# Dell SmartFabric OS10 and SmartFabric Services Security Configuration Guide

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DELL Technologies

## Notes, cautions, and warnings

**NOTE:** A NOTE indicates important information that helps you make better use of your product.

**CAUTION: A CAUTION indicates either potential damage to hardware or loss of data and tells you how to avoid the problem.**

**WARNING: A WARNING indicates a potential for property damage, personal injury, or death.**

# Contents

# 1

# Preface

This document provides a set of recommendations for securing switches that run Dell SmartFabric OS10 including the SmartFabric Services (SFS) mode. For detailed configuration, see the *Dell SmartFabric OS10 User Guide* and the *Dell SmartFabric Services User Guide*.

You can find Dell documentation at https://www.dell.com/support/home/en-us/product-support/product/dell-emc-smartfabric-os10/docs.

The recommendations that are provided in this document apply up to SmartFabric OS10 10.5.x and SmartFabric Services 10.5.x.

## Change history

The following table provides an overview of the changes to this guide from a previous version.

**Table 1. Change history**

| Revision | Description |
|---|---|
| A10 | Added the following topic: TCP and UDP port usage information. |
| A09 | Revamped the document. |
| A08 | Changed the document title from *Dell SmartFabric OS10 and SmartFabric Services Security Best Practice Guide* to *Dell SmartFabric OS10 and SmartFabric Services Security Configuration Guide*. Added STIG-related information. |
| A07 | Rebranded the document. |
| A06 | Revamped the document. |

## Typographical conventions

| | |
|---|---|
| **`Keyword`** | Keywords are in Courier font and must be entered in the CLI as listed. |
| ***parameter*** | Parameters are in italics and require a number or word to be entered in the CLI. |
| **{X}** | Keywords and parameters within braces must be entered in the CLI. |
| **[X]** | Keywords and parameters within brackets are optional. |
| **x\|y** | Keywords and parameters that are separated by a bar requires you to choose one option. |
| **x\|\|y** | Keywords and parameters that are separated by a double bar allows you to choose any or all the options. |

## SmartFabric OS10 and SFS

SmartFabric OS10 is a network operating system (NOS) supporting multiple architectures and environments. The SmartFabric OS10 solution allows multilayered disaggregation of network functionality. SmartFabric OS10 bundles industry-standard management, monitoring, and Layer 2 and Layer 3 networking stacks over CLI, SNMP, and REST interfaces. Users can choose their own third-party networking, monitoring, management, and orchestration applications. To develop scalable L2 and L3 networks, the SmartFabric OS10 delivers a modular and disaggregated solution in a single-binary image.

SFS is a SmartFabric OS10 feature that provides network fabric automation and API-based programming capabilities. SFS has different personalities that can be integrated with systems including VxRail, PowerScale, generic PowerEdge servers,

PowerStore, storage, and MX servers. SFS integrated with these solution-specific deployments delivers autonomous fabric deployment, expansion, and life cycle management.

**NOTE:** Unless stated otherwise, all configurations that are provided in this document are applicable to SFS as well.

**Topics:**



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# Document references

The following documents provide additional information:

## Related documentation

Following are the standard documents for SmartFabric OS10 releases. However, not all of them may be delivered for each release.

- *Dell SmartFabric OS10 User Guide*
- *Dell SmartFabric OS10 Installation, Upgrade, and Downgrade Guide*
- *Dell EMC SmartFabric OS10 System Log Message Reference Guide*
- *Dell EMC SmartFabric Services User Guide*

## Where to find product documentation

- https://www.dell.com/support
- https://www.dell.com/community

# Security resources

Use the following links to to access Dell Security resources.

- Dell SmartFabric OS10 User Guide

- Security Advisories and Notices

# Getting help

## Where to get support

The Support website https://www.dell.com/support provides access to product licensing, documentation, advisories, downloads, and how-to and troubleshooting information. The information can enable you to resolve a product issue before you contact Support.

To access a product-specific page:

1. Go to https://www.dell.com/support.
2. In the search box, type a product name, and then from the list that appears, select the product.

## Knowledgebase

The Knowledgebase contains applicable solutions that you can search for either by solution number (for example, KB000xxxxxx) or by keyword.

To search the Knowledgebase:

1. Go to https://www.dell.com/support.
2. On the **Support** tab, click **Knowledge Base**.
3. In the search box, type either the solution number or keywords. Optionally, you can limit the search to specific products by typing a product name in the search box, and then selecting the product from the list that appears.

## Live chat

To participate in a live interactive chat with a support agent:

1. Go to https://www.dell.com/support.
2. On the **Support** tab, click **Contact Support**.
3. On the **Contact Information** page, click the relevant support, and then proceed.

## Service requests

To obtain in-depth help from Licensing, submit a service request. To submit a service request:

1. Go to https://www.dell.com/support.
2. On the **Support** tab, click **Service Requests**.

   **NOTE:** To create a service request, you must have a valid support agreement. For details about either an account or obtaining a valid support agreement, contact a sales representative. To find the details of a service request, in the Service Request Number field, type the service request number, and then click the right arrow.

To review an open service request:

1. Go to https://www.dell.com/support.
2. On the **Support** tab, click **Service Requests**.
3. On the **Service Requests** page, under **Manage Your Service Requests**, click **View All Dell Service Requests**.

## Online communities

For peer contacts, conversations, and content on product support and solutions, go to the Community Network https://www.dell.com/community. Interactively engage with customers, partners, and certified professionals online.

## How to provide feedback

Feedback helps to improve the accuracy, organization, and overall quality of publications. Go to https://contentfeedback.dell.com/s to provide feedback.

# Reporting security vulnerabilities

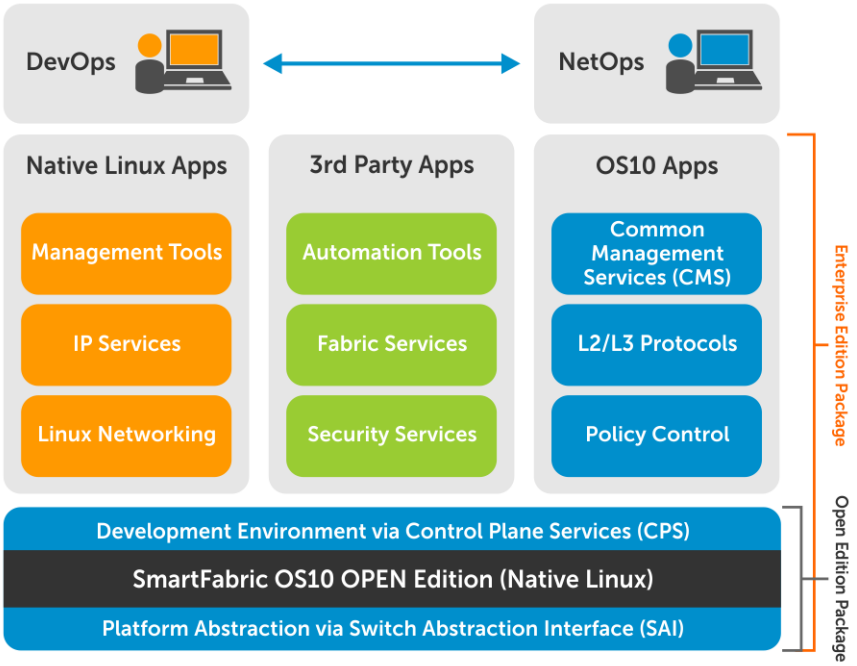
Dell takes reports of potential security vulnerabilities in our products very seriously. If you discover a security vulnerability, you are encouraged to report it to Dell immediately.

For the latest instructions on how to report a security issue to Dell, see the Dell Vulnerability Response Policy on the Dell.com site.

# 2

# Security Quick Reference

Dell SmartFabric OS10 is a network operating system (NOS) supporting multiple architectures and environments. The SmartFabric OS10 solution allows multi-layered disaggregation of network functionality. SmartFabric OS10 bundles industry-standard management, monitoring, and Layer 2 and Layer 3 networking stacks over CLI, SNMP, and REST interfaces. Users can choose their own third-party networking, monitoring, management, and orchestration applications. To develop scalable L2 and L3 networks, the SmartFabric OS10 delivers a modular and disaggregated solution in a single-binary image.



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# Product and Subsystem Security

Topics include:

**Topics:**



# Authentication

Learn about authentication in SmartFabric OS10 in this section. For AAA, see the *Authentication, authorization, and accounting* section.

## Login security settings

Login security includes login banners and failed login behavior.

### Login banner configuration

The system displays a message before and after a user logs in to the system. These messages can communicate legal rights to the user and assume consent to the usage policy by the user.

**Enable login banner**

The login banner is displayed to the user when the user attempts to log in to the system.

```
OS10(config)# banner login %
DellEMC S4148U-ON login
Enter your username and password
%
OS10(config)# exit
OS10# write memory
```

**Enable message of the day banner**

```
OS10(config)# banner motd %
DellEMC S4148U-ON login
Enter your username and password
%
OS10(config)# exit
OS10# write memory
```

### Failed login behavior

Configure the system to prevent the user from logging in to the system for a specific time after a specified number of failed login attempts.

```
OS10(config)# password-attributes max-retry number lockout-period minutes
OS10(config)# exit
OS10# write memory
```

- `max-retry number`—(Optional) Sets the maximum number of consecutive failed login attempts for a user before the user is locked out, from 0 to 16.
- `lockout-period minutes`—(Optional) Sets the amount of time that a user ID is prevented from accessing the system after exceeding the maximum number of failed login attempts, from 0 to 43,200.

# User and credential management

This section describes how to manage user accounts and credentials.

## Preloaded accounts

The following accounts are initialized during the installation of SmartFabric OS10:

- Sysadmin account: `admin`
- Linux shell user: `linuxadmin`

## Default credentials

The following are the default credentials for the preloaded accounts.

**Table 2. Default credentials**

| User account | Default password | Description |
|---|---|---|
| admin | admin | Default user with the `sysadmin` user role. |
| linuxadmin | linuxadmin | Default user to access the Linux shell. |

## Managing credentials

### Change the default CLI password

When you log in to the switch for the first time, the system prompts you to enter a username to enter the command-line interface. To log in to OS10 for the first time, enter `admin` as the username and the password. Change the default `admin` password after your first login to something secure or create at least one OS10 user with the `sysadmin` role and delete the default `admin` username. The system saves the new password for future logins. After you change the password using the CLI, use the `write memory` command to save the configuration.

```
OS10# configure terminal
% Error: ZTD is in progress(configuration is locked).
OS10# ztd cancel
OS10# configure terminal
OS10(config)# username admin password new-password role sysadmin
OS10(config)# exit
OS10# write memory
```

To delete the default `admin` username, log in to a different account with the `sysadmin` role, and do the following:

```
OS10(config)# no username admin
```

Use the following command to view the details of all users configured on the system:

```
OS10# show running-configuration users
```

### Change the default linuxadmin password

You use the Linux shell for troubleshooting and diagnostic purposes. After the first OS10 login, enter `linuxadmin` for both the default Linux shell username and password and change the default `linuxadmin` password. The system saves the new

password for future logins. After you change the password using the CLI, use the `write memory` command to save the configuration.

```
OS10# configure terminal
OS10(config)# system-user linuxadmin password {clear-text-password | hashed-password}
OS10(config)# exit
OS10# write memory
```

**Disable the linuxadmin account**

If you do not want your users to access the Linux shell, disable the `linuxadmin` account.

```
OS10(config)# system-user linuxadmin disable
OS10(config)# exit
OS10# write memory
```

**Disable access to Linux commands**

Even if you disable the `linuxadmin` user, users can access Linux commands using the `system` command. To disable access to Linux commands completely, use the `system-cli` command.

```
OS10(config)# system-cli disable
OS10(config)# exit
OS10# write memory
```

## Securing credentials

When the user views the running configuration, the password is displayed in an encrypted format. You can obscure passwords in `show` command outputs so that text characters do not display.

```
OS10(config)# service obscure-password
OS10(config)# exit
OS10# write memory
OS10# show running-configuration users
username admin password **** role sysadmin priv-lvl 15
username desk1 password **** role sysadmin priv-lvl 15
```

## Password complexity

Strict password rules ensure better security of the device.

**Enable strong passwords**

Strong passwords make it difficult to guess your passwords. By default, a strong password check is enabled on the system which checks if the password contains at least alphanumeric and special characters. If a strong password check is disabled, enable it.

```
OS10(config)# no service simple-password
OS10(config)# exit
OS10# write memory
```

**Check if strong password check is enabled**

By default, a strong password check is enabled on the system and the `no service simple-password` command is implicit in the running configuration. To verify if a strong password check is enabled, use the following command:

```
OS10(config)# do show running-configuration | grep simple
service simple-password
```

**Enforce custom password complexity**

By default, the password you configure must have at least nine characters with alphanumeric and special characters. To increase the password strength further, you can enforce a custom password complexity.

```
OS10(config)# password-attributes {[min-length number] [character-restriction {[upper
number] [lower number][numeric number] [special-char number]}}
```

```
OS10(config)# exit
OS10# write memory
```

- `min-length` *`number`*—(Optional) Sets the minimum number of required alphanumeric characters, from 6 to 32; default 9.
- `character-restriction`:
  - `upper` *`number`*—(Optional) Sets the minimum number of uppercase characters that are required, from 0 to 31; default 0.
  - `lower` *`number`*—(Optional) Sets the minimum number of lowercase characters that are required, from 0 to 31; default 0.
  - `numeric` *`number`*—(Optional) Sets the minimum number of numeric characters that are required, from 0 to 31; default 0.
  - `special-char` *`number`*—(Optional) Sets the minimum number of special characters that are required, from 0 to 31; default 0.

When choosing your password, Dell Technologies recommends that you use multiple and easy-to-remember common words in your password instead of using complex passwords which you may not remember. Combine multiple words that you can remember and modify the passphrase using special characters and numbers to get a final password. For example, instead of `correcthorsebatterystaple`, you can use `C0rr3c+h0r5e8atTerystapl3`.

**NOTE:** To recover a lost or forgotten OS10 username password, including the admin password, see Recover OS10 user name password.

# Authentication, authorization, and accounting

Authentication, authorization, and accounting (AAA) services secure networks against unauthorized access. AAA is a centralized means of access control to users who want to access the system.

### Enable AAA login authentication

Configuring AAA authentication with a fallback option provides resiliency while authentication. If one method fails, the system uses the other method of authentication.

```
OS10(config)# aaa authentication login {console | default} {local | group radius | group
tacacs+}
OS10(config)# exit
OS10# write memory
```

- `console`—Configure authentication methods for console logins.
- `default`—Configure authentication methods for SSH and Telnet logins.
- `local`—Use the local username, password, and role entries configured with the `username password role` command.
- `group radius`—Use the RADIUS servers configured with the `radius-server host` command.
- `group tacacs+`—Use the TACACS+ servers configured with the `tacacs-server host` command.

The authentication methods in the method list work in the order they are configured.

### Enable AAA re-authentication or enable mode

Prevent users from accessing resources, perform tasks that they are not authorized to perform, and require users to reauthenticate by logging in again when an authentication method or server changes.

```
OS10(config)# aaa re-authenticate enable
```

### Configure authorization

AAA command authorization controls user access to a set of commands assigned to users and is performed after user authentication. When enabled, AAA authorization checks a remote authorization server for each command that a user enters on the switch. If the commands that are entered by the user are configured in the remote server for that user, the remote server authorizes the usage of the command.

By default, the role you configure with the `username password role` command sets the level of CLI commands that a user can access.

An OS10 switch uses a list of authorization methods and the sequence in which they apply to determine the level of command authorization granted to a user. You can configure authorization methods with the `aaa authorization` command. By default, OS10 uses only the `local` authorization method. You can also configure TACACS+ server-based authorization.

The authorization methods in the method list run in the order that you configure them. Reenter the methods to change the order. The `local` authorization method remains enabled even if you remove all configured methods in the list using the `no aaa authorization` command.

- Enable authorization and configure the authorization methods for CLI access in CONFIGURATION mode. Reenter the command to configure additional authorization methods and CLI access.

```
aaa authorization {commands | config-commands | exec-commands} {role user-role}
{console | default} {[local] [group tacacs+]}
```

  - `commands` — Configure authorization for all CLI commands, including all EXEC and configuration commands.
  - `config-commands` — Configure authorization only for configuration commands.
  - `exec-commands` — Configure authorization only for EXEC commands.
  - `role user-role` — Configure command authorization for a user role: `sysadmin`, `secadmin`, `netadmin`, or `netoperator`.
  - `console` — Configure authorization for console-entered commands.
  - `default` — Configure authorization for nonconsole-entered commands and commands that are entered in nonconsole sessions, such as in SSH and VTY.
  - `local` — Use the local username, password, and role entries configured with the `username password role` command for command authorization.
  - `group tacacs+` — Use the TACACS+ servers that are configured with the `tacacs-server host` command for command authorization.

**NOTE:** Custom user roles are supported, but the custom privilege levels are not supported. The default privilege level based on the user role is assigned.

For detailed information about how to configure vendor-specific attributes on a security server, see the respective RADIUS or TACACS+ server documentation.

**Examples: AAA authorization**

- All commands that are entered from a console session with the `sysadmin` user role are authorized using configured TACACS+ servers first, and local user credentials next, if TACACS+ servers are not reachable or configured.

```
OS10(config)# aaa authorization commands role sysadmin console group tacacs+ local
```

- All configuration commands that are entered from a nonconsole session with the `sysadmin` user role are authorized using the configured TACACS+ servers.

```
OS10(config)# aaa authorization config-commands role sysadmin default group tacacs+
```

**Remove AAA authorization methods**

```
OS10(config)# no aaa authorization commands role sysadmin console
```

**Enable AAA accounting for commands**

AAA accounting for commands records login and command information about console connections and remote connections, such as Telnet and SSH.

```
OS10(config)# aaa accounting commands all {console | default} {start-stop | stop-only |
none} [logging] [group tacacs+]
OS10(config)# exit
OS10# write memory
```

- `commands all`—Record all user-entered commands. RADIUS accounting does not support this option.
- `console`—Record all user authentication and logins or all user-entered commands in OS10 sessions on console connections.
- `default`—Record all user authentication and logins or all user-entered commands in OS10 sessions on remote connections; for example, Telnet and SSH.
- `start-stop`—Send a start notice when a process begins, and a stop notice when the process ends.
- `stop-only`—Send only a stop notice when a process ends.
- `none`—No accounting notices are sent.
- `logging`—Logs all accounting notices in syslog.
- `group tacacs+`—Logs all accounting notices on the first reachable TACACS+ server.

**Enable AAA accounting for authentication events**

```
OS10(config)# aaa accounting exec {console | default} {start-stop | stop-only | none}
[logging] [group tacacs+]
OS10(config)# exit
OS10# write memory
```

- `console`—Record all user authentication and logins or all user-entered commands in OS10 sessions on console connections.
- `default`—Record all user authentication and logins or all user-entered commands in OS10 sessions on remote connections; for example, Telnet and SSH.
- `start-stop`—Send a start notice when a process begins, and a stop notice when the process ends.
- `stop-only`—Send only a stop notice when a process ends.
- `none`—No accounting notices are sent.
- `logging`—Logs all accounting notices in syslog.
- `group tacacs+`—Logs all accounting notices on the first reachable TACACS+ server.

The authentication methods in the method list work in the order they are configured.

## Privilege and Role-Based Access Control

Role-based access control (RBAC) provides control for access and authorization. Users are granted permissions based on defined roles. Create user roles based on job functions to allow users appropriate system access. A user can be assigned only a single role, and many users can have the same role. A user role authenticates and authorizes a user at login.

**Default roles**

The following are the default roles on the system:

- `sysadmin`—Full access to all commands in the system, exclusive access to commands that manipulate the file system, and access to the system shell. A system administrator can create user IDs and user roles.
- `secadmin`—Full access to configuration commands that set security policy and system access, such as password strength, AAA authorization, and cryptographic keys. A security administrator can display security information, such as cryptographic keys, login statistics, and log information.
- `netadmin`—Full access to configuration commands that manage traffic flowing through the switch, such as routes, interfaces, and ACLs. A network administrator cannot access configuration commands for security features or view security information.
- `netoperator`—Access to EXEC mode to view the system status. A network operator cannot access the `show running-configuration` or `show startup-configuration` commands or modify configuration settings on a switch.

**Configuring roles**

Controlling terminal access to a switch is one method of securing the device and network. To increase security, you can limit user access to a subset of commands using privilege levels.

- Create privilege levels in CONFIGURATION mode.

  ```
  OS10(config)# privilege mode priv-lvl privilege-level command-string
  ```

  - *mode*—Enter the privilege mode used to access CLI modes:
    - `exec`—Accesses EXEC mode.
    - `configure`—Accesses class-map, DHCP, logging, monitor, OpenFlow, policy-map, QOS, support-assist, telemetry, CoS, Tmap, UFD, VLT, VN, VRF, WRED, and alias modes.
    - `interface`—Accesses Ethernet, fibre-channel, loopback, management, null, port-group, lag, breakout, range, port channel, and VLAN modes.
    - `route-map`—Accesses route-map mode.
    - `router`—Accesses `router-bgp` and `router-ospf` modes.
    - `line`—Accesses line-vty mode.
  - `priv-lvl` *privilege-level*—Enter the number of a privilege level, from 2 to 14.
  - *command-string*—Enter the commands supported at the privilege level.
- Create a username, password, assign a role, and assign a privilege level in CONFIGURATION mode.

  ```
  OS10(config)# username username password password role role priv-lvl privilege-level
  ```

- `username username`—Enter a text string; 32 alphanumeric characters maximum; one character minimum.
- `password password`—Enter a text string; 32 alphanumeric characters maximum, nine characters minimum.
- `role role`—Enter a user role.
- `priv-lvl privilege-level`—Enter a privilege level, from 0 to 15.
  - Level 0—Provides users the least privilege, restricting access to basic commands.
  - Level 1—Provides access to a set of show commands and certain operations such as ping, traceroute, and so on.
  - Level 15—Provides access to all available commands, equivalent to the commands permitted with the `sysadmin` role.
  - Levels 0, 1, and 15—System configured privilege levels with a predefined command set.
  - Levels 2 to 14—Not configured. You can customize these levels for different users and access rights.

- Configure an enable password for each privilege level in CONFIGURATION mode. Use the `enable password` command to switch between privilege levels and access the commands that are supported at each level.

```
OS10(config)# enable password encryption-type password-string priv-lvl privilege-level
OS10(config)# exit
OS10# write memory
```

  - `encryption-type`—Enter an encryption type for the password entry:
    - `0`—Use plain text with no password encryption.
    - `sha-256`—Encrypt the password using the SHA-256 algorithm.
    - `sha-512`—Encrypt the password using the SHA-512 algorithm.

    **NOTE:** Ensure that you use either `sha-256` or `sha512` encryption for your passwords.
  - `priv-lvl privilege-level`—Enter a privilege level, from 1 to 15.

**NOTE:** Use SHA-256 or SHA-512 for password encryption.

```
OS10(config)# privilege exec priv-lvl 12 "show version"
OS10(config)# privilege exec priv-lvl 12 "configure terminal"
OS10(config)# privilege configure priv-lvl 12 "interface ethernet"
OS10(config)# privilege interface priv-lvl 12 "ip address"
OS10(config)# username delluser password $6$Yij02Phe2n6whp7b$ladskj0HowijIlkajg981 role
secadmin priv-lvl 12
OS10(config)# enable password sha-256 $5$2uThib1o$84p.tykjmz/w7j26ymoKBjrb7uepkUB priv-
lvl 12
OS10(config)# exit
OS10# write memory
```

#### View users and their roles

The following shows the users that are configured on the local system, their roles, and the assigned privilege levels:

```
OS10# show running-configuration users
username admin password $6$q9QBeYjZ$jfxzVqGhkxX3smxJSH9DDz7/3OJc6m5wjF8nnLD7/
VKx8SloIhp4NoGZs0I/UNwh8WVuxwfd9q4pWIgNs5BKH. role sysadmin priv-lvl 15
OS10# show running-configuration userrole
```

#### Configure user role on server

If a console user logs in with RADIUS or TACACS+ authentication, the role you configured for the user on the RADIUS or TACACS+ server applies. User authentication fails if no role is configured on the authentication server.

To authenticate a user on OS10 through a TACACS+ server, configure the mandatory role with a value.

## Configure remote authentication

This section describes how to configure remote authentication on the system.

#### Configure RADIUS authentication

Traditional RADIUS-based user authentication runs over UDP and uses the MD5 message-digest algorithm for secure communications. To provide enhanced security in RADIUS user authentication exchanges, RFC 6614 defines the RADIUS over

Transport Layer Security (TLS) protocol. RADIUS over TLS secures the entire authentication exchange in a TLS connection and provides additional security.

```
OS10(config)# radius-server host {hostname | ip-address} tls security-profile profile-
name [auth-port port-number] key {0 authentication-key | 9 authentication-key |
authentication-key}
OS10(config)# exit
OS10# write memory
```

- *hostname*—Enter the hostname of the RADIUS server.
- *ip-address*—Enter the IPv4 (A.B.C.D) or IPv6 (x:x:x:x::x) address of the RADIUS server.
- `tls security-profile` *profile-name*—Enter the security profile to use the X.509v3 certificate on the switch to use for TLS authentication with a RADIUS server.
- `key 0` *authentication-key*—Enter an authentication key in plain text. A maximum of 42 characters.
- `key 9` *authentication-key*—Enter an authentication key in encrypted format. A maximum of 128 characters.
- *authentication-key*—Enter an authentication in plain text. A maximum of 42 characters. It is not necessary to enter `0` before the key.
- `auth-port` *port-number*—(Optional) Enter the UDP port number used on the server for authentication, from 0 to 65535, default 1812.
- `key` *authentication-key*—(Optional) Enter the authentication key to authenticate the device on the server. A maximum of 42 characters; default `radius_secure`.

**Configure RADIUS authentication retries**

Configure the number of times OS10 retransmits a RADIUS authentication request. To avoid unnecessary retries, configure a lower value.

```
OS10(config)# radius-server retransmit retries
OS10(config)# exit
OS10# write memory
```

*retries*—Enter the number of retry attempts, from 0 to 100.

**Configure TACACS+ authentication**

Configure the global timeout used to wait for an authentication response from TACACS+ servers. To avoid long waiting, configure a lower value.

```
OS10(config)# tacacs-server host {hostname | ip-address} key {0 authentication-key | 9
authentication-key | authentication-key} [auth-port port-number]
OS10(config)# exit
OS10# write memory
```

- *hostname*—Enter the hostname of the RADIUS server.
- *ip-address*—Enter the IPv4 (A.B.C.D) or IPv6 (x:x:x:x::x) address of the RADIUS server.
- `0` *authentication-key*—Enter an authentication key in plain text. A maximum of 42 characters.
- `9` *authentication-key*—Enter an authentication key in encrypted format. A maximum of 128 characters.
- *authentication-key*—Enter an authentication in plain text. A maximum of 42 characters. It is not necessary to enter `0` before the key.
- `auth-port` *port-number*—(Optional) Enter the UDP port number used on the server for authentication, from 0 to 65535, default 1812.
- *authentication-key*—(Optional) Enter the authentication key used to authenticate the switch on the server. A maximum of 42 characters; default `radius_secure`.

**Configure TACACS+ authentication response timer**

Configure the global timeout used to wait for an authentication response from TACACS+ servers. To avoid long waiting, configure a lower value.

```
OS10(config)# tacacs-server timeout seconds
OS10(config)# exit
OS10# write memory
```

*seconds*—Enter the timeout period used to wait for an authentication response from a TACACS+ server, from 1 to 1000 seconds.

**View what authentication method is configured**

To view what authentication method is configured on the system use the following command:

```
OS10# show running-configuration aaa
aaa authentication login default group radius local
aaa authentication login console local
```

# Network security

SmartFabric OS10 security includes the security of networked subsystems and interfaces.

## Network exposure

The following section provides information on network exposure.

## Network separation using VRF

VRF is a Layer 3 technology that allows a routing device to maintain multiple and distinct routing tables on the same device. Devices in different VRFs cannot communicate with each other and hence provides network separation.

**Services that are supported for VRF**

You can enable various services in both management and default VRF instances. The services that are supported in the management and default VRF instances are:

**Table 3. Services supported**

| Application | Management VRF | Default VRF | Nondefault VRF |
|---|---|---|---|
| BGP | No | Yes | Yes |
| COPP ACL | Yes | Yes | No |
| DHCP client | Yes | Yes | Yes |
| DHCP relay | No | Yes | Yes |
| DHCP server | No | Yes | No |
| DNS client | Yes | Yes | Yes |
| FTP client | Yes | Yes | Yes |
| HTTP client | Yes | Yes | Yes |
| HTTP server | No | Yes | No |
| ICMP/Ping | Yes | Yes | Yes |
| NTP client | Yes | Yes | Yes |
| NTP server | Yes | Yes | Yes |
| OSPFV2 /OSPFV3 | No | Yes | Yes |
| RADIUS server | Yes | Yes | Yes |
| SCP client | Yes | Yes | Yes |
| sFlow | Yes | Yes | Yes |
| SFTP | Yes | Yes | Yes |
| SNMP server | Yes | Yes | No |
| SNMP traps | Yes | Yes | No |
| SSH server | Yes | Yes | Yes |

**Table 3. Services supported (continued)**

| Application | Management VRF | Default VRF | Nondefault VRF |
|---|---|---|---|
| Syslog | Yes | Yes | Yes |
| TACACS+ server | Yes | Yes | Yes |
| Telnet server | Yes | Yes | Yes |
| TFTP client | Yes | Yes | Yes |
| Traceroute | Yes | Yes | Yes |
| VLT backup link | Yes | Yes | No |
| VRRP | Yes | Yes | Yes |

For information about configuring the management VRF, default, and nondefault VRFs, see the *Dell SmartFabric OS10 User Guide*.

# Communication Security Settings

Using authentication for routing protocols prevents unauthorized users from corrupting your routing table.

**Configure BGP authentication if BGP is used**

Configure BGP, and secure the session with a password on both BGP peers. When you configure MD5 authentication between two BGP peers, each segment of the TCP connection is verified and the MD5 digest is checked on every segment that is sent on the TCP connection.

```
OS10(conf-router-neighbor)# password {9 encrypted-password-string | password-string}
OS10(conf-router-neighbor)# end
OS10# write memory
```

- `9 encrypted-password-string`—Enter 9 and then the encrypted password.
- `password-string`—Enter a password for authentication. A maximum of 128 characters are supported.

**View what BGP neighbor authentication is enabled**

Use the following to view what BGP neighbor authentication is enabled on the system:

```
OS10# show running-configuration bgp
!
router bgp 100
 !
 neighbor 1.1.1.1
  password 9 9ee88a6225a049667a2e5294d8b0808c2ac2141a2930c06e431bf40cfcf685b1
....
```

**Configure OSPF authentication if OSPF is used**

Configure OSPF, and secure the session with a password on both OSPF peers.

```
OS10(conf-if-eth1/1/1)# ip ospf message-digest-key 2 md5 password
OS10(conf-if-eth1/1/1)# end
OS10# write memory
```

**View what OSPF neighbor authentication is enabled**

Use the following to view what OSPF neighbor authentication is enabled on the system:

```
OS10# show running-configuration ospf
!
ip ospf 100 area 0.0.0.0
ip ospf message-digest-key 2 md5 sample12345
...
```

**Disable proxy ARP**

Proxy ARP is a technique that network devices use to acquire the MAC address of a device which is not present in the network on behalf of other devices. DoS attacks are possible with misconfigured network devices.

```
OS10(config)# interface interface-name
OS10(conf-if-eth1/1/1)# no ip proxy-arp
OS10(conf-if-eth1/1/1)# end
OS10# write memory
```

## NTP rules

Network Time Protocol (NTP) synchronizes timekeeping among a set of distributed time servers and clients and coordinates time distribution in a large, diverse network. NTP clients synchronize with NTP servers that provide accurate time measurement.

**Configure trusted NTP server**

Configure the system to synchronize time from a trusted NTP server.

```
OS10(config)# ntp server ntp1-server-ip-address
OS10(config)# exit
OS10# write memory
```

*ntp1-server-ip-address*—Enter the IPv4 address in A.B.C.D format or IPv6 address in A::B format of the NTP server.

**Configure trusted secondary NTP server**

Configure the system to synchronize time from a trusted secondary NTP server.

```
OS10(config)# ntp server ntp2-server-ip-address
OS10(config)# exit
OS10# write memory
```

*ntp1-server-ip-address*—Enter the IPv4 address in A.B.C.D format or IPv6 address in A::B format of the NTP server.

**Configure NTP authentication**

NTP authentication and the corresponding trusted key provide a reliable exchange of NTP packets with trusted time sources. NTP authentication uses the message digest 5 (MD5) algorithm. The key is embedded in the synchronization packet that is sent to an NTP time source.

```
OS10(config)# ntp authentication-key number {sha1 | sha2-256} key
OS10(config)# ntp master {2-10}
OS10(config)# exit
OS10# write memory
```

- *number*—Enter the authentication key number, from 1 to 4294967295.
- sha1—Set to SHA1 encryption.
- sha2-256—Set to sha2-256 encryption.

**View what NTP authentication is used**

Use the following to view what NTP authentication is configured on the system:

```
OS10# show running-configuration ntp
!
ntp authenticate
ntp authentication-key 345 md5 0 5A60910FED211F02
ntp server 1.1.1.1 key 345
ntp trusted-key 345
ntp master 7
...
```

# Firewall settings

This section provides various configuration procedures to harden the switch.

## Access rules

Configure secure access rules.

**Enable only SSH for remote system access**

By default, in OS10, SSH is the only protocol that is enabled for remote system access. As the Telnet protocol is not secure, Dell Technologies recommends that you do not enable the Telnet server.

**NOTE:** If you have disabled the SSH server, reenable it and disable the Telnet server. Always use SSH for remote system access.

```
OS10(config)# ip ssh server enable
OS10(config)# ip ssh server max-auth-tries 4
OS10(config)# no ip telnet server enable
OS10(config)# exit
OS10# write memory
```

**Enable SSH access control**

Filter SSH connections to the switch using an access list.

```
OS10(config)# ip access-list permit10
OS10(config-ipv4-acl)# permit ip 172.16.0.0 255.255.0.0 any
OS10(config-ipv4-acl)# exit
OS10(config)# line vty
OS10(config-line-vty)# ip access-class permit10
OS10(config-line-vty)# exit
OS10(config)# exit
OS10# write memory
```

**Configure EXEC session timeout**

By default, there is no EXEC timeout configured. To prevent unauthorized access to the EXEC mode, configure a timeout interval.

```
OS10(config)# exec-timeout timeout-value
OS10(config)# exit
OS10# write memory
```

*timeout-value*—Specify the number of seconds of inactivity on the system before disconnecting the current session (0 to 3600).

**Limit concurrent login sessions**

To avoid an unlimited number of active sessions on a switch for the same user ID, limit the number of console and remote connections.

```
OS10(config)# login concurrent-session limit-number
OS10(config)# exit
OS10# write memory
```

*limit-number*—Specify the number of concurrent sessions that any user can have on the console or virtual terminal lines (1 to 12).

**Ensure user lockout**

Configure the system to prevent the user from logging in to the system for a specific time after a specified number of failed login attempts.

```
OS10(config)# password-attributes max-retry number lockout-period minutes
OS10(config)# exit
OS10# write memory
```

- `max-retry number`—(Optional) Sets the maximum number of consecutive failed login attempts for a user before the user is locked out, from 0 to 16.
- `lockout-period minutes`—(Optional) Sets the amount of time that a user ID is prevented from accessing the system after exceeding the maximum number of failed login attempts, from 0 to 43,200.

**Enable login statistics**

Enable login statistics to view user login information, including the number of successful and failed logins, role changes, and the last time a user logged in, displays after a successful login. After enabling login statistics, you can use the `show login statistics {all | user}` command to view user login information.

```
OS10(config)# login-statistics enable
OS10(config)# exit
OS10# write memory
```

## Loopback rules

Lookback interfaces are virtual interfaces and unlike physical interfaces, loopback interfaces do not go down unless they are manually removed. This property provides security and consistency for device identification and stability.

**Configure a loopback interface**

Configure a loopback interface which can be used for system multiple services.

```
OS10(config)# interface loopback 0
OS10(config)# exit
OS10# write memory
```

**Remove multiple loopback interfaces**

Ensure that there is not more than one loopback interface configured.

```
OS10(config)# no interface loopback loopback-instance
OS10(config)# exit
OS10# write memory
```

**Bind AAA services to a loopback interface**

AAA services are bound to a loopback interface so that the AAA services are not interrupted.

```
OS10(config)# ip tacacs source-interface loopback 0
OS10(config)# exit
OS10# write memory
```

**Bind the NTP service to a loopback interface**

The NTP service is bound to a loopback interface so that the AAA services are not interrupted.

```
OS10(config)# ntp source loopback 0
OS10(config)# exit
OS10# write memory
```

## Restrict access to the CPU

Use control-plane ACLs to selectively restrict packets that are destined to the CPU, hence preventing flooding and DoS attacks.

```
OS10# configure terminal
OS10(config)# control-plane
OS10(config-control-plane)# ip access-group acl_name in
OS10(config-control-plane)# end
OS10# write memory
```

**NOTE:** Define the necessary ACL rules before applying to the control plane.

## Data plane rules

The data plane is part of the network that carries user traffic. Data plane rules include services and settings that affect user data. Apply these rules on border-filtering devices that connect internal networks to external networks, such as the Internet.

**Forbid private source addresses from external networks**

Private IP addresses are meant to be used in internal networks, such as networks that connect workstations, printers, DMZ, and so on. These IP addresses are not routed to the Internet which uses public IP addresses. A private IP address originating from the Internet is mostly an attack. Configure ACL rules to deny any traffic from the external network that has a source address that should reside on the internal network, and apply them on the interface that connect to an external network.

**CAUTION: Verify that multicast is not in use before blocking an address range.**

```
OS10(config)# ip access-list deny-private-external
OS10(config-ipv4-acl)# deny ip source-ip-address mask any log
OS10(config-ipv4-acl)# end
OS10# write memory
```

**Forbid external source addresses on outbound traffic**

Ensure that the outbound traffic carries only valid internal addresses of the IP address range of your organization.

```
OS10(config)# ip access-list deny-source-external
OS10(config-ipv4-acl)# permit ip internal-ip-address mask any
OS10(config-ipv4-acl)# exit
OS10(config)# interface ethernet 1/1/1
OS10(conf-if-eth1/1/1)# ip access-group deny-source-external in
OS10(conf-if-eth1/1/1)# end
OS10# write memory
```

## Port security

Use the port security feature to restrict the number of workstations that can send traffic through an interface and to control MAC address movement. Port security is a package of the following sub features that provide added security to the system:

1. MAC address learning limit (MLL)
2. Sticky MAC
3. MAC address movement control

**Configure the MAC address learning limit**

Using the MAC address learning limit method, you can set an upper limit on the number of allowed MAC addresses on an interface. Limiting the MAC addresses protects switches from MAC address flooding attacks. After the configured limit is reached on an interface, by default, the system drops all traffic from any unknown device. After you enable port security on an interface, the interface can learn one secure MAC address by default. This limit is applicable for both secure dynamic and secure static MAC addresses.

1. Enable port security on the system in CONFIGURATION mode.

   ```
   OS10(config)# switchport port-security
   ```

2. Enable port security on an interface in CONFIGURATION mode.

   ```
   OS10(config)# switchport port-security
   OS10(config)# no disable
   ```

3. Configure the number of secure MAC addresses that an interface can learn in INTERFACE PORT SECURITY mode:

   ```
   mac-learn {limit | no-limit}
   ```

   For the `limit` keyword, the range is from 0 to 3072. To enable the interface to learn the maximum number of MAC addresses that the hardware supports, use the `no-limit` keyword.

**MAC address learning limit example**

```
OS10# configure terminal
OS10(config)#interface ethernet 1/1/1
OS10(config-if-eth1/1/1)# switchport port-security
OS10(config-if-port-sec)# no disable
OS10(config-if-port-sec)# mac-learn limit 100
OS10(config-if-port-sec)# end
OS10# write memory
```

**Configure MAC address learning limit violation actions**

After the number of secure MAC addresses reaches the maximum configured, if an interface receives a frame with the source MAC address different from any of the learned MAC addresses, the system considers this as a MAC address learning limit violation.

Use the following commands in INTERFACE PORT SECURITY mode:

- To display which MAC address causes a violation, use the `log` option. The system also drops the packet.

  ```
  OS10(config-if-port-sec)#mac-learn limit violation log
  ```

- To drop the packet when a MAC address learning limit violation occurs, use the `drop` option.

  ```
  OS10(config-if-port-sec)#mac-learn limit violation drop
  ```

- To forward the packet when a MAC address learning limit violation occurs, use the `flood` option. The system does not learn the MAC address.

  ```
  OS10(config-if-port-sec)#mac-learn limit violation forward
  ```

- To shut down an interface on a MAC address learning limit violation, use the `shutdown` option.

  ```
  OS10(config-if-port-sec)#mac-learn limit violation shutdown
  ```

**MAC address learning limit violation actions configuration example**

```
OS10# configure terminal
OS10(config)# interface ethernet 1/1/1
OS10(config-if-eth1/1/1)# switchport port-security
OS10(config-if-port-sec)# no disable
OS10(config-if-port-sec)# mac-learn limit 100
OS10(config-if-port-sec)# mac-learn limit violation shutdown
OS10(config-if-port-sec)# end
OS10# write memory
```

**Configure sticky MAC addresses**

When you reload the system, port security removes the dynamically learned secure MAC addresses. You can use the sticky feature to make the dynamically learned secure MAC addresses persist even after a system reboot so that the interface does not have to learn these MAC addresses again.

Enter the following command in INTERFACE PORT SECURITY mode:

```
sticky
```

**NOTE:** Before enabling sticky MAC address learning, ensure that you restrict the number of MAC addresses that an interface can learn using the `mac-learn limit` command.

**Sticky MAC addresses configuration example**

```
OS10# configure terminal
OS10(config)#interface ethernet 1/1/1
OS10(config-if-eth1/1/1)#switchport port-security
OS10(config-if-port-sec)#no disable
OS10(config-if-port-sec)#mac-learn limit 100
OS10(config-if-port-sec)#sticky
OS10(config-if-port-sec)# end
OS10# write memory
```

#### MAC address movement

A MAC address movement happens when the system detects the same MAC address on an interface which it has already learned through another port security-enabled interface on the same broadcast domain. MAC address movement is not allowed for secure static and sticky MAC addresses. By default, MAC address movement for dynamically-learned MAC address is disabled on the system. Secure dynamic MAC address movement is allowed between port-security-enabled and port-security-disabled interfaces.

Use the following command in INTERFACE PORT SECURITY mode:

```
OS10(config-if-port-sec)#mac-move allow
OS10(config-if-port-sec)# end
OS10# write memory
```

#### MAC address movement configuration example

```
OS10# configure terminal
OS10(config)# interface ethernet 1/1/1
OS10(config-if-eth1/1/1)# switchport port-security
OS10(config-if-port-sec)# no disable
OS10(config-if-port-sec)# mac-learn limit 100
OS10(config-if-port-sec)# mac-move allow
OS10(config-if-port-sec)# end
OS10# write memory
```

#### Configure MAC address movement violation actions

If the system detects the same MAC address in a port-security-enabled interface which it has already learned through another port-security-enabled interface, by default, the system considers this as a MAC address move violation. You can configure MAC address move violation actions. You can also configure the system to permit MAC address movement across port security-enabled interfaces.

- To display which MAC address causes a violation, use the `log` option. The system also drops the packet.

  ```
  OS10(config-if-port-sec)#mac-move violation log
  ```

- To drop the packet when a MAC address movement violation occurs, use the `drop` option.

  ```
  OS10(config-if-port-sec)#mac-move violation drop
  ```

- To shut down the original interface that learned the MAC address on a MAC movement violation, use the `shutdown-original` option.

  ```
  OS10(config-if-port-sec)#mac-move violation shutdown-original
  ```

- To shut down the interface that detected a MAC address that is already learned by another interface, use the `shutdown-offending` option.

  ```
  OS10(config-if-port-sec)#mac-move violation shutdown-offending
  ```

- To shut down both original and offending interfaces, use the `shutdown-both` option.

  ```
  OS10(config-if-port-sec)#mac-move violation shutdown-both
  ```

#### Verify what port security features are enabled and running

Use the following command to verify if the port security is enabled on all interfaces. This command also shows information about the status of port security features. Specify specific interfaces to view details about individual interfaces.

```
OS10# show switchport port-security interface ethernet 1/1/1
Global Port-security status       : Enabled

Interface name                    : ethernet1/1/1

Port Security                     : Enabled
Port Status                       : Up
Mac learn limit                   : 100
MAC-learn-limit-Violation action  : Log
Sticky                            : Disabled
Mac-move-allow                    : Not Allowed
Mac-move-violation action         : shutdown-both
```

```
Aging                              : Enabled
Total MAC Addresses                : 10
Secure static MAC Addresses        : 0
Sticky MAC Addresses               : 10
Secure Dynamic MAC addresses       : 0
```

# TCP and UDP port usage information

This section provides details of TCP and UDP ports that each protocol uses on SmartFabric OS10 switches.

## Inbound port usage

SmartFabric OS10 provides the following network-based services and applications that listen on TCP and UDP ports.

**Table 4. Inbound port usage**

| Service/application | Port | Description |
|---|---|---|
| sssd | TCP/22 | Allows SSH access to the switch. Enabled by default on all interfaces. |
| telnet | TCP/23 | Allows Telnet access to the switch. Enabled on all interfaces. |
| DHCP | UDP/67 | OS10 switch accepts connections when configured as DHCP server. Enabled on all interfaces. |
| DHCP | UDP/68 | DHCP client listens on this port. Enabled on all interfaces. |
| NTP | UDP/UDP6/123 | When the OS10 switch acts as NTP server or client, it listens on this port. |
| snmpd | UDP/UDP6/161 | SNMP agent listens on this port. Enabled by default on all interfaces. |
| BGP | TCP/TCP6/179 | BGP process listens on this port. Enabled only when BGP is configured on the switch. Enabled on the interfaces for which BGP is configured. |
| nginx:master | TCP/TCP6/443 | HTTPS server listens on this port for incoming connections when REST is enabled or SmartFabric mode is configured. Enabled on all interfaces. |
| netconf server | TCP/830 | The netconf server listens on this port, only local connections. Enabled by default. |
| dhcrelay | UDP/8029 | OS10 switch relays the DHCP requests to the server when the DHCP relay is configured. Enabled on all interfaces. |
| SFS cluster image upgrade | TCP/8282 | SmartFabric Services (SFS) leader or master node listens on this port and provides service for the other nodes to download the image. |
| cps-rdbsd | TCP6/54320 | Control Plane Services (CPS) Remote Database Service daemon listens on this port. |
| zmq-bind-proxyd | TCP6/54321 | Zmqc listens on this port for peer nodes communication. This is limited to the VLANs required for VLT or SFS nodes |

**Table 4. Inbound port usage (continued)**

| Service/application | Port | Description |
|---|---|---|
| | | communication when it is configured on the switch. |

## Outbound port usage

SmartFabric OS10 provides the following network-based client applications that use TCP and UDP ports on external servers.

**Table 5. Outbound port usage**

| Service/application | Port | Description |
|---|---|---|
| ftp client | TCP/20/21 | Used to get images from the remote server when used for image install. |
| ssh client | TCP/22 | Used to get images from the remote server when used for image install or to do an SSH session to the remote server. |
| sftp client | TCP/22 | Used to get images from the remote server when used for image installation. |
| telnet client | TCP/23 | Used when a Telnet session to a remote server is started from the OS10 switch. |
| tacacs client | TCP/49 | Used to authenticate the user credentials when a RADIUS server is configured to authenticate. |
| dns client | UDP/53 | Used for resolution of host names. |
| tftp client | UDP/69 | Used to get images from the remote server when used for image installation. |
| curl/http client | http/80 | Used to get images from the remote server when used for image installation or to do a curl command to the remote server. |
| snmp | UDP/161 | Send traps from the SNMP agent to the SNMP manager. You must enable traps for the OS10 switch to send it. |
| bgp | TCP/179 | Used to communicate to the BGP peers when BGP is configured on the OS10 switch. |
| https client | TCP/TCP6/443 | Used to get images from the remote server when used for image installation or do a HTTPs session to the remote server. |
| dhcpv6 relay | UDP6/547 | The DHCPv6 relay process listens on this port. |
| radius client | UDP/1812,1813 | Used for RADIUS authentication and authorization communication. |
| RADIUS Over TLS | TCP/2083 | Used to communicate with RADIUS server over TLS. |

## Other network services

SmartFabric OS10 provides the following network-based applications that use other protocols.

**Table 6. Port usage of other network services**

| Service/application | Network protocol | Description |
|---|---|---|
| LLDP | LLDP | Link Layer Discovery Protocol (LLDP) is a L2 protocol that is used to discover nodes in the network. |
| LACP | LACP | Link Aggregation Control Protocol (LACP) is a L2 protocol that is used to aggregate Ethernet interfaces. |
| PNAC(802.1x) | EAPOL | Extensible Authentication Protocol over LAN (EAPoL) is a L2 protocol that is used for client authentication on switch ports. EAPoL packets are L2 packets. |
| OSPF | IP | Open Shortest Path First (OSPF) packets are encapsulated in IP with protocol 89. |

# Cryptography

This section provides information about cryptography.

## X.509v3 certificates

OS10 supports X.509v3 certificates to secure communications between the switch and a host, such as a RADIUS server. Both the switch and the server exchange a public key in a signed X.509v3 certificate that is issued by a certificate authority (CA) to authenticate each other. The certificate authority uses its private key to sign host certificates.

### Generate a certificate signing request and private key

To use X.509v3 certificates for secure communication and user authentication on OS10 switches in a network, a public key infrastructure (PKI) with a certificate authority (CA) is required. The CA signs certificates that prove the trustworthiness of network devices.

- Create a private key and a CSR in EXEC mode. Store the CSR file in the home directory or *flash:* so that you can later copy it to a CA server. Specify a *keypath* to store the *device.key* file in a secure persistent location, such as the home directory, or use the *private* option to store the key file in a private hidden location in the internal file system that is not visible to users.

  ```
  OS10# crypto cert generate request cert-file cert-path key-file {private | keypath}
  country 2-letter code state state locality city organization organization-name
  orgunit unit-name cname common-name email email-address validity days length length
  altname alt-name]
  ```

  - `request`—Create a certificate signing request to copy to a CA.
  - `cert-file cert-path`—(Optional) Enter the local path where the self-signed certificate or CSR is stored. You can enter a full path or a relative path, for example, `flash://certs/s4810-001-request.csr` or `usb://s4810-001.crt`. If you do not enter the `cert-file` option, the system interactively prompts you to enter the remaining fields of the certificate signing request. Export the CSR to a CA using the `copy` command.
  - `key-file {key-path | private}`—Enter the local path where the downloaded or locally generated private key is stored. If the key was downloaded to a remote server, enter the server path using a secure method, such as HTTPS, SCP, or SFTP. Enter `private` to store the key in a local hidden location.
  - `country 2-letter-code`—(OPTIONAL) Enter the two-letter code that identifies the country.

- `state` *state*—Enter the name of the state.
- `locality` *city*—Enter the name of the city.
- `organization` *organization-name*—Enter the name of the organization.
- `orgunit` *unit-name*—Enter name of the unit.
- `cname` *common-name*—Enter the common name that is assigned to the certificate. Common name is the main identity that is presented to connecting devices. By default, the hostname of the switch is the common name. You can configure a different common name for the switch, for example, an IP address. If the *common-name* value does not match the identity of the device, a signed certificate does not validate.
- `email` *email-address*—Enter a valid email address used to communicate with the organization.
- `validity` *days*—Enter the number of days that the certificate is valid. For a CSR, validity has no effect. For a self-signed certificate, the default is 3650 days or 10 years.
- `length` *bit-length*—Enter a bit value for the keyword length. For FIPS mode, the range is from 2048 to 4096; for non-FIPS mode, the range is from 1024 to 4096. The default key length for both FIPS and non-FIPS mode is 2048 bits. The minimum key length value for FIPS mode is 2048 bits. The minimum key length value for non-FIPS mode is 1024 bits.
- `altname` *altname*—Enter an alternate name for the organization, for example, using the IP address such as `altname IP:192.168.1.100`.

- Copy CSR to the CA server.

```
OS10# copy home://DellHost.pem scp:///file-path/DellHost.pem
password:
```

  The CA server signs the CSR with its private key. The CA server then makes the signed certificate available for the OS10 switch to download and install it.

- Install host certificate.
  - Use the copy command to download an X.509v3 certificate signed by a CA server to the local home directory using a secure method, such as HTTPS, SCP, or SFTP.
  - Use the `crypto cert install` command to install the certificate and the private key that is generated with the CSR.

```
crypto cert install cert-file home://cert-filepath key-file {key-path | private}
[password passphrase] [fips]
```

**Generate a certificate signing request and private key**

```
OS10# crypto cert generate request cert-file home://DellHost.pem key-file home://
DellHost.key
email admin@dell.com length 1024 altname DNS:dell.domain.com
Processing certificate ...
Successfully created CSR file /home/admin/DellHost.pem and key
OS10# copy home://DellHost.pem scp:///tftpuser@10.11.178.103:/tftpboot/certs/DellHost.pem
password:
OS10# copy scp:///tftpuser@10.11.178.103:/tftpboot/certs/Dell_host1_CA1.pem home://
Dell_host1_CA1.pem
password:
OS10# copy scp:///tftpuser@10.11.178.103:/tftpboot/certs/Dell_host1_CA1.key home://
Dell_host1_CA1.key
password:
OS10# crypto cert install cert-file home://Dell_host1_CA1.pem key-file home://
Dell_host1_CA1.key
Processing certificate ...
Certificate and keys were successfully installed as "Dell_host1_CA1.pem" that may be
used in a
security profile. CN = Dell_host1_CA1
```

**Display trusted certificates**

The following output displays the installed certificates, the validity period, and details about the CA.

```
OS10# show crypto cert
-------------------------------------
| Installed non-FIPS certificates |
```

```
-------------------------------------
Dell_host1_CA1.pem
-------------------------------------
| Installed FIPS certificates |
-------------------------------------

OS10# show crypto cert Dell_host1_CA1.pem
------------ Non FIPS certificate -----------------
Certificate:
Data:
Version: 3 (0x2)
Serial Number: 4096 (0x1000)
Signature Algorithm: sha256WithRSAEncryption
Issuer: C = US, ST = California, O = Dell EMC, OU = Networking, CN = Dell_interCA1
Validity
Not Before: Jul 25 19:11:19 2018 GMT
Not After : Jul 22 19:11:19 2028 GMT
Subject: C = US, ST = California, L = Santa Clara, O = Dell EMC, OU = Networking, CN
= Dell_host1_CA1
Subject Public Key Info:
Public Key Algorithm: rsaEncryption
Public-Key: (2048 bit)
Modulus:
00:e7:81:4b:4a:12:8d:ce:88:e6:73:3f:da:19:03:
c6:56:01:19:b2:02:61:3f:5b:1e:33:28:a1:ed:e3:
85:bc:56:fb:18:d5:16:2e:a0:e7:3a:f9:34:b4:df:
37:97:93:a9:b9:94:b2:9f:69:af:fa:31:77:68:06:
89:7b:6d:fc:91:14:4a:c8:7b:23:93:f5:44:5a:0a:
3f:ce:9b:af:a6:9b:49:29:fd:fd:cb:34:40:c4:02:
30:95:37:28:50:d8:81:fb:1f:83:88:d9:1f:a3:0e:
49:a1:b3:df:90:15:d4:98:2b:b2:38:98:6e:04:aa:
bd:92:1b:98:48:4d:08:49:69:41:4e:6a:ee:63:d8:
2a:9f:e6:15:e2:1d:c3:89:f5:f0:d0:fb:c1:9c:46:
92:a9:37:b9:2f:a0:73:cf:e7:d1:88:96:b8:4a:84:
91:83:8c:f0:9a:e0:8c:6e:7a:fa:6e:7e:99:3a:c3:
2c:04:f9:06:8e:05:21:5f:aa:6e:9f:b7:10:37:29:
0c:03:14:a0:9d:73:1f:95:41:39:9b:96:30:9d:0a:
cb:d0:65:c3:59:23:01:f7:f5:3a:33:b9:e9:95:11:
0c:51:f4:e9:1e:a5:9d:f7:95:84:9c:25:74:0c:21:
4f:8b:07:29:2f:e3:47:14:50:8b:03:c1:fb:83:85:
dc:bb
Exponent: 65537 (0x10001)
X509v3 extensions:
X509v3 Basic Constraints:
CA:FALSE
Netscape Cert Type:
SSL Client, S/MIME
Netscape Comment:
OpenSSL Generated Client Certificate
X509v3 Subject Key Identifier:
4A:20:AA:E1:69:BF:BE:C5:66:2E:22:71:70:B4:7E:32:6F:E0:05:28
X509v3 Authority Key Identifier:
keyid:A3:39:CB:C7:76:86:3B:05:44:34:C2:6F:90:73:1F:5F:64:55:5C:76
X509v3 Key Usage: critical
```

## Generate a self-signed certificate

Administrators may prefer to not set up a Certificate Authority and implement a certificate trust model in the network, but still want to use the privacy features provided by the Transport Layer Security (TLS) protocol. In this case, self-signed certificates can be used.

A self-signed certificate is not signed by a CA. The switch presents itself as a trusted device in its certificate. Connecting clients may prompt their users to trust the certificate—for example, when a web browser warns that a site is unsafe—or to reject the certificate, depending on the configuration. A self-signed certificate does not provide protection against man-in-the-middle attacks.

1. Create a self-signed certificate in EXEC mode. Store the `device.key` file in a secure, persistent location, such as NVRAM.

```
crypto cert generate self-signed [cert-file cert-path key-file {private | keypath}]
[country 2-letter code] [state state] [locality city] [organization organization-
```

```
name] [orgunit unit-name] [cname common-name] [email email-address] [validity days]
[length length] [altname alt-name]
```

If you enter the cert-file option, you must enter all the required parameters, including the local path where the certificate and private key are stored. If you do specify the cert-file option, you are prompted to enter the other parameter values for the certificate interactively, for example:

```
You are about to be asked to enter information that will be incorporated in your
certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank.
For some fields there will be a default value; if you enter '.', the field will be
left
blank.
Country Name (2 letter code) [US]:
State or Province Name (full name) [Some-State]:California
Locality Name (eg, city) []:San Francisco
Organization Name (eg, company) []:Starfleet Command
Organizational Unit Name (eg, section) []:NCC-1701A
Common Name (eg, YOUR name) [hostname]:S4148-001
Email Address []:scotty@starfleet.com
```

2. Install a self-signed certificate and key file in EXEC mode.

```
crypto cert install cert-file home://cert-filename key-file {key-path | private}
[password passphrase] [fips]
```

- `cert-file cert-path` specifies a source location for a downloaded certificate, for example, `home://s4048-001-cert.pem or usb://s4048-001-cert.pem`.
- `key-file {key-path | private}` specifies the local path to retrieve the downloaded or locally generated private key. Enter private to install the key from a local hidden location and rename the key file with the certificate name.
- `password passphrase` specifies the password that is used to decrypt the private key if it was generated using a password.

3. `fips` installs the certificate-key pair as FIPS-compliant. Enter `fips` to install a certificate-key pair that is used by a FIPS-aware application, such as RADIUS over TLS. If you do not enter `fips`, the certificate-key pair is stored as a non-FIPS compliant pair.

   **NOTE:** You determine if the certificate-key pair is generated as FIPS-compliant. Do not use FIPS-compliant certificate-key pairs outside of FIPS mode.

4. If you enter `fips` after using the `key-file` private option in the `crypto cert generate request` command, a FIPS-compliant private key is stored in a hidden location in the internal file system that is not visible to users.

If the certificate installation is successful, the file name of the self-signed certificate and its common name are displayed. Use the file name to configure the certificate in a security profile using the `crypto security-profile` command.

**Example: Generate and install self-signed certificate and key**

```
OS10# crypto cert generate self-signed cert-file home://DellHost.pem key-file home://
DellHost.key email admin@dell.com length 1024 altname DNS:dell.domain.com validity 365
Processing certificate ...
Successfully created certificate file /home/admin/DellHost.pem and key
OS10# crypto cert install cert-file home://DellHost.pem key-file home://DellHost.key
Processing certificate ...
Certificate and keys were successfully installed as "DellHost.pem" that may be used in a
security profile. CN = DellHost.
```

**Display self-signed certificate**

```
OS10# show crypto cert
-------------------------------------
| Installed non-FIPS certificates |
-------------------------------------
DellHost.pem
-------------------------------------
| Installed FIPS certificates |
-------------------------------------
OS10# show crypto cert DellHost.pem
------------ Non FIPS certificate -----------------
Certificate:
Data:
```

```
Version: 3 (0x2)
Serial Number: 245 (0xf5)
Signature Algorithm: sha256WithRSAEncryption
Issuer: emailAddress = admin@dell.com
Validity
Not Before: Feb 11 20:10:12 2019 GMT
Not After : Feb 11 20:10:12 2020 GMT
Subject: emailAddress = admin@dell.com
Subject Public Key Info:
Public Key Algorithm: rsaEncryption
Public-Key: (1024 bit)
Modulus:
00:c7:12:ca:a8:d6:d2:1c:ab:66:9a:d1:db:50:5a:
b5:8a:e4:53:9d:f6:b4:fc:cd:f4:b9:46:8a:03:86:
be:0b:50:51:c7:25:76:9f:ff:b4:f9:f8:d9:6f:5d:
53:52:0c:4d:05:ed:31:23:79:44:5c:d7:62:01:9d:
41:e8:ff:3a:b0:35:0c:22:d7:ef:df:05:9a:28:6b:
95:10:8e:bc:c6:62:3a:82:30:0f:4f:4e:19:17:48:
f1:bd:1e:0c:4f:54:03:42:f3:a7:de:22:40:3d:5e:
6b:b2:8e:23:17:53:ef:10:d9:ae:1d:1f:d6:e4:ae:
25:9f:d9:39:60:5c:49:b0:ad
Exponent: 65537 (0x10001)
X509v3 extensions:
X509v3 Subject Key Identifier:
DA:39:A3:EE:5E:6B:4B:0D:32:55:BF:EF:95:60:18:90:AF:D8:07:09
X509v3 Subject Alternative Name:
DNS:dell.domain.com
Signature Algorithm: sha256WithRSAEncryption
b8:83:ae:34:bb:84:e6:b4:a3:fd:77:20:67:15:3f:02:76:ca:
f6:74:d4:d2:36:0e:58:8c:96:13:c2:85:8a:df:ba:c0:d9:c8:
```

## Certificate revocation

A certificate revocation list (CRL) is a list of digital certificates that have been revoked by the issuing certificate authority (CA) before their scheduled expiration date. These certificates are no longer meant to be trusted.

Before the switch and an external device, such as a RADIUS or TLS server, set up a secure connection, they present CA-signed certificates to each other. The certificate validation allows peers to authenticate each other's identity, and is followed by checking to ensure that the certificate has not been revoked by the issuing CA.

A certificate includes the URL and other information about the certificate distribution point (CDP) that issued the certificate. Using the URL, OS10 accesses the CDP to download a certificate revocation list (CRL). If the external device's certificate is on the list or if the CDP server does not respond, the connection is not set up.

1. Configure the URL for a certificate distribution point in EXEC mode.

   ```
   OS10# crypto cdp add cdp-namecdp-url
   ```

   Verify the CDPs accessed by the switch in EXEC mode.

   ```
   OS10# show crypto cdp [cdp-name]
   ```

   To delete an installed CDP, use the `crypto cdp delete` *cdp-name* command.
2. Install CRLs that have been downloaded from CDPs in EXEC mode.

   ```
   OS10# crypto crl install crl-path [crl-filename]
   ```

   Display a list of the CRLs installed on the switch in EXEC mode.

   ```
   OS10# show crypto crl [crl-filename]
   ```

   To delete a manually installed CRL that was configured with the `crypto crl install` command, use the `crypto crl delete [`*crl-filename*`]` command.

**Example: Configure CDP**

```
OS10# crypto cdp add cert1_cdp http://crl.chambersign.org/chambersignroot.crl
Successfully added CDP
```

```
OS10# show crypto cdp
--------------------------------------
| Manually installed CDPs |
--------------------------------------
cert1_cdp.crl_url
--------------------------------------
| Automatically installed CDPs |
--------------------------------------
```

**Example: Install CRL**

```
OS10# crypto crl install home://pki-regression/Network_Solutions_Certificate_
Authority.0.crl.pem
Processing file ...
issuer=C=US,O=Network Solutions L.L.C.,CN=Network Solutions Certificate
Authority.0.crl.pem
lastUpdate=Jul 7 04:15:08 2019 GMT
nextUpdate=Jul 11 04:15:08 2019 GMT
OS10# show crypto crl
--------------------------------------
| Manually installed CRLs |
--------------------------------------
Network_Solutions_Certificate_Authority.0.crl.pem
--------------------------------------
| Downloaded CRLs |
--------------------------------------
```

**View revoked certificates**

The following displays a list of revoked certificates:

```
OS10# show crypto crl COMODO_Certification_Authority.0.crl.pem
Certificate Revocation List (CRL):
Version 2 (0x1)
Signature Algorithm: sha1WithRSAEncryption
Issuer: /C=GB/ST=Greater Manchester/L=Salford/O=COMODO CA Limited/
CN=COMODO Certification
Authority
Last Update: May 8 20:34:21 2019 GMT
Next Update: May 12 20:34:21 2019 GMT
CRL extensions:
X509v3 Authority Key Identifier:
keyid:0B:58:E5:8B:C6:4C:15:37:A4:40:A9:30:A9:21:BE:47:36:5A:56:FF
X509v3 CRL Number:
2904
No Revoked Certificates.
Signature Algorithm: sha1WithRSAEncryption
5b:77:52:c0:a0:4e:77:be:4a:c4:6a:7e:92:98:2e:a1:6b:3c:
ad:2d:ac:db:0a:19:1d:a3:56:98:7f:d6:93:f3:1d:4b:61:40:
c3:e0:40:45:0b:41:4b:66:87:35:2b:3a:4c:f3:f1:7e:44:7e:
fe:7f:51:5d:17:ee:b3:4c:15:75:a6:a0:7b:2e:b1:92:3e:b6:
71:a8:01:8d:78:ac:80:3b:16:f2:f1:a8:fd:09:68:9f:7e:09:
55:c6:80:2c:2f:e7:f3:54:51:94:3a:d8:b4:d6:00:3f:63:b1:
19:f3:42:2a:d2:c4:3b:de:c4:4d:ad:f0:72:c5:b4:25:51:e5:
3c:76:8b:97:3c:db:fe:3f:7f:41:d2:d9:aa:7f:98:90:6b:cf:
27:53:0e:66:83:8e:cc:81:ef:6a:e5:cd:c2:f1:e2:ea:84:4f:
73:bb:90:5a:b3:19:a3:50:6a:c7:b3:99:e4:09:fd:56:99:83:
3a:15:93:b0:4a:49:28:78:69:85:de:fc:06:cc:b9:a5:5b:d9:
4a:b0:46:90:ce:94:3a:9c:f3:04:e4:d7:98:36:29:a8:8b:fe:
72:26:b0:fd:39:5e:14:f5:00:6d:0e:4f:ec:d4:a5:ca:4f:e1:
d9:4f:5a:37:21:e3:a2:fb:80:db:cd:68:0b:a0:fa:58:0d:5e:
40:e1:e4:1c
```

## Configure security profiles

To use independent sets of security credentials for different OS10 applications, you can configure multiple security profiles and assign them to OS10 applications. A security profile consists of a certificate and private key pair.

For example, you can maintain different security profiles for RADIUS over TLS authentication and SmartFabric services. Assign a security profile to an application when you configure the profile.

When you install a certificate-key pair, both take the name of the certificate. For example, if you install a certificate using:

```
OS10# crypto cert install cert-file home://Dell_host1.pem key-file home://abcd.key
```

The certificate-key pair is installed as `Dell_host1.pem` and `Dell_host1.key`. In configuration commands, enter the pair as `Dell_host1`. When you configure a security profile, you enter `Dell_host1` in the `certificate certificate-name` command.

- Create an application-specific security profile in CONFIGURATION mode.

  ```
  OS10(config)# crypto security-profile profile-name
  ```

- Assign a certificate and private key pair to the security profile in SECURITY-PROFILE mode. For `certificate-name`, enter the name of the certificate-key pair as it appears in the `show crypto certs` output without the `.pem` extension.

  ```
  OS10(config-sec-profile)# certificate certificate-name
  exit
  ```

- (Optional) Enable CRL checking for certificates received from external devices in SECURITY-PROFILE mode. CRL checking verifies the validity of a certificate using the CRLs installed on the switch.

  ```
  OS10(config-sec-profile)#revocation-check
  ```

- (Optional) Enable peer name checking for certificates presented by external devices in SECURITY-PROFILE mode. Peer name checking ensures that the certificate matches the name of the peer device, such as a remote server name.

  ```
  OS10(config-sec-profile)#peer-name-check
  ```

- Use the security profile to configure X.509v3-based service, for example, to configure RADIUS over TLS authentication using an X.509v3 certificate, enter the `radius-server host tls` command:

  ```
  OS10(config)# radius-server host {hostname | ip-address} tls security-profile profile-
  name [auth-port port-number] key {0 authentication-key | 9 authentication-key |
  authenticationkey}
  ```

**Example: Security profile in RADIUS over TLS authentication**

```
OS10# show crypto cert
-------------------------------------
| Installed non-FIPS certificates |
-------------------------------------
dv-fedgov-s6010-1.pem
-------------------------------------
| Installed FIPS certificates |
-------------------------------------
OS10#
OS10(config)#
OS10(config)# crypto security-profile radius-prof
OS10(config-sec-profile)# certificate dv-fedgov-s6010-1
OS10(config-sec-profile)# revocation-check
OS10(config-sec-profile)# peer-name-check
OS10(config-sec-profile)# exit
OS10(config)#
OS10(config)# radius-server host radius-server-2.test.com tls security-profile radius-
prof
key radsec
OS10(config)# end
OS10# show running-configuration crypto security-profile
!
crypto security-profile radius-prof
   certificate dv-fedgov-s6010-1
```

**Check if a security profile is enabled**

The following shows if a security profile is enabled.

```
OS10# show running-configuration radius-server
radius-server host radius-server-2.test.com tls security-profile radius-prof key 9
2b9799adc767c0efe8987a694969b1384c541414ba18a44cd9b25fc00ff180e9
```

# Smart card authentication for SSH

OS10 allows you to use Common Access Card (CAC) and Personal Identity Verification (PIV) smart cards for authenticating users when connecting to the device with SSH. CAC and PIV smart cards contain Public Key Infrastructure (PKI) X.509v3 certificates that are issued by certificate authorities. This feature allows the OS10 software to verify user authentication and email signing and encryption. To use smart card authentication, use an SSH client that supports X.509v3 authentication.

Although users can use strong and complex passwords for secure access to their devices, people tend to write their passwords down or store them in unsecured locations. Using a smart card for SSH improves security such that users need not memorize complex passwords.

The OS10 SSH server supports X.509v3 smart card authentication in two forms - with or without a password. When you use X.509v3 authentication with passwords, you can use X.509v3 authentication along with remote authentication using RADIUS or TACACS+ authentication.

**Remote user authentication with a password**

When you configure the switch for X.509v3 SSH authentication and remote authentication of users using RADIUS or TACACS+, and when connecting using SSH, the following sequence occurs:

1. Insert a CAC or PIV smart card into the card reader slot in your system or keyboard.
2. Start an RFC 6187 X.509v3 compatible SSH client application, set authentication to smart card or CAC, and make a connection to the OS10 switch.
3. The SSH client application makes the initial connection to the switch, negotiates X.509v3 authentication, and validates the OS10 switch X.509v3 certificate.
4. The SSH client application prompts you to select the required authentication certificate from the CAC or PIV card.
5. The SSH client application prompts you to enter the PIN for the CAC or PIV card.
6. The SSH client application sends an authentication request with your X.509v3 certificate.
7. The OS10 SSH server validates the public certificate, including validating the trust chain, valid date range, and usage fields. If any of the fields are invalid, the authentication fails.
8. If the configured OS10 security profile calls for revocation checking, the OS10 SSH server verifies that the certificate is not revoked. Verification is done by checking either the appropriate CRL or by sending an OCSP request to the appropriate OCSP responder.
9. If the certificate is revoked, the authentication fails.
10. If peer-name-checking is enabled in the security profile, the OS10 SSH server matches the common name or principal name fields from the user certificate against the username. The authentication fails if there is no match.
11. The OS10 SSH server prompts you for a password.
12. The OS10 SSH server performs standard RADIUS or TACACS+ user authentication using the username and returned password.
13. On successful authentication, the SSH session continues.

**Local user authentication with a password**

When you configure the OS10 SSH server for X.509v3 SSH local authentication and when you connect using SSH, the following sequence occurs:

1. Insert a CAC or PIV smart card into the card reader slot in your computer or keyboard.
2. Start an RFC 6187 X.509v3 compatible SSH client application, set authentication to smart card or CAC, and make a connection to the OS10 switch.
3. The SSH client application makes the initial connection to the switch, negotiates X.509v3 authentication, and validates the X.509v3 certificate.
4. The SSH client application prompts you to select the required authentication certificate from the CAC or PIV card.
5. The SSH client application prompts you to enter the PIN for the CAC or PIV card.
6. The SSH client application sends an authentication request with the X.509v3 certificate.
7. The OS10 SSH server validates the public certificate, including validating the trust chain, valid date range, and usage fields. If any of the fields are invalid, the authentication fails.
8. If the configured OS10 security profile calls for revocation checking, the OS10 SSH server verifies that the certificate is not revoked. Verification is done by checking either the appropriate CRL or by sending an OCSP request to the appropriate OCSP responder.
9. If the certificate is revoked, the authentication fails.
10. If peer-name-checking is enabled in the security profile, the OS10 SSH server matches the common name or principal name fields from the user certificate against the username.
11. If there is no match, the OS10 SSH server attempts to match the user certificate fields against any configured certificate for that local username.
12. If there is no match, the authentication fails.

13. The OS10 SSH server prompts you for a password.
14. The OS10 SSH server performs standard local user authentication using the username and returned password.
15. On successful authentication, the SSH session continues.

**Local user authentication without a password**

When you configure OS10 SSH server for X.509v3 SSH local authentication, and when connecting using SSH, the following sequence occurs:

1. Insert a CAC or PIV smart card into the card reader slot in your computer or keyboard.
2. Start an RFC 6187 X.509v3 compatible SSH client application, set authentication to smart card or CAC, and make a connection to the OS10 switch.
3. The SSH client application makes the initial connection to the switch, negotiates X.509v3 authentication, and validates the OS10 switch X.509v3 certificate.
4. The SSH client application prompts you to select the required authentication certificate from the CAC or PIV card.
5. The SSH client application prompts you to enter the PIN for the CAC or PIV card.
6. The SSH client application sends an authentication request with the X.509v3 certificate.
7. The OS10 SSH server validates the public certificate, including validating the trust chain, valid date range, and usage fields. If any of the fields are invalid, the authentication fails.
8. If the configured OS10 security profile calls for revocation checking, the OS10 SSH server verifies that the certificate is not revoked. Verification is done by checking either the appropriate CRL or by sending an OCSP request to the appropriate OCSP responder.
9. If the certificate is revoked, the authentication fails.
10. The OS10 SSH server attempts to match the user certificate fields against the configured certificate for that local username.
11. If there is a match, the authentication succeeds and the SSH session proceeds without a password prompt.

**Configure remote user authentication with a password**

To support remote user authentication by smart card and password, configure the following:

- Enable RADIUS or TACACS+ authentication.

```
radius-server host {hostname | ip-address} key {0 authentication-key | 9
authentication-key | authentication-key} [auth-port port-number]
aaa authentication login default group radius local
```

- Enable X.509v3 authentication in the SSH server.

```
ip ssh server x509v3-authentication security-profile profile-name
```

- If all SSH login attempts require an X.509v3 certificate, disable the plain password authentication and SSH public key authentication in the SSH server.

```
no ip ssh server password-authentication
no ip ssh server pubkey-authentication
```

**Configure local user authentication with a password**

To support local user authentication by smart card and password, configure the following:

- Enable X.509v3 authentication in the SSH server.

```
ip ssh server x509v3-authentication security-profile profile-name
```

- If all SSH login attempts present an X.509v3 certificate, disable the plain password authentication and SSH public key authentication in the SSH server.

```
no ip ssh server password-authentication
no ip ssh server pubkey-authentication
```

- If you enable the key-usage-check in the security profile but the user certificates use a different name syntax than the user login names, configure the user certificate details to allow the SSH server to match the user certificate to the account.

```
username username certificate subject “x509v3-subject-string”
or
username username certificate principal-name user-principal-name-string
or
username username certificate fingerprint fingerprint-value
```

**Configure local user authentication without a password**

To support password-less local user authentication using a smart card and password, configure the following:

- Enable password-less X.509v3 authentication in the SSH server.

```
ip ssh server x509v3-authentication security-profile profile-name password-less
```

- Leave plain password authentication enabled for users that do not have a configured certificate.

```
ip ssh server password-authentication
```

- Leave plain public key authentication enabled if it is required that users can alternatively use SSH public key password-less authentication.

```
ip ssh server pubkey-authentication
```

- Configure the user X.509v3 certificate details to allow the SSH server to match the user certificate to the account.

```
username username certificate subject "x509v3-subject-string"
or
username username certificate principal-name user-principal-name-string
or
username username certificate fingerprint fingerprint-value
```

## Generate and install a new security certificate on OS10 10.4.3.0 and later releases for full switch mode

Switches running on OS 10.5.0.7P3 and previous supported releases, that have VLT or SmartFabric Services enabled, use secure channels to communicate with each other. To establish secure channels, OS10 uses X.509v3 certificates.

When a user logs in to the system, OS10 images from 10.4.3.x to 10.5.0.7P3 display a warning message that the cluster manager is using the default credentials.

**Configuration notes:**

- Even if you reinstall OS10, the certificate is present on the system. If you reinstall OS10, reinstall the certificate by removing and readding the security profile using the `no cluster security-profile` and the `cluster security-profile` *`profile-name`* commands.

Use the following procedure to install a valid certificate so that the system stops displaying the warning message and continues to function properly. This procedure only works for OS10 releases 10.4.3.0 and later. If you are running OS10 releases between 10.4.1.4 and 10.4.2.x, upgrade to a later release.

1. Verify the OS10 version on both devices.

   **Switch-A:**

```
Switch-A# show version
Dell EMC Networking OS10 Enterprise
Copyright (c) 1999-2020 by Dell Inc. All Rights Reserved. OS Version: 10.5.0.7P3
Build Version: 10.5.0.7.745
Build Time: 2020-06-02T22:46:24+0000
System Type: MX9116N-ON
Architecture: x86_64
Up Time: 00:07:32
```

   **Switch-B:**

```
Switch-B# show version
Dell EMC Networking OS10 Enterprise
Copyright (c) 1999-2020 by Dell Inc. All Rights Reserved. OS Version: 10.5.0.7P3
Build Version: 10.5.0.7.745
Build Time: 2020-06-02T22:46:24+0000
System Type: MX9116N-ON
Architecture: x86_64
Up Time: 00:08:10
```

2. Verify if the system is in full switch mode.

**Switch-A:**

```
Switch-A# show switch-operating-mode
8713-ToR-2# Switch-Operating-Mode : Full Switch Mode
```

**Switch-B:**

```
Switch-B# show switch-operating-mode
8713-ToR-2# Switch-Operating-Mode : Full Switch Mode
```

3. Verify if VLT is converged.

**Switch-A:**

```
Switch-A# show vlt 255
Domain ID : 255
Unit ID : 1 Role : primary
Version : 2.3
Local System MAC address : 20:04:0f:20:86:00
Role priority : 32768
VLT MAC address : 20:04:0f:21:9a:00
IP address : fda5:74c8:b79e:1::1
Delay-Restore timer : 90 seconds
Peer-Routing : Disabled
Peer-Routing-Timeout timer : 0 seconds
VLTi Link Status
port-channel1000 : up
VLT Peer Unit ID System MAC Address Status IP Address Version
------------------------------------------------------------------------------
2 20:04:0f:21:9a:00 up fda5:74c8:b79e:1::2 2.3
```

**Switch-B:**

```
Switch-B# show vlt 255
Domain ID : 255
Unit ID : 2 Role : secondary
Version : 2.3
Local System MAC address : 20:04:0f:21:9a:00
Role priority : 32768
VLT MAC address : 20:04:0f:21:9a:00
IP address : fda5:74c8:b79e:1::2
Delay-Restore timer : 90 seconds
Peer-Routing : Disabled
Peer-Routing-Timeout timer : 0 seconds
VLTi Link Status
port-channel1000 : up
VLT Peer Unit ID System MAC Address Status IP Address Version
------------------------------------------------------------------------------
1 20:04:0f:20:86:00 up fda5:74c8:b79e:1::1 2.3
```

4. Create a self-signed certificate using the OS10 CLI. You can do this on one of the switches in the same VLT domain or SmartFabric Cluster.

**Switch-A:**

```
Switch-A# crypto cert generate self-signed cert-file home://dell.crt key-file home://
dell.ky cname sfscert
Processing file ...
Successfully created certificate file and key
```

You can also specify the following parameters:

- `country` *`2-letter-code`* — (OPTIONAL) Enter the two-letter code that identifies the country.
- `state` *`state`* — Enter the name of the state.
- `locality` *`city`* — Enter the name of the city.
- `organization` *`organization-name`* — Enter the name of the organization.
- `orgunit` *`unit-name`* — Enter name of the unit.

- `cname common-name` — Enter the common name assigned to the certificate. Common name is the main identity that is presented to connecting devices. By default, the host name of the switch is the common name. You can configure a different common name for the switch, for example, an IP address. If the *common-name* value does not match the device's presented identity, a signed certificate does not validate.
- `email email-address` — Enter a valid email address used to communicate with the organization.
- `validity days` — Enter the number of days that the certificate is valid. For a self-signed certificate, the default is 3650 days.
- `length bit-length` — Enter a bit value for the keyword length. For FIPS mode, the range is from 2048 to 4096; for non-FIPS mode, the range is from 1024 to 4096. The default key length for both FIPS and non-FIPS mode is 2048 bits. The minimum key length value for FIPS mode is 2048 bits. The minimum key length value for non-FIPS mode is 1024 bits.
- `altname altname` — Enter an alternate name for the organization, for example, using the IP address such as `altname IP:192.168.1.100`.

5. Verify if the newly created certificates are present in the home directory.

   **Switch-A:**

```
Switch-A# dir home
Directory contents for folder: home
Date (modified) Size (bytes) Name
---------------------- ------------ ------------------------------------
2020-12-18T14:20:32Z 1017 dell.crt 2020-12-18T14:20:32Z 1675 dell.ky
```

6. Copy the certificate and key from Switch-A to an SCP server. In this example, SCP is used but you can also use a TFTP or FTP server.

   **Switch-A:**

```
Switch-A# copy home://dell.crt scp://<username>:<password>@100.104.54.214/dell.crt
Switch-A# copy home://dell.ky scp://<username>:<password>@100.104.54.214/dell.ky
```

7. Copy the certificate and key from the SCP server to Switch- B.

   **Switch-B:**

```
Switch-B# copy scp://<username>:<password>@100.104.54.214/dell.crt home://dell.crt
Switch-B# copy scp://<username>:<password>@100.104.54.214/dell.ky home://dell.ky
```

   **NOTE:** All devices in the SFS cluster or VLT domain must have the same certificate and key files.

8. Verify if the certificate is copied to Switch- B.

   **Switch-B:**

```
Switch-B# dir home
Directory contents for folder: home
Date (modified) Size (bytes) Name
---------------------- ------------ ------------------------------------
2020-12-18T14:59:51Z 1017 dell.crt 2020-12-18T15:00:42Z 1675 dell.ky
```

9. Install a self-signed certificate and key file.

   **Switch-A:**

```
Switch-A# crypto cert install cert-file home://dell.crt key-file home://dell.ky
```

   **Switch-B:**

```
Switch-B# crypto cert install cert-file home://dell.crt key-file home://dell.ky
```

   Run the `show crypto cert` command to make sure that the certificate is installed on the system.

10. Create a security profile.

    **Switch-A:**

```
Switch-A(config)# crypto security-profile DELL123
```

**Switch-B:**

```
Switch-B(config)# crypto security-profile DELL123
```

11. Assign the certificate and private key pair to the security profile. Enter the certificate name without the file extension.

    **Switch-A:**

    ```
    Switch-A(config-sec-profile)# certificate dell
    ```

    **Switch-B:**

    ```
    Switch-B(config-sec-profile)# certificate dell
    ```

12. Create a security profile for the cluster.

    **Switch-A:**

    ```
    Switch-A(config)# cluster security-profile DELL123
    ```

    **Switch-B:**

    ```
    Switch-A(config)# cluster security-profile DELL123
    ```

13. (Only if you are running release 10.4.3.x) Create the `store` folder under the /config/certs/ directory on both devices.

    ```
    Switch-A# system "sudo mkdir /config/certs/store"
    ```

    ```
    Switch-B# system "sudo mkdir /config/certs/store"
    ```

14. Copy the certificate to the /config/certs/store/ location and run the `c_rehash` command on both VLT peers.

    ```
    Switch-A# system "sudo cp /config/certs/dell.crt /config/certs/store/"
    Switch-A# system "sudo c_rehash /config/certs/store/"
    ```

    ```
    Switch-B# system "sudo cp /config/certs/dell.crt /config/certs/store/"
    Switch-B# system "sudo c_rehash /config/certs/store/"
    ```

15. Open a new SSH session and verify that the warning messages are not displayed. Even if the new certificate is not in effect on the VLT domain or SFS cluster, the system does not generate the warning message.
16. For MX devices, reboot one of the VLT peers in each VLT pair and the SFS primary node if you are running a multinode cluster deployment. For non-MX devices, flap the VLTi link.

    **CAUTION: Flapping the VLTi link or rebooting the node may lead to transient packet loss. Perform this step during a maintenance window.**

17. (Optional) Verify if VLT is converged.

    **Switch-A:**

    ```
    Switch-A# show vlt 255
    Domain ID : 255
    Unit ID : 1
    Role : primary
    Version : 2.3
    Local System MAC address : 20:04:0f:20:86:00
    Role priority : 32768
    VLT MAC address : 20:04:0f:21:9a:00
    IP address : fda5:74c8:b79e:1::1
    Delay-Restore timer : 90 seconds
    Peer-Routing : Disabled
    Peer-Routing-Timeout timer : 0 seconds
    VLTi Link Status
    port-channel1000 : up
    VLT Peer Unit ID System MAC Address Status IP Address Version
    ------------------------------------------------------------------------------
    2 20:04:0f:21:9a:00 up fda5:74c8:b79e:1::2 2.3
    ```

**Switch-B:**

```
Switch-B# show vlt 255
Domain ID : 255
Unit ID : 2
Role : secondary
Version : 2.3
Local System MAC address : 20:04:0f:21:9a:00
Role priority : 32768
VLT MAC address : 20:04:0f:21:9a:00
IP address : fda5:74c8:b79e:1::2
Delay-Restore timer : 90 seconds
Peer-Routing : Disabled
Peer-Routing-Timeout timer : 0 seconds
VLTi Link Status
port-channel1000 : up
VLT Peer Unit ID System MAC Address Status IP Address Version
--------------------------------------------------------------------------------
1 20:04:0f:20:86:00 up fda5:74c8:b79e:1::1 2.3
```

# Auditing and logging

This section provides information about auditing and logging features that are supported.

## Logging rules

Logging can be used to for error and information notification, security auditing, and network forensics.

**Enable logging on the console**

Enable logging to the console and restrict the severity to critical so that log messages do not affect system performance.

```
OS10(config)# logging console enable
OS10(config)# logging console severity log-crit
OS10(config)# exit
OS10# write memory
```

**Enable logging to a syslog server over TLS**

Enable logging to a syslog server, and secure the connection using TLS.

```
OS10(config)# logging server {hostname | ipv4-address | ipv6-address} tls [port-number]
[severity severity-level] [vrf {management | vrf-name]
OS10(config)# exit
OS10# write memory
```

- *ipv4-address* | *ipv6-address*—(Optional) Enter the IPv4 or IPv6 address of the logging server.
- tls *port-number*—(Optional) Send syslog messages using TCP, UDP, or TLS transport to a specified port on a remote logging server, from 1 to 65535.
- *severity-level*—(Optional) Set the logging threshold severity:
  - log-emerg—System is unusable.
  - log-alert—Immediate action is needed.
  - log-crit—Critical conditions
  - log-err—Error conditions
  - log-warning—Warning conditions
  - log-notice—Normal, but significant conditions (default)
  - log-info—Informational messages
  - log-debug—Debug messages
- vrf {management | *vrf-name*}—(Optional) Configure the logging server for the management or a specified VRF instance.

For more information about configuring X.509v3 PKI certificates, see the *Dell SmartFabric OS10 User Guide*.

**Enable audit logging**

To monitor user activity and configuration changes on the switch, enable the audit log. Only the `sysadmin` and `secadmin` roles can enable, view, and clear the audit log.

- Configure audit logging.

```
OS10(config)# logging audit enable
OS10(config)# exit
OS10# write memory
```

- View audit log.

```
show logging audit [reverse] [number]
```

  - `reverse` —Display entries starting with the most recent events.
  - *number*—Display the specified number of audit log entries users, from 1 to 65535.

**View what logging rules are enabled**

```
OS10# show running-configuration logging
!
logging audit enable
```

## Simple Network Management Protocol

Network management stations use simple network management protocol (SNMP) to retrieve and modify software configurations for managed objects on an agent in network devices. A managed object is a data of management information. The SNMP agent in a managed device maintains the data for managed objects in management information bases (MIBs).

OS10 supports different security models and levels in SNMP communication between SNMP managers and agents. Each security model refers to an SNMP version used in SNMP messages. SNMP versions provide different levels of security, such as user authentication and message encryption.

SNMP version 3 (SNMPv3) provides an enhanced security model for user authentication and SNMP message encryption. User authentication requires that SNMP packets come from an authorized source. Message encryption ensures that packet contents cannot be viewed by an unauthorized source.

To configure SNMPv3-specific security settings—user authentication and message encryption—use the `snmp-server user` command. You can generate localized keys with enhanced security for authentication and privacy (encryption) passwords.

### SNMP rules

Restricted Simple Network Management Protocol (SNMP) access improves device security when SNMP is used.

**Forbid read and write access to a specific SNMP community**

Forbid read and write access to one or more SNMP communities so that an unauthorized entity cannot remotely manipulate the device.

```
OS10(config)# no snmp-server community community_string {ro | rw}
OS10(config)# exit
OS10# write memory
```

**Forbid access to SNMP without ACL**

If no ACL is configured, anyone with a valid SNMP community string can access the system and potentially make unnecessary changes. Define and apply an ACL so that only an authorized group of trusted stations can have access SNMP access to the system.

```
OS10(config)# snmp-server community name {ro | rw} acl acl-name
OS10(config)# exit
OS10# write memory
```

```
OS10(config)# ip access-list snmp-read-only-acl
OS10(config-ipv4-acl)# permit ip 172.16.0.0 255.255.0.0 any
OS10(config-ipv4-acl)# exit
OS10(config)# snmp-server community public ro acl snmp-read-only-acl
```

```
OS10(config)# exit
OS10# write memory
```

**Configure SNMP v3**

SNMP v2 does not support encryption or authentication. Dell Technologies strongly recommends that you use SNMP v3 which supports secure access to SNMP resources.

- Configure SNMP engine ID.`snmp-server engineID [local engineID] [remote ip-address {[udp-port port-number] remote-engineID}]`
  - `local engineID`—Enter the engine ID that identifies the local SNMP agent on the switch as an octet colon-separated number. A maximum of 27 characters.
  - `remote ip-address`—Enter the IPv4 or IPv6 address of a remote SNMP device that accesses the local SNMP agent.
  - `udp-port port-number`—Enter the UDP port number on the remote device, from 0 to 65535.
  - `remote-engineID`—Enter the engine ID that identifies the SNMP agent on a remote device, `0x` then by a hexadecimal string).
- Configure SNMP views.

  ```
  OS10(config)# snmp-server view view-name oid-tree [included | excluded]
  ```

  - `view-name`—Enter the name of a read-only, read/write, or notify view. A maximum of 32 characters.
  - `oid-tree`—Enter the SNMP object ID at which the view starts in 12-octet dotted-decimal format.
  - `included`—(Optional) Include the MIB family in the view.
  - `excluded`—(Optional) Exclude the MIB family from the view.
- Configure SNMP groups.

  ```
  OS10(config)# snmp-server group group-name v3 security-level [read view-name] [write
  view-name] [notify view-name]
  ```

  - `group-name`—Enter the name of the group. A maximum of 32 alphanumeric characters.
  - `v3 security-level`—SNMPv3 provides optional user authentication and encryption for SNMP messages, which are configured with the `snmp-server user` command.
  - `security-level`—(SNMPv3 only) Configure the security level for SNMPv3 users:
    - `auth`—Authenticate users in SNMP messages.
    - `noauth`—Do not authenticate users or encrypt SNMP messages; send messages in plain text.
    - `priv`—Authenticate users and encrypt or decrypt SNMP messages.
  - `access acl-name`—(Optional) Enter the name of an IPv4 or IPv6 access list to filter SNMP requests received on the switch. A maximum of 16 characters.
  - `read view-name`—(Optional) Enter the name of a read-only view. A maximum of 32 characters maximum.
  - `write view-name`—(Optional) Enter the name of a read/write view. A maximum of 32 characters maximum.
  - `notify view-name`—(Optional) Enter the name of a notification view. A maximum of 32 characters maximum.
- Configure SNMP users.

  ```
  OS10(config)# snmp-server user user-namegroup-namesecurity-model localized auth sha
  auth-password priv aes priv-password
  OS10(config)# exit
  OS10# write memory
  ```

  - `user-name`—Enter the name of the user. A maximum of 32 alphanumeric characters.
  - `group-name`—Enter the name of the group to which the user belongs. A maximum of 32 alphanumeric characters.
  - `security-model`—Enter an SNMP version that sets the security level for SNMP messages:
    - `3`—Dell Technologies recommends using SNMPv3 which provides user authentication and encryption for SNMP messages. SNMPv1 may be not be supported on future SmartFabric OS10 versions.
  - `auth`—(SNMPv3 only) Include a user authentication key for SNMPv3 messages sent to the user:
    - `sha`—Generate an authentication key using the SHA algorithm.
    - `auth-password`—Enter the encrypted string.
  - `priv`—Configure encryption for SNMPv3 messages sent to the user:
    - `aes`—Encrypt messages using AES 128-bit algorithm.
    - `priv-password`—Enter the encrypted string.
  - `localized`—Generate an SNMPv3 authentication and/or privacy key in localized key format.

### Configure SNMP traps

Use the following configuration to enable SNMP traps:

- Enable SNMP traps on the system.

```
OS10(config)# snmp-server enable traps [notification-type] [notification-option]
```

  - *notification-typenotification-option* — Enter an SNMP notification type, and optionally, a notification option for the type.

**Table 7. Notification types and options**

| Notification type | Notification option |
|---|---|
| entity — Enable entity change traps. | None |
| envmon — Enable SNMP environmental monitor traps. | ▪ fan — Enable fan traps.<br>▪ power-supply — Enable power-supply traps.<br>▪ temperature — Enable temperature traps. |
| lldp — Enable LLDP state change traps. | ▪ rem-tables-change — Enable the lldpRemTablesChange trap. |
| snmp — Enable SNMP traps. | ▪ authentication — Enable authentication traps.<br>▪ coldstart — Enable coldstart traps when you power on the switch and the SNMP agent initializes.<br>▪ linkdown — Enable link-down traps.<br>▪ linkup — Enable link-up traps.<br>▪ warmstart — Enable warmstart traps when the switch reloads and the SNMP agent reinitializes. |

- Configure a host to receive SNMP notifications.

```
snmp-server host {ipv4-address | ipv6-address} {informs version
                  version-number | traps version
                  version-number | version
                  version-number} [snmpv3-security-level] [community-name] [udp-port
                  port-number] [dom | entity | envmon | lldp | snmp]
```

  - *ipv4-address | ipv6-address* — Enter the IPv4 or IPv6 address of the SNMP host.
  - informs — Send inform messages to the SNMP host.
  - traps — Send trap messages to the SNMP host.
  - version *version-number* — Enter the SNMP security model used to send traps or informs to the SNMP host. Dell Technologies recommends using 3. For SNMPv3 traps and informs, enter the security level:
    - noauth — (SNMPv3 only) Send SNMPv3 traps without user authentication and privacy encryption.
    - auth — (Recommended) Include a user authentication key for SNMPv3 messages sent to the host:
      - md5 — Generate an authentication key using the Message Digest Algorithm (MD5) algorithm.
      - sha — Generate an authentication key using the Secure Hash Algorithm (SHA) algorithm.
      - *auth-password* — Enter a text string used to generate the authentication key that identifies the user. A maximum of 32 alphanumeric characters. For an encrypted password, enter the encrypted string instead of plain text.
    - priv — (SNMPv3 only) Configure encryption for SNMPv3 messages sent to the host:
      - aes — Encrypt messages using an AES 128-bit algorithm.
      - des — Encrypt messages using a DES 56-bit algorithm.
      - *priv-password* — Enter a text string used to generate the privacy key used in encrypted messages. A maximum of 32 alphanumeric characters. For an encrypted password, you can enter the encrypted string instead of plain text.
  - *community-name* — (Optional) Enter an SNMPv1 or SNMPv2c community string name or an SNMPv3 username.
  - udp-port *port-number* — (Optional) Enter the UDP port number on the SNMP host, from 0 to 65535.
  - dom | entity | envmon | lldp | snmp — Enter one or more types of traps and notifications to send to the SNMP host — digital optical monitor, entity change, environment monitor, or LLDP state change traps, or SNMP-type notifications.

**Check what SNMP rules are running**

```
OS10# show running-configuration snmp
!
snmp-server community public ro acl snmp-read-only-acl
```

# Serviceability

This section provides information about serviceability.

## Data shared with Dell Technologies

This section provides information about what is shared with Dell Technologies.

**Support bundle**

The Support Bundle is based on the `sosreport` tool. Use the Support Bundle to generate an `sosreport` tar file that collects Linux system configuration, diagnostics information, and the `show` command output to send to Dell Technical Support.

To send Dell Technical Support troubleshooting details about the Linux system configuration and OS10 diagnostics, generate an `sosreport` tar file.

1. Generate the tar file in EXEC mode.

   ```
   generate support-bundle
   ```

2. Verify the generated file in EXEC mode.

   ```
   dir supportbundle
   ```

3. Send the support bundle using FTP, SFTP, SCP, or TFTP in EXEC mode.

   ```
   copy supportbundle://sosreport-filename.tar.gz tftp://server-address/path
   ```

You can also use the `generate support-bundle scp://userid:passwd@hostip/directory-path` command to generate the support bundle and copy the generated `sosreport` and MD5 files as a tar file to the specified remote server directory through SCP.

Use the `delete supportbundle://sosreport-filename.tar.gz` command to delete a generated support bundle.

# 4

# Federal and DoD Standards and Compliance

Topics include:

**Topics:**



## FIPS Compliance

Federal Information Processing Standards (FIPS) is a set of standards that were developed by NIST to ensure security on the systems by using specific set of algorithms and methods.

**Enable FIPS if FIPS-validated cryptographic protection is required within your environment**

When you install a certificate, specifically indicate whether that certificate is to be used for FIPS mode services only. To install a certificate, use the `crypto cert install` command with the `fips` option.

**NOTE:** If you plan to use FIPS, Dell Technologies recommends enabling FIPS as one of the first steps of configuring your new switch.

```
OS10# crypto fips enable
OS10# write memory
```

**Check if FIPS is enabled**

Use the following command to verify if FIPS is enabled on the system:

```
OS10# show fips status

FIPS mode: Disabled
```

## STIG compliance

This section contains configuration and maintenance standards that the US Department of Defense (DoD) Information Assurance (IA) program requires.

These guidelines are designed to enhance security settings and configuration options before the systems are connected to a network. For more information about the various STIGs, see the Security Technical Implementation Guides (STIGs) section on DoD Cyber Exchange.

Severity Category Codes (CAT) describe the vulnerabilities that are used to assess a facility or system security posture. CAT I Severity Code describes security protections that can be bypassed, allowing immediate access by unauthorized personnel or unauthorized use of superuser privileges. CAT I weaknesses must be corrected before an Authorization to Operate (ATO) is granted.

SmartFabric OS10 compliance with CAT I Security Requirements is described in this section:

**NOTE:** For detailed configuration steps, see the *Dell SmartFabric OS10 User Guide*.

### Table 8. CAT I Security Requirements

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| V-206647 | The Layer 2 switch must uniquely identify all network-connected endpoint devices before establishing any connection. | CAT I | Configure RADIUS for 802.1x authentication:<br>`OS10(config)# radius-server host server-address> key shared-secret`<br>`OS10(config)# radius-server retransmit 10`<br>`OS10(config)# radius-server timeout 10`<br>Enable 802.1x on the specific interfaces:<br>`OS10(config)# dot1x system-auth-control`<br>`OS10(config)# interface range ethernet 1/1/1-1/1/48`<br>`OS10(conf-range-eth1/1/1-1/1/48)# dot1x port-control auto`<br>`OS10(conf-range-eth1/1/1-1/1/48)# dot1x re-authentication` | Controlling LAN access using 802.1x authentication can help in preventing a malicious user from connecting an unauthorized personal computer to a switch port to inject or receive data from the network without detection. For a description of the 802.1x configuration, see the *802.1x* chapter in the *Dell SmartFabric OS10 User Guide*. |
| V-202017 | The network device must be configured to assign appropriate user roles or access levels to authenticated users. | CAT I | For local users assign the user role when creating the user:<br>`OS10(config)# username string password ****** role netadmin`<br>For remote authentication, role is assigned by AAA server using vendor-specific attributes: | Successful identification and authentication must not automatically give an entity full access to a network device or security domain. The lack of authorization-based access control could result in the immediate compromise and unauthorized access to sensitive information. All DoD systems must be properly configured to incorporate access control methods that do not rely solely on authentication for authorized access. |
| V-202049 | The network device must be configured to prohibit the use of all unnecessary and/or nonsecure functions, ports, protocols, and/or services. | CAT I | In OS10, in nonapproved protocols are disabled by default. Also, control-plane ACLs can be added to block specific ports and protocols, or to restrict protocols to a limited set of addresses or subnets:<br>`ip access-list permit-cli`<br>`seq 10 permit ip 192.168.16.0 255.255.255.0 192.168.16.0 255.255.255.0`<br>`seq 20 permit ip 10.0.0.0 255.0.0.0 10.0.0.0 255.0.0.0`<br>`seq 30 deny ip any any`<br>`!`<br>`line vty`<br>`ip access-class permit-cli`<br>`!`<br>`ip access-list ipv4-cp-acl`<br>`seq 5 deny tcp host 192.168.16.34 any log` | In order to prevent unauthorized connection of devices, unauthorized transfer of information, or unauthorized tunneling (embedding of datatype within datatype), organizations must disable unused or unnecessary physical and logical ports/ protocols on information systems. |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| | | | seq 60 permit ip any any<br>!<br>ipv6 access-list ipv6-cp-acl<br>seq 20 deny tcp any any eq 443<br>seq 60 deny tcp any any eq 54320<br>seq 70 deny tcp any any eq 54321<br>seq 80 permit ipv6 any any<br>!<br>control-plane<br>ipv6 access-group ipv6-cp-acl in<br>ip access-group ipv4-cp-acl in | |
| V-202064 | The network device must only store cryptographic representations of passwords. | CAT I | Passwords are stored with a securely hashed and salted. Prevent display of password hashes in the `show running-configuration` output:<br>`OS10(config)# service obscure-password` | Passwords must be protected always, and encryption is the standard method for protecting passwords. If passwords are not encrypted, they can be plainly read (clear text) and easily compromised. |
| V-202065 | The network device must transmit only encrypted representations of passwords. | CAT I | On OS10, passwords are never transmitted unencrypted. | Passwords must be protected always, and encryption is the standard method for protecting passwords. If passwords are not encrypted, they can be plainly read (clear text) and easily compromised. |
| V-202071 | The network device must obscure feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. | CAT I | On OS10, passwords are not displayed when entered during authentication. | To prevent the compromise of authentication information such as passwords during the authentication process, the feedback from the network device must not provide any information that would allow an unauthorized user to compromise the authentication mechanism. |
| V-202072 | The network device must use FIPS 140-2 approved algorithms for authentication to a cryptographic module. | CAT I | Remote authentication over FIPS 140-2 validated cryptography is supported when using RADIUS over TLS. For detailed configuration, see the *Dell SmartFabric OS10 User Guide*. | Unapproved mechanisms that are used for authentication to the cryptographic module are not validated and therefore cannot be relied upon to provide confidentiality or integrity, and DoD data may be compromised. |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| V-202074 | The network device must terminate all network connections that are associated with a device management session at the end of the session, or the session must be terminated after 10 minutes of inactivity except to fulfill documented and validated mission requirements. | CAT I | Configure inactivity timeout:<br>`OS10(config)# exec-timeout 600` | Terminating an idle session within a short time period reduces the window of opportunity for unauthorized personnel to take control of a management session that is enabled on the console or console port that has been left unattended. In addition, quickly terminating an idle session will also free up resources that are committed by the managed network element. |
| V-202078 | The network device must only allow authorized administrators to view or change the device configuration, system files, and other files stored either in the device or on removable media (such as a flash drive). | CAT I | Viewing and modification of files in OS10 are fully controlled by the Role-Based Access Control that is applied to each user. Also, no user shell access is available when the system CLI command is disabled. Disable access to Linux shell:<br>`OS10(config)# system-cli disable` | This requirement is intended to address the confidentiality and integrity of system information at rest (example, network device rule sets) when it is located on a storage device within the network device or as a component of the network device. This protection is required to prevent unauthorized alteration, corruption, or disclosure of information when not stored directly on the network device. |
| V-202093 | The network device must prevent nonprivileged users from performing privileged functions to include disabling, circumventing, or altering implemented security safeguards/ countermeasures. | CAT I | OS10 always applies RBAC, and nonprivileged users are prohibited from running privileged functions. | Preventing nonprivileged users from performing privileged functions mitigates the risk that unauthorized individuals or processes may gain unnecessary access to information or privileges. |
| V-202117 | The network devices must use FIPS-validated Keyed-Hash Message Authentication Code (HMAC) to protect the integrity of nonlocal maintenance and diagnostic communications. | CAT I | To enable FIPS 140-2 compliant mode use the following CLI command:<br>`OS10(config)# crypto fips enable`<br>Dell Technologies recommends enabling FIPS mode early in the configuration process, as some cryptographic settings are then limited to only allow FIPS-compliant algorithm choices. | Unapproved mechanisms that are used for authentication to the cryptographic module are not verified and therefore cannot be relied upon to provide confidentiality or integrity, and DoD data may be compromised. |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| V-202118 | The network device must be configured to implement cryptographic mechanisms using a FIPS 140-2 approved algorithm to protect the confidentiality of remote maintenance sessions. | CAT I | To enable FIPS 140-2 compliant mode use the following CLI command:<br>`OS10(config)# crypto fips enable`<br>Dell Technologies recommends enabling FIPS mode early in the configuration process, as some cryptographic settings are then limited to only allow FIPS-compliant algorithm choices. | This requires the use of secure protocols instead of their unsecured counterparts, such as SSH instead of telnet, SCP instead of FTP, and HTTPS instead of HTTP. If unsecured protocols (lacking cryptographic mechanisms) are used for sessions, the contents of those sessions are susceptible to eavesdropping, potentially putting sensitive data (including administrator passwords) at risk of compromise and potentially allowing hijacking of maintenance sessions. |
| V-202132 | The network device must be configured to use an authentication server for the purpose of authenticating users prior to granting administrative access. | CAT I | OS10 supports remote authentication using TACACS+ and RADIUS over UDP, TCP, or TLS. The only one that meets the FIPS-140.2 requirements of rule is RADIUS over TLS. For configuration of RADIUS over TLS see the *RADIUS over TLS authentication* section in the *Dell EMC SmartFabric OS10 user Guide*. | Centralized management of authentication settings increases the security of remote and nonlocal access methods. This control is important protection against the insider threat. With robust centralized management, audit records for administrator account access to the organization's network devices can be more readily analyzed for trends and anomalies. The alternative method of defining administrator accounts on each device exposes the device configuration to remote access authentication attacks and system administrators with multiple authenticators for each network device. |
| V-213467 | The network device must be configured to send log data to a central log server for the purpose of forwarding alerts to the administrators and the ISSO. | CAT I | Configure a remote syslog server to provide robust and compliant logging functionality:<br>`OS10(config)# logging server {hostname \| ip-address} [udp\|tcp\|tls]` | The aggregation of log data that is kept on a syslog server can be used to detect attacks and trigger an alert to the appropriate security personnel. The stored log data can used to detect weaknesses in security that enable the |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| | | | | network IA team to find and address these weaknesses before breaches can occur. Reviewing these logs, whether before or after a security breach, are important in showing whether someone is an internal employee or an outside threat. |
| V-213468 | The network device must be running an operating system release that is currently supported by the vendor. | CAT I | The latest OS10 releases are available on Dell Digital Locker. Install the latest versions using the following command:<br>`OS10# image secure-install file-url pki signature signature-file-path public-key key-file` | Network devices running an unsupported operating system lack current security fixes required to mitigate the risks associated with recent vulnerabilities. |
| V-237779 | The network device must be configured to use DoD PKI as multifactor authentication (MFA) for interactive logins. | CAT I | Configure necessary PKI certificates, security profiles, RADIUS over TLS, and X.509 SSH authentication. For detailed configuration steps, see the *X.509v3 certificates* chapter in the *Dell SmartFabric OS10 User Guide*. | The DoD public key infrastructure (PKI) is the only prescribed method that is approved for DoD organizations to implement MFA. For authentication purposes, centralized DoD certificate authorities (CA) issue PKI certificate key pairs (public and private) to individuals using the prescribed x.509 format. |
| V-237780 | The network device must be configured to use DoD-approved OCSP responders or CRLs to validate certificates used for PKI-based authentication. | CAT I | Configure the appropriate certificate revocation checking in the security profile that is used for SSH X.509 authentication:<br>`OS10(config)# crypto security-profile profile-name`<br>If certificate revocation checking by certificate revocation list is wanted, enable revocation checking in the security profile.<br>`OS10(config-sec-profile)# revocation-check`<br>If certificate revocation checking by OCSP is wanted, enable OCSP checking in the security profile. If a proxy OCSP responder is in use, configure its address in the command:<br>`OS10(config-sec-profile)# ocsp-check ocsp-responder-url` | PKI user certificates that are presented as part of the identification and authentication criteria (for example, DoD PKI as multifactor authentication [MFA]) must be checked for validity by network devices. For example, valid PKI certificates are digitally signed by a trusted DoD certificate authority (CA). Also, valid PKI certificates are not expired, and valid certificates have not been revoked by a DoD CA. |
| V-237781 | The network device, for PKI-based authentication, must | CAT I | OS10 fully supports using remote AAA authentication to map PKI-based authentication to unique user accounts. Also, | Without mapping the PKI certificate to a unique user account, the |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| | be configured to map validated certificates to unique user accounts. | | if wanted, the administrator can configure certificate matching information for locally defined users as well with the following commands: `OS10(config)# username` *`string`* `certificate {principal-name \| fingerprint \| subject \| certificate}`. For more information about smartcard authentication, see the Smart card authentication for SSH section. | ability to determine the identities of individuals or the status of their non-repudiation is considerably impacted during forensic analysis. A strength of using PKI as MFA is that it can help ensure that only the assigned individual is using their associated user account. This can only be accomplished if the network device is configured to enforce the relationship which binds PKI certificates to unique user accounts. |
| V-251367 | The organization must implement a deep packet inspection solution when protecting perimeter boundaries. | CAT I | OS10 switches should be deployed on networks that are protected at the perimeter by compliant firewall and deep packet protection devices. | Deep packet inspection (DPI) examines the packet beyond the Layer 4 header by examining the payload to identify the application or service. DPI searches for illegal statements, predefined criteria, malformed packets, and malicious code, thereby enabling the IA appliances to make a more informed decision on whether to allow or not allow the packet through. |
| V-251368 | A deny-by-default security posture must be implemented for traffic entering and leaving the enclave. | CAT I | OS10 switches should be deployed on networks that are protected at the perimeter by compliant firewall devices. | To prevent malicious or accidental leakage of traffic, organizations must implement a deny-by-default security posture at the network perimeter. Such rulesets prevent many malicious exploits or accidental leakage by restricting the traffic to only known sources and only those ports, protocols, or services that are permitted and operationally necessary. |
| V-207113 | The perimeter router must be configured to protect an enclave that is connected to an alternate gateway by using an inbound | CAT I | Configure appropriate ACL rules for each interface. For a description of ACL configuration in OS10, see the Access Control List chapter in the *Dell SmartFabric OS10 User Guide*. | Enclaves with alternate gateway connections must take additional steps to ensure there is no compromise on the enclave network or NIPRNet. Without |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| | filter that only permits packets with destination addresses within the site address space. | | | verifying the destination address of traffic coming from the site's alternate gateway, the perimeter router could be routing transit data from the Internet into the NIPRNet. This could also make the perimeter router vulnerable to a denial-of-service (DoS) attack and provide a back door into the NIPRNet. The DoD enclave must ensure the ingress filter that is applied to external interfaces on a perimeter router connecting to an Approved Gateway is secure through filters permitting packets with a destination address belonging to the DoD enclave's address block. |
| V-207114 | The perimeter router must be configured to not be a Border Gateway Protocol (BGP) peer to an alternate gateway service provider. | CAT I | For more information about configuring BGP, see the *Border Gateway Protocol* section of the *Dell SmartFabric OS10 User Guide*. | ISPs use BGP to share route information with other autonomous systems (other ISPs and corporate networks). If the perimeter router is configured to BGP-peer with an ISP, NIPRnet routes could be advertised to the ISP; thereby creating a backdoor connection from the Internet to the NIPRnet. |
| V-207132 | The perimeter router must be configured to deny network traffic by default and allow network traffic by exception. | CAT I | Configure appropriate ACL rules for each interface. For a description of ACL configuration in OS10, see the Access Control List chapter in the *Dell EMC SmartFabric OS10 User Guide*. | A deny-all, permit-by-exception network communications traffic policy ensures that only connections that are essential and approved are allowed. |
| V-207133 | The router must be configured to restrict traffic that is destined to itself. | CAT I | See the *Control-plane ACLs* and *Configure control plane policing* chapters in the *Dell SmartFabric OS10 User Guide*. | The route processor handles traffic that is destined to the router —the key component that is used to build forwarding paths and is also instrumental with all network management functions. Hence, any disruption or DoS attack to the route processor |

**Table 8. CAT I Security Requirements (continued)**

| STIG vulnerability ID | Rule title | Category | User configuration | Comments |
|---|---|---|---|---|
| | | | | can result in mission-critical network outages. |
| V-216979 | The perimeter router must be configured to restrict it from accepting outbound IP packets that contain an illegitimate address in the source address field via egress filter or by enabling Unicast Reverse Path Forwarding (uRPF). | CAT I | Configure appropriate ACL rules for each interface. For a description of ACL configuration in OS10, see the Access Control List chapter in the *Dell EMC SmartFabric OS10 User Guide*. | DDoS attacks frequently leverage IP source address spoofing to send packets to multiple hosts that in turn will then send return traffic to the hosts with the IP addresses that were forged. This can generate significant amounts of traffic. Therefore, protection measures to counteract IP source address spoofing must be taken. When uRPF is enabled in strict mode, the packet must be received on the interface that the device would use to forward the return packet; thereby mitigating IP source address spoofing. |

# 5

# Miscellaneous configuration and management

Topics include:

**Topics:**



## Installing client software

For detailed information and procedure on the SmartFabric OS10 and SFS installation process, see the *Dell SmartFabric OS10 Installation, Upgrade, and Downgrade Guide* and the *Dell SmartFabric Services User Guide*.

## Code and Protect authenticity and integrity

OS10 secure boot provides a mechanism to verify the authenticity and integrity of the OS10 image. Secure Boot protects a system from malicious code being loaded and run during the boot process. Use the secure boot feature to validate the OS10 image during installation and on demand at any time.

**Enable secure boot**

Enabling the secure boot feature prevents a compromised kernel and system binaries from loading during the boot operation.

```
OS10(config)# secure-boot enable
OS10(config)# exit
OS10# write memory
```

**Protect the startup configuration file**

Protecting the startup configuration file saves a protected copy of the current startup config file internally. During switch boot up, the protected version of the startup configuration is loaded. Protecting the startup configuration file ensures that a compromised configuration file is not loaded when the system boots.

```
OS10(config)# secure-boot protect startup-config
OS10(config)# exit
OS10# write memory
```

**Validate OS10 image file on demand**

Validate an OS10 image file anytime to verify the signature of the image files to ensure that the OS10 image is not compromised.

```
OS10# image verify image-filepath {sha256 signature signature-filepath | gpg signature
signature-filepath | pki signature signature-filepath public-key key-file}
```

For GPG validation, before you validate the OS10 image, use the `image gpg-key key-server keyserver.ubuntu.com key-id 7FDA043B` command to install the GPG key in the switch keyring.

**Validate OS10 kernel, system binaries, and startup configuration file**

Validate the OS10 kernel binary image, system binary files, and startup configuration file at system startup. Validating these files at startup ensures that the system does not load a compromised file.

```
OS10# secure-boot verify {kernel | file-system-integrity | startup-config}
```

**Validate OS10 upgrade image files**

Validate the digital signature in the image files before installing an OS10 upgrade. You can use the following command to validate an OS10 image before installing.

```
OS10# image secure-install image-filepath {sha256 signature signature-filepath | gpg
signature signature-filepath | pki signature signature-filepath public-key key-file}
```

**NOTE:** When secure boot is enabled, you can only upgrade OS10 using the `image secure-install` command.

**Validate OS10 image before ONIE OS manual installation**

When secure boot is enabled and you manually install an OS10 image using ONIE, you can validate the image using PKI or SHA256.

```
ONIE:/ # onie-nos-install image_url pki signature_filepathcertificate_filepath
```

Or

```
ONIE:/ # onie-nos-install image_url sha256 signature_filepath
```

**Check if secure boot is enabled and the file integrity status**

Use the following commands to check the status of the secure boot operation and the file integrity status:

```
OS10# show secure-boot status
Last boot was via secure boot     : yes
Secure boot configured          : yes
Latest startup config protected     : yes
OS10# show secure-boot file-integrity-status
File Integrity Status: OK
```

**Enable bootloader protection**

To prevent unauthorized users with malicious intent from accessing your switch, protect the bootloader using a GRUB password.

```
OS10# boot protect enable username username password password
OS10# write memory
```

**Check if bootloader protection is enabled**

Use the following command to view the status of bootloader protection on the system:

```
OS10# show boot protect
Boot protection enabled
Authorized users: root linuxadmin admin
```

# System clock rules

These system clock rules enforce device time and timestamp settings.

**Set the time zone to Coordinated Universal Time (UTC)**

By default, the system time zone is set to UTC. If the default time zone is changed, set it to UTC. Setting the system time zone to UTC eliminates difficulty troubleshooting issues across different time zones.

```
OS10(config)# clock timezone standard-timezone UTC
OS10(config)# exit
OS10# write memory
```

# Physical security

This section provides information about physical security o the switch.

## Physical interfaces

**Disable unused interfaces**

To prevent unauthorized users from connecting to your network on front-end interfaces, disable the interfaces that you are not using.

```
OS10(config)# interface range ethernet 1/1/10-1/1/32
OS10(conf-range-eth1/1/10-1/1/32)# shutdown
OS10(conf-range-eth1/1/10-1/1/32)# end
OS10# write memory
```

# IPv6 support

SmartFabric OS10 supports IPv6 protocol. SmartFabric OS10 can operate in dual-stack (IPv4 and IPv6) and mixed IP mode environments.

OS10 is USGv6 certified for router and host under the 2008 profile with capabilities:

- USGv6-v1-Host: IPv6-Base+Addr-Arch+SLAAC+Link = Ethernet
- USGv6-v1-Router: IPv6-Base+Addr-Arch+SLAAC+Link = Ethernet

# A

# TLS Cipher Suites

This appendix lists the TLS cipher suites supported by Dell SmartFabric OS10.

A cipher suite defines a set of technologies to secure your TLS communications.

The following table provides the OpenSSL names of the TLS cipher suites for the network device system and the associated ports.

**Table 9. Default and Supported TLS cipher suites**

| Cipher Suites | Application | Ports |
|---|---|---|
| ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES256-GCM-SHA384<br>ECDHE-ECDSA-CHACHA20-POLY1305<br>ECDHE-RSA-CHACHA20-POLY1305<br>ECDHE-ECDSA-AES128-GCM-SHA256<br>ECDHE-RSA-AES128-GCM-SHA256 | DreamCatcher HTTPS Client | - |
| TLS_AES_256_GCM_SHA384<br>TLS_CHACHA20_POLY1305_SHA256<br>TLS_AES_128_GCM_SHA256<br>ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES256-GCM-SHA384<br>DHE-RSA-AES256-GCM-SHA384<br>ECDHE-ECDSA-CHACHA20-POLY1305<br>ECDHE-RSA-CHACHA20-POLY1305<br>DHE-RSA-CHACHA20-POLY1305<br>ECDHE-ECDSA-AES128-GCM-SHA256<br>ECDHE-RSA-AES128-GCM-SHA256<br>DHE-RSA-AES128-GCM-SHA256<br>ECDHE-ECDSA-AES256-SHA384<br>ECDHE-RSA-AES256-SHA384<br>DHE-RSA-AES256-SHA256<br>ECDHE-ECDSA-AES128-SHA256<br>ECDHE-RSA-AES128-SHA256<br>DHE-RSA-AES128-SHA256<br>ECDHE-ECDSA-AES256-SHA<br>ECDHE-RSA-AES256-SHA<br>ECDHE-ECDSA-AES128-SHA<br>ECDHE-RSA-AES128-SHA<br>RSA-PSK-AES256-GCM-SHA384<br>DHE-PSK-AES256-GCM-SHA384<br>RSA-PSK-CHACHA20-POLY1305 | HTTPS Client : Copy and Image Install | 443 |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| DHE-PSK-CHACHA20-POLY1305<br>ECDHE-PSK-CHACHA20-POLY1305<br>AES256-GCM-SHA384<br>PSK-AES256-GCM-SHA384<br>PSK-CHACHA20-POLY1305<br>RSA-PSK-AES128-GCM-SHA256<br>DHE-PSK-AES128-GCM-SHA256<br>AES128-GCM-SHA256<br>PSK-AES128-GCM-SHA256<br>AES256-SHA256<br>AES128-SHA256<br>ECDHE-PSK-AES256-CBC-SHA384<br>ECDHE-PSK-AES256-CBC-SHA<br>RSA-PSK-AES256-CBC-SHA384<br>DHE-PSK-AES256-CBC-SHA384<br>PSK-AES256-CBC-SHA384<br>ECDHE-PSK-AES128-CBC-SHA256<br>ECDHE-PSK-AES128-CBC-SHA<br>RSA-PSK-AES128-CBC-SHA256<br>DHE-PSK-AES128-CBC-SHA256<br>PSK-AES128-CBC-SHA256 | | |
| AES128-GCM-SHA256<br>AES256-GCM-SHA384<br>CHACHA20_POLY1305_SHA256<br>ECDHE-ECDSA-AES128-GCM-SHA256<br>ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES128-GCM-SHA256<br>ECDHE-RSA-AES256-GCM-SHA384 | GNMI | - |
| TLS_AES_256_GCM_SHA384<br>TLS_CHACHA20_POLY1305_SHA256<br>TLS_AES_128_GCM_SHA256<br>ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES256-GCM-SHA384<br>DHE-DSS-AES256-GCM-SHA384<br>DHE-RSA-AES256-GCM-SHA384<br>ECDHE-ECDSA-CHACHA20-POLY1305<br>ECDHE-RSA-CHACHA20-POLY1305<br>DHE-RSA-CHACHA20-POLY1305<br>ECDHE-ECDSA-AES256-CCM8<br>ECDHE-ECDSA-AES256-CCM | OpenFlow TLS Client | - |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| DHE-RSA-AES256-CCM8 | | |
| DHE-RSA-AES256-CCM | | |
| ECDHE-ECDSA-ARIA256-GCM-SHA384 | | |
| ECDHE-ARIA256-GCM-SHA384 | | |
| DHE-DSS-ARIA256-GCM-SHA384 | | |
| DHE-RSA-ARIA256-GCM-SHA384 | | |
| ECDHE-ECDSA-AES256-SHA384 | | |
| ECDHE-RSA-AES256-SHA384 | | |
| DHE-RSA-AES256-SHA256 | | |
| DHE-DSS-AES256-SHA256 | | |
| ECDHE-ECDSA-CAMELLIA256-SHA384 | | |
| ECDHE-RSA-CAMELLIA256-SHA384 | | |
| DHE-RSA-CAMELLIA256-SHA256 | | |
| DHE-DSS-CAMELLIA256-SHA256 | | |
| ECDHE-ECDSA-AES256-SHA | | |
| ECDHE-RSA-AES256-SHA | | |
| AECDH-AES256-SHA | | |
| RSA-PSK-AES256-GCM-SHA384 | | |
| DHE-PSK-AES256-GCM-SHA384 | | |
| RSA-PSK-CHACHA20-POLY1305 | | |
| DHE-PSK-CHACHA20-POLY1305 | | |
| ECDHE-PSK-CHACHA20-POLY1305 | | |
| DHE-PSK-AES256-CCM8 | | |
| DHE-PSK-AES256-CCM | | |
| RSA-PSK-ARIA256-GCM-SHA384 | | |
| DHE-PSK-ARIA256-GCM-SHA384 | | |
| AES256-GCM-SHA384 | | |
| AES256-CCM8 | | |
| AES256-CCM | | |
| ARIA256-GCM-SHA384 | | |
| PSK-AES256-GCM-SHA384 | | |
| PSK-CHACHA20-POLY1305 | | |
| PSK-AES256-CCM8 | | |
| PSK-AES256-CCM | | |
| PSK-ARIA256-GCM-SHA384 | | |
| AES256-SHA256 | | |
| CAMELLIA256-SHA256 | | |
| ECDHE-PSK-AES256-CBC-SHA384 | | |
| ECDHE-PSK-AES256-CBC-SHA | | |
| RSA-PSK-AES256-CBC-SHA384 | | |
| DHE-PSK-AES256-CBC-SHA384 | | |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| ECDHE-PSK-CAMELLIA256-SHA384 | | |
| RSA-PSK-CAMELLIA256-SHA384 | | |
| DHE-PSK-CAMELLIA256-SHA384 | | |
| PSK-AES256-CBC-SHA384 | | |
| PSK-CAMELLIA256-SHA384 | | |
| ECDHE-ECDSA-AES128-GCM-SHA256 | | |
| ECDHE-RSA-AES128-GCM-SHA256 | | |
| DHE-DSS-AES128-GCM-SHA256 | | |
| DHE-RSA-AES128-GCM-SHA256 | | |
| ECDHE-ECDSA-AES128-CCM8 | | |
| ECDHE-ECDSA-AES128-CCM | | |
| DHE-RSA-AES128-CCM8 | | |
| DHE-RSA-AES128-CCM | | |
| ECDHE-ECDSA-ARIA128-GCM-SHA256 | | |
| ECDHE-ARIA128-GCM-SHA256 | | |
| DHE-DSS-ARIA128-GCM-SHA256 | | |
| DHE-RSA-ARIA128-GCM-SHA256 | | |
| ECDHE-ECDSA-AES128-SHA256 | | |
| ECDHE-RSA-AES128-SHA256 | | |
| DHE-RSA-AES128-SHA256 | | |
| DHE-DSS-AES128-SHA256 | | |
| ECDHE-ECDSA-CAMELLIA128-SHA256 | | |
| ECDHE-RSA-CAMELLIA128-SHA256 | | |
| DHE-RSA-CAMELLIA128-SHA256 | | |
| DHE-DSS-CAMELLIA128-SHA256 | | |
| ECDHE-ECDSA-AES128-SHA | | |
| ECDHE-RSA-AES128-SHA | | |
| AECDH-AES128-SHA | | |
| RSA-PSK-AES128-GCM-SHA256 | | |
| DHE-PSK-AES128-GCM-SHA256 | | |
| DHE-PSK-AES128-CCM8 | | |
| DHE-PSK-AES128-CCM | | |
| RSA-PSK-ARIA128-GCM-SHA256 | | |
| DHE-PSK-ARIA128-GCM-SHA256 | | |
| AES128-GCM-SHA256 | | |
| AES128-CCM8 | | |
| AES128-CCM | | |
| ARIA128-GCM-SHA256 | | |
| PSK-AES128-GCM-SHA256 | | |
| PSK-AES128-CCM8 | | |
| PSK-AES128-CCM | | |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| PSK-ARIA128-GCM-SHA256<br>AES128-SHA256<br>CAMELLIA128-SHA256<br>ECDHE-PSK-AES128-CBC-SHA256<br>ECDHE-PSK-AES128-CBC-SHA<br>RSA-PSK-AES128-CBC-SHA256<br>DHE-PSK-AES128-CBC-SHA256<br>ECDHE-PSK-CAMELLIA128-SHA256<br>RSA-PSK-CAMELLIA128-SHA256<br>DHE-PSK-CAMELLIA128-SHA256<br>PSK-AES128-CBC-SHA256<br>PSK-CAMELLIA128-SHA256 | | |
| TLS_AES_256_GCM_SHA384<br>TLS_CHACHA20_POLY1305_SHA256<br>TLS_AES_128_GCM_SHA256<br>DHE-RSA-AES256-SHA256<br>DHE-RSA-AES256-SHA<br>AES256-SHA256<br>RSA-PSK-AES256-CBC-SHA384<br>RSA-PSK-AES256-CBC-SHA<br>AES256-SHA<br>DHE-RSA-AES128-SHA256<br>DHE-RSA-AES128-SHA<br>AES128-SHA256<br>RSA-PSK-AES128-CBC-SHA256<br>RSA-PSK-AES128-CBC-SHA<br>AES128-SHA | RADIUS TLS Client | - |
| DHE-RSA-AES128-GCM-SHA256<br>DHE-RSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES128-GCM-SHA256<br>ECDHE-RSA-AES256-GCM-SHA384 | REST HTTPS Server | 443 |
| ecdh-sha2-nistp256 (256)<br>diffie-hellman-group16-sha512 (4096)<br>diffie-hellman-group14-sha1 (2048) | SSH server | 22 |
| TLS_AES_256_GCM_SHA384<br>TLS_CHACHA20_POLY1305_SHA256<br>TLS_AES_128_GCM_SHA256<br>ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES256-GCM-SHA384 | Stunnel for Redis-server | - |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| ECDHE-ECDSA-CHACHA20-POLY1305 | | |
| ECDHE-RSA-CHACHA20-POLY1305 | | |
| ECDHE-ECDSA-AES256-CCM8 | | |
| ECDHE-ECDSA-AES256-CCM | | |
| ECDHE-ECDSA-ARIA256-GCM-SHA384 | | |
| ECDHE-ARIA256-GCM-SHA384 | | |
| ECDHE-ECDSA-AES128-GCM-SHA256 | | |
| ECDHE-RSA-AES128-GCM-SHA256 | | |
| ECDHE-ECDSA-AES128-CCM8 | | |
| ECDHE-ECDSA-AES128-CCM | | |
| ECDHE-ECDSA-ARIA128-GCM-SHA256 | | |
| ECDHE-ARIA128-GCM-SHA256 | | |
| ECDHE-ECDSA-AES256-SHA384 | | |
| ECDHE-RSA-AES256-SHA384 | | |
| ECDHE-ECDSA-CAMELLIA256-SHA384 | | |
| ECDHE-RSA-CAMELLIA256-SHA384 | | |
| ECDHE-ECDSA-AES128-SHA256 | | |
| ECDHE-RSA-AES128-SHA256 | | |
| ECDHE-ECDSA-CAMELLIA128-SHA256 | | |
| ECDHE-RSA-CAMELLIA128-SHA256 | | |
| ECDHE-ECDSA-AES256-SHA | | |
| ECDHE-RSA-AES256-SHA | | |
| ECDHE-ECDSA-AES128-SHA | | |
| ECDHE-RSA-AES128-SHA | | |
| RSA-PSK-AES256-GCM-SHA384 | | |
| DHE-PSK-AES256-GCM-SHA384 | | |
| RSA-PSK-CHACHA20-POLY1305 | | |
| DHE-PSK-CHACHA20-POLY1305 | | |
| ECDHE-PSK-CHACHA20-POLY1305 | | |
| DHE-PSK-AES256-CCM8 | | |
| DHE-PSK-AES256-CCM | | |
| RSA-PSK-ARIA256-GCM-SHA384 | | |
| DHE-PSK-ARIA256-GCM-SHA384 | | |
| AES256-GCM-SHA384 | | |
| AES256-CCM8 | | |
| AES256-CCM | | |
| ARIA256-GCM-SHA384 | | |
| PSK-AES256-GCM-SHA384 | | |
| PSK-CHACHA20-POLY1305 | | |
| PSK-AES256-CCM8 | | |
| PSK-AES256-CCM | | |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| PSK-ARIA256-GCM-SHA384 | | |
| RSA-PSK-AES128-GCM-SHA256 | | |
| DHE-PSK-AES128-GCM-SHA256 | | |
| DHE-PSK-AES128-CCM8 | | |
| DHE-PSK-AES128-CCM | | |
| RSA-PSK-ARIA128-GCM-SHA256 | | |
| DHE-PSK-ARIA128-GCM-SHA256 | | |
| AES128-GCM-SHA256 | | |
| AES128-CCM8 | | |
| AES128-CCM | | |
| ARIA128-GCM-SHA256 | | |
| PSK-AES128-GCM-SHA256 | | |
| PSK-AES128-CCM8 | | |
| PSK-AES128-CCM | | |
| PSK-ARIA128-GCM-SHA256 | | |
| AES256-SHA256 | | |
| CAMELLIA256-SHA256 | | |
| AES128-SHA256 | | |
| CAMELLIA128-SHA256 | | |
| ECDHE-PSK-AES256-CBC-SHA384 | | |
| ECDHE-PSK-AES256-CBC-SHA | | |
| RSA-PSK-AES256-CBC-SHA384 | | |
| DHE-PSK-AES256-CBC-SHA384 | | |
| ECDHE-PSK-CAMELLIA256-SHA384 | | |
| RSA-PSK-CAMELLIA256-SHA384 | | |
| DHE-PSK-CAMELLIA256-SHA384 | | |
| PSK-AES256-CBC-SHA384 | | |
| PSK-CAMELLIA256-SHA384 | | |
| ECDHE-PSK-AES128-CBC-SHA256 | | |
| ECDHE-PSK-AES128-CBC-SHA | | |
| RSA-PSK-AES128-CBC-SHA256 | | |
| DHE-PSK-AES128-CBC-SHA256 | | |
| ECDHE-PSK-CAMELLIA128-SHA256 | | |
| RSA-PSK-CAMELLIA128-SHA256 | | |
| DHE-PSK-CAMELLIA128-SHA256 | | |
| PSK-AES128-CBC-SHA256 | | |
| PSK-CAMELLIA128-SHA256 | | |
| DHE-DSS-AES256-GCM-SHA384 | | |
| DHE-RSA-AES256-GCM-SHA384 | | |
| DHE-RSA-CHACHA20-POLY1305 | | |
| DHE-RSA-AES256-CCM8 | | |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| DHE-RSA-AES256-CCM<br>DHE-DSS-ARIA256-GCM-SHA384<br>DHE-RSA-ARIA256-GCM-SHA384<br>DHE-DSS-AES128-GCM-SHA256<br>DHE-RSA-AES128-GCM-SHA256<br>DHE-RSA-AES128-CCM8<br>DHE-RSA-AES128-CCM<br>DHE-DSS-ARIA128-GCM-SHA256<br>DHE-RSA-ARIA128-GCM-SHA256<br>DHE-RSA-AES256-SHA256<br>DHE-DSS-AES256-SHA256<br>DHE-RSA-CAMELLIA256-SHA256<br>DHE-DSS-CAMELLIA256-SHA256<br>DHE-RSA-AES128-SHA256<br>DHE-DSS-AES128-SHA256<br>DHE-RSA-CAMELLIA128-SHA256<br>DHE-DSS-CAMELLIA128-SHA256 | | |
| DHE-RSA-AES256-SHA256<br>DHE-RSA-AES128-SHA256<br>AES256-SHA256<br>AES128-SHA256 | Syslog-ng TLS client | - |
| AES128-GCM-SHA256<br>AES256-GCM-SHA384<br>CHACHA20_POLY1305_SHA256<br>ECDHE-ECDSA-AES128-GCM-SHA256<br>ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES128-GCM-SHA256<br>ECDHE-RSA-AES256-GCM-SHA384 | Telemetry Agent - GRPC TLS Client | - |
| TLS_AES_256_GCM_SHA384<br>TLS_CHACHA20_POLY1305_SHA256<br>TLS_AES_128_GCM_SHA256<br>ECDHE-ECDSA-AES256-GCM-SHA384<br>ECDHE-RSA-AES256-GCM-SHA384<br>DHE-DSS-AES256-GCM-SHA384<br>DHE-RSA-AES256-GCM-SHA384<br>ECDHE-ECDSA-CHACHA20-POLY1305<br>ECDHE-RSA-CHACHA20-POLY1305<br>DHE-RSA-CHACHA20-POLY1305<br>ECDHE-ECDSA-AES256-CCM8<br>ECDHE-ECDSA-AES256-CCM | VXLAN VTEP TLS Client | - |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| DHE-RSA-AES256-CCM8 | | |
| DHE-RSA-AES256-CCM | | |
| ECDHE-ECDSA-ARIA256-GCM-SHA384 | | |
| ECDHE-ARIA256-GCM-SHA384 | | |
| DHE-DSS-ARIA256-GCM-SHA384 | | |
| DHE-RSA-ARIA256-GCM-SHA384 | | |
| ECDHE-ECDSA-AES256-SHA384 | | |
| ECDHE-RSA-AES256-SHA384 | | |
| DHE-RSA-AES256-SHA256 | | |
| DHE-DSS-AES256-SHA256 | | |
| ECDHE-ECDSA-CAMELLIA256-SHA384 | | |
| ECDHE-RSA-CAMELLIA256-SHA384 | | |
| DHE-RSA-CAMELLIA256-SHA256 | | |
| DHE-DSS-CAMELLIA256-SHA256 | | |
| ECDHE-ECDSA-AES256-SHA | | |
| ECDHE-RSA-AES256-SHA | | |
| AECDH-AES256-SHA | | |
| RSA-PSK-AES256-GCM-SHA384 | | |
| DHE-PSK-AES256-GCM-SHA384 | | |
| RSA-PSK-CHACHA20-POLY1305 | | |
| DHE-PSK-CHACHA20-POLY1305 | | |
| ECDHE-PSK-CHACHA20-POLY1305 | | |
| DHE-PSK-AES256-CCM8 | | |
| DHE-PSK-AES256-CCM | | |
| RSA-PSK-ARIA256-GCM-SHA384 | | |
| DHE-PSK-ARIA256-GCM-SHA384 | | |
| AES256-GCM-SHA384 | | |
| AES256-CCM8 | | |
| AES256-CCM | | |
| ARIA256-GCM-SHA384 | | |
| PSK-AES256-GCM-SHA384 | | |
| PSK-CHACHA20-POLY1305 | | |
| PSK-AES256-CCM8 | | |
| PSK-AES256-CCM | | |
| PSK-ARIA256-GCM-SHA384 | | |
| AES256-SHA256 | | |
| CAMELLIA256-SHA256 | | |
| ECDHE-PSK-AES256-CBC-SHA384 | | |
| ECDHE-PSK-AES256-CBC-SHA | | |
| RSA-PSK-AES256-CBC-SHA384 | | |
| DHE-PSK-AES256-CBC-SHA384 | | |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| ECDHE-PSK-CAMELLIA256-SHA384 | | |
| RSA-PSK-CAMELLIA256-SHA384 | | |
| DHE-PSK-CAMELLIA256-SHA384 | | |
| PSK-AES256-CBC-SHA384 | | |
| PSK-CAMELLIA256-SHA384 | | |
| ECDHE-ECDSA-AES128-GCM-SHA256 | | |
| ECDHE-RSA-AES128-GCM-SHA256 | | |
| DHE-DSS-AES128-GCM-SHA256 | | |
| DHE-RSA-AES128-GCM-SHA256 | | |
| ECDHE-ECDSA-AES128-CCM8 | | |
| ECDHE-ECDSA-AES128-CCM | | |
| DHE-RSA-AES128-CCM8 | | |
| DHE-RSA-AES128-CCM | | |
| ECDHE-ECDSA-ARIA128-GCM-SHA256 | | |
| ECDHE-ARIA128-GCM-SHA256 | | |
| DHE-DSS-ARIA128-GCM-SHA256 | | |
| DHE-RSA-ARIA128-GCM-SHA256 | | |
| ECDHE-ECDSA-AES128-SHA256 | | |
| ECDHE-RSA-AES128-SHA256 | | |
| DHE-RSA-AES128-SHA256 | | |
| DHE-DSS-AES128-SHA256 | | |
| ECDHE-ECDSA-CAMELLIA128-SHA256 | | |
| ECDHE-RSA-CAMELLIA128-SHA256 | | |
| DHE-RSA-CAMELLIA128-SHA256 | | |
| DHE-DSS-CAMELLIA128-SHA256 | | |
| ECDHE-ECDSA-AES128-SHA | | |
| ECDHE-RSA-AES128-SHA | | |
| AECDH-AES128-SHA | | |
| RSA-PSK-AES128-GCM-SHA256 | | |
| DHE-PSK-AES128-GCM-SHA256 | | |
| DHE-PSK-AES128-CCM8 | | |
| DHE-PSK-AES128-CCM | | |
| RSA-PSK-ARIA128-GCM-SHA256 | | |
| DHE-PSK-ARIA128-GCM-SHA256 | | |
| AES128-GCM-SHA256 | | |
| AES128-CCM8 | | |
| AES128-CCM | | |
| ARIA128-GCM-SHA256 | | |
| PSK-AES128-GCM-SHA256 | | |
| PSK-AES128-CCM8 | | |
| PSK-AES128-CCM | | |

**Table 9. Default and Supported TLS cipher suites (continued)**

| Cipher Suites | Application | Ports |
|---|---|---|
| PSK-ARIA128-GCM-SHA256<br>AES128-SHA256<br>CAMELLIA128-SHA256<br>ECDHE-PSK-AES128-CBC-SHA256<br>ECDHE-PSK-AES128-CBC-SHA<br>RSA-PSK-AES128-CBC-SHA256<br>DHE-PSK-AES128-CBC-SHA256<br>ECDHE-PSK-CAMELLIA128-SHA256<br>RSA-PSK-CAMELLIA128-SHA256<br>DHE-PSK-CAMELLIA128-SHA256<br>PSK-AES128-CBC-SHA256<br>PSK-CAMELLIA128-SHA256 | | |