rules for logging

When you create ACL rules for which you want to enable logging, you must include the **log** parameter.

1. Enter the **configure** command to access global configuration mode.

```
device# configure
```

2. Enter the **ipv6 access-list** command to create or modify an access list.

```
device(config)# ipv6 access-list extended ipv6_acl_1
```

3. For each ACL rule for which you need logging, include the **log** keyword.

```
device(conf-ip6acl-ext)# seq 20 deny ipv6 2002:2003:1234:1::/64 2001:3001:1234:1::/64 log
```

4. Apply the ACL that you created to the appropriate interface.

ACL Show and Clear commands

There is a full range of ACL show and clear commands. They are documented in the *Network OS Command Reference*, and listed here with descriptions.

TABLE 9 ACL Show commands in the Network OS Command Reference

Command	Description
show access-list	For a given network protocol and inbound/outbound direction, displays ACL information. You can show information for a specified ACL or only for that ACL on a specified interface or RBridge. You can also display information for all ACLs bound to a specified device interface, RBridge, or VXLAN overlay gateway.
show access-list-log buffer	Displays the contents of the ACL buffer.
show access-list-log buffer config	Displays the ACL buffer configuration.
show running-config access-list	For a given network protocol and standard/extended type, displays ACL configuration. You can show the configuration of a specified ACL or for all such ACLs.
show statistics access-list	For a given network protocol and inbound/outbound direction, displays statistical information—for ACL rules that include the **count** keyword. You can show statistics for a specified ACL or only for that ACL on a specified interface or Rbridge. You can also display statistical information for all ACLs bound to a specified device interface, RBridge, or VXLAN overlay gateway.

TABLE 10 ACL Clear commands in the Network OS Command Reference

Command	Description
clear counters access-list	For a given network protocol and inbound/outbound direction, clears ACL statistical information. You can clear all statistics for a specified ACL or only for that ACL on a specified interface or RBridge. You can also clear statistical information for all ACLs bound to a specified device interface, RBridge, or VXLAN overlay gateway.

PBR - Policy-Based Routing

Policy-Based Routing

Policy-Based Routing (PBR) allows you to use ACLs and route maps to selectively modify and route IP packets in hardware.

Basically, the ACLs classify the traffic and route maps that match on the ACLs set routing attributes for the traffic. A PBR policy specifies the next hop for traffic that matches the policy, as follows:

- For standard ACLs with PBR, you can route IP packets based on their source IP address.
- For extended ACLs with PBR, you can route IP packets based on all of the matching criteria in the extended ACL.

NOTE
For details about ACLs, refer to the "ACLs" section of the *Network OS Security Configuration Guide*.

To configure PBR, you define the policies using IP ACLs and route maps, then enable PBR on individual interfaces. The platform programs the ACLs on the interfaces, and routes traffic that matches the ACLs according to the instructions provided by the “set” statements in the route map entry.

Currently, the following platforms support PBR:

- VDX 8770
- VDX 6740
- VDX 6740T
- VDX 6740T-1G
- VDX 6940

You can configure the device to perform the following types of PBR based on a packet's Layer 3 and Layer 4 information:

- Select the next-hop gateway.
- Set the DSCP value.
- Send the packet to the null interface (null0) to drop the packets.

Using PBR, you can define a set of classifications that, when met, cause a packet to be forwarded to a predetermined next-hop interface, bypassing the path determined by normal routing. You can define multiple match and next-hop specifications on the same interface. The configuration of a set of match criteria and corresponding routing information (for example next hops and DSCP values) is referred to as a stanza.

You can create multiple stanzas within a route-map configuration and assign the stanza an “Instance_ID” that controls the program positioning within the route map. Furthermore, when the route map is created, you specify a deny or permit construct for the stanza. In addition, the ACL used for the “match” criteria also contains a deny or permit construct.

The deny or permit nomenclature has a different meaning within the context of the PBR operation than it does within the normal context of user-applied ACLs (where deny and permit are directly correlated to the forwarding actions of forward and drop). The following table

lists the behavior between the permit and deny actions specified at the route-map level, in conjunction with the permit and deny actions specified at the ACL rule level.

Route-map level permit and deny actions	ACL clause permit and deny actions	Resulting Ternary Content Addressable Memory (TCAM) action
Permit	Permit	The "set" statement of the route-map entry is applied.
Permit	Deny	The packet is "passed" and routed normally. The contents of the "set" command are not applied. A rule is programmed in the TCAM as a "permit" with no result actions preventing any further statements of the route-map ACL from being applied.
Deny	Permit	The packet is "passed" and routed normally. There should be no "set" commands following the "match" command of a deny route-map stanza. A rule is programmed in the TCAM as a "permit" with no result actions preventing any further statements of the route-map ACL from being applied.
Deny	Deny	No TCAM entry is provisioned; no other route-map ACL entries will be compared against. If no subsequent matches are made, the packet is forwarded as normal.

Notes:

- Ternary Content Addressable Memory is high-speed hardware memory.
- Consider the permit and deny keywords as allowing the specified match content as either being permitted to or denied from using the defined "set criteria" of the route map. The permit and deny keywords do not correlate to the forwarding action of forward and drop as they do in the ACL application.
- PBR route maps may only be applied to Layer 3 (L3) interfaces. Application of a route map to a non-L3 interface results in the configuration being rejected.
- Deletion of a route map or deletion of an ACL used in the route map "match" is not allowed when the route map is actively bound to an interface. Attempts to delete an active route map or associated ACL is rejected, and an error and log will be generated.
- The "set" commands are only available within the context of a "permit" stanza. The CLI should not allow the use of a "set" command within a PBR "deny" stanza.

Policy-Based Routing behavior

Policy-Based Routing (PBR) next-hop behavior selects the first live next-hop specified in the policy that is "UP".

If none of the policy's direct routes or next hops is available, the packets are forwarded as per the routing table. The order in which the next hop addresses are listed in the route map is an implicit preference for next hop selection. For example, if you enter the next hop addresses A, B, and C (in that order), and all paths are reachable, then A is the preferred selection. If A is not reachable, the next hop is B. If the path to A becomes reachable, the next hop logic will switch to next-hop A.

PBR does not have implicit "deny ip any any" ACL rule entry, as used in ACLs, to ensure that for route maps that use multiple ACLs (stanzas), the traffic is compared to all ACLs. However, if an explicit "deny ip any any" is configured, traffic matching this clause is routed normally using L3 paths and is not compared to any ACL clauses that follow the clause.

The set clauses are evaluated in the following order:

1. Set clauses where the next hop is specified.
2. Set interface NULL0.

The order in which you enter either the **set ip next-hop** or the **set ipv6 next-hop** command determines the order preference. If no next-hops are reachable, the egress interface is selected based on the order of interface configuration. The set interface NULL0 clause — regardless of which position it was entered — is always placed as the last selection in the list.

For example if you enter the order shown below, the PBR logic will treat 3.3.3.5 as its first choice. If 3.3.3.5 is unavailable, the PBR logic will determine if 6.6.6.7 is available. NULL0 is recognized only if 3.3.3.5 and 6.6.6.7 are both unavailable.

```
route-map foo permit 20
   match ip address acl Vincent
   set ip next-hop 3.3.3.5
   set ip interface NULL0
   set ip next-hop  6.6.6.7
```

NOTE

If a PBR route map is applied to an interface that is actively participating in a control protocol, and the ACL specified in the route map also matches the control protocol traffic, the control protocol traffic is trapped to the local processor and is not forwarded according to the route map.

Policy-Based Routing with differing next hops

In this example, traffic is routed from different sources to different places (next hops). Packets arriving from source 1.1.1.1 are sent to the VRF pulp_fiction's next hop at 3.3.3.3; packets arriving from source 2.2.2.2 are sent to the VRF pulp_fiction's next hop at 3.3.3.5. If next hop 3.3.3.5 is not available, then the packet is sent to the next hop 2001:db8:0:0:0:ff00:42:8329.

1. Configure the ACLs.

```
device(config)# ip access-list standard Jules
device(conf-ipacl-std)# permit ip 1.1.1.1

device(config)# ip access-list standard Vincent
device(conf-ipacl-std)# permit ip 2.2.2.2
```

2. Create the first stanza of the route map, which is done in RBridge ID configuration mode. (The example is using a route-map named pulp_fiction.)

```
witch(config)# rbridge-id 1
device(config-rbridge-id-1)# route-map pulp_fiction permit 10
device(config-routemap pulp_fiction)# match ip address acl Jules
device(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.3
```

3. Create the second stanza of the route-map (in this example well define a route-map named pulp_fiction.)

```
device(config-rbridge-id-1)# route-map pulp_fiction permit 20
device(config-routemap pulp_fiction)# match ip address acl Vincent
device(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.5
device(config-routemap pulp_fiction)# set ip next-hop 6.6.6.7
```

4. Bind the route map to the desired interface.

```
device(config)# interface TenGigabitEthernet 4/1
device(conf-if-te-4/1)# ip policy route-map pulp_fiction
```

5. View the route map configuration contents.

```
device# show running-config route-map pulp-fiction
route-map pulp-fiction permit 10
 match ip address acl Jules
  set ip vrf pulp_fiction next-hop 3.3.3.3
!
route-map pulp-fiction permit 20
 match ip address acl Vincent
 set ip vrf pulp_fiction next-hop 3.3.3.5
 set ip next-hop 6.6.6.7
!
```

6. View the route map application.

```
device# show route-map pulp-fiction
Interface TenGigabitEthernet 3/3
  route-map pulp-fiction permit 10
    match ip address acl Jules       (Active)
    set ip vrf pulp_fiction next-hop 3.3.3.3
    Policy routing matches: 0 packets; 0 bytes

  route-map pulp-fiction permit 20
    match ip address acl Vincent     (Active)
    set ip vrf pulp_fiction next-hop 3.3.3.5  (selected)
    set ip next-hop 6.6.6.7
    Policy routing matches: 0 packets; 0 bytes
```

NOTE

For the first stanza (10) created in step 2, the absence of the keyword selected indicates that the none of the next hops in the list is being used; the packet is being routed by the standard routing mechanism.

Policy-Based Routing uses of NULL0

NULL0 is a mechanism used to drop packets in policy-based routing.

NULL0 is a mechanism used to drop packets in policy-based routing. If the NULL0 interface is specified within a stanza and the stanza also contains a “match ACL” statement, only traffic meeting the match criteria within the ACL is forwarded to the NULL0 interface. If the NULL0 interface is specified within a stanza that does not contain a “match” statement, the match criteria is implicitly “match any.”

Examples of using NULL0 include:

- NULL0 in conjunction with a “match” statement.
- NULL0 as a default action of a route map.

Policy-Based Routing and NULL0 with match statements

NULL0 is a mechanism used to drop packets in the Policy-Based Routing (PBR). If the NULL0 interface is specified within a stanza and the stanza also contains a “match ACL” statement, only traffic meeting the match criteria within the ACL is forwarded to the NULL0 interface. If the NULL0 interface is specified within a stanza that does not contain a “match” statement, the match criteria is implicitly “match any.”

In this example, the use of the NULL0 interface is only applicable to frames that meet the match criteria defined in the created ACL, or implicit "permit any" when no explicit match statement is listed for the stanza.

1. Configure the ACLs.

```
sw0(config)# ip access-list standard Jules
sw0(conf-ipacl-std)# permit ip 1.1.1.1
sw0(conf-ipacl-std)# deny ip 11.11.11.11
sw0(config)# ip access-list standard Vincent
sw0(conf-ipacl-std)# permit ip 2.2.2.2
```

2. Create the first stanza of the route map, which is done in RBridge ID configuration mode. (The example is using a route-map named pulp_fiction.)

```
sw0(config)# rbridge-id 1
sw0(config-rbridge-id-1)# route-map pulp_fiction permit 10
sw0(config-routemap pulp_fiction)# match ip address acl Jules
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.3
sw0(config-routemap pulp_fiction)# set ip interface NULL0
```

3. Create the second stanza of the route map. (The example is using a route map named pulp_fiction.)

```
sw0(config-rbridge-id-1)# route-map pulp_fiction permit 20
sw0(config-routemap pulp_fiction)# match ip address acl Vincent
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.5
sw0(config-routemap pulp_fiction)# set ipv6 next-hop 2001:db8:0:0:0:ff00:42:8329
```

Based on the above configuration, when address 1.1.1.1 is received, it matches stanza 10:

- If the next hop 3.3.3.3 is selected, the packet is forwarded to 3.3.3.3.
- If 3.3.3.3 is not selected by the PBR logic, the packet is sent to the next specified next-hop, which is the NULL0 interface, resulting in the traffic being dropped.
- If address 11.11.11.11 is received, since it matches the deny case of the ACL, it is denied from using the next hops specified in the route map and is forwarded according to the standard logic.
- If address 12.12.12.12 is received, because it meets none of the specified match criteria in either of the two stanzas, it basically falls off the end of the route map and reverts to using the standard routing logic.

Policy-Based Routing and NULL0 as route map default action

This example shows the use of the NULL0 interface.

In this example, the use of the NULL0 interface is only applicable to frames that meet the match criteria defined in the created ACL.

1. Configure the ACLs.

```
sw0(config)# ip access-list standard Jules
sw0(conf-ipacl-std)# permit ip 1.1.1.1
sw0(conf-ipacl-std)# deny ip 11.11.11.11
sw0(config)# ip access-list standard Vincent
sw0(conf-ipacl-std)# permit ip 2.2.2.2
```

2. Create the first stanza of the route map, which s done in RBridge ID configuration mode. (The example is using a route-map named pulp_fiction.)

```
sw0(config)# rbridge-id 1
sw0(config-rbridge-id-1)# route-map pulp_fiction permit 10
sw0(config-routemap pulp_fiction)# match ip address acl Jules
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.3
sw0(config-routemap pulp_fiction)# set ip interface NULL0
```

3. Create the second stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
sw0(config-rbridge-id-1)# route-map pulp_fiction permit 20
sw0(config-routemap pulp_fiction)# match ip address acl Vincent
sw0(config-routemap pulp_fiction)# set ip vrf pulp_fiction next-hop 3.3.3.5
```

4. Create the third stanza, which provides the default action of the route map.

```
sw0(config-rbridge-id-1)# route-map pulp_fiction permit 30
sw0(config-routemap pulp_fiction)# set ip interface NULL0
```

The above configuration introduces a third stanza that defines the routing desired for all frames that do not meet any of the match criteria defined by the route map.

Based on the above configuration, when address 1.1.1.1 is received, it matches stanza 10:

- If the next hop 3.3.3.3 is selected, the packet is forwarded to 3.3.3.3.
- If 3.3.3.3 is not selected by the PBR logic, the packet is sent to the next specified next-hop, which is the NULL0 interface, resulting in the traffic being dropped.
- If address 11.11.11.11 is received, since it matches the deny case of the ACL, it is denied from using the next hops specified in the route map and will be forwarded according to the standard logic.
- If address 12.12.12.12 is received, because it meets none of the specified match criteria in either of the first two stanzas, it reaches the third stanza. Since a no “match” statement is specified, it is an implicit “match any.” The address 12.12.12.12 is forwarded to the NULL0 interface where it is dropped.

Providing the default stanza enables a mechanism whereby if any packet is received that does not meet the match criteria set by the route map, the traffic is dropped.

802.1x Port Authentication

802.1x protocol overview

The 802.1x protocol defines a port-based authentication algorithm involving network data communication between client-based supplicant software, an authentication database on a server, and the authenticator device. In this situation the authenticator device is the VDX hardware.

As the authenticator, the VDX hardware prevents unauthorized network access. Upon detection of the new supplicant, the VDX hardware enables the port and marks it "unauthorized." In this state, only 802.1x traffic is allowed. All other traffic (for example, DHCP and HTTP) is blocked. The VDX hardware transmits an Extensible Authentication Protocol (EAP) Request to the supplicant, which responds with the EAP Response packet. The VDX hardware then forwards the EAP Response packet to the RADIUS authentication server. If the credentials are validated by the RADIUS server database, the supplicant may access the protected network resources.

When the supplicant logs off, it sends an EAP Logoff message to the VDX hardware, which then sets the port back to the "unauthorized" state.

NOTE
802.1x port authentication is not supported by LAG (Link Aggregation Group) or interfaces that participate in a LAG.

NOTE
The EAP-MD5, EAP-TLS, EAP-TTLS and PEAP-v0 protocols are supported by the RADIUS server and are transparent to the authenticator device.

Configuring 802.1x authentication

The tasks in this section describe the common 802.1x operations that you will need to perform. For a complete description of all the available 802.1x CLI commands for the VDX hardware, refer to the *Extreme Network OS Command Reference*.

Understanding 802.1x configuration guidelines and restrictions

When configuring 802.1x, be aware of this 802.1x configuration guideline and restriction: If you globally disable 802.1x, then all interface ports with 802.1x authentication enabled automatically switch to force-authorized port-control mode.

Configuring authentication

The **radius-server** command attempts to connect to the first RADIUS server. If the RADIUS server is not reachable, the next RADIUS server is contacted. However, if the RADIUS server is contacted and the authentication fails, the authentication process does not check for the next server in the sequence.

Perform the following steps to configure authentication.

1. Enter the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **radius-server** command to add RADIUS to the device as the authentication server. This command can be repeated for additional servers. However, this command moves the new RADIUS server to the top of the access list.

```
device(config)# radius-server host 10.0.0.5
```

3. Enable 802.1x authentication globally

```
device(config)# dot1x enable
```

4. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

5. Use the **dot1x authentication** command to enable 802.1x authentication.

```
device(conf-if-te-5/1/12)# dot1x authentication
```

6. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

Configuring interface-specific administrative features for 802.1x

It is essential to configure the 802.1x port authentication protocol globally on the VDX hardware, and then enable 802.1x and make customized changes for each interface port. Because 802.1x is enabled and configured in Configuring 802.1x authentication on page 103, use the administrative tasks in this section to make any necessary customizations to specific interface port settings.

802.1x readiness check

The 802.1X readiness check audits all the ports for 802.1X activity and displays information about the devices with 802.1X-supported ports. The 802.1X readiness check can be used to establish whether the devices connected to the ports are 802.1X-capable.

The 802.1X readiness check is allowed on all ports that can be configured for 802.1X. The 802.1X readiness check is not available on a port that is configured by the **dot1x port-control force-unauthorized** command.

When you execute the **dot1x test eapol-capable** command on an 802.1X-enabled port, and the link comes up, the port queries the connected client about its 802.1X capability. When the client responds with a notification packet, it is 802.1X-capable. A RASLog message is generated if the client responds within the timeout period. If the client does not respond to the query, the client is not 802.1X-capable, and a syslog message is generated indicating the client is not EAPOL-capable.

Follow these guidelines to enable the 802.1X readiness check on the device:

- The 802.1X readiness check is typically used before 802.1X is enabled on the device.
- 802.1X authentication cannot be initiated while the 802.1X readiness check is in progress.
- The 802.1X readiness check cannot be initiated while 802.1X authentication is active.
- 802.1X readiness can be checked on a per-interface basis.
- The 802.1X readiness check for all interfaces at once is not supported.
- The 802.1X test timeout is shown in the output of the **show dot1x** command.

Configuring 802.1x port authentication on specific interface ports

To configure 802.1x port authentication on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you wish to modify.

1. Enter the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. Use the **dot1x authentication** command to enable 802.1x authentication.

```
device(conf-if-te-5/1/12)# dot1x authentication
```

4. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

Configuring 802.1x timeouts on specific interface ports

NOTE
While you are free to modify the timeout values, Extreme recommends that you leave all timeouts set to their defaults.

To configure 802.1x timeout attributes on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you wish to modify.

1. Enter the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. Configure the **dot1x timeout** interval.

```
device(conf-if-te-5/1/12)# dot1x timeout supp-timeout 40
```

4. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

Configuring 802.1x port reauthentication on specific interface ports

To configure 802.1x port reauthentication on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you want to modify.

1. Enter the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. Use the **dot1x authentication** command to enable 802.1x authentication for the interface port.

```
device(conf-if-te-5/1/12)# dot1x authentication
```

4. Configure reauthentication for the interface port.

```
device(conf-if-te-5/1/12)# dot1x reauthentication
device(conf-if-te-5/1/12)# dot1x timeout re-authperiod 4000
```

5. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

6. Save the *running-config* file to the *startup-config* file.

```
device# copy running-config startup-config
```

Configuring 802.1x port-control on specific interface ports

To configure 802.1x port-control on a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you want to modify.

1. Use the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. Use the **dot1x authentication** command to enable 802.1x authentication for the interface port.

```
device(conf-if-te-5/1/12)# dot1x authentication
```

4. Change the port authentication mode to **auto**, **force-authorized** or **force-unauthorized**.

```
device(conf-if-te-5/1/12)# dot1x port-control overlay auto
```

5. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

Reauthenticating specific interface ports

To reauthenticate a supplicant connected to a specific interface port, perform the following steps from privileged EXEC mode. Repeat this task for each interface port you wish to reauthenticate.

1. Use the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. Use the **dot1x reauthenticate** command to re-authenticate a port where dot1x is already enabled.

```
device(conf-if-te-5/1/12)# dot1x reauthenticate
```

4. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

Disabling 802.1x on specific interface ports

To disable 802.1x authentication on a specific interface port, perform the following steps from privileged EXEC mode.

1. Enter the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. Use the **no dot1x port-control** command to disable 802.1x authentication.

```
device(conf-if-te-5/1/12)# no dot1x port-control
```

4. Return to privileged EXEC mode.

```
device(conf-if-te-5/1/12)# end
```

Disabling 802.1x globally

To disable 802.1x authentication globally, perform the following steps from privileged EXEC mode.

1. Enter the **configure** command to change to global configuration mode.

```
device# configure
```

2. Use the **no dot1x enable** command to disable 802.1x authentication.

```
device(config)# no dot1x enable
```

3. Return to privileged EXEC mode.

```
device(config)# end
```

Checking 802.1x configurations

To check 802.1x configurations, perform the following steps from privileged EXEC mode.

1. To view all dot1x configuration information, use the **show dot1x** command with the **all** keyword.

```
device# show dot1x all
```

2. To check 802.1x configurations for specific interface ports, use the **interface** command to select the interface port to modify.

```
device(config)# interface tengigabitethernet 5/1/12
```

3. To check 802.1x authentication statistics on specific interface ports, use the **show dot1x** command with the **statistics interface** keyword.

```
device# show dot1x statistics interface tengigabitethernet 5/1/12
```

4. To check all diagnostics information of the authenticator associated with a specific interface port, use the **show dot1x** command with the **diagnostics interface** keyword.

```
device# show dot1x diagnostics interface tengigabitethernet 5/1/12
```

5. To check all statistical information of the established session, use the **show dot1x** command with the **session-info interface** keyword.

```
device# show dot1x session-info interface tengigabitethernet 5/1/12
```

MAC authentication

In a network, many types of clients may gain access through publicly accessible ports and use the network resources. Such networks cannot be left unrestricted due to security concerns. There must be a mechanism to enforce authentication of the clients before allowing access to the network.

MAC authentication is a mechanism by which incoming traffic originating from a specific MAC address is switched or forwarded by the device only if the source MAC address is successfully authenticated by an authentication server. The RADIUS server is configured with a database of client MAC addresses that are allowed to gain access to the network. The MAC address itself is used as the username and password for authentication; and the user does not need to provide a specific username and password to gain network access.

When the authenticator device receives an Ethernet packet from the client, a RADIUS Access-Request packet containing the MAC address of the client is sent to the authentication server (RADIUS server).The RADIUS server looks up the database to validate the MAC address. If the MAC address is found in the database, the RADIUS server sends an Access-Accept packet to the device authenticating the client, and traffic from the client (MAC address) is forwarded normally.

The device supports multiple RADIUS servers; if communication with one of the RADIUS servers times out, the others are tried in sequential order. If a response from a RADIUS server is not received within a specified time (by default, 5 seconds) the RADIUS session times out, and the device retries the request up to 5 times. If no response is received, the next RADIUS server is chosen, and the request is sent for authentication.

If authorization fails, re-authentication attempt for the clients that are denied access will occur after a hold-off time of 300 seconds which is not configurable.

MAC authentication bypass

A single authentication method such as 802.1X authentication may not be compatible for all the clients that support different authentication methods.

Some clients such as printers and fax machines cannot respond to EAPOL messages to initiate 802.1X authentication. In such cases, it is not feasible to assign separate ports with specific authentication methods for different types of clients. MAC authentication bypass (MAB) provides a means to authenticate the client based on the MAC address, if the 802.1X authentication times out while waiting for an EAPOL message exchange.

MAB can be enabled only on an 802.1X authentication-enabled port. When the authenticator does not receive EAPOL response from the client to initiate 802.1X authentication after the maximum number of reauthentication attempts specified using the **dot1x reauthMax** command, MAB is triggered.

NOTE

The **dot1x reauthMax** command must be configured to a value from 3 through 10 to initiate MAB. If EAPOL response is received within the specified number of attempts, 802.1X authentication remains active and authentication request is sent to the RADIUS server.

When the port falls back to MAB mode, the device uses the MAC address as the client identity for authentication, and thereupon the port will not revert to the 802.1X authentication mode.

Dynamic VLAN assignment in MAC authentication and MAB

After successful MAC authentication, a VLAN assignment policy can be applied to control the destination of the client.

When a client or supplicant successfully completes the EAP authentication process, the authentication server (RADIUS server) sends the authenticator (the device) a RADIUS Access-Accept message that grants the client access to the network. Dynamic VLAN assignment allows clients to connect to the network anywhere and, based on their credentials, they get placed in the RADIUS-assigned VLAN irrespective of the ports to which they are connected.

For every MAC address, a VLAN can be assigned in the RADIUS server. The RADIUS Access-Accept message contains attributes set for the user in the user's access profile on the RADIUS server. A client is dynamically assigned to a VLAN based on the attribute sent from the RADIUS server. If one of the attributes in the Access-Accept message specifies a VLAN identifier (ID), and this VLAN is available on the device, the client's port is moved from its default VLAN to the specified VLAN. However, based on the VLAN response, device accepts only the first VLAN learned from the RADIUS server and all the subsequent authenticated clients are added to the same VLAN. The subsequent clients authenticated with different VLANs are rejected. When all MAC addresses learnt with dynamic VLAN are aged out, the interface is placed back in the default VLAN.

TABLE 11 RADIUS attributes for dynamic VLAN assignment

Attribute name	Type	Value
Tunnel-Type	064	13 (decimal) - VLAN
Tunnel-Medium-Type	065	6 (decimal) - 802
Tunnel-Private-Group-ID	081	*vlan-number* (decimal).

The device reads the attributes as follows:

- All three VLAN ID attributes (Tunnel-Private-Group-ID, Tunnel-Type, and Tunnel-Medium-Type) must be present in the response from the RADIUS server for VLAN processing.
- If the Tunnel-Type or Tunnel-Medium-Type attributes (or both) are not present, then the client is moved to the unauthorized state displaying an error message on the device.
- If the Tunnel-Type or Tunnel-Medium-Type attributes in the Access-Accept message have the values specified in the table, but there is no value specified for the Tunnel-Private-Group-ID attribute, the client will not become authorized.
- When the device receives the value specified for the Tunnel-Private-Group-ID attribute, it checks whether the vlan-ID matches the VLAN configured on the device. If there is a VLAN on the device that matches the vlan-ID, then the client's port is placed in the VLAN that corresponds to the VLAN ID.

If the RADIUS server does not assign any VLAN, the authenticated clients are added to the default VLAN. If the access port is configured with non-default VLAN, the client is moved to the non-default access VLAN irrespective of the VLAN assignment done in the RADIUS server. If MAC-based VLAN classifier is configured on the access port, the client is moved to the corresponding VLANs as per the VLAN classifier irrespective of the VLAN assignment done in the RADIUS server. The dynamically assigned VLAN will be removed and the device reverts to the default VLAN when the last authenticated MAC address is removed or ages out.

NOTE
VLAN assignment per supplicant is not supported.

Configuration notes for MAC authentication and MAB

- MAC authentication and MAB are supported only on Layer 2 switch ports configured as access ports. These authentication methods are not supported on port-channel members, port-channels, profiled port, ISL port, and trunk port.
- If 802.1X or MAB is enabled for a port, MAC authentication cannot be enabled on the same port.
- If the port authentication mode is set to force-authorized or force-unauthorized, the port does not fall back to MAB. That is, the port remains in port-based authentication mode itself.
- A maximum of 3000 clients (source MAC addresses) are supported for both MAC authentication and MAB respectively. This number includes both authenticated and non-authenticated MACs.
- MAC authentication and MAB are interoperable with port MAC security. If port MAC security is enabled on the port and the MAC limit is set to a value less than 3000 (MAC authentication scale limit) using the **switchport port-security max** command, the MAC limit set for port MAC security is honored for MAB and MAC authentication.
- If port MAC security is enabled on the same port, authentication request is sent only for the dynamically learnt MACs. Port MAC security secure MACs and sticky MACs are not supported.
- If ACL is applied on the access port or access VLAN, authentication request is sent only for the permitted packets and the MAC addresses are authenticated or denied as per the RADIUS database.
- MAC authentication is not supported with OUI security.
- All MAC authentication related configurations are persistent across the reboot.

Configuring MAC authentication bypass

To enable and activate MAC authentication bypass (MAB), perform the following steps.

MAB can be enabled only on an 802.1X authentication-enabled port and requires the same prerequisite tasks as for the 802.1X authentication. Before configuring MAB, communication between the devices and the authentication server must be established. The following configurations must be completed before configuring MAB:

- Configure the RADIUS server to authenticate access to the device. The **radius-server** command adds the RADIUS server to the device as the authentication server. This command can be repeated for additional servers. The **radius-server** command attempts to connect to the first RADIUS server. If the RADIUS server is not reachable, the next RADIUS server is contacted. If the RADIUS server is contacted and the authentication fails, the authentication process does not check for the next server in the sequence.

```
device(config)# radius-server host 10.0.0.5
```

1. (Optional) Enable the 802.1X readiness check on the device to determine if the devices connected to the ports are 802.1X-capable.

```
dot1x test eapol-capable interface Tengigabitethernet 5/1/12
DOT1X_PORT_EAPOL_CAPABLE:DOT1X: MAC 00-01-02-4b-f1-a3 on tengigabitethernet 5/1/12 is EAPOL capable.
```

2. Enter the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
```

3. Enable 802.1X authentication globally.

```
device(config)# dot1x enable
```

If you globally disable 802.1X authentication, then all interface ports with 802.1X authentication enabled, automatically switch to force-authorized port control mode.

4. Enter interface configuration mode to configure interface-specific administrative features for 802.1X authentication.

```
device(config)# interface Tengigabitethernet 5/1/12
```

5. Define the interface in Layer 2 mode to set the switching characteristics of the Layer 2 interface.

```
device(conf-if-te-5/1/12)# switchport
```

   All Layer 2 interfaces are mapped to default VLAN 1 and the interface is set to access mode. For changing the interface configuration mode to trunk or changing the default VLAN mapping, use additional switchport commands.

6. Enable 802.1X authentication on a specific interface port.

```
device(conf-if-te-5/1/12)# dot1x authentication
```

7. (Optional) Enter the dot1x port-control auto command to set the controlled port in the unauthorized state until authentication takes place between the client and the authentication server.

```
device(conf-if-te-5/1/12)# dot1x port-control auto
```

   The port control is set to auto by default. The action activates authentication on an 802.1X-enabled interface. Once the client passes authentication, the port becomes authorized for that client. The controlled port remains in the authorized state for that client until the client logs off.

8. Configure the device to periodically reauthenticate the clients connected to 802.1X-enabled interfaces at regular intervals.

```
device(conf-if-te-5/1/12)# dot1x reauthentication
```

   When you enable periodic reauthentication, the device reauthenticates the clients every 3,600 seconds by default.

9. (Optional) Configure the timeout parameters that determine the time interval for client reauthentication and EAP retransmissions using the following commands:
   - Enter the **dot1x timeout re-authperiod** command to change and specify a different reauthentication interval.

```
device(conf-if-te-5/1/12)# dot1x timeout re-authperiod 300
```

   - Enter the **dot1x timeout tx-period** command to change the amount of time the device should wait before retransmitting EAP-Request/Identity frames to the client.

```
device(conf-if-te-5/1/12)# dot1x timeout tx-period 30
```

   - Enter the **dot1x timeout supp-timeout** command to change the amount of time the device should wait before retransmitting RADIUS EAP-Request/Challenge frames to the client.

```
device(conf-if-te-5/1/12)# dot1x timeout supp-timeout 30
```

   Based on the timeout parameters, client reauthentication and retransmission of EAP-Request/Identity frames and EAP-Request/Challenge frames is performed.

10. Configure the maximum number of reauthentication attempts before the port goes to the unauthorized state.

```
device(conf-if-te-5/1/12)# dot1x reauthMax 3
```

    The maximum number of reauthentication attempts must be configured to a value from 3 through 10 to initiate MAB. If EAPOL response is received within the specified number of attempts, 802.1X authentication remains active and authentication request is sent to the RADIUS server.

11. Configure MAC authentication bypass to authenticate the client based on the MAC address if the 802.1X authentication times out while waiting for an EAPOL message exchange.

```
device(conf-if-te-5/1/12)# dot1x mac-auth-bypass
```

Configuring MAC authentication

To enable and activate MAC authentication, perform the following steps.

MAC authentication requires some prerequisite tasks be performed before executing MAC authentication configurations at the interface level. Before configuring MAC authentication, communication between the devices and the authentication server must be established. The following configurations must be completed before configuring MAC authentication:

- Configure the RADIUS server to authenticate access to the device. The **radius-server** command adds the RADIUS server to the device as the authentication server. This command can be repeated for additional servers. The **radius-server** command attempts to connect to the first RADIUS server. If the RADIUS server is not reachable, the next RADIUS server is contacted. If the RADIUS server is contacted and the authentication fails, the authentication process does not check for the next server in the sequence.

```
device(config)# radius-server host 10.0.0.5
```

1. (Optional) Enable the 802.1X readiness check on the device to determine if the devices connected to the ports are 802.1X-capable.

```
dot1x test eapol-capable interface tengigabitethernet 5/1/12
DOT1X_PORT_EAPOL_CAPABLE:DOT1X: MAC 00-01-02-4b-f1-a3 on tengigabitethernet 5/1/12 is EAPOL capable.
```

2. Enter the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
```

3. Enable 802.1X authentication globally.

```
device(config)# dot1x enable
```

   If you globally disable 802.1X authentication, then all interface ports with 802.1X authentication enabled, automatically switch to force-authorized port control mode.

4. Enter interface configuration mode to configure interface-specific administrative features for 802.1X authentication.

```
device(config)# interface Tengigabitethernet 5/1/12
```

5. Define the interface in Layer 2 mode to set the switching characteristics of the Layer 2 interface.

```
device(conf-if-te-5/1/12)# switchport
```

   All Layer 2 interfaces are mapped to default VLAN 1 and the interface is set to access mode. For changing the interface configuration mode to trunk or changing the default VLAN mapping, use additional switchport commands.

6. Configure MAC authentication to authenticate the client based on the MAC address.

```
device(conf-if-te-5/1/12)# dot1x mac-auth-enable
```

Fabric Authentication

Fabric authentication overview

When you connect an Extreme VCS Fabric to a Fabric OS fabric, the Fibre Channel E_Ports on the hardware connect through Inter-Switch Links (ISLs) to EX_Ports on an FC router, which in turn connects to the Fabric OS network.

Refer to the Fibre Channel ports overview section of the *Extreme Network OS Management Configuration Guide*.

To ensure that no unauthorized devices can access the fabric, the software provides support for security policies and protocols capable of authenticating the software (E_Ports) to the EX_Ports on the FC router (FCR) that provides access to the SAN storage and services.

Understanding fabric authentication

This section presents a brief overview of SSH server key exchange, configuring an authentication policy and device authentication, and configuring SCC policy sets.

DH-CHAP

The software uses the Diffie-Hellman Challenge Handshake Authentication Protocol (DH-CHAP) to control access between devices. DH-CHAP is a password-based, key exchange authentication protocol that negotiates hash algorithms and Diffie Hellman (DH) groups before performing authentication. It supports both MD5 and SHA-1 hash algorithm-based authentication.

The Fibre Channel Security Protocol (FC-SP) defines the DH groups supported in the DH-CHAP protocol. Following current FC-SP standards, the software supports the following DH groups:

- 00 - DH Null option
- 01 - 1024 bit key
- 02 - 1280 bit key
- 03 - 1536 bit key
- 04 - 2048 bit key

To configure DH-CHAP authentication between devices (E_Ports) and FC routers (EX_Ports) you must apply a matching configuration to both sides of the connection. Each device must be configured locally.

Configuring an authentication policy

The device authentication (AUTH) policy initiates DH-CHAP authentication on all E_Ports. This policy is persistent across reboots, which means authentication will be initiated automatically on ports or devices brought online if the policy is active. You must configure the AUTH policy on all connected fabric entities.

If you are in logical chassis mode, the authentication policy is *not* distributed across the fabric. The RBridge ID of the node should be used to configure protocol and policy configurations.

By default the policy is set to PASSIVE and you can change the policy. All changes to the AUTH policy take effect during the next authentication request. This includes starting authentication on all E_Ports on the local device if the policy is changed to ON or ACTIVE, and clearing the authentication requirement if the policy is changed to OFF.

Authentication policy configuration is not distributed across the fabric. The RBridge ID of the node should be used to configure protocol and policy configurations.

You can set the authentication policy to any of the values listed in the following table. The remaining attributes are optional.

TABLE 12 User account attributes

Setting	Description
ON	Strict authentication is enforced on all E_Ports. During device initialization, authentication is initiated on all E_Ports automatically. The authentication handshaking is completed before the devices exchange the fabric parameters (EFP) for E_Port bring-up. If the connecting device does not support the authentication or the policy is turned off, all ports are disabled and the ISL goes down.
ACTIVE	A device with an ACTIVE policy is more tolerant and can connect to a device with any type of policy. During device initialization, authentication is initiated on all E_Ports, but the port is not disabled if the connecting device does not support authentication, or if the authentication policy is turned off.
PASSIVE (default)	The device does not initiate authentication, but participates in authentication if the connecting device initiates authentication. The device does not start authentication on E_Ports, but accepts the incoming authentication requests, and will not be disabled if the connecting device does not support authentication or the policy is turned off.
OFF	The device does not support authentication, and rejects any authentication negotiation request from a neighbor device or device. A device with the policy set to OFF should not be connected to a device with a policy set to ON. A policy set to ON policy is strict and disables the port if a peer rejects the authentication. DH CHAP shared secrets must be configured on both sides of the connection before you can change the policy from an OFF state to an ON state.

The behavior of the policy between two adjacent devices is defined as follows:

- If the policy is ON or ACTIVE, the device sends an Authentication Negotiation request to the connecting device.
- If the connecting device does not support authentication or the policy is OFF, the request is rejected.
- Once the authentication negotiation succeeds, the DH-CHAP authentication is initiated. If DH-CHAP authentication fails, the port is disabled, regardless of the policy settings.

The policy defines the responses of the host if the connecting device does not support authentication. By default, the policy is set to PASSIVE and you can change the policy with the **fcsp auth** command. This includes starting authentication on all E_Ports if the policy is changed to ON or ACTIVE, and clearing the authentication if the policy is changed to OFF. Before enabling the policy, you must install the DH-CHAP shared secrets. Refer to Configuring DH-CHAP shared secrets on page 114.

Configuring DH-CHAP shared secrets

To configure the DH-CHAP shared secrets, enter the **fcsp auth-secret** command in privileged EXEC mode. Provide the following information as shown in the example:

- The world wide name (WWN) of the peer.
- The secret of the peer that authenticates the peer to the local device.

- The local secret that authenticates the local device to the peer.

  NOTE
  Only the following non-alphanumeric characters are valid for the secret key:@ $ % ^ & * ( ) _ + - < > { } [ ] ; ' :

```
device# fcsp auth-secret dh-chap node 10:00:00:05:1e:7a:c3:00 peer-secret    12345678 local-secret 87654321
Shared secret is configured successfully.
```

To display the device (WWN) for which the shared secret is configured, use the **show fcsp auth-secret dh-chap** command in privileged EXEC mode.

```
device# show fcsp auth-secret dh-chap 10:00:00:05:1e:7a:c3:00
```

To remove the shared secrets, use the **no fcsp auth-secret** command in privileged EXEC mode.

```
device# no fcsp auth-secret dh-chap node 10:00:00:05:1e:7a:c3:00
Shared secret successfully removed
```

Setting up secret keys

Setting up secret keys can quickly become an administrative challenge as your fabric size increases. As a minimum, key pairs need to be installed on all connected fabric entities. However, when connections change, you must install new key pairs to accommodate these changes. If you anticipate this situation, you may install key pairs for all possible connections up front, thus enabling links to change arbitrarily while still maintaining a valid key pair for any new connection.

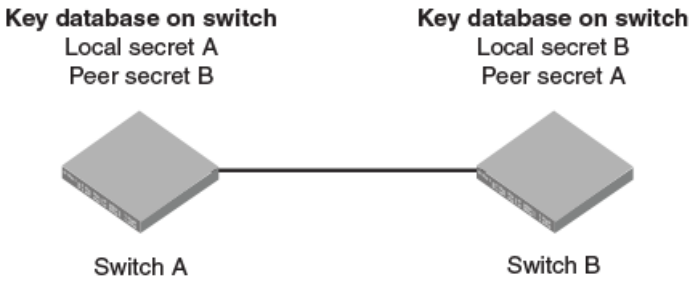
Shared secret keys

When you configure device ports for DH-CHAP authentication, you define a pair of shared secrets known to both devices as a secret key pair. A key pair consists of a local secret and a peer secret. The local secret uniquely identifies the local device. The peer secret uniquely identifies the entity to which the local device may authenticate. Every device may share a secret key pair with any other device or host in a fabric.

Shared secret keys have the following characteristics:

- The shared secrets must be configured locally on every device.
- If shared secrets are not set up for a link, authentication fails. The “Authentication Failed” error is reported for the port.
- The minimum length of a shared secret is 8 bytes and the maximum 40 bytes.

FIGURE 3 DH-CHAP authentication



The preceding figure illustrates how the secrets are configured. Assume two devices, A and B. Each device has a local secret (local secret A and local secret B), and a matching peer secret (peer secret A and peer secret B). If device B wants to shake hands with A, it will use A’s local secret (B’s peer secret A) to send the information. In doing so, A authenticates B by confirming its identity through the exchange of matching secret pairs. Conversely, B authenticates A when A sends information to B using B’s local secret (A’s peer secret B).

On the FC router, the authentication configuration for EX_Ports is set to fixed default values and cannot be changed. The Fabric OS **authutil** command is applicable only to the E_Ports on the FC router, not to EX_Ports. The following table shows the default authentication configuration for EX_Ports:

TABLE 13 Default EX_Port configuration

Operand	Value
Auth-type	DHCHAP
Auth-Policy	PASSIVE
Auth-Group	* (0, 1, 2, 3, 4)
Auth-Hash	msd5, sha1

Setting the authentication policy parameters

The following procedure configures an authentication policy auth-type DH-CHAP (only option), a DH group of 2, and a hash type of md5. The switch policy is set to OFF until you are ready to explicitly activate the policy.

1. In privileged EXEC mode, use the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **fcsp auth** command with the specified parameters.

```
device(config)# fcsp auth auth-type dh-chap hash md5 group 2 switch policy off
```

3. Enter the **do show running-config fcsp auth** command to verify the configuration.

```
device(config)# do show running-config fcsp auth
fcsp auth group 2
fcsp auth hash md5
fcsp auth policy switch off
```

Activating the authentication policy

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.

```
device# configure terminal
Entering configuration mode terminal
```

2. Enter the **fcsp auth auth-type** command to change the policy state from OFF to ON.

```
device(config)# fcsp auth auth-type switch policy on
```

3. Enter the **do show running-config fcsp auth** command to verify the configuration.

```
device(config)# do show running-config fcsp auth
fcsp auth group 2
fcsp auth hash md5
fcsp auth policy switch on
```

Switch connection control policy

The Switch Connection Control (SCC) policy controls access between neighboring devices. The policy defines and restricts which devices can join the fabric. Each time an E_Port-to-EX_Port connection is attempted, the devices are checked against the policy and the connection is either accepted or rejected depending on whether the connecting device is listed in the policy. The policy is named SCC_POLICY and accepts members listed as world wide names (WWNs).

A device configured with an active SCC policy reviews its database whenever a neighboring device tries to establish a connection. If the WWN of the connecting device is found in the SCC active policy database, the connecting device is allowed to join the fabric. If the neighboring device is not specified in the SCC policy active list, both devices are segmented.

By default, any device is allowed to join the fabric; the SCC policy is not enforced until it is created and activated. Creating a policy without any entries blocks access from all devices. The local device is not required to be included in a device-local SCC policy.

SCC policy commands are not distributed across the fabric. The RBridge ID of the node should be used to configure policy configurations.

Configuring defined and active SCC policy sets

The Switch Connection Control (SCC) policy maintains two versions, active, and defined, and creating a policy includes two distinct operations:

1. Creating the defined SCC policy set.

2. Activating the SCC policy.

The defined policy includes a list of WWN members and it is configurable. You can create the SCC policy and its members using a single command, **secpolicy defined-policy SCC_POLICY**. Or you can create the SCC policy first and add the members later. You can modify the defined policy at any time thereafter.

When you create the SCC policy and its defined member set, it remains inactive until you explicitly activate the policy with the **secpolicy activate** command. The SCC policy is enforced on the E_Ports only after you activate the policy. When the policy is active, only the members included in the activated policy can communicate with each other. If you add additional devices to the defined policy, they remain inactive and access is blocked until you active the defined policy again.

Follow these guidelines and restrictions when configuring SCC policy:

- During the configuration replay operation, the defined and active policies are replayed and the E_Ports are enabled or disabled based on the SCC policy entries in the active policy list.

  During a configuration replay operation, if an E_Port is already disabled due to a violation, it will not come online even if the WWN entry is found in the active policy list. You must explicitly bring up the E_Port to enforce the active policy.
- During execution of the **copy file running-config** command, only the defined policy in the device is updated with the config file entries; the active policy entries remain unchanged. In this case, you must use the **secpolicy activate** command to activate the defined policy list.
- If an empty policy is created and activated, but not saved, all Fibre Channel (FC) E_Ports will be in the disabled state after a reboot.
- Network OS requires that you invoke the **shutdown** command, followed by the **no shutdown** command to bring up the E_Port. Invoking the **no shutdown** command alone does not enable the port.

Creating a defined SCC policy

The following procedure creates a Switch Connection Control (SCC) policy, adds two members, and verifies the configuration.

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.

2. Issue the **rbridge-id** command.
3. Enter the **secpolicy defined-policy SCC_POLICY** command.

   This command places you into the defined SCC configuration mode where you can add policy member WWNs.
4. Specify a policy member with the **member-entry** *WWN* command.
5. Specify a second policy member with the **member-entry** *WWN* command.
6. Exit the defined SCC configuration mode.
7. Enter the **do show running-config secpolicy defined-policy** command to verify the configuration.

Creating an SCC policy in VCS mode

This example creates an SCC policy in VCS mode:

```
device# config
Entering configuration mode terminal

device(config)# rbridge-id 3

device(config-rbridge-id-3)# secpolicy defined-policy SCC_POLICY

device(config-defined-policy-SCC_POLICY)# exit

device(config)#
```

Creating an SCC policy and adding members into the defined policy set in VCS mode

This VCS mode example creates a SCC policy and adds members into the defined policy set

```
device# config
Entering configuration mode terminal

device(config)# secpolicy defined-policy SCC_POLICY member-entry 10:00:00:05:1e:00:69:00

device(config-member-entry-10:00:00:05:1e:00:69:00)# exit

device(config-defined-policy-SCC_POLICY)# exit

device(config)# exit
```

Modifying the SCC policy

The same command sequence that creates the Switch Connection Control (SCC) policy adds additional members. The defined SCC member entries are cumulative. Use the **no member-entry** command to remove members from the policy.

The following example adds a member and subsequently removes the same added member:

```
device# configure terminal
Entering configuration mode terminal

device(config)# rbridge-id 3

device(config-rbridge-id-3)# secpolicy defined-policy SCC_POLICY

device(config-defined-policy-SCC_POLICY)# member-entry 10:00:00:05:1e:00:69:00

device(config-defined-policy-SCC_POLICY)# no member-entry 10:00:00:05:1e:00:69:00

device(config-defined-policy-SCC_POLICY)# exit

device(config-rbridge-id-3)# do show running-config secpolicy defined-policy
secpolicy defined-policy SCC_POLICY
 member-entry 10:00:00:05:1e:00:69:00
```

```
 !
 member-entry 10:00:00:08:2f:00:79:00
```

Activating the SCC policy

1. Define the SCC policy as shown in section Creating a defined SCC policy on page 117.
2. Enter the **secpolicy activate** command in privileged EXEC mode.
3. Enter the **do show running-config secpolicy active -policy** command to verify the configuration.

VCS mode example

```
device# secpolicy activate rbridge-id 3

device# do show running-config rbridge-id 3 secpolicy defined-policy rbridge-id 3
secpolicy defined-policy SCC_POLICY
 member-entry aa:aa:aa:aa:aa:aa:aa:aa
 !
 member-entry bb:bb:bb:bb:bb:bb:bb:bb
 !
 member-entry cc:cc:cc:cc:cc:cc:cc:cc
 !
!
```

Removing the SCC Policy

1. In privileged EXEC mode, issue the **configure terminal** command to enter global configuration mode.
2. Enter the **no secpolicy defined-policy SCC_POLICY** command.
3. Exit global configuration mode.
4. Activate the SCC policy to save the defined policy configuration to the active configuration.
5. Enter the **do show running-config secpolicy active-policy** command to verify that the policy is empty.

Removing an entry from the policy list of RBridge ID 3 in VCS mode

```
device# configure terminal
Entering configuration mode terminal

device(config)# rbridge-id 3

device(config-rbridge-id-3)# no secpolicy defined-policy SCC_POLICY member-entry 10:00:00:05:1e:00:69:01

device(config)# exit

device# do show running-config secpolicy active-policy
% No entries found.
```

Removing the SCC_POLICY entry of RBridge ID 3 in VCS mode

```
device# configure terminal
Entering configuration mode terminal

device(config)# rbridge-id 3

device(config-rbridge-id-3)# no secpolicy defined-policy SCC_POLICY

device(config)# exit

device# do show running-config secpolicy active-policy
% No entries found.
```

Port MAC Security

Port MAC security overview

Port MAC security can be used to prevent administrators or malicious users from being able to change the MAC address of a virtual machine (VM) in a data center environment. This is especially helpful in virtual desktop infrastructure (VDI) environments, where users might have full administrative control of the VM and can change the MAC address of a virtual network interface card (vNIC). Here port security can be used to provide more control over the behavior of VMs.

The secured ports can be categorized as either trusted or untrusted. The administrator can apply policies appropriate to those categories to protect against various types of attacks. Port MAC security features can be turned on to obtain the most robust port-security level that is appropriate. Basic port MAC security features are enabled in the device's default configuration. Additional features can be enabled with minimal configuration steps.

The following port MAC security features enhance security at Layer 2:

- MAC address limiting—This restricts input to an interface by limiting and identifying the MAC addresses of workstations that are allowed to access the port. When secure MAC addresses are assigned to a secure port, the port does not forward packets with source addresses outside the group of defined addresses.
- OUI-based port security—If an administrator knows which types of systems are connecting to the network, it is possible to configure an Organizationally Unique Identifier (OUI) on a secure port to ensure that only traffic coming from devices that are part of the configured OUI is forwarded.
- Port MAC security with sticky MAC addresses—Using sticky MAC addresses is similar to using static secure MAC addresses, but sticky MAC addresses are learned dynamically. These addresses are retained when a link goes down.

Default port MAC security configuration options

Port MAC security is disabled by default. The following table summarizes default port MAC security configuration options that are applied to an interface when it is made a secure port.

TABLE 14 Default configurations for port MAC security

Feature	Default configuration
Max. number of secure MAC addresses	8192
Violation mode	Shutdown
Shutdown time (minutes)	0

Port MAC security commands

Port MAC security is enabled on an interface by means of a series of switchport commands. For configuration examples, refer to Configuring port MAC security section and the *Network OS Command Reference*.

Command	Description
switchport port-security	Enables or disables port MAC security on an interface port.

Command	Description
switchport port-security mac-address	Configures the MAC address option for port MAC security on an interface port.
switchport port-security max	Configures the maximum number of MAC addresses used for port MAC security on an interface port.
switchport port-security oui	Configures an Organizationally Unique Identifier (OUI) MAC address for port MAC security on an interface port.
switchport port-security shutdown-time	Configures the shutdown-time option for port MAC security on an interface port.
switchport port-security sticky	Converts dynamic MAC addresses to sticky secure MAC addresses.
switchport port-security violation	Configures the violation response options for port MAC security on an interface.

Port MAC security troubleshooting commands

The following commands can be used to troubleshoot port security configuration issues.

Command	Description
show ip interface brief	Displays port-security status when the port MAC security feature is applied.
show port-security	Displays the configuration information related to port MAC security.
show port-security addresses	Displays the configuration information related to port MAC security addresses.
show port-security interface	Displays the configuration information related to port MAC security interfaces.
show port-security oui interface	Displays the configuration information related to port MAC security for Organizationally Unique Identifier (OUI) interfaces.
show port-security sticky interface	Displays the configuration information related to port MAC security for a sticky interface

Port MAC security guidelines and restrictions

Note the following guidelines and restrictions for configuring port MAC security:

- A port mode change is not allowed when port MAC security is enabled on the interface.
- A maximum of 4 OUIs are allowed per secure port. A maximum of 20 secure ports are allowed to enable OUI-based port MAC security.
- Static secure MAC addresses are not supported for OUI-based port security.
- When the user tries to configure the first OUI IPv4 address on a secure port, traffic is flooded until all entries are programmed in the hardware.
- If a port MAC security-based change occurs when a port is shut down, the shutdown timer is not triggered. Consequently, the user must restore the full functionality of the port.
- When port MAC security causes a port to be shut down and the user manually changes the shutdown time, the shutdown timer is reset and the timer starts with the new shutdown time.
- A secure port cannot be a destination port for Switch Port Analyzer (SPAN) purposes, because the port cannot be a Layer 2 port.
- Port MAC security configurations are not allowed on member interfaces of a link aggregation group (LAG). They are allowed on the LAG interface, however, as they are in other Layer 2 configurations.
- Static MAC addresses cannot be configured on a secure port. They must be configured as secure MAC addresses on the secure port.
- Access control lists (ACLs) take precedence over the port MAC security feature.

Configuring port MAC security

The following section covers how to configure port MAC security for access and trunk ports, set port MAC security MAC address limits and shutdown time, set up OUI-based port security, and configure port MAC security with sticky MAC addresses.

Refer also to Port MAC security overview on page 121.

Configuring port MAC security on an access port

To enable port MAC security on an access port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

```
device(config)# interface TenGigabitEthernet 1/0/1
```

2. Put the interface in Layer 2 mode by using the **switchport** command.

```
device(conf-if-te-1/0/1)# switchport
```

3. Enable switchport security by using the **switchport port-security** command.

```
device(conf-if-te-1/0/1)# switchport port-security
```

Configuring port MAC security on a trunk port

To enable port MAC security on a trunk port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

```
device(config)# interface TenGigabitEthernet 1/0/1
```

2. Put the interface in Layer 2 mode by using the **switchport** command.

```
device(conf-if-te-1/0/1)# switchport
```

3. Set the mode of the interface to trunk.

```
device(conf-if-te-1/0/1)# switchport mode trunk
```

4. Set the VLANs that will transmit and receive through the Layer 2 interface.

```
device(conf-if-te-1/0/1)# switchport trunk allowed vlan add 100
```

5. Enable switch port security by using the **switchport port-security** command.

```
device(conf-if-te-1/0/1)# switchport port-security
```

Configuring port MAC security MAC address limits

To configure the MAC address option for port MAC security on an interface port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

```
device(config)# interface TenGigabitEthernet 1/0/1
```

2. Put the interface in Layer 2 mode by using the **switchport** command.

```
device(conf-if-te-1/0/1)# switchport
```

3. Set the MAC address and VLAN ID for the interface.

```
device(conf-if-te-1/0/1)# switchport port-security mac-address 1000.2000.3000 vlan 100
```

Configuring port MAC security shutdown time

You can configure two responses to a violation of port security: **restrict** and **shutdown**.

- The **restrict** option drops packets that have unknown source addresses until you remove a sufficient number of secure MAC addresses until this value is below that set by the **switchport port-security max** command.
- The **shutdown** option puts the interface in the error-disabled state immediately for a predetermined amount of time.

To configure the port MAC security shutdown time for an interface port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

```
device(config)# interface TenGigabitEthernet 1/0/1
```

2. Put the interface in Layer 2 mode by using the **switchport** command.

```
device(conf-if-te-1/0/1)# switchport
```

3. Set the violation response option to shutdown.

```
device(conf-if-te-1/0/1)# switchport port-security violation shutdown
```

4. Set the shutdown time, in minutes.

```
device(conf-if-te-1/0/1)# switchport port-security shutdown-time 10
```

Configuring OUI-based port MAC security

If you know which types of systems are connected to your network, use this security feature to configure an Organizationally Unique Identifier (OUI) MAC address on a secure port. This ensures that only traffic from a known OUI MAC address is forwarded.

To configure OUI-based port MAC security, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

```
device(config)# interface TenGigabitEthernet 1/0/1
```

2. Put the interface in Layer 2 mode by using the **switchport** command.

```
device(conf-if-te-1/0/1)# switchport
```

3. Configure a permitted OUI MAC address by using the **switchport port-security oui** command.

```
device(conf-if-te-1/0/1)# switchport port-security oui 2000.3000.4000
```

Configuring port MAC security with sticky MAC addresses

You can configure an interface to convert dynamic MAC addresses to sticky secure MAC addresses and add them to the running-config by enabling sticky learning. This converts all dynamic secure MAC addresses, including those learned dynamically before sticky learning was enabled, to sticky secure MAC addresses.

To configure sticky MAC addresses on a secure port, do the following in global configuration mode.

1. Enable interface subconfiguration mode for the interface you want to modify.

```
device(config)# interface TenGigabitEthernet 1/0/1
```

2. Put the interface in Layer 2 mode by using the **switchport** command.

```
device(conf-if-te-1/0/1)# switchport
```

3. Enable switchport security by using the **switchport port-security oui** command.

```
device(conf-if-te-1/0/1)# switchport port-security oui 2000.3000.4000
```

4. Configure the sticky option.

```
device(conf-if-te-1/0/1)# switchport port-security sticky
```

SSH - Secure Shell

Configuring SSH encryption protocol

Secure Shell (SSH) is a protocol which encrypts remote access connections to network devices.

Using encrypted shared keys, SSH authenticates clients or servers, ensuring that the devices accessing your network are authentic.

The steps to configuring SSH are:

- Configure the SSH Server and Client ciphers.
- Configure the SSH Server and Client key-exchange algorithms.
- Configure the SSH Server and Client MACs.
- Configure the maximum number of SSH sessions.

Ciphers, non-CBC ciphers, algorithms, and MACs are not mutually exclusive. Any combination of these items may be configured on the device.

Configuring SSH ciphers

Configures the Secure Shell (SSH) ciphers.

Refer to the online help on the device for the complete list of supported ciphers.

1. Enter global configuration mode.

```
device# configure terminal
```

2. Enter Rbridge-ID configuration mode.

```
device(config)# rbridge-id 1
```

3. Use the **ssh server cipher** command to set the server cipher for SSH.

   You can use multiple ciphers by separating the string names with commas.

```
device(config-rbridge-id-1)# ssh server cipher aes192-cbc,aes128-ctr
```

4. Use the **ssh client cipher** command to set the client cipher for SSH.

   You can use multiple ciphers by separating the string names with commas.

```
device(config-rbridge-id-1)# ssh client cipher aes192-cbc,aes128-ctr
```

5. Shutdown and restart the SSH server using the **ssh server shutdown** command.

```
device(config)# ssh server shutdown
device(config)# no ssh server shutdown
```

6. Confirm the cipher setting with the **show running-config** command or the **show ssh** command.

```
device(config-rbridge-id-1)## show running-config rbridge-id ssh server cipher
rbridge-id 1
ssh server cipher aes192-cbc,aes128-ctr

device(config-rbridge-id-1)## show running-config rbridge-id ssh client cipher
rbridge-id 1
ssh client cipher aes192-cbc,aes128-ctr

device(config-rbridge-id-1)# do show ssh server status rbridge-id 1
rbridge-id 1:SSH server status:Enabled
rbridge-id 1: SSH Server Cipher: aes192-cbc,aes128-ctr

device(config-rbridge-id-176)# do show ssh client status rbridge-id 1
rbridge-id 1: SSH Client Cipher: aes192-cbc, aes128-ctr
```

Typical command sequence:

```
device# configure terminal
device(config)# rbridge-id 1
device(config-rbridge-id-1)# ssh server cipher aes192-cbc, aes128-ctr
device(config-rbridge-id-1)# ssh client cipher aes192-cbc, aes128-ctr
device(config-rbridge-id-1)# do show ssh server status rbridge-id 1
rbridge-id 1:SSH server status:Enabled
rbridge-id 1: SSH Server Cipher: aes192-cbc,aes128-ctr

device(config-rbridge-id-176)# do show ssh client status rbridge-id 1
rbridge-id 1: SSH Client Cipher: aes192-cbc, aes128-ctr
```

Configuring non-CBC SSH cipher

Configures the non-CBC ciphers for Secure Shell (SSH).

1. Enter global configuration mode.

```
device# configure terminal
```

2. Enter Rbridge-ID configuration mode.

```
device(config)# rbridge-id 1
```

3. Use the **ssh server cipher** command to set the server cipher for SSH.

```
device(config-rbridge-id-1)# ssh server cipher non-cbc
```

4. Use the **ssh client cipher** command to set the client cipher for SSH.

```
device(config-rbridge-id-1)# ssh client cipher non-cbc
```

5. Shutdown and restart the SSH server using the **ssh server shutdown** command.

```
device(config)# ssh server shutdown
device(config)# no ssh server shutdown
```

6. Confirm the cipher setting with the **show running-config** command to set the client cipher version for SSH.
7. Confirm the cipher setting with the **show running-config** command to set the client cipher version for SSH.

```
device(config-rbridge-id-1)# ssh client cipher non-cbc
```

Typical command sequence:

```
device# configure terminal
device(config)# rbridge-id 1
device(config-rbridge-id-1)# ssh server cipher non-cbc
device(config-rbridge-id-1)# ssh client cipher non-cbc
```

Removing an SSH cipher

The "no" form of the **ssh server cipher** and **ssh client cipher** commands sets the SSH ciphers back to the default algorithms.

1. Enter global configuration mode.

   ```
   device# configure terminal
   ```

2. Enter Rbridge-ID configuration mode.

   ```
   device(config)# rbridge-id 1
   ```

3. Use the **no ssh server cipher** command to remove the server cipher for SSH.

   You can remove multiple ciphers by separating the string names with commas.

   ```
   device(config-rbridge-id-1)# no ssh server cipher
   ```

4. Use the **no ssh client cipher** command to remove the client cipher for SSH.

   You can remove multiple ciphers by separating the string names with commas.

   ```
   device(config-rbridge-id-1)# no ssh client cipher
   ```

Configuring SSH key-exchange

The SSH key-exchange specifies the algorithms used for generating one-time session keys for encryption and authentication with the SSH server.

Refer to the online help on the device for the complete list of supported key exchange algorithms.

For backward compatibility, the string "dh-group-14" is also acceptable in place of "diffie-hellman-group-14-sha1".

1. Enter global configuration mode.

   ```
   device# configure terminal
   ```

2. Enter Rbridge-ID configuration mode.

   ```
   device(config)# rbridge-id 3
   ```

3. Use the **ssh server key-exchange** command to set the key exchange algorithm for the server.

   You can use multiple key exchange algorithms by separating the string names with commas.

   ```
   device(config-rbridge-id-3)# ssh server key-exchange diffie-hellman-group14-sha1,ecdh-sha2-nistp521
   ```

4. Use the **ssh client key-exchange** command to set the key exchange algorithm for the client.

   You can use multiple key exchange algorithms by separating the string names with commas.

   ```
   device(config-rbridge-id-3)# ssh client key-exchange diffie-hellman-group14-sha1,ecdh-sha2-nistp521
   ```

5. Restart the SSH server using the **no ssh server shutdown** command.

Typical command sequence example.

```
device# configure terminal
device(config)# rbridge-id 3
device(config-rbridge-id-3)# ssh server key-exchange diffie-hellman-group14-sha1, ecdh-sha2-nistp521
device(config-rbridge-id-3)# ssh client key-exchange diffie-hellman-group14-sha1, ecdh-sha2-nistp521
```

Removing an SSH key-exchange

The "no" version of the **ssh server key-exchange** command is used to reset the SSH key exchange algorithms back to the default values.

1. Enter configure terminal mode.

   ```
   device#configure terminal
   ```

2. Enter RBridge ID mode.

   ```
   device(config)#rbridge-id 3
   ```

3. Use the **no ssh server key-exchange** command to reset the key exchange algorithm for the server to the default value.
4. Use the **no ssh client key-exchange** command to reset the key exchange algorithm for the client to the default value.

Configuring SSH MAC

Configures SSH Server and Client Message Authentication Codes (MACs).

SSH server must be enabled.

Refer to the online help on the device for the complete list of supported MACs.

1. Enter configure terminal mode.

   ```
   device#configure terminal
   ```

2. Enter RBridge ID mode.

   ```
   device(config)#rbridge-id 176
   ```

3. On the SSH server, enter the **ssh server mac** command to configure the SSH server information.

   You can use multiple MACs by separating the string names with commas.

   ```
   device(config-rbridge-id-176)# ssh server mac hmac-sha1,hmac-sha2-256,hmac-sha2-512
   ```

4. On the SSH client, enter the **ssh client mac** command to configure the SSH client information.

   You can use multiple MACs by separating the string names with commas.

   ```
   device(config-rbridge-id-176)# ssh client mac hmac-sha1,hmac-sha2-256,hmac-sha2-512
   ```

5. Restart the SSH server using the **no ssh server shutdown** command.
6. Enter the **show ssh** command to confirm the SSH configuration information.

   ```
   device(config-rbridge-id-176)# do show ssh server status
   rbridge-id 176:SSH Server Mac : hmac-md5,hmac-sha1,hmac-sha2-256 rbridge-id 176
   VRF-Name: mgmt-vrf    Status: Enabled
   VRF-Name: default-vrf    Status: Enabled
   ```

Removing an SSH MAC

Removes SSH Server and Client Message Authentication Codes (MACs).

The "no" form of the **ssh server mac** and **ssh client mac** commands removes the MACS.

1. Enter configure terminal mode.

```
device# configure terminal
```

2. Enter RBridge ID mode.

```
device(config)#rbridge-id 176
```

3. On the SSH server, enter the **no ssh server mac** command to set the SSH server MACs to default values.
4. Restart the SSH server using the **no ssh server shutdown** command.
5. On the SSH client, enter the **no ssh client mac** command to set the SSH server MACs to default values.

Importing an SSH public key

Importing an SSH public key allows you to establish an authenticated login for a switch.

You must be in privileged EXEC mode to import an SSH public key to a switch.

1. To import an SSH public key, enter **certutil import sshkey**, followed by **user** *Username* **host** *IP_Address* **directory** *File_Path* **file** *Key_filename* **login** *Login_ID*.

```
device# certutil import sshkey user admin host 10.70.4.106 directory /users/home40/bmeenaks/.ssh
file id_rsa.pub login fvt
```

   This enables you to import the SSH public key for the user "admin" from a remote host.

2. Enter the password for the user.

```
Password: ***********

device# 2012/11/14-10:28:58, [SEC-3050], 75,, INFO, VDX6740-48, Event: sshutil, Status: success,
Info: Imported SSH public key from 10.70.4.106 for user 'admin'.
```

   NOTE

   In a VCS Fabric, you must enter RBridge ID configuration mode before issuing the command.

```
device# certutil import sshkey user admin host 10.70.4.106 directory /users/home40/bmeenaks/.ssh file
id_rsa.pub login fvt rbridge-id 3
```

Deleting an SSH public key

Deleting an SSH public key from a switch prevents it from being used for an authenticated login.

You must be in privileged EXEC mode to delete an SSH public key from a switch.

To delete an SSH public key, enter **no certutil sshkey user** *Username* followed by either **rbridge-id** *rbridge-id* or **rbridge-id all**.

```
device# no certutil sshkey user admin rbridge-id all
```

Specifying a specific RBridge ID removes the key from that RBridge ID; specifying all removes it from all RBridge IDs on the switch.

Configuring self-signed certificates for VXLAN gateways

For the details of generating and removing a self-signed certificate on a VXLAN gateway, refer to "VXLAN gateway and NSX Controller deployments" in the *Network OS Layer 2 Switching Configuration Guide*.

Removing self-signed certificates for VXLAN gateways

Use the **nsx-controller client-cert delete** command to remove the certificate.

1. Use the **nsx-controller client-cert delete** command to remove the certificate.

   You can remove multiple ciphers by separating the string names with commas.

   ```
   device# nsx-controller client-cert delete
   ```

2. Use the **show nsx-controller client-cert** command to verify the configuration.

Configuring the maximum number of SSH sessions

An SSH server can reuse an already established TCP connection for multiple sessions (also known as multiplexing). This reduces the time required to open a new connection for each SSH session, as well as the overhead of allocating separate resources for each connection.

SSH clients must also be configured to support multiplexing, in accordance with local best practices.

Note the following additional usage guidelines.

After executing this command, in order to use the new number of sessions, you must first shut down the SSH server, by means of the **ssh server use-vrf shutdown** command, and then restart it, by means of the **no ssh server use-vrf shutdown** command.

The maximum number of sessions specified by this command is synchronized to the standby management module (MM). However, to make the change effective on the standby MM, you must first disable service on that module by means of the **no ssh server standby enable** command, and then reenable service by means of the **ssh server standby enable** command.

Use the **show running-config rbridge-id ssh server** command or the **show ssh server status** command to confirm the configuration.

A downgrade to a previous release is blocked if this command has been executed in the running configuration.

Use the **no ssh server max-sessions** command to revert to the default of 1 session. You must also stop and restart service as in the usage guidelines above.

1. From global configuration mode, enter RBridge ID configuration mode for a specified RBridge.

   ```
   device# configure terminal
   device(config)# rbridge-id 176
   device(config-rbridge-id-176)#
   ```

2. Enter the **ssh server max-sessions** command and specify the maximum number of sessions to be supported. (Range is from 1 through 10.)
3. Use the **show running-config rbridge-id ssh server** command in this mode to confirm the running configuration, which includes key types as well as the maximum number of SSH sessions configured.

   ```
   device(config-rbridge-id-176)# do show running-config rbridge-id ssh server
   rbridge-id 176
   ssh server max-sessions 7
   ssh server key rsa 2048
   ssh server key ecdsa 256
   ssh server key dsa
   ```

4. You can also use the **show running-config rbridge-id ssh server** command in this mode to view the maximum number of SSH sessions configured, as well as VRF status.

```
device(config-rbridge-id-176)# do show ssh server status rbridge-id 176
rbridge-id 176:
VRF-name: mgmt-vrf       Status: Enabled
VRF-name: default-vrf    Status: Enabled
rbridge-id 176: SSH Server Max sessions: 7
```

Router Advertisement (RA) Guard

RA Guard overview

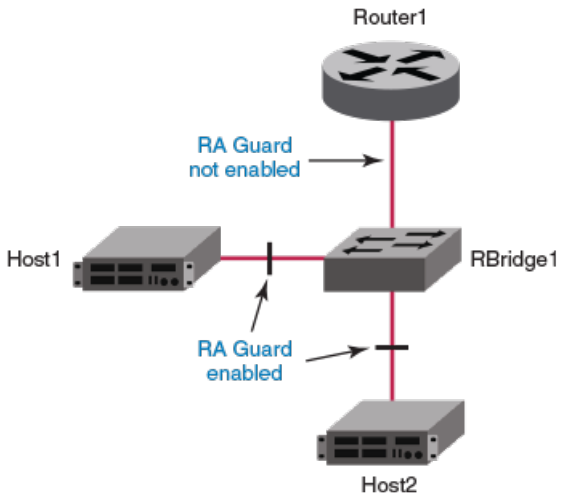
In a routed network, devices are configured to send router advertisements (RAs). RAs enable link nodes to discover routers, allowing the nodes to autoconfigure.

However, routed protocols are susceptible to rogue RAs generated by unauthorized or improperly configured devices connected to the segment. RA Guard prevents RAs from such devices from entering an L2 network.

RA Guard is effective in an environment where messages between IPv6 end-devices traverse L2 networking devices.

In the following diagram, the system is configured to block RAs on ports connected to hosts and to allow RAs on router-facing ports.

FIGURE 4 RA Guard scenario



RA Guard configuration guidelines

When implementing RA Guard, be aware of these configuration guidelines.

If RA Guard is enabled on an interface, this defines an internal ACL rule, for example:

```
seq 10 hard-drop IPv6-ICMP any any icmp-type 134 icmp-code 0
```

Be aware of the following ACL-related issues:

- RA Guard requires a profile with Ternary Content-Addressable Memory (TCAM) resources for IPv6 ACLs. Such resources are shared by RA Guard and user-defined ACLs.
- An RA Guard rule takes precedence over user-configured ACL rules applied to that interface.

NOTE
For more information on ACLs, refer to ACLs on page 75.

You can apply RA Guard only on the Physical Switchport interface type.

RA Guard is only supported on the VDX 6740 and the VDX 6940.

Enabling and disabling RA Guard

Use this procedure to enable or disable RA Guard on an interface.

1. Enter **configure** to change to global configuration mode.

```
device# configure
```

2. Enter the **interface** command, specifying the interface type and the rbridge-id/slot/port number.

```
device(config)# interface ten 122/5/22
```

3. To enable RA Guard on this interface, enter **ipv6 raguard**.

```
device(conf-if-te-122/5/22)# ipv6 raguard
```

4. To disable RA Guard on this interface, enter **no ipv6 raguard**.

```
device(conf-if-te-122/5/22)# no ipv6 raguard
```

RA Guard Show commands

There are several **show** commands that display RA Guard information. They are documented in the *Network OS Command Reference*, and listed here with descriptions.

TABLE 15 RA Guard Show commands in the Network OS Command Reference

Command	Description
show ipv6 raguard	Displays RA Guard status on a specified interface or all interfaces on the device.
show running-config interface	Displays configuration information for an interface type or for a specific interface. RA Guard configuration is also displayed.

Zones

Zoning overview

Zoning is a fabric-based service that enables you to partition your network into logical groups of devices that can access each other and prevent access from outside the group. Grouping devices into zones in this manner not only provides security, but also relieves the network from Registered State Change Notification (RSCN) storms that occur when too many native FCoE devices attempt to communicate with one another.

You can use zoning to partition your network in many ways. For example, you can partition your network into two zones, *winzone* and *unixzone*, so that your Windows servers and storage do not interact with your UNIX servers and storage. You can use zones to logically consolidate equipment for efficiency or to facilitate time-sensitive functions; for example, you can create a temporary zone to back up nonmember devices.

A device in a zone can communicate only with other devices connected to the fabric within the same zone. A device not included in the zone is not available to members of that zone. When zoning is enabled, devices that are not included in *any* zone configuration are inaccessible to all other devices in the fabric.

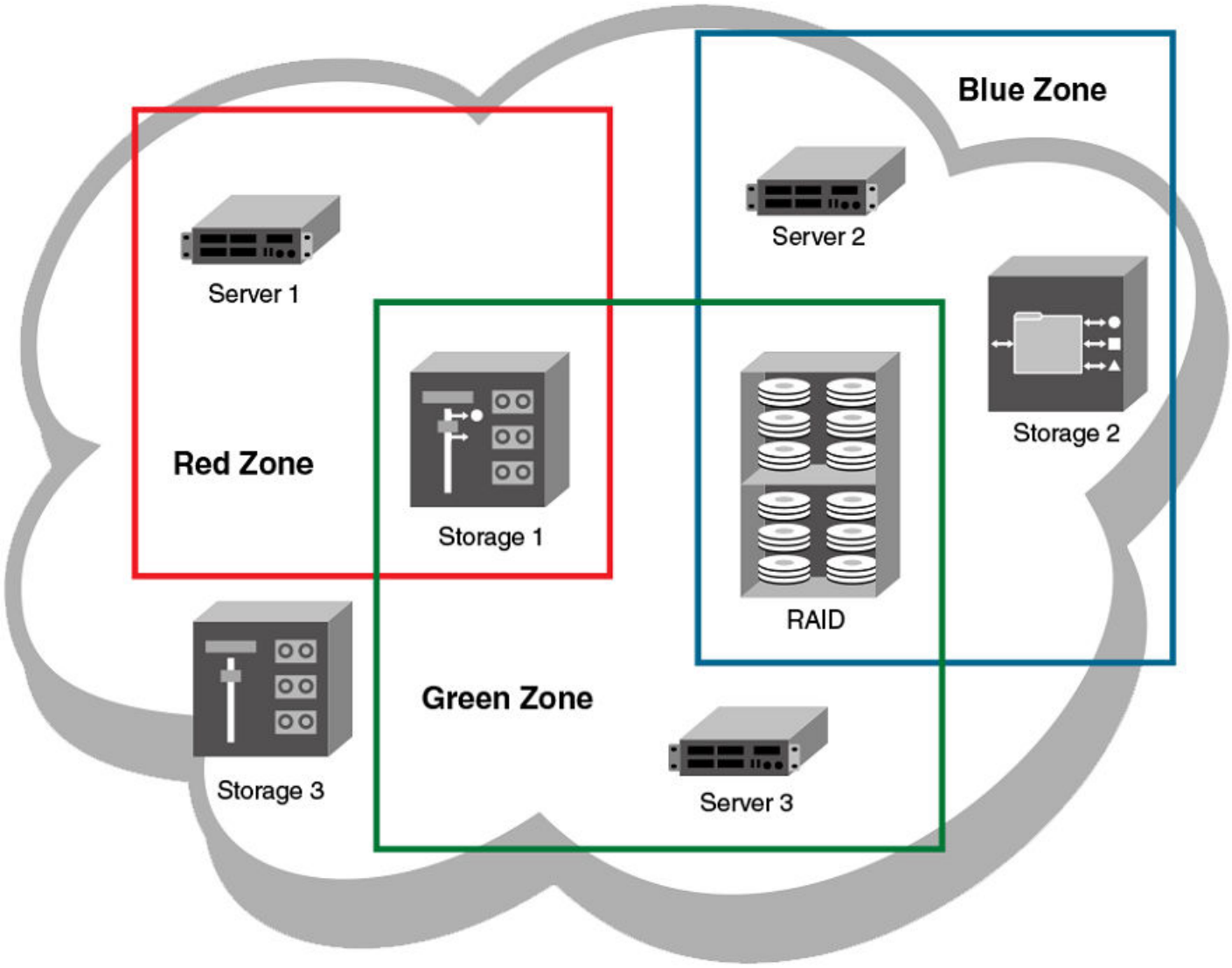
Zones can be configured dynamically. They can vary in size, depending on the number of fabric-connected devices, and devices can belong to more than one zone.

Example zoning topology

Consider the following figure, which shows three configured zones: Red, Green, and Blue. In this figure the following is true:

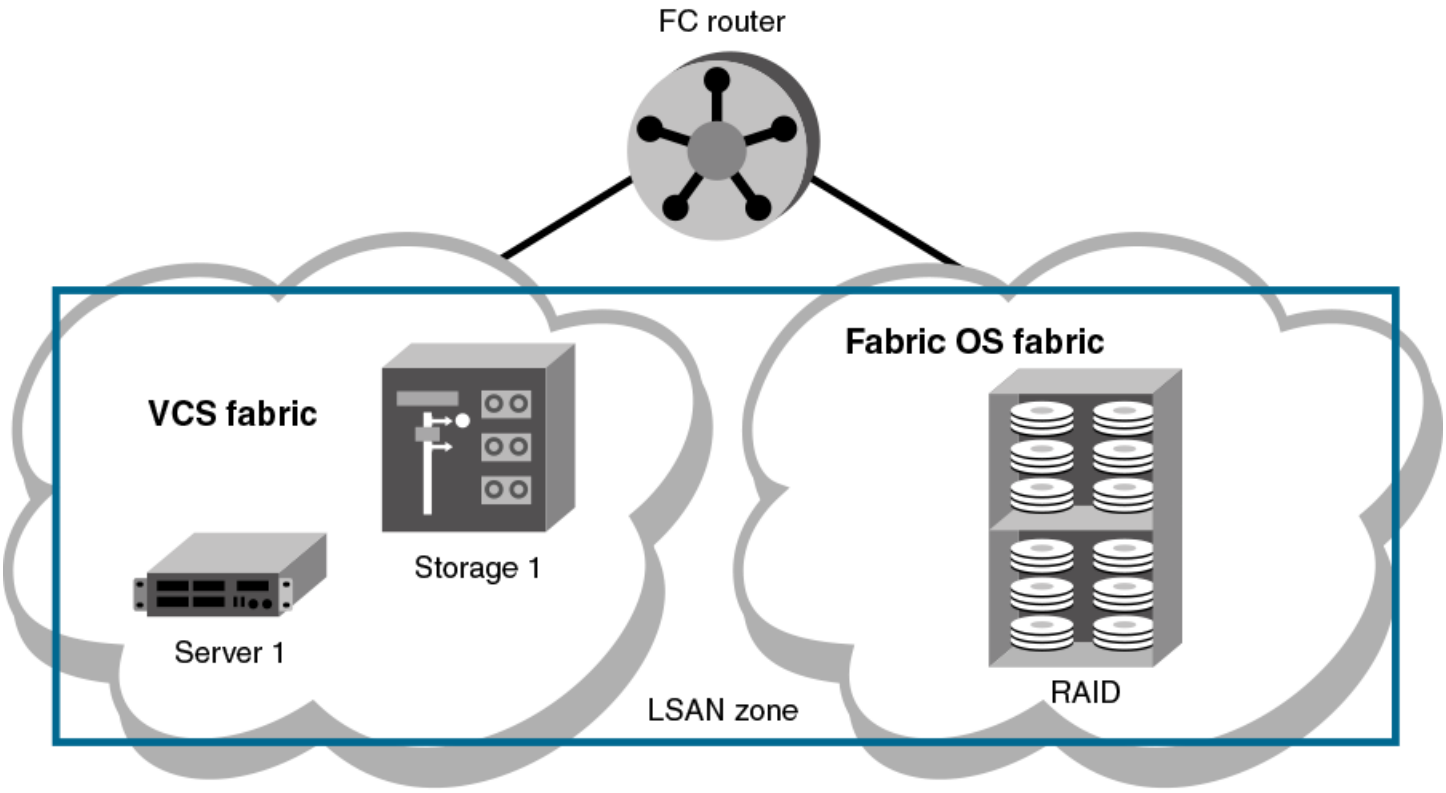
- Server 1 can communicate only with the Storage 1 device.
- Server 2 can communicate only with the RAID and Storage 2 devices.
- Server 3 can communicate with the RAID and Storage 1 devices.
- The Storage 3 is not assigned to a zone; no other zoned fabric device can access it.

FIGURE 5 Zoning



Connecting to another network through a Fibre Channel (FC) router, you can create a Logical SAN (LSAN) zone to include zone objects on other fabrics, including Fabric OS networks. No merging takes place across the FC router when you create an LSAN zone. The figure below shows an example in which Server 1, which is connected to device in an Extreme VCS Fabric, has access to local storage and to RAID storage on a Fabric OS fabric. (For a detailed discussion of LSAN zones, refer to LSAN zones on page 139.)

FIGURE 6 LSAN zoning



NOTE

Zoning in Network OS 4.0.0 and later has the following restrictions:

- Zone objects based on physical port number or port ID (D,I ports) are not supported.
- You cannot access a target on a Network OS fabric from a server on the Fabric OS fabric.

LSAN zones

LSAN zones are distinct from conventional zones. This section details how to define and manage LSAN zones and provides recommendations about LSAN zone naming.

LSAN zones overview

A Logical SAN (LSAN) consists of zones in two or more edge or backbone fabrics that contain the same devices. LSANs essentially provide selective device connectivity between fabrics without forcing you to merge those fabrics. FC routers provide multiple mechanisms to manage inter-fabric device connectivity through extensions to existing switch management interfaces.

NOTE

A backbone fabric consists of one or more FC switches with configured EX_Ports. These EX_Ports in the backbone connect to edge fabric switches through E_Ports. This type of EX_Port-to-E_Port connectivity is called an "*Inter-Fabric Link* (IFL)".

The Extreme VCS Fabric connection to the FC router is an ISL that connects an FC port on a VDX 6740 to an EX_Port on the FC router. Similarly, an FC port on the Fabric OS fabric connects to an EX_Port on the FC router.

You can define and manage LSANs using the same zone management tools as for regular zones. The FC router makes LSAN zoning possible by importing devices in effective zones. For example, consider two devices:

- 11:22:33:44:55:66:77:99 is connected to a switch in an Extreme VCS Fabric.
- 11:22:33:44:55:66:77:88 is connected to a switch in a Fabric OS fabric.

The FC-FC routing service on the FC router that connects the two fabrics presents 11:22:33:44:55:66:77:88 as a phantom device to the Extreme VCS Fabric and also presents 11:22:33:44:55:66:77:99 as a phantom device to the Fabric OS fabric. You can then use the regular zone management tools on the Extreme VCS Fabric to incorporate 11:22:33:44:55:66:77:99 into an LSAN zone on the Extreme VCS Fabric. Similarly, you can use the regular zone management tools in Fabric OS to incorporate 11:22:33:44:55:66:77:88 into an LSAN zone in the Fabric OS fabric. Once both the Extreme VCS Fabric zone and the Fabric OS zone are enabled, the FC router imports devices common to both zones and makes them available to the zones in each fabric.

LSAN naming

Zones that contain hosts and targets that are shared between the two fabrics need to be explicitly coordinated. To share devices between any two fabrics, you must create an LSAN zone in both fabrics containing the WWNs of the devices to be shared. Although you manage an LSAN zone by using the same tools as any other zone on the edge fabric, two behaviors distinguish an LSAN zone from a conventional zone:

- A required naming convention. The name of an LSAN zone begins with the prefix "LSAN_". The LSAN name is case-insensitive; for example, lsan_ is equivalent to LSAN_, Lsan_, and so on.
- LSAN zone members in all fabrics must be identified by their WWN. You cannot use the port IDs that are supported only in Fabric OS fabrics.

  NOTE
  The "LSAN_" prefix must appear at the beginning of the zone name.

To enable device sharing across multiple fabrics, you must create LSAN zones on the edge fabrics (and optionally on the backbone fabric as well), using normal zoning operations to create zones with names that begin with the special prefix "LSAN_", and adding host and target port WWNs from both local and remote fabrics to each local zone as desired. Zones on the backbone and on multiple edge fabrics that share a common set of devices will be recognized as constituting a single multi-fabric LSAN zone, and the devices that they have in common will be able to communicate with each other across fabric boundaries.

Managing domain IDs

FCoE connectivity across the Fibre Channel link between Extreme VCS Fabrics and FC routers uses domain IDs to identify devices. Within a BExtreme VCS Fabric, a domain ID is the same as a routing bridge ID. When you connect to a Fibre Channel router, the FC Fabric Fibre Channel router service emulates virtual *phantom* FC domains in the FCoE fabric. Each FCR-enabled device emulates a single "front" phantom domain and each FC fabric is represented by a *translate* phantom domain.

It is important to ensure that front domain IDs and translate domain IDs presented by the FC router do not overlap routing bridge IDs in the FCoE fabric; otherwise, the connectivity will fail and the Network OS device with the overlapping routing bridge ID becomes isolated from the fabric. To prevent potential overlap, use the **portCfgExport -d** Fabric OS command on the FC router to apply a unique front domain ID — one that will not be used in the FCoE fabric. Similarly, use the **fcrXlateConfig** *importedFID exportedFID preferredDomainID* Fabric OS command to set the translate domain ID to a unique value that is also not used as a routing bridge ID.

Refer to the *Fabric OS Command Reference Manual* for details about the **portCfgExport** and **fcrXlateConfig** commands.

Approaches to zoning

The following table lists the various approaches you can take when implementing zoning in a Network OS fabric.

TABLE 16 Approaches to fabric-based zoning

Zoning approach	Description
Recommended approach	
Single HBA	Zoning by single HBA most closely re-creates the original SCSI bus. Each zone created has only one HBA (initiator) in the zone; each of the target devices is added to the zone. Typically, a zone is created for the HBA and the disk storage ports are added. If the HBA also accesses tape devices, a second zone is created with the HBA and associated tape devices in it. In the case of clustered systems, it could be appropriate to have an HBA from each of the fabric members included in the zone; this zoning is equivalent to having a shared SCSI bus between the fabric members and assumes that the clustering software can manage access to the shared devices. In a large fabric, zoning by single HBA requires the creation of possibly hundreds of zones; however, each zone contains only a few members. Zone changes affect the smallest possible number of devices, minimizing the impact of an incorrect zone change. *This zoning philosophy is the preferred method.*
Alternative approaches	
Application	Zoning by application typically requires zoning multiple, perhaps incompatible, operating systems into the same zones. This method of zoning creates the possibility that a minor server in the application suite could disrupt a major server (such as a Web server disrupting a data warehouse server). Zoning by application can also result in a zone with a large number of members, meaning that more notifications, such as RSCNs, or errors, go out to a larger group than necessary.
Operating system	Zoning by operating system has issues similar to zoning by application. In a large site, this type of zone can become very large and complex. When zone changes are made, they typically involve applications rather than a particular server type. If members of different operating system clusters can detect storage assigned to another fabric, they might attempt to own the other fabric's storage and compromise the stability of the fabrics.
Port allocation	Avoid zoning by port allocation unless the administration team has very rigidly enforced processes for port and device allocation in the fabric. It does, however, provide some positive features. For instance, when a storage port, server HBA, or tape drive is replaced, the change of WWN for the new device is of no consequence. As long as the new device is connected to the original port, it continues to have the same access rights. The ports on the edge switches can be pre-associated to storage ports, and control of the fan-in ratio (the ratio of the input port to output port) can be established. With this pre-assigning technique, the administrative team cannot overload any one storage port by associating too many servers with it.
Not recommended	
No zoning	Using no zoning is the least desirable zoning option because it allows devices to have unrestricted access on the fabric and causes RSCN storms. Additionally, any device attached to the fabric, intentionally or maliciously, likewise has unrestricted access to the fabric. This form of zoning should be used only in a small and tightly controlled environment, such as when host-based zoning or LUN masking is deployed.

Zone objects

A zone object can be one of the following types: a zone, a zone member, an alias for one or more zone members, or a zoning configuration.

Zones

A zone is made up of one or more zone members. Each zone member can be a device, a port, or an alias. If the zone member is a device, it must be identified by its Node World Wide Name (node WWN). If it is a port, it must be identified by its Port World Wide Name (port WWN). Port WWNs and node WWNs can be mixed in the same zone. For LSAN zones, only port WWNs can be used.

World Wide Names are specified as 8-byte (16-digit) hexadecimal numbers, separated by colons (:) for example, 10:00:00:90:69:00:00:8a. When a zone object is the node WWN, only the specified device is in the zone. When a zone object is the port WWN name, only the single port is in the zone.

NOTE
You are not restricted from configuring more than 255 zone members. However, that figure is considered a best-practices limit, and exceeding it can lead to unpredictable results leading to the possibility of a severe failure condition.

Zone aliases

A zone alias is a name assigned to a device or a group of devices. By creating an alias, you can assign a familiar name to one or more devices and refer to these devices by that name. Aliases simplify cumbersome data entry by allowing you to create an intuitive naming structure (such as using "NT_Hosts" to define all NT hosts in the fabric).

As a shortcut for zone members, zone aliases simplify the entry and tracking of zone objects that are defined by their WWNs. For example, you can use the name "Eng" as an alias for "10:00:00:80:33:3f:aa:11".

Naming zones for the initiator they contain can also be useful. For example, if you use the alias SRV_MAILSERVER_SLT5 to designate a mail server in PCI slot 5, then the alias for the associated zone is ZNE_MAILSERVER_SLT5. This kind of naming strategy clearly identifies the server host bus adapter (HBA associated with the zone).

Zone configurations

A *zone configuration* is a group of one or more zones. A zone can be included in more than one zone configuration. When a zone configuration is enabled, all zones that are members of that configuration are enabled.

Several zone configurations can reside on a switch at once, and you can quickly alternate between them. For example, you might want to have one configuration enabled during the business hours and another enabled overnight. However, only one zone configuration can be enabled at a time.

The different types of zone configurations are:

- Defined Configuration

The complete set of all zone objects defined in the fabric.

- Enabled Configuration

A single zone configuration that is currently in effect. The enabled configuration is built when you enable a specified zone configuration.

If you disable the enabled configuration, zoning is disabled on the fabric, and default zoning takes effect. When default zoning takes effect, either all devices within the fabric can communicate with all other devices, or no device communicate with any other device, depending on how default zoning is configured. Disabling the configuration does not mean that the zone database is deleted, however, only that no configuration is active in the fabric.

On power-up, the switch automatically reloads the saved configuration. If a configuration was active when it was saved, the same configuration is reinstated on the local switch.

Naming conventions

Naming zones and zone configurations is flexible. You can devise prefixes to differentiate between zones used for production, backup, recovery, or testing. One configuration should be named PROD_*fabricname*, where *fabricname* is the name that the fabric has been assigned. The purpose of the PROD configuration is to easily identify the configuration that can be implemented and provide the most generic services. If you want to use other configurations for specific purposes, you can use names such as "BACKUP_A," "RECOVERY_2," and "TEST_18jun02".

Zoning enforcement

Zone enforcement is by name server. The name server filters queries and RSCNs based on the enabled zoning configuration.

Considerations for zoning architecture

This table lists considerations for zoning architecture.

TABLE 17 Considerations for zoning architecture

Item	Description
Effect of changes in a production fabric	Zone changes in a production fabric can result in a disruption of I/O under conditions when an RSCN is issued because of the zone change and the HBA is unable to process the RSCN fast enough. Although RSCNs are a normal part of a functioning SAN, the pause in I/O might not be acceptable. For these reasons, you should perform zone changes only when the resulting behavior is predictable and acceptable. Ensuring that the HBA drivers are current can shorten the response time in relation to the RSCN.
Allowing time to propagate changes	Zoning commands make changes that affect the entire fabric. When executing fabric-level configuration tasks, allow time for the changes to propagate across the fabric before executing any subsequent commands. For a large fabric, you should wait several minutes between commands.
Confirming operation	After changing or enabling a zone configuration, you should confirm that the nodes and storage can identify and access one another. Depending on the platform, you might need to reboot one or more nodes in the fabric with the new changes.
Use of aliases	The use of aliases is optional with zoning. Using aliases requires structure when defining zones. Aliases aid administrators of zoned fabrics in understanding the structure and context of zoning.

Operational considerations for zoning

Consider the following topics when configuring zoning.

Zoning configuration changes

When you save, enable, or disable a configuration, the changes are automatically distributed to all switches in the VCS Fabric.

Supported firmware for zoning

Zoning is supported only if all RBridges in the fabric are running Network OS 2.1 or later.

Connecting an RBridge running Network OS 2.0 to an RBridge running Network OS 2.1 or later merges the two networks only if the RBridge running Network OS 2.1 or later is in BExtreme VCS Fabric mode and no zone database elements are defined or enabled.

A device running Network OS v3.0.0 will segment if it is attached to a device running Network OS v2.0.0 regardless of zoning configuration. A device running Network OS v3.0.0 will join the fabric with a 2.1.x device and zones will be merged, but the fabric will not form, so no further zoning commands will be allowed until all devices are upgraded to the same firmware version and the fabric has formed.

The Inter-Switch Links (ISLs) connecting the two RBridges will segment if the RBridge running Network OS 2.1 or later has any zone defined or enabled, or the default zone is set to No Access. Any such configuration requires automatic distribution of zoning configuration data, which is not compatible with RBridges running Network OS 2.0.

Firmware downgrade and upgrade considerations for zoning

A firmware downgrade from Network OS 4.1.0 to Network OS 2.1.x is not permitted under the following conditions:

1. One or more zone aliases are configured on the switch. You must remove all references to zone aliases prior to a firmware downgrade. Use the **no zoning defined-configuration alias** command to delete all zone alias objects. Then issue the **zoning enabled-configuration cfg-action**{**cfg-save** | **cfg-disable**} command or the **zoning enabled-configuration cfg-name** *cfg_name* command to commit the operation before re-attempting a firmware download.

2. An open zone transaction in progress. You must either commit or abort the current open transaction before re-attempting a firmware download. Use the **zoning enabled-configuration cfg-action** {**cfg-save** | **cfg-disable**} command or the **zoning enabled-configuration cfg-name cfg_name** command to commit the current open transaction. Alternately, use the **zoning enabled-configuration cfg-action cfg-transaction-abort** command to abort the open transaction.

   You cannot downgrade any switch in an Extreme VCS Fabric to Network OS 2.0 or earlier if any zone definition exists in the defined configuration. Any attempt to do so will fail while attempting to download the earlier firmware. For the downgrade to succeed, you must clear the defined configuration, disable any active configuration, set the default zoning mode to *All Access,* and then try again to download the firmware.

   When you upgrade from Network OS 2.1.0 to versions 2.1.1 or later, the zone database is cleared.

   CAUTION
   Clearing the defined configuration clears the zoning database for the entire fabric. If you want to downgrade just one switch without affecting the rest of the fabric, disconnect the switch from the fabric before deleting the defined configuration.

Configuring and managing zones

Zone configuration management overview

You can perform zoning operations on any RBridge in the VCS Fabric, but they are always executed on the principal RBridge.

Any edits made to the zoning database are allowed only from the principal RBridge, and you can issue **show** commands from non-principal switches in this mode.

Automatic distribution of the zoning configuration ensures that the effects of these operations are shared and instantly visible on all switches in the VCS Fabric. However, these operations are not permanent until a transaction commit operation saves them to nonvolatile memory, which holds the master copy of the zoning database. Once the zoning configuration is saved in permanent memory, it persists across reboot operations.

A transaction commit occurs when you or another user initiates any of the following zoning operations:

- Saving the database to nonvolatile memory with the **zoning enabled-configuration cfg-action cfg-save** command.
- Enable a specific zone configuration with the **zoning enabled-configuration cfg-name** command.
- Disabling the currently enabled zone configuration with the **no zoning enabled-configuration cfg-name** command.

Executing the **zoning enabled-configuration cfg-action cfg-transaction-abort** command cancels the currently open transaction.

If the principal RBridge reboots or goes down, Network OS selects a new principal and any pending zoning transaction is rolled back to the last committed transaction, which is the effective zoning configuration saved in nonvolatile memory. Any changes made to the effective configuration prior to an abort operation must be re-entered.

If an RBridge other than the principal reboots or goes down, the ongoing transaction is not backed out. Any zoning operations initiated by the RBridge are still part of the global transaction maintained on the principal RBridge.

If a fabric segments, the newly elected principal RBridge determines whether transaction data are retained. If a segment retains the original principal, it also retains ongoing transaction data. If a segment elects a new principal, the transaction is aborted.

You can save a snapshot of the current running configuration using the **copy running-config** *file* command. You can add configuration entries from a saved configuration using the **copy** *file* **running-config** command. When saving the snapshot you must ensure that the

saved running configuration contains no zoning transaction data, otherwise failures will occur when you attempt to restore configuration entries from the saved file. Any transaction data would cause such a failure, including empty configuration definitions or empty zones.

Notes

- When you re-enable the enabled-configuration (using the **zoning enabled-configuration** command) on the principal switch in the fabric, the system propagates the enabled-configuration across the fabric. There is a slight risk of doing this in that the defined-configuration may contain configuration edits that you may not want to enable yet. This feature prevents switches in the fabric from having mismatched enabled-configurations.
- When restoring the running configuration, Extreme recommends copying the file to the running configuration in the absence of any other command line input.
- When you restore a configuration using the **copy** command, the contents of the file are added to the defined configuration; they do not replace the defined configuration. The result is cumulative, is as if the input came from the command line.

Understanding and managing default zoning access modes

The default zoning mode controls device access if zoning is not implemented or if there is no enabled zone configuration. Default zoning has two access modes:

- *All Access* — All devices within the fabric can communicate with all other devices.
- *No Access* — Devices in the fabric cannot access any other device in the fabric.

The default setting is All Access. Changing the default access mode requires committing the ongoing transaction for the change to take effect.

The default zoning mode takes effect when you disable the effective zone configuration. If your default zone has a large number of devices, to prevent RSCN storms from overloading those devices, you should set the default zoning mode to No Access before attempting to disable the zone configuration. If your default zone includes more than 300 devices, the zoning software prevents you from disabling the zoning configuration if the default zoning mode is All Access.

Setting the default zoning mode

1. In privileged EXEC mode, enter the **configure terminal** command to enter the global configuration mode.
2. Enter one of the following commands, depending on the default access mode you want to configure:
   - To set the default access mode to All Access, enter **zoning enabled-configuration default-zone-access allaccess**.
   - To set the default access mode to No Access, enter **zoning enabled-configuration default-zone-access noaccess**.
3. Enter the **zoning enabled-configuration cfg-action cfg-save** or **zoning enabled-configuration cfg-name** command to commit the ongoing transaction and save the access mode change to nonvolatile memory.
4. Enter the **show running-config zoning enabled-configuration** command to verify the access mode change.

   Example of setting the default zoning mode to no access:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning enabled-configuration default-zone-access noaccess
device(config)# zoning enabled-configuration cfg-action cfg-save
device(config)# do show running-config zoning enabled-configuration
zoning enabled-configuration cfg-name cfg1
zoning enabled-configuration default-zone-access noaccess
zoning enabled-configuration cfg-action cfg-save
```

Understanding and managing zone database size

The maximum size of a zone database is the upper limit for the defined configuration, and it is determined by the amount of memory available for storing the master copy of the defined configuration in flash memory.

Use the following information displayed by the **show zoning operation-info** command to determine whether there is enough space to complete outstanding transactions:

- db-max — Theoretical maximum size of the zoning database kept in nonvolatile memory
- db-avail — Theoretical amount of free space available
- db-committed — The size of the defined configuration currently stored in nonvolatile memory
- db-transaction — The amount of memory required to commit the current transaction

The supported maximum zone database size is 100 KB. If the outstanding transaction data (db-transaction field) is less than the remaining supported space (100 KB minus db-committed), enough space exists to commit the transaction.

> NOTE
> The db-max field has a theoretical zone database limit of approximately 1 MB. However, performance might become unacceptable if the zoning database exceeds 150 KB.

Viewing database size information

In privileged EXEC mode, enter the **show zoning operation-info** command.

Database and transaction size information is displayed in bytes.

```
device# show zoning operation-info
db-max 1045274
db-avail 1043895
db-committed 367
db-transaction 373
transaction-token 1
last-zone-changed-timestamp 2011-11-16 16:54:31 GMT-7:00
last-zone-committed-timestamp 2011-11-16 16:23:44 GMT-7:00
```

Managing zone aliases

A zone alias is user-defined name for a logical group of ports or WWNs. You can simplify the process of creating and managing zones by first specifying aliases for zone members. Aliases facilitate tracking and eliminate the need for long lists of individual zone member names. An alias can be a member of a zone, but it cannot be a member of a zoning configuration.

Creating an alias

1. In privileged EXEC mode, enter the **show name-server detail** command to list the WWNs of devices and targets available in the Extreme VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration alias** command followed by a name for the alias.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command to specify at least one member entry.

   The member entry must be specified as a port WWN or a node WWN.

   You can add multiple members in one operation by separating each member entry with a semicolon (;). No spaces are allowed after the semicolon.

5. Enter the **exit** command to return to global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   The following is an example of creating an alias with one member node WWN:

```
device# show name-server detail
PID: 013100
Port Name: 20:00:00:00:00:00:00:01
Node Name: 10:00:00:00:00:00:00:01
      (output truncated)
device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration alias alias1
device(config-alias-alias1)# member-entry 10:00:00:00:00:00:00:01
device(config-alias-alias1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Adding additional members to an existing alias

1. In privileged EXEC mode, enter the **show name-server detail** command to list the WWNs of devices and targets available in the Extreme VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration alias** command followed the name of an existing zone alias.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command to specify at least one member entry.

   The member entry must be specified as a port WWN or a node WWN.

   You can add multiple members in one operation by separating each member entry with a semicolon (;). No spaces are allowed after the semicolon.
5. Enter the **exit** command to return to global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   Example of adding two member node WWNs to an existing alias:

```
device# show name-server detail
PID: 013200
Port Name: 20:00:00:00:00:00:00:02
Node Name: 10:00:00:00:00:00:00:02
(output truncated)
PID: 013300
Port Name: 20:00:00:00:00:00:00:03
Node Name: 10:00:00:00:00:00:00:03
(output truncated)
device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration alias alias1
device(config-alias-alias1)# member-entry 10:00:00:00:00:00:00:02;10:00:00:00:00:00:00:03
device(config-alias-alias1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
device(config)#
```

Removing a member from an alias

1. In privileged EXEC mode, enter the **show running-config zoning** command to display the alias and its member WWNs.
2. Enter the **configure terminal** command to enter global configuration mode.

3. Enter the **zoning defined-configuration alias** command followed the name of an existing zone alias.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **no member-entry** command to specify the WWN to be removed from the zone alias.

   You can only remove one member at a time.
5. Enter the **exit** command to return to the global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   The following provides an example of removing two members from an alias:

```
device# show running-config zoning
zoning defined-configuration alias alias1
 member-entry 10:00:00:00:00:00:00:01
 member-entry 10:00:00:00:00:00:00:02
 member-entry 10:00:00:00:00:00:00:03
      (output truncated)
device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration alias alias1
device(config-alias-alias1)# no member-entry 10:00:00:00:00:00:00:02
device(config-alias-alias1)# no member-entry 10:00:00:00:00:00:00:03
device(config-alias-alias1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Deleting an alias

1. In privileged EXEC mode, enter the **show running-config zoning** command to display the alias and its member WWNs.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **no zoning defined-configuration alias** command followed by the name of the alias you want to delete.
4. Enter the **show running-config zoning** command to verify the change in the defined configuration (optional).
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the configuration to nonvolatile memory.

   Example of deleting an alias:

```
device# show running-config zoning
zoning defined-configuration alias alias1
 member-entry 10:00:00:00:00:00:00:01
!
zoning enabled-configuration cfg-name ""
zoning enabled-configuration default-zone-access allaccess
zoning enabled-configuration cfg-action cfg-none
device#
device# configure terminal
Entering configuration mode terminal
device(config)# no zoning defined-configuration alias alias1
device(config)# do show running-config zoning
zoning enabled-configuration cfg-name ""
zoning enabled-configuration default-zone-access allaccess
zoning enabled-configuration cfg-action cfg-none
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Creating zones

Consider the following topics when creating zones.

Creating a zone

A zone cannot persist without any zone members. When you create a new zone, the **zoning defined-configuration zone** command places you in a command subconfiguration mode where you can add the first zone member entry. You can specify multiple members by separating each member from the next by a semicolon (;).

> NOTE
> Zones without any zone members cannot exist in volatile memory. They are deleted when the transaction commits successfully.

The following procedure adds a new zone to the defined configuration.

1. In privileged EXEC mode, enter the **show name-server detail** command to obtain the WWNs of servers and targets available in the Extreme VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration zone** command and enter a new zone name to add a new zone.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command to specify at least one member entry.

   The member entry must be specified as a port WWN, a node WWN, or an alias. You can mix WWNs and aliases.

   Add multiple members in one operation by separating each member entry with a semicolon (;). No spaces are allowed after the semicolon.
5. Enter the **exit** command to return to global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of creating a zone with two members, a WWN and an alias:

```
device# show name-server detail
PID: 012100
Port Name: 10:00:00:05:1E:ED:95:38
Node Name: 20:00:00:05:1E:ED:95:38
      (output truncated)

device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration zone zone1
device(config-zone-zone1)# member-entry 20:00:00:05:1E:ED:95:38;alias2
device(config-zone-zone1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Adding a member to a zone

1. In privileged EXEC mode, enter the **show name-server detail** command to list the WWNs of devices and targets available on the Extreme VCS Fabric.
2. Enter the **configure terminal** command to enter global configuration mode.
3. Enter the **zoning defined-configuration zone** command and enter the name of an existing zone.

   A subconfiguration mode prompt appears.
4. Enter the subconfiguration mode **member-entry** command and specify the member you want to add.

   The new member can be specified by a port WWN, a node WWN, or a zone alias.

   Add multiple members in one operation by separating each member with a semicolon (;).

5. Enter the **exit** command to return to the global configuration mode.
6. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of adding three members to a zone, two node WWNs and an alias:

```
device# show name-server detail
PID: 012100
Port Name: 50:05:07:61:00:1b:62:ed
Node Name: 50:05:07:61:00:1b:62:ed
      (output truncated)
PID: 012200
Port Name: 50:05:07:61:00:09:20:b4
Node Name: 50:05:07:61:00:09:20:b4
      (output truncated)

device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration zone zone1
device(config-zone-zone1)# member-entry 50:05:07:61:00:1b:62:ed;50:05:07:61:00:09:20:b4;alias3
device(config-zone-zone1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Removing a member from a zone

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration zone** command and enter the name of the zone from which you want to remove a member.

   A subconfiguration mode prompt appears.
3. Enter the subconfiguration mode **no member-entry** parameter and specify the WWN or the alias of the member you want to remove.

   You can remove only one member at a time. To remove more than one member, you must issue the **no member-entry** command for each member you want to remove.
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   NOTE
   The parent configuration is removed when the last child object is removed, irrespective of the save operation.

   Example of removing more than one member from a zone:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration zone zone1
device(config-zone-zone1)# no member-entry 50:05:07:61:00:09:20:b4
device(config-zone-zone1)# no member-entry alias3
device(config-zone-zone1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Deleting a zone

Before deleting a zone, ensure that the zone is not a member of any enabled zone configuration. Although the deletion will proceed in RAM, you will not be able to save the configuration to nonvolatile memory if an enabled zone configuration has the deleted zone as a member.

1. In privileged EXEC mode, enter the **show running-config zoning defined-configuration** command and verify that the zone you want to delete is not a member of an enabled zone configuration. If the zone is a member of an enabled zone configuration, remove it.
2. Enter the **configure terminal** command to enter the global configuration mode.
3. Enter the **no zoning defined-configuration zone** command and enter the name of the zone you want to delete.
4. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   NOTE
   The parent configuration is removed when the last child object is removed, irrespective of the save operation.

   Example of removing a zone from the defined configuration:

```
device# show running-config zoning defined-configuration
zoning defined-configuration zone zone1
member-entry 10:00:00:00:00:00:00:01
!
zoning defined-configuration zone zone2
member-entry 10:00:00:00:00:00:00:02
!
device# configure terminal
Entering configuration mode terminal
device(config)# no zoning defined-configuration zone zone2
device(config)# zoning enabled-configuration cfg-action cfg-save
Updating flash ...
device(config)# exit
device# show running-config zoning defined-configuration
zoning defined-configuration zone zone1
member-entry 10:00:00:00:00:00:00:01
```

Managing zones

Consider the following topics when managing zones.

Viewing the defined configuration

To view the defined configuration, in privileged EXEC mode enter the **show running-config zoning defined-configuration** command.

For each configuration, the command lists each member zone. For each zone, the command lists the WWN or alias name of each member. The following example illustrates this.

```
device# show running-config zoning defined-configuration

zoning defined-configuration cfg cfg0
 member-zone zone_0_1
 member-zone zone_0_2
 member-zone zone_0_3
 member-zone zone_0_4
 member-zone zone_same
!
zoning defined-configuration cfg cfg1
 member-zone zone_1_1
```

```
 member-zone zone_1_2
 member-zone zone_1_3
 member-zone zone_1_4
 member-zone zone_same
!
zoning defined-configuration cfg cfg2
 member-zone zone_2_1
 member-zone zone_2_2
 member-zone zone_2_3
 member-zone zone_2_4
 member-zone zone_same
!
zoning defined-configuration cfg cfg4
 member-zone zone2
 member-zone zone3
!
zoning defined-configuration zone zone0
 member-entry 11:22:33:44:55:66:77:80
 member-entry 11:22:33:44:55:66:77:81
 member-entry 11:22:33:44:55:66:77:82
 member-entry 11:22:33:44:55:66:77:83
 member-entry 11:22:33:44:55:66:77:84
!
zoning defined-configuration zone zone1
 member-entry 11:22:33:44:55:66:77:80
 member-entry 11:22:33:44:55:66:77:81
 member-entry 11:22:33:44:55:66:77:82
 member-entry 11:22:33:44:55:66:77:83
 member-entry 11:22:33:44:55:66:77:84
!
zoning defined-configuration zone zone2
 member-entry 11:22:33:44:55:66:77:80
 member-entry 11:22:33:44:55:66:77:81
 member-entry 11:22:33:44:55:66:77:82
 member-entry 11:22:33:44:55:66:77:83
 member-entry 11:22:33:44:55:66:77:84
!
     (output truncated)
```

Viewing the enabled configuration

To view the enabled configuration, in privileged EXEC mode enter the **show zoning enabled-configuration** command. The following information about the enabled configuration is displayed:

- The name of the configuration
- The configuration action
- The mode of the default zone — the mode that will be active if you disable the enabled configuration

NOTE
In Network OS 4.0.0 and later, the enabled-zone output is no longer available from the **show running-config zoning enabled-configuration enabled-zone** command. It is now available from the **show running-config zoning enabled-configuration** command.

The configuration name has CFG_MARKER asterisk (*) appended to it if an outstanding transaction exists; the asterisk is not present if no outstanding transaction exists. Similarly, the configuration action is flagged as "cfg-save" if no outstanding transaction exists; "cfg-none" indicates that an outstanding transaction exists. A CFG_MARKER flag is appended to the configuration if the enabled configuration does not exactly match the defined configuration. This scenario occurs when you have an enabled configuration and make changes to the defined-configuration, and then, instead of enabling the defined configuration, you issue the **cfg-save** command.

CAUTION
When edits are made to the defined configuration, and those edits affect a currently enabled zone configuration, issuing a "cfg-save" command makes the enabled configuration effectively stale. Until the enabled configuration is reenabled, the merging of new RBridges into the fabric is not recommended. This merging may cause unpredictable results, with the potential for mismatched enabled-zoning configurations among the RBridges in the fabric.

Example of viewing the zoning enabled configuration:

```
device# show zoning enabled-configuration

zoning enabled-configuration cfg-name cfg1
zoning enabled-configuration enabled-zone zone1 member-entry 10:00:00:00:00:00:00:01
zoning enabled-configuration enabled-zone zone2 member-entry 10:00:00:00:00:00:00:02
```

Creating a zone configuration

A zone configuration cannot persist without any member zones. When creating a new zone configuration, the **zoning defined-configuration cfg** command places you in a command sub-configuration mode where you must add at least one member zone. While zone configurations without any member zones can exist in volatile memory, they are deleted when the transaction commits successfully.

The following procedure adds a new zone configuration to the defined configuration.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration cfg** command and enter a new configuration name.

   A subconfiguration mode prompt appears.
3. Enter the **member-zone** subconfiguration mode command and specify the name of at least one zone.

   Add multiple zones in one operation by separating each zone name with a semicolon (;).
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of creating a zone configuration with one member zone:

   ```
   device# configure terminal
   Entering configuration mode terminal
   device(config)# zoning defined-configuration cfg config1
   device(config-cfg-config1)# member-zone zone1
   device(config-cfg-config1)# exit
   device(config)# zoning enabled-configuration cfg-action cfg-save
   ```

   NOTE
   Zone aliases are not valid zone configuration members. Adding an alias to an existing zone configuration will not be blocked. However, the attempt to enable a zone configuration that contains aliases will fail with an appropriate error message.

Adding a zone to a zone configuration

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration cfg** command and enter the name of the configuration to which you want to add zones.

   The command prompt changes to indicate a subconfiguration mode.
3. Enter the **member-zone** subconfiguration mode command and specify the name of at least one member zone.

   Add multiple zones in one operation by separating each zone name with a semicolon (;).

4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   Example of adding two zones to config1:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration cfg config1
device(config-cfg-config1)# member-zone zone2;zone3
device(config-cfg-config1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Removing a zone from a zone configuration

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning defined-configuration cfg** command and enter the name of the configuration from which you want to remove a zone.

   The command prompt changes to indicate a subconfiguration mode.
3. Enter the **no member-zone** subconfiguration mode command and specify the name of the zone you want to remove from the configuration.

   You can remove only one member at a time. To remove more than one member, you must issue the **no member-zone** command for each member you want to remove.
4. Enter the **exit** command to return to global configuration mode.
5. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified configuration to nonvolatile memory.

   NOTE
   The parent configuration is removed when the last child object is removed, irrespective of the save operation.

   Example of removing two zones from config1:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning defined-configuration cfg config1
device(config-cfg-config1)# no member-zone zone2
device(config-cfg-config1)# no member-zone zone3
device(config-cfg-config1)# exit
device(config)# zoning enabled-configuration cfg-action cfg-save
```

Enabling a zone configuration

Only one zone configuration can be enabled in a VCS Fabric. The following procedure selects a configuration from the defined configuration and makes it the enabled configuration. If a zone configuration is currently enabled, the newly enabled configuration replaces the previously enabled configuration.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.

2. Enter the **zoning enabled-configuration cfg-name** command with the name of the configuration you want to enable.

   In addition to enabling the specified configuration, this command also saves any changes made to the zoning database in volatile memory to nonvolatile memory. The saved configuration is persistent.

   If the configuration refers to a nonexistent zone or a zone with no members assigned to it, the operation fails and the command returns an error message. The following example enables config1.

   Example of enabling a zone configuration:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning enabled-configuration cfg-name config1
```

   Example of a failed enable operation:

   The enable operation fails because the configuration contains a zone without members.

```
device(config)# do show running-config zoning
zoning defined-configuration cfg cfg1
member-zone-zone1
member-zone zone2
!
zoning defined-configuration zone zone1 <------------Zone with no member
!
zoning defined-configuration zone zone2
member-entry 20:03:00:11:0d:bc:76:09
!
zoning enabled-configuration cfg-name ""
zoning enabled-configuration default-zone-access allaccess
zoning enabled-configuration cfg-action cfg-none
device(config)# zoning enabled-configuration cfg-name cfg1
% Error: Command Failed. Cfg contains empty zone object "zone1"
```

Disabling a zone configuration

Disabling the currently enabled configuration returns the fabric to no-zoning mode. All devices can then access one another or not at all, depending on the default zone access mode setting.

> NOTE
> For fabrics with many devices, Extreme recommends setting the default zone access mode to No Access before disabling a zone configuration to avoid RSCN storms.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **no zoning enabled-configuration cfg-name** command.

   In addition to disabling the currently enabled configuration, this command also saves any changes made to the zoning database in volatile memory to nonvolatile memory. The saved configuration is persistent.

   Example of disabling a zone configuration:

```
device# configure terminal
Entering configuration mode terminal
device(config)# no zoning enabled-configuration cfg-name
```

Deleting a zone configuration

The following procedure deletes a zone configuration from the defined configuration.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.

2. Enter the **no zoning defined-configuration cfg** command and the name of the zone configuration you want to delete.
3. Enter the **zoning enabled-configuration cfg-action cfg-save** command to save the modified defined configuration to nonvolatile memory.

   Example of deleting a zone configuration:

```
device# configure terminal
Entering configuration mode terminal
device(config)# no zoning defined-configuration cfg cfg2
device(config)# zoning enabled-configuration cfg-action cfg-save
```

> NOTE
> If you try to delete the enabled configuration from the defined configuration, the **zoning enabled-configuration cfg-action cfg-save** command returns an error. However, if you commit the transaction with the **zoning enabled-configuration cfg-action cfg-disable** command, the operation proceeds without error.

Clearing changes to a zone configuration

The following procedure aborts all pending transactions and removes all uncommitted operations from the database. It returns the configuration in volatile memory to the state it was in when a **zoning enabled-configuration cfg-action cfg-save** or **zoning enabled-configuration cfg-name** command was last executed successfully.

1. In privileged EXEC mode, enter the **configure terminal** command to enter the global configuration mode.
2. Enter the **zoning enabled-configuration cfg-action cfg-transaction-abort** command.

   Example of aborting a transaction:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning enabled-configuration cfg-action cfg-transaction-abort
```

Clearing all zone configurations

The following procedure clears all zone configurations from the defined configuration and enables the default zone.

> NOTE
> For fabrics with many devices, Extreme recommends setting the default access mode to No Access before clearing all zone configurations to avoid RSCN storms.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Enter the **zoning enabled-configuration cfg-action cfg-clear** command.
3. Enter one of the following commands, depending on whether an enabled zone configuration exists:
   - If no enabled zone configuration exists, enter the **zoning enabled-configuration cfg-action cfg-save** command.
   - If an enabled zone configuration exists, enter the **no zoning enabled-configuration cfg-name** command to disable and clear the zone configuration in nonvolatile memory for all devices in the fabric.

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning enabled-configuration cfg-action cfg-clear
device(config)# no zoning enabled-configuration cfg-name
```

Backing up the zone configuration

To back up your zoning configuration you copy it to a file and store it on a server or on an attached USB device. You can use the copy to restore the configuration if needed.

NOTE
Ensure that no transaction is pending before you perform the copy operation, otherwise failures will occur when you attempt to restore configuration entries from the saved file. Any transaction data would cause such a failure, including empty configuration definitions or empty zones.

1. In privileged EXEC mode, enter the **configure terminal** command to enter global configuration mode.
2. Empty the transaction buffer by either committing the transaction to nonvolatile memory or aborting the transaction.
   - To commit the transaction, enter the **zoning enabled-configuration cfg-action cfg-save** command, the **zoning enabled configuration cfg-name** command, or the **zoning enabled-configuration cfg-action cfg-disable** command.
   - To abort the transaction, enter the **zoning enabled-configuration cfg-action cfg-transaction-abort** command.
3. Enter the **exit** command to return to privileged EXEC mode.
4. Enter the **copy** command. For the source file, use **running-config** . For the destination file, use the file name you want the configuration copied to.

   Example of making a backup copy on a USB device:

```
device# configure terminal
Entering configuration mode terminal
device(config)# zoning enabled-configuration cfg-action cfg-save
device(config)# exit
device# copy running-config usb://myconfig
```

Restoring a configuration from backup

When you restore a configuration from backup and add to the running configuration, the zone configuration identified in the backup copy as the enabled configuration becomes the new enabled configuration.

In privileged EXEC mode, enter the **copy** command. For the source file use the file where the saved configuration is stored. For the destination file, use **running-config**.

This operation updates the defined configuration in RAM.

NOTE
The **copy** command adds to the defined configuration. It does not replace the defined configuration.

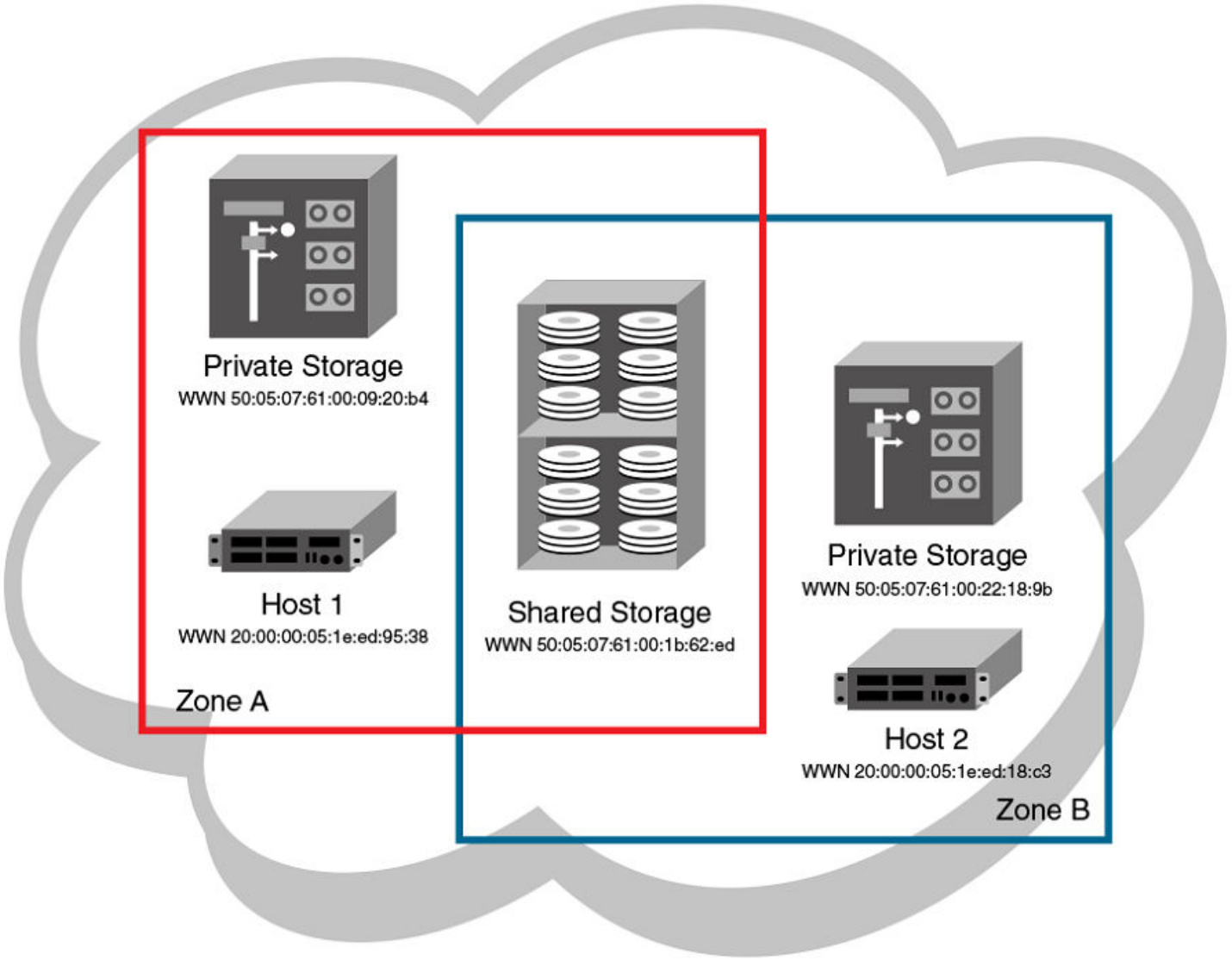
The following example adds the configuration in the file named myconfig on the attached USB device to the defined configuration.

```
device# copy usb://myconfig running-config
```

Zone configuration scenario example

This example creates the zone configuration shown below. The example assumes that two hosts need access to the same storage device, while each host needs private storage of its own. You create two zones: Zone A contains Host 1, its private storage device, and the shared storage device; Zone B contains Host 2, its private storage device, and the shared storage device. In addition, you create two zone configurations: cfg1 in which only Zone A is effective; cfg2, in which both zones are effective.

FIGURE 7 Zone configuration example



1. Log in to any switch in the Extreme VCS Fabric.
2. Enter the **show name-server detail** command to list the available WWNs,
3. Enter the **configure terminal** command to enter global configuration mode.
4. Enter the **zoning defined-configuration zone** command to create Zone A.
5. Enter the **zoning defined-configuration zone** command to create Zone B.
6. Enter the **zoning defined-configuration cfg** command to create the configuration cfg1 with Zone A as its only member.
7. Enter the **zoning defined-configuration cfg** command to create the configuration cfg2 with Zone A and Zone B as its members.
8. Enter the **zoning running-config defined-configuration** command to view the defined zone configuration.
9. Enter the **zoning enabled-configuration cfg-name** command to enable cfg2.

10. Verify the enabled zoning configuration, by means of the **show zoning enabled-configuration** command.

```
switch# show name-server detail
switch# configure terminal
Entering configuration mode terminal
switch(config)# zoning defined-configuration zone ZoneA
switch(config-zone-ZoneA)# member-entry 20:00:00:05:1e:ed:
95:38;50:05:07:61:00:09:20:b4;50:05:07:61:00:1b:62:ed
switch(config-zone-ZoneA)# exit
switch(config)# zoning defined-configuration zone ZoneB
switch(config-zone-ZoneB)# member-entry 20:00:00:05:1e:ed:18:c3;50:05:07:61:00:22:18:9b;
50:05:07:61:00:1b:62:ed
switch(config-zone-ZoneB)# exit
switch(config)# zoning defined-configuration cfg cfg1
switch(config-cfg-cfg1)# member-zone ZoneA
switch(config-cfg-cfg1)# exit
switch(config)# zoning defined-configuration cfg cfg2
switch(config-cfg-cfg2)# member-zone ZoneA;ZoneB
switch(config-cfg-cfg2)# exit
switch(config)# zoning enabled-configuration cfg-name cfg2
switch(config)# exit
switch# show zoning enabled-configuration
zoning enabled-configuration cfg cfg1
 member-zone ZoneA
!
zoning enabled-configuration cfg cfg2
 member-zone ZoneA
 member-zone ZoneB
!
zoning enabled-configuration zone ZoneA
 member-entry 20:00:00:05:1e:ed:95:38
 member-entry 50:05:07:61:00:09:20:b4
 member-entry 50:05:07:61:00:1b:62:ed
!
zoning enabled-configuration zone ZoneB
 member-entry 20:00:00:05:1e:ed:18:c3
 member-entry 50:05:07:61:00:22:18:9b
 member-entry 50:05:07:61:00:1b:62:ed
```

Merging zones

This section provides the background needed to merge zones successfully. The tables at the end of this section summarize scenarios involving Switch A and Switch B and the results to be expected following a merge.

Preconditions for zone merging

When a new device is added to a VCS fabric, it automatically inherits the zone configuration information from the fabric. You can verify the zone configuration on any device by using the procedure described in Viewing the defined configuration on page 151. Take care to avoid mismatched enabled-configuration scenarios.

CAUTION

When edits are made to the defined configuration, and those edits affect a currently enabled zone configuration, issuing a "cfg-save" command makes the enabled configuration effectively stale. Until the enabled configuration is reenabled, the merging of new RBridges into the fabric is not recommended. This merging may cause unpredictable results, with the potential for mismatched enabled-zoning configurations among the RBridges in the fabric.

If you are adding a device that is already configured for zoning, you must clear the zone configuration on that device before connecting it to the zoned fabric. Refer to Clearing all zone configurations on page 156 for instructions.

Adding a new fabric that has no zone configuration information to an existing zoned fabric is very similar to adding a new device. All devices in the new fabric inherit the zone configuration data. If the existing fabric has an effective zone configuration, then the same configuration becomes the effective configuration for all devices in the added fabric.

NOTE
To prevent an unwanted zone merge, use the **no fabric isl enable** command on ISL interfaces instead of the **shutdown** command on tengigabitethernet ports.

Before the new fabric can merge successfully, it must satisfy the following criteria:

- Before merging
  - Ensure that all devices adhere to the default zone merge rules as described in Zone merging scenarios on page 161.
  - Ensure that the enabled and defined zone configurations match. If they do not match and you merge with another device, the merge might be successful, but unpredictable zoning and routing behavior can occur. Refer to the Caution in this section and refer to Viewing the defined configuration on page 151.
- Merging and segmentation

The system checks each port as it comes online to determine whether the ports should be segmented. E_Ports come online on power up, enabling a device, or adding a new device, and the system checks the zone database to detect if the two database that can be merged safely. Refer to Zone merging scenarios on page 161.

Observe the following rules when merging zones:

- Merging rules
  - Local and adjacent configurations: If the local and adjacent zone database configurations are the same, they will remain unchanged after the merge.
  - Enabled configurations: If there is an enabled configuration between two devices, the enabled zone configurations must match.
  - Zone membership: If a zoning object has the same name in both the local and adjacent defined configurations, the content and order of the members are important.
  - Objects in adjacent configurations: If a zoning object appears in an adjacent defined configuration, but not in the local defined configuration, the zoning object is added to the local defined configuration. The modified zone database must fit in the nonvolatile memory area allotted for the zone database.
  - Local configuration modification: If a local defined configuration is modified because of a merge, the new zone database is propagated to the other devices within the merge request.
- Merging two fabrics

For best practices, the default-zone access modes should match, although this is not a requirement. Refer to Zone merging scenarios on page 161.

If the two fabrics have conflicting zone configurations, they will not merge. If the two fabrics cannot join, the ISLs between the devices will segment.

The transaction state after the merge depends on which device is elected as the principal RBridge. The newly elected principal RBridge retains the same transaction information it had before the merge. Transaction data is discarded from any device that lost its principal status during the merge.

- Merge conflicts

When a merge conflict is present, a merge does not take place and the ISLs will segment.

If the fabrics have different zone configuration data, the system attempts to merge the two sets of zone configuration data. If the zones cannot merge, the ISLs will be segmented.

- A merge is not possible under any of the following conditions:
  - Configuration mismatch: Zoning is enabled in both fabrics and the zone configurations that are enabled are different in each fabric.
  - Zone Database Size: The zone database size exceeds the maximum limit of another device.

  NOTE
  If the zone members on two devices are not listed in the same order, the configuration is considered a mismatch, and the devices will segment from the fabric. For example: `cfg1 = z1; z2` is different from `cfg1 = z2; z1`, even though the members of the configuration are the same. If zone members on two devices have the same names defined in the configuration, make sure the zone members are listed in the same order.

Fabric segmentation and zoning

If the connections between two fabrics are no longer available, the fabric segments into two separate fabrics. Each new fabric retains the previous zone configuration.

If the connections between two fabrics are replaced and no changes have been made to the zone configuration in either of the two fabrics, the two fabrics can merge back into one single fabric. If any changes that cause a conflict have been made to either zone configuration, a fabric merge may fail.

Zone merging scenarios

The following tables provide information on merging zones and the expected results.

TABLE 18 Zone merging scenarios: Defined and enabled configurations

Description	Switch A	Switch B	Expected results
Switch A has a defined configuration. **Switch B** does not have a defined configuration.	defined:cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	defined: none enabled: none	Configuration from **Switch A** propagates throughout the fabric in an inactive state, because the configuration is not enabled.
Switch A has a defined and enabled configuration. **Switch B** has a defined configuration but no enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	Configuration from **Switch A** propagates throughout the fabric. The configuration is enabled after the merge in the fabric.
Switch A and **Switch B** have the same defined configuration. Neither have an enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	No change (clean merge).
Switch A and **Switch B** have the same defined and enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1:	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1:	No change (clean merge).
Switch A does not have a defined configuration. **Switch B** has a defined configuration.	defined: none enabled: none	defined:cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	**Switch A** absorbs the configuration from the fabric.

TABLE 18 Zone merging scenarios: Defined and enabled configurations (continued)

Description	Switch A	Switch B	Expected results
Switch A does not have a defined configuration. **Switch B** has a defined and enabled configuration.	defined: none enabled: none	defined:cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	**Switch A** absorbs the configuration from the fabric, with cfg1 as the enabled configuration.
Switch A and **Switch B** have the same defined configuration. Only **Switch B** has an enabled configuration.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	Clean merge, with cfg1 as the enabled configuration.
Switch A and **Switch B** have different defined configurations. Neither have an enabled configuration.	defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: none	Clean merge. The new configuration will be a composite of the two. defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: none
Switch A and **Switch B** have different defined configurations. **Switch B** has an enabled configuration.	defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1	Clean merge. The new configuration is a composite of both, with cfg1 as the enabled configuration.
Switch A does not have a defined configuration. **Switch B** has a defined configuration and an enabled configuration, but the enabled configuration is different from the defined configuration.	defined: none enabled: none	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b effective: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b zone2: 10:00:00:90:69:00:00:8c, 10:00:00:90:69:00:00:8d	Clean merge. **Switch A** absorbs the defined configuration from the fabric, with cfg1 as the effective configuration. In this case, however, the effective configurations for **Switch A** and **Switch B** are different. You should issue a **zoning enabled-configuration cfg-name** command from the switch with the proper effective configuration.

TABLE 19 Zone merging scenarios: Different content

Description	Switch A	Switch B	Expected results
Enabled configuration mismatch.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b	defined: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: cfg2 zone2: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d	Fabric segments due to mismatching zone configurations
Configuration content mismatch.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: irrelevant	defined: cfg1 zone1: 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8d enabled: irrelevant	Fabric segments due to mismatching zone content

TABLE 20 Zone merging scenarios: Different names

Description	Switch A	Switch B	Expected results
Same content, different enabled configuration name.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b	defined:cfg2 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: cfg2 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b	Fabric segments due to mismatching zone configurations
Same content, different zone name.	defined: cfg1 zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: irrelevant	defined: cfg1 zone2: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b enabled: irrelevant	Fabric segments due to mismatching zone content
Same name, same content, different order.	defined: cfg1zone1: 10:00:00:90:69:00:00:8a; 10:00:00:90:69:00:00:8b; 10:00:00:90:69:00:00:8c enabled: irrelevant	defined: cfg1zone1: 10:00:00:90:69:00:00:8b; 10:00:00:90:69:00:00:8c; 10:00:00:90:69:00:00:8a enabled: irrelevant	Fabric segments due to mismatching zone content
Same name, different types.	effective: zone1: MARKETING	enabled: cfg1: MARKETING	Fabric segments due to mismatching types

TABLE 21 Zone merging scenarios: Default access mode

Description	Switch A	Switch B	Expected results
Different default zone access mode settings.	default zone: All Access	default zone: No Access	Clean merge. No Access takes precedence and default zone configuration from **Switch B** propagates to fabric. default zone: No Access
Same default zone access mode settings.	default zone: All Access	default zone: All Access	Clean merge. Default zone configuration is All Access in the fabric.
Same default zone access mode settings.	default zone: No Access	default zone: No Access	Clean merge. Default zone configuration is No Access in the fabric.
Enabled zone configuration.	No enabled configuration. default zone = All Access	enabled: cfg2 default zone: All Access or No Access	Clean merge. Enabled zone configuration and default zone mode from **Switch B** propagates to fabric.
Enabled zone configuration.	No enabled configuration. default zone = No Access	enabled: cfg2 default zone: All Access	Fabric segments because **Switch A** has a hidden zone configuration (No Access) activated and **Switch B** has an explicit zone configuration activated.
Enable zone configuration.	enabled: cfg1 default zone: No Access	No enabled configuration. default zone: No Access	Clean merge. Enabled zone configuration from **Switch A** propagates to fabric.
Enable zone configuration.	enabled: cfg1 default zone: All Access	No enabled configuration. default zone: No Access	Fabric segments. You can resolve the zone conflict by changing the default zone to No Access on **Switch A**.

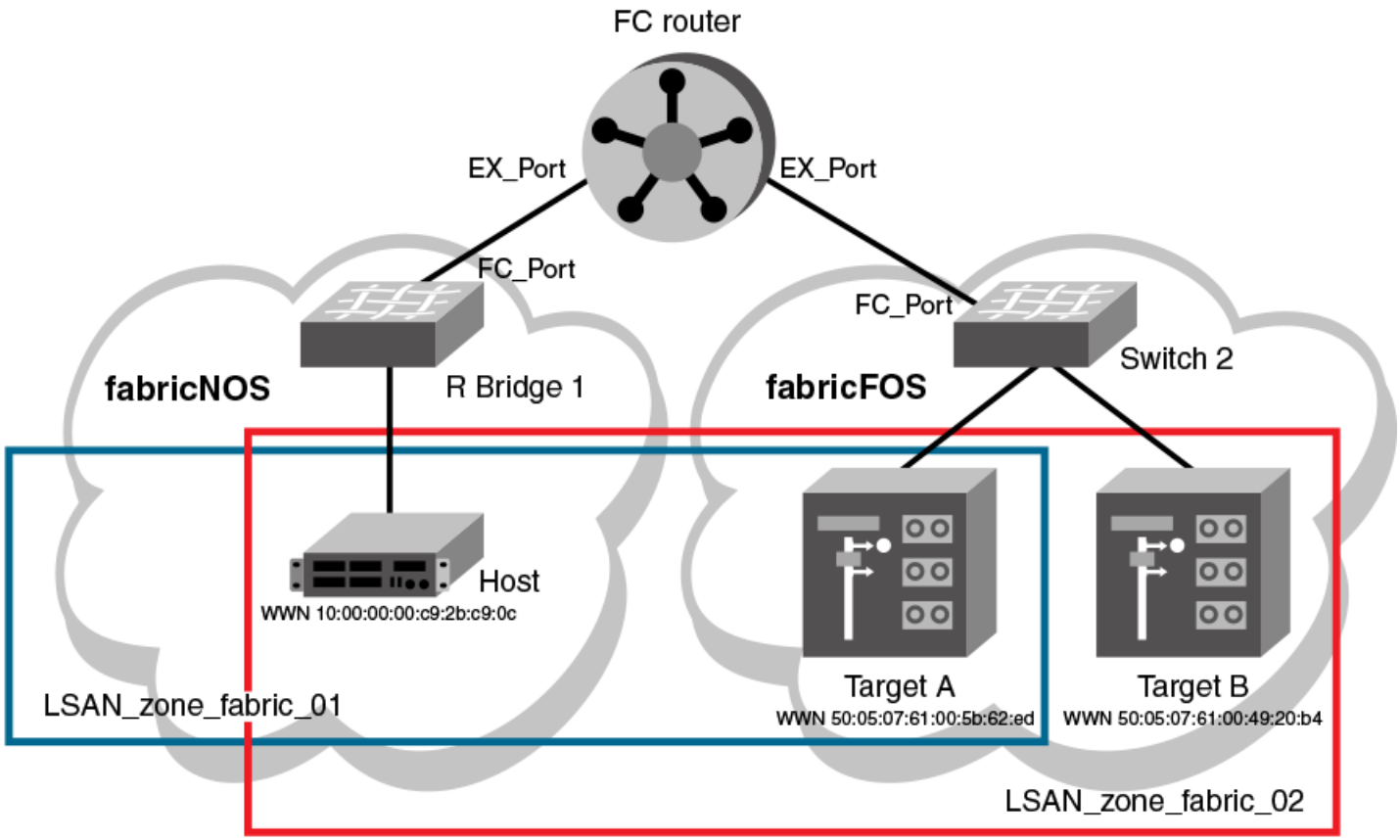
Configuring LSAN zones: Device-sharing example

The following example shows LSANs sharing devices in separate fabrics. The procedure illustrates the creation of two LSAN zones (called lsan_zone_fabric_02 and lsan_zone_fabric_01), which involve the following devices and connections:

- RBridge1 and the host in a Network OS fabric named fabric_01.
- Switch2, Target A, and Target B in a Fabric OS fabric named fabric_02.
- RBridge1 is connected by one of its FC_Ports to an EX_Port on the FC router.
- Switch2 is connected to the FC router using another EX_Port or VEX_Port.
- Host has WWN 10:00:00:00:c9:2b:c9:0c (connected to RBridge1).
- Target A has WWN 50:05:07:61:00:5b:62:ed (connected to switch2).
- Target B has WWN 50:05:07:61:00:49:20:b4 (connected to switch2).

The following illustration shows the connectivity.

FIGURE 8 LSAN zones example



The following example steps create this set of LSAN zones.

1. Obtain the host WWN in fabric_01:
   a) Log in to any switch in fabric_01.
   b) On the fabric_01 switch, enter the **show name-server detail** command to list the WWN of the host (10:00:00:00:c9:2b:c9:0c).

      NOTE
      The **show name-server detail** output displays both the port WWN and node WWN; the port WWN must be used for LSANs.

```
device# show name-server detail
PID: 012100
Port Name: 10:00:00:00:c9:2b:c9:0c
Node Name: 20:00:00:00:c9:2b:c9:0c
SCR: 3
FC4s: FCP
PortSymb: [27] "Brocade-1020|2.3.0.0|localhost.localdomain|Red Hat
Enterprise Linux Server release 5.5"
NodeSymb: NULL
Fabric Port Name: 20:21:00:05:1E:CD:79:7A
Permanent Port Name: 10:00:00:00:c9:2b:c9:0c
Device type: Physical Initiator
Interface: Fcoe 1/1/9
Physical Interface: Te 1/0/9
Share Area: No
Redirect: No
```

2. Obtain the target WWNS in fabric_02:
   a) Log in as admin on switch2 in fabric_02.
   b) On fabric_02, enter the **nsShow** command to list Target A (50:05:07:61:00:5b:62:ed) and Target B (50:05:07:61:00:49:20:b4).

```
device:admin> nsshow
{
Type Pid    COS  PortName                NodeName                TTL(sec)
NL   0508e8; 3;  50:05:07:61:00:5b:62:ed; 50:05:07:61:00:1b:62:ed; na
 FC4s: FCP [IBM   DNEF-309170   F90F]
 Fabric Port Name: 20:08:00:05:1e:34:11:e5
 Permanent Port Name: 50:05:07:61:00:5b:62:ed

NL   0508ef; 3;  50:05:07:61:00:49:20:b4; 50:05:07:61:00:09:20:b4; na
 FC4s: FCP [IBM   DNEF-309170   F90F]
 Fabric Port Name: 20:08:00:05:1e:34:11:e5
 Permanent Port Name: 50:05:07:61:00:49:20:b4
The Local Name Server has 2 entries }
```

3. Create an LSAN zone in the Network OS fabric (fabric_01)
4. In fabric_01, enter the **zoning defined-configuration zone** command to create the LSAN lsan_zone_fabric_01, and include the host.

```
device# config terminal
device(config)# zoning defined-configuration zone lsan_zone_fabric_01
device(config-zone-lsan_zone_fabric_01)# member-entry 10:00:00:00:c9:2b:c9:0c
```

5. In fabric_01, add Target A to the LSAN.

```
device(config-zone-lsan_zone_fabric_01)# member-entry 50:05:07:61:00:5b:62:ed
device(config-zone-lsan_zone_fabric_01)# exit
```

6. In fabric_01, enter the **zoning defined-configuration cfg** and **zoning enabled-configuration cfg-name** commands to add and enable the LSAN configuration.

```
device(config)# zoning defined-configuration cfg zone_cfg
device(config-cfg-zone_cfg)# member-zone lsan_zone_fabric_01
device(config-cfg-zone_cfg)# exit
device(config)# zoning enabled-configuration cfg_name zone_cfg
```

Create an LSAN zone in the Fabric OS fabric (fabric_02)

7. On switch2 (fabric_02), enter the **zoneCreate** command to create the LSAN lsan_zone_fabric2, which includes the host (10:00:00:00:c9:2b:c9:0c), Target A (50:05:07:61:00:5b:62:ed) , and Target B (50:05:07:61:00:49:20:b4).

```
device:admin> zonecreate "lsan_zone_fabric_02", "10:00:00:00:c9:2b:c9:0c;
                                                 50:05:07:61:00:5b:62:ed;
                                                 50:05:07:61:00:49:20:b4"
```

8. On switch2 (fabric_02), enter the **cfgShow** command to verify that the zones are correct.

```
device:admin> cfgshow
Defined configuration:
 zone: lsan_zone_fabric_02
        10:00:00:00:c9:2b:c9:0c;
        50:05:07:61:00:5b:62:ed;
        50:05:07:61:00:49:20:b4
Effective configuration:
 no configuration in effect
```

9. On switch2 (fabric_02), enter the **cfgAdd** and **cfgEnable** commands to create and enable the LSAN configuration.

```
device:admin> cfgadd "zone_cfg", "lsan_zone_fabric_02"
device:admin> cfgenable "zone_cfg"
You are about to enable a new zoning configuration.
This action will replace the old zoning configuration with the
current configuration selected.
Do you want to enable 'zone_cfg' configuration (yes, y, no, n): [no] y
zone config "zone_cfg" is in effect
Updating flash ...
```

Display the configuration on the FC router:

10. Log in as an admin and connect to the FC router.

11. On the FC router, enter the following commands to display information about the LSANs.

    The **lsanZoneShow -s** command shows the LSAN.

```
device:admin> lsanzoneshow -s
Fabric ID: 2 Zone Name: lsan_zone_fabric_02
    10:00:00:00:c9:2b:c9:0c Imported
    50:05:07:61:00:5b:62:ed EXIST
    50:05:07:61:00:49:20:b4 EXIST
Fabric ID: 75 Zone Name: lsan_zone_fabric_01
    10:00:00:00:c9:2b:c9:0c EXIST
    50:05:07:61:00:5b:62:ed Imported
```

    The **fcrPhyDevShow** command shows the physical devices in the LSAN.

```
device:admin> fcrphydevshow
    Device      WWN                       Physical
    Exists                                PID
    in Fabric
    ------------------------------------------
    75         10:00:00:00:c9:2b:c9:0c   c70000
     2         50:05:07:61:00:49:20:b4   0100ef
     2         50:05:07:61:00:5b:62:ed   0100e8
 Total devices displayed: 3
```

    The **fcrProxyDevShow** command shows the proxy devices in the LSAN.

```
device:admin> fcrproxydevshow

Proxy      WWN                              Proxy Device  Physical State
Created                                     PID Exists    PID
in Fabric                                   in Fabric
-------------------------------------------------------------------------
75         50:05:07:61:00:5b:62:ed 01f001   2          0100e8  Imported
 2         10:00:00:00:c9:2b:c9:0c 02f000  75          c70000  Imported
Total devices displayed: 2
```

    On the FC router, the host and Target A are imported, because both are defined by lsan_zone_fabric_02 and lsan_zone_fabric_01. However, target B is defined by lsan_zone_fabric_02 and is not imported because lsan_zone_fabric_01 does not allow it.