BROCADE

CONFIGURATION GUIDE

Brocade SLX-OS Security Configuration Guide, 16r.1.00

Supporting the Brocade SLX 9850 Router

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Contents

Preface

Document conventions

The document conventions describe text formatting conventions, command syntax conventions, and important notice formats used in Brocade 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.
value	In Fibre Channel products, a fixed value provided as input to a command option is printed in plain text, for example, **--show** WWN.
[ ]	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. In Fibre Channel products, square brackets may be used instead for this purpose.
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.

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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 Brocade Communications Systems, Inc. for SLX-OS Release 16r.1.00, documenting all possible configurations and scenarios is beyond the scope of this document.

The following hardware platforms are supported by this release:

- Brocade SLX 9850-4 router
- Brocade SLX 9850-8 router

To obtain information about other Brocade OS versions, refer to the documentation specific to that version.

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 *Brocade 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: **cfm**, **execute-script**, **exit**, **mtrace**, **no**, **ping**, **rasman**, **ssh**, **sysmon**, **telnet**, **timestamp**, **trace-l2**, and **traceroute**.

  NOTE
  For details on non-default roles (also known as *user-defined roles*), refer to User-defined roles on page 16.

Account guidelines and limitations

Be aware of the following guidelines and limitations:

- Brocade 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 16.

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 23 for more information.

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
**USER SESSIONS**
Username    Role    Host IP       Device    Time Logged In
jsmith      user    192.0.2.0     Cli       2016-04-30 01:59:35
jdoe        admin   192.0.2.1     Cli       2016-05-30 01:57:41

**LOCKED USERS**
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
**USER SESSIONS**
Username    Role    Host Ip       Method    Time Logged In          TTY
jsmith      user    192.0.2.0     cli       2016-04-30 01:59:35     pts/2
jdoe        admin   192.0.2.1     cli       2016-05-30 01:57:41     tty80

**LOCKED USERS**
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.

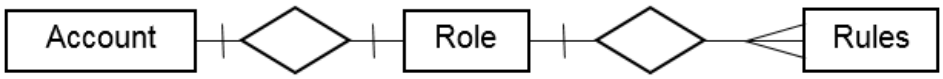
The following tools are available for managing user-defined roles:

- 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:



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
```

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
ethernet 1/4
device(config)# rule 65 action accept operation read-write role NetworkAdmin command interface port-
channel 2
device(config)# rule 68 role NetworkAdmin action reject command interface ethernet 3/4
```

- 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 **ethernet** instances.

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

- If a role has a rule with **read-only** or **read-write** operation, and the **reject** action for an interface **ethernet** 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 ethernet** 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 **ethernet** instances.

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

- 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** instances.

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

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

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 Brocade 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

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

The following three subsections detail the configurable password policies.

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.

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.

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 15.

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 or TACACS+ 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.

Command shortcuts (aliases)

Aliases are command shortcuts that you can define both globally and per user.

Configuring global aliases

Global aliases (command shortcuts) are accessible to any logged-in user.

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

```
device# configure terminal
```

2. Enter the **alias-config** command to access alias configuration mode.

```
device(config)# alias-config
```

3. Enter the **alias** command, specifying the alias and its corresponding command.

```
device(config-alias-config)# alias ck "show clock"
```

4. Verify the alias.

```
device(config-alias-config)# exit
device(config)#  exit
device# ck
device#  show clock
2016-06-14 13:03:55 Etc/GMT
```

Configuring user-level aliases

User-level aliases (command shortcuts) are defined per user account

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

```
device# configure terminal
```

2. Enter the **alias-config** command to access alias configuration mode.

```
device(config)# alias-config
```

3. Enter the **user** command to access user-alias configuration mode.

```
device(config-alias-config)# user jdoe
```

4. Enter the **alias** command, specifying the alias and its corresponding command.

```
device(config-user-jdoe)# alias int2 "interface ethernet 1/2"
```

5. Verify the alias.

NOTE
The following verification flow assumes that the user jdoe defined the user-level alias "int2" by herself. If an admin had defined it for her, the actual flow would have shown the admin logging out and jdoe logging in.

```
device(config-alias-config)# exit
device(config-user-jdoe)# exit
device(config-alias-config)# exit
device(config)# int2

<Displayed automatically:>
device(config)#interface ethernet 1/2
device(conf-if-eth-1/2)#
```

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.

User accounts and passwords Show commands

There are several **show** commands that display user account and password information. They are documented in the *SLX-OS Command Reference* for the SLX 9850 Router, and listed here with descriptions.

TABLE 2 User account and password Show commands in the *SLX-OS Command Reference for the SLX 9850 Router.*

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.

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 or deny traffic according to source address only.
- *Extended ACLs* — Permit or deny 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 or UDP
  - 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 or at global configuration 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** commands.

TABLE 3 ACLs applied to interfaces or at global configuration level

Target/type	Description	Applied from	Applied with	Types supported	Reference
Interface	Filters all traffic entering or exiting an interface.	Interface configuration sub-modes (including VLAN and VE)	{ **mac** | **ip** | **ipv6** } **access-group** { **in** | **out** }	MAC, IPv4, IPv6 Standard, extended	Layer 2 (MAC) ACLs on page 29 Layer 3 (IPv4 and IPv6) ACLs on page 38
Receive-path	Receive-path ACLs (rACLs) are applied at global configuration level. Their primary function is to filter CPU-bound traffic.	Global configuration mode	{ **ip** | **ipv6** } **receive access-group**	IPv4, IPv6 Standard, extended	Interface ACLs and rACLs on page 28

The following table summarizes details of ACL types not discussed in the current unit, as they differ significantly from ACLs applied to interfaces and at global configuration level.

TABLE 4 Other ACL applications

Target/type	Description	Created with	Applied with	Types supported	Notes
ACL-RL	Support rate-limiting and policing; can also protect against denial of service (DOS) attacks.	{ **ip** | **ipv6** } **access-list**	**match access-group** *acl-name*	IPv4 Standard, extended	The **mirror** keyword is not supported. Applied from class-map configuration mode.
PBR	If an incoming packet matches an ACL rule, can modify default routing behavior, for example, by changing the destination port.	{ **ip** | **ipv6** } **access-list**	**match {ip|ipv6} address acl** *acl-name*	IPv4, IPv6 Standard, extended	The **mirror** keyword is not supported. Applied from route-map configuration mode.

Interface ACLs and rACLs

Layer 3 ACLs applied at global configuration level to filter CPU-bound traffic are called *receive-path ACLs* or *rACLs*. All other ACLs discussed in the current document are applied to an interface (including VLAN or VE). They can be referred to an *interface ACLs*.

Traffic entering a device can be divided into two categories:

- Datapath traffic
- CPU-bound traffic

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

Rules in an rACL, applied at global configuration level, primarily filter CPU-bound traffic. Implementing rACLs offers the following advantages:

- Shields the 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 flows for rACLs and interface ACLs on page 38.

Otherwise, continue with ACLs applied to interfaces on page 29.

ACLs applied to interfaces

This topic describes interfaces that support ACLs.

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

- Physical (Ethernet) interfaces—in switchport mode
- Port-channel interfaces—in switchport mode
- VLANs

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

- User interfaces
  - Physical (Ethernet) interfaces
  - Port-channel interfaces
  - Virtual Ethernet (VE) interfaces
- Management interfaces

ACL and rule limits

For each ACL type (Layer 2, IPv4, and IPv6), there are SW limits to the number of ACLs and rules supported.

TABLE 5 ACL and rule software limits

ACL type (standard and extended)	Maximum ACLs per type	Maximum rules per ACL	Maximum total rules per ACL type
Layer 2	2048	2038	100K
IPv4	2048	2038 CAM entries, including implicit deny	102400
IPv6	2048	2K	100K

The following software limits apply to all ACL types:

- 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 1 through 65535.

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 rules. For example, following a **permit** match, subsequent **deny** or **hard-drop** rules do not override the **permit**.

- 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.
- To modify an ACL rule, delete it and then replace it with a rule of the same **seq** number.
- There is an implicit Layer 2 deny rule programmed in the CAM. This rule denies streams that do not match any of the configured rules in the ACL.
- The **hard drop** keyword is equivalent to the **deny** keyword.
- In ingress Layer 2 ACLs, **deny** and **hard-drop** rules affect protocol packets.
- In egress Layer 2 ACLs, **deny** and **hard-drop** rules do not affect protocol packets.
- You can apply up to five 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
- You can apply a specific ACL to one or more interfaces, for ingress or egress, or for both.

Basic Layer 2 ACLs and rules

You can create standard and extended Layer 2 (MAC) ACLs, and define permit and deny rules within them.

See also Advanced Layer 2 ACL rules and features on page 33.

Creating a standard MAC 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 **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, PCP value, 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. For each ACL rule, enter a permit or deny command, command, specifying the needed parameters.

```
device(conf-macl-ext)# seq 5 permit host 0022.3333.4444 host 0022.3333.5555
device(conf-macl-ext)# permit host 0022.3333.5555 host 0022.3333.6666
```

4. 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 a physical interface in switchport mode.

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

```
device# configure
```

2. Enter the **interface ethernet** command, specifying the slot/port number.

```
device(config)# interface ethernet 2/2
```

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

```
device(conf-if-eth-2/2)# 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** command to access global configuration mode.

```
device# configure
```

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 and the in/out direction.

```
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** command to access global configuration mode.

```
device# configure
```

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

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

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

```
device(config-Vlan-50)# mac access-group test_02 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 ethernet 2/9
```

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

```
device(conf-if-eth-2/9)# no mac access-group macacl2 in
```

Layer 2 ACL modification

You can replace the contents of an ACL rule. You can also modify ACL sequence (**seq**) numbers.

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** command to access global configuration mode.

```
device# configure
```

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 1 through 65535, and the increment number can range from 1 through 65534.

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
```

Advanced Layer 2 ACL rules and features

Many advanced ACL features are implemented per ACL rule, according to parameters that you specify. Some of the features also require global configuration.

Guidelines for advanced L2 ACL rules

Here is a summary of which rule keywords are supported for the various types of Layer 2 ACLs and rules. There are also notes on interactions among keywords.

For details, refer to the following *Brocade SLX-OS Command Reference* topics:

- seq (rules in MAC standard ACLs)
- seq (rules in MAC extended ACLs)

TABLE 6 Layer 2 ACL advanced keywords

Keyword	Per rule, implements	L2 standard ACL	L2 extended ACL	Notes
pcp	802.1p filtering	NA	P/D; I/O	
pcp-force	802.1p re-marking	NA	P; I	
drop-precedence-force	Re-marking drop-precedence	NA	NA	Not currently supported.
count	Counter statistics	P/D; I/O	P/D; I/O	
log	Logging	P/D; I	P/D; I	
mirror	Mirroring	NA	P/D; I	Effective only in ACLs applied to physical interfaces.
copy-sflow	sFlow monitoring	P/D; I	P/D; I	

Key:

- **P**—Supported in a permit rule
- **D**—Supported in a deny or a hard-drop rule. For Layer 2 ACLs, the **hard-drop** keyword functions exactly like the **deny** keyword. (It does not override the trap behavior for control frames.)
- **I**—Supported in an ACL applied to incoming traffic
- **O**—Supported in an ACL applied to outgoing traffic
- **NA**—Not available

Advanced-rule limitations

The following limitations apply to rules in Layer 2 ACLs applied in the incoming direction.

Although in a standard-ACL rule you can include **log** and **copy-sflow**, only one of the two is processed, as follows:

- In a permit rule, the order of precedence is **copy-sflow** > **log**.
- In a deny or hard-drop rule, the order of precedence is **log** > **copy-sflow**.

Although in an extended-ACL rule you can include **log**, **mirror**, and **copy-sflow**, only one of the three is processed, as follows:

- In a permit rule, the order of precedence is **mirror** > **copy-sflow** > **log**.
- In a deny or hard-drop rule, the order of precedence is **log** > **copy-sflow** > **mirror**.

For example, in the following extended ACL:

- In the permit rule, only the **mirror** keyword is processed.
- In the deny rule, only the **log** keyword is processed.

```
device(config)# mac access-list extended mac1
device(conf-macl-ext)# seq 10 permit host 0000.1324.3333 any count log mirror copy-sflow
device(conf-macl-ext)# seq 20 deny host 0000.1357.4444 any count log mirror copy-sflow
```

Filtering and forcing PCP values (L2 ACLs)

In Layer 2 extended ACL rules, re-marking (forcing) PCP values can change priority on egress traffic, by which you can prioritize ingress traffic. You can also filter Layer 2 packets by PCP value.

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

```
device# configure
```

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

```
device(config)# mac access-list extended mac_acl2
```

3. To filter incoming or outgoing packets by PCP value, define permit and deny rules specifying the **pcp** parameters.

```
device(conf-macl-ext)# seq 5 permit host 0022.3333.4444 host 0022.3333.5555 pcp 2
device(conf-macl-ext)# deny host 0022.3333.7777 host 0022.3333.6666 pcp 5
```

4. To re-mark the PCP value of incoming packets, define permit rules specifying the **pcp-force** parameters.

```
device(conf-macl-ext)# seq 10 permit host 0022.3333.4445 host 0022.3333.5556 pcp-force 2
```

5. Apply the ACL to the appropriate interface.

```
device(config)# interface ethernet 2/1
device(conf-if-eth-2/1)# mac access-group mac_acl2 in
```

Creating a MAC ACL rule enabled for counter statistics

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

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

```
device# configure
```

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-macl-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 network traffic only
- 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
Frames Logged on interface 2/1 :
--------------------------------
Frame Received Time : Fri Dec 9 3:8:48 2011
Ethernet,       Src : (00:34:56:78:0a:ab), Dst: (00:12:ab:54:67:da)
  Ethtype           : 0x8100
  Vlan tag type     : 0x800
  VlanID            : 0x1
Internet proto, Src : 192.85.1.2, Dst: 192.0.0.1
  Interface         :
  Type of service   : 0
  Length            : 110
  Identification    : 0
  Fragmentation     : 00 00
  TTL               : 255
  protocol          : 253
  Checksum          : 39 3a
  Payload type      :
packet(s) repeated  : 30
Ingress Deny Logged
```

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** command to access global configuration mode.

```
device# configure
```

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 2 ACL-based mirroring

ACL-based mirroring enables you to monitor specified inbound traffic in the mirrored port by attaching a protocol analyzer to the mirror.

Enabling L2 ACL rules for mirroring

ACL-based inbound mirroring applies to extended-ACL rules that include the **mirror** keyword.

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

```
device# configure
```

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

```
device(config)# mac access-list extended mac_ac12
```

3. In each rule for which you need to enable mirroring, include the **mirror** keyword.

```
device(conf-macl-ext)# seq 5 permit host 0022.3333.4444 host 0022.3333.5555 mirror
device(conf-macl-ext)# deny host 0022.3333.7777 host 0022.3333.6666 mirror
```

4. Apply the ACL that you created to the appropriate physical interface, specifying the **in** keyword.

```
device(config)# interface ethernet 2/1
device(conf-if-eth-2/1)# mac access-group mac_acl2 in
```

Defining an ACL mirror port

To support ACL mirroring, define a destination ACL mirror port common to all ports of a port processor (PPCR).

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

```
device# configure
```

2. To define a physical interface as the mirror, enter a command such as the following example.

```
device(config)# acl-mirror source ethernet 1/1 destination ethernet 1/2
```

3. To define a port-channel as the mirror, enter a command such as the following example.

```
device(config)# acl-mirror source ethernet 1/1 destination port-channel 1
```

Enabling L2 ACL rules for sFlow monitoring

sFlow is a sampling technology for monitoring networks. You can monitor specified incoming data flows by including the **copy-sflow** keyword in rules within an ACL applied to a device.

In order for sFlow to function, the sFlow collector must be globally configured. For details, refer to the *Brocade SLX -OS Layer 2 Switching Configuration Guide*.

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

```
device# configure terminal
```

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

```
device(config)# mac access-list extended mac_ac12
```

3. In each rule for which you need to enable sFlow, include the **copy-sflow** keyword.

```
device(conf-macl-ext)# seq 5 permit host 0022.3333.4444 host 0022.3333.5555 copy-sflow
device(conf-macl-ext)# deny host 0022.3333.7777 host 0022.3333.6666 copy-sflow
```

4. Apply the ACL that you created to the appropriate physical interface, specifying **in**.

```
device(config)# interface ethernet 2/1
device(conf-if-eth-2/1)# mac access-group mac_acl2 in
```

Layer 3 (IPv4 and IPv6) ACLs

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

Implementation flows for rACLs and interface ACLs

The implementation flows for Layer 3 interface ACLs and receive-path ACLs (rACLs) are similar.

> **NOTE**
> For a comparison of rACLs and interface ACLs, refer to Interface ACLs and rACLs on page 28.

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 38	
	One of the following procedures: • Creating a standard IPv4 ACL on page 40 • Creating a standard IPv6 ACL on page 41 • Creating an extended IPv4 ACL on page 41 • Creating an extended IPv6 ACL on page 42	
Applying Layer 3 ACLs to interfaces on page 42		Applying an rACL to a device on page 44

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 (including VE) configuration mode, using the { **ip** | **ipv6** } **access-group** command.
- You apply rACLs from global configuration mode, using the { **ip** | **ipv6** } **receive access-group** command.
- Mirroring is not supported for rACLs.

Layer 3 ACL configuration guidelines

We present guidelines for all Layer 3 ACLs, then for ACLs applied to a user interface, then for ACLs applied to a management interface, 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).
- 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.
- To modify an ACL rule, delete it and then replace it with a rule of the same **seq** number.
- In ingress Layer 3 ACLs, **hard-drop** rules affect protocol packets.
- In egress Layer 3 ACLs, **deny** and **hard-drop** rules do not affect protocol packets.

- Although L3 ACL **deny** rules do not drop protocol packets, best practice is to define an explicit permit rule for needed protocols.

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 configured rules in the ACL.
- Egress IPv4 ACLs are applicable only for routed traffic.
- Traffic generated by the CPU—for example, echo request packets—are not filtered by egress IPv4 ACLs.
- You can apply up to five 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

    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:

- When any ACL is bound to management interface, ICMP packet types are implicitly permitted. An implicit deny entry is programmed for rest of the non-matching traffic.
- (Standard ACLs) Only packets with TCP/UDP protocols are filtered for the configured match condition (for example, SIP).
- (Standard ACLs) By default, TCP, UDP, ESP, AH, and ICMP are allowed.
- (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.
- 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, ICMP pings are allowed. In addition, 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 rACLs

In addition to the general guidelines, the following additional guidelines are relevant for receive-path ACLs (rACLs):

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

Basic Layer 3 ACLs and rules

You can create standard and extended Layer 3 (IPv4 and IPv6) ACLs, and define permit and deny rules within them.

See also Advanced Layer 3 ACL rules and features on page 46.

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. Enter rules, 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 rules 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 10 permit 20.20.33.5
device(config-ipacl-std)# seq 15 deny any
device(config-ipacl-std)# exit
device(config)# interface ethernet 5/2
device(conf-if-eth-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. Enter rules, 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 to the appropriate interface.

Creating an extended IPv4 ACL

An extended ACL permits or denies traffic according to one or more parameters, including source address, destination address, port, protocol (TCP or UDP), and 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. Enter rules, 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 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.

```
device(config)# ip access-list extended ipv4-receive-acl-example
device(conf-ipacl-ext)# deny tcp host 10.0.0.1 any count
device(conf-ipacl-ext)# deny 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)# deny tcp host 10.0.0.3 host 224.0.0.1 count

device(conf-ipacl-ext)# exit
device(config)# ip receive access-group ipv4-receive-acl-example
```

Creating an extended IPv6 ACL

An extended ACL permits or denies traffic according to one or more parameters, including source address, destination address, port, protocol (TCP or UDP), and TCP flags.

> NOTE
> For the current release, filtering by destination address is not supported.

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 ipv6_acl_1
```

3. Enter rules, 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 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 ethernet 5/22
device(conf-if-eth-5/22)# ipv6 access-group ipv6_acl_1 in
```

The following example creates an IPv6 extended ACL, defines rules in the ACL, and applies it as a receive-path ACL.

```
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)# exit
device(config)# ipv6 receive access-group ipv6-receive-acl-example
```

Applying Layer 3 ACLs to interfaces

An ACL affects network traffic only after you apply it to an interface or globally, using one of the **access-group** commands. Use these procedures to apply standard or extended IPv4 and IPv6 ACLs or to remove them.

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 **ip/ipv6 access-group** command.

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

```
device# configure
```

2. Enter the **interface ethernet** command, specifying the slot/port number.

```
device(config)# interface ethernet 5/2
```

3. Enter the **ip/ipv6 access-group** command, specifying the ACL that you are applying to the interface and the in/out direction.

```
device(conf-if-eth-5/2)# ipv6 access-group ip_acl_1 in
```

The following example shows how to apply an IPv6 ACL to a physical interface.

```
device# configure
device(config)# interface ethernet 5/2
device(conf-if-eth-5/2)# ipv6 access-group ip_acl_1 in

device(conf-if-eth-5/2)# 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** command to access global configuration mode.

```
device# configure
```

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 and the in/out direction.

```
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** command to access global configuration mode.

```
device# configure
```

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 and the in/out direction.

```
device(config-ve-50)# ip access-group test_02 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 **{ip | ipv6} access-group** command.

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.

```
device(config)# interface management 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-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-1)# ipv6 access-group stdV6ACL1 in
```

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 ethernet 5/2
```

3. Enter the **no {ip | ipv6} access-group** command.

```
device(conf-if-eth-5/2)# no ipv6 access-group ip_acl_1 in
```

Applying an rACL to a device

Use this procedure for applying an IPv4 or IPv6 receive-path ACL (rACL) at global configuration level, using one of the **receive access-group** commands.

(IPv4 rACLs only) Note the following regarding destination parameters in the rules contained in the ACL that you are applying:

- To filter only unicast, routed route-processor traffic, in the rules contained in the ACL that you apply with this command, specify **any** for the destination parameter.
- To filter all traffic (switched, routed, unicast, multicast, router-processor, and data-plane), specify a destination IP address,

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

```
device# configure terminal
```

2. Enter the { **ip** | **ipv6** } **receive access-group** command, specifying the ACL that you are applying.

```
device(config)# ip receive access-group ipv4-receive-acl-example
```

The following example shows how to create an IPv4 ACL, define rules needed for an rACL, and apply the ACL to the device.

```
device# configure terminal
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)# exit
device(config)# ip receive access-group ipv4-receive-acl-example
```

The following example shows how to create an IPv6 ACL, define rules needed for an rACL, and apply the ACL to the device.

```
device# configure terminal
device(config)# ipv6 access-list extended ipv6-receive-acl-example
device(conf-ipacl-ext)# deny tcp host 10::1 any count
device(conf-ipacl-ext)# deny 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)# exit
device(config)# ipv6 receive access-group ipv6-receive-acl-example
```

Removing an rACL from a device

To suspend rACL rules, you can remove the ACL containing those rules from the device 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 **no** { **ip** | **ipv6** } **receive access-group** command, specifying the ACL name.

```
device(config)# no ip receive access-group ipv4-receive-acl-example
```

Layer 3 ACL modification

You can replace the contents of an ACL rule. You can also modify ACL sequence (**seq**) numbers.

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** command to access global configuration mode.

```
device# configure
```

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 1 through 65535; the increment can also range from 1 through 65534.

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
```

Advanced Layer 3 ACL rules and features

Many advanced ACL features are implemented per ACL rule, according to parameters that you specify. Some of the features also require global configuration.

Guidelines for advanced L3 ACL rules

Here is a summary of which rule keywords are supported for the various types of Layer 3 ACLs and rules. There are also notes on interactions among keywords.

For details, refer to the following *Brocade SLX-OS Command Reference* topics:

- seq (rules in IPv4 standard ACLs)
- seq (rules in IPv4 extended ACLs)

- seq (rules in IPv6 standard ACLs)
- seq (rules in IPv6 extended ACLs)

TABLE 7 Layer 3 ACL advanced keywords

Keyword	Per rule, implements	IPv4 standard ACL	IPv6 standard ACL	IPv4 extended ACL	IPv6 extended ACL	Comments
dscp	DSCP filtering	NA	NA	P/D/H; I/O	P/D/H; I	
dscp-force	DSCP re-marking	NA	NA	P; I	P; I	For routed traffic only.
drop-precedence-force	Re-marking drop-precedence	NA	NA	NA	NA	Not currently supported.
count	Counter statistics	P/D/H; I/O	P/D/H; I	P/D/H; I/O	P/D/H; I	
log	Logging	P/D; I	P/D; I	P/D; I	P/D; I	
mirror	Mirroring	NA	NA	P/D; I	P/D; I	Effective only in ACLs applied to physical interfaces. Not supported for: • PBR ACLs (policy-based routing) • rACLs (receive-path) • ACL-RL (rate-limiting)
copy-sflow	sFlow monitoring	P/D; I	P/D; I	P/D; I	P/D; I	

Key:

- **P**—Supported in a permit rule
- **D**—Supported in a deny rule
- **H**—Supported in a hard-drop rule
- **I**—Supported in an ACL applied to incoming traffic
- **O**—Supported in an ACL applied to outgoing traffic
- **NA**—Not available

Advanced-rule limitations

The following limitations apply to advanced Layer 3 ACL rules:

- As indicated in the previous chart, hard-drop rules do not support ACL-based mirroring. In addition, port mirroring functionality would not work for traffic that matches hard-drop rules of ACL bound on the interface.
- Although in a standard-ACL rule you can include **log** and **copy-sflow**, only one of the two is processed, as follows:
  - In a permit rule, the order of precedence is **copy-sflow** > **log**.
  - In a deny, the order of precedence is **log** > **copy-sflow**.
- Although in an extended-ACL rule you can include **log**, **mirror**, and **copy-sflow**, only one of the three is processed, as follows:
  - In a permit rule, the order of precedence is **mirror** > **copy-sflow** > **log**.

- In a deny rule, the order of precedence is **log** > **copy-sflow** > **mirror**.

Filtering and forcing DSCP values (IPv4 ACLs)

In IPv4 extended ACL rules, re-marking (forcing) DSCP values can change priority on egress traffic, by which you can prioritize ingress traffic. You can also filter IPv4 packets by DSCP value.

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

```
device# configure
```

2. Enter the **ip access-list extended** command to create or access the ACL.

```
device(config)# ip access-list extended extd_ACL5
```

3. To filter incoming or outgoing packets by DSCP value, define **permit** or **deny** rules specifying the **dscp** parameters.

```
device(config-ipacl-ext)# seq 5 deny tcp host 10.24.26.145 any dscp 25
device(config-ipacl-ext)# seq 15 permit tcp 10.24.26.146 any dscp 20
```

4. To re-mark the DSCP value of incoming packets, define **permit** rules specifying the **dscp-force** parameters.

```
device(config-ipacl-ext)# seq 25 permit tcp 10.24.26.147 any dscp-force 10
```

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

```
device(config)# interface ethernet 2/2
device(conf-if-eth-2/2)# ip access-group extd_ACL5 in
```

Filtering and forcing DSCP values (IPv6 ACLs)

In IPv6 extended ACL rules, re-marking (forcing) DSCP values can change priority on egress traffic, by which you can prioritize ingress traffic. You can also filter IPv6 packets by DSCP value.

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

```
device# configure terminal
```

2. Enter the **ipv6 access-list extended** command to create or access the ACL.

```
device(config)# ipv6 access-list extended ipv6_acl_1
```

3. To filter incoming packets by DSCP value, define **permit** or **deny** rules specifying the **dscp** parameters.

```
device(conf-ip6acl-ext)# seq 10 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 dscp 25 count
device(conf-ip6acl-ext)# seq 20 permit ipv6 2001:2002:2345:1::/64 any dscp 20 count
```

4. To re-mark the DSCP value of incoming packets, define **permit** rules specifying the **dscp-force** parameters.

```
device(conf-ip6acl-ext)# seq 30 permit ipv6 2001:2002:2346:1::/64 any dscp-force 10
```

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

```
device(config)# interface ethernet 2/2
device(conf-if-eth-2/2)# ipv6 access-group ipv6_acl_1 in
```

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 network traffic only
- 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
Frames Logged on interface 2/1 :
--------------------------------
Frame Received Time : Fri Dec 9 3:8:48 2011
Ethernet,       Src : (00:34:56:78:0a:ab), Dst: (00:12:ab:54:67:da)
  Ethtype           : 0x8100
  Vlan tag type     : 0x800
  VlanID            : 0x1
Internet proto, Src : 192.85.1.2, Dst: 192.0.0.1
  Interface         :
  Type of service   : 0
  Length            : 110
  Identification    : 0
  Fragmentation     : 00 00
  TTL               : 255
  protocol          : 253
  Checksum          : 39 3a
  Payload type      :
packet(s) repeated  : 30
Ingress Deny Logged
```

Enabling IPv4 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 terminal** command 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 ip_acl_1
```

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

```
device(config-ipacl-std)# seq 5 permit host 10.20.33.4 log
```

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

5. (Optional) To display ACL logs, enter the **show access-list log buffer** command.

```
device# show access-list-log buffer
Frames Logged on interface 2/1 :
--------------------------------
Frame Received Time : Fri Dec 9 3:8:48 2011
Ethernet,       Src : (00:34:56:78:0a:ab), Dst: (00:12:ab:54:67:da)
  Ethtype           : 0x8100
  Vlan tag type     : 0x800
  VlanID            : 0x1
Internet proto, Src : 192.85.1.2, Dst: 192.0.0.1
  Interface         :
  Type of service   : 0
  Length            : 110
  Identification    : 0
  Fragmentation     : 00 00
  TTL               : 255
  protocol          : 253
  Checksum          : 39 3a
  Payload type      :
packet(s) repeated  : 30
Ingress Deny Logged
```

NOTE
If an ACL with rules that contain the **log** keyword is applied to a management interface, logs are not recorded for that ACL.

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.

NOTE
If an ACL with rules that contain the **log** keyword is applied to a management interface, logs are not recorded for that ACL.

5. (Optional) To display ACL logs, enter the **show access-list log buffer** command.

```
device# show access-list-log buffer
Frames Logged on interface 2/1 :
--------------------------------
Frame Received Time : Fri Dec 9 3:8:48 2011
Ethernet,       Src : (00:34:56:78:0a:ab), Dst: (00:12:ab:54:67:da)
  Ethtype           : 0x8100
  Vlan tag type     : 0x800
  VlanID            : 0x1
Internet proto, Src : 192.85.1.2, Dst: 192.0.0.1
  Interface         :
  Type of service   : 0
  Length            : 110
  Identification    : 0
  Fragmentation     : 00 00
  TTL               : 255
  protocol          : 253
  Checksum          : 39 3a
  Payload type      :
packet(s) repeated  : 30
Ingress Deny Logged
```

Layer 3 ACL-based mirroring

ACL-based mirroring enables you to monitor specified inbound traffic in the mirrored port by attaching a protocol analyzer to it.

Enabling IPv4 ACL rules for mirroring

ACL-based inbound mirroring applies to extended-ACL rules that include the **mirror** keyword.

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

```
device# configure terminal
```

2. Enter the **ip access-list extended** command to create or access the ACL.

```
device(config)# ip access-list extended extd_ACL5
```

3. In each rule for which you need to enable mirroring, include the **mirror** keyword.

```
device(conf-ipacl-ext)# seq 5 deny tcp host 10.24.26.145 any mirror
device(conf-ipacl-ext)# seq 15 permit tcp 10.24.26.146 any mirror
```

4. Apply the ACL that you created to the appropriate physical interface, specifying the **in** keyword.

```
device(config)# interface ethernet 2/1
device(conf-if-eth-2/1)# ip access-group extd_ACL5 in
```

Enabling IPv6 ACL rules for mirroring

ACL-based inbound mirroring applies to extended-ACL rules that include the **mirror** keyword.

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

```
device# configure terminal
```

2. Enter the **ipv6 access-list extended** command to create or access the ACL.

```
device(config)# ipv6 access-list extended extd_v6_01
```

3. In each rule for which you need to enable mirroring, include the **mirror** keyword.

```
device(conf-ipv6acl-ext)# seq 5 permit tcp 1000:1::/64 2000:1::/64 mirror
device(conf-ipacl-ext)# seq 15 deny udp 1000:1::/64 2000:1::/64 mirror
```

4. Apply the ACL that you created to the appropriate physical interface, specifying the **in** keyword.

```
device(config)# interface ethernet 3/1
device(conf-if-eth-3/1)# ipv6 access-group extd_v6_01 in
```

Defining an ACL mirror port

To support ACL mirroring, define a destination ACL mirror port common to all ports of a port processor (PPCR).

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

```
device# configure
```

2. To define a physical interface as the mirror, enter a command such as the following example.

```
device(config)# acl-mirror source ethernet 1/1 destination ethernet 1/2
```

3. To define a port-channel as the mirror, enter a command such as the following example.

```
device(config)# acl-mirror source ethernet 1/1 destination port-channel 1
```

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** to access global configuration mode.

```
device# configure
```

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** 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 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.

```
device# show statistics access-list ipv6 ip_acl_1 in
ipv6 access-list ip_acl_1 on Ethernet 2/3 at Ingress (From User)
    seq 10 deny ipv6 2001:2002:1234:1::/64 2001:1001:1234:1::/64 count (0 frames)
    seq 20 deny ipv6 2002:2003:1234:1::/64 2001:3001:1234:1::/64 count (33 frames)
```

The following example shows how to create an IPv6 extended ACL and define a counter-enabled rule for it.

```
device# configure
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
```

Enabling IPv4 ACL rules for sFlow monitoring

sFlow is a sampling technology for monitoring networks. You can monitor specified incoming data flows by including the **copy-sflow** keyword in rules within an ACL applied to a device.

In order for sFlow to function, the sFlow collector must be globally configured. For details, refer to the *Brocade SLX-OS Layer 2 Switching Configuration Guide*.

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

```
device# configure terminal
```

2. Enter the **ip access-list standard/extended** command to create or access the ACL.

```
device(config)# ip access-list extended ext-vfour1
```

3. In each rule for which you need to enable sFlow, include the **copy-sflow** keyword.

```
device(conf-ipacl-ext)# permit 30.30.30.0 255.255.255.0 any copy-sflow
device(conf-ipacl-ext)# deny 31.31.31.0 255.255.255.0 copy-sflow
```

4. Apply the ACL that you created to the appropriate physical interface, specifying the **in** keyword.

```
device(config)# interface ethernet 3/1
device(conf-if-eth-3/1)# ip access-group ext-vfour1 in
```

Enabling IPv6 ACL rules for sFlow monitoring

sFlow is a sampling technology for monitoring networks. You can monitor specified incoming data flows by including the **copy-sflow** keyword in rules within an ACL applied to a device.

In order for sFlow to function, the sFlow collector must be globally configured. For details, refer to the *Brocade SLX -OS Layer 2 Switching Configuration Guide*.

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

```
device# configure terminal
```

2. Enter the **ipv6 access-list standard/extended** command to create or access the ACL.

```
device(config)# ipv6 access-list extended ipv6_ac1_1
```

3. In each rule for which you need to enable sFlow, include the **copy-sflow** keyword.

```
device(conf-ip6acl-ext)# seq 20 deny ipv6 2002:2003:1234:1::/64 2001:3001:1234:1::/64 copy-sflow
device(conf-ip6acl-ext)# seq 30 permit ipv6 2002:2004:1234:1::/64 2001:3002:1234:1::/64 copy-sflow
```

4. Apply the ACL that you created to the appropriate physical interface, specifying the **in** keyword.

```
device(config)# interface ethernet 2/1
device(conf-if-eth-2/1)# ipv6 access-group ipv6_ac1_1 in
```

Disabling conflicting-rule check

Towards editing ACLs, you can disable the default restriction on conflicting rules within an ACL. You can then create a conflicting rule before deleting the previous version.

NOTE
Brocade recommends that after ACL-editing sessions towards which you disabled conflicting-rule check, restore the default setting—by entering the **no allow-conflicting-rules** command.

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

```
device# configure terminal
```

2. Enter **acl-policy** to access ACL policy mode.

```
device(config)# acl-policy
```

3. Enter **allow-conflicting-rules**.

```
device(config-acl-policy)# allow-conflicting-rules
```

The following example is a typical editing flow.

1. Enter the **show running-config** command to display the rules in the ACL that you need to modify.

```
device# show running-config mac access-list extended mac1
mac access-list extended mac1
 seq 10 permit host 0001.0001.0001 any
 seq 20 deny host 0001.0001.0002 any count
 seq 30 hard-drop host 0001.0001.0003 any mirror
```

2. Enter the **allow-conflicting-rules** command.

```
device# configure terminal
device(config)# acl-policy
device(config-acl-policy)# allow-conflicting-rules
```

3. In the ACL that you need to modify, create the new rule and then delete the old rule.

```
device(config-acl-policy)# exit
device(config)# mac access-list mac1
device(conf-macl-ext)# seq 21 permit host 0001.0001.0002 any count
device(conf-macl-ext)# no seq 20
```

4. Enter the **no allow-conflicting-rules** command to restore the default setting.

```
device(conf-macl-ext)# exit
device(config)# acl-policy
device(config-acl-policy)# no allow-conflicting-rules
```

Disabling duplicate-rule check

Towards editing ACLs, you can disable the default restriction on duplicate rules within an ACL. You can then create a duplicate rule at a new sequence before deleting the previous version.

NOTE
Brocade recommends that after ACL-editing sessions towards which you disabled duplicate-rule check, restore the default setting—by entering the **no allow-duplicate-rules** command.

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

```
device# configure terminal
```

2. Enter **acl-policy** to access ACL policy mode.

```
device(config)# acl-policy
```

3. Enter **allow-duplicate-rules**.

```
device(config-acl-policy)# allow-duplicate-rules
```

The following example is a typical editing flow.

1. Enter the **show running-config** command to display the rules in the ACL that you need to modify.

```
device# show running-config mac access-list extended mac1
mac access-list extended mac1
 seq 10 permit host 0001.0001.0001 any
 seq 20 deny host 0001.0001.0002 any count
 seq 30 hard-drop host 0001.0001.0003 any mirror
```

2. Enter the **allow-duplicate-rules** command.

```
device# configure terminal
device(config)# acl-policy
device(config-acl-policy)# allow-duplicate-rules
```

3. In the ACL that you need to modify, create the duplicate rule—specifying the new sequence number—and then delete the old rule.

```
device(config-acl-policy)# exit
device(config)# mac access-list mac1
device(conf-macl-ext)# seq 11 hard-drop host 0001.0001.0003 any mirror
device(conf-macl-ext)# no seq 30
```

4. Enter the **no allow-duplicate-rules** command to restore the default setting.

```
device(conf-macl-ext)# exit
device(config)# acl-policy
device(config-acl-policy)# no allow-duplicate-rules
```

ACL Show and Clear commands

There is a full range of ACL show and clear commands, listed here with descriptions.

TABLE 8 ACL Show commands

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. You can also display information for all ACLs bound to a specified interface.
show access-list-log buffer	Displays the contents of the ACL log buffer.
show access-list-log buffer config	Displays the ACL log buffer configuration.
show running-config {mac | ip | ipv6} 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. You can also display statistical information for all ACLs bound to a specified interface.

TABLE 9 ACL Clear commands

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

TABLE 9 ACL Clear commands (continued)

Command	Description
	only for that ACL on a specified interface. You can also clear statistical information for all ACLs bound to a specified interface.

Policy-Based Routing

Policy-based routing overview

Policy-based routing (PBR) is the process of altering a packet's path based on criteria other than the destination address. PBR allows you to use ACLs and route maps to selectively route an IP packet. The ACLs classify the traffic and the route maps that match on the ACLs set routing attributes for the traffic.

A PBR policy specifies the routing attributes for traffic that matches the policy. Using standard ACLs with route maps in PBR, an IP packet is routed based on their source IP address. With extended ACLs, you can route IP packets based on all of the clauses in the extended ACL.

> NOTE
> For more details about ACLs, refer to the Access Control Lists chapter.

You can configure the Brocade device to perform the following types of PBR based on a packet Layer 3 and Layer 4 information:

- Select the next-hop gateway.
- Send the packet to the null interface (null0).

To configure PBR, you define the policies using 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.

The configuration of a set of match criteria and corresponding routing information (for example next hops) is referred to as a stanza. You can create multiple stanzas and assign 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. 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. 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.

Route map

Route maps enable you to define routing policy for the traffic causing a packet to be forwarded to a predetermined next-hop interface, bypassing the path determined by normal routing.

Each entry in a route map statement contains a combination of match and set statements. A route map specifies the match criteria that correspond to ACLs, followed by a set statement that specifies the resulting action if all of the match clauses are met. You can define multiple match and next-hop specifications (set statement) on the same interface. When a PBR policy has multiple next hops to a destination, PBR 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.

Match statement

The IP standard or extended ACLs can be used to establish the match criteria. Using the standard ACLs with route maps in PBR, an IP packet is routed based on their source IP address. Using the extended ACLs, you can route IP packets based on all of the clauses in the extended ACL.

Set statement

Traffic that matches a match statement in the route map is forwarded as defined by set commands. Multiple set commands can be configured and when a match condition is met, the device works sequentially through the list of set commands until it finds the first "next hop" that is operational and uses it. If that "next hop" goes down, the next hop as defined in a set command is chosen and if all next hop interfaces in the list are down, the packet is routed as determined in the IP Route Table. If a next hop interface that was down comes back up, the next hop selection process begins again and restarts its selection process from the top of the list.

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 the **set ip next-hop** commands 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.

NOTE
The "match" and "set" statements described in this chapter are the only route-map statements supported for PBR. Other route-map statements described in the documentation apply only to the protocols with which they are described.

NOTE
If none of the clauses of a PBR routemap definition contains both 'match' and 'set' statements together, PBR does not work and the packets are forwarded as per the routing table.

The following are the PBR next hops that can be specified in a route map for a matched traffic:

- IPv4 address
- IPv6 address
- Null interface

Configuring a PBR policy

To configure a PBR, you must define the policies using ACLs and route map, then enable PBR globally or on individual interfaces. The device programs the ACLs into the session CAM on the interfaces and routes traffic that matches the ACLs according to the instructions in the route maps.

The following are the basic steps to configure a PBR policy:

1. Configure ACLs that specify all the conditions required to match the desired packets to be routed using PBR.

   For more information about configuring ACLs, refer to the *Security Configuration Guide* for your platform.
2. Configure a route map that matches on the ACLs and sets the route information.
3. Enable PBR by applying the route map on an interface.

Policy-based routing (IPv4)

This section provides configuration details of PBR policy that specifies to match and route IPv4 packets.

Configuration considerations and guidelines for PBR

- 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.
- 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.

Configuring an IPv4 PBR with IPv4 address as the next hop

The following steps configure an IPv4 PBR by setting an IPv4 address as the next hop in the route map. This task uses Access Control Lists (ACLs) which are explained in greater detail in the Security configuration guide for your platform.

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

   ```
   device# configure terminal
   ```

2. Define the required IPv4 ACLs to be added to the route map.

   ```
   device(config)# ip access-list standard 99
   device(conf-ipacl-std)# permit 192.168.0.0 255.255.255.0
   ```

3. Enter the **exit** command to return to global configuration mode.

   ```
   device(conf-ipacl-std)# exit
   ```

4. Enter the **route-map** command to define the route and specify the match criteria and the resulting action if all the match clauses are met.

```
device(config)# route-map test-route permit 99
```

5. Add IPv4 ACLs to match the IP address that is permitted by the ACL.

```
device(config-route-map-test-route/permit/99)# match ip address acl 99
```

6. Set the IPv4 address of the next hop to which the traffic that matches a match statement in the route map must be routed.

```
device(config-route-map-test-route/permit/99)# set ip next-hop 192.168.3.1
```

   Optionally, you can specify the configured next hop address to be resolved from either the global routing table or VRF routing table using the **global** or **VRF** *vrf-name* options.

7. Enter the **exit** command to return to the global configuration mode.

```
device(config-route-map-test-route/permit/99)# exit
```

8. Enable PBR by applying the route map on an interface or on virtual interface.
   - Enable IPv4 PBR by applying the route map on an interface.

```
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ip policy route-map test-route
```

   - Enable IPv4 PBR by applying the route map on a virtual interface.

```
device(config)# interface Ve 1
device(config-if-Ve-1)# ip policy route-map test-route
```

The following example shows the configuration steps to configure an IPv4 PBR by setting an IPv4 address as the next hop in the route map.

```
device# configure terminal
device(config)# ip access-list standard 99
device(conf-ipacl-std)# permit 192.168.0.0 255.255.255.0
device(conf-ipacl-std)# exit
device(config)# route-map test-route permit 99
device(config-route-map-test-route/permit/99)# match ip address acl 99
device(config-route-map-test-route/permit/99)# set ip next-hop 192.168.3.1
device(config-route-map-test-route/permit/99)# exit
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ip policy route-map test-route
device(conf-if-eth-1/1)# end
```

Configuring an IPv4 PBR with NULL0 interface as the next hop

The following steps configure an IPv4 PBR by setting NULL0 interface as the next hop in the route map.

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

```
device# configure terminal
```

2. Define the required IPv4 ACLs to be added to the route map.

```
device(config)# ip access-list standard 99
device(conf-ipacl-std)# permit 192.168.0.0 255.255.255.0
```

3. Enter the **exit** command to return to global configuration mode.

```
device(conf-ipacl-std)# exit
```

4. Enter the **route-map** command to define the route and specify the match criteria and the resulting action if all the match clauses are met.

```
device(config)# route-map test-route permit 99
```

5. Add IPv4 ACLs to match the IP address that is permitted by the ACL.

```
device(config-route-map-test-route/permit/99)# match ip address acl 99
```

6. Set the next hop as NULL0 interface to send the traffic to the null interface, thus dropping the packet instead of forwarding it.

```
device(config-route-map-test-route/permit/99)# set ip interface null0
```

7. Enter the **exit** command to return to the global configuration mode.

```
device(config-routemap-test-route/permit/99)# exit
```

8. Enter configuration mode on the interface where you want to enable PBR by applying the route map.

```
device(config)# interface ethernet 1/1
```

9. Enable policy-based routing on the interface and specify the route map to be used.

```
device(conf-if-eth-1/1)# ip policy route-map test-route
```

The following example shows the configuration steps to configure an IPv4 PBR to send all traffic from 10.157.23.0 0.0.0.255 to the null interface, thus dropping the traffic instead of forwarding it.

```
device# configure terminal
device(config)# evice(config)# ip access-list standard 99
device(conf-ipacl-std)# permit 10.157.23.0 0.0.0.255
device(conf-ipacl-std)# exit
device(config)# route-map test-route permit 99
device(config-route-map-test-route/permit/99)# match ip address acl 99
device(config-route-map-test-route/permit/99)# set ip interface null0
device(config-route-map-test-route/permit/99)# exit
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ip policy route-map test-route
device(conf-if-eth-1/1)# end
```

Configuration examples for policy based routing

This section presents configuration examples for configuring and applying a PBR policy.

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 192.168.0.0 are sent to the VRF vroutefwd's next hop at 3.3.3.3; packets arriving from source 192.168.1.1 are sent to the VRF vroutefwd's next hop at 3.3.3.5.

1. Configure the ACLs.

```
device(config)# ip access-list standard Jules
device(conf-ipacl-std)# permit 192.168.0.0 255.255.255.0
device(conf-ipacl-std)# exit
device(config)# ip access-list standard Vincent
device(conf-ipacl-std)# permit 192.168.1.1 255.255.255.0
device(conf-ipacl-std)# exit
```

2. Create the first stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
device(config)# route-map pulp_fiction permit 10
device(config-routemap-pulp_fiction/permit/10)# match ip address acl Jules
device(config-routemap-pulp_fiction/permit/10)# set ip vrf vroutefwd next-hop 3.3.3.3
device(config-routemap-pulp_fiction/permit/10)# exit
```

3. Create the second stanza of the route-map (The example is using a route-map named pulp_fiction.)

```
device(config)# route-map pulp_fiction permit 20
device(config-routemap-pulp_fiction/permit/20)# match ip address acl Vincent
device(config-routemap-pulp_fiction/permit/20)# set ip vrf vroutefwd next-hop 3.3.3.5
device(config-routemap-pulp_fiction/permit/20)# set ip next-hop 6.6.6.7
device(config-routemap-pulp_fiction/permit/20)# exit
```

4. Bind the route map to the desired interface.

```
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ip policy route-map pulp_fiction
```

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.

```
device(config)# ip access-list standard Jules
device(conf-ipacl-std)# permit 192.168.0.0 255.255.255.0
device(conf-ipacl-std)# deny 192.168.1.1 255.255.255.0
device(config)# ip access-list standard Vincent
device(conf-ipacl-std)# permit 192.168.2.2 255.255.255.0
```

2. Create the first stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
device(config)# route-map pulp_fiction permit 10
device(config-routemap-pulp_fiction/permit/10)# match ip address acl Jules
device(config-routemap-pulp_fiction/permit/10)# set ip vrf pulp_fiction next-hop 3.3.3.3
device(config-routemap-pulp_fiction/permit/10)# set ip interface NULL0
```

3. Create the second stanza of the route map. (The example is using a route map named pulp_fiction.)

```
device(config)# route-map pulp_fiction permit 20
device(config-routemap-pulp_fiction/permit/20)# match ip address acl Vincent
device(config-routemap-pulp_fiction/permit/20)# set ip vrf pulp_fiction next-hop 3.3.3.5
```

Based on the above configuration, when address 192.168.0.0 255.255.255.0 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 192.168.1.1 255.255.255.0 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 the traffic is forwarded according to global route table.
- 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 the traffic is forwarded according to global route table.

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.

```
device(config)# ip access-list standard Jules
device(conf-ipacl-std)# permit 192.168.0.0 255.255.255.0
device(conf-ipacl-std)# deny 192.168.1.1 255.255.255.0
device(config)# ip access-list standard Vincent
device(conf-ipacl-std)# permit 192.168.2.2 255.255.255.0
```

2. Create the first stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
device(config)# route-map pulp_fiction permit 10
device(config-routemap-pulp_fiction/permit/10)# match ip address acl Jules
device(config-routemap-pulp_fiction/permit/10)# set ip vrf pulp_fiction next-hop 3.3.3.3
device(config-routemap-pulp_fiction/permit/10)# set ip interface NULL0
```

3. Create the second stanza of the route map. (The example is using a route-map named pulp_fiction.)

```
device(config)# route-map pulp_fiction permit 20
device(config-routemap-pulp_fiction/permit/20)# match ip address acl Vincent
device(config-routemap-pulp_fiction/permit/20)# 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.

```
device(config)# route-map pulp_fiction permit 30
device(config-routemap-pulp_fiction/permit/30)# 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 192.168.0.0 255.255.255.0 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 192.168.1.1 255.255.255.0 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 global route table.
- 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.

Displaying PBR route map information

Various show commands can be used to display PBR configuration details.

Enter the **show route-map** command to display the route map information.

```
device# show route-map
Interface Ethernet 1/6
 ip policy route-map route1
```

Enter the **show route-map** *route-map name* command to display the details of the configured routing attributes.

```
device# show route-map route1
Interface Ethernet 1/6
ip policy route-map route1 permit 1 (Active)
    match ip address acl test1
    set ip next-hop 6.0.0.1 (selected)
    Policy routing matches: 1443 packets
```

Enter the **show route-map interface ethernet** *slot/port* command to display the route-map configuration details on a specific interface.

```
device# show route-map interface ethernet 1/6
Interface Ethernet 1/6
ip policy route-map route1 permit 1 (Active)
    match ip address acl test1
    set ip next-hop 6.0.0.1 (selected)
    Policy routing matches: 1543 packets
```

Policy-based routing (IPv6)

IPv6 PBR allows you to manually configure how IPv6 packets that match certain criteria can be forwarded instead of following the IPv6 Routing Table Manager (RTM) routes. This section provides configuration details of PBR policy that specifies to match and route IPv6 packets.

Configuring an IPv6 PBR with IPv6 address as the next hop

The following steps configure an IPv6 PBR by setting an IPv6 address as the next hop in the route map. This task uses Access Control Lists (ACLs). For more information about configuring ACLs, refer to the *Security Configuration Guide* for your platform.

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

```
device# configure terminal
```

2. Define the required IPv6 ACLs to be added to the route map.

```
device(config)# ipv6 access-list standard 99
device(conf-ip6acl-std)# permit any
```

3. Enter the **exit** command to return to global configuration mode.

```
device(conf-ip6acl-std)# exit
```

4. Enter the **route-map** command to define the route and specify the match criteria and the resulting action if all the match clauses are met.

```
device(config)# route-map test-route permit 99
```

5. Add IPv6 ACLs to match the IP address that is permitted by the ACL.

```
device(config-route-map-test-route/permit/99)# match ipv6 address acl 99
```

6. Set the IPv6 address of the next hop to which the traffic that matches a match statement in the route map must be routed.

```
device(config-route-map-test-route/permit/99)# set ipv6 next-hop 2001:db8:0:0:0:ff00:42:8329
```

7. Enter the **exit** command to return to the global configuration mode.

```
device(config-route-map-test-route/permit/99)# exit
```

8. Enable IPv6 PBR by applying the route map on an interface or on virtual interface.
   - Enable IPv6 PBR by applying the route map on an interface.

```
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ipv6 policy route-map test-route
```

   - Enable IPv6 PBR by applying the route map on a virtual interface.

```
device(config)# interface Ve 1
device(config-if-Ve-1)# ipv6 policy route-map test-route
```

The following example shows the configuration steps to configure an IPv6 PBR by setting an IPv6 address as the next hop in the route map.

```
device# configure terminal
device(config)# ipv6 access-list standard 99
device(conf-ip6acl-std)# permit any
device(conf-ip6acl-std)# exit
device(config)# route-map test-route permit 99
device(config-route-map-test-route/permit/99)# match ipv6 address acl 99
device(config-route-map-test-route/permit/99)# set ipv6 next-hop 2001:db8:0:0:0:ff00:42:8329
device(config-route-map-test-route/permit/99)# exit
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ipv6 policy route-map test-route
device(conf-if-eth-1/1)# end
```

Configuring an IPv6 PBR with NULL0 interface as the next hop

The following steps configure an IPv6 PBR by setting NULL0 interface as the next hop in the route map.

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

   ```
   device# configure terminal
   ```

2. Define the required IPv6 ACLs to be added to the route map.

   ```
   device(config)# ipv6 access-list standard 99
   device(conf-ip6acl-std)# permit any
   ```

3. Enter the **exit** command to return to global configuration mode.

   ```
   device(conf-ip6acl-std)# exit
   ```

4. Enter the **route-map** command to define the route and specify the match criteria and the resulting action if all the match clauses are met.

   ```
   device(config)# route-map test-route permit 99
   ```

5. Add IPv6 ACLs to match the IP address that is permitted by the ACL.

   ```
   device(config-route-map-test-route/permit/99)# match ipv6 address acl 99
   ```

6. Set the next hop as NULL0 interface to send the traffic to the null interface, thus dropping the packet instead of forwarding it.

   ```
   device(config-route-map-test-route/permit/99)# set ipv6 interface null0
   ```

7. Enter the **exit** command to return to the global configuration mode.

   ```
   device(config-routemap-test-route/permit/99)# exit
   ```

8. Enter configuration mode on the interface where you want to enable PBR by applying the route map.

   ```
   device(config)# interface ethernet 1/1
   ```

9. Enable policy-based routing on the interface and specify the route map to be used.

   ```
   device(conf-if-eth-1/1)# ipv6 policy route-map test-route
   ```

The following example shows the configuration steps to configure an IPv6 PBR to send the IPv6 traffic to the null interface, thus dropping the traffic instead of forwarding it.

```
device# configure terminal
device(config)# ipv6 access-list standard 99
device(conf-ip6acl-std)# permit any
device(conf-ip6acl-std)# exit
device(config)# route-map test-route permit 99
device(config-route-map-test-route/permit/99)# match ipv6 address acl 99
device(config-route-map-test-route/permit/99)# set ipv6 interface null0
device(config-route-map-test-route/permit/99)# exit
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ipv6 policy route-map test-route
device(conf-if-eth-1/1)# end
```

Configuration examples for policy based routing

This section presents configuration examples for configuring and applying a PBR policy.

Basic example of IPv6 PBR

The following commands configure and apply an IPv6 PBR policy that routes HTTP traffic received on a virtual routing interface.

```
device# configure terminal
device(config)# ipv6 access-list standard 99
device(conf-ip6acl-std)# permit any
device(conf-ip6acl-std)# exit
device(config)# route-map test-route permit 99
device(config-route-map-test-route/permit/99)# match ipv6 address acl 99
device(config-route-map-test-route/permit/99)# set ipv6 next-hop 2001:db8:0:0:0:ff00:42:8329
device(config-route-map-test-route/permit/99)# exit
device(config)# interface ethernet 1/1
device(conf-if-eth-1/1)# ipv6 policy route-map test-route
device(conf-if-eth-1/1)# end
```

Port MAC Security

Port MAC security overview

Port MAC security feature allows you to configure the device to learn a limited number of secure MAC addresses on an interface. The interface forwards only packets with source MAC addresses that match these secure addresses.

The secure MAC addresses can be specified statically or learned dynamically. If the device reaches the maximum limit for the number of secure MAC addresses allowed on the interface and if the interface receives a packet with a source MAC address that is different from any of the secure learned addresses, it is considered a security violation.

There are three types of secure MAC addresses that are used in port MAC security:

- Static MAC address: These are the secure MAC addresses that are manually configured using the **switchport port-security mac-address** command. Static MAC addresses persist even if the port goes down or after the device reboots. When static MAC address is configured on an access secure port, the MACs qualify for access VLANs, but on trunk port, VLAN must be specified.
- Dynamic MAC address: These are the secure MAC addresses that the device learns automatically. Dynamically learned MAC address does not persist if the port goes down.
- Sticky MAC address: These are the secure MAC addresses that are learned dynamically but are added automatically as static MAC addresses. When sticky MAC learning is enabled on a secured port, the interface converts all the dynamic secure MAC addresses, including those that were dynamically learned before sticky learning was enabled, to sticky secure MAC addresses. All the subsequent sets of dynamically learned MAC addresses will also be converted to sticky secure MAC addresses. If sticky MAC learning is disabled on a secure port, all the sticky MAC addresses will be converted back to dynamically learned MAC addresses. Similar to the static MAC address, sticky MAC addresses persist even if the port goes down or if the device reboots.

  NOTE
  Secure MAC addresses age out based on the device MAC age value that is configured for the device.

  NOTE
  The maximum MAC address limit for sticky MAC address and static MAC address depends on the device limit. For dynamically learned MAC addresses, the maximum limit is 8192 per port.

Port MAC security violation

A security violation occurs when the maximum limit for the number of secure MAC addresses allowed on the interface is exceeded.

When a security violation occurs, a RASLog is generated. In addition, you can configure the following response action if a violation occurs:

- Shutdown: Puts the interface into the error-disabled state for a specified amount of time. All the dynamically learned MACs will be flushed.

  NOTE
  If a MAC address already learned on a secured port ingresses on a non-secured port or through another secured port, it is not considered security violation. In this scenario, MAC movement happens if it is a dynamically learned MAC address. If it is a static MAC address or sticky MAC address, MAC movement does not happen, but the traffic is switched (flooded or forwarded) based on the destination MAC address.

If the port shuts down after security violation, an administrator can explicitly bring up the interface or a shutdown timer can be configured. After the configured shutdown time, the interface automatically comes up and the port security configuration remains configured on the port.

NOTE
When the device reboots after port shutdown due to security violation, the ports come up in the shutdown state.

Auto recovery for port MAC security violation

Auto recovery for port MAC security violation can be configured to bring up a port that is forced to shut down after a security violation by specifying a shutdown time.

The shutdown time which serves as the recovery interval, provides an option to bring up a port within a configured time without any manual intervention. The shutdown time can be configured using the **switchport port-security shutdown-time** command. The shutdown and no-shutdown processes initiated as part of the port violation action is independent of the shutdown process explicitly initiated by an administrator on the same port on which port MAC security is enabled.

Port MAC security configuration guidelines and considerations

Note the following guidelines and restrictions for configuring port security:

- A port mode change is not allowed when port security is enabled on the interface.
- If a port-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 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.
- Static MAC addresses cannot be configured on a secure port. They must be configured as secure MAC addresses on the secure port.

Configuring port MAC security

The following steps are the common operations that you will need to perform for configuring port MAC security.

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

```
device# configure terminal
```

2. Enter the interface configuration mode to configure interface-specific administrative features for port MAC security.

```
device(config)# interface Ethernet 3/2
```

3. Define the interface in Layer 2 mode to set the switching characteristics of the Layer 2 interface.

```
device(conf-if-eth-3/2)# 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.

4. Enable port MAC security on the interface.

```
device(conf-if-eth-3/2)# switchport port-security
```

5. Set the maximum number of secure MAC addresses for an interface.

```
device(conf-if-eth-3/2)# switchport port-security max 10
```

   For dynamically learned MAC addresses, the maximum limit is 8192 per port which is also the default value.

6. Specify the auto recovery time for port security violation.

```
device(conf-if-eth-3/2)# switchport port-security shutdown-time 4
```

7. Specify secure MAC address.

```
device(conf-if-eth-3/2)# switchport port-security mac-address 0000.00eb.2d14 vlan 2
```

8. Enable sticky MAC learning on the port to convert the dynamically learned MAC addresses to sticky secure MAC addresses.

```
device(conf-if-eth-3/2)# switchport port-security sticky
```

9. Configure port security with sticky MAC address.

```
device(conf-if-eth-3/2)# switchport port-security sticky mac-address 0000.0018.747C vlan 5
```

10. (Optional) Configure the action that must be taken when a port security violation occurs.

```
device(conf-if-eth-3/2)# switchport port-security violation shutdown
```

    By default, the port shuts down if a port security violation occurs.

The following example shows the steps to configure port MAC security.

```
device# configure terminal
device(config)# interface Ethernet 3/2
device(conf-if-eth-3/2)# switchport
device(conf-if-eth-3/2)# switchport port-security
device(conf-if-eth-3/2)# switchport port-security max 8192
device(conf-if-eth-3/2)# switchport port-security shutdown-time 4
device(conf-if-eth-3/2)# switchport port-security mac-address 0000.00eb.2d14 vlan 2
device(conf-if-eth-3/2)# switchport port-security sticky mac-address 0000.0018.747C vlan 5
device(conf-if-eth-3/2)# switchport port-security violation shutdown
```

Displaying port MAC security information

When port MAC security is enabled, various **show** commands can be used to display information about port security and secure MAC addresses.

You can display the following information about the port MAC security feature:

- The details of port MAC security configured on the device
- The port MAC security configuration details
- The port MAC security settings for an individual port
- The secure MAC addresses configured on the device

Displaying port MAC security details on the device

To display the port MAC security configured on a particular interface, enter the following command:

```
device# configure terminal
device(config)# interface Ethernet 3/2
device(conf-if-eth-3/2)# do show run interface Ethernet 3/2
interface Ethernet 3/2
switchport
switchport mode trunk
switchport port-security
switchport port-security max 10
switchport port-security mac-address 3200.1110.0002 vlan 250
switchport trunk allowed vlan add 250
switchport trunk tag native-vlan
no shutdown
```

Displaying port MAC security configuration details

To display the port MAC security configuration details across ports on the device, enter the following command:

```
device(conf-if-eth-3/2)# do show port-security
Secure    MaxSecureAddr  CurrentAddr  StaticSec  Violated  Action   Sticky
Port         (count)       (count)     (count)
Eth 3/2       10           0            1           No     Shutdown  No
```

Displaying port MAC security settings for an individual port

To display the statistics of the port MAC security configured for an interface, enter the following command:

```
device(conf-if-eth-3/2)# do show port-security interface ethernet 3/2
Port Security               : Enabled
Port Status                 : Up
Violation Mode              : Shutdown
Violated                    : No
Sticky Enabled              : No
Maximum MAC addresses       : 10
Total MAC addresses         : 0
Configured MAC addresses    : 1
Last violation time         :
Shutdown time (in Minutes)  : 0
```

Displaying secure MAC addresses information

To list the secure MAC addresses configured on the device, enter the following command.

```
device(conf-if-eth-3/2)# do show port-security addresses
                    Secure Mac Address Table
------------------------------------------------------------------
Vlan       Mac-address            Type                      Ports
250        3200.1110.0002         Secure-Static             Eth 3/2
```

802.1x authentication

802.1X authentication overview

The IEEE 802.1X standard is designed to govern the authentication of devices attached to LAN ports. 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. Using 802.1X authentication, you can configure a device to grant access to a port based on information supplied by a client to an authentication server.

When a user logs on to a network that uses 802.1X authentication, the device grants (or does not grant) access to network services after the user is authenticated by an authentication server. The user-based authentication in 802.1X authentication provides an alternative to granting network access based on a user's IP address, MAC address, or subnetwork.

The Brocade implementation of 802.1X authentication supports the following RFCs:

- RFC 2284: PPP Extensible Authentication Protocol (EAP)
- RFC 2865: Remote Authentication Dial In User Service (RADIUS)
- RFC 2869: RADIUS Extensions

NOTE
SNMP is not supported for 802.1X authentication.

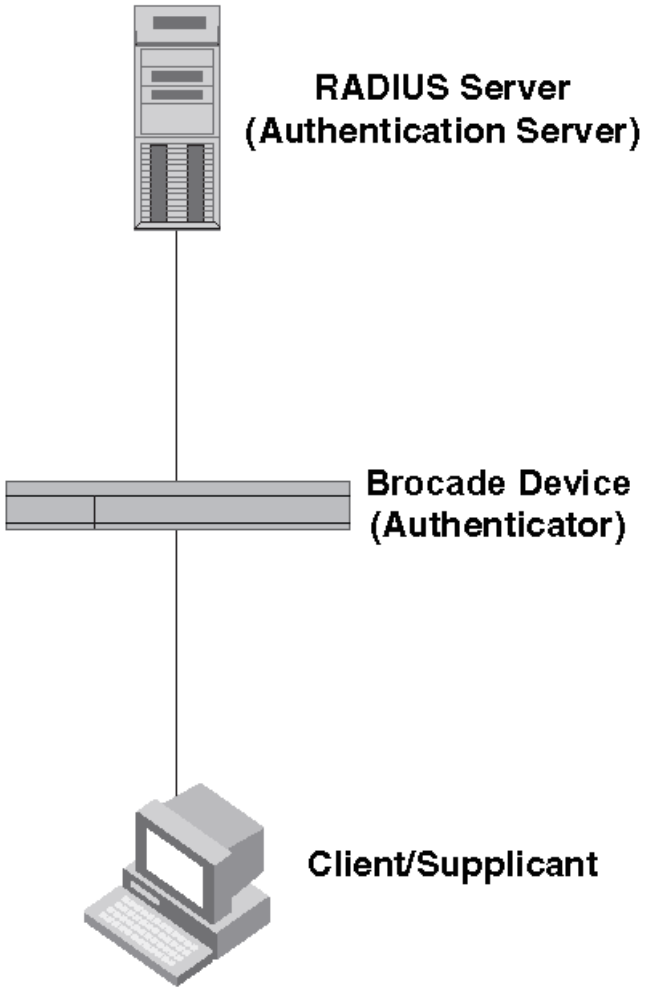
Device roles in an 802.1X configuration

The 802.1X standard defines the roles of client/supplicant, authenticator, and authentication server in a network.

The client (known as a supplicant in the 802.1X standard) provides username and password information to the authenticator. The authenticator sends this information to the authentication server. Based on the client's information, the authentication server determines whether the client can use services provided by the authenticator. The authentication server passes this information to the authenticator, which then provides services to the client, based on the authentication result.

The following figure illustrates these roles.

FIGURE 1 Authenticator, client/supplicant, and authentication server in an 802.1X configuration



Authenticator: The device that controls access to the network. In an 802.1X configuration, the Brocade device serves as the authenticator. The authenticator passes messages between the client and the authentication server. Based on the identity information supplied by the client, and the authentication information supplied by the authentication server, the authenticator either grants or does not grant network access to the client.

Client/supplicant: The device that seeks to gain access to the network. Clients must be running software that supports the 802.1X standard (for example, the Windows 7 operating system). Clients can either be directly connected to a port on the authenticator, or can be connected by way of a hub.

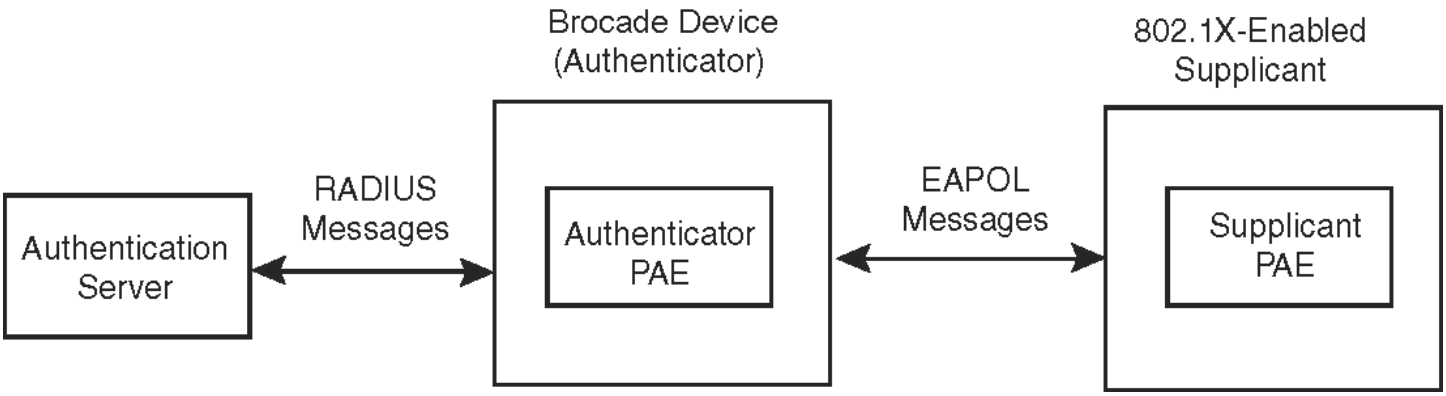
Authentication server: The device that validates the client and specifies whether or not the client may access services on the device. Brocade supports authentication servers running RADIUS.

Communication between the devices

For communication between the devices, 802.1X uses the Extensible Authentication Protocol (EAP), defined in RFC 2284. The 802.1X standard specifies a method for encapsulating EAP messages so that they can be carried over a LAN. This encapsulated form of EAP is known as EAP over LAN (EAPOL). The standard also specifies a means of transferring the EAPOL information between the client/supplicant, authenticator, and authentication server.

EAPOL messages are passed between the Port Access Entity (PAE) on the supplicant and the authenticator. The following figure shows the relationship between the authenticator PAE and the supplicant PAE.

FIGURE 2 Authenticator PAE and supplicant PAE



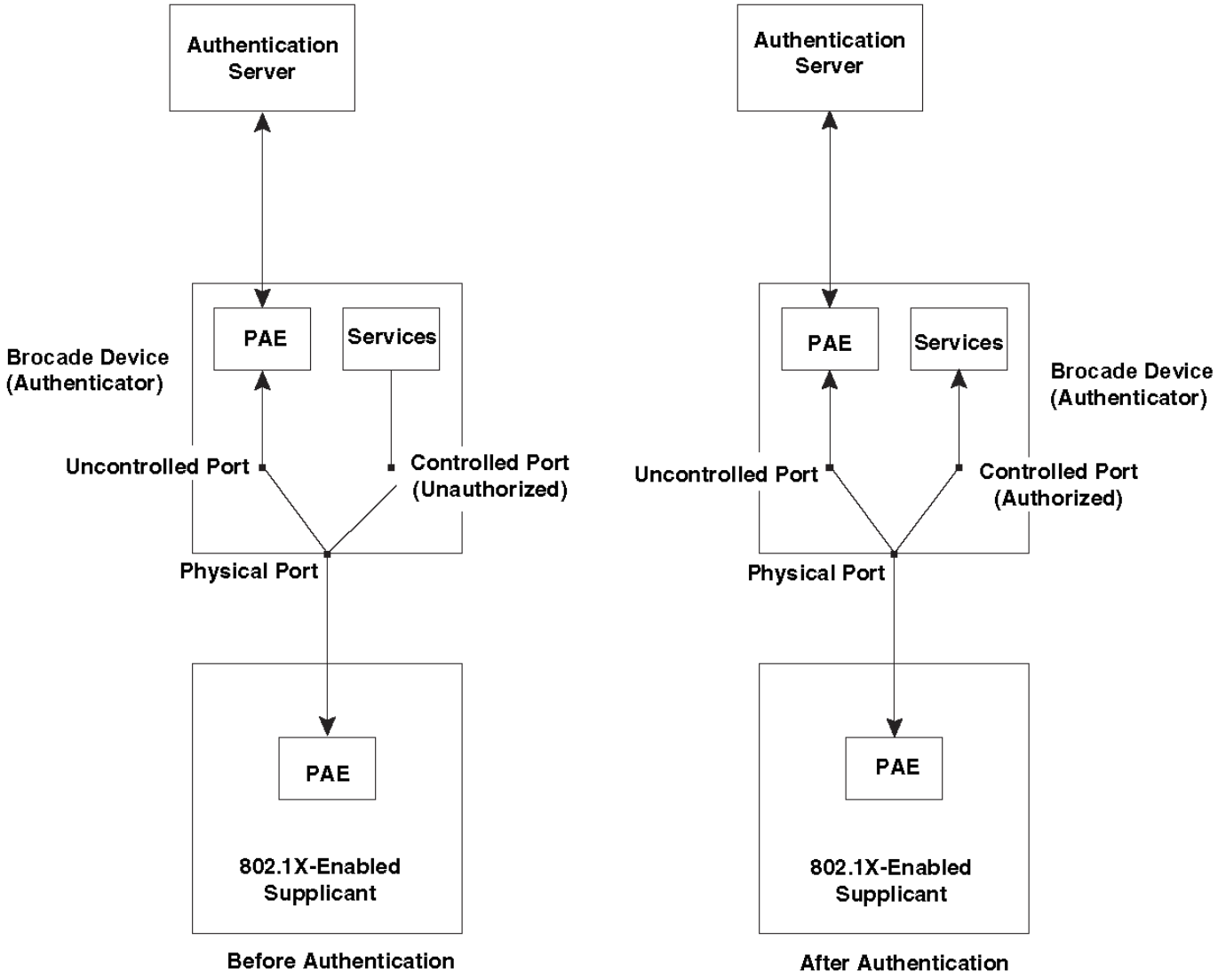
Authenticator PAE: The authenticator PAE communicates with the supplicant PAE, receiving identifying information from the supplicant. Acting as a RADIUS client, the authenticator PAE passes the supplicant information to the authentication server, which decides whether the supplicant can gain access to the port. If the supplicant passes authentication, the authenticator PAE grants it access to the port.

Supplicant PAE: The supplicant PAE supplies information about the client to the authenticator PAE and responds to requests from the authenticator PAE. The supplicant PAE can also initiate the authentication procedure with the authenticator PAE, as well as send log off messages.

Controlled and uncontrolled ports

A physical port on the device used with 802.1X authentication has two virtual access points: a controlled port and an uncontrolled port. The controlled port provides full access to the network. The uncontrolled port provides access only for EAPOL traffic between the client and the authenticator. When a client is successfully authenticated, the controlled port is opened to the client. The following figure illustrates this concept.

FIGURE 3 Controlled and uncontrolled ports before and after client authentication



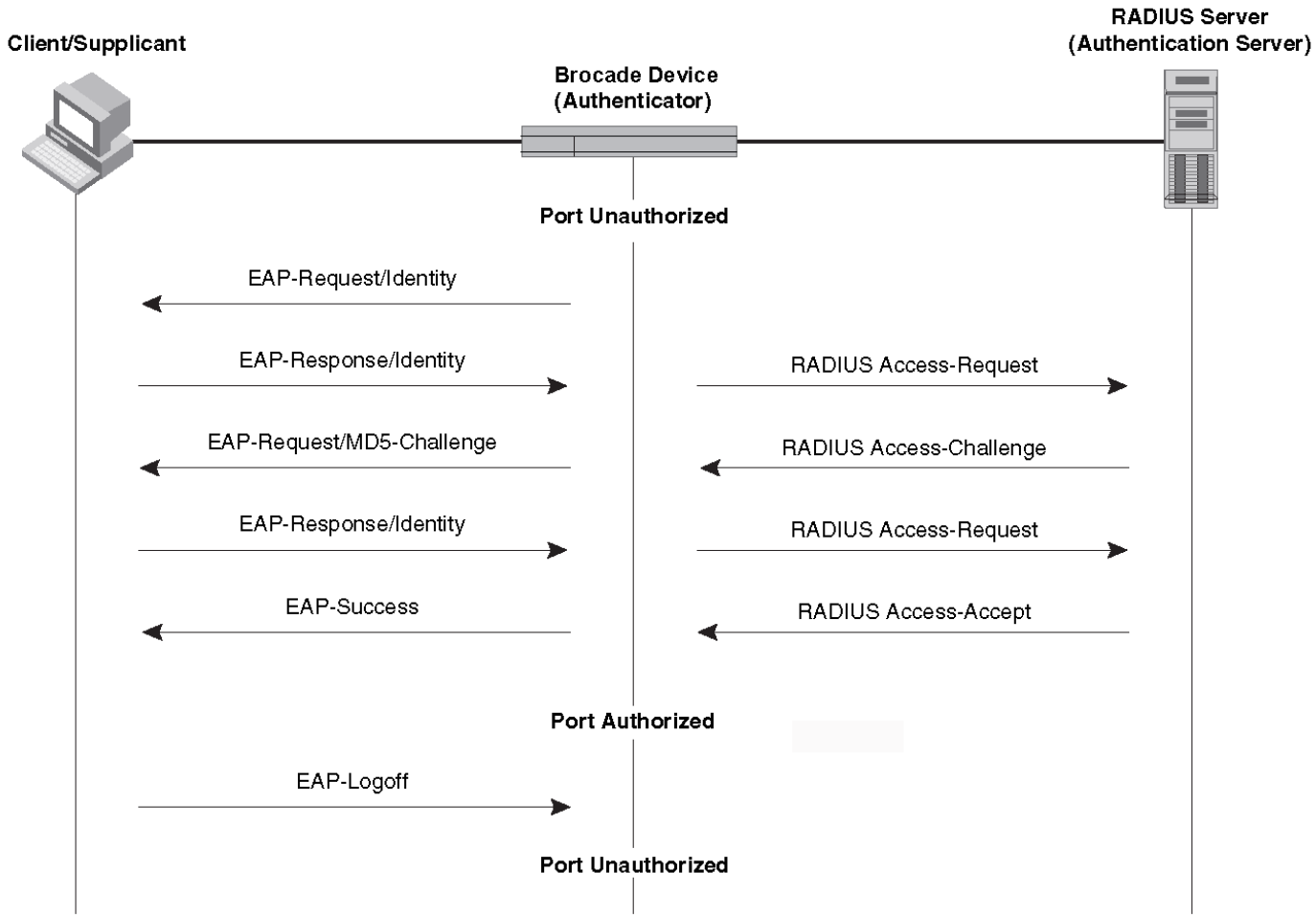
Before a client is authenticated, only the uncontrolled port on the authenticator is open. The uncontrolled port allows only EAPOL frames to be exchanged between the client and the authenticator. The controlled port is in the unauthorized state and allows no traffic to pass through.

During authentication, EAPOL messages are exchanged between the supplicant PAE and the authenticator PAE, and RADIUS messages are exchanged between the authenticator PAE and the authentication server. If the client is successfully authenticated, the controlled port becomes authorized for that client, and traffic from the client can flow through the port normally. When a client connected to the port is successfully authenticated, client is authorized to send traffic through controlled port until the client logs off.

Message exchange during authentication

The following figure illustrates a sample exchange of messages between an 802.1x-enabled client, a Brocade device acting as authenticator, and a RADIUS server acting as an authentication server.

FIGURE 4 Message exchange between client/supplicant, authenticator, and authentication server



In this example, the authenticator (the Brocade device) initiates communication with an 802.1x-enabled client. When the client responds, it is prompted for a username and password. The authenticator passes this information to the authentication server, which determines whether the client can access services provided by the authenticator. When the client is successfully authenticated by the RADIUS server, the client is authorized to use services provided by the authenticator. When the client logs off, the port becomes unauthorized for that client.

If a client does not support 802.1x, authentication cannot take place. The Brocade device sends EAP-Request/Identity frames to the client, but the client does not respond to them.

When a Client that supports 802.1X attempts to gain access through a non-802.1X-enabled port, it sends an EAP start frame to the Brocade device. When the device does not respond, the client considers the port to be authorized, and starts sending normal traffic.

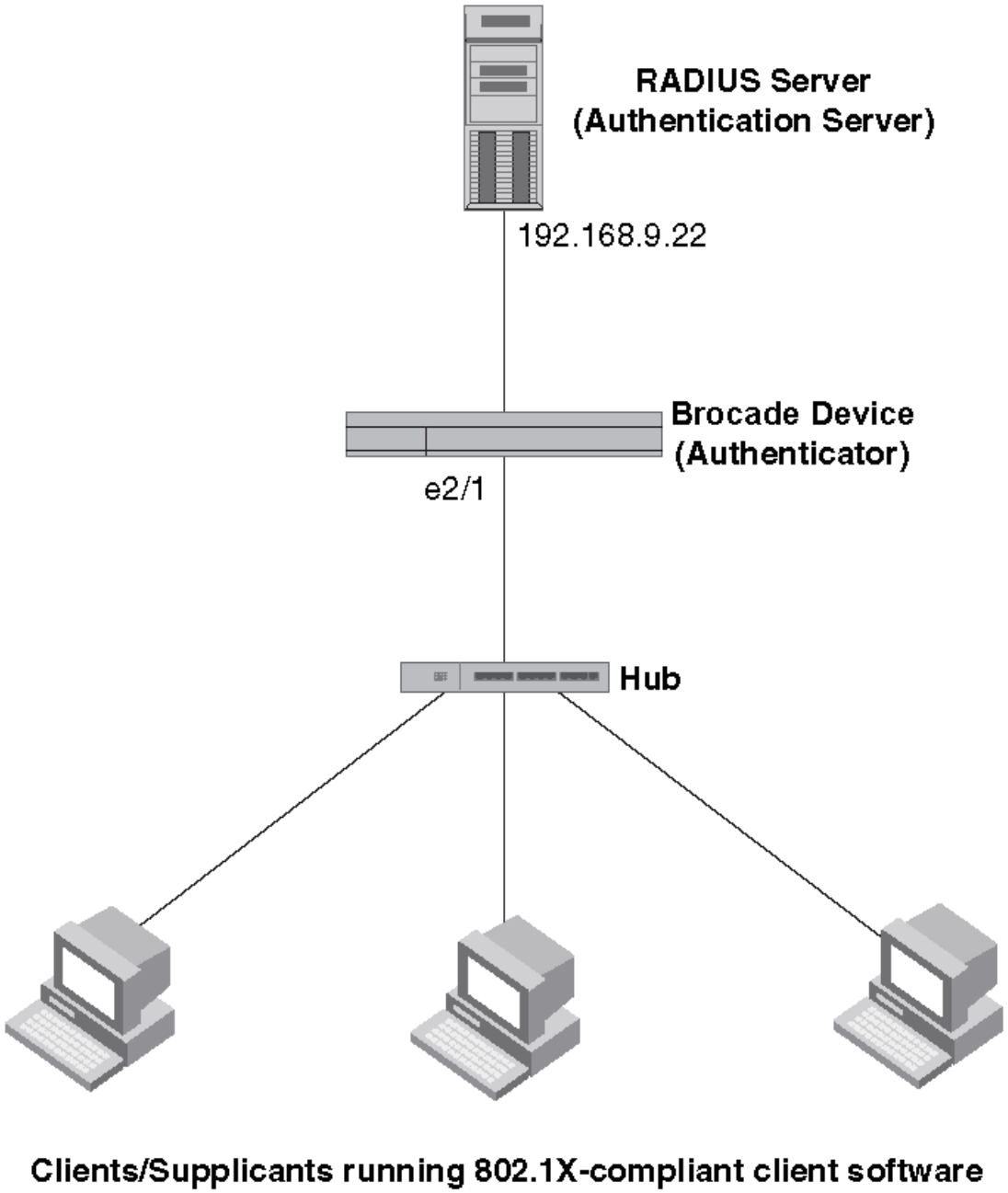
The Brocade 802.1x implementation supports dynamic VLAN assignment. If one of the attributes in the Access-Accept message sent by the RADIUS server specifies a VLAN identifier, and this VLAN is available on the Brocade device, the client port is moved from its default VLAN to the specified VLAN. When the client disconnects from the network, the port is placed back in its default VLAN. For more information, refer to Dynamic VLAN assignment for 802.1X ports on page 85.

The Brocade 802.1x implementation supports dynamically applying an IP ACL or MAC ACL to a port, based on information received from the authentication server. When the client disconnects from the network, the assigned ACLs will be removed from the port.

Authentication of multiple clients connected to the same port

Brocade devices support 802.1X authentication for ports with more than one client connected to them. The following figure illustrates a sample configuration where multiple clients are connected to a single 802.1X port.

FIGURE 5 Multiple clients connected to a single 802.1X-enabled port



If there are multiple clients connected to a single 802.1X-enabled port, the device authenticates each of them individually. Each client's authentication status is independent of the others, so that if one authenticated client disconnects from the network, it has no effect on the authentication status of any of the other authenticated clients.

By default, traffic from clients that cannot be authenticated by the RADIUS server is dropped.

How 802.1x multiple client authentication works

When multiple clients are connected to a single 802.1x-enabled port on a router (as in Authentication of multiple clients connected to the same port on page 82), 802.1x authentication is performed in the following ways.

1. One of the 802.1x-enabled clients attempts to log into a network in which a device serves as an Authenticator.
2. The device performs 802.1x authentication for the client. Messages are exchanged between the device and the client, and between the device and the Authentication Server (RADIUS server). The result of this process is that the client is either successfully authenticated or not authenticated, based on the username and password supplied by the client.
3. If the client is successfully authenticated, traffic from the client is forwarded normally.
4. When the client disconnects from the network, the device marks the client as unauthorized and the status is displayed in the output of **show dot1x session-info** command with the **interface ethernet** options. This does not affect the authentication status (if any) of the other clients connected on the port.

RADIUS attributes for authentication

RADIUS attributes are used to define specific authentication, authorization, and accounting (AAA) elements in a user profile, which is stored in the RADIUS server. When a client successfully completes the EAP authentication process, the authentication server (the RADIUS server) sends the authenticator (the Brocade device) a RADIUS Access-Accept message that grants the client access to the network. The RADIUS Access-Accept message contains attributes set for the user in the user's access profile on the RADIUS server.

Many functions, such as dynamic VLAN assignment and dynamic IP ACL and MAC filter assignment, are based on the RADIUS attributes. Brocade devices support the following RADIUS attributes for 802.1X authentication:

- Username (1): RFC 2865
- Filter-Id (11): RFC 2865
- Tunnel-Type (64): RFC 2868
- Tunnel-Medium-Type (65): RFC 2868
- Tunnel-Private-Group-Id (81): RFC 2868

Support for the RADIUS user-name attribute in Access-Accept messages

Authentication-enabled ports support the RADIUS user-name (type 1) attribute in the Access-Accept message returned during authentication.

When sFlow is enabled on the port, sFlow samples taken from the interface include the username of 802.1X client based on the source MAC address of the sFlow sample. For example, when the user-name attribute is sent in the Access-Accept message, it is then available for display in sFlow sample messages sent to a collector, and in the output of some **show dot1x** commands, such as **show dot1x session-info**.

To enable the user-name attribute, add the following attribute on the RADIUS server.

TABLE 10 RADIUS user-name attribute details

Attribute name	Type	Value
user-name	1	*name* (string)

Dynamic VLAN assignment for 802.1X ports

The Brocade 802.1X implementation supports assigning a port to a VLAN dynamically, based on information received from an authentication server (RADIUS server).

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. The RADIUS Access-Accept message contains attributes set for the user in the user's access profile on 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. When the client disconnects from the network, the port is placed back in its default VLAN.

To enable 802.1X VLAN ID support on the device, you must add the following attributes to a user's profile on the RADIUS server.

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 with an that ID corresponds to the VLAN ID.

Considerations for dynamic VLAN assignment in an 802.1X multiple client configuration

The port must be the switch port for allowing dynamic VLAN assignment and the corresponding VLAN must be preconfigured on the device. If the RADIUS Access-Accept message specifies the ID of a VLAN that does not exist on the device, then it is considered an authentication failure. If the port is not already a member of a RADIUS-specified VLAN, and the RADIUS Access-Accept message specifies the ID of a valid VLAN on the device, then the port is placed in that VLAN. When the client disconnects from the network, the port is moved out of the VLAN.

The client port is moved to the specified VLAN as tagged or untagged depending on the VLAN port mode (access, trunk, or hybrid). When multiple clients connect to the port with different VLANs, the VLAN is applied based on the port mode, which is either access or trunk.

In the case of access mode, the VLAN ID that is received for the first client is applied on the port. The subsequent clients authenticated with different VLANs are rejected. The port's VLAN membership is not changed. However, for trunk ports, multiple VLANs can be tagged.

Dynamic ACLs and MAC address filters in authentication

After successful authentication, different network policies can be applied to restrict the way the network resources are accessed by the client. The 802.1X authentication implementation supports dynamically applying an IP ACL to a port, based on information received from the authentication server. The 802.1X authentication also supports dynamic assignment of MAC ACLs to a port.

NOTE
ACL must not be manually applied to an 802.1X authentication-enabled port.

When a client or supplicant is authenticated, the authentication server (the RADIUS server) sends the authenticator (the Brocade device) a RADIUS Access-Accept message containing the Filter-Id (type 11) attribute, the Brocade device can use information in the attribute to apply an IP ACL or MAC ACL to the authenticated port. This IP ACL or MAC ACL applies to the port for as long as the client is connected to the network. The IP ACL or MAC ACL is removed from the corresponding port when the client logs out, or the port goes down.

The ACL IDs received in the Radius Access-Accept message for the first authenticated client is applied to the port. The subsequent authenticated clients that receive the same ACL IDs will be authorized. If the subsequent clients receive different ACL IDs, they will be considered unauthorized. If all the clients are logged out due to a log-off message from the clients, the assigned ACL ID set is removed from the port when the last client logs out.

The Brocade device uses information in the Filter-Id attributes as follows:

- The Filter-Id attribute can specify existing IP ACL or MAC ACL configured on the Brocade device. IP ACL or MAC ACL with the specified ACL name is applied to the port.

  NOTE
  Only IPv4 ACL is supported and IPv6 ACL binding is not supported.

ACL bind fails in the following scenarios:

- The ACL is not configured in the device.
- The port is already applied with the same ACL type in the same direction but different ACL ID.
- The port is not a switch port and the MAC type ACL is sent from the RADIUS server for that port.
- The ACL type sent from the RADIUS server does not match with the ACL type configured in the device.
- On the same port, multiple clients are connected with different ACLs. In this case, the ACL that is sent for the first client is applied on the port. The other clients with different ACLs are rejected.

  NOTE
  Dynamically assigned ACLs are not displayed in the running-config.

Dynamically applying existing ACLs or MAC ACL

When a port is authenticated using 802.1X security, an IP ACL or MAC ACL that exists in the running configuration on the device can be dynamically applied to the port. To do this, you configure the Filter-Id (type 11) attribute on the RADIUS server. The Filter-Id attribute specifies the name of the IP ACL or MAC ACL.

The following table shows the syntax for configuring the Filter-Id attribute to refer to an IP ACL or MAC ACL.

TABLE 12 Syntax for Filter-Id attribute

Value	Description
ip.*name* .in	Applies the specified named ACL to the 802.1X authenticated port in the inbound direction.
ip.*name* .out	Applies the specified named ACL to the 802.1X authenticated port in the outbound direction.
mac.*name* .in	Applies the specified MAC ACL to the 802.1X authenticated port in the inbound direction.

NOTE

- The *name* variable in the Filter-Id attribute is case-sensitive.
- Dynamic IP ACL filters are supported for the inbound and outbound directions.
- MAC ACLs are supported only for the inbound direction. Outbound MAC ACLs are not supported.
- The RADIUS server sends the ACL name in the Filter-Id attribute in the following form: <ip/mac>.<acl_name>.<in/out>
- Only one ACL ID per ACL type is allowed in each direction.

Strict security mode for dynamic filter assignment

By default, dynamic filter assignment operates in strict security mode. When strict security mode is enabled, authentication for a port fails if the Filter-Id attribute contains invalid information to implement the IP ACLs or MAC ACLs. You can manually disable the strict security mode using the **no filter-strict-security** command in the interface configuration mode.

When strict security mode is enabled:

- If the Filter-Id attribute in the Access-Accept message contains a value that does not refer to an existing filter (that is, a MAC ACL or IP ACL configured on the device), then the client will not be authorized, regardless of any other information in the message (for example, if the Tunnel-Private-Group-ID attribute specifies a VLAN on which to assign the port).

When strict security mode is disabled:

- If the Filter-Id attribute in the Access-Accept message contains a value that does not refer to an existing filter (that is, a MAC ACL or IP ACL configured on the device), then the client remains authorized and no filter is dynamically applied to it.

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.

802.1X authentication enablement

By default, 802.1X authentication is disabled on the Brocade device. To enable 802.1X authentication, you must initialize 802.1X authentication globally and then enable 802.1X authentication on a specific interface.

The **dot1x enable** command in the global configuration mode initializes 802.1X authentication globally on all ports. After which, you can enable 802.1x authentication on a specific interface using the **dot1x authentication** command in interface configuration mode.

Port control for authentication

To activate authentication on an 802.1X-enabled interface, you must specify the kind of port control to be used on the interface.

The port control type can be one of the following:

- force-authorized: The controlled port is placed unconditionally in the authorized state, allowing all traffic. This is the default state for ports on the Brocade device.
- force-unauthorized: The controlled port is placed unconditionally in the unauthorized state.
- auto: The controlled port is unauthorized until authentication takes place between the client and the authentication server. Once the client passes authentication, the client is authorized to send traffic through that port. Auto is the default port control type used when 802.1X authentication is enabled on the port.

  NOTE
  Before activating the authentication on a port, you must remove the configured static ACL and static VLANs, if any, from the port.

NOTE
Do not configure ACLs or VLANs through the CLI manually on the authentication-enabled port.

Periodic reauthentication

You can configure the device to periodically reauthenticate clients connected to 802.1x-enabled interfaces. When periodic reauthentication is enabled using the **dot1x reauthentication** command, the device reauthenticates the clients every 3,600 seconds by default. The **dot1x timeout re-authperiod** command resets the reauthentication interval, which takes precedence over the default interval.

Manual reauthentication of a port

When periodic reauthentication is enabled, the device reauthenticates clients connected to an 802.1X-enabled interface every 3,600 seconds (or the time specified by the **dot1x timeout re-authperiod** command) by default. You can also manually reauthenticate clients connected to a specific port using the **dot1x reauthenticate** command in the privileged EXEC mode.

Quiet period for reauthentication

If the device is unable to authenticate the client, the device waits for a specified amount of time before trying again. The amount of time the device remains idle between a failed authentication and a reauthentication attempt is specified with the **dot1x timeout quiet-period** command.

Retransmission interval for EAP-Request/Identity frames

When the device sends a client an EAP-Request/Identity frame, it expects to receive an EAP-Response/Identity frame from the client. If the client does not send back an EAP-Response/Identity frame, the device waits a specified amount of time and then retransmits the EAP-Request/Identity frame. You can specify the amount of time the device waits before retransmitting the EAP-Request/Identity frame to the client. This amount of time is specified using the **dot1x timeout tx-period** command.

Retransmission limit for EAP-Request/Identity frame

If the device does not receive an EAP-Response/Identity frame from a client, the device waits 30 seconds (or the amount of time specified with the **dot1x timeout tx-period** command), and then retransmits the EAP-Request/Identity frame. By default, the device retransmits the EAP-Request/Identity frame a maximum of two times. If no EAP-Response/Identity frame is received from the client after two EAP-Request/Identity frame retransmissions, the device restarts the authentication process with the client. You can specify from 1 through 10 frame retransmissions using the **dot1x max-req** command.

Retransmission timeout of EAP-Request frames to the client

Acting as an intermediary between the RADIUS authentication server and the client, the device receives RADIUS messages from the RADIUS server, encapsulates them as EAPOL frames, and sends them to the client. When the device relays an EAP-Request frame from the RADIUS server to the client, it expects to receive a response from the client within 30 seconds. If the client does not respond within the allotted time, the device retransmits the EAP-Request frame to the client. The timeout value for retransmission of EAP-Request frames to the client can be configured using the **dot1x timeout supp-timeout** command.

Configuring 802.1x authentication

To enable and activate 802.1X authentication, perform the following steps.

802.1x authentication requires some prerequisite tasks be performed before executing 802.1x authentication configurations at the global and interface levels. Before configuring 802.1x authentication, communication between the devices and the authentication server must be established. The following configurations must be completed before configuring 802.1X authentication:

- Configure the RADIUS server to authenticate access to the Brocade 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.

  NOTE
  If multiple RADIUS servers are configured, the recommended configuration for RADIUS server retries is 2.

```
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 switch ports are 802.1X-capable.

```
device# dot1x test eapol-capable interface ethernet 1/1
device# 2016/07/18-00:49:03, [DOT1-1012], 5006, M2 | Active | DCE, INFO, sw0,
DOT1X_PORT_EAPOL_CAPABLE: Peer connected to port Ethernet 1/1 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 Ethernet 1/1
```

5. Enable 802.1X authentication on a specific interface port.

```
device(conf-if-eth-1/1)# dot1x authentication
```

6. 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-eth-1/1)# dot1x port-control auto
```

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 .

7. (Optional) Configure the device to periodically reauthenticate the clients connected to 802.1X-enabled interfaces at regular intervals.

```
device(conf-if-eth-1/1)# dot1x reauthentication
```

When you enable periodic reauthentication, the device reauthenticates the clients every 3,600 seconds by default.

8. (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-eth-1/1)# 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-eth-1/1)# 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-eth-1/1)# 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.

9. (Optional) Configure the maximum number of reauthentication attempts before the port goes to the unauthorized state.

```
device(conf-if-eth-1/1)# dot1x reauthMax 3
```

10. (Optional) Configure the retransmission parameter that defines the maximum number of times EAP-Request/Challenge frames are retransmitted when an EAP Response/Identity frame is not received from the client.

```
device(conf-if-eth-1/1)# dot1x max-req 3
```

11. (Optional) Configure the time interval the device remains idle between a failed authentication and a reauthentication attempt.

```
device(conf-if-eth-1/1)# dot1x quiet-period 30
```

12. (Optional) Enter the **no dot1x filter-strict-security** command to authenticate the client even if the Filter-Id attribute returned by RADIUS contains invalid information.

```
device(conf-if-eth-1/1)# no dot1x filter-strict-security
```

By default, strict security mode is enabled.

Displaying 802.1x information

Various show commands can be used to display the following 802.1x-related information:

- Information about the 802.1x configuration on the device and on individual ports
- Statistics about the EAPOL frames passing through the device
- Information about 802.1x-enabled ports dynamically assigned to a VLAN
- Information about the dynamically applied MAC and IP ACLs currently active on the device
- Information about the 802.1x multiple client configuration

Enter the **show dot1x** command to display the overall state of 802.1X authentication on the system.

```
device# show dot1x
802.1X Port-Based Authentication: Enabled
PAE Capability:                   Authenticator Only
Protocol Version:                 2
Auth Server:                      RADIUS
Readiness test timeout:           10
RADIUS Configuration
--------------------
Position:                 1
Server Address:           10.24.65.6
Port:                     1812
Secret:                   xxxxxxxxx
Retry Interval:           5 seconds
```

Enter the **show dot1x all** command to display detailed 802.1X authentication information for all of the ports.

```
Brocade# show dot1x all
802.1X Port-Based Authentication: Enabled
PAE Capability:                   Authenticator Only
Protocol Version:                 2
Auth Server:                      RADIUS
Readiness test timeout:           10

RADIUS Configuration
--------------------
Position:                 1
Server Address:           10.24.65.6
Port:                     1812
Secret:                   xxxxxxxxx
Retry Interval:           5 seconds

802.1X info for interface Eth 1/2
---------------------------------
Port Control:             Auto
```

```
Protocol Version:         2
ReAuthentication:         Disabled
Auth Fail Max Attempts:   0
ReAuth Max:               2
Tx Period:                30 seconds
Quiet Period:             60 seconds
Supplicant Timeout:       30 seconds
Server Timeout:           30 seconds
Re-Auth Interval:         3600 seconds
Dynamic VLAN assigned:    N/A
Filter-strict-security:   Enabled
IP ACL assigned (IN|OUT): N/A | N/A
MAC ACL assigned:         N/A
```

Enter the **show dot1x diagnostics interface** command to display all diagnostics information for the authenticator associated with a port.

```
device# show dot1x diagnostics interface ethernet 1/2
802.1X Diagnostics for interface Eth 1/2
----------------------------------------
authEnterConnecting:               1
authEaplogoffWhileConnecting:      0
authEnterAuthenticating:           1
authSuccessWhileAuthenticating:    1
authTimeoutWhileAuthenticating:    0
authFailWhileAuthenticating:       0
authEapstartWhileAuthenticating:   0
authEaplogoffWhileAuthenticating:  0
authReauthsWhileAuthenticated:     0
authEapstartWhileAuthenticated:    0
authEaplogoffWhileAuthenticated:   0
BackendResponses:                  11
BackendAccessChallenges:           10
BackendOtherrequestToSupplicant:   11
BackendAuthSuccess:                1
BackendAuthFails:                  0
```

Enter the **show dot1x interface** command to display state of a specified interface.

```
device# show dot1x interface ethernet 1/2
802.1X info for interface Eth 1/2
---------------------------------
Port Control:             Auto
Protocol Version:         2
ReAuthentication:         Disabled
Auth Fail Max Attempts:   0
ReAuth Max:               2
Tx Period:                30 seconds
Quiet Period:             60 seconds
Supplicant Timeout:       30 seconds
Server Timeout:           30 seconds
Re-Auth Interval:         3600 seconds
Dynamic VLAN assigned:    N/A
Filter-strict-security:   Enabled
IP ACL assigned (IN|OUT): N/A | N/A
MAC ACL assigned:         N/A
```

Enter the **show dot1x session-info interface** command to display information for all clients on the port .

```
device# show dot1x session-info interface ethernet 1/2
802.1X Session info for interface Eth 1/2
----------------------------------------
Mac Address: 0021.5ec6.15ce
----------------------------------------
User Name:                md5user2
Session Time:             2 secs
Terminate Cause:          Not terminated yet
Session Status:           Authorized
PAE State:                Authenticated
BE State:                 Idle
VLAN:                     N/A
IP ACL (IN | OUT):        N/A | N/A
```

```
MAC ACL:                  N/A
Current Id:               18
Id From Server:           17
```

Enter the **show dot1x statistics interface** command to display the statistics of a specified interface.

```
device# show dot1x statistics interface ethernet 1/2
802.1X statistics for interface Eth 1/2
---------------------------------------
EAPOL Frames Rx:                    12
EAPOL Frames Tx:                    43
EAPOL Start Frames Rx:              1
EAPOL Logoff Frames Rx:             0
EAP Rsp/Id Frames Rx:               1
EAP Response Frames Rx:             10
EAP Req/Id Frames Tx:               23
EAP Request Frames Tx:              10
Invalid EAPOL Frames Rx:            0
EAPOL Length Error Frames Rx:       0
EAPOL Last Frame Version Rx:        1
Invalid EAP Frames Rx:              0
EAP Length Error Frames Rx:         0
EAPOL Last Frame Src:               0021.5ec6.15ce
```

Configuring External Server Authentication

Understanding and configuring remote server authentication

Remote server authentication overview

The software supports various protocols to provide external Authentication, Authorization, and Accounting (AAA) services for Brocade 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.

Brocade 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.

Conditions for conformance

- 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+.

- Understanding and configuring RADIUS on page 99
- Understanding and configuring TACACS+ on page 107
- Understanding and configuring LDAP on page 117

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 SLX-OS *Command Reference* for the SLX 9850 Router.

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
```

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

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, but you cannot change or delete an existing authentication mode with the same command. You can only reset the configuration to the default value using the **no aaa authentication login** command and then reconfigure the authentication sequence to the correct value.

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

```
device(config)# no aaa authentication login tacacs+ local
```

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

```
device(config)# aaa authentication login radius local
```

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

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

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

RADIUS Server Authentication

Understanding and configuring RADIUS

The remote authentication dial-in user service (RADIUS) protocol manages authentication, authorization, and accounting (AAA) services centrally. The supported management access channels that integrate with RADIUS are serial port, Telnet, and SSH.

Authentication and accounting

When a Brocade device is configured with a set of RADIUS servers to be used for authentication, the device also sends accounting data to the RADIUS server implicitly.

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

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

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

  NOTE
  If the RADIUS server is not configured to support accounting, the accounting events sent by the device to the server are dropped.

Authorization

User authorization through the RADIUS protocol is not supported. The access control of RADIUS users is enforced by the Brocade 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 Brocade 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 a Brocade 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 Brocade device.

Configuring a RADIUS server with Linux

FreeRADIUS is an open source RADIUS server that runs on Linux (all versions), FreeBSD, NetBSD, and Solaris. Download the package from www.freeradius.org and follow the installation instructions at the FreeRADIUS website.

You will need the following information to configure Brocade-specific attributes. Refer to the RADIUS product documentation for information on configuring and starting up a RADIUS server.

Adding the Brocade attribute to the RADIUS server configuration

For the configuration on a Linux FreeRADIUS server, define the values outlined in the following table in a vendor dictionary file named dictionary.brocade.

TABLE 13 dictionary.brocade file entries

Include	Key	Value
VENDOR	Brocade	1588
ATTRIBUTE	Brocade-Auth-Role	1 string Brocade

1. Create and save the file `$PREFIX/etc/raddb/dictionary.brocade` with the following information:

```
#
# dictionary.brocade
#
VENDOR Brocade 1588
#
# attributes
#
ATTRIBUTE         Brocade-Auth-Role          1      string      Brocade.
```

2. Open the master dictionary file `$PREFIX/etc/raddb/dictionary` in a text editor and add the line:

```
$INCLUDE dictionary.brocade
```

   The file `dictionary.brocade` is located in the RADIUS master configuration directory and loaded for use by the RADIUS server.

Configuring a Brocade user account

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

1. Open the `$PREFIX/etc/raddb/users` file in a text editor.
2. Add the user name and associated the permissions.

   The user must log in using the permissions specified with Brocade-Auth-Role.

   The following example configures an account called "jsmith" with admin permissions and a password "jspassword".

```
jsmith    Auth-Type := Local,
                  User-Password == "jspassword",
                  Brocade-Auth-Role = "admin"
```

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

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 Brocade device.

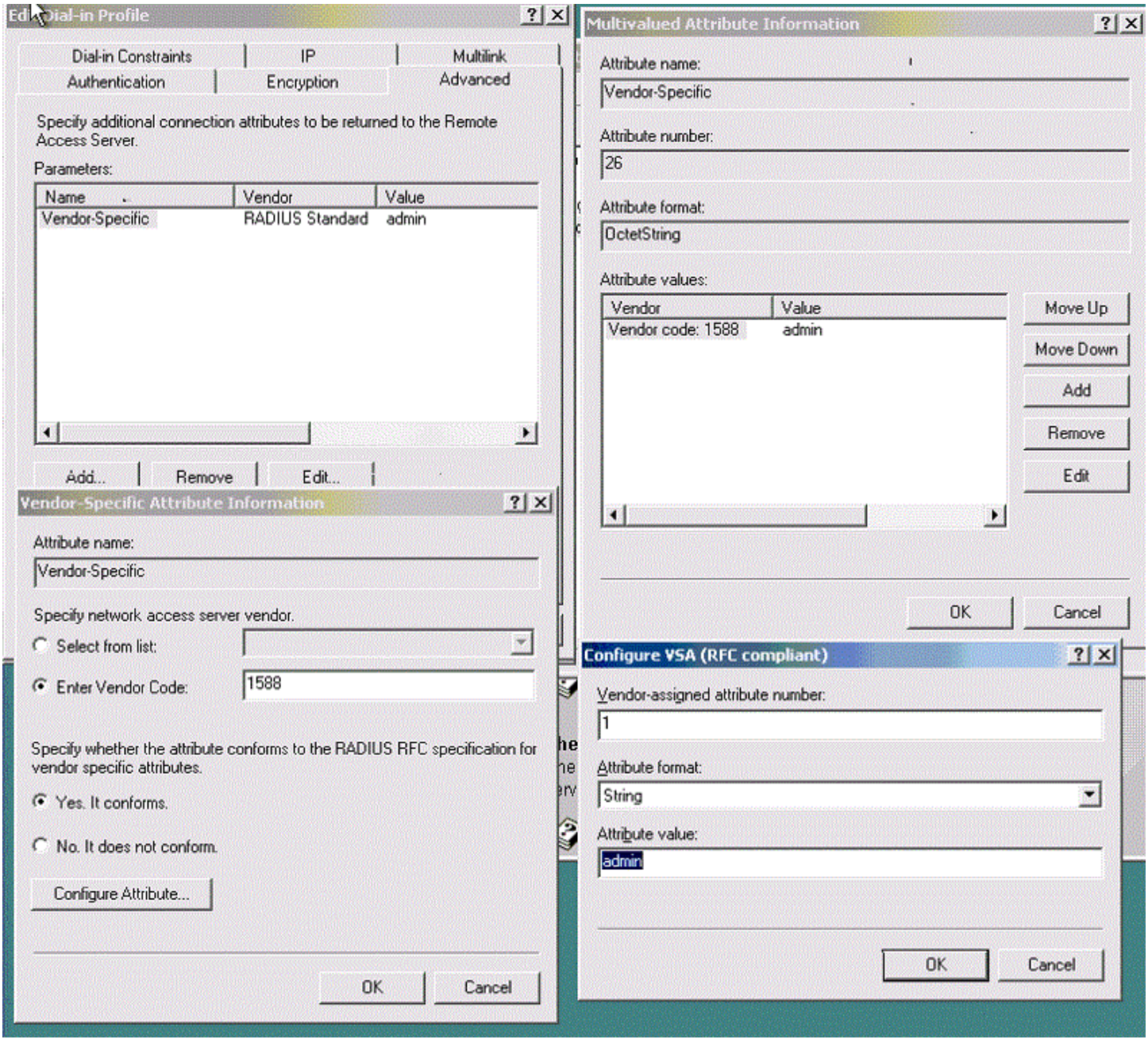
NOTE
This is not a complete presentation of steps.

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 Brocade vendor code value of **1588**.
   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 6 Windows server VSA configuration



Configuring RADIUS Server on a Brocade device

Each Brocade device client must be individually configured to use RADIUS servers. You use the **radius-server** command to specify the server IP address, authentication protocols, and other parameters. You can configure a maximum of 5 RADIUS servers on a Brocade 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 Brocade device.

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

TABLE 14 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.

Adding a RADIUS server

You must configure the Domain Name System (DNS) server on the device prior to adding the RADIUS server with a domain name or a host name. Without the DNS server, name resolution of the RADIUS server 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 on the device, failover from one server to another server happens only if a RADIUS server fails to respond; it does not happen when user authentication fails.

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** command with the *use-vrf* parameter to enter the AAA server configuration submode.

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

3. Enter any additional parameters for the RADIUS server configuration.

```
device(config-host-10.38.37.180/mgmt-vrf)# protocol pap  timeout 10
device(config-host-10.38.37.180/mgmt-vrf)# key "new#vertigo*secret"
device(config-host-10.38.37.180/mgmt-vrf)# timeout 10
```

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

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

5. Enter the **do show running-config radius-server host** *host_IP* command to verify the configuration.

```
device(config)# do 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 11
!
```

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 configuration submode where you can specify the parameters you want to modify.

4. Enter the parameters and values you want to change.

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

5. Enter the **do show running-config radius-server** command to verify the configuration.

   NOTE
   This command does not display default values.

```
device(config)# do 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
   The **no radius-server host** command removes the server configuration from the list of configured RADIUS servers.

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 Login authentication mode on page 95 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. SLX-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.

  NOTE
  RADIUS two factor authentication does not support Challenge Handshake Authentication Protocol (CHAP).

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/tokencode works automatically without any changes to the Brocade 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+

The 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 Brocade devices seamlessly integrates into these environments. Once configured to use TACACS+, a Brocade device becomes a network access server.

TACACS+ authorization

The TACACS+ server is used only for authentication and accounting. Authorization is enforced by the Brocade role-based access control (RBAC) protocol at the device level. The same role should 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 is used for RBAC.

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

Brocade 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 Brocade 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 Brocade 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 Brocade device for AAA service.

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

TABLE 15 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	The shared secret between the device and the TACACS+ 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 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. 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 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.

Refer also to:

- Adding a TACACS+ server to the client server list on page 108
- Modifying the client-side TACACS+ server configuration on page 109
- Configuring the client to use TACACS+ for login authentication on page 110
- Configuring TACACS+ accounting on the client side on page 110

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 the privileged EXEC mode, enter **configure terminal** to enter the 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 use-vrf mgmt-vrf
```

   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 host fec0:60:69bc:94:211:25ff:fec4:6010
device(config-host-fec0:60:69bc:94:211:25ff:fec4:6010/mgmt-vrf)# protocol chap key
"new#hercules*secret"
device(config-host-fec0:60:69bc:94:211:25ff:fec4:6010/mgmt-vrf)# exit
```

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

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

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

```
device(config)# do show running-config tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010 use-vrf mgmt-vrf
 key "nPbWil58uf/UJ4UoTUEzGmx/+m8/9fJbHe1uGUH/gM8=\n" encryption-level 7
!
```

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 use-vrf mgmt-vrf
```

   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/mgmt-vrf)# key "changedsec" retries
100
```

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

```
device(config-tacacs-server-fec0:60:69bc:94:211:25ff:fec4:6010/mgmt-vrf)# 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 host fec0:60:69bc:94:211:25ff:fec4:6010
tacacs-server host fec0:60:69bc:94:211:25ff:fec4:6010 use-vrf mgmt-vrf
 key "h8mcoUf2LZF+P+AjaYnO1Q==\n" encryption-level 7 retries 100
!
```

   The **no tacacs-server host** command removes the server configuration from the list of configured RADIUS 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 configured the client-side TACACS+ server list, you must set the authentication mode so that TACACS+ is used as the primary source of authentication. refer to the Login authentication mode topic for information on how to configure the login authentication mode.

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 a TACACS+ server is used for both authentication and accounting, the device first attempts to connect to the TACACS+ server that was successfully used for authentication when sending accounting packets to the server. If the TACACS+ server cannot be reached, the device attempts to send the packets to the next server on the list.

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 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.

Configuring TACACS+ accounting on the client

By default, accounting is disabled on the TACACS+ client (the device) and you must explicitly enable the feature. 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, if it is the only server in the list, you cannot remove a TACACS+ server.

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 default exec 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 default command 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 the global configuration mode.

This example shows two ways of disabling command accounting. The commands are executed in the global configuration mode.

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

This example shows 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.

These 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 depend 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-eth-1/3
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-eth-1/3 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.

```
Aug 19 20:57:12 10.24.12.77     admin   /dev/pts/0      10.252.200.38   stop    task_id=1
timezone=Etc/ config radius-server host 10.2.3"      Stop_time=Fri Aug 19 08:25:56 2016
        Status=%% Error: Invalid host name or IP address
```

Login (EXEC) accounting examples

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

```
Aug 19 21:01:46 10.24.12.77     user    /dev/pts/1      10.252.200.38   start   task_id=1
timezone=Etc/GMT     service=shell
```

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

```
Aug 19 21:03:11 10.24.12.77     user    /dev/pts/1      10.252.200.38   stop    task_id=1
timezone=Etc/GMT     service=shell   elapsed_time=85 reason=admin reset
```

Configuring TACACS+ on the server side

Step-by-step instructions for installing and configuring can be obtained from www.cisco.com. 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 Brocade device. Along with each account name, you must assign appropriate device access roles. A user account can exist on TACACS+ server 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 a Brocade 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. The following configuration examples are based on the documentation provided by Cisco for its TACACS+ daemon users.

Establishing a server-side user account

The following example assigns the user "Mary" the Brocade role of "vlanadmin" and different passwords depending on whether the CHAP or the PAP protocol is used. In the following example, the brcd-role attribute is mandatory, which works in a Brocade-only environment. In a mixed vendor environment, the brcd-role attribute most be set to optional. Refer to Configuring TACACS+ for a mixed vendor environment on page 114 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. Configure the account as shown in the following example.

```
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 Brocade role concept, has no relation with the value of "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 "Brocade" with the group "admin".

```
user = Brocade {
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 = Brocade {
member = admin
expires = "Jan 1 2011"
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 Brocade device and the TACACS+ server. The TACACS+ server key must be configured on both the TACACS+ server and the client Brocade device. Only one key is defined per server in the TACACS+ server configuration file. The key is defined as follows:

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

Configuring TACACS+ for a mixed vendor environment

Brocade 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 Brocade and non-Brocade platforms. You can use TACACS+ to provide centralized AAA services to multiple network access servers or clients. To use TACACS+ services in multi-vendor environments, you must configure the Attribute-Value Pair (AVP) argument to be optional as shown in the example.

```
brcd-role*admin
```

The Brocade device sends the optional argument 'brcd-role' in the authorization request to the TACACS+ service. 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 Brocade users are able to successfully authorize with all TACACS+ services in a mixed-vendor environment.

Example: Configuring optional arguments in tac_plus

The following is a specific example for tac_plus package. Syntax for other packages may differ.

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

The following example configures a user with the optional attribute value pair, brcd-role = admin. A Brocade 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>
}
```

LDAP - 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 which supports a number of standardized protocols such as LDAP, Kerberos authentication, and 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 the part of directory information, so it can be used as a centralized database for authenticating the third-party resources.

User authentication

A Brocade 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, it supports server authentication during the TLS handshake. Only the user principal name from the AD server is supported for LDAP authentication on the Brocade device. The Common Name-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

A Brocade device configured to perform LDAP-based authentication supports its 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 devices.

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

Server authentication

As a part of user authentication using LDAP, the Brocade 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 should be added as the host parameter, instead of the IP address. A FQDN is needed to validate the server identity as mentioned in the common name of the server certificate.
- The CA certificate of the AD server's certificate should 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 should be imported, or CA certificates should 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 should 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 should be assigned a nonprimary group, and that group name should 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 AD server (or default role) is used for RBAC.

If multiple nonprimary groups are associated to the AD user, only one of the groups should 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 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 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 should be installed on the device, and the FIPS-compliant TLS ciphers for LDAP should be used.

Configuring LDAP

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

Client-side tasks:

- Configuring an Active Directory server on the client side on page 119
- Configuring Active Directory groups on the client side on page 122

Server-side tasks:

- Configuring an Active Directory server on the client side on page 119

Importing an LDAP CA certificate

The following example imports the LDAP CA certificate from a remote server to a Brocade 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
```

Configuring an Active Directory server on the client side

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

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

TABLE 16 Active Directory parameters

Parameter	Description
host	IP address (v4) 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

A maximum of five LDAP/AD servers can be configured on a Brocade device for authentication service.

Adding an LDAP server to the client server list

The following procedure configures an LDAP server on an ADAP client (Brocade 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 basedn sec.brocade.com port 3890
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 preceding table).

```
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 the global configuration mode.

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

6. Use the **no ldap-server** command to set an attribute back to the default value.

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

Changing LDAP server parameters

Changing an LDAP server 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, then enter the new values as required.

Refer to Adding an LDAP server to the client server list on page 120.

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

Removing an LDAP server

The following example 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
```

Importing an LDAP CA certificate

This procedure imports the LDAP CA certificate from the remote host to the device.

1. Connect to the device and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **certutil import ldapca** command. Include the full path to the certificate on the host, specify SCP as the protocol, and include the IP address of the host.

```
device# certutil import ldapca directory /usr/ldapcacert/ file cacert.pem protocol SCP host
10.23.24.56 user jane password rbridge-id 3
password: ****
```

Deleting an LDAP CA certificate

This procedure deletes the LDAP CA certificates of all attached Microsoft Active Directory servers from the device.

1. Connect to the device and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **no certutil ldapca** command.

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

3. Enter **Y** to confirm that you want to delete the LDAP CA certificates.

Verifying LDAP CA certificates

To test whether an LDAP CA certificate has been imported on the device, in privileged EXEC mode, enter the **no certutil ldapca** command and examine the message returned by the system. The command returns an error if there is no LDAP CA certificate on the device. If an LDAP CA certificate exists on the device, you are prompted to delete it. Enter **no certutil ldapcacert** command to retain the certificate.

When no LDAP CA certificate is present

When an LDAP CA certificate exists on the device

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 **certutil import syslogca** command. Include the full path to the certificate on the host, specify SCP as the protocol, and include the IP address of the host.

Importing a syslog CA certificate

The following procedure imports the syslog CA certificate from the remote host to the device.

1. Connect to the device and log in using an account with admin role permissions.
2. In privileged EXEC mode, enter the **certutil import syslogca** command. Include the full path to the certificate on the host, specify SCP as the protocol, and include the IP address of the host.

Deleting a syslog CA certificate

The following procedure deletes the syslog CA certificates of all attached Active Directory servers from the device.

1. Connect to the device and log in using an account with admin role permissions.
2. In Privileged EXEC mode, enter the **no certutil syslogca** command. You will be prompted to confirm that you want to delete the syslogca certificates.

Verifying syslog CA certificates

To test whether a syslogCA certificate has been imported on the device, in privileged EXEC mode, enter the **no certutil syslogca** command and examine the message returned by the system. The command returns an error if there is no syslog CA certificate on the device. If a syslog CA certificate exists on the device, you are prompted to delete it. Enter the **no certutil syslogcacert** command to retain the certificate.

When no syslog CA certificate is present

```
device# no certutil syslogcacert
% Error: syslog CA certificate does not exist.
```

When a syslog CA certificate exists on the device

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

Viewing the syslog CA certificate

The following procedure allows you to view the syslog 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 syslogcacert** command.

Configuring Active Directory groups on the client side

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

A user on an AD server should be assigned a nonprimary group, and that group name should 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 with any nonprimary group.

Mapping an Active Directory group to a device role

In the following example, a Brocade 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 Brocade admin role and the Active Directory (AD) Administrator group. A Brocade 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 configured the device LDAP server list, you must set the authentication mode so that ALDAP is used as the primary source of authentication.

Configuring an Active Directory server on the client 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

1. Create a user on the Microsoft Active Directory server.
2. Create a group. The group should either match with the user's Brocade device role.
3. Associate the user with the group by adding the user to the group.
   The user account configuration is complete.

Verifying the user account on the 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 an AD server

1. Create a user.
   a) Go to **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.
   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 Brocade device. In this instance, Domain Users is the primary group and therefore should not be mapped with the device role.

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.

SLX-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. 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)# crypto key label k1 rsa modulus 2048
```

3. 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)# crypto ca trustpoint t1
device(config-ca-t1)#
```

4. 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
```

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

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

6. 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: **********
```

7. 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: **********
```

8. 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: **********
```

9. Save the running configuration to the startup configuration with the **copy** command.

```
device#copy running-config startup-config
```

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

```
device# show crypto key mypubkey
key type: rsa
key label: k1
key size: 2048

device#  show crypto ca trustpoint
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 crypto
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 enable state (by default HTTP is enabled), then execute **http server shutdown**, followed by **no http server shutdown** to enable HTTPS.
    - If HTTP is in disable state, then execute **no http server shutdown**.
    - 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
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
Trustpoint: t1
certificate: none
CA certificate: none
```

3. Enter configure terminal mode.

```
device#configure terminal
```

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

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

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

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

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

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

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

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

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

8. Save the running configuration to the startup configuration with the **copy** command.

```
device#copy running-config startup-config
```

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.
- Reboot the entire device.
- Commit an HA failover, if that option is available.

Disabling HTTPS service

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

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. 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)# ssh server cipher aes192-cbc,aes128-ctr
   ```

3. 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)# ssh client cipher aes192-cbc,aes128-ctr
   ```

4. Restart the SSH server using the **no ssh server shutdown** command.

5. Confirm the cipher setting with the **show running-config** command or the **show ssh** command.

```
device(config)## show running-config ssh server cipher
ssh server cipher aes192-cbc,aes128-ctr

device(config)## show running-config ssh client cipher
ssh client cipher aes192-cbc,aes128-ctr

device(config)# do show ssh server status
SSH server status:Enabled
SSH Server Cipher: aes192-cbc,aes128-ctr

device(config)# do show ssh client status
SSH Client Cipher: aes192-cbc, aes128-ctr
```

Configuring non-CBC SSH cipher

supports Cipher Block Chaining (CBC) ciphers and non-CBC ciphers. This task configures the non-CBC ciphers for Secure Shell (SSH).

1. Enter global configuration mode.

```
device# configure terminal
```

2. Use the **ssh server cipher** command to set the server cipher for SSH.

```
device(config)# ssh server cipher non-cbc
```

3. Use the **ssh client cipher** command to set the client cipher for SSH.

```
device(config)# ssh client cipher non-cbc
```

4. Restart the SSH server using the **no ssh server shutdown** command.
5. Confirm the cipher setting with the **show running-config** command to set the client cipher version for SSH.

```
device(config)# 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. Use the **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)# no ssh server cipher
```

3. Use the **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)# 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-hellmangroup14-sha1".

1. Enter global configuration mode.

```
device# configure terminal
```

2. 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)# ssh server key-exchange diffie-hellman-group14-sha1,ecdh-sha2-nistp521
```

3. 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)# ssh client key-exchange diffie-hellman-group14-sha1,ecdh-sha2-nistp521
```

4. Restart the SSH server using the **no ssh server shutdown** command.

Removing an SSH key-exchange

1. Enter configure terminal mode.

```
device#configure terminal
```

2. Use the **no ssh server key-exchange** command to reset the key exchange algorithm for the server to the default value.
3. 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. 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)# ssh server mac
```

3. 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)# ssh client mac
```

4. Restart the SSH server using the **no ssh server shutdown** command.

5. Enter the **show running-config** command or the the **show ssh** command to confirm the SSH configuration information.

```
device(config)# do show running-config ssh server
ssh server mac hmac-sha1,hmac-sha2-256,hmac-sha2-512
ssh server key rsa 2048
ssh server key ecdsa 256
ssh server key dsa

device(config)# do show running-config ssh client
ssh client mac hmac-sha1,hmac-sha2-256,hmac-sha2-512

device(config)# do show ssh server status
SSH server status:Enabled
SSH server Mac: hmac-sha1,hmac-sha2-256,hmac-sha2-512

device(config)# do show ssh client status
SSH Client Mac: hmac-sha1,hmac-sha2-256,hmac-sha2-512
```

Removing an SSH MAC

1. Enter configure terminal mode.

```
device#configure terminal
```

2. On the SSH server, enter the **no ssh server mac** command to set the SSH server MACs to default values.
3. Restart the SSH server using the **no ssh server shutdown** command.
4. On the SSH client, enter the **no ssh client mac** command to set the SSH server MACs to default values.

Configuring self-signed certificates for VXLAN gateways

Configures the self-signed certificates for VXLAN gateways

> ATTENTION
> To help ensure security, administrators are encouraged to use signature algorithms with cryptographic hash functions that are stronger than SHA-1, as are available in the SHA-2 family of algorithms.

This command is supported in logical chassis cluster mode only.

If a digest algorithm is not specified, the SHA-1 algorithm is used. The valid values are SHA1, SHA-256, and SHA256.

Only one certificate can be generated. Additional attempts result in an error.

Use the **show nsx-controller client-cert** command to verify the configuration.

During an upgrade from NOS 6.x.x or NOS 7.0.x, the existing (SHA-1) certificate is retained. To use an SHA-2 family certificate, the previous certificate must be deleted and either an SHA-256 or SHA 512 certificate must be generated. An SHA-2 family certificate is not retained following a downgrade to a release prior to NOS 7.1.0. Communication with the NSX controller is not affected.

1. Use the **nsx-controller client-cert** command to set the self-signed certificates for VXLAN gateways.

```
device# nsx-controller client-cert generate digest sha512
```

2. Use the **show nsx-controller client-cert** command to verify the configuration.

Removing self-signed certificates for VXLAN gateways

Use the **nsx-controller client-cert delete** command to remove the certificate.

1. Use the **ssh server cipher** 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 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. Enter global configuration mode.

   ```
   device# configure terminal
   ```

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 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.

   ```
   devioe(config)# do show running-config ssh server
   rbridge-id 176
   ssh server max-sessions 7
   ssh server key rsa 2048
   ssh server key ecdsa 256
   ssh server key dsa
   ```