ExtremeCloud™ Orchestrator v4.0.2 Security Configuration Guide

Authentication, Authorization, and Hardening

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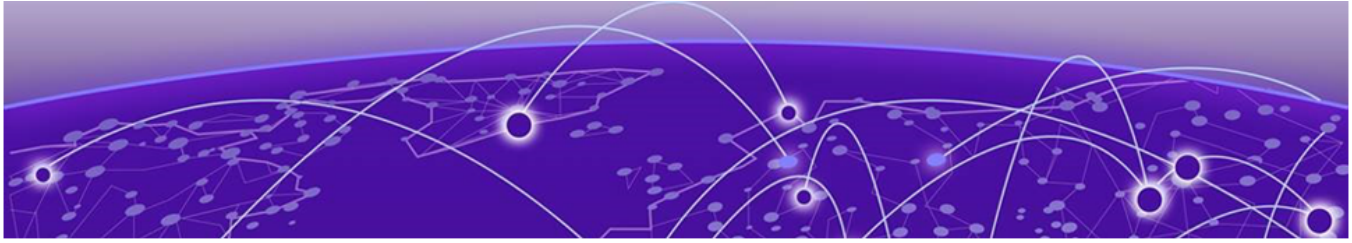

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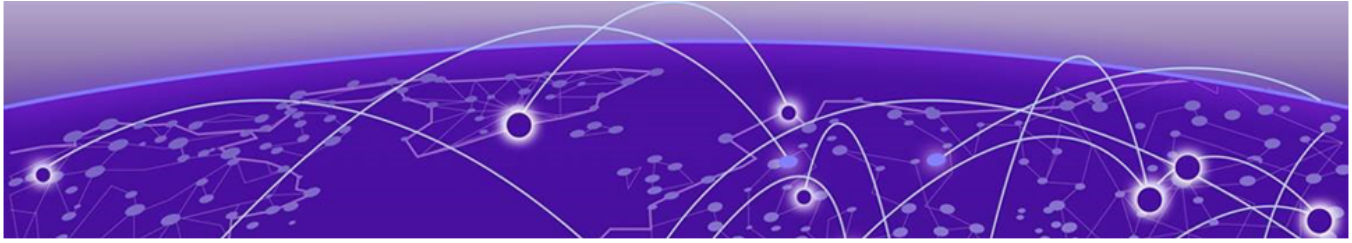

Abstract

This security configuration guide for ExtremeCloud™ Orchestrator version 4.0.2 outlines comprehensive procedures for implementing robust authentication, authorization, and system hardening across managed environments. It details CLI-based configuration of authentication policies using Unix, LDAP, and TACACS+, and enforces role-based access control (RBAC) for REST APIs. The guide includes instructions for managing local users, assigning roles via LDAP groups or custom attributes, and configuring BGP MD5 authentication for both fabric and edge links, with phased deployment strategies to minimize network disruption. System hardening techniques cover Ubuntu Linux and SLX-OS devices, including CIS-CAT assessments, iptables firewall policies, secure GRUB bootloader settings, auditd logging, OSSEC HIDS, authenticated NTP, encrypted DNS via dnscrypt-proxy, and rootkit detection with rkhunter. Designed for technically proficient administrators, the document ensures secure deployment and operation of XCO in both Clos and non-Clos topologies, with emphasis on configuration idempotency, drift reconciliation, and secure password handling.

Preface

Read the following topics to learn about:

- The meanings of text formats used in this document.
- Where you can find additional information and help.
- How to reach us with questions and comments.

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	Warning	Risk of severe personal injury

Table 2: Text

Convention	Description
`screen displays`	This typeface indicates command syntax, or represents information as it is displayed on the screen.
The words *enter* and *type*	When you see the word *enter* in this guide, you must type something, and then press the Return or Enter key. Do not press the Return or Enter key when an instruction simply says *type*.
Key names	Key names are written in boldface, for example **Ctrl** or **Esc**. If you must press two or more keys simultaneously, the key names are linked with a plus sign (+). Example: Press **Ctrl**+**Alt**+**Del**
Words in italicized type	Italics emphasize a point or denote new terms at the place where they are defined in the text. Italics are also used when referring to publication titles.
NEW!	New information. In a PDF, this is searchable text.

Table 3: Command syntax

Convention	Description
bold text	Bold text indicates command names, keywords, and command options.
italic text	Italic text indicates variable content.
`[ ]`	Syntax components displayed within square brackets are optional. Default responses to system prompts are enclosed in square brackets.
`{ x | y | z }`	A choice of required parameters is enclosed in curly brackets separated by vertical bars. You must select one of the options.
x | **y**	A vertical bar separates mutually exclusive elements.
< >	Nonprinting characters, such as passwords, are enclosed in angle brackets.
...	Repeat the previous element, for example, *member*[*member*...].
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- A description of any actions already taken to resolve the problem
- A description of your network environment (such as layout, cable type, other relevant environmental information)
- Network load at the time of trouble (if known)
- The device history (for example, if you have returned the device before, or if this is a recurring problem)
- Any related RMA (Return Material Authorization) numbers

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Provide as much detail as possible including the publication title, topic heading, and page number (if applicable), along with your comments and suggestions for improvement.

What's New in this Document

As of version 4.0.0, the ExtremeCloud Orchestrator (XCO) no longer includes support for the Visibility Skill. This deprecation follows the official End-of-Sale (EOS) announcement issued on February, 2025.

The following table describes information updated to this guide for the ExtremeCloud Orchestrator (XCO) 4.0.2 software release.

Table 4: Summary of changes

Description	Link
Updated procedure for changing TPVM password in High Availability Deployment	Update TPVM Password in High Availability Deployment on page 19
System Hardening for CIS-CAT Assessments	System Hardening for CIS-CAT Assessments on page 50

Security Features in XCO

The following section provides an overview of the security features in ExtremeCloud Orchestrator (XCO).

Note
From release 3.2.0 onwards, Extreme Fabric Automation (EFA) is referred to as ExtremeCloud Orchestrator (XCO). The terms EFA and XCO refer to the same product and are used interchangeably.

XCO is always installed in secure mode and is operational. For details on how to achieve this, refer to the *ExtremeCloud Orchestrator CLI Administration Guide, 4.0.2*, which includes details on XCO security options and commands.

The following section provides detailed information on security features:

- **Authentication and authorization**: Explains how XCO users are validated and managed with Role-based Access Control (RBAC).
- **BGP MD5 authentication on edge links**: How to authenticate all the BGP peer and peer-group used for edge connectivity.
- **BGP MD5 authentication on fabric links**: How to use MD5 for BGP connections across all fabric links.

XCO User Authentication and Authorization

At installation time, starting with EFA 2.5.0, all XCO users of services such as MySQL and RabbitMQ are assigned random passwords that are stored in XCO configuration files. This satisfies the requirement to enforce the change of default passwords, and no two XCO installations share identical passwords.

For more information, see XCO RBAC Policy Enforcement on page 15 and Assign and View XCO Roles on page 14.

Authentication

XCO validates users and their credentials using the following mechanisms:

- Unix authentication (local and remote) on the host where XCO is installed. Host credentials are the default validation method if LDAP validation fails.

- External LDAP server: Users configured in LDAP use their LDAP credentials to log in to XCO.
- Authentication support:

  1. External authentication:

     a. LDAP
     b. TACACS
     c. Auth preference and fallback

  The following graphic illustrates how users can check all modes of authentication at the same time. Define the authentication preference to help users to configure multiple modes of authentication at once.

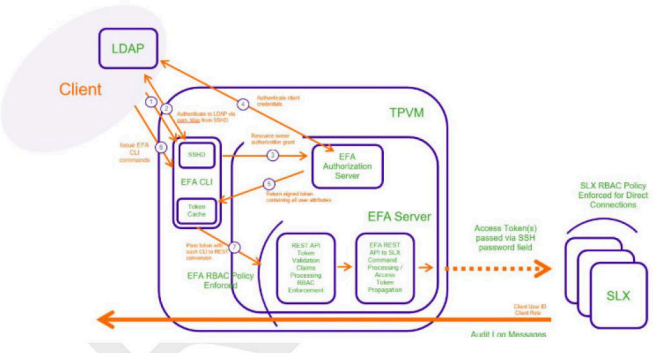


Figure 1: LDAP authentication example

Operational or maintenance tasks are propagated to SLX-OS devices through OAuth2 and JWT access tokens. TLS is used for connections with SLX-OS devices. When XCO is installed in secure mode, traffic to northbound interfaces uses TLS. For more information about secure mode, see the "XCO Installation Modes" topic in the *ExtremeCloud Orchestrator Deployment Guide, 4.0.2*.

Authentication Policy CLI configuration

For CLI users, the auth preference configuration is available under `efa auth authentication preference`.

```
KVM:~$ efa auth authentication preference

Available Commands:
  add         Add the authentication preference
  update      Update the authentication preference
  delete      Delete the authentication preference
  show        show authentication preference
```

Show authentication preference:

```
KVM:~$ efa auth authentication preference show
+-----------+------------+------------+
| Auth Type | Identifier | Preference |
+-----------+------------+------------+
| HOST      | HOST       | 1          |
+-----------+------------+------------+
```

Add authentication preference:

```
KVM:~$ efa auth authentication preference add --authType=LOCAL --identifier=LOCAL --
preference=3
Successfully updated the auth preference.

+-----------+------------+------------+
| Auth Type | Identifier | Preference |
+-----------+------------+------------+
| LOCAL     | LOCAL      | 3          |
+-----------+------------+------------+
```

Show authentication preference:

```
KVM:~$ efa auth authentication preference show
+-----------+------------+------------+
| Auth Type | Identifier | Preference |
+-----------+------------+------------+
| HOST      | HOST       | 1          |
+-----------+------------+------------+
| LOCAL     | LOCAL      | 3          |
+-----------+------------+------------+
```

Update authentication preference:

```
KVM:~$ efa auth authentication preference update --authType=LOCAL --identifier=LOCAL --
preference=2
Successfully updated the auth preference.

+-----------+------------+------------+
| Auth Type | Identifier | Preference |
+-----------+------------+------------+
| LOCAL     | LOCAL      | 2          |
+-----------+------------+------------+

KVM:~$ efa auth authentication preference delete --authType=LOCAL --identifier=LOCAL
```

Add authentication preference for TACACS authentication:

```
efa auth authentication preference add --authType=TACACS --identifier=10.37.135.12 --
preference=3
Successfully added the auth preference.

+-----------+--------------+------------+
| Auth Type | Identifier   | Preference |
+-----------+--------------+------------+
| TACACS    | 10.37.135.12 | 3          |
+-----------+--------------+------------+

efa auth authentication preference add --authType=LDAP --identifier=kvm12.com --
preference=4
Successfully added the auth preference.
```

Add authentication preference for LDAP authentication:

```
efa auth authentication preference add --authType=LDAP --identifier=kvm12.com --
preference=4
Successfully added the auth preference.

+-----------+------------+------------+
| Auth Type | Identifier | Preference |
+-----------+------------+------------+
| LDAP      | kvm12.com  | 4          |
+-----------+------------+------------+
```

Show authentication preference:

```
efa auth authentication preference show
+-----------+--------------+------------+
| Auth Type | Identifier   | Preference |
+-----------+--------------+------------+
| HOST      | HOST         | 1          |
+-----------+--------------+------------+
| LOCAL     | LOCAL        | 2          |
+-----------+--------------+------------+
| TACACS    | 10.37.135.12 | 3          |
+-----------+--------------+------------+
| LDAP      | kvm12.com    | 4          |
+-----------+--------------+------------+
```

Authorization

After XCO is deployed, the installer has the role of SystemAdmin and has complete access to XCO functionality. For installation on TPVM, this user has the username ‘extreme’. By default, no other host OS users can access XCO unless the SystemAdmin assigns the appropriate roles. RBAC occurs on XCO and API.

Assign and View XCO Roles

You can assign a role to a user and to an LDAP group. For more information about XCO roles, see XCO RBAC Policy Enforcement on page 15.

1. To assign a role to a user, run the following command:

   ```
   # efa auth rolemapping add --name=user2 --role SystemAdmin –auth-type HOST
   Successfully added the role mapping
   ```

   In this example, a user named user2 was assigned the role of SystemAdmin.
2. To assign a role to an LDAP group, run the following command:

   ```
   # efa auth rolemapping add --name "cn=viewer,dc=extr,dc=com" --role NetworkOperator
   --type group
   --auth-type LDAP --auth-identifier ldapconfig
   Successfully added the role mapping.
   ```

   In this example, a group named "cn=viewer,dc=extr,dc=com" was assigned the role of NetworkOperator.
3. To view all role assignments, run the following command:

   ```
   # efa auth rolemapping show
   +----+----------+-----------------+-------+-----------+------------+
   | ID | Name     | Role            | Type  | Auth Type | Auth Identifier
   | +----+----------+-----------------+-------+-----------+------------+
   | 1  | efauser  | SystemAdmin     | USER  | HOST      |
   | +----+----------+-----------------+-------+-----------+------------+
   | 2 | fabricuser| FabricAdmin     | USER | LOCAL      |
   | +----+----------+-----------------+-------+-----------+------------+
   | 3 | viewer     | NetworkOperator | GROUP  | TACACS      | 10.x.x.x
   | +----+----------+-----------------+-------+-----------+------------+
   | 5 | cn=viewer,dc=extr,dc=com    | NetworkOperator     | GROUP  | LDAP      |
   ldapconfig
   | +----+----------+-----------------+-------+-----------+------------+
   ```

4. To delete a role assignment, run the following command:

```
# efa auth rolemapping remove --id 3
Deleted role mapping successfully
```

In this example, the role for the user with ID 3 was removed.

XCO RBAC Policy Enforcement

XCO implements an RBAC policy governing access to northbound REST APIs.

The RBAC policy is enforced at the northbound interface, immediately after validation of the access token. An error message is returned if the RBAC permission check fails.

Security Troubleshooting

Use the following logs to troubleshoot authentication, authorization, or RBAC issues.

Table 5: Security log locations

Log source	Filepath
XCO server	`/var/log/efa/auth/auth-server.log` `/var/log/efa/rbac/rbac-server.log`
XCO TPVM	`/apps/efa_logs/auth/auth-server.log` `/apps/efa_logs/rbac/rbac-server.log`
SLX-OS device	`/var/log/pam-oauth2.log`

Use the following commands to see the list of commands that were run during a specified time and identify potential causes for issues, such as when an RBAC error occurred.

- **`efa auth execution show`**
- **`efa rbac execution show`**
- **`efa inventory execution show`**

RBAC and REST URI Matrix

The RBAC policy is expressed in a permissions matrix indexed by RBAC role and REST URI, in which each matrix element enumerates the permitted HTTP methods.

Table 6: RBAC and REST Matrix

	Role A	Role B	Role C
REST URI 1	GET	GET	GET, POST, PUT, PATCH, DELETE
REST URI 2	GET, POST	GET, POST, PUT	GET, POST, PUT, PATCH, DELETE
REST URI 3	GET, POST	GET, POST	GET, POST, PUT, PATCH, DELETE

RBAC Roles

Roles can be populated into the upstream LDAP instance.

Note
The SystemAdmin and NetworkOperator roles are applicable for VM mode of installation.

Table 7: Role definitions

Role	Description
FabricAdmin	• Registers devices to the fabric • Configures fabric parameters • Validates all devices in the fabric • Configures switches for IP fabric with overlay and without overlay • Creates tenants • Creates networks inside tenants, such as VRF, EPG, and PO • Performs fabric debug activities • Has privileges for Hyper-V and vCenter operations
SecurityAdmin	Performs user management, PKI, and key management operations
NetworkOperator	• Has view-only privileges for fabric configurations, information for tenants and inventory, and all ecosystem information • Cannot make changes in the system
SystemDebugger	• Has privileges to perform supportsave and system backup, and to view the running system configurations • Has privileges to perform fabric debug operations • Sets debug levels for services • Has privileges to collect execution logs from services
SystemAdmin	Has complete privileges to all operations in the system
<Tenant>Admin * Created dynamically per tenant	Performs tenant administration within the assigned tenant, such as the following: • Adds networks to the tenant • Configures network parameters • Configure switches with tenant-specific information Cannot perform actions for any other tenant

* Tenant Administrator roles are added dynamically to the system when a tenant is created. The name of the role is presented in the `<Tenant-name>Admin` format. For example, if a tenant with the name “RegionOne” is created, the role created for the Tenant Administrator is “RegionOneAdmin”.

Note
You cannot create custom roles.

Role Permissions

Table 8: Role permissions for fabric manager

Allowed Privileges	System Admin	Fabric Admin	Tenant Admin	Network Operator	Security Admin	System Debugger
Create, clone, delete fabric in the system	✓	✓				
Register, unregister devices in fabric, configure IP fabric on the device	✓	✓				
Add, delete, and update location	✓	✓				
Show IP fabric physical, underlay, overlay topology, IP fabric configs and devices in IP fabric	✓	✓		✓		
Debug fabric operations	✓	✓				✓
Inventory, asset service operations	✓	✓				
Run CLI access on the device	✓	✓				
Create, delete, update tenants	✓	✓				✓
Create, delete EPG, PO, VRFs inside tenant	✓	✓	✓			
Add, remove port, port channels to and from EPG	✓	✓	✓			
Add, remove network policies to EPG	✓	✓	✓			
Detach network from EPG	✓	✓	✓			
Identify drift in device configuration	✓	✓				
Set tenant debug level	✓	✓	✓			✓
Create, delete router interfaces	✓	✓	✓			

Table 8: Role permissions for fabric manager (continued)

Allowed Privileges	System Admin	Fabric Admin	Tenant Admin	Network Operator	Security Admin	System Debugger
View vCenter details, events, ESXI details, physical links, virtual links, disconnected links, get server settings	✓	✓	✓	✓		
Register, delete, update vCenter	✓	✓	✓			
Set vCenter debug level	✓	✓	✓			✓
Update vCenter polling frequency, dead link clearing time	✓	✓	✓			
View SCVMM server details, service settings, physical links, virtual links	✓	✓	✓	✓		
Register, delete, update SCVMM server	✓	✓	✓			
Update SCVMM server polling frequency	✓	✓	✓			
User management, assign roles to users, configure LDAP, configure TACACS+, view available roles in the system	✓			✓	✓	
Notification service (add, delete subscribers)	✓	✓				
Execution log view	✓	✓ (No Auth and RBAC)	✓ (only Tenant)	✓	✓ (only Auth and RBAC)	✓
Support save collection	✓	✓	✓	✓	✓	✓
Backup and restore operation	✓	✓ (only backup)				✓
Install certificates	✓	✓			✓	

Update TPVM Password in High Availability Deployment

Update the TPVM password at both the Linux and SLX-OS configuration levels to ensure credential synchronization and upgrade persistence.

Caution
Changing only the Linux password does not update the SLX-OS configuration. This may result in password rollback during configuration replay or upgrade.

- Ensure console access to both SLX-OS switches hosting the TPVM instances.
- Plan a maintenance window. Removing trusted-peer temporarily causes the standby EFA node to go down.

This procedure applies to HA deployments where two TPVM instances operate in active/standby mode.

For details on changing TPVM password after a TPVM upgrade, see "TPVM Complete Package Upgrade" and “Change TPVM Password from XCO” in the ExtremeCloud Orchestrator Deployment Guide, 4.0.2.

1. Verify the HA state.

   ```
   efa status
   ```

2. Remove trusted-peer configuration from both switches.

   ```
   configure terminal
   tpvm
   no trusted-peer
   ```

   The standby EFA node transitions to down state after this command.

3. On the switch hosting the standby TPVM instance, update the TPVM password.

   ```
   configure terminal
   tpvm
   password NEWPASSWORD
   ```

4. For SLX-OS versions earlier than 20.6.3, restart the TPVM instance.

   ```
   tpvm stop
   tpvm start
   ```

   From SLX-OS 20.6.3 onward, TPVM does not need to be stopped before updating the password.

5. Repeat the password update on the switch hosting the active TPVM instance.
6. Reconfigure trusted-peer with the new password.

   ```
   trusted-peer ip <peer-ip> password NEWPASSWORD
   ```

7. Verify that both TPVM instances are operational.

   ```
   efa status
   ```

The TPVM password is synchronized at both Linux and SLX-OS configuration levels, and HA operation is restored.

Configure an External LDAP Server

You can configure an LDAP server for user validation and to fetch user groups.

LDAP supports three modes for fetching the roles assigned to a user.

- The role is available as an attribute in the user Distinguished Name (DN) entry. Group attribute definition is not needed.
- The user has a "memberOf" attribute or any appropriate group DN attribute to identify the groups assigned to the user. Assign the corresponding LDAP group to a role in XCO.
- LDAP groups have user entries in their group definitions. Assign the LDAP groups to roles in XCO.

Note

If you configure LDAP server over SSL, and use IP to connect to the server, ensure that the certificate includes the IP as part of the subject alternative names (SANs) for a successful connection.

For more information about commands and supported parameters, see *ExtremeCloud Orchestrator Command Reference, 4.0.2*.

Basic Configuration

Attribute	Description	Default Value
name	Unique identifier for LDAP configuration in XCO.	-
host	IPv4 or IPv6 Address/ Hostname of the LDAP server.	-
port	Port at which the LDAP server is listening for connections.	389
timeout	Duration in number of seconds before considering the server unreachable.	5
bind-user-name	Distinguished Name (DN) of the user that should be used to bind, search, and retrieve LDAP entries.	-
bind-user-password	Password of the bind user.	

TLS Configuration

Attribute	Description	Default Value
tls	Use LDAP over SSL/TLS.	-
cacert	Local path to the CA certificate file for SSL verification.	-
insecuretls	Option to skip certificate validation while connecting to the LDAP server	false

Authentication

Attribute	Description	Default Value
user-search-base	Distinguished Name of the node in your directory tree from which to start searching for user objects.	-
user-object-base	Name of the object class used for user objects.	inetOrgPerson
user-login-attribute	Attribute whose value matches the username part of credentials entered by your users when logging in.	uid

Examples

To enable LDAP for authentication in XCO with OpenLDAP, use the following command:

```
efa auth ldapconfig add --name ldap_xco --host 10.x.x.x --bind-user-name
cn=ldapuser,dc=xxx,dc=com
--bind-user-password ******* --user-search-base ou=people,dc=xxx,dc=com
```

To enable LDAP for authentication in XCO with Windows AD, use the following command:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com
--bind-user-password ******* --user-search-base CN=Users,DC=xxx,DC=com --user-object-
class user
--user-login-attribute sAMAccountName
```

To use the same configuration with TLS enabled:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --tls --cacert root-ca.pem --
bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password ******* --user-search-base
CN=Users,DC=xxx,DC=com
--user-object-class user --user-login-attribute sAMAccountName
```

To skip certificate verification over the encrypted connection, use the following command:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --tls --cacert root-ca.pem --
insecuretls
--bind-user-name CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password *******
--user-search-base CN=Users,DC=xxx,DC=com --user-object-class user --user-login-attribute
sAMAccountName
```

Examples

To enable LDAP for authentication in XCO with OpenLDAP, use the following command:

```
efa auth ldapconfig add --name ldap_xco --host 10.x.x.x --bind-user-name
cn=ldapuser,dc=xxx,dc=com
--bind-user-password ******* --user-search-base ou=people,dc=xxx,dc=com
```

To enable LDAP for authentication in XCO with Windows AD, use the following command:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com
--bind-user-password ******* --user-search-base CN=Users,DC=xxx,DC=com --user-object-
class user
--user-login-attribute sAMAccountName
```

To use the same configuration with TLS enabled:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --tls --cacert root-ca.pem --
bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password ******* --user-search-base
CN=Users,DC=xxx,DC=com
--user-object-class user --user-login-attribute sAMAccountName
```

To skip certificate verification over the encrypted connection, use the following command:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --tls --cacert root-ca.pem --
insecuretls
--bind-user-name CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password *******
--user-search-base CN=Users,DC=xxx,DC=com --user-object-class user --user-login-attribute
sAMAccountName
```

Authorization

There are multiple ways to define authorization for authenticated users.

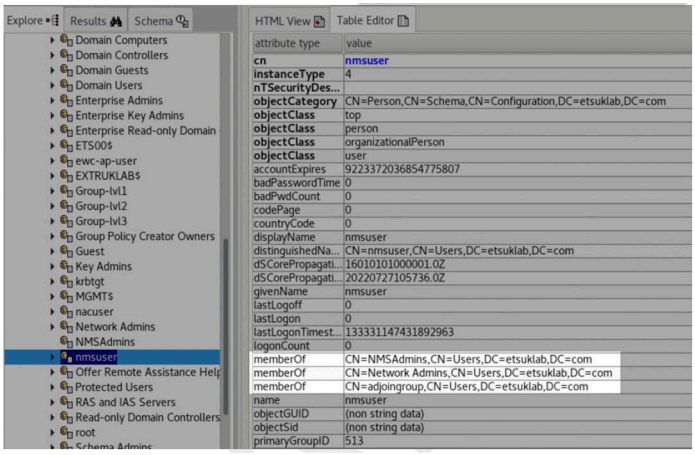
1. Assign roles to users using LDAP groups when users hold group membership details:

Attribute	Description	Default Value
user-member-attribute	Attribute to read the member of the group the user is part of.	-

Example

In Windows AD, if the user has an attribute ‘memberOf’ which gives the groups that he belongs to, then define ‘user-member-attribute’

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password *******
--user-search-base CN=Users,DC=xxx,DC=com --user-object-class user
--user-login-attribute sAMAccountName --user-member-attribute memberOf
```



These groups should be mapped to XCO roles using the role mapping command.

```
efa auth rolemapping add --name CN=NMSAdmins,CN=Users,DC=etsuklab,DC=com --role
SystemAdmin
--type group --auth-type LDAP --auth-identifier ldap_winad
```

Assign roles for multiple groups, if required.

2. To enable LDAP for authentication in XCO with OpenLDAP, use the following command:

```
efa auth ldapconfig add --name ldap_xco --host 10.x.x.x --bind-user-name
cn=ldapuser,dc=xxx,dc=com
--bind-user-password ******* --user-search-base ou=people,dc=xxx,dc=com
```

To enable LDAP for authentication in XCO with Windows AD, use the following command:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com
--bind-user-password ******* --user-search-base CN=Users,DC=xxx,DC=com --user-object-
class user
--user-login-attribute sAMAccountName
```

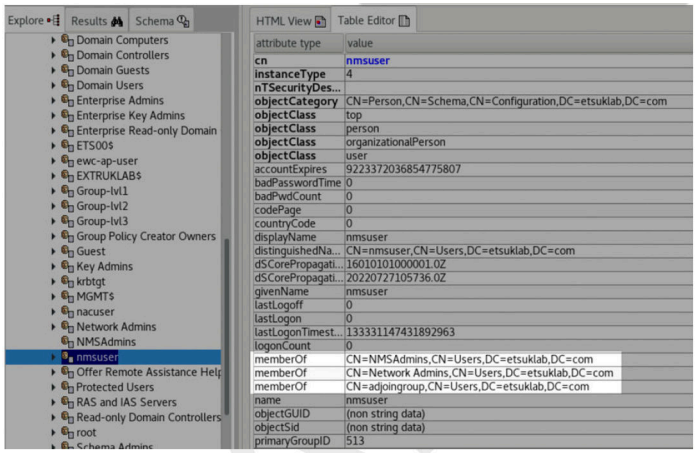
To use the same configuration with TLS enabled:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --tls --cacert root-ca.pem
--bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password ******* --user-search-base
CN=Users,DC=xxx,DC=com
--user-object-class user --user-login-attribute sAMAccountName
```

To skip certificate verification over the encrypted connection, use the following command:

```
efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --tls --cacert root-ca.pem
--insecuretls
--bind-user-name CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password *******
```

```
--user-search-base CN=Users,DC=xxx,DC=com --user-object-class user --user-login-
attribute sAMAccountName

efa auth ldapconfig add --name ldap_winad --host 10.x.x.x --bind-user-name
CN=ldapuser,CN=Users,DC=xxx,DC=com --bind-user-password *******
--user-search-base CN=Users,DC=xxx,DC=com --user-object-class user
--user-login-attribute sAMAccountName --user-member-attribute memberOf
```



These groups should be mapped to XCO roles using the role mapping command.

```
efa auth rolemapping add --name CN=NMSAdmins,CN=Users,DC=etsuklab,DC=com --role
SystemAdmin
--type group --auth-type LDAP --auth-identifier ldap_winad
```

Assign roles for multiple groups, if required.

3. Assign roles to users using LDAP groups when the groups are in a different search base:

Attribute	Description	Default Value
group-search-base	Distinguished Name of the node in your directory tree from which to start searching for group objects.	-
group-object-class	object class used for group objects.	groupOfNames
group-attribute	Attribute to define search filter on group.	cn
group-member-user-attribute	Name of the user attribute whose format matches the group members.	entrydn
group-member-mapping-attribute	Name of the group attribute containing the members of a group.	member

```
efa auth ldapconfig add --name ldap_xco --host 10.x.x.x --bind-user-name
cn=ldapuser,dc=xxx,dc=com
--bind-user-password ******* --user-search-base ou=people,dc=xxx,dc=com --group-search-
base
ou=groups,dc=extrnet,dc=com
```

To override the defaults for different LDAP:

```
efa auth ldapconfig add --name ldap_xco --host 10.x.x.x --bind-user-name
cn=ldapuser,dc=xxx,dc=com
--bind-user-password ******* --user-search-base ou=people,dc=xxx,dc=com --group-search-
base
ou=groups,dc=extrnet,dc=com --group-member-user-attribute dn --group-member-mapping-
attribute memberUid --group-object-class posixGroup
```

Assign the required roles for the groups in XCO using the role mapping command.

4. Assign roles to user from a custom attribute and XCO role defined with a key/value pair:

Attribute	Description	Default Value
user-role-attribute	Attribute to read the role of user from.	-
user-role-attribute-key	Attribute to read the role value from role attribute.	-

```
efa auth ldapconfig add --name ldap1 --host 10.x.x.x --bind-user-name
cn=admin,dc=extrnet,dc=com
--bind-user-password ******* --user-search-base ou=people,dc=extrnet,dc=com
--user-role-attribute role --user-role-attribute-key  rolename
```

Here role is the custom schema defined in LDAP as an attribute for user and the rolename is where it holds the XCO role in LDAP.

The role attribute for the user entry in LDAP has the value of *rolename:SystemAdmin,rolename:FabricAdmin*

5. To defines roles in XCO and skip authorization in LDAP, add the required role for each user:

```
efa auth rolemapping add --name=testuser --role=FabricAdmin --type=user --auth-
type=ldap
--auth-identifier=ldap_xco
```

TACACS+ Settings

Terminal Access Controller Access-Control System Plus (TACACS+) is an external authentication server used for verifying user credentials.

The TACACS+ protocols support environments that are configured for authentication, authorization, and accounting (AAA) services.

XCO supports TACACS+ authentication in the following ways.

- XCO supports up to five auth preferences and TACACS+ servers can be added accordingly. If any TACACS+ server addition fails due to auth preference limit, delete the unwanted auth preference and add a new TACACS+ config.
- TACACS+ authentication must be enabled. If TACACS+ authentication is not enabled, only local authentication is used.
- If remote authentication fails, XCO attempts to use local authentication, which is successful only if the user is in the XCO database.

- The *secret key* configured for XCO must match the *secret key* from the TACACS+ server configuration file. Authentication fails if the two values do not match.
- The *service* and *xco-role* entries configured for XCO must match the equivalent entries in the TACAS+ server configuration file.

Configure TACACS using CLI

Only users with the role SecurityAdmin or SystemAdmin can perform this task.

Note
For details about the command and its parameters, see the *ExtremeCloud Orchestrator Command Reference, 4.0.2*.

1. Run the following command:

```
efa auth tacacsconfig add --host 10.24.15.200 --port 49 --secret sharedsecret --
protocol CHAP
```

   The command validates the attributes. If the validation is successful, the attributes are saved in the database. These details are used to validate user credentials and fetch the user role during token generation.
2. Run the following role mapping command to map TACACS server roles with the XCO roles:

```
efa auth tacacsconfig rolemapping add --host 10.24.15.200 --tacacsRole=tacAdmin --
xcoRole SystemAdmin
```

   The rolemapping command validates whether or not the host is already configured in XCO. If yes, then the command maps the TACACS role with the XCO supported role. Similarly, the deletion of the host from TACACS config also deletes the TACACS roles of the host already configured using role mapping.

   Example:

```
efa auth rolemapping add --name=tacAdmin --role SystemAdmin --auth-type TACACS
--auth-identifier 10.37.32.51
Successfully added the role mapping.

+--------------+--------------------+
| attribute  | value                |
+--------------+--------------------+
| id               | 5                       |
+--------------+--------------------+
| name       | tacAdmin          |
+-------------+---------------------+
| role          | SystemAdmin  |
+-------------+---------------------+
| type         | GROUP             |
+-------------+---------------------+
| auth type  | TACACS          |
+-------------+--------------------+
| identifier| 10.37.32.51     |
+-------------+--------------------+

efa auth rolemapping show
+----+--------------+--------------------+-----------+--------------
+---------------------+
```

```
| ID | Name          | Role
| Type       | Auth Type     | Auth Identifier     |
+----+--------------+--------------------+-----------+--------------
+---------------------+
| 3  | admin         | SystemAdmin
| GROUP      |    TACACS     | 10.37.32.51         |
+----+--------------+--------------------+-----------+--------------
+---------------------+
| 5  | tacAdmin      | SystemAdmin
| GROUP      |    TACACS     |    10.37.32.51      |
+----+--------------+--------------------+-----------+--------------
+---------------------+
| 1  | user          |        SystemAdmin
|   USER     | HOST         |                     |
+----+--------------+--------------------+-----------+--------------
+---------------------+
```

Configure Local User using CLI

Manage local users using the cli.

Only users with the role SecurityAdmin or SystemAdmin can perform this task.

1. Add user:

   For the local user creation, username, email id, and user role parameters are mandatory. The username and email id must be unique.

```
efa auth user add --userName user1 --emailID user1@test.com --roles SystemAdmin
Password: ****
Successfully added the user configuration
```

2. Change Password on First Login:

   You are prompted to change the password on first login.

   a. In the New Password field, enter the password.
   b. In the Confirm Password field, enter the password again.
   c. The password is changed and you are logged out.
   d. Login again using the new password.

```
efa login --username user1
Password: ****
Please reset the password
New password: ****
Confirm password: ****

The user password was reset successfully. Please log in again.
```

3. Update User:

   Updating the profile details of a local user.

```
Example:
efa auth user update --userName=user1 --roles NetworkOperator
Successfully updated the user configuration.
+----------+-----------------+------------+----------------+---------------
+--------------+
| Username | Roles           | Is Blocked | Email
ID       | Mobile Number | Organization |
+----------+-----------------+------------+----------------+---------------
+--------------+
| user1    | NetworkOperator | false      | user1@test.com
|               |              |
```

```
+----------+-----------------+------------+----------------+---------------
+--------------+
```

4. Block User:

   Block the local user account. The blocked user will be prohibited from login to the XCO.

```
efa auth user block-unblock --userName=user1 --isBlock=true
Successfully updated the user state.
+----------+-----------+
| UserName | IsBlocked |
+----------+-----------+
| user1    | true      |
+----------+-----------+
```

5. Unblock User:

   Unblock the local user account.

```
efa auth user block-unblock --userName=user1 --isBlock=false
Successfully updated the user state.
+----------+-----------+
| UserName | IsBlocked |
+----------+-----------+
| user1    | false     |
+----------+-----------+
```

6. Change password:

   Change the password of a logged in user.

```
efa auth user change-password
Old password: ****
New password: ****
The password was changed successfully
```

7. Reset password:

   Only a user with the SystemAdmin role can reset the password of local users.

```
efa auth user reset-password --userName user1 --emailID user1@test.com
Password:
Successfully updated the user configuration
```

8. Show users:

   Display the local users with details.

```
efa auth user show
+----------+-----------------+------------+-------------------+---------------
+--------------+
| Username | Roles           | Is Blocked | Email ID
| Mobile Number | Organization |
+----------+-----------------+------------+-------------------+---------------
+--------------+
| testabc  | SystemAdmin     | false      | testabc@test.com
|               |              |
+----------+-----------------+------------+-------------------+---------------
+--------------+
| user1    | NetworkOperator | false      | user1@test.com
|               |              |
+----------+-----------------+------------+-------------------+---------------
+--------------+
```

9. Delete user:

   Only a user with the role of SystemAdmin or SecurityAdmin can delete a local user.

```
efa auth user delete --userName=user1
Deleted User configuration successfully.
```

BGP MD5 Authentication

The Border Gateway Protocol (BGP) is an exterior gateway protocol designed to exchange routing and reachability information among autonomous systems on the internet. The following table provides a list of some of the threats against BGP.

Note
BGP depends on TCP as its transport protocol. Therefore, it is vulnerable to the same security attacks as any TCP-based protocol.

Threats against BGP	Description
Denial of Service (DoS)	A malicious host sends unexpected or unwanted BGP traffic to a neighbor in an attempt to saturate control plane resources, which results in not having enough resources to process legitimate BGP traffic on the neighbor.
Route Manipulation	A malicious host modifies the contents of a BGP routing table, diverting traffic, and preventing it, without the sender's knowledge, from reaching its intended destination.
Route Hijacking	A rogue BGP neighbor maliciously advertises a victim's networks to redirect some or all of victim's traffic to itself.
Misconfiguration (non-malicious)	An unintentionally misconfigured BGP router could affect the Internet's BGP routing table, possibly leading to network outages and, worse, unauthorized access to the network traffic.

BGP authentication enables the routers to share information only if they can verify that they are communicating to a trusted source, based on a password. Successful authentication between BGP neighbors proves that the neighbors are legitimate and trusted, verifies communications between those neighbors, and ensures that only routes learned from legitimate neighbors are added to the routing table.

Authentication must be enabled on both sides of the peering session and the same password must be used on both peers.

Note
For BGP MD5 passwords, the ASCII characters 0-32 are not supported. In addition, special handling is required for MD5 passwords that contain certain special characters.

Examples

MD5 password provided through CLI	Actual MD5 password
'~`!@#$%^&*()_-+={[}]|\"<>"/"'"'	~`!@#$%^&*()_-+={[}]|\"<>"/'
'a"'"a"	a"a
'a"'"'a"	a"'"a"
'a"'"'"'a'"	a"a'

BGP MD5 Authentication on Fabric Links

XCO provides secure TCP using MD5 for BGP connections across all fabric links. You are able to configure or modify the MD5 password at any time.

This feature enables you to provide an `md5-password` as a fabric setting that further becomes configured on all the fabric links, that is, BGP peer-groups and individual neighbors without peer-groups on the SLX-OS devices, so that the peer sessions are established using MD5 authentication. This will be applied to both Clos and non-Clos fabrics. By default, MD5 authentication on the fabric is disabled. Any new fabric or the fabrics upgraded from previous releases will have the MD5 authentication disabled.

Configure BGP MD5 Password Create, Update, and Clear

Use the `efa fabric setting update` command to set or clear the MD5 password on a new fabric.

Here is the `efa fabric setting update` command:

```
efa fabric setting update --name <fabric-name> --md5-password-enable <yes/no> --md5-
password <password>
```

If the command is entered with `md5-password-enable` as “yes” but without the `md5-password` option, then a prompt is displayed to input string and the password string entered using the prompt is not displayed on the screen.

Note
When providing a password string in the command line, that is using `efa fabric setting update --name <fabric-name> --md5-password <password>`, if the string contains special characters, then you must enclose the string in single quotes. For example, `efa fabric setting update --name fabric1 --md5-password 'pass%!'`. Enclosing the password string in single quotes is not required when the string is entered using the prompt.

After setting the `md5-password`, you must configure the fabric, using the command `efa fabric configure --name <fabric-name>`, to apply this MD5 password on fabric devices so that the BGP neighbor sessions are authenticated.

When you configure the `md5-password` on a fabric that has just been created, or a fabric that has not yet been configured, there is no change in the device `app-state`. However, if the `md5-password` is set after the fabric is configured, there is a new `app-state`, the fabric setting is refreshed (and devices will be set to), indicating the fabric properties have been modified and the fabric has to be reconfigured to apply the new settings. As part of fabric configuration, when the MD5 password was successfully configured on all the fabric links on a device, the app state on that device will go back to `cfg-in-sync` state.

1. Run the **`efa fabric setting update --name <fabric-name> --md5-password-enable <yes/no> --md5-password <password>`** command to set the MD5 password.

   ```
   efa fabric setting update --name fabric1 --md5-password-enable yes
   Please supply a password for BGP MD5 authentication on fabric links:
   ```

2. Run the **`efa fabric configure --name <fabric-name>`** command to apply this MD5 password on fabric devices so that the BGP neighbor sessions are authenticated.

   To create or update MD5 authentication:

   ```
   efa fabric configure --name fabric1
   ```

   To clear MD5 authentication:

   ```
   efa fabric setting update --name fabric1 --md5-password-enable no
   efa fabric configure --name fabric1
   ```

   When you configure the `md5-password` on a fabric that has just been created, or a fabric that has not yet been configured, there is no change in the device `app-state`. However, if the `md5-password` is set after the fabric is configured, the fabric status is set to `settings-updated` along with the field `BGP-MD5`, indicating that settings have been updated. This indicates that the fabric properties have been modified and the fabric has to be reconfigured to apply the new settings. As part of fabric configure, when the devices are successfully configured, the fabric status will go back to `configure-success`.

Example

```
Fabric Name: fabric1, Fabric Description: , Fabric Stage: 3, Fabric Type: clos, Fabric
Status: settings-updated
Updated Fabric Settings: BGP-MD5
+---------------+-----+-----------+-------+-------+--------------
+--------------------------+------------------+-----------------+---------+-------+
|  IP ADDRESS   | POD | HOST NAME  |  ASN  | ROLE
| DEVICE STATE |  APP STATE  | CONFIG GEN REASON | PENDING CONFIGS | VTLB ID | LB ID |
+---------------+-----+-----------+-------+-------+---------------
+--------------------------+------------------+-----------------+---------+-------+
| 10.17.112.223 |     | spine1    | 64512 | spine
| provisioned   | cfg in-sync | MD5               | MD5-U           | NA      | 1     |
| 10.17.112.224 |     | spine2    | 64512 | spine
| provisioned   | cfg in-sync | MD5               | MD5-U           | NA      | 1     |
| 10.17.112.221 |     | leaf1     | 65002 | leaf
| provisioned   | cfg in-sync | MD5               | MD5-U           | 2       | 1     |
| 10.17.112.222 |     | leaf2     | 65002 | leaf
| provisioned   | cfg in-sync | MD5               | MD5-U           | 2       | 1     |
| 10.17.112.225 |     | leaf3     | 65000 | leaf
| provisioned   | cfg in-sync | MD5               | MD5-U           | 2       | 1     |
| 10.17.112.226 |     | leaf4     | 65000 | leaf
| provisioned   | cfg in-sync | MD5               | MD5-U           | 2       | 1     |
+---------------+-----+-----------+-------+-------+---------------
+--------------------------+------------------+-----------------+---------+-------+
FABRIC SETTING:
BGPLL - BGP Dynamic Peer Listen Limit, BGP-MD5 - BGP MD5 Password
CONFIG GEN REASON:
LD - Link Delete, LA - Link Add, IU - Interface
Update, PLC - IPPrefixList Create, PLD - IPPrefixList Delete, PLU - IPPrefixList Update
MD/MU - MCT Delete/Update, OD - Overlay Gateway Delete, OU - Overlay Gateway Update,
ED - Evpn Delete, PC - RouterPim Create, PD - RouterPim Delete, BGP – BGP Config
DD - Dependent Device Update, DA - Device Add, DR - Device ReAdd, ASN -
Asn Update, PU - RouterPim Update, SYS - System Properties Update, NA - Not Applicable
PENDING CONFIGS:
MCT - MCT Cluster, O - Overlay
Gateway, SYSP - System Properties, INTIP - Interface IP, BGP – BGP Config
C/D/U - Create/Delete/Update, PA/PD - Port Add/Port Delete
For App or Device Error/Failure reason, run "efa fabric error show" for details
For config refresh reason, run "efa fabric debug config-gen-reason" for details
```

Note

When the MD5 password is updated, for the new configuration to take effect, the neighbor sessions have to be cleared, resulting in a network outage until the new sessions are established. Because the configuration of the MD5 password toggles the network, a new warning message with a confirmation is provided indicating the impact of the `md5-password` setting on an active fabric, before it is applied. This warning message is displayed only when there is a need to reconfigure the fabric, that is, the password is set after the fabric is configured.

```
efa fabric setting modify --name fabric1 --md5-password-enable yes

Please supply a password for BGP MD5 authentication on fabric links:

WARNING: configuring/clearing md5-password on an active fabric will result in
BGP neighborsessions
going down for a brief period when the fabric is reconfigured.

Please confirm if you want to continue with the fabric setting update [y/n]?
```

Employ a Phased Approach

Reduce network impact by applying the password and clearing sessions on fabric links in a phased manner.

When an updated MD5 password is being applied on fabric links during fabric configuration, you can reduce network impact by applying the password and clearing sessions on fabric links in a phased manner. First gather a list of neighbor sessions on each device. Then, one device at a time, apply `md5-password` and clear a single peering. Application of password and clearing of the neighbor session is done on both ends of the peering session simultaneously. When the session is established, the MD5 password is applied on the next peering session. When all the neighbor sessions on the device are updated, it will move to the next device.

After you clear the session, it takes 10 seconds for the new session to be established. Before applying the new MD5 password, the session states are determined. After applying the password and clearing the session on both ends of the peering session, the session state is checked again. Only when the state matches with the previous (pre-password update) state on the session, or is better than the previous state (for example, previously the session was not established and the current state is established), it will move to updating the next neighbor session.

Note
The phased application of clearing the session and checking the state is performed **only** when the password is updated on a configured fabric and is not applicable during the configuration of a new fabric. Because the neighbor sessions are created for the first time during configuration of a new fabric with the MD5 password, there is no need to clear sessions.

Configure BGP MD5 Password: Failures When Clearing the Neighbor Session

When the MD5 password is updated, failures can occur during the process of clearing the neighbor sessions.

After clearing the session, if the session state is not established, or is not in the same state as it was prior to clearing the session within the wait time of 10 seconds, then the wait time is extended for an additional 10 seconds. If the session state is not established after the expiration of the second wait time, it is marked as a failure. The execution continues with the clearing of the remaining neighbor sessions.

When all the neighbor sessions are cleared, any sessions that have been marked as failure are presented under fabric errors at the end of the fabric configure operation, as part of the existing fabric error command `efa fabric error show`. The

failure information will include the details of the neighbor session that could not be established.

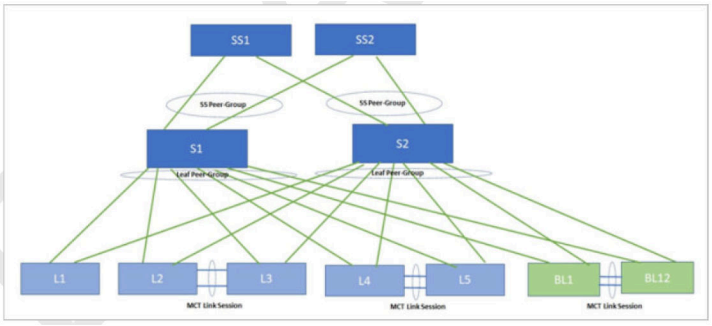
Note
If there are any sessions that could not be established during the clear operation, the fabric configuration operation displays an error indicating a failure. However, if the fabric configuration has been successfully pushed to the devices, the devices are set to cfg-in-sync, even though the clear operation failed.

Configure BGP MD5 Password: Clos Topology (3-Stage and 5-Stage)

In a Clos topology, session clearing is done on each device on the fabric.

In a Clos topology, the clearing of the sessions is done by walking through each device on the fabric and the sessions cleared, depending on the role of the device. The clearing is done in the following manner:

- **Spine**: Neighbor sessions at the peer-group level are cleared. On the spine, there are two peer-groups, one for the links to the leaves (Leaf Peer-Group) and the other for the links to the super-spines (SS Peer-Group). Clearing of the sessions is done on both peer-groups simultaneously.
- **Leaf**: The neighbor session on the MCT link is cleared.
- **Super-spine**: There is no need to clear any session on the super-spine because all the sessions on the super-spines are covered at the spine device.



Configure BGP MD5 Password: Non-Clos Topology and Fabric Events

In a non-Clos topology, the process of clearing the session is performed on one leaf device at a time, until all sessions are cleared.

Because the MD5 password on fabric links is applied as part of fabric configure, no additional events are generated as a result of configuring MD5 password. The Fabric Deployed event that is currently generated by the Fabric service when a fabric is configured should be used as a trigger by other services that are dependent on the Fabric MD5 password for any of their operations.

Fabric Events and the MD5 Password

Because the MD5 password on each fabric link is applied as part of fabric configuration, no additional events are generated as a result of configuring the MD5 password.

The Fabric Deployed event that is generated by the fabric service when a fabric is configured should be used as a trigger by other services that are dependent on the fabric MD5 password for any of their operations.

Verify the BGP MD5 Password

Use the **`efa fabric setting show`** command to verify that the MD5 password is configured on the fabric.

The password is not displayed in clear text because of security concerns. The password is displayed as a hidden string (`*****`) or as an encrypted string. The password is displayed as a hidden string if the fabric is not configured after the MD5 password is set. And if the fabric is configured after the password is set, then the show command displays the password as an encrypted string. This encrypted string matches the password string displayed on the SLX-OS devices.

The same applies to the **`efa show-running-config`** command. Until the fabric is configured, the MD5 password is displayed as `*****`. After the fabric is configured, the encrypted string is displayed.

Run the **`efa fabric setting show --name <fabric-name> --advanced`** command.

```
efa fabric setting show --name fabric1 --advanced
+--------------------------------+------------------------------+
| NAME                           | VALUE                        |
+--------------------------------+------------------------------+
| Fabric Name                    | fabric1                      |
+--------------------------------+------------------------------+
| Link IP Range                  | 10.10.10.0/23                |
+--------------------------------+------------------------------+
| Loopback IP Range              | 172.31.254.0/24              |
+--------------------------------+------------------------------+
| Loopback Port Number           | 1                            |
+--------------------------------+------------------------------+
| VTEP Loopback Port Number      | 2                            |
+--------------------------------+------------------------------+
| Spine ASN Block                | 64512-64768                  |
+--------------------------------+------------------------------+
| SuperSpine ASN Block           | 64769                        |
+--------------------------------+------------------------------+
| Leaf ASN Block                 | 65000-65534                  |
+--------------------------------+------------------------------+
| Border Leaf ASN Block          | 66000-66100                  |
+--------------------------------+------------------------------+
| P2P IP Type                    | numbered                     |
+--------------------------------+------------------------------+
| Any cast MAC                   | 0201.0101.0101               |
+--------------------------------+------------------------------+
| IPV6 Any cast MAC              | 0201.0101.0102               |
+--------------------------------+------------------------------+
| MAC Aging Timeout              | 1800                         |
+--------------------------------+------------------------------+
| MAC Aging Conversational       | 300                          |
| Timeout                        |                              |
+--------------------------------+------------------------------+
```

```
| MAC Move Limit                 | 20                          |
+--------------------------------+-----------------------------+
| Duplicate MAC Timer            | 5                           |
+--------------------------------+-----------------------------+
| Duplicate MAC Timer MAX Count  | 3                           |
+--------------------------------+-----------------------------+
| BFD Enable                     | Yes                         |
+--------------------------------+-----------------------------+
| BFD Tx                         | 300                         |
+--------------------------------+-----------------------------+
| BFD Rx                         | 300                         |
+--------------------------------+-----------------------------+
| BFD Multiplier                 | 3                           |
+--------------------------------+-----------------------------+
| BGP MultiHop                   | 2                           |
+--------------------------------+-----------------------------+
| MaxPaths                       | 8                           |
+--------------------------------+-----------------------------+
| AllowAsIn                      | 0                           |
+--------------------------------+-----------------------------+
| MTU                            | 9216                        |
+--------------------------------+-----------------------------+
| IPMTU                          | 9100                        |
+--------------------------------+-----------------------------+
| MCT Link IP Range              | 10.20.20.0/24               |
+--------------------------------+-----------------------------+
| MCT PortChannel                | 64                          |
+--------------------------------+-----------------------------+
| LACP Timeout                   | long                        |
+--------------------------------+-----------------------------+
| Control Vlan                   | 4090                        |
+--------------------------------+-----------------------------+
| Control VE                     | 4090                        |
+--------------------------------+-----------------------------+
| Leaf PeerGroup | spine-group   |                             |
+--------------------------------+-----------------------------+
| Spine PeerGroup | leaf-group   |                             |
+--------------------------------+-----------------------------+
| SuperSpine PeerGroup           | spine-group                 |
+--------------------------------+-----------------------------+
| Configure Overlay Gateway      | Yes                         |
+--------------------------------+-----------------------------+
| VNI Auto Map                   | Yes                         |
+--------------------------------+-----------------------------+
| Backup Routing Enable          | No                          |
+--------------------------------+-----------------------------+
| Backup Routing IPv4 Range      | 10.40.40.0/24               |
+--------------------------------+-----------------------------+
| Backup Routing IPv6 Range      | fd40:4040:4040:1::/120      |
+--------------------------------+-----------------------------+
| Optimized Replication Enable   | No                          |
+--------------------------------+-----------------------------+
| MDT Group IPv4 Range           | 239.0.0.0/8                 |
+--------------------------------+-----------------------------+
| Default MDT Group IPv4 address | 239.1.1.1                   |
+--------------------------------+-----------------------------+
| MD5 Password Enable            | Yes                         |
+--------------------------------+-----------------------------+
| MD5 Password                   | $9$GiXG/W7938rCj4lzgf14NQ== |
+--------------------------------+-----------------------------+
```

Configure BGP MD5 Password: Switch Configuration

The following provides a sample XCO MD5 password configuration and the corresponding switch configuration on one of the fabric devices after the fabric is configured.

1. Run the **`efa fabric setting update`** command.

```
efa fabric setting update --name fabric1 --md5-password-enable yes
Please supply a password for BGP MD5 authentication on fabric links:
efa fabric configure --name fabric1
```

2. Complete the following configuration on SLX-OS device:

```
router bgp
  local-as 65000
  capability as4-enable
  fast-external-fallover
  neighbor spine-group peer-group
  neighbor spine-group remote-as 64512
  neighbor spine-group description To Spine
  neighbor spine-group password $9$GiXG/W7938rCj4lzgf14NQ==
  neighbor 10.10.10.2 peer-group spine-group
  neighbor 10.20.20.2 remote-as 65000
  neighbor 10.20.20.2 next-hop-self
  neighbor 10.20.20.2 password $9$GiXG/W7938rCj4lzgf14NQ==
  address-family ipv4 unicast
  network 172.31.254.2/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv6 unicast
 !
 address-family l2vpn evpn
  graceful-restart
  neighbor spine-group encapsulation vxlan
  neighbor spine-group next-hop-unchanged
  neighbor spine-group enable-peer-as-check
  neighbor spine-group activate
 !
!
```

The BGP MD5 Password, Drift and Reconcile, and Idempotency

Drift is identified if you modify the MD5 password through SLX-OS , the CLI, or other management tool.

A reconcile operation pushes the intended configuration to SLX-OS , thereby synchronizing the SLX-OS configuration with XCO.

Note
A reconcile operation configures the MD5 password on the device back to its original value (pre-drift) but does not clear the session. Also, the state is not verified after the password is configured.

Field	Identity Drift	Reconcile Configuration	Idempotency
`md5-password`	Yes	Yes	Yes*

* There are some caveats to idempotency. The fabric service does not store the plain text password you provide after the fabric has been configured. It stores the encrypted string of the user-provided password, matching with the encrypted string available on the SLX-OS device. So, setting the same original MD5 password after the fabric is configured results in devices going into cfg-refreshed state. For the operation to be idempotent, after the fabric is configured, the encrypted string should be provided as the `md5-password` and not the original plain text password.

Devices in the fabric are in cfg-refreshed state when the MD5 password has been updated but the fabric is not yet reconfigured. In such a scenario, the previous MD5 password is used for drift detection until the fabric is configured with the new password.

Configure BGP MD5 Password: Fabric Clone

When a fabric is cloned using the command `efa fabric clone --source <old-fabric-name> -- destination <new-fabric-name>`, the MD5 password configuration from the source fabric is used in the new cloned fabric.

Configure BGP MD5 Password: Rules for Clearing BGP Sessions

MD5 password configuration and clearing BGP neighbor sessions.

The following table lists different scenarios of MD5 password configuration, under which a BGP neighbor session is required to be cleared.

Scenarios	Clearing BGP neighbor session required?
Creating new BGP peer-group with MD5 password	Not required
Creating new BGP neighbor with MD5 password	Not required
Updating existing BGP peer-group with MD5 password	Yes
Updating existing BGP neighbor with MD5 password	Yes
Removing MD5 password from a BGP peer-group	Yes
Removing MD5 password from a BGP neighbor	Yes
Modifying MD5 password for a BGP peer-group	Yes
Modifying MD5 password for a BGP neighbor	Yes
Reload	Not required
Copy `<ftp://backup-config>` startup-config and reload	Not required
Copy `<ftp://backup-config>` running-config	Not required

SLX-OS Commands to clear the BGP neighbor sessions

```
clear ip bgp neighbor <neighbor ip> vrf <vrf name>
```

```
clear ip bgp neighbor <peer-group> vrf <vrf name>
```

The `vrf` used on the XCO fabric links is `default-vrf`.

BGP MD5 Authentication on Edge Links

This feature authenticates all the BGP peer and peer-group used for edge connectivity. You can provide an MD5 password per BGP peer and peer-group created for external connectivity.

Important
BGP MD5 authentication for tenant dynamic peers is not yet supported.

Configure BGP MD5 Authentication for Tenant BGP Peer

Provide md5-password during BGP peer create or update operations.

1. Run the **`efa tenant service bgp peer create`** command to create the peer.

```
efa tenant service bgp peer create
           --name <bgp-peer-name> --tenant <tenant-name>
           --ipv4-uc-nbr <device-ip,vrf-name:neighbor-ip,remote-asn>
           --ipv4-uc-nbr-bfd <device-ip,vrf-name:neighbor-ip,true|false>
           --ipv4-uc-nbr-md5-password <device-ip,vrf-name:neighborip, ipv4-md5-
password>
```

2. Run the **`efa tenant service bgp peer update`** command to update the peer.

```
efa tenant service bgp peer update
           --name <bgp-peer-name> --tenant <tenant-name>
           --operation peer-add
           --ipv4-uc-nbr <device-ip,vrf-name:neighbor-ip,remote-asn>
           --ipv4-uc-nbr-bfd <device-ip,vrf-name:neighbor-ip,true|false>
           --ipv4-uc-nbr-md5-password <device-ip,vrf-name:neighborip, ipv4-md5-
password>
```

Example

```
efa tenant service bgp peer create
           --name ten1bgppeer1 --tenant ten1
           --ipv4-uc-nbr 10.20.246.15,ten1vrf1:10.20.30.40,50000
           --ipv4-uc-nbr-bfd 10.20.246.15,ten1vrf1:10.20.30.40,true
           --ipv4-uc-nbr-md5-password 10.20.246.15,ten1vrf1:10.20.30.40,password
           --ipv4-uc-nbr 10.20.246.16,ten1vrf1:10.20.30.40,50000
           --ipv4-uc-nbr-bfd 10.20.246.16,ten1vrf1:10.20.30.40,true
           --ipv4-uc-nbr-md5-password 10.20.246.16,ten1vrf1:10.20.30.40,password
efa tenant service bgp peer update
           --name ten1bgppeer1 --tenant ten1
           --operation peer-add
           --ipv4-uc-nbr 10.20.246.15,ten1vrf1:10.20.30.50,50000
           --ipv4-uc-nbr-bfd 10.20.246.15,ten1vrf1:10.20.30.50,true
           --ipv4-uc-nbr-md5-password 10.20.246.15,ten1vrf1:10.20.30.50,password1
```

```
          --ipv4-uc-nbr 10.20.246.16,ten1vrf1:10.20.30.50,50000
          --ipv4-uc-nbr-bfd 10.20.246.16,ten1vrf1:10.20.30.50,true
          --ipv4-uc-nbr-md5-password 10.20.246.16,ten1vrf1:10.20.30.50,password1
```

```
efa tenant service bgp peer show --
detail
==================================
========================
Name              : ten1bgppeer1
Tenant            : ten1
State             : bs-state-created
Description       :

Static Peer
-----------
        Device IP         :
10.20.246.15
        VRF               : ten1vrf1
        AFI               : ipv4
        SAFI              : unicast
        Remote IP         :
10.20.30.40
        Remote ASN        : 50000
        Next Hop Self     : false
        Update Source IP  :
        BFD Enabled       : true
        BFD Interval      : 0
        BFD Rx            : 0
        BFD Multiplier    : 0
        MD5 Password :
$9$MCgKGaNt6OASX68/7TC6Lw==
        Dev State         :
provisioned
        App State         : cfg-in-
sync

        Device IP         :
10.20.246.15
        VRF               : ten1vrf1
        AFI               : ipv4
        SAFI              : unicast
        Remote IP         :
10.20.30.50
        Remote ASN        : 50000
        Next Hop Self     : false
        Update Source IP  :
        BFD Enabled       : true
        BFD Interval      : 0
        BFD Rx            : 0
        BFD Multiplier    : 0
        MD5 Password :
$9$ufD04Gw+49ex4H8UtvifqA==
        Dev State         :
provisioned
        App State         : cfg-in-
sync
```

```
        Device IP         :
10.20.246.16
        VRF               : ten1vrf1
        AFI               : ipv4
        SAFI              : unicast
        Remote IP         :
10.20.30.40
        Remote ASN        : 50000
        Next Hop Self     : false
        Update Source IP  :
        BFD Enabled       : true
        BFD Interval      : 0
        BFD Rx            : 0
        BFD Multiplier    : 0
        MD5 Password :
$9$MCgKGaNt6OASX68/7TC6Lw==
        Dev State         :
provisioned
        App State         : cfg-in-
sync

        Device IP         :
10.20.246.16
        VRF               : ten1vrf1
        AFI               : ipv4
        SAFI              : unicast
        Remote IP         :
10.20.30.50
        Remote ASN        : 50000
        Next Hop Self     : false
        Update Source IP  :
        BFD Enabled       : true
        BFD Interval      : 0
        BFD Rx            : 0
        BFD Multiplier    : 0
        MD5 Password :
$9$ufD04Gw+49ex4H8UtvifqA==
        Dev State         :
provisioned
        App State         : cfg-in-
sync
Dynamic Peer
------------
        0 Records
        0 Records
==================================
========================
```

3. Complete the configuration on SLX-OS as provided in the following example.

```
L1# show running-config router bgp
router bgp
 local-as 4200000000
 capability as4-enable
 fast-external-fallover
 neighbor 10.20.20.4 remote-as
4200000000
 neighbor 10.20.20.4 next-hop-self
 address-family ipv4 unicast
  network 172.31.254.46/32
  network 172.31.254.123/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv4 unicast vrf
ten1vrf1
  redistribute connected
  neighbor 10.20.30.40 remote-as
50000
  neighbor 10.20.30.40 password
$9$MCgKGaNt6OASX68/7TC6Lw==
  neighbor 10.20.30.40 bfd
  neighbor 10.20.30.50 remote-as
50000
  neighbor 10.20.30.50 password
$9$ufD04Gw+49ex4H8UtvifqA==
  neighbor 10.20.30.50 bfd
  maximum-paths 8
 !
 address-family ipv6 unicast
 !
 address-family ipv6 unicast vrf
ten1vrf1
  redistribute connected
  maximum-paths 8
 !
 address-family l2vpn evpn
  graceful-restart
 !
!
```

```
L2# show running-config router bgp
router bgp
 local-as 4200000000
 capability as4-enable
 fast-external-fallover
 neighbor 10.20.20.5 remote-as
4200000000
 neighbor 10.20.20.5 next-hop-self
 address-family ipv4 unicast
  network 172.31.254.46/32
  network 172.31.254.176/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv4 unicast vrf
ten1vrf1
  redistribute connected
  neighbor 10.20.30.40 remote-as
50000
  neighbor 10.20.30.40 password
$9$MCgKGaNt6OASX68/7TC6Lw==
  neighbor 10.20.30.40 bfd
  neighbor 10.20.30.50 remote-as
50000
  neighbor 10.20.30.50 password
$9$ufD04Gw+49ex4H8UtvifqA==
  neighbor 10.20.30.50 bfd
  maximum-paths 8
 !
 address-family ipv6 unicast
 !
 address-family ipv6 unicast vrf
ten1vrf1
```

Note
The MD5 password cannot be set or unset on an existing BGP peer present within a peer instance. You need to remove the BGP peer from the BGP peer instance and then add back the BGP peer to the peer instance with the desired MD5 password configuration.

Configure BGP MD5 Authentication for Tenant BGP Peer-group

You can provide an MD5 password during BGP peer-group create or update operations.

1. Use the **`efa tenant service bgp peer-group create`** command to create the peer group.

```
efa tenant service bgp peer-group create
           --name <bgp-pg-name> --tenant <tenant-name>
           --pg-name <device-ip:pg-name> --pg-asn <device-ip,pg-name:remote-asn>
           --pg-bfd-enable <device-ip,pg-name:true|false>
           --pg-md5-password <device-ip,pg-name:md5-password>
```

2. Use the **efa tenant service bgp peer-group update** command to update the peer group.

```
efa tenant service bgp peer-group update
           --name <bgp-pg-name> --tenant <tenant-name>
           --operation peer-group-add
           --pg-name <device-ip:pg-name> --pg-asn <device-ip,pg-name:remote-asn>
           --pg-bfd-enable <device-ip,pg-name:true|false>
           --pg-md5-password <device-ip,pg-name:md5-password>
```

Example

```
efa tenant service bgp peer-group create
           --name ten1bgppg1 --tenant ten1
           --pg-name 10.20.246.15:pg1 --pg-asn 10.20.246.15,pg1:55001
           --pg-bfd-enable 10.20.246.15,pg1:true
           --pg-md5-password 10.20.246.15,pg1:password
           --pg-name 10.20.246.16:pg1 --pg-asn 10.20.246.16,pg1:55001
           --pg-bfd-enable 10.20.246.16,pg1:true
           --pg-md5-password 10.20.246.16,pg1:password

efa tenant service bgp peer-group update
           --name ten1bgppg1 --tenant ten1
           --operation peer-group-add
           --pg-name 10.20.246.15:pg2 --pg-asn 10.20.246.15,pg2:55002
           --pg-bfd-enable 10.20.246.15,pg2:true
           --pg-md5-password 10.20.246.15,pg2:password1
           --pg-name 10.20.246.16:pg2 --pg-asn 10.20.246.16,pg2:55002
           --pg-bfd-enable 10.20.246.16,pg2:true
           --pg-md5-password 10.20.246.16,pg2:password1


efa tenant service bgp peer-group show --detail
================================================================================================
=====
Name             : ten1bgppg1
Tenant           : ten1
State            : bgp-pg-state-created

Peer Group
----------
        Device IP        : 10.20.246.15
        Peer Group       : pg1
        Remote ASN       : 55001
        Next Hop Self    : false
        BFD Enabled      : true
        BFD Interval     :
        BFD Rx           :
        BFD Multiplier   :
    MD5 Password : $9$MCgKGaNt6OASX68/7TC6Lw==
        Dev State        : provisioned
        App State        : cfg-in-sync

        Device IP        : 10.20.246.15
        Peer Group       : pg2
        Remote ASN       : 55002
        Next Hop Self    : false
        BFD Enabled      : true
        BFD Interval     :
        BFD Rx           :
        BFD Multiplier   :
        MD5 Password : $9$ufD04Gw+49ex4H8UtvifqA==
```

```
        Dev State        : provisioned
        App State        : cfg-in-sync

        Device IP        : 10.20.246.16
        Peer Group       : pg1
        Remote ASN       : 55001
        Next Hop Self    : false
        BFD Enabled      : true
        BFD Interval     :
        BFD Rx           :
        BFD Multiplier   :
    MD5 Password : $9$MCgKGaNt6OASX68/7TC6Lw==
        Dev State        : provisioned
        App State        : cfg-in-sync

        Device IP        : 10.20.246.16
        Peer Group       : pg2
        Remote ASN       : 55002
        Next Hop Self    : false
        BFD Enabled      : true
        BFD Interval     :
        BFD Rx           :
        BFD Multiplier   :
    MD5 Password : $9$ufD04Gw+49ex4H8UtvifqA==
        Dev State        : provisioned
        App State        : cfg-in-sync
================================================================================
=====
```

3. Complete the following configuration on SLX-OS .

```
L1# show running-config router bgp
router bgp
 local-as 4200000000
 capability as4-enable
 fast-external-fallover
 neighbor pg1 peer-group
 neighbor pg1 remote-as 55001
 neighbor pg1 password
$9$MCgKGaNt6OASX68/7TC6Lw==
 neighbor pg1 bfd
 neighbor pg2 peer-group
 neighbor pg2 remote-as 55002
 neighbor pg2 password
$9$ufD04Gw+49ex4H8UtvifqA==
 neighbor pg2 bfd
 neighbor 10.20.20.4 remote-as
4200000000
 neighbor 10.20.20.4 next-hop-self
 address-family ipv4 unicast
  network 172.31.254.46/32
  network 172.31.254.123/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv4 unicast vrf
ten1vrf1
  redistribute connected
  maximum-paths 8
 !
 address-family ipv6 unicast
 !
 address-family ipv6 unicast vrf
ten1vrf1
  redistribute connected
  maximum-paths 8
 !
 address-family l2vpn evpn
  graceful-restart
 !
!
```

```
L2# show running-config router bgp
router bgp
 local-as 4200000000
 capability as4-enable
 fast-external-fallover
 neighbor pg1 peer-group
 neighbor pg1 remote-as 55001
 neighbor pg1 password
$9$MCgKGaNt6OASX68/7TC6Lw==
 neighbor pg1 bfd
 neighbor pg2 peer-group
 neighbor pg2 remote-as 55002
 neighbor pg2 password
$9$ufD04Gw+49ex4H8UtvifqA==
 neighbor pg2 bfd
 neighbor 10.20.20.5 remote-as
4200000000
 neighbor 10.20.20.5 next-hop-self
 address-family ipv4 unicast
  network 172.31.254.46/32
  network 172.31.254.176/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv4 unicast vrf
ten1vrf1
  redistribute connected
  maximum-paths 8
 !
 address-family ipv6 unicast
 !
 address-family ipv6 unicast vrf
ten1vrf1
  redistribute connected
  maximum-paths 8
 !
 address-family l2vpn evpn
  graceful-restart
 !
!
```

Note

The MD5 password cannot be set or unset on an existing BGP peer-group present within a peer-group instance. You need to remove the BGP peer-group from the BGP peer-group instance and then add back the BGP peer-group to the peer-group instance with the desired MD5 password configuration.

Configure BGP MD5 Authentication for Tenant BGP Peer and Peer-group Securely

You can securely provide MD5 passwords during BGP peer-group create or update operations.

Configure BGP MD5 Authentication for Tenant BGP Peer on page 39 and Configure BGP MD5 Authentication for Tenant BGP Peer-group on page 41 present instructions for providing an md5-password per BGP peer or peer-group during the BGP peer or peer-group create and update operations.

This topic provides an additional method for doing so - in a secure manner - using the `--md5-password-prompt-enable=true` option in the **`efa tenant service bgp peer create`** and **`efa tenant service bgp peer-group create`** commands.

You are prompted to supply a password the same number of times as the number of BGP peer or peer-group inputs you specify in the command. Then, you can choose to type in a password, in which case, it is not shown. Alternatively, you can skip the input of the password altogether by pressing Enter.

Note
You can choose to provide the BGP peer or peer-group md5-password either in a secure manner (using the prompt) or in an unsecure manner, as described in the topics referenced above, but not both.

1. Run the **`efa tenant service bgp peer create`** command to create or update a BGP peer.

   For example:

   ```
   efa tenant service bgp peer create --name bgp173-2501 --tenant tenant11
                         --ipv4-uc-nbr 10.20.246.6,v1:25.1.1.3,5901
                         --ipv4-uc-nbr-bfd 10.20.246.6,v1:25.1.1.3,true
                         --ipv6-uc-nbr 10.20.246.5,v1:25:1::3,5901
                         --ipv6-uc-nbr-bfd 10.20.246.5,v1:25:1::3,true
                         --md5-password-prompt-enable=true
   ```

   The following output is displayed:

   ```
   Enter Md5 Password for 10.20.246.6::v1::25.1.1.3:
   ```

   For the first prompt, suppose you enter a password. It is not displayed on the screen. You are prompted for the second password:

   ```
   Enter Md5 Password for 10.20.246.5::v1::25:1::3:
   ```

   Suppose that this time, you do not enter a password at all but press Enter.

   The following output is displayed:

   ```
   BgpService created successfully.
   ```

2. Run the **`efa tenant service bgp peer-group create`** command to create or update a BGP peer-group.

   For example:

   ```
   efa tenant service bgp peer-group create --tenant "tenant11" --name "v1-PeerGrp"
                         --pg-name 10.20.246.5:v1-PeerGrp --pg-asn 10.20.246.5,v1-
   PeerGrp:5200
                         --pg-bfd-enable 10.20.246.5,v1-PeerGrp:true
                         --pg-name 10.20.246.5:v3-PeerGrp --pg-asn 10.20.246.5,v3-
   PeerGrp:5201
                         --pg-bfd-enable 10.20.246.5,v3-PeerGrp:true
                         --pg-name 10.20.246.6:v1-PeerGrp --pg-asn 10.20.246.6,v1-
   PeerGrp:5200
                         --pg-bfd-enable 10.20.246.6,v1-PeerGrp:true
                         --pg-md5-password-prompt-enable=true
   ```

The following output is displayed:

```
Enter Md5 Password for 10.20.246.5::v1-PeerGrp:
```

For the first prompt, suppose you enter a password. It is not displayed on the screen.

You are prompted for the second password:

```
Enter Md5 Password for 10.20.246.5::v3-PeerGrp:
```

Suppose you enter a password this time, too. It is not displayed on the screen.

Now you are prompted a third time:

```
Enter Md5 Password for 10.20.246.6::v1-PeerGrp:
```

Suppose that this time, you do not type in a password at all but press Enter.

The following output is displayed:

```
BgpService created successfully.
```

Configure BGP MD5 Authentication for Backup Routing Neighbors

The BGP MD5 password for the backup routing neighbors is the same as the one set at the fabric setting level. The BGP MD5 password for the backup routing neighbors is configured during the configuration of VRF on SLX-OS .

If the MD5 password setting is updated or set on a provisioned fabric followed by **`efa fabric configure`**, then the modified backup routing neighbor configuration is applied on all the tenant VRF backup routing BGP neighbors during **`efa fabric configure`**.

1. Run the series of commands as shown in the following example.

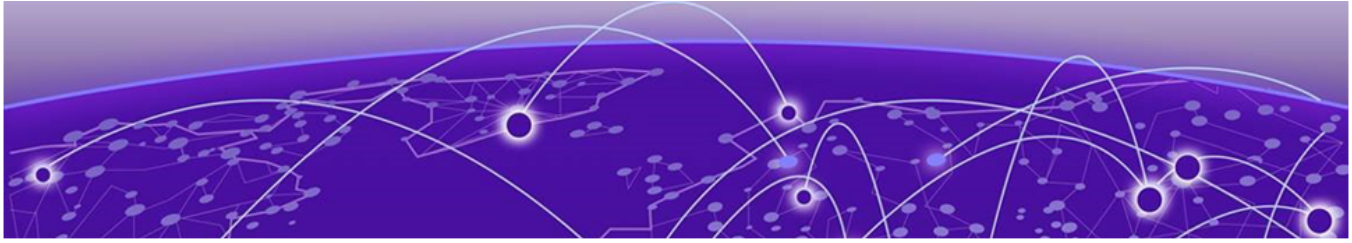
```
efa fabric show --name fabric1
Fabric Name: fabric1, Fabric Description: , Fabric Type: non-clos
+--------------+-------+--------------+------------+------+--------------+-------------
+-------------------+-----------------+---------+-------+
|  IP ADDRESS  | RACK  |  HOST NAME   |    ASN     | ROLE | DEVICE STATE |  APP STATE
| CONFIG GEN REASON | PENDING CONFIGS | VTLB ID | LB ID |
+--------------+-------+--------------+------------+------+--------------+-------------
+-------------------+-----------------+---------+-------+
| 10.20.246.15 | rack1 | Avalanche-01 | 4200000000 | leaf | provisioned  | cfg in-sync
| NA                | NA              | 2       | 1     |
| 10.20.246.16 | rack1 | Avalanche-02 | 4200000000 | leaf | provisioned  | cfg in-sync
| NA                | NA              | 2       | 1     |
+--------------+-------+--------------+------------+------+--------------+-------------
+-------------------+-----------------+---------+-------+
 efa fabric setting show --name fabric1 --advanced | grep -i "backup routing"
| Backup Routing Enable          | Yes                     |
| Backup Routing IPv4 Range      | 10.40.40.0/24           |
| Backup Routing IPv6 Range      | fd40:4040:4040:1::/120 |


efa tenant show
+------+---------+------------+-------------+--------------+-----------+-----------
+----------------------+
| Name |  Type   | VLAN Range | L2VNI Range | L3VNI Range  | VRF Count | Enable BD
```

```
|        Ports         |
+------+---------+-----------+-------------+--------------+-----------+-----------
+----------------------+
| ten1 | private |   11-20    | 20001-20020 | 21001-210020 |    10     |   false   |
10.20.246.15[0/1-10] |
|      |         |           |             |              |           |           |
10.20.246.16[0/1-10] |
+------+---------+-----------+-------------+--------------+-----------+-----------
+----------------------+

efa tenant vrf show
+----------+--------+--------------+--------------------+--------------+----------
+-----------+-----------+------------+-----------------+-----------+
|   Name   | Tenant | Routing Type | Centralized Routers | Redistribute | Max Path |
Local Asn | Enable GR |   State    |    Dev State    | App State |
+----------+--------+--------------+--------------------+--------------+----------
+-----------+-----------+------------+-----------------+-----------+
| ten1vrf1 |  ten1  | distributed  |                     |  connected   |    8
|           |   false   | vrf-create | not-provisioned | cfg-ready |
+----------+--------+--------------+--------------------+--------------+----------
+-----------+-----------+------------+-----------------+-----------+

efa fabric setting show --name fabric1 -advanced | grep -i MD5
| MD5 Password Enable            | Yes                                                |
| MD5 Password | $9$jrujIQqNxWkAyUOoI4cMtzhc4oP2VGREKwLOsSKH8bw= |

efa tenant epg show --name ten1epg1 --tenant ten1 -detail
================================================================================================
=========================================================================
Name          : ten1epg1
Tenant        : ten1
Type          : extension
State         :
Description   :
Ports         : 10.20.246.15[0/1]
POs           :
Port Property : SwitchPort Mode               : trunk
              : Native Vlan Tagging           : false
              : Single-Homed BFD Session Type : auto
NW Policy     : Ctag Range                    : 11
              : VRF                           : ten1vrf1
              : L3Vni                         : 21001
+------+-------------------------+-------+---------+--------------+--------------
+-----------------------+--------+---------+----------------+--------------
+-------------+-------------+
| Ctag |          Ctag           | L2Vni | BD Name | Anycast IPv4 | Anycast IPv6
|       Local IP        | IP MTU | IPv6 ND |    IPv6 ND     |   IPv6 ND    |  Dev
State  |  App State  |
|      |       Description       |       |         |              |              |
[Device-IP->Local-IP] |        |   Mtu   | Managed Config | Other Config |
|             |
+------+-------------------------+-------+---------+--------------+--------------
+-----------------------+--------+---------+----------------+--------------
+-------------+-------------+
|  11  | Tenant L3 Extended VLAN | 20001 |         | 10.0.11.1/24 |
|                       |        |         |     false      |    false     |
provisioned | cfg-in-sync |
+------+-------------------------+-------+---------+--------------+--------------
+-----------------------+--------+---------+----------------+--------------
+-------------+-------------+
```

2. Complete the configuration on SLX-OS as provided in the following example.

```
L1# show running-config router bgp
router bgp
 local-as 4200000000
 capability as4-enable
 fast-external-fallover
 neighbor 10.20.20.3 remote-as
4200000000
 neighbor 10.20.20.3 next-hop-self
 address-family ipv4 unicast
  network 172.31.254.71/32
  network 172.31.254.151/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv4 unicast vrf
ten1vrf1
  redistribute connected
  neighbor 10.40.40.252 remote-as
4200000000
  neighbor 10.40.40.252 next-hop-
self
  neighbor 10.40.40.252 password
$9$jrujIQqNxWkAyUOoI4cMtzhc4oP2VGRE
KwLOsSKH8bw=
  maximum-paths 8
 !
 address-family ipv6 unicast
 !
 address-family ipv6 unicast vrf
ten1vrf1
  redistribute connected
  neighbor fd40:4040:4040:1::fe
remote-as 4200000000
  neighbor fd40:4040:4040:1::fe
next-hop-self
  neighbor fd40:4040:4040:1::fe
password
$9$jrujIQqNxWkAyUOoI4cMtzhc4oP2VGRE
KwLOsSKH8bw=
  neighbor fd40:4040:4040:1::fe
activate
  maximum-paths 8
 !
 address-family l2vpn evpn
  graceful-restart
 !
!
```

```
L2# show running-config router bgp
router bgp
 local-as 4200000000
 capability as4-enable
 fast-external-fallover
 neighbor 10.20.20.2 remote-as
4200000000
 neighbor 10.20.20.2 next-hop-self
 address-family ipv4 unicast
  network 172.31.254.71/32
  network 172.31.254.195/32
  maximum-paths 8
  graceful-restart
 !
 address-family ipv4 unicast vrf
ten1vrf1
  redistribute connected
  neighbor 10.40.40.253 remote-as
4200000000
  neighbor 10.40.40.253 next-hop-
self
  neighbor 10.40.40.253 password
$9$jrujIQqNxWkAyUOoI4cMtzhc4oP2VGRE
KwLOsSKH8bw=
  maximum-paths 8
 !
 address-family ipv6 unicast
 !
 address-family ipv6 unicast vrf
ten1vrf1
  redistribute connected
  neighbor fd40:4040:4040:1::ff
remote-as 4200000000
  neighbor fd40:4040:4040:1::ff
next-hop-self
  neighbor fd40:4040:4040:1::ff
password
$9$jrujIQqNxWkAyUOoI4cMtzhc4oP2VGRE
KwLOsSKH8bw=
  neighbor fd40:4040:4040:1::ff
activate
  maximum-paths 8
 !
 address-family l2vpn evpn
  graceful-restart
 !
!
```



Security Hardening

Learn how to install and use open source security tools to achieve an enhanced security stance for XCO.

Overview of System Hardening in XCO

Get an overview of techniques for hardening security in XCO.

Learn about security hardening guidance for ExtremeCloud Orchestrator (XCO), with an emphasis on the installation and usage of open source security tools to achieve a hardened operational security stance. It is assumed that you have some basic knowledge of security principles and operations of the Linux operating system and associated technologies.

Note
This document assumes that XCO has been installed in secure mode and is operational. For details on how to achieve this, refer to the *ExtremeCloud Orchestrator CLI Administration Guide, 4.0.2*, which includes details on XCO security options and commands.

Note
After upgrading SLX-OS , inventory device updates may intermittently fail with 401 Unauthorized errors. The root cause is linked to a token validation issue triggered by service restarts during hardening script execution. These service restarts initiate HA events, which invalidate tokens. Manual updates succeed, but REST API calls fail due to 401 Unauthorized responses.

Log in to XCO (**`efa login`**) only after all dependent components have completed deployment and upgrade.

- Do not log in to XCO (via CLI or REST) during deployment.
- Avoid obtaining an `access_token` or starting an XCO session before all components are finished deploying.
- Wait until the following are fully completed:
  - XCO deployment or upgrade
  - SLX-OS upgrade
  - TPVM upgrade
  - Hardening script (HS) execution and completion

The following security hardening topics are included in this document:

- **CIS-CAT security hardening**: Details of a custom python script from Extreme Networks that hardens the underlying operating system.
- **Iptables firewall**: Securing the XCO networking stance.
- **Grub boot loader security**: How to set a hardened security posture for Grub.
- **System auditing with `auditd`**: Instructions for monitoring various aspects of system runtime activities.
- **OSSEC HIDS installation and usage**: A broad set of indicators relevant for host intrusion detection.
- **Authenticated NTP**: How to ensure that NTP communications are authenticated.
- **Secure DNS**: Details about encrypted DNS communications.
- **Detecting rootkits with `rkhunter`**: Specialized run time checks for various types of Linux rootkits.

System Hardening for CIS-CAT Assessments

TPVM provides a security hardening capability in the form of a python script located at `/opt/security/extr-granite.py` (for TPVM installations valid from version 4.5.0). The goal of this script is to modify various system security settings to achieve a more secure state under the examination of the CIS-CAT host scanner. Specifically, XCO running on TPVM is deployed into the Ubuntu server environment, and it is this environment that is hardened by `extr-granite.py`.

Note
The `/opt/security/extr-granite.py` script should not be exported to other 3rd party systems.

To perform the steps that follow, make sure you have Java Runtime Environment (JRE) installed. Also, ensure that the CIS-CAT scanner has been copied to the TPVM at `/root/cis-cat/Assessor-CLI`.

Note
CIS-CAT scanner is not bundled with TPVM. You must procure an external CIS-CAT license and install it on the TPVM environment.

The procedure itself involves the running of the `extr-granite.py` script. Notable aspects of the script are:

- The `extr-granite.py` script keeps a dedicated Git repository for all changes it makes to the underlying file system. This repository is located at `/opt/extr-granite-hardening/OS-files-git`.
- Git tags are used by `extr-granite.py` for every run cycle. This allows easy comparison of what the script changes on the host operating system from one run to the next.
- A comprehensive log file is kept at `/opt/extr-granite-hardening/hardening-log`.

The hardening script can be run multiple times, and even run at every boot using the init scripts. Every run receives its own Git tag in the `OS-files-git` repository. This makes it possible to track the changes the script has made, going back to the initial import.

It is discouraged to add, remove, or modify the hardening script audit rules unless necessary.

Hardening script must be run Post XCO installation for the audit logs feature to be function properly.

The Auditd default rules are set by the hardening script (extr-granite.py), which includes the necessary login/logout related rules. If the hardening script is not run, the Host OS login/logout functionality may not function accordingly. These rules should not be removed. It is the customer's responsibility to ensure Auditd rules are maintained. Editing the Auditd rules is not part of the XCO functionality. The hardening script sets the Auditd rules according to industry well-known CIS-CAT recommendations.

Perform the following steps to run the security script and verify that it is working:

1. Install CIS-CAT on the host and produce a scan result.
   Here is an example of the abbreviated output. There is a CIS-CAT score of 56.11% on the TPVM.

```
-------------------------------------------------------------------------------
***** Assessment Results Summary *****
-------------------------------------------------------------------------------
Total # of Results: 241
Total Scored Results: 180
Total Pass: 101 Total
Fail: 78
Total Error: 1
Total Unknown: 0
Total Not Applicable: 0
Total Not Checked: 20
```

```
Total Not Selected: 37
Total Informational: 4
-------------------------------------------------------------------------------
***** Assessment Scoring *****
-------------------------------------------------------------------------------
Score Earned: 101.0
Maximum Available: 180.0
Total: 56.11%
-------------------------------------------------------------------------------
```

2. Run `/opt/security/extr-granite.py`.

   Here is an example of an abbreviated output.

```
root@node-1:/opt/security# ./extr-granite.py
Initialized empty Git repository in /opt/extr-granite-hardening/OS-files-git/.git/
[master (root-commit) 1e2796b] initial import
1 file changed, 1 insertion(+)
create mode 100644 README
[+] ./extr-granite.py version: 0.89 - Initialized
sending incremental file list
/usr/
/usr/sbin/
/usr/sbin/grub-mkconfig

sent 3,467 bytes  received 47 bytes  7,028.00 bytes/sec
total size is 8,219  speedup is 2.34
[master 8b2b4bd] initial import: /usr/sbin/grub-mkconfig, for CIS-CAT test: 1.4.1
Ensure permissions on bootloader config are not overridden
1 file changed, 311 insertions(+)
create mode 100755 usr/sbin/grub-mkconfig
sending incremental file list
/etc/
/etc/sysctl.conf

sent 1,163 bytes  received 39 bytes  2,404.00 bytes/sec
total size is 2,683  speedup is 2.23
[master 2f4ad6c] initial import: /etc/sysctl.conf, for CIS-CAT test: 1.5.2 Ensure
address space layout randomization (ASLR) is enabled
1 file changed, 77 insertions(+)
create mode 100644 etc/sysctl.conf
kernel.randomize_va_space = 2
sending incremental file list
/etc/security/
/etc/security/limits.conf

.........................
.........................
.........................

sent 1,168 bytes  received 44 bytes  2,424.00 bytes/sec
total size is 2,306  speedup is 1.90
[master 7ef96f4] file: /etc/pam.d/su, CIS-CAT test: 5.7 Ensure access to the su
command is restricted
1 file changed, 1 insertion(+)
sending incremental file list
/etc/group

sent 544 bytes  received 36 bytes  1,160.00 bytes/sec
total size is 832  speedup is 1.43
[master 374f6c9] file: /etc/group, CIS-CAT test: 5.7 Ensure access to the su command
is restricted (2)
1 file changed, 1 insertion(+), 1 deletion(-)
sending incremental file list
/etc/profile
```

```
sent 436 bytes  received 36 bytes  944.00 bytes/sec
total size is 619  speedup is 1.31
[master b305cfe] file: /etc/profile, CIS-CAT test: 5.5.5 Ensure default user shell
timeout is 900 seconds or less
1 file changed, 3 insertions(+)

[+] Total checks run: 55


root@node-1:/opt/security#
```

The following example shows all changes from the initial import to the tag of the first run:

`extr-granite-run1`

Further, the example does the same `git diff`, except it shows just the changes that were made to the original `/etc/ssh/sshd_config` file.

```
root@tpvm:/opt/extr-granite-hardening/OS-files-git# git tag -l
extr-granite-initial-import
extr-granite-run1
root@tpvm:/opt/extr-granite-hardening/OS-files-git# git diff extr-granite-initial-
import extr-granite-run1
diff --git a/etc/issue b/etc/issue
index 80ae21e..5192c40 100644
--- a/etc/issue
+++ b/etc/issue
@@ -1,2 +1 @@
-Ubuntu XX.XX
-
+Extreme Networks, Inc. EFA product. Authorized users only. All activity may be
monitored and reported.
diff --git a/etc/issue.net b/etc/issue.net
index 5e9e2fa..5192c40 100644
--- a/etc/issue.net
+++ b/etc/issue.net
@@ -1 +1 @@
-Ubuntu XX.XX
+Extreme Networks, Inc. EFA product. Authorized users only. All activity may be
monitored and reported.
diff --git a/etc/modprobe.d/cramfs.conf b/etc/modprobe.d/cramfs.conf
new file mode 100644
index 0000000..b77c93a
--- /dev/null
+++ b/etc/modprobe.d/cramfs.conf
@@ -0,0 +1 @@
+install cramfs /bin/true
diff --git a/etc/modprobe.d/freevxfs.conf b/etc/modprobe.d/freevxfs.conf
new file mode 100644
index 0000000..72d4aec
--- /dev/null
+++ b/etc/modprobe.d/freevxfs.conf
@@ -0,0 +1 @@
+install freevxfs /bin/true
root@tpvm:/opt/extr-granite-hardening/OS-files-git# ls etc/ssh/sshd_config
etc/ssh/sshd_config
root@tpvm:/opt/extr-granite-hardening/OS-files-git# git help diff^C
root@tpvm:/opt/extr-granite-hardening/OS-files-git# git diff extr-granite-initial-
import extr-granite-run1 ./etc/ssh/sshd_config
diff --git a/etc/ssh/sshd_config b/etc/ssh/sshd_config
index 3f0e52e..f640120 100644
--- a/etc/ssh/sshd_config
```

```
+++ b/etc/ssh/sshd_config
@@ -121,4 +121,11 @@ Subsystem sftp     /usr/lib/openssh/sftp-server
 #      PermitTTY no
 #      ForceCommand cvs server
 PasswordAuthentication yes
-MaxStartups 30:30:100
+MaxStartups 10:30:60
+MaxAuthTries 4
+MACs hmac-sha2-512-etm@openssh.com,hmac-sha2-256-etm@openssh.com,hmac-sha2-512,hmac-
sha2-256
+KexAlgorithms curve25519-sha256,curve25519-sha256@libssh.org,diffie-hellman-
group14-sha256,diffie-hellman-group16-sha512,diffie-hellman-group18-sha512,ecdh-sha2-
nistp521,ecdh-sha2-nistp384,ecdh-sha2-nistp256,diffie-hellman-group-exchange-sha256
+LoginGraceTime 60
+Banner /etc/issue.net
```

Note

After running the security hardening script, reconnect to the existing TPVM SSH sessions (active/standby/vip) for the new ssh parameters to take effect.

3. Rerun the CIS-CAT auditor and verify that the scan results produce a score greater than 80%.
   Note that the hardening results are against version 4.55.0 of the CIS-CAT Assessor.

   On a Multinode TPVM setup CIS-CAT score is:

   : - Active TPVM: 81.14% (PASS)

   : - Standby TPVM: 81.14% (PASS)

Hardening Script for Ubuntu Linux Host Servers

Hardening Script for Ubuntu Linux Host Servers

Note that the hardening results are against version 4.52.0 of the CIS-CAT Assessor.

As well as the `/opt/security/extr-granite.py` script for TPVM deployments, a security hardening script for Ubuntu Linux 20.04 LTS host servers is available at `/opt/efa/security/extr-granite-server.py`. The script depends on three packages, auditd, audispd-plugins, and iptables-persistant. These packages are not shipped with XCO and they and their dependencies must be installed on the XCO server before using the security script.

To run this procedure, complete the following:

```
(efa:user)user@server2:~/efa33$ cd /opt/efa/security/
(efa:user)user@server2:/opt/efa/security$ ls
extr-granite-server.py
(efa:user)user@server2:/opt/efa/security$ sudo su
root@server2:/opt/efa/security# ls
extr-granite-server.py
root@server2:/opt/efa/security# ./extr-granite-server.py
Initialized empty Git repository in /opt/extr-granite-server-hardening/OS-files-git/.git/
[master (root-commit) 136e544] initial import
1 file changed, 1 insertion(+)
create mode 100644 README
```

```
[+] ./extr-granite-server.py version: 0.01 - Initialized
sent 433 bytes  received 36 bytes  938.00 bytes/sec
total size is 619  speedup is 1.32
[master f09c26c] file: /etc/profile, CIS-CAT test: 5.5.5 Ensure default user shell
timeout is 900 seconds or less
1 file changed, 3 insertions(+)

[+] Total checks run: 71

root@server2:/opt/efa/security# exit
exit
(efa:user)user@server2:/opt/efa/security$
```

Security Hardening for SLX-OS in XCO

Harden your security for SLX-OS devices in ExtremeCloud Orchestrator.

SLX-OS Device Configuration

As part of security hardening of the SLX-OS device, several configurations are supported from XCO. These configurations are applicable only for the SLX-OS versions 20.3.2 and above. Any SSH server settings change need SSHD to be restarted, and hence any client connected via SSH needs to reconnect..

The following configuration are applied on the SLX-OS device during registration in XCO.

1. SSH Server restarts on the device after the SSH configuration is completed.

Setting	Default Value
SSHD MAC Algorithms	hmac-sha2-512-etm@openssh.com,hmac-sha2-256-etm@openssh.com,hmac-sha2-512,hmac-sha2-256
SSHD Key Exchange Algorithms	curve25519-sha256,curve25519-sha256@libssh.org,diffie-hellman-group14-sha256,diffie-hellman-group16-sha512,diffie-hellman-group18-sha512,diffie-hellman-group-exchange-sha256
Cipher	non-cbc

The following SLX-OS command is for the SSH configuration on SLX-OS devices:

```
SLX# config
Entering configuration mode terminal
SLX(config)# ssh server mac hmac-sha2-512-etm@openssh.com,hmac-sha2-256-
etm@openssh.com,umac-128-etm@openssh.com,hmac-sha2-256,hmac-sha2-512
% Info: Configuration is successful.For this config to take effect immediately,
restart SSH server via exec command ssh-server restart or save the config and reload.
SLX(config)# ssh server key-
exchange curve25519-sha256,curve25519-sha256@libssh.org,diffie-hellman-group-
exchange-sha256,diffie-hellman-group16-sha512,diffie-hellman-group18-sha512,diffie-
hellman-group14-sha256
% Info: Configuration is successful.For this config to take effect immediately,
restart SSH server via exec command ssh-server restart or save the config and reload.
SLX(config)# ssh server cipher
SLX(config)# ssh server cipher non-cbc
```

```
% Info: Configuration is successful.For this config to take effect immediately,
restart SSH server via exec command ssh-server restart or save the config and reload.
SLX(config)# exit
SLX# ssh-server restart

Warning: This operation will disconnect all active SSH sessions.

Are you sure you want to restart the SSH server [y/n]? y
SSH server is going down for restart NOW !!
```

2. The following command shows the SSH configuration parameters on SLX-OS :

```
SLX# show ssh server status
SSH Kex Exchange Algorithm: curve25519-sha256,curve25519-sha256@libssh.org,diffie-
hellman-group-exchange-sha256,diffie-hellman-group16-sha512,diffie-hellman-group18-
sha512,diffie-hellman-group14-sha256
SSH Server Rekey Volume: 1024
SSH Server Auth Tries: 6
SSH Server Login Timeout: 120
SSH Server Cipher: non-cbc
SSH Server Mac : hmac-sha2-512-etm@openssh.com,hmac-sha2-256-etm@openssh.com,umac-128-
etm@openssh.com,hmac-sha2-256,hmac-sha2-512
VRF-Name: mgmt-vrf    Status: Enabled
VRF-Name: default-vrf    Status: Enabled
```

3. The following SLX-OS command disables the Telnet server on mgmt-vrf:

```
SLX# config
Entering configuration mode terminal
SLX(config)# telnet server use-vrf mgmt-vrf shutdown
```

4. The following command shows the Telnet configuration on SLX-OS :

```
SLX# show telnet server status
VRF-Name: default-vrf    Status: Enabled
VRF-Name: mgmt-vrf    Status: Disabled
```

5. The following attributes on the SLX-OS devices (applicable for versions above 20.3.1) are applicable for password configuration:

Setting	Default Value
Max Password Age	90
Force Default Password Change	Disabled

The following SLX-OS command configures the password attributes on SLX-OS devices:

```
SLX# config
Entering configuration mode terminal
SLX(config)# password-attributes max-password-age 365
SLX(config)# password-attributes force-default-password-change
```

6. The following command shows the password configuration on SLX-OS :

```
SLX# show running-config password-attributes
password-attributes force-default-password-change
password-attributes max-password-age 365
```

7. The following SLX-OS command configures TLS on SLX-OS devices: (applicable for versions above 20.3.2):

The minimum version of TLS Configuration on the server is set to 1.2.

```
SLX# config
Entering configuration mode terminal
SLX(config)# management-security
SLX(mgmt-security)# ssl-profile server
SLX(mgmt-sec-ssl-profile-server)# tls min-version 1.2
To view the configuration on SLX,
SLX# show running-config management-security ssl-profile server tls
management-security
 ssl-profile server
  tls min-version 1.2
 !
!
```

- The configuration attributes described above are the default values that are available in XCO on installation.
- The settings are ‘enabled’ by default. On device registration, the settings are applied on SLX-OS based on the supported versions.
- When you update the settings before device registration, the same values are applied on the device.
- If the settings are changed after device registration, you must manually apply the settings on the specific devices.
- On a device update, if there is any deviation, the AppState will be in ‘cfg-refresh'.
- When the device is unregistered from XCO, these settings are removed from the device.

Global Device Security Settings

1. The following command displays the security settings that are configured on the SLX-OS devices:

   These settings are common across all devices registered on the XCO installation.

```
efa inventory device secure settings show
+--------------------------+----------------------------------------+
|        NAME              | VALUE                                  |
+--------------------------+----------------------------------------+
| Min-tls-version          | 1.2                                    |
+--------------------------+----------------------------------------+
| Mac-algorithm            | hmac-sha2-512-etm@openssh.com          |
|                          | hmac-sha2-256-etm@openssh.com          |
|                          | hmac-sha2-512                          |
|                          | hmac-sha2-256                          |
+--------------------------+----------------------------------------+
| Key-exchange-algorithm   | curve25519-sha256                      |
|                          | curve25519-sha256@libssh.org           |
|                          | diffie-hellman-group14-sha256          |
|                          | diffie-hellman-group16-sha512          |
|                          | diffie-hellman-group18-sha512          |
|                          | diffie-hellman-group-exchange-sha256   |
+--------------------------+----------------------------------------+
| Cipher                   | non-cbc                                |
+--------------------------+----------------------------------------+
| Telnet                   | Disable                                |
+--------------------------+----------------------------------------+
```

```
| Max-password-age          | 365                                      |
+---------------------------+------------------------------------------+
```

2. The following command updates a security setting applicable for the SLX-OS devices:

```
efa inventory device secure settings update --min-tls-version 1.2

efa inventory device secure settings update --mac-algorithm hmac-sha2-512-
etm@openssh.com,hmac-sha2-256-etm@openssh.com,hmac-sha2-512,hmac-sha2-256

efa inventory device secure settings
update --key-exchange-algorithm curve25519-sha256,curve25519-
sha256@libssh.org,diffie-hellman-group14-sha256,diffie-hellman-group16-sha512,diffie-
hellman-group18-sha512,diffie-hellman-group-exchange-sha256

efa inventory device secure settings update --telnet enable --cipher non-cbc --
max-password-age 365
```

Note

After modifying any device secure settings, the changes are not automatically applied. You must manually enforce these settings on the devices or fabric, as described in "Device Security Settings".

3. The following command resets the security setting to the default value on the SLX-OS devices:

```
efa inventory device secure settings reset --telnet --cipher --max-password-age

      --min-tls-version                Reset minimum TLS version to the default value
      --mac-algorithm                  Reset MAC Algorithms to the default values
      --key-exchange-algorithm         Reset Key-Exchange Algorithms to the default
values
      --cipher                         Reset Ciphers to the default values
      --telnet                         Reset telnet to the default value of disabled
      --max-password-age               Reset the maximum number of days before
password expiry to the default value
      --force-default-password-change  Reset force a change in the default password
to the default value
```

4. The following command enables or disables the security settings on the SLX-OS devices:

   If you do not want to configure any security hardening settings on the device, disable the secure settings before device registration.

```
$ efa inventory device secure settings disable
Device secure settings have been disabled.
--- Time Elapsed: 57.000421492s ---
```

Note

If you disable the security settings after device registration, there will not be any change done on the device.

Device Security Settings

Apply the security hardening configuration on the device. You can use this command for enabling security hardening on devices that are already registered in XCO or if there is any update in the security settings.

1. The following command applies the security settings on the SLX-OS devices:

```
efa inventory device secure settings apply [ --ip device-ips | --fabric fabric |

--ip device-ip       Specifies a comma-separated range of device IP addresses.
Example: 1.1.1.1-3,1.1.1.2,2.2.2.2.
--fabric fabric      Specifies fabric name.
```

   Example:

```
efa inventory device secure settings apply --ip 1.1.1.1-3,2.2.2.2
efa inventory device secure settings apply --fabric fabric1
```

2. The following command shows the current settings on an SLX-OS device:

```
efa inventory device secure settings show [ --ip device-ip |

--ip device-ip      Specifies a device IP address. Example: 1.1.1.1.
```

   Example:

```
efa inventory device secure settings show --ip 1.1.1.1
+-----------------------------+----------------------------------------+
|           NAME              | VALUE                                  |
+-----------------------------+----------------------------------------+
| Min-tls-version             | 1.2                                    |
+-----------------------------+----------------------------------------+
| Mac-algorithm               | hmac-sha2-512-etm@openssh.com          |
|                             | hmac-sha2-256-etm@openssh.com          |
|                             | hmac-sha2-512                          |
|                             | hmac-sha2-256                          |
+-----------------------------+----------------------------------------+
| Key-exchange-algorithm      | curve25519-sha256                      |
|                             | curve25519-sha256@libssh.org           |
|                             | diffie-hellman-group14-sha256          |
|                             | diffie-hellman-group16-sha512          |
|                             | diffie-hellman-group18-sha512          |
|                             | diffie-hellman-group-exchange-sha256   |
+-----------------------------+----------------------------------------+
| Cipher                      | non-cbc                                |
+-----------------------------+----------------------------------------+
| Telnet                      | Disable                                |
+-----------------------------+----------------------------------------+
| Max-password-age            | 365                                    |
+-----------------------------+----------------------------------------+
```

Drift and Reconcile for Security Settings

Drift is calculated by comparing the settings on the device and the global security settings as these settings are the user intended settings that must be available on the system. SSH server restarts whenever applicable.

Table 9: Drift Reconcile & Idempotency support

Identify Drift	Reconcile configuration	Idempotency
Yes	Yes	Yes

```
(efa:extreme)extreme@tpvm:/opt $ efa inventory drift-reconcile detail --uuid
3d073e9c-879f-4db7-9ab9-852c3f669d51
+--------------------------------+--------------------------------------+
|              NAME              |                VALUE                 |
+--------------------------------+--------------------------------------+
| UUID                           | 3d073e9c-879f-4db7-9ab9-852c3f669d51 |
+--------------------------------+--------------------------------------+
| Device IP                      | 10.x.x.x                             |
+--------------------------------+--------------------------------------+
| Status                         | success                              |
+--------------------------------+--------------------------------------+
| Execution Reason               | manual                               |
+--------------------------------+--------------------------------------+
| operation                      | drift-and-reconcile                  |
+--------------------------------+--------------------------------------+
| Inventory Status               | inventory-dr-success                 |
+--------------------------------+--------------------------------------+
| Is Inventory config Refreshed  | true                                 |
+--------------------------------+--------------------------------------+
| Inventory Duration             | 15.586983384s                        |
+--------------------------------+--------------------------------------+
| Fabric Status                  | fabric-dr-success                    |
+--------------------------------+--------------------------------------+
| Is Fabric config Refreshed     | false                                |
+--------------------------------+--------------------------------------+
| Fabric Duration                | 121.479233ms                         |
+--------------------------------+--------------------------------------+
| Policy Status                  | policy-dr-success                    |
+--------------------------------+--------------------------------------+
| Is Policy config Refreshed     | false                                |
+--------------------------------+--------------------------------------+
| Policy Duration                | 88.764104ms                          |
+--------------------------------+--------------------------------------+
| Tenant Status                  | tenant-dr-success                    |
+--------------------------------+--------------------------------------+
| Is Tenant config Refreshed     | false                                |
+--------------------------------+--------------------------------------+
| Tenant Duration                | 49.042052ms                          |
+--------------------------------+--------------------------------------+
| Device Update Count            | 2                                    |
+--------------------------------+--------------------------------------+
| Device Update Total Duration   | 2m34.074986291s                      |
+--------------------------------+--------------------------------------+
| Maintenance Mode Disable       |                                      |
| Duration                       |                                      |
+--------------------------------+--------------------------------------+
| Start Time                     | 2022-09-19 20:25:47 +0530 IST        |
+--------------------------------+--------------------------------------+
| Last Modified                  | 2022-09-19 20:29:16 +0530 IST        |
+--------------------------------+--------------------------------------+
| Duration                       | 3m29.931352961s                      |
+--------------------------------+--------------------------------------+


Inventory Service Response:
Config Drift: Device Secure Settings
+-----------------------+--------------+--------------------------------+
```

```
|          NAME          |   APP STATE   |          CHILD CONFIG          |
+------------------------+---------------+--------------------------------+
| Device Secure Settings | cfg-refreshed | Secure Setting Max Password    |
|                        |               | Age                            |
+------------------------+---------------+--------------------------------+

Reconcile Status:
+-------------------+---------------+---------------+
|    CONFIG-TYPE    |   APP STATE   | ERROR-MESSAGE |
+-------------------+---------------+---------------+
| NtpAuthKey        | Not-Attempted |               |
| SnmpHost          | Not-Attempted |               |
| MMOnReboot        | Not-Attempted |               |
| InterfaceConfig   | Not-Attempted |               |
| SnmpUser          | Not-Attempted |               |
| DeviceTimezone    | Not-Attempted |               |
| ThresholdMonitor  | Not-Attempted |               |
| SecureSetting     | Success       |               |
| NtpDisable        | Not-Attempted |               |
| SnmpView          | Not-Attempted |               |
| SnmpGroup         | Not-Attempted |               |
| DeviceSetting     | Not-Attempted |               |
| NtpServer         | Not-Attempted |               |
| SnmpCommunity     | Not-Attempted |               |
| BreakoutInterface | Not-Attempted |               |
+-------------------+---------------+---------------+


Fabric Service Response:


Policy Service Response:


Tenant service Response:
--- Time Elapsed: 75.311491ms ---
```

The following table describes scenarios for the device secure settings:

Scenario	Secure Settings	Device Config
Fresh installation of XCO	Enabled (Default)	Applied on device registration
Fresh installation	Disabled	No settings are applied during registration
Upgrade from prior releases. Security hardening configuration is executed on the device with same configuration as the default settings in XCO.	Enabled (Default)	Device update will result in `cfg-in-sync`
Upgrade from prior releases. Security hardening configuration is executed on the device with different configuration than the default settings in XCO.	Enabled (Default)	Device update will result in `cfg-refresh`

Scenario	Secure Settings	Device Config
Upgrade from prior releases. No security hardening configuration is executed on the device.	Enabled (Default)	Device update will result in `cfg-refresh`
Upgrade from prior releases	Disabled	Device update will result in `cfg-in-sync`

The iptables Policy

As a core component of XCO, Kubernetes uses iptables to control the network connections between pods (and between nodes), handling many of the networking and port forwarding rules. XCO builds a custom iptables policy to firewall off services (such as the MySQL database) on the XCO management interface. The XCO iptables policy is instantiated by default at installation time and is enabled at boot, through the system service.

To see the status of the XCO iptables policy, in addition to the policy itself, run the following commands:

```
$ ssh -l extreme 192.168.10.109
Password:
extreme@tpvm:~$ sudo su -
root@tpvm:~#
root@tpvm:~# systemctl status efa-iptables
   efa-iptables.service - iptables rules for EFA
   Loaded: loaded (/lib/systemd/system/efa-iptables.service; enabled; vendor preset:
enabled)
   Active: active (exited) since Fri 2020-10-09 20:48:03 UTC; 1 day 17h ago
 Main PID: 19384 (code=exited, status=0/SUCCESS)
    Tasks: 0 (limit: 4638)
   CGroup: /system.slice/efa-iptables.service

Oct 09 20:48:03 tpvm systemd[1]: Starting iptables rules for EFA...
Oct 09 20:48:03 tpvm systemd[1]: Started iptables rules for EFA.
root@tpvm:~# iptables -v -nL EFA_INPUT
Chain EFA_INPUT (1 references)
 pkts bytes target     prot opt in     out     source         destination
    0     0 DROP       tcp  --  eth0   *       0.0.0.0/0      0.0.0.0/0       multiport
dports 1024:6513,6515:8077,8079:65535 ctstate NEW
    0     0 DROP       udp  --  eth0   *       0.0.0.0/0      0.0.0.0/0       multiport
dports 1024:65535 ctstate NEW
```

With iptables policy active, it should not be possible to connect to the MySQL database on TCP port 3306 on the management interface from an external host. Use Nmap to verify that port 3306 been firewalled off:

```
# nmap -n -p 3306 -sV 192.168.10.109

Starting Nmap 7.60 ( https://nmap.org ) at 2020-10-11 14:42 UTC
Nmap scan report for 192.168.10.109
Host is up (0.0039s latency).

PORT     STATE  SERVICE VERSION
3306/tcp filtered mysql

Service detection performed. Please report any incorrect results at https://nmap.org/
```

```
submit/ .
Nmap done: 1 IP address (1 host up) scanned in 0.81 seconds

Service detection performed. Please report any incorrect results at https://nmap.org/
submit/ .
Nmap done: 1 IP address (1 host up) scanned in 0.85 seconds
```

Nmap Scan Output from a Remote System on the VIP

```
Host is up (0.23s latency).

Not shown: 64511 filtered ports, 1018 closed ports

PORT      STATE  SERVICE      VERSION

22/tcp    open   ssh          OpenSSH 7.6p1 Ubuntu 4ubuntu0.5 (Ubuntu Linux; protocol 2.0)

80/tcp    open   http         Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

443/tcp   open   ssl/https

514/tcp   open   shell?

6514/tcp  open   ssl/syslog-tls?

8078/tcp  open   ssl/http      Golang net/http server (Go-IPFS json-rpc or InfluxDB API)
```

Nmap Scan Output on the Active Node on a Multi-node Setup

```
Host is up (0.0020s latency).

Not shown: 65515 closed ports

PORT      STATE  SERVICE      VERSION

22/tcp    open   ssh          OpenSSH 7.6p1 Ubuntu 4ubuntu0.5 (Ubuntu Linux; protocol 2.0)

80/tcp    open   http         Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

111/tcp   open   rpcbind      2-4 (RPC #100000)

443/tcp   open   ssl/https

514/tcp   open   shell?

3306/tcp  open   mysql?

4567/tcp  open   tram?

6514/tcp  open   ssl/syslog-tls?

8078/tcp  open   ssl/http     Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

8079/tcp  open   ssl/http     Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

8080/tcp  open   ssl/http     Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

8088/tcp  open   http         Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

8091/tcp  open   http         Golang net/http server (Go-IPFS json-rpc or InfluxDB API)
```

```
8092/tcp  open   http         Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

10250/tcp open   ssl/http     Golang net/http server (Go-IPFS json-rpc or InfluxDB API)

24007/tcp open   rpcbind

49152/tcp open   rpcbind

49153/tcp open   rpcbind

49154/tcp open   rpcbind
```

Secure the Grub Boot Loader

To add the Grub boot loader to the security posture, perform the following steps.

Securing the Grub boot loader is an important addition to the security posture for the operating system where XCO is deployed. There are two general phases for securing the boot loader:

- Set a password in the Grub configuration to harden against modifications to the Linux kernel boot-time command line.
- Set a password for the 'root' user to protect against attempts to acquire single-user mode at boot.

1. Set a password in the Grub configuration:
   a. Acquire root and then run the `grub-mkpasswd-pbkdf2` command (full output is shown below).
   b. Append the password hash and the string `set superusers="root"` to the file `/etc/grub.d/40_custom`.
   c. Add `--unrestricted` to the `"CLASS=" definition` line in `/etc/grub.d/10_linux`.
   d. Run the command `update-grub`.

```
root@tpvm:~# grub-mkpasswd-pbkdf2
Enter password:
Reenter password:
PBKDF2 hash of your password is
grub.pbkdf2.sha512.10000.72C8CE3112C007A315A94DD7A63B58392DD00653ACAF8795C8528D83967
FA24105B0B53D0092522460532AF05C60EE3E0C7EAC95213E865DF31580A341188ABC.843EF94A9C8EE8
AC1776F5B88261D1B6DE437A70AEABE3C814764596F696EE5F7FDF912E63B4D47AE3E7BB468A6B639F00
051D142698142EF158E6C141CF38B7
root@tpvm:~# cat >> /etc/grub.d/40_custom
set superusers="root"
password_pbkdf2 root
grub.pbkdf2.sha512.10000.A577D1C8F13C93B82EA5E25E834D5BD88ECB94A5B42F2DABE4FB7A235F3
A25A12E6542CB5DA9620B2E0342FE28A4F066BE1B99F2EFBE8C0688FBE11FDB3138DD.2C7C81C7FA0404
C768DDCE097B3AA8DD08C042B4FDBA089C0837F91B6C8864EE83B19CBC6D4C5C126E76FA20BE93789920
913B12CAC841CA65EA3BAD5921F8D5
root@tpvm:~# <edit /etc/grub.d/10_linux to make the CLASS line look like the
following>
root@tpvm:~# grep CLASS /etc/grub.d/10_linux | head -n 1
CLASS="--class gnu-linux --class gnu --class os --unrestricted"
root@tpvm:~ # update-grub
Sourcing file `/etc/default/grub'
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.4.0-48-generic
Found initrd image: /boot/initrd.img-5.4.0-48-generic
Found linux image: /boot/vmlinuz-5.3.0-40-generic
```

```
Found initrd image: /boot/initrd.img-5.3.0-40-generic
Found linux image: /boot/vmlinuz-4.15.0-118-generic
Found initrd image: /boot/initrd.img-4.15.0-118-generic
Found linux image: /boot/vmlinuz-4.15.0-88-generic
Found initrd image: /boot/initrd.img-4.15.0-88-generic
done
```

2. Set a password for the ‘root’ user by running the following commands:

```
root@tpvm~:# passwd
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
```

Install the Linux Audit System

To install the Linux Audit System, perform the following steps.

XCO is based on the Ubuntu operating system, which by default, does not come with auditd (Linux Audit System) installed. Perform the instructions that follow to install it in XCO. During the installation process, auditd is enabled by default via systemctl and starts writing audit trail log data to the file `/var/log/audit/audit.log`

Note
Linux Audit System is available by default on TPVM 4.5.10 and above.

To install, run the following command:

```
# apt-get install auditd
```

This is an example output:

```
type=DAEMON_START msg=audit(1591152521.117:3494): op=start ver=2.8.2 format=raw
kernel=5.3.0-53-generic auid=4294967295 pid=27162 uid=0 ses=4294967295 subj=unconfined
res=success
type=CONFIG_CHANGE msg=audit(1591152521.153:23): op=set audit_backlog_limit=8192 old=64
auid=4294967295 ses=4294967295 res=1
type=CONFIG_CHANGE msg=audit(1591152521.157:24): op=set audit_failure=1 old=1
auid=4294967295 ses=4294967295 res=1
type=CONFIG_CHANGE msg=audit(1591152521.157:25): op=set audit_backlog_wait_time=0
old=15000 auid=4294967295 ses=4294967295 res=1
type=SERVICE_START msg=audit(1591152521.157:26): pid=1 uid=0 auid=4294967295
ses=4294967295 msg='unit=auditd comm="systemd" exe="/lib/systemd/systemd" hostname=?
addr=? terminal=? res=success'
```

You can produce more interesting data from the `audit.log` file when you authenticate to the XCO host. In this case, the audit trail data for the user ‘extreme’ authenticating via SSH is displayed:

```
type=USER_LOGIN msg=audit(1591975761.779:39): pid=7894 uid=0 auid=4294967295
ses=4294967295 msg='op=login acct="extreme" exe="/usr/sbin/sshd" hostname=?
addr=192.168.10.12 terminal=sshd res=failed'
type=USER_AUTH msg=audit(1591975763.219:40): pid=7894 uid=0 auid=4294967295
ses=4294967295 msg='op=PAM:authentication acct="extreme" exe="/usr/sbin/sshd"
hostname=192.168.10.12 addr=192.168.10.12 terminal=ssh res=success'
type=USER_ACCT msg=audit(1591975763.219:41): pid=7894 uid=0 auid=4294967295
ses=4294967295 msg='op=PAM:accounting acct="extreme" exe="/usr/sbin/sshd"
hostname=192.168.10.12 addr=192.168.10.12 terminal=ssh res=success'
type=CRED_ACQ msg=audit(1591975763.223:42): pid=7894 uid=0 auid=4294967295 ses=4294967295
msg='op=PAM:setcred acct="extreme" exe="/usr/sbin/sshd" hostname=192.168.10.12
addr=192.168.10.12 terminal=ssh res=success'
```

```
type=LOGIN msg=audit(1591975763.223:43): pid=7894 uid=0 old-auid=4294967295 auid=1000
tty=(none) old-ses=4294967295 ses=127 res=1
type=USER_START msg=audit(1591975764.487:44): pid=7894 uid=0 auid=1000 ses=127
msg='op=PAM:session_open acct="extreme" exe="/usr/sbin/sshd" hostname=192.168.10.12
addr=192.168.10.12 terminal=ssh res=success'
type=CRED_ACQ msg=audit(1591975764.491:45): pid=8113 uid=0 auid=1000 ses=127
msg='op=PAM:setcred acct="extreme" exe="/usr/sbin/sshd" hostname=192.168.10.12
addr=192.168.10.12 terminal=ssh res=success'
type=USER_LOGIN msg=audit(1591975764.547:46): pid=7894 uid=0 auid=1000 ses=127
msg='op=login id=1000 exe="/usr/sbin/sshd" hostname=192.168.10.12 addr=192.168.10.12
terminal=/dev/pts/1 res=success'
```

Further, when the 'extreme' user authenticates to the 'XCO' command line with `efa login`, the following audit trail message is generated (in case of success):

```
type=USER_AUTH msg=audit(1591975780.823:47): pid=21139 uid=0 auid=4294967295
ses=4294967295 msg='op=PAM:authentication acct="extreme" exe="/apps/bin/hostauth"
hostname=? addr=? terminal=? res=success'
```

And here is the output in case of failures:

```
type=USER_AUTH msg=audit(1591976323.760:58): pid=21139 uid=0 auid=4294967295
ses=4294967295 msg='op=PAM:authentication acct="extreme" exe="/apps/bin/hostauth"
hostname=? addr=? terminal=? res=failed'
```

Secure NTP and XCO

For XCO, authenticated NTP can be used in two possible configurations:

- XCO acts as a client to existing NTP infrastructure.
- XCO runs its own NTP server. Steps for achieving this solution are provided below.

Also, there are many different visions for secure NTP that can range from authentication (at the low end) to leveraging the newest NTS (Network Time Secure) protocol that leverages public key cryptography via TLS (at the high end).

XCO is based on Ubuntu 18.04, and ntpsec from the upstream package maintainers does not allow for a comprehensive and well-supported usage of NTS. However, if this is an absolute requirement, you can achieve NTS support on XCO by manually compiling and deploying a recent version of ntpsec, **but this is not a supported solution**. This comes at the cost of not using the sanctioned Ubuntu packaging system for package updates, and this tradeoff may not be worth it within certain operational environments.

Enforcing authentication where XCO acts as a client to existing NTP infrastructure

If XCO is to act only as a client for authenticated NTP, then upstream NTP servers where XCO is pointed also need to support authenticated NTP. You can use public NTP servers for this purpose, such as those of the US National Institute of Standards and Technology (NIST). For more information, see the NIST website. The following is an excerpt from the site:

"The time messages will be authenticated using symmetric-key encryption in a manner that is fully compatible with the published NTP documentation. (Autokey and asymmetric key modes will not be used.) Each registered user will be assigned a unique encryption key, which will be linked to the IP address(es) of the user's system(s).

A registered user will be able to communicate with the authenticated server using this assigned encryption key or using a default key of 0, which is equivalent to disabling the encryption algorithm. Users who are not registered will not be able to connect to this server, but can use any of the other NIST servers, which will not be modified."

Enforcing authentication where XCO provides its own NTP server

1. Populate the `/etc/ntp.keys` file with a SHA1 symmetric key. This can easily be done with the following command (which uses the `/etc/shadow` file as input to produce the SHA1 hash, and this hash must be shared with all clients that need to authenticate):

```
echo "3 SHA1 `sha1sum /etc/shadow |cut -d ' ' -f 1`" > ntp.keys
```

2. Add the line 'keys /etc/ntp.keys' to the `/etc/ntp.conf` file on XCO.
3. Share the SHA1 symmetric key from Step 1 with any clients that are authorized to acquire NTP data from XCO. This could include the population of managed SLX-OS devices for example.
4. Restart the NTP daemon on XCO, and verify that no start-up error for the ntpd process is logged to `/var/log/syslog`. For example, if the format of the `/etc/ntp.keys` file is invalid, then the following error is displayed.

```
Jun 12 20:38:36
        tpvm ntpd[16498]: authreadkeys: rejecting file '/etc/ntp.keys' after 1 error(s)
```

Note

From the perspective of NTP clients, if coming from a Linux system the `/etc/ntp.keys` file from the server configuration steps above should be available in the file system. For example, if this file is also placed at `/etc/ntp.keys`, then the step for acquiring NTP information from XCO is as follows:

```
# sntp -k /etc/ntp.keys <efa hostname>
```

Secure DNS and XCO

To achieve secure DNS communications using dnscrypt-proxy, perform the following steps.

Achieving secure DNS communications can be a critical aspect of a strong operational security posture. Use the open source 'dnscrypt-proxy' package to bring encrypted DNS communications to XCO.

1. Install dnscrypt-proxy by running:

```
apt-get install
        dnscrypt-proxy
```

2. Review the various resolvers that support encrypted DNS in the file `/usr/share/dnscrypt-proxy/dnscrypt-resolvers.csv` and select one. The name of this resolver is in the first column in this file. For example, the 'adguard-dns-ns1' resolver is displayed here:

```
adguard-dns-ns1,"Adguard DNS 1","Remove ads and protect your computer from
        malware","Anycast","",https://adguard.com/en/adguard-dns/
overview.html,1,no,yes,no,176.103.130.130:5443,2.dnscrypt.default.ns1.adguard.com,D12B:
47F2:52DC:F2C2:BBF8:9910:86EA:F79C:E449:5D8B:16C8:A0C4:322E:52CA:3F39:0873,pk.default.n
s1.adguard.com
```

3. Edit the `/etc/dnscrypt/dnscrypt-proxy.conf` file, and set

```
ResolverName adguard-dns-ns1

LocalAddress 127.0.0.1:53
```

4. Edit the `/etc/systemd/system/sockets.target.wants/dnscrypt-proxy.socket` file and make sure the `[Socket]` section looks like this:

```
[Socket]
 ListenStream=127.0.0.1:53
 ListenDatagram=127.0.0.1:53
```

5. Reload systemd, disable and re-enable dnscrypt-proxy.socket, and reboot:

```
# systemctl daemon-reload
 # systemctl disable dncrypt-proxy.service
 # systemctl enable dnscrypt-proxy.service
 # reboot
```

   At this point, dnscrypt-proxy should be functioning normally. One way to verify this is to look for DNS requests on the XCO management interface ('eth0' for TPVM installations of XCO). There should be no traffic on UDP port 53 because encrypted DNS traffic is sent over UDP port 443.

6. To verify, run a sniffer on eth0, cause the system to issue a DNS lookup, and ensure that there are no UDP packets on port 53. The output should look similar to this:

```
# tcpdump -i eth0 -l -nn port 53 or port 443
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes

15:26:54.136556 IP 192.168.10.109.40632 > 176.103.130.130.443: UDP, length 512
15:26:54.151425 IP 176.103.130.130.443 > 192.168.10.109.40632: UDP, length 304
15:26:54.152783 IP 192.168.10.109.40632 > 176.103.130.130.443: UDP, length 512
15:26:54.166523 IP 176.103.130.130.443 > 192.168.10.109.40632: UDP, length 304
```

Detect Rootkits with rkhunter

Rootkit Hunter (rkhunter) is a standard tool for the detection of rootkits on Linux. The Ubuntu Linux distribution maintains a package for rkhunter. The complete set of checks that rkhunter performs provides a good security baseline for finding some of the most malicious elements of the offensive security landscape. It is recommended you regularly run the `rkhunter --check` command and review the contents of the `/var/log/rkhunter.log` file.

1. Install rkhunter by running:

```
# apt-get install rkhunter
```

2. Run a scan for rootkits:

```
# rkhunter --check
    T0rn Rootkit                                [ Not found ]
    trNkit Rootkit                              [ Not found ]
    Trojanit Kit                                [ Not found ]
    Tuxtendo Rootkit                            [ Not found ]
    URK Rootkit                                 [ Not found ]
    Vampire Rootkit                             [ Not found ]
    VcKit Rootkit                               [ Not found ]
    Volc Rootkit                                [ Not found ]
    Xzibit Rootkit                              [ Not found ]
    zaRwT.KiT Rootkit                           [ Not found ]
    ZK Rootkit                                  [ Not found ]
```

3. For additional details of what is being checked on the system, refer to the `/var/log/rkhunter.log` file. For example, in the following example, the scan looked for evidence of the `T0rn` rootkit and specifically, the existence of the following files were checked (output abbreviated):

```
[21:28:18] Checking for T0rn Rootkit...
[21:28:18]   Checking for file '/dev/.lib/lib/lib/t0rns'     [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/du'        [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/ls'        [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/t0rnsb'    [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/ps'        [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/t0rnp'     [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/find'      [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/ifconfig'  [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/pg'        [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/ssh.tgz'   [ Not found ]
[21:28:18]   Checking for file '/dev/.lib/lib/lib/top'       [ Not found ]
[21:28:19]   Checking for file '/dev/.lib/lib/lib/sz'        [ Not found ]
[21:28:19]   Checking for file '/dev/.lib/lib/lib/login'     [ Not found ]
[21:28:19]   Checking for file '/dev/.lib/lib/lib/in.fingerd' [ Not found ]
[21:28:19]   Checking for file '/dev/.lib/lib/lib/1i0n.sh'   [ Not found ]
```