Cisco Crosswork Infrastructure 4.3 and Applications Administration Guide

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APPENDIX A

CHAPTER 1

Get Up and Running (Post-Installation)

This section contains the following topics:

Before You Begin

Before you begin using the Cisco Crosswork applications, you are recommended to be familiar with the following basic concepts and complete the planning and information-gathering steps:

- **User Roles**: Cisco recommends that you use role-based access control to confine users to just the software functions needed to perform their job duties. By default, every new user you create has full administrative privileges. Unless you want to extend the same privileges to every user, you will need to plan a system of user roles, create them, and assign them to the user profiles you create.

- **User Accounts** : Cisco recommends as a best practice that you create separate accounts for all of your users, so that there is an audit record of user activity on the system. Prepare a list of the people who will use the Crosswork application. Decide on their user names and preliminary passwords, and create user profiles for them. Crosswork also supports integration with many TACACS+ and LDAP servers to allow you to centrally manage user roles and accounts. See Set Up User Authentication (TACACS+ and LDAP), on page 279 for more details.

- **Credential Profiles**: For Cisco Crosswork to be able to access a device or to interact with a provider, it must be able to present credentials. Rather than entering credentials each time they are needed, you can instead create credential profiles to securely store this information. The platform supports unique credentials for each type of access protocol, and allows you to bundle multiple protocols and their corresponding credentials in a single profile. Devices that use the same credentials can share a credential profile. For example, if all of your routers in a particular building share a single SSH user ID and password, you can create a single credential profile to allow Cisco Crosswork to access and manage them.

  Before creating a credential profile, you must gather access credentials and supported protocols that you will use to monitor and manage your devices. For devices, it includes user IDs, passwords, and additional data such as the SNMP v2 read and write community strings, and SNMPv3 auth and privilege types. For other type of providers (NSO, SR-PCE, Storage, Alert, and WAE), this always includes user IDs, passwords, and connection protocols. You will use these to create credential profiles.

- **Tags**: Tags are simple text strings you can attach to devices to help group them. Cisco Crosswork comes with a short list of ready-made tags used to group network devices. You can create your own tags and use them to identify, find, and group devices for a variety of purposes.

  Plan a preliminary list of custom tags to create when setting up the system, so that you can use them to group your devices when you first onboard them. You need not have a complete list of tags at first, as you can always add more later, but please note that all the tags you do plan to use must be in place before you need them. Otherwise, you will need to manually go back and add them where you wish to use them. See Add Cisco NSO Providers, on page 127 for more details.

- **Providers**: Cisco Crosswork applications rely on external services such as Cisco Network Services Orchestrator (NSO) or SR-PCE for various tasks like configuration changes, segment routing path computation, and so on. In order to manage the access and reuse of information between Crosswork applications, a Provider (such as NSO and SR-PCE) needs to be configured for each external service. The provider family determines the type of service that provider supplies to Cisco Crosswork, and the parameters unique to that service, which must be configured. The parameters needed to configure a provider depend on what Crosswork application is used. It is important to review and gather each Crosswork application requirement, before configuring a Provider. For more information, see About Provider Families, on page 123 and Provider Dependency, on page 124.

  - Cisco Network Services Orchestrator (Cisco NSO) is the default provider used in every Cisco Crosswork application installation, so you will need to gather the Cisco NSO IP address or host name, port and protocol, and the credentials to be used to communicate with it (which you will need to add as a credential profile).

  - If you plan to use Crosswork Optimization Engine, a Cisco SR-PCE provider, at minimum, must be defined in order to discover devices and to distribute policy configuration to devices. You should determine the auto-onboarding mode and device credential profile you will use (if you auto-onboard devices). For more information, see Add Cisco SR-PCE Providers, on page 130.

- **Devices**: You can onboard devices using the UI, a CSV file, an API, SR-PCE discovery, or ZTP. The way a device is onboarded determines the type of information needed to configure a device in Crosswork. Also, Crosswork can forward device configuration to NSO which can change how you provision an NSO provider. For more information, see Add Devices to the Inventory, on page 155.

- **External Data Destination(s)**: Cisco Crosswork functions as the controller for the Cisco Crosswork Data Gateway. Operators who plan to have Cisco Crosswork Data Gateway forward data to other data destinations, need to know about the format required by those destinations and other connection requirements. This is covered in detail in Cisco Crosswork Data Gateway, on page 23.

- **Labels**: Labels are used with Crosswork Change Automation to restrict which users are able to execute a playbook. For example, while you may want lower-level operators to be able to run check playbooks you may use lables labels to prevent them from running more complex or impactful playbooks that make changes to network device configuration.

- If you plan to use Crosswork Health Insights, **KPI (Key Performance Indicators) Profile(s)** are used to monitor the health of the network. You can establish unique performance criteria based on the way a device or devices are used in the network. KPIs can be grouped to form a KPI Profile. It is helpful to have a good idea of the data you plan to monitor and the performance targets that you want to establish as you setup Health Insights.

- If you plan to install the Crosswork Service Health application, you should review the samples provided to determine how they will monitor services in their network.

Note that you can capture the devices, credential profiles, tags, and providers lists in spreadsheet form, convert the spreadsheet to CSV format, and then upload them in bulk to the Cisco Crosswork application that you are using with the help of the Import feature. You can access CSV templates for each of these lists by clicking the Import icon in the corresponding places in the user interface. Select the **Download template** link when prompted to choose an export destination path and file name.

Setup Workflow

The first step in getting started with Cisco Crosswork is to prepare the system for use. The table below provides topics to refer to for help when executing each of the following tasks:

Note This workflow assumes that you have already installed Cisco Crosswork Data Gateway as explained in *Cisco Crosswork Infrastructure 4.1 and Applications Installation Guide*.

If you were able to complete the recommended planning steps explained in "Before you begin", you should have all the information you need to finish each step in this workflow.

Table 1: Tasks to Complete to Get Started with Cisco Crosswork

Step	Action
1. Ensure that your devices are configured properly for communication and telemetry.	Refer to the guidelines and sample configurations in: Telemetry Prerequisites for New Devices, on page 157 Sample Configuration for Cisco NSO Devices, on page 158
2. (Optional) If the set-up is a Cisco NSO LSA deployment, enable LSA.	Follow the steps in Enable Layered Service Architecture (LSA), on page 287
3. Create credential profiles.	Follow the steps in Create Credential Profiles, on page 116
4. Add the provider(s).	Follow the steps in About Adding Providers, on page 125
5. Validate communications with the provider(s).	Check on the provider's reachability using the steps in Get Provider Details, on page 146
6. Import or create tags.	To import them: Import Tags, on page 151 To create them: Create Tags, on page 150
7. Onboard devices using the method you prefer.	See Add Devices to the Inventory, on page 155
8. Setup Crosswork Data Gateway	Follow the steps in Set Up Crosswork Data Gateway to Collect Data, on page 28.

Step	Action
9. Validate Cisco Crosswork communications with devices.	Review the **Devices** window (see Manage Network Devices, on page 164). All the devices you have onboarded should be reachable. Click ⓘ to investigate any device whose **Reachability State** is marked as ✖ (unreachable), ⚠ (degraded), or ❓ (unknown).
10. (Optional) Create additional user accounts and user roles.	Follow the steps in Manage Users, on page 274 and Create User Roles, on page 277.
11. (Optional) Import or create additional credential profiles and providers.	To import providers: Import Providers, on page 145 To create providers: Add Providers Through the UI, on page 126
12. (Optional) Group your devices logically as per your requirement.	Follow the steps in Create and Modify Device Groups, on page 171.
13. (Optional) Set display preferences for your topology.	Follow the steps in Define Map Display Settings, on page 249 and Define Color Thresholds for Link Bandwidth Utilization, on page 251.

Log In and Log Out

The Cisco Crosswork user interface is browser based. See the *Cisco Crosswork Infrastructure 4.1 and Applications Installation Guide* for the supported browser versions.

Note Cisco Crosswork locks out users for a specified period of time after repeated unsuccessful login attemtps. Users can attempt to login with the correct credentials once the wait time is over. Users will remain locked out until they enter the valid login credentials.

The number of unsuccessful login attempts and the lock out time are configured by the administators in the **Local Password Policy**. For more information, see Configure AAA Settings, on page 282.

Step 1 Open a web browser and enter:

```
https://<Crosswork Management Network Virtual IP (IPv4)>:30603/
```

or

```
https://[<Crosswork Management Network Virtual IP (IPv6)>]:30603/
```

Note Please note that the IPv6 address in the URL must be enclosed with brackets.

When you access Cisco Crosswork from your browser for the first time, some browsers display a warning that the site is untrusted. When this happens, follow the prompts to add a security exception and download the self-signed certificate from the server. After you do this, the browser accepts the Cisco Crosswork server as a trusted site in all subsequent logins.

Step 2 The Cisco Crosswork browser-based user interface displays the login window. Enter your username and password.

Note The default administrator user name and password is **`admin`**. This account is created automatically at installation (see Administrative Users Created During Installation, on page 275). The initial password for this account must be changed during installation verification. Cisco strongly recommends that you keep the default administrator credential secure, and never use it for routine logins. Instead, create new user roles with appropriate privileges and assign new users to those roles. At least one of the users you create should be assigned the "administrator" role.

Step 3 Click **Log In**.

Step 4 To log out, click 👤 in the top right of the main window and choose **Log out**.

CHAPTER 2

Manage the Crosswork Cluster

This section contains the following topics:

Cluster Management Overview

The Cisco Crosswork platform uses a cluster architecture. The cluster distributes platform services across a unified group of virtual machine (VM) hosts, called nodes. The underlying software architecture distributes processing and traffic loads across the nodes automatically and dynamically. This architecture helps Cisco Crosswork respond to how you actually use the system, allowing it to perform in a scalable, highly available, and extensible manner.

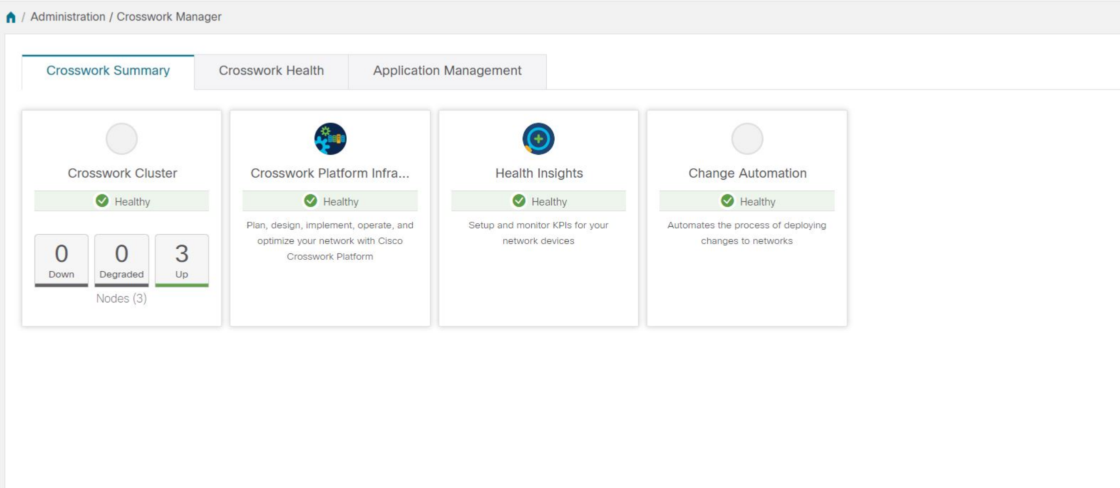
For the 4.1 release, a single cluster consists of a minimum of three nodes, all operating in a hybrid configuration. These three hybrid nodes are mandatory for all Cisco Crosswork deployments. If you have more demanding scale requirements, you can add up to three worker nodes. For more information, see Deploy New Cluster Nodes, on page 9.

As a user assigned in the administrator role, you have full access to all cluster configuration and monitoring functions.

Check Cluster Health

Use the **Crosswork Manager** window to check the health of the cluster. To display this window, from the main menu, choose **Administration** > **Crosswork Manager**.

Figure 1: Crosswork Manager Window



Administration / Crosswork Manager

Crosswork Summary | Crosswork Health | Application Management

Crosswork Cluster
Healthy
0 Down
0 Degraded
3 Up
Nodes (3)

Crosswork Platform Infra...
Healthy
Plan, design, implement, operate, and optimize your network with Cisco Crosswork Platform

Health Insights
Healthy
Setup and monitor KPIs for your network devices

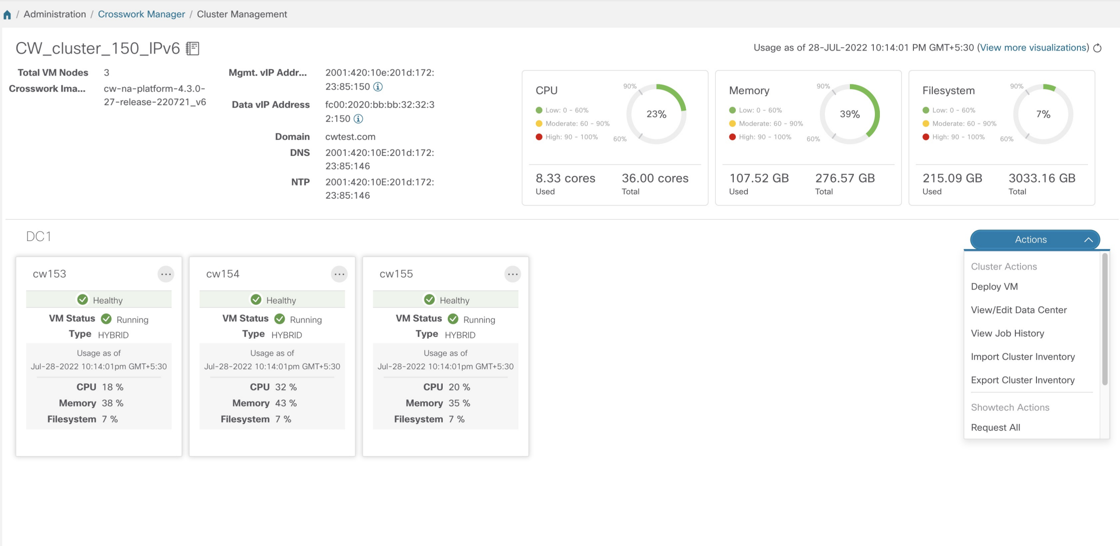
Change Automation
Healthy
Automates the process of deploying changes to networks

The **Crosswork Manager** window gives you summary information about the status of the cluster nodes, the Platform Infrastructure, and the applications you have installed.

Cluster Management

For details on the nodes in the cluster: On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile. Cisco Crosswork displays a **Cluster Management** window like the one shown in the following figure.

Figure 2: Cluster Management Window



Administration / Crosswork Manager / Cluster Management

CW_cluster_150_IPv6

Usage as of 28-JUL-2022 10:14:01 PM GMT+5:30 (View more visualizations)

Total VM Nodes 3
Crosswork Ima... cw-na-platform-4.3.0-27-release-220721_v6
Mgmt. vIP Addr... 2001:420:10e:201d:172:23:85:150
Data vIP Address fc00:2020:bb:bb:32:32:32:150
Domain cwtest.com
DNS 2001:420:10E:201d:172:23:85:146
NTP 2001:420:10E:201d:172:23:85:146

CPU: 23% — 8.33 cores Used, 36.00 cores Total
Memory: 39% — 107.52 GB Used, 276.57 GB Total
Filesystem: 7% — 215.09 GB Used, 3033.16 GB Total
Low: 0 - 60%
Moderate: 60 - 90%
High: 90 - 100%

DC1

cw153
Healthy
VM Status Running
Type HYBRID
Usage as of Jul-28-2022 10:14:01pm GMT+5:30
CPU 18 %
Memory 38 %
Filesystem 7 %

cw154
Healthy
VM Status Running
Type HYBRID
Usage as of Jul-28-2022 10:14:01pm GMT+5:30
CPU 32 %
Memory 43 %
Filesystem 7 %

cw155
Healthy
VM Status Running
Type HYBRID
Usage as of Jul-28-2022 10:14:01pm GMT+5:30
CPU 20 %
Memory 35 %
Filesystem 7 %

Attention In some cases of manual installations, the Cluster Management window may not display the inventory details correctly. In such cases, you need to manually import the cluster inventory file as described in Import Cluster Inventory, on page 11

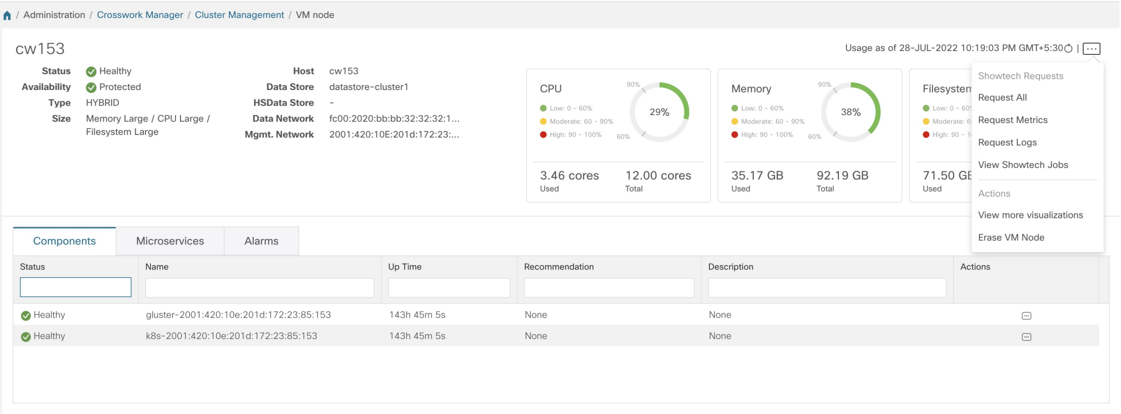
The top section of the window shows the total resources that the cluster is using. The bottom section breaks down the resource utilization by node, with a separate detail tile for each node. The window shows other details, including the IP addresses in use, whether each node is a hybrid or worker, and so on.

Click the **View more visualizations** link to Visually Monitor System Functions in Real Time, on page 293.

VM Node Details

To see details for a single node: On the tile for the node, click ⋯ and choose **View Details**. The VM Node window displays the node details and the list of microservices running on the node.

Figure 3: Cluster Management Window



cw153

Status	Healthy	Host	cw153
Availability	Protected	Data Store	datastore-cluster1
Type	HYBRID	HSData Store	-
Size	Memory Large / CPU Large / Filesystem Large	Data Network	fc00:2020:bb:bb:32:32:32:1...
		Mgmt. Network	2001:420:10E:201d:172:23:...

CPU		Memory		Filesystem
3.46 cores Used	12.00 cores Total	35.17 GB Used	92.19 GB Total	71.50 GB Used

Status	Name	Up Time	Recommendation	Description	Actions
Healthy	gluster-2001:420:10e:201d:172:23:85:153	143h 45m 5s	None	None	⋯
Healthy	k8s-2001:420:10e:201d:172:23:85:153	143h 45m 5s	None	None	⋯

To restart a microservice, click ⋯ under the **Action** column, and choose **Restart**.

For information on how to use the **Crosswork Health** tab, see Monitor Platform Infrastructure and Application Health, on page 292.

Deploy New Cluster Nodes

After the cluster installer forms the Cisco Crosswork cluster, you may find you need more nodes to meet your requirements. The following steps show how to deploy a new node.

Note This procedure is currently only supported for Crosswork deployments done on VMware vCenter.

Before you begin

Before you begin, you must know:

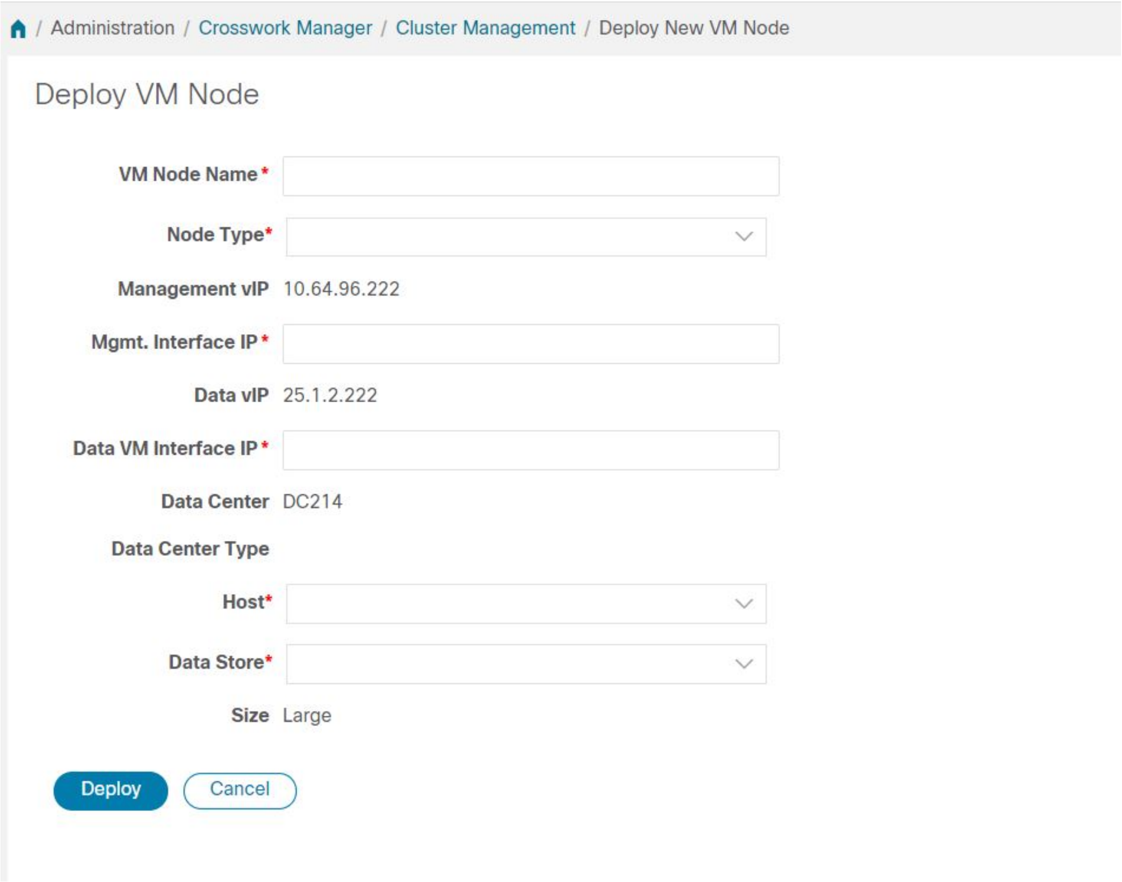
- Details about the Cisco Crosswork network configuration, such as the management IP address.
- Details about the VMware host where you are deploying the new node, such as the data store and data VM interface IP address.
- The type of node you want to add. Your cluster can have a minimum of three hybrid nodes and up to three worker nodes.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 Choose **Actions** > **Deploy VM** to display the **Deploy New VM Node** window.

Figure 4: Deploy VM Node Window



/ Administration / Crosswork Manager / Cluster Management / Deploy New VM Node

Deploy VM Node

VM Node Name*	
Node Type*	
Management vIP	10.64.96.222
Mgmt. Interface IP*	
Data vIP	25.1.2.222
Data VM Interface IP*	
Data Center	DC214
Data Center Type	
Host*	
Data Store*	
Size	Large

Step 4 Fill the relevant values in the fields provided.

Step 5 Click **Deploy**. The system starts to provision the new node in VMware. Cisco Crosswork adds a tile for the new node in the **Crosswork Manager** window. The tile displays the progress of the deployment.

You can monitor the node deployment status by choosing **Cluster Management** > **Actions** > **View Job History**, or from the VMware user interface.

If you added the VM node using Cisco Crosswork APIs: On the newly added VM node tile, click ··· and choose **Deploy** to complete the operation.

View and Edit Data Center Credentials

You can deploy the Cisco Crosswork platform in a data center under either VMware vCenter or Cisco CSP management. The following steps show how to view and edit the credentials for the data center.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 Choose **Actions** > **View/Edit Data Center** to display the **Edit Data Center** window.

The **Edit Data Center** window displays details of the data center.

Step 4 Use the **Edit Data Center** window to enter values for the **Access** fields: Address, Username, and Password).

Step 5 Click **Save** to save the data center credential changes.

View Cluster Job History

Use the Job History window to track the status of cluster jobs, such as deploying a VM or importing cluster inventory.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 Choose **Actions** > **View Job History**.

The **Job History** window displays a list of cluster jobs. You can filter or sort the **Jobs** list using the fields provided: Status, Job ID, VM ID, Action, and Users.

Step 4 Click any job to view it in the **Job Details** panel at the right.

Import Cluster Inventory

Cisco Crosswork uses a cluster inventory file to deploy or replace nodes in your cluster. If your cluster was a manual install, you must import the cluster inventory file to Cisco Crosswork manually.

Note Importing the cluster inventory file is a **required** operation for manually-installed clusters. "Manually installed" means clusters that are created without the help of the cluster installer. You cannot deploy or remove VM nodes until you complete this operation.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 Choose **Actions** > **Import Cluster Inventory** to display the **Import Cluster Inventory** dialog box.

Step 4 (Optional) Click **Download sample template file** to download and edit the template.

Step 5 Click **Browse** and select the cluster inventory file.

Step 6 Click **Import** to complete the operation.

Export Cluster Inventory

Use the cluster inventory file to monitor and manage your Cisco Crosswork cluster.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 Choose **Actions** > **Export Cluster Inventory**.

Cisco Crosswork downloads the cluster inventory gzip file to your local directory.

Collect Cluster Logs and Metrics

As an administrator, you can monitor or audit the components of your Cisco Crosswork cluster by collecting periodic logs and metrics for each cluster component. These components include the cluster as a whole, individual nodes in the cluster, and the microservices running on each of the nodes.

Cisco Crosswork provides logs and metrics using the following showtech options:

- **Request All** to collect both logs and metrics.
- **Request Metrics** to collect only metrics.
- **Collect Logs** to collect only logs.
- **View Showtech Jobs** to view all showtech jobs.

Note Showtech logs must be collected separately for each application.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 To collect logs and metrics for the cluster, click **Actions** and select the showtech option that you want to perform.

Step 4 To collect logs and metrics for any node in the cluster:

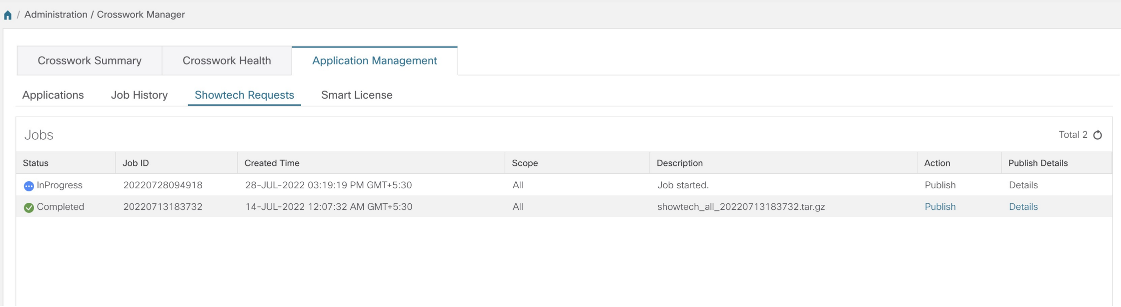
a) Click the node tile.

b) Click **Showtech Options** and select the operation that you want to perform.

Step 5 To collect logs and metrics for the individual microservices running on the VM node, click the ⋯ under the **Actions** column. Then select the showtech option that you want to perform.

Step 6 (Optional) Click **View Showtech Jobs** to view the status of your showtech jobs. The **Showtech Requests** window displays the details of the showtech jobs.

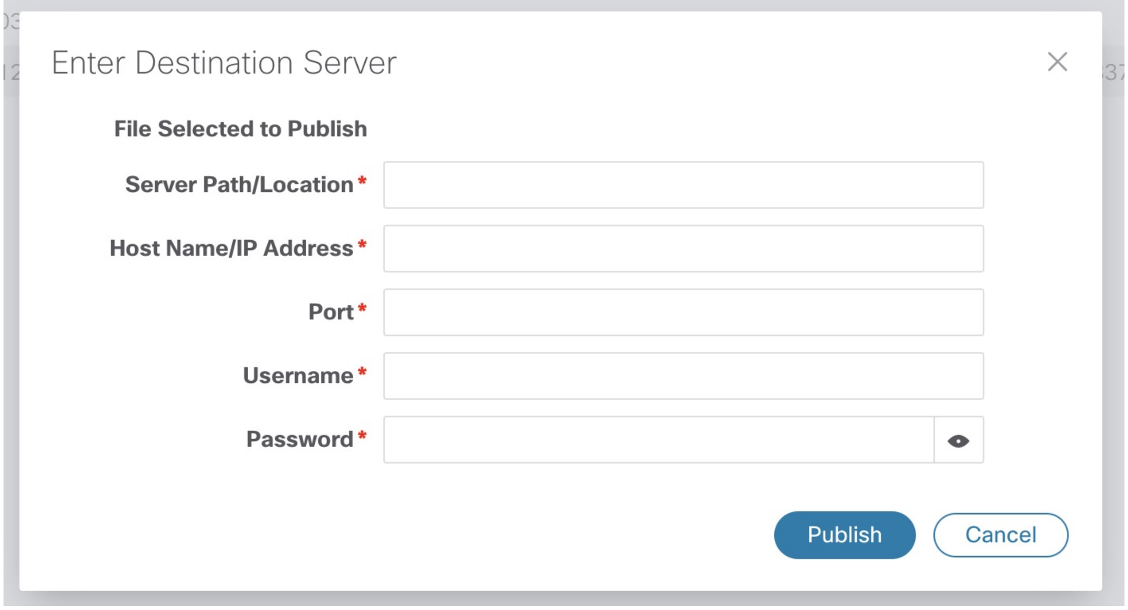
Figure 5: Showtech Requests window



Status	Job ID	Created Time	Scope	Description	Action	Publish Details
InProgress	20220728094918	28-JUL-2022 03:19:19 PM GMT+5:30	All	Job started.	Publish	Details
Completed	20220713183732	14-JUL-2022 12:07:32 AM GMT+5:30	All	showtech_all_20220713183732.tar.gz	Publish	Details

Step 7 (Optional) Click **Publish** to publish the showtech logs. The **Enter Destination Server** dialog box is displayed. Enter the relevant details and click **Publish**.

Figure 6: Showtech Requests window



Click **Details** to view details of the showtech log publishing.

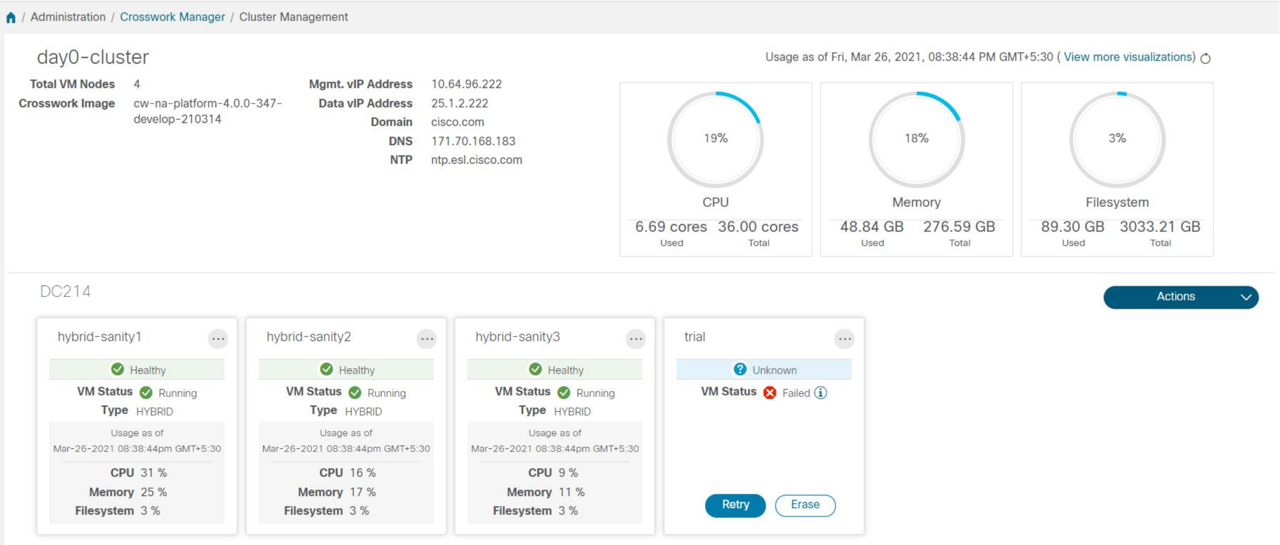
Retry Failed Nodes

Node deployments with incorrect information can fail. After providing the correct details, you can retry the deployment.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Figure 7: Cluster Management Window: Failed VM Deployment



/ Administration / Crosswork Manager / Cluster Management

day0-cluster

Usage as of Fri, Mar 26, 2021, 08:38:44 PM GMT+5:30 (View more visualizations)

Total VM Nodes 4

Crosswork Image cw-na-platform-4.0.0-347-develop-210314

Mgmt. vIP Address 10.64.96.222

Data vIP Address 25.1.2.222

Domain cisco.com

DNS 171.70.168.183

NTP ntp.esl.cisco.com

CPU	Memory	Filesystem
19%	18%	3%
6.69 cores Used 36.00 cores Total	48.84 GB Used 276.59 GB Total	89.30 GB Used 3033.21 GB Total

DC214

hybrid-sanity1	hybrid-sanity2	hybrid-sanity3	trial
Healthy	Healthy	Healthy	Unknown
VM Status Running	VM Status Running	VM Status Running	VM Status Failed
Type HYBRID	Type HYBRID	Type HYBRID	
Usage as of Mar-26-2021 08:38:44pm GMT+5:30	Usage as of Mar-26-2021 08:38:44pm GMT+5:30	Usage as of Mar-26-2021 08:38:44pm GMT+5:30	
CPU 31 %	CPU 16 %	CPU 9 %	
Memory 25 %	Memory 17 %	Memory 11 %	
Filesystem 3 %	Filesystem 3 %	Filesystem 3 %	Retry Erase

Step 3 Click **Retry** on the failed node tile to display the **Deploy New VM Node** window.

Step 4 Provide corrected information in the fields provided.

Step 5 Click **Deploy**.

Erase Nodes

As an Administrator, you can erase (that is, remove or delete) any **failed** or **healthy** node from your Cisco Crosswork cluster. Erasing a node removes the node reference from the Cisco Crosswork cluster and deletes it from the host VM.

The steps to erase a node are the same for both hybrid and worker nodes. However, the number and timing of erasure is different in each case:

- The system must maintain three operational hybrid nodes at all times. If one of the three hybrid nodes is faulty, the system will be functional, but degraded from an availability point of view. In such cases, the faulty node is removed and a new hybrid node needs to be deployed to replace it.
- You can have from one to three worker nodes. While you can erase all of them without consequences, we recommend that you erase and replace them one at a time.
- If one hybrid node is faulty, along with one or more worker nodes and applications, try the "Clean System Reboot" procedure described in Cluster System Recovery, on page 16.

  If more than one hybrid node is faulty, follow the "Redeploy and Recover" procedure described in Cluster System Recovery, on page 16.
- If you are still having trouble after taking these steps, contact the Cisco Customer Experience team for assistance.

Warning

- Erasing a node is a disruptive action and can block some processes until the action is completed. To minimize disruption, conduct this activity during a maintenance window only.
- Removing worker and hybrid nodes places extra workload on the remaining nodes and can impact system performance. You are encouraged to contact your Cisco Cisco Customer Experience team before removing nodes.

Note While removing a Hybrid or Worker node, the Cisco Crosswork UI may become unreachable for 1-2 minutes, due to the relocation of the `cw-ui` pod to a new node.

Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

Step 3 On the tile for the node you want to remove, click ··· and select **Erase** to display the **Erase VM Node** dialog box .

Step 4 Click **Erase** again to confirm the action.

Note A removed node will continue to be visible in the Grafana dashboard as an entry with only historical data.

Manage Maintenance Mode Settings

Maintenance mode provides a means for shutting down the Crosswork system temporarily. The maintenance mode shut down is graceful. Crosswork synchronizes all application data before the shutdown.

It can take several minutes for the system to enter maintenance mode and to restart after the shut down. During that period, other users should not attempt to log in or use the Crosswork applications.

Before you begin

Notify other users that you intend to put the system in maintenance mode and give them a deadline to log out. The maintenance mode operation cannot be canceled once you initiate it.

Step 1 To put Crosswork in maintenance mode:

a) From the main menu, choose **Administration** > **Settings** > **System Settings** > **Maintenance Mode**
b) Drag the **Maintenance** slider to the right, or **On** position.
c) Crosswork warns you that it is about to initiate a shut down. Click the **Continue** to confirm your choice.

It can take several minutes for the system to enter maintenance mode. During that period, other users should not attempt to log in or use the Crosswork applications.

Note If you wish to reboot the cluster, wait for 5 minutes after system has entered maintenance mode in order to allow the Cisco Crosswork database to sync, before proceeding.

Step 2 To restart Crosswork from maintenance mode:

a) From the main menu, choose **Administration** > **Settings** > **System Settings** > **Maintenance Mode**
b) Drag the **Maintenance** slider to the left, or **Off** position.

It can take several minutes for the system to restart. During that period, other users should not attempt to log in or use the Crosswork applications.

Note If a reboot or restore was performed when the system was previously put in maintenance mode, the system will boot up in the maintenance mode and you will be prompted with a popup window to toggle the maintenance mode off. If you do not see a prompt (even when the system was rebooted while in maintenance mode), you must toggle the maintenance mode on and off to allow the applications to function normally.

Cluster System Recovery

When System Recovery Is Needed

⚠

Caution The methods explained in this topic may fail if you use a cluster profile consisting of only 3 hybrid VM nodes (and no worker nodes). The failure happens due to the lack of VM resiliency caused by the absence of worker nodes.

At some time during normal operations of your Cisco Crosswork cluster, you may find that you need to recover the entire system. This can be the result of one or more malfunctioning nodes, one or more malfunctioning services or applications, or a disaster that destroys the hosts for the entire cluster.

A functional cluster requires a minimum of three hybrid nodes. These hybrid nodes share the processing and traffic loads imposed by the core Cisco Crosswork management, orchestration and infrastructure services. The hybrid nodes are highly available and able to re-distribute processing loads among themselves, and to worker nodes, automatically.

The cluster can tolerate one hybrid node reboot (whether graceful or ungraceful). During the hybrid node reboot, the system is still functional, but degraded from an availability point of view. The system can tolerate any number of failed worker nodes, but again, system availability is degraded until the worker nodes are restored.

Cisco Crosswork generates alarms when nodes, applications, or services are malfunctioning. If you are experiencing system faults, first examine the alarm. Then check on the health of the individual node, application, or service identified in the alarm. You can use the features described in Check Cluster Health, on page 8 to drill down on the source of the problem and, if it turns out to be a service fault, restart the problem service.

If you see alarms indicating that one hybrid node has failed, or that one hybrid node and one or more worker nodes have failed, start by attempting to reboot or replace (erase and then re-add) the failed nodes. If you are still having trouble after that, consider performing a clean system reboot.

The loss of two or more hybrid nodes is a double fault. Even if you replace or reboot the failed hybrid nodes, there is no guarantee that the system will recover correctly. There may also be cases where the entire system has degraded to a bad state. For such states, you can deploy a new cluster, and then recover the entire system using a recent backup taken from the old cluster.

Important

- VM shutdown is not supported on a 3 VM cluster that is running the Crosswork Network Controller solution. If a VM fails, the remaining two VMs cannot support all the pods being migrated from the failed VM. You must deploy additional worker nodes to enable the VM shutdown.
- Reboot of one of the VMs is supported in a 3 VM cluster. In case of a reboot, the VM restore can take from 5 minutes (if the `orch pod` is not running in the rebooted VM) up to 25 minutes (if the `orch pod` is running in the rebooted VM).

The following two sections describe the steps to follow in each case.

Clean System Reboot (VMware)

Follow these steps to perform a clean system reboot:

1. Put Crosswork in Maintenance mode. See Manage Maintenance Mode Settings, on page 15 for more details.
2. Power down the VM hosting each node:
   a. Log in to the VMware vSphere Web Client.
   b. In the **Navigator** pane, right-click the VM that you want to shut down.
   c. Choose **Power** > **Power Off**.
   d. Wait for the VM status to change to **Off**.
3. Repeat Step 2 for each of the remaining VMs, until you are sure they are all shut down.
4. Power up the VM hosting the first of your hybrid nodes:
   a. In the **Navigator** pane, right-click the VM that you want to power up.
   b. Choose **Power** > **Power Up**.
   c. Wait for the VM status to change to **On**, then wait another 30 seconds before continuing.

5. Repeat Step 4 for each of the remaining hybrid nodes, staggering the reboot by 30 seconds before continuing. Then continue with each of your worker nodes, again staggering the reboot by 30 seconds.

6. The time taken for all the VMs to be powered on can vary based on the performance characteristics of your hardware. After all VMs are powered on, wait for a few minutes and login to Crosswork.

7. Move Crosswork out of Maintenance mode. See Manage Maintenance Mode Settings, on page 15 for more details.

Note If your Crosswork cluster is not in a healthy state, your attempts to force maintenance mode will likely fail. Despite a successful attempt, application sync issues may still happen. In such cases, alarms will be generated indicating the list of failed services and the failure reason. If you face this scenario, you may still proceed with the "Redeploy and Restore" method mentioned below.

Redeploy and Restore (VMware)

Follow these steps to redeploy and recover your system from a backup. Note that this method assumes you have taken periodic backups of your system before it needed recovery. For information on how to take backups, see Manage Cisco Crosswork Backup and Restore, on page 103.

1. Power down the VM hosting each node:

   a. Log in to the VMware vSphere Web Client.

   b. In the **Navigator** pane, right-click the VM that you want to shut down.

   c. Choose **Power** > **Power Off**.

   d. Wait for the VM status to change to **Off**.

   e. Repeat these steps as needed for the remaining nodes in the cluster.

2. Once all the VMs are powered down, delete them:

   a. In the VMware vSphere Web Client **Navigator** pane, right-click the VM that you want to delete.

   b. Choose **Delete from Disk**.

   c. Wait for the VM status to change to **Deleted**.

   d. Repeat these steps as needed for the remaining VM nodes in the cluster.

3. Deploy a new Cisco Crosswork cluster, as explained in the *Cisco Crosswork Platform 4.3 and Applications Installation Guide*.

4. Recover the system state to the newly deployed cluster, as explained in Restore Cisco Crosswork After a Disaster, on page 106.

Note If you instantiated your Cisco Crosswork nodes using Cisco CSP 5000, the process in both cases is similar to the process for VMware. See the relevant CSP 5000 documentation for more details.

Rebalance Cluster Resources

As part of cluster management, Crosswork constantly monitors the resource utilization in each cluster node. If the CPU ulitization in any of the nodes becomes high (by default, the "high" range is set as 67-100%), Crosswork triggers a notification prompting you to take action. You can then use the **Rebalance** feature to reallocate the resources between the existing VM nodes in your cluster.

If the other nodes in your cluster are also nearing their full capacity, you are recommended to deploy a new worker node before attempting the **Rebalance**option to ensure easy reallocation of resouces. For more information about adding a worker node, see Deploy New Cluster Nodes, on page 9.

⚠ **Caution** Rebalancing can take from 15 to 30 minutes during which the Crosswork Applications will be unavailable. Once initiated, a rebalance operation cannot be cancelled.

Before you begin

- Crosswork must be in maintenance mode before rebalancing to ensure data integity.
- Any users logged in during the rebalancing will lose their sessions. Kindly notify other users beforehand that you intend to put the system in maintenance mode for rebalancing, and give them a deadline to log out.

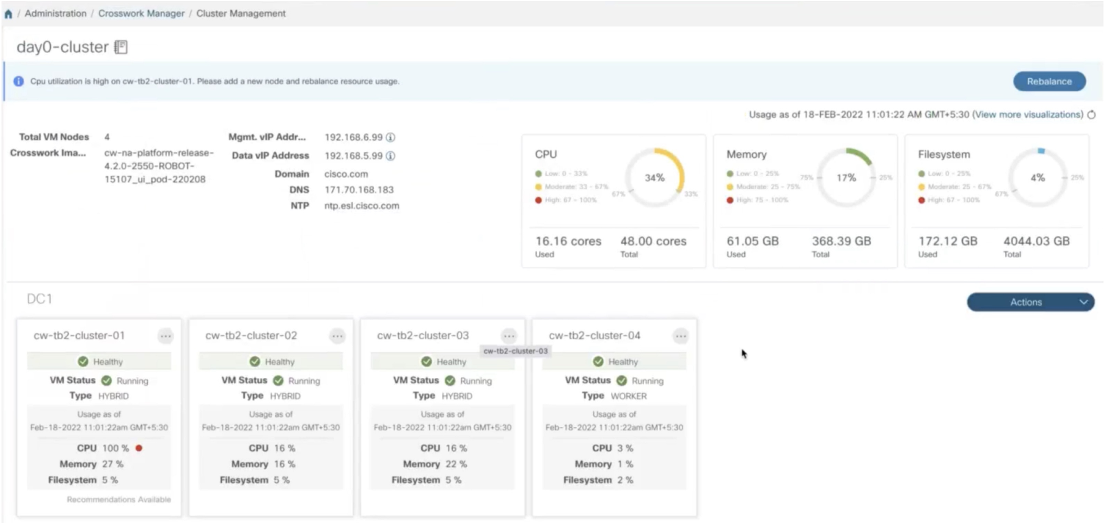
Step 1 From the main menu, choose **Administration** > **Crosswork Manager**.

Step 2 On the **Crosswork Summary** tab, click the **Crosswork Cluster** tile to display the **Cluster Management** window.

For the sake of this procedure, a sample cluster (**day0-control**) with 3 hybrid nodes and 1 worker node is considered. The CPU utilization is high in one of the hybrid nodes (100% in **cw-tb2-cluster-01**). See the below image for more details.

A banner is displayed below the cluster name warns you about the resouce overutilization in the cluster node and recommends adding more worker nodes.

Figure 8: Rebalance notification



Administration / Crosswork Manager / Cluster Management

day0-cluster

Cpu utilization is high on cw-tb2-cluster-01. Please add a new node and rebalance resource usage.

Usage as of 18-FEB-2022 11:01:22 AM GMT+5:30 (View more visualizations)

Total VM Nodes 4
Crosswork Ima... cw-na-platform-release-4.2.0-2550-ROBOT-15107_ui_pod-220208
Mgmt. vIP Addr... 192.168.6.99
Data vIP Address 192.168.5.99
Domain cisco.com
DNS 171.70.168.183
NTP ntp.esl.cisco.com

CPU 34%	Memory 17%	Filesystem 4%
16.16 cores Used 48.00 cores Total	61.05 GB Used 368.39 GB Total	172.12 GB Used 4044.03 GB Total

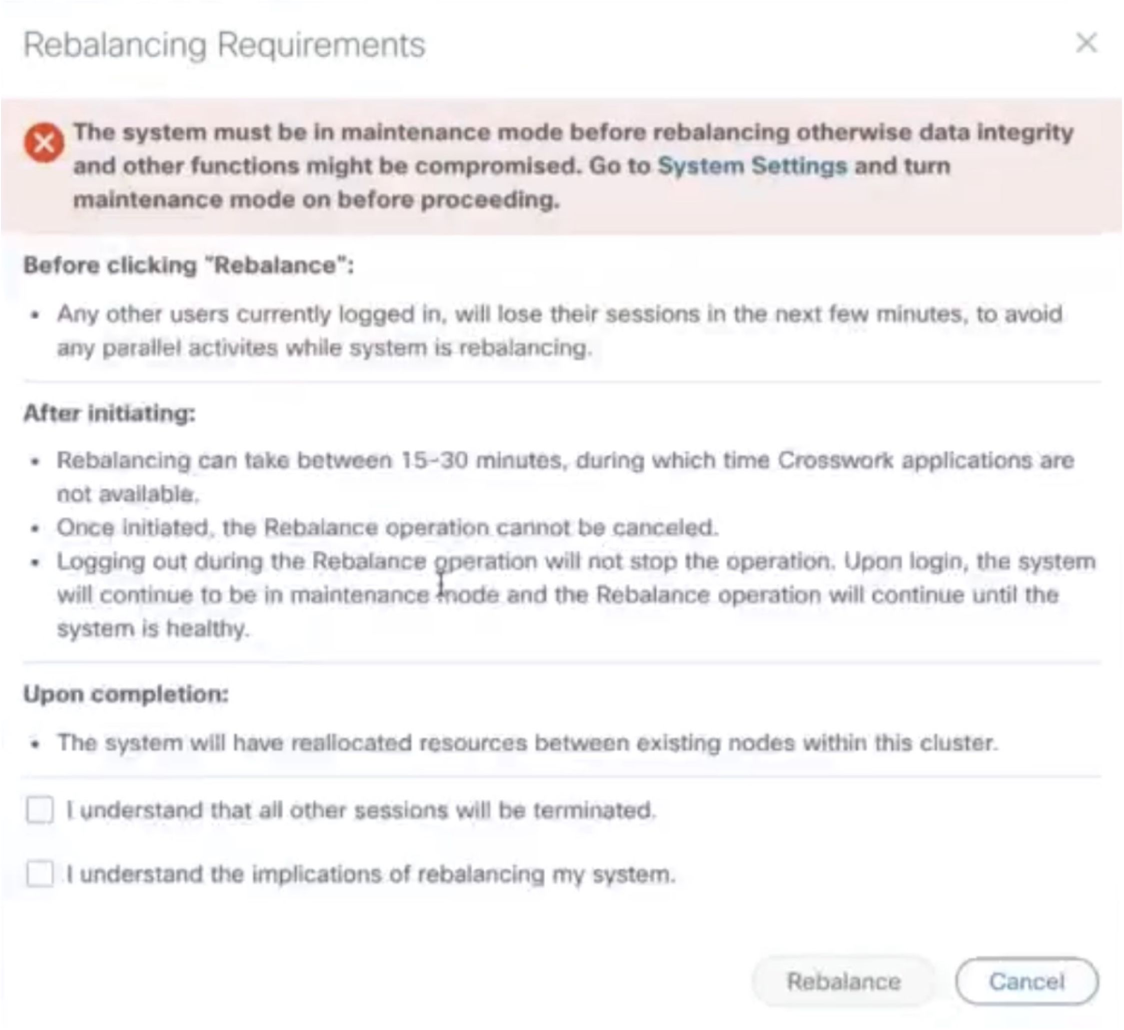
DC1

cw-tb2-cluster-01	cw-tb2-cluster-02	cw-tb2-cluster-03	cw-tb2-cluster-04
Healthy	Healthy	Healthy	Healthy
VM Status Running	VM Status Running	VM Status Running	VM Status Running
Type HYBRID	Type HYBRID	Type HYBRID	Type WORKER
Usage as of Feb-18-2022 11:01:22am GMT+5:30	Usage as of Feb-18-2022 11:01:22am GMT+5:30	Usage as of Feb-18-2022 11:01:22am GMT+5:30	Usage as of Feb-18-2022 11:01:22am GMT+5:30
CPU 100 % ●	CPU 16 %	CPU 16 %	CPU 3 %
Memory 27 %	Memory 16 %	Memory 22 %	Memory 1 %
Filesystem 5 %	Filesystem 5 %	Filesystem 5 %	Filesystem 2 %
Recommendations Available			

On the tile for the node, you can click ··· and choose **View Details** to see more details.

Step 3 Click **Rebalance**, and the **Rebalance Requirements** are displayed. Read through the requirements and select the two checkboxes once you are ready to start the rebalancing.

Figure 9: Rebalancing Requirements



Rebalancing Requirements

The system must be in maintenance mode before rebalancing otherwise data integrity and other functions might be compromised. Go to System Settings and turn maintenance mode on before proceeding.

Before clicking "Rebalance":

- Any other users currently logged in, will lose their sessions in the next few minutes, to avoid any parallel activites while system is rebalancing.

After initiating:

- Rebalancing can take between 15-30 minutes, during which time Crosswork applications are not available.
- Once initiated, the Rebalance operation cannot be canceled.
- Logging out during the Rebalance operation will not stop the operation. Upon login, the system will continue to be in maintenance mode and the Rebalance operation will continue until the system is healthy.

Upon completion:

- The system will have reallocated resources between existing nodes within this cluster.

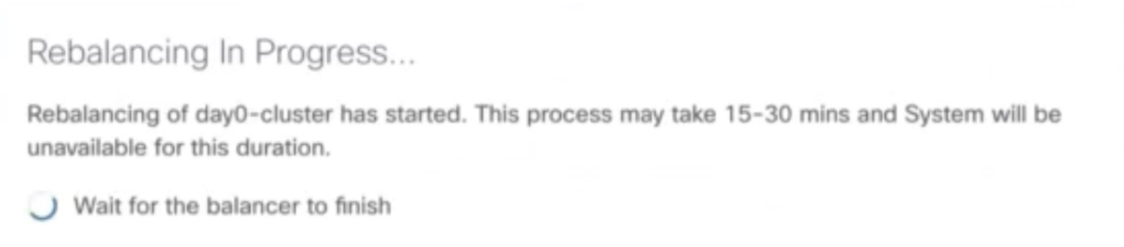
□ I understand that all other sessions will be terminated.

□ I understand the implications of rebalancing my system.

Step 4 Click **Rebalance** to initiate the process. Crosswork begins to reallocate the resources in the overutilized VM node to the other nodes in the cluster.

A dialog box indicating the status of rebalancing is displayed. Kindly wait for the process to complete.

Figure 10: Rebalancing Status



Rebalancing In Progress...

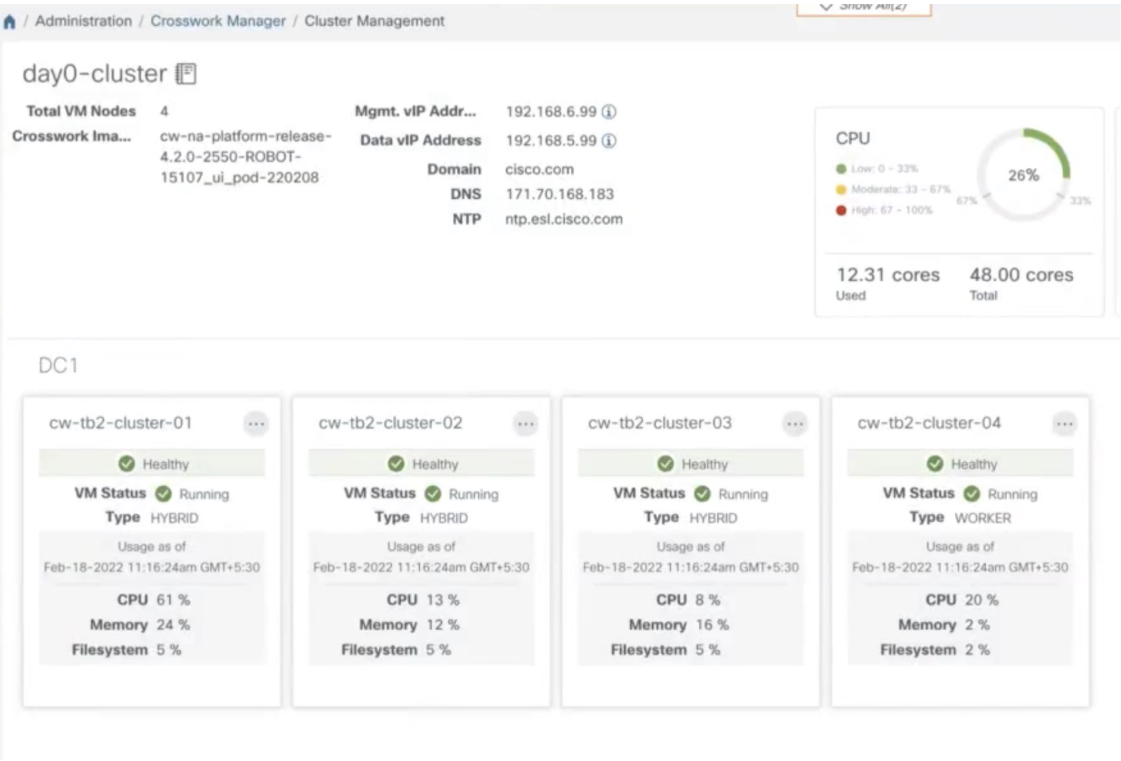
Rebalancing of day0-cluster has started. This process may take 15-30 mins and System will be unavailable for this duration.

Wait for the balancer to finish

Step 5 After the rebalancing is finished, the cluster management screen is displayed.

The CPU utilization is now reduced in the affected VM node (61% in **cw-tb2-cluster-01**).

Figure 11: Rebalancing Result



day0-cluster

Total VM Nodes 4
Crosswork Ima... cw-na-platform-release-4.2.0-2550-ROBOT-15107_ui_pod-220208

Mgmt. vIP Addr... 192.168.6.99
Data vIP Address 192.168.5.99
Domain cisco.com
DNS 171.70.168.183
NTP ntp.esl.cisco.com

CPU
● Low: 0 - 33%
● Moderate: 33 - 67%
● High: 67 - 100%
26%
12.31 cores Used
48.00 cores Total

DC1

cw-tb2-cluster-01
Healthy
VM Status Running
Type HYBRID
Usage as of Feb-18-2022 11:16:24am GMT+5:30
CPU 61 %
Memory 24 %
Filesystem 5 %

cw-tb2-cluster-02
Healthy
VM Status Running
Type HYBRID
Usage as of Feb-18-2022 11:16:24am GMT+5:30
CPU 13 %
Memory 12 %
Filesystem 5 %

cw-tb2-cluster-03
Healthy
VM Status Running
Type HYBRID
Usage as of Feb-18-2022 11:16:24am GMT+5:30
CPU 8 %
Memory 16 %
Filesystem 5 %

cw-tb2-cluster-04
Healthy
VM Status Running
Type WORKER
Usage as of Feb-18-2022 11:16:24am GMT+5:30
CPU 20 %
Memory 2 %
Filesystem 2 %

CHAPTER 3

Cisco Crosswork Data Gateway

This section contains the following topics:

Overview of Cisco Crosswork Data Gateway

Cisco Crosswork Data Gateway is a secure, common collection platform for gathering network data from multi-vendor devices. It is an on-premise application deployed close to network devices and supports multiple data collection protocols including MDT, SNMP, CLI, gNMI, Syslog and NETCONF. The number of Crosswork Data Gateways you need depends on the number of devices supported, the amount of data being processed, the frequency at which it is collected and your network architecture.

When Crosswork Data Gateway is deployed with Cisco Crosswork Infrastructure (also referred to as Cisco Crosswork in this guide), Cisco Crosswork acts as the **controller application**.

Crosswork Data Gateway uses the following concepts:

- **Crosswork Data Gateway VM** - Crosswork Data Gateway VM that you install.
- **Crosswork Data Gateway Profile** -

  Cisco Crosswork Data Gateway supports the following profiles for On-Premise deployment. For information on VM requirements for each profile, see Section: Crosswork Data Gateway Requirements in the *Cisco Crosswork Infrastructure 4.1 and Applications Installation Guide*.

  - **Standard** - for use with all Crosswork applications, except Crosswork Health Insights, and Crosswork Service Health (Automated Assurance).
  - **Standard Plus** - for use with Cisco Evolved Programmable Network Manager.

Note VMs for this profile are installed using the **On-Premise Standard with Extra Resources.**

- **Extended** - for use with Crosswork Health Insights and Crosswork Service Health (Automated Assurance).

- **Crosswork Data Gateway Pool** - A logical unit of one or more Crosswork Data Gateway VMs with an option to enable high availability. When a Crosswork Data Gateway VM goes down, Cisco Crosswork automatically replaces the VM with a spare VM from the pool to ensure that devices are managed and data collections have minimal disruption.

- **Crosswork Data Gateway**- A Crosswork Data Gateway VM that is assigned a virtual IP address when it is added to a Crosswork Data Gateway pool. Operations such as attaching or detaching devices, creating collection jobs happen on the Crosswork Data Gateway.

- **Data Destination** - Internal or external recipients of data collected by the Crosswork Data Gateway. By default, Cisco Crosswork is defined as a data destination. Other destinations (external users) can be defined using the Cisco Crosswork UI or APIs.

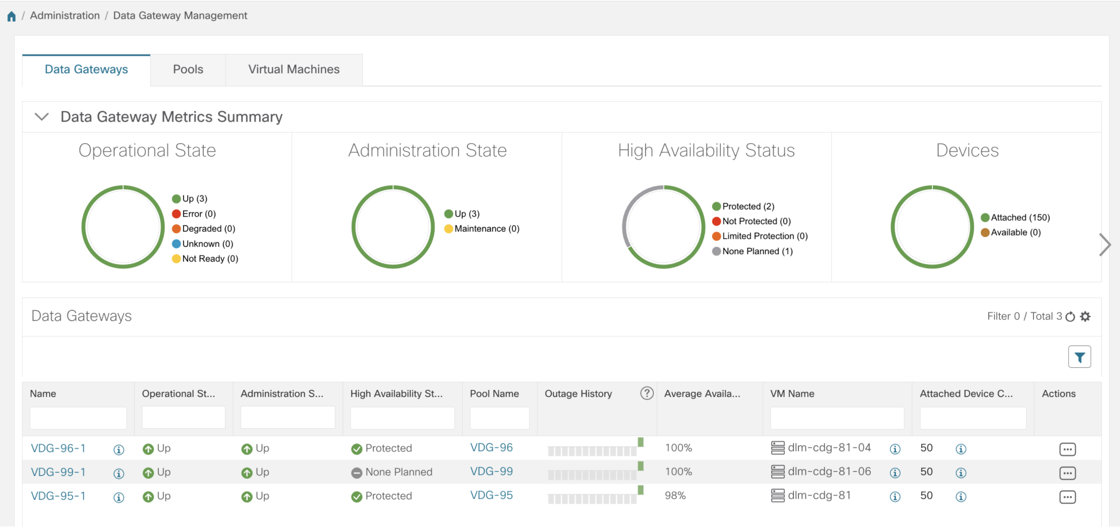
- **Collection Job** - A task that Crosswork Data Gateway has to complete to collect data. Crosswork applications create collection jobs to check device reachability, collect telemetry data needed to determine network and service health. The Cisco Crosswork UI and API allow you to configure collection jobs for non-Crosswork applications.

- **Custom Software Packages** - Files and device model definitions to extend device coverage and support data collection from currently unsupported devices.

Note This chapter explains only the Cisco Crosswork Data Gateway features that can be accessed via Cisco Crosswork UI. For more information about Cisco Crosswork Data Gateway Base VM and how to manage it, see **Appendix A**: Configure Crosswork Data Gateway VM, on page 313.

Crosswork Data Gateway UI Overview

To open the Cisco Crosswork Data Gateway management view, log in to Cisco Crosswork and choose **Administration** > **Data Gateway Management** from the left navigation bar.



Name	Operational St...	Administration S...	High Availability St...	Pool Name	Outage History	Average Availa...	VM Name	Attached Device C...	Actions
VDG-96-1	Up	Up	Protected	VDG-96		100%	dlm-cdg-81-04	50	⋯
VDG-99-1	Up	Up	None Planned	VDG-99		100%	dlm-cdg-81-06	50	⋯
VDG-95-1	Up	Up	Protected	VDG-95		98%	dlm-cdg-81	50	⋯

The **Data Gateway Management** page has three tabs:

- **Data Gateways**: Displays details of the virtual Cisco Crosswork Data Gateways in the network. You can attach or detach devices to the Data Gateway from this tab.
- **Pools**: Manage Cisco Crosswork Data Gateway pools.
- **Virtual Machines**: Manage physical Cisco Crosswork Data Gateway VMs.

The following table explains the various fields in the **Data Gateway Management** page.

Table 2: Cisco Crosswork Data Gateway UI

Field	Description
Operational State	Operational state of the Cisco Crosswork Data Gateway VM. A Crosswork Data Gateway VM has following operational states: • **Unknown**: The Crosswork Data Gateway VM's operational state is unknown as it has enrolled itself with Cisco Crosswork, but hasn't established a session yet. • **Degraded**: The Cisco Crosswork Data Gateway VM is reachable but one or more of its components are in a state other than OK. • **Not Ready**: When Cisco Crosswork Data Gateway has enrolled with Cisco Crosswork but is not ready to receive collection jobs since it is not an Active Data Gateway with an associated south bound virtual IP address • **Up**: The Cisco Crosswork Data Gateway VM is operational and all individual components are "OK". • **Error**: The Cisco Crosswork Data Gateway VM is unreachable or some of its components are in Error state.

Field	Description
Admin State	Administration state of the Cisco Crosswork Data Gateway VM. • ⬆**Up**: The VM is administratively up. • 🛠 **Maintenance**: Operations between Cisco Crosswork and the Cisco Crosswork Data Gateway are suspended to perform upgrades or other maintenance activities (for example, uploading certificates).
Virtual Machine Name	Name of the Cisco Crosswork Data Gateway VM. Clicking the info icon next to the name displays the enrollment details of each VM. This includes details such as, the • Pool name • VM name • VM Type indicating if the profile of the Crosswork Data Gateway is **Standard**, **Extended** or **Standard-Plus** (the VM resource profile choosen during installtion is **On-Premise Standard with Extra Resources**). • Management IP (eth0) with related MAC address • eth1 IP (north bound/vNIC1) with related MAC address • eth2 (south bound/vNIC2) with only the MAC address **Note** The eth2 IP (south bound IP) is assigned to the Crosswork Data Gateway VM during pool creation. Hence, it will not be displayed as part of enrollment details for each VM.
IPv4 Mgmt.IP Address	Management IPv4 address of the Cisco Crosswork Data Gateway VM.
IPv6 Mgmt.IP Address	Management IPv6 address of the Cisco Crosswork Data Gateway VM.

Field	Description
Role	Shows the role of the Cisco Crosswork Data Gateway VM. It can be either: • **Assigned**: when Cisco Crosswork Data Gateway VM is assigned to a pool. • **Unassigned**: when Cisco Crosswork Data Gateway VM is not assigned to any pool. • **Spare**: when Cisco Crosswork Data Gateway VM is part of a pool but is in standby mode Cisco Crosswork Data Gateway VMs that have the **Role** as **Unassigned** need to be assigned to a Crosswork Data Gateway pool before they can used.
Outage History	Outage history of the Cisco Crosswork Data Gateway VM over a period of 14 days. State aggregation for a day is done in the order of precedence as Error , Degraded, Up, Unknown and Not Ready. For example, if the Crosswork Data Gateway VM went Unknown to Degraded to Up, color is displayed as Degraded (orange) for that day as Degraded takes precedence over Up and Unknown. If the Crosswork Data Gateway was in Error state at any time during that day, the tile is Red. If the Data Gateway was not in Error but in Degraded State anytime of the day, the tile is Orange. If the DG was not in Error or Degraded state and was only Up, then the tile is Green.
Pool Name	Name of the Crosswork Data Gateway pools to which the Crosswork Data Gateway VM has been assigned.
Data Gateway Name	Name of the Cisco Crosswork Data Gateway that is created automatically when you add a Crosswork Data Gateway VM to a pool.

Field	Description
High Availability Status	High availability status of a Crosswork Data Gateway could be either: • **Protected**: All VMs are UP and there is at least one standby available in the pool. • **Not Protected**: All standby VMs are DOWN. • **Limited Protection**: Some standby VMs are DOWN, but there is still at least one standby that is UP. • **None Planned**: No standby VMs were added to the pool during pool creation.
Average Availability	Value indicating the health of the Cisco Crosswork Data Gateway VM. This percentage is calculated as the total time (in milliseconds) a Crosswork Data Gateway was in UP state over the time between start time of first event and end time of last event . **Note** The end time of last event is the current time stamp, so the duration of last event is between its start time and current time stamp.
VM ID	VM ID of the Cisco Crosswork Data Gateway VM.
Attached Device Count	Number of devices attached to the Cisco Crosswork Data Gateway pool.
Unique Identifier	Unique identifier of the Cisco Crosswork Data Gateway VM.

Set Up Crosswork Data Gateway to Collect Data

Crosswork Data Gateway requires you to complete the following setup tasks first, before it can run collection jobs.

Note This workflow assumes that you have already installed Cisco Crosswork Data Gateway as explained in *Cisco Crosswork Infrastructure 4.1 and Applications Installation Guide*.

It is sufficient to complete Step 1 to Step 3 in the following table to get Crosswork Data Gateway set up and running with Cisco Crosswork and other Crosswork applications. Step 4 to Step 6 are optional and required only in case you wish to extend the Crosswork Data Gateway's capability to collect and forward data by creating external data destinations and custom collection jobs.

Table 3: Tasks to Complete to Set Up Cisco Crosswork Data Gateway to Collect Data

Task	Follow the steps in...
1. Create Crosswork Data Gateway pools.	Create a Cisco Crosswork Data Gateway Pool, on page 31
2. Attach devices to Crosswork Data Gateway.	Attach Devices to a Crosswork Data Gateway, on page 33
3. Verify that the default collection jobs are created and running successfully.	Monitor Collection Jobs, on page 92
4. (optional) Extend device coverage to collect data from currently unsupported devices or third-party devices.	Manage Custom Device Packages, on page 48
5. (optional) Forward data to external data destinations.	Create and Manage External Data Destinations, on page 43
6. (optional) Create custom collection jobs (outside of those built for you by Cisco Crosswork).	Manage Crosswork Data Gateway Collection Jobs, on page 53

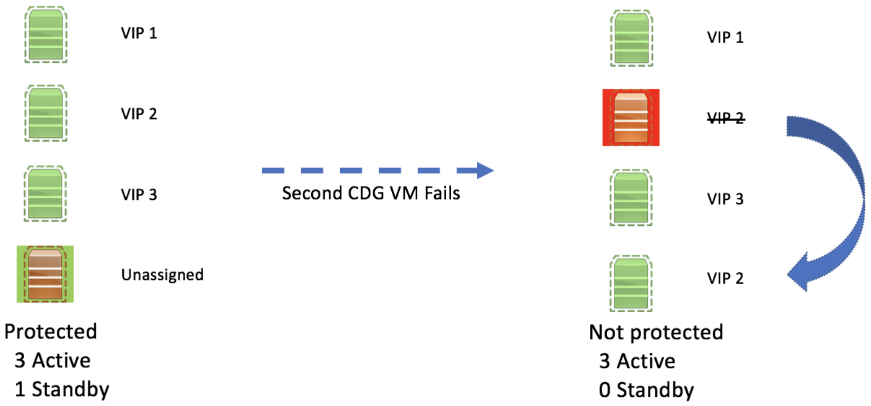
Crosswork Data Gateway High Availability with Pools

A Cisco Crosswork Data Gateway pool ensures that your devices are managed and collections occur with minimal disruption.

A pool can consist of one or more Cisco Crosswork Data Gateway VMs with an option to enable high availability.

If a Crosswork Data Gateway VM in the pool goes down, Cisco Crosswork automatically replaces that VM with a standby VM from the pool (failover). A Crosswork Data Gateway VM that has the **Operational state** as **Error** and is part of a pool that is **Protected** is eligible for failover. Devices and any existing collection jobs are assigned automatically from the failed VM to the standby VM. Once the VM that went down becomes operational, it becomes a standby VM in the pool.

Figure 12: Crosswork Data Gateway High Availability



Note If more than one Crosswork Data Gateway VM in a pool have same Southbound IP address, reboot the standby Crosswork Data Gateway, so that the standby Crosswork Data Gateway VM loses its southbound IP address once it comes up.

For example, CDG1 (Active) with southbound IP address IP1 goes down. Cisco Crosswork replaces CDG1 with CDG2(Standby) as new active and programs the same IP1 as southbound IP on CDG2. CDG1 later comes up and becomes the new standby in the pool, but retains the same IP1 as its southbound IP address. This results in both CDG1 and CDG2 having same IP1 as southbound IPs.

A Crosswork Data Gateway pool has following states:

- **Protected**: All VMs are UP and there is at least one standby VM in the pool.
- **Not Protected**: All the standby VMs are DOWN and there are none available to replace a VM that is in use.
- **Limited Protection**: Some standby VMs are DOWN, but there is still at least one standby that is UP.
- **None Planned**: No standby VMs were added to the pool during pool creation.

The **Operational state** of the Data Gateway is considered to be in the **Error** state if the Datagateway has failed to report its health for 3 consecutive vitals cycles (30 seconds). This failure in reporting health may be due to:

- Issues in the Datagateway VM. For example, the Data Gateway has run out of resources to report the health.
- Network issues between Cisco Crosswork and Crosswork Data Gateway.

The **Operational state** of the Crosswork Data Gateway is checked every 20 seconds. If the active VM is in the **Error** state , a failover is triggered and the spare VM in the pool becomes the active VM in the pool.

Enable FQDN for Secure Syslog Communication

Crosswork Data Gateway supports secure syslog communication to devices which require the syslog certificate to contain the host name or Fully Qualified Domain Name (FQDN) instead of the virtual IP address of the Crosswork Data Gateway. This is an optional feature that can be enabled for devices which mandate having the host name or FQDN in the syslog certificate. If enabled, Cisco Crosswork fetches the host name or FQDN for each virtual IP address of the Crosswork Data Gateway from the DNS server. FQDNs for newly added virtual IP(s) will be fetched after you save the pool. The syslog certificate will then contain the FQDN in the CN and SAN instead of the virtual IP address of the Crosswork Data Gateway. For details on how to configure secure syslog on devices, see Configure Secure Syslog on Device, on page 72.

Note Crosswork Data Gateway pools can be created without enabling FQDN in which case the syslog certificate will contain virtual IP addresses of the Crosswork Data Gateway. You can always edit the pool later to enable or disable FQDN to switch between having FQDNs or virtual IP addresses in the syslog certificate.

To refresh the FQDN values for virtual IP(s) in the pool (if FQDN values were updated in the DNS server) , use the **Actions** > **Refresh FQDN** option for the pool.

Create a Cisco Crosswork Data Gateway Pool

When you create a Cisco Crosswork Data Gateway pool, follow these guidelines:

- You must create at least one pool and assign Crosswork Data Gateway VMs to it. This step is mandatory to set up the Crosswork Data Gateway for collection.
- All the Crosswork Data Gateway VMs in a pool need to be of the same configuration (either Standard, Standard Plus or Extended).

To create a Crosswork Data Gateway pool:

Before you begin

Before creating a Cisco Crosswork Data Gateway pool:

- Decide if you wish to enable high availability for the pool.
- Ensure that you have installed all Crosswork Data Gateway VMs that you wish to add to the pool.
- Confirm that the Operational State of the Crosswork Data Gateway VMs is **Not Ready**.
- Have network information such as virtual IP address (one virtual IP for each active data gateway), subnet mask and gateway information ready.

  Note Gateway is only required when using 3 NICs.

  Depending on the number of number of vNICs in your deployment, the virtual IP address would be:

  - An additional IP address on the Management Network in a single NIC deployment.
  - An additional IP address on the Data Network for 2 NIC deployment.
  - An IP address on the Southbound Network for 3 NICs deployment.

These virtual IP addresses must be planned in advance during the network design phase.

- Decide if you wish to enable Fully Qualified Domain Name (FQDN) for virtual IP(s) addresses in the pool. If yes, ensure that you have configured FQDN for virtual IP(s) in the DNS server to create the pool successfully.

Step 1 From the main menu, choose **Administration** > **Data Gateway Management** and click **Pools** tab.

Step 2 In the **Pools** tab, click ⊞ button to create a pool.

Step 3 In the **Pool Parameters** pane, enter the values for the following parameters:

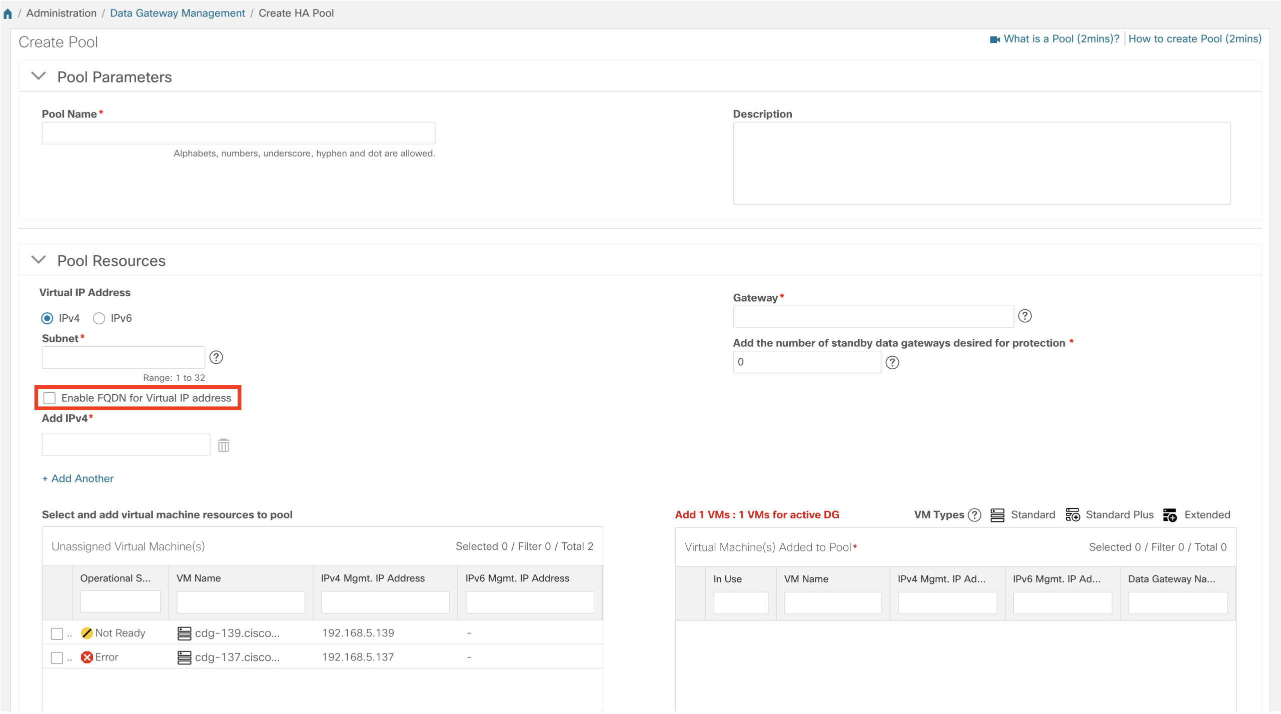
- **Pool Name**: Name of the pool that suitably describes the network.
- **Description**: A description of the pool.

Step 4 In the **Pool Resources** pane, add the following details:

- **IPv4** or **IPv6**: Select either an IPv4 or IPv6 address family for virtual IPs.
- **Subnet Mask**: Subnet mask for each Cisco Crosswork Data Gateway
- **Gateway**: Gateway address for each Cisco Crosswork Data Gateway to communicate with the devices.

  Note This field is not applicable if a Cisco Crosswork Data Gateway VM has fewer than 3 vNICs.

- (Optional) **Enable FQDN for Virtual IP address**: Select this option to use hostname or Fully Qualified Domain Name (FQDN) for each virtual IP address of the Crosswork Data Gateway in the syslog certificate.


/ Administration / Data Gateway Management / Create HA Pool
Create Pool
What is a Pool (2mins)? | How to create Pool (2mins)
Pool Parameters
Pool Name*
Alphabets, numbers, underscore, hyphen and dot are allowed.
Description
Pool Resources
Virtual IP Address
● IPv4 ○ IPv6
Subnet*
Range: 1 to 32
□ Enable FQDN for Virtual IP address
Add IPv4*
+ Add Another
Gateway*
Add the number of standby data gateways desired for protection *
0
Select and add virtual machine resources to pool
Add 1 VMs : 1 VMs for active DG
VM Types Standard Standard Plus Extended

Unassigned Virtual Machine(s) Selected 0 / Filter 0 / Total 2

	Operational S...	VM Name	IPv4 Mgmt. IP Address	IPv6 Mgmt. IP Address
□ ..	Not Ready	cdg-139.cisco...	192.168.5.139	-
□ ..	Error	cdg-137.cisco...	192.168.5.137	-

Virtual Machine(s) Added to Pool* Selected 0 / Filter 0 / Total 0

	In Use	VM Name	IPv4 Mgmt. IP Ad...	IPv6 Mgmt. IP Ad...	Data Gateway Na...

- **Add IPv4** or **Add IPv6**: Based on the address family you chose earlier (IPv4 or IPv6), enter a virtual IP address for every active Cisco Crosswork Data Gateway VM.

- **Add the number of standby data gateways desired for protection**: Entering a value greater than 0 in this field enables high availability for the pool. When an active data gateway goes down, a 'standby' in the pool replaces it to ensure protection.

  The number of Crosswork Data Gateway VMs you add to the pool should be equal to the total number of virtual IPs and standby Crosswork Data Gateway VMs. For example, if you have entered 3 virtual IPs and wish to have 2 standby VMs, add 5 Cisco Crosswork Data Gateway VMs to the pool.

- **Select and Add VM Resources to pool**: Select VMs from the **Unassigned Virtual Machine(s)** on the left and click right arrow to move the VMs to the **Virtual Machine(s) Added to Pool**.

Step 5 Click **Save**.

After you click **Save**, a virtual Crosswork Data Gateway gets created automatically and is visible under **Data Gateways** tab. Attach devices to this virtual Crosswork Data Gateway to run collection jobs.

Note Pool creation will fail if the FQDN configurations are missing for virtual IP(s) in the DNS server. Either check FQDN configuration in the DNS server or disable the FQDN option and try again.

Attach Devices to a Crosswork Data Gateway

Follow these guidelines when you attach devices to a Crosswork Data Gateway.

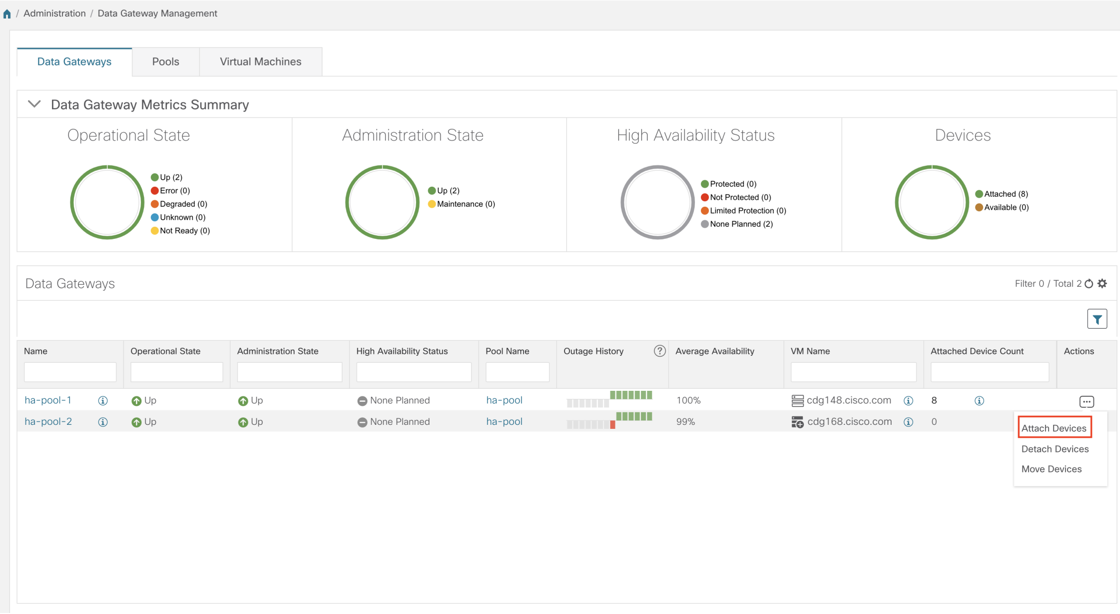
- A device can be attached to only one Crosswork Data Gateway.
- For optimal performance, we recommend attaching devices to a Crosswork Data Gateway in batches of 300 devices or fewer.

Before you begin

Ensure that the **Admin state** and **Operational state** of the Crosswork Data Gateway to which you want to attach devices is **Up**.

Step 1 (Optional) Before attaching devices to an exisiting Crosswork Data Gateway, we recommend that you check the health of the Crosswork Data Gateway. See Monitor Crosswork Data Gateway Health, on page 34 for more information.

Step 2 From the main menu, navigate to **Administration** > **Data Gateway Management** > **Data Gateways**.



Name	Operational State	Administration State	High Availability Status	Pool Name	Outage History	Average Availability	VM Name	Attached Device Count	Actions
ha-pool-1	Up	Up	None Planned	ha-pool		100%	cdg148.cisco.com	8	⋯
ha-pool-2	Up	Up	None Planned	ha-pool		99%	cdg168.cisco.com	0	

Step 3 For the Crosswork Data Gateway to which you want to attach devices, in **Actions** column, click ⋯ and select **Attach Devices**. The **Attach Devices** window opens showing all the devices available for attaching.

Step 4 To attach all the devices, click **Attach All Devices**. Otherwise, select the devices you want to attach and click **Attach Selected Devices**.

Step 5 In **Confirm - Attach Devices** dialog, click **Attach**.

Verify that your changes are successful by checking the **Attached Device Count** column in the **Data Gateways** pane.

Monitor the Crosswork Data Gateway health to ensure that the Crosswork Data Gateway is functioning well with the newly attached devices. See Monitor Crosswork Data Gateway Health, on page 34.

Manage Crosswork Data Gateway Post-Setup

This section explains various maintenance tasks within the Crosswork Data Gateway.

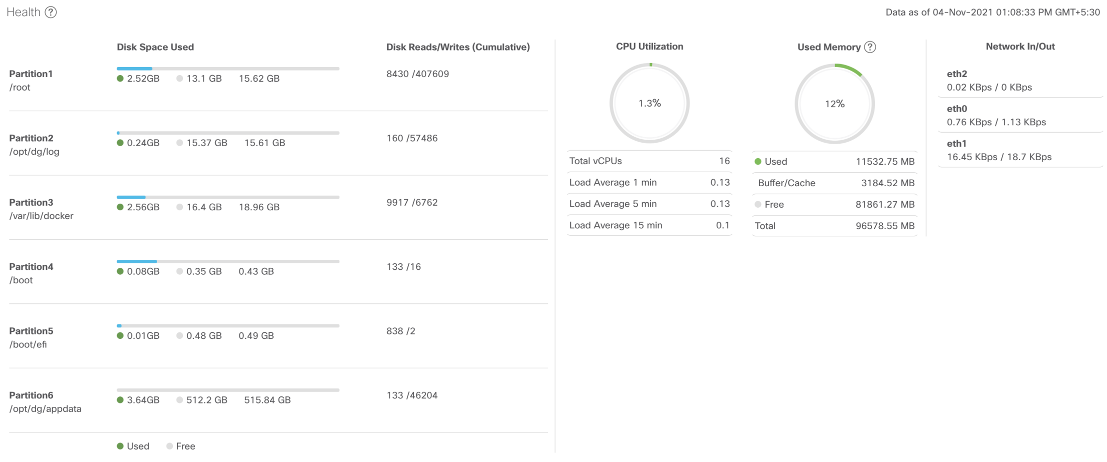
- Monitor Crosswork Data Gateway Health, on page 34
- Crosswork Data Gateway High Availability with Pools, on page 29
- Manage Cisco Crosswork Data Gateway Device Assignments, on page 38
- Maintain Crosswork Data Gateway VMs, on page 40

Monitor Crosswork Data Gateway Health

You can view the operations and health summary of a Crosswork Data Gateway from the Crosswork Data Gateway details page at **Administration** > **Data Gateway Management** > **Data Gateways** > **(click){Crosswork Data Gateway}**. This page also has details of the health of various containerized services running on the Crosswork Data Gateway. The overall health of Crosswork Data Gateway also depends on the health of each containerized service.

The following parameters are displayed in this page.

- **General Cisco Crosswork Data Gateway Details** - Displays general details of the Crosswork Data Gateway including operational state, high availability state, attached device count, and assigned jobs. The **Actions** option lists the various troubleshooting options that are available from the UI.
- **History** - Shows the outage history chart of the Cisco Crosswork Data Gateway over 14 days including timestamp, outage time, and clear time. Use the options in the top-right corner of the pane to zoom in, zoom out, pan, or download the SVG and PNG of the history chart of a specific time period within the graph.
- **Events** - Displays a list of all Cisco Crosswork Data Gateway transition state changes over the last 14 days. It includes information such as the event details, including operational state changes, role changes, a message indicating the reason for the status change, timestamp, and duration.
- **Health** - Shows the health information of the Cisco Crosswork Data Gateway. The timestamp in the top-right corner is the timestamp when the last health data was collected. If the Crosswork Data Gateway is in an **Error** state or if the data is stale for any reason, the timestamp label highlights that the data is old. If the **CPU Utilization** of a Crosswork Data Gateway exceeds 80%, we recommend taking corrective action before the **CPU Utilization** increases further leading to failure of the Crosswork Data Gateway.



Health ⓘ

Data as of 04-Nov-2021 01:08:33 PM GMT+5:30

	Disk Space Used	Disk Reads/Writes (Cumulative)
Partition1 /root	● 2.52GB ● 13.1 GB 15.62 GB	8430 /407609
Partition2 /opt/dg/log	● 0.24GB ● 15.37 GB 15.61 GB	160 /57486
Partition3 /var/lib/docker	● 2.56GB ● 16.4 GB 18.96 GB	9917 /6762
Partition4 /boot	● 0.08GB ● 0.35 GB 0.43 GB	133 /16
Partition5 /boot/efi	● 0.01GB ● 0.48 GB 0.49 GB	838 /2
Partition6 /opt/dg/appdata	● 3.64GB ● 512.2 GB 515.84 GB	133 /46204

● Used ● Free

CPU Utilization

1.3%

Total vCPUs	16
Load Average 1 min	0.13
Load Average 5 min	0.13
Load Average 15 min	0.1

Used Memory ⓘ

12%

● Used	11532.75 MB
Buffer/Cache	3184.52 MB
● Free	81861.27 MB
Total	96578.55 MB

Network In/Out

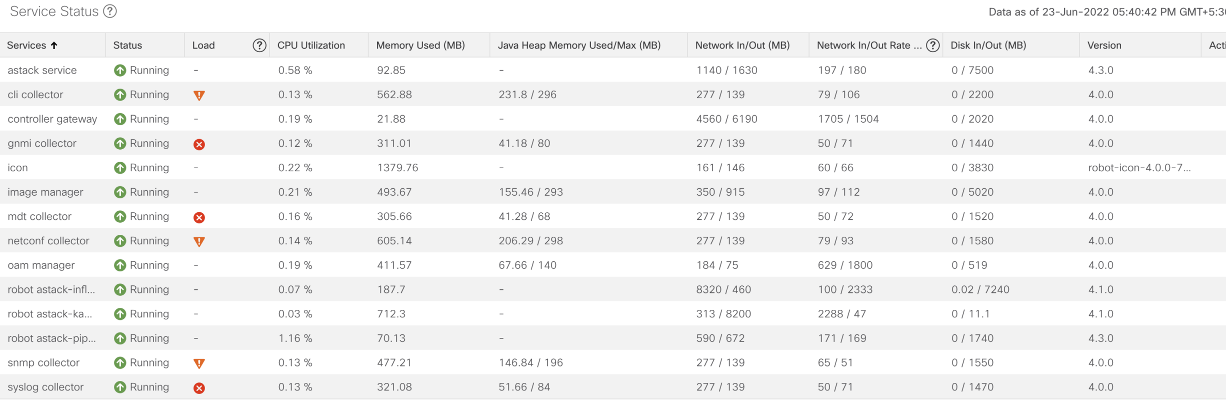
eth2	0.02 KBps / 0 KBps
eth0	0.76 KBps / 1.13 KBps
eth1	16.45 KBps / 18.7 KBps

- **Service Status** - Displays the health information of the individual container services running on the Crosswork Data Gateway and their resource consumption with an option to restart (**Action**> **Restart**) an individual service. The Load column indicates the processing load of that specific collector/service. The load score of a collector is calculated using several metrics. . The load scores are mapped to low, medium or high severity zones. A collector that is consistently operating in the **High** zone will mean that the collector has reached peak capacity for the given CPU/Memory resource profile. For more information on how the load score is calculated, see Load Score Calculation

Note

The list of container services differs between Standard Crosswork Data Gateway and Extended Crosswork Data Gateway. Extended Crosswork Data Gateway has more containers installed.

The resource consumption data that is displayed is from docker statistics. These values are higher than the actual resources consumed by the containerized service.



Service Status ?

Data as of 23-Jun-2022 05:40:42 PM GMT+5:3

Services ↑	Status	Load ?	CPU Utilization	Memory Used (MB)	Java Heap Memory Used/Max (MB)	Network In/Out (MB)	Network In/Out Rate ... ?	Disk In/Out (MB)	Version	Acti
astack service	Running	-	0.58 %	92.85	-	1140 / 1630	197 / 180	0 / 7500	4.3.0	
cli collector	Running	⚠	0.13 %	562.88	231.8 / 296	277 / 139	79 / 106	0 / 2200	4.0.0	
controller gateway	Running	-	0.19 %	21.88	-	4560 / 6190	1705 / 1504	0 / 2020	4.0.0	
gnmi collector	Running	✖	0.12 %	311.01	41.18 / 80	277 / 139	50 / 71	0 / 1440	4.0.0	
icon	Running	-	0.22 %	1379.76	-	161 / 146	60 / 66	0 / 3830	robot-icon-4.0.0-7...	
image manager	Running	-	0.21 %	493.67	155.46 / 293	350 / 915	97 / 112	0 / 5020	4.0.0	
mdt collector	Running	✖	0.16 %	305.66	41.28 / 68	277 / 139	50 / 72	0 / 1520	4.0.0	
netconf collector	Running	⚠	0.14 %	605.14	206.29 / 298	277 / 139	79 / 93	0 / 1580	4.0.0	
oam manager	Running	-	0.19 %	411.57	67.66 / 140	184 / 75	629 / 1800	0 / 519	4.0.0	
robot astack-infl...	Running	-	0.07 %	187.7	-	8320 / 460	100 / 2333	0.02 / 7240	4.1.0	
robot astack-ka...	Running	-	0.03 %	712.3	-	313 / 8200	2288 / 47	0 / 11.1	4.1.0	
robot astack-pip...	Running	-	1.16 %	70.13	-	590 / 672	171 / 169	0 / 1740	4.3.0	
snmp collector	Running	⚠	0.13 %	477.21	146.84 / 196	277 / 139	65 / 51	0 / 1550	4.0.0	
syslog collector	Running	✖	0.13 %	321.08	51.66 / 84	277 / 139	50 / 71	0 / 1470	4.0.0	

We recommend monitoring the health of the Crosswork Data Gateways in your network periodically to prevent overloading and take corrective actions, such as adding additional resources or reducing load on the Crosswork Data Gateway well in time proactively.

1. Alarms are generated by the DG-Manager if the Crosswork Data Gateway fails or is getting close to reaching resource capacity limits.
2. If the **CPU Utilization** of a Crosswork Data Gateway exceeds 80%, we recommend that you do not create more collection jobs until you have reduced the **CPU Utilization** by moving devices to another CDG or have added other VMs to the pool or the increased the cadence of existing collection jobs.
3. If the **CPU Utilization** of a Crosswork Data Gateway exceeds 90%, we recommend that you move devices to another Crosswork Data Gateway that has a lower **CPU Utilization** percentage.
4. We recommend that you check the system alarms weekly. Investigate to confirm it is not because of a resource problem and data drops are not frequent. Then fix issues on the data destinations or increase cadence of the collection job.

Manage a Crosswork Data Gateway Pool

Follow the steps to edit or delete a Cisco Crosswork Data Gateway pool. To create a pool, see Create a Cisco Crosswork Data Gateway Pool, on page 31.

Before you begin

Important points to consider before you edit or delete the pool:

- Virtual IP addresses that have devices attached cannot be deleted.

- A Crosswork Data Gateway VM can be removed from the pool only if all devices have been unmapped from the Crosswork Data Gateway. When a Crosswork Data Gateway VM is removed from the pool, a standby VM from the same pool becomes its replacement automatically.
- Before you delete a Crosswork Data Gateway pool, detach devices from the Crosswork Data Gateway first or move the devices to another Crosswork Data Gateway.

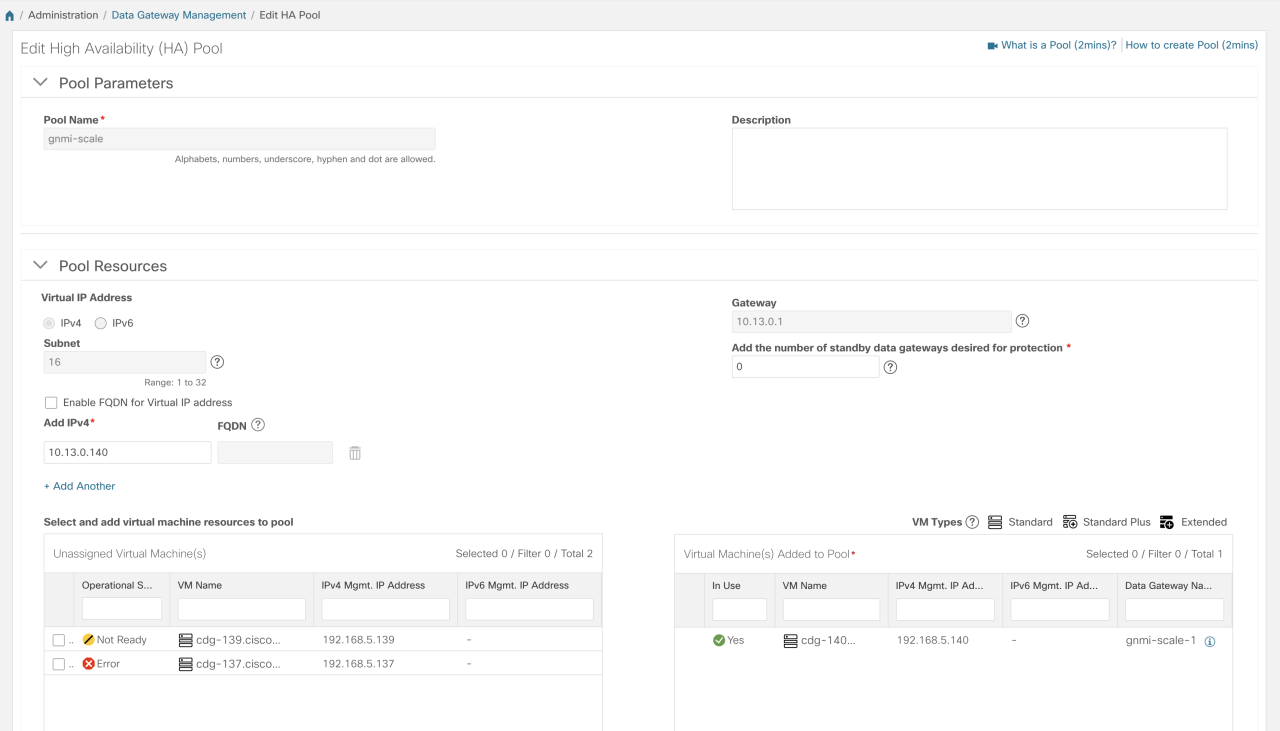
Step 1 From the main menu, choose **Administration** > **Data Gateway Management** and click **Pools** tab.

Step 2 **Edit a Crosswork Data Gateway Pool**:

a) Select the pool which you wish to edit from the list of pools that is displayed in this page,

b) Click ✎ button to open **Edit High Availability (HA) Pool** page.

When you edit a resource pool, you can only change the parameters in the **Pool Resources** pane. You cannot edit the parameters in the **Pool Parameters** pane. To make changes to the parameters in the **Pool Parameters** pane, create a new pool with the desired values and move the Cisco Crosswork Data Gateway VMs to that pool.


/ Administration / Data Gateway Management / Edit HA Pool
What is a Pool (2mins)? | How to create Pool (2mins)
+ Add Another

Edit High Availability (HA) Pool

Pool Parameters

Pool Name*: gnmi-scale
Alphabets, numbers, underscore, hyphen and dot are allowed.

Description:

Pool Resources

Virtual IP Address
○ IPv4 ○ IPv6

Subnet: 16 ?
Range: 1 to 32

□ Enable FQDN for Virtual IP address

Add IPv4*: 10.13.0.140
FQDN ?:

Gateway: 10.13.0.1 ?

Add the number of standby data gateways desired for protection *: 0 ?

Select and add virtual machine resources to pool

VM Types ? Standard Standard Plus Extended

Unassigned Virtual Machine(s) — Selected 0 / Filter 0 / Total 2

	Operational S...	VM Name	IPv4 Mgmt. IP Address	IPv6 Mgmt. IP Address
□ ..	Not Ready	cdg-139.cisco...	192.168.5.139	-
□ ..	Error	cdg-137.cisco...	192.168.5.137	-

Virtual Machine(s) Added to Pool* — Selected 0 / Filter 0 / Total 1

In Use	VM Name	IPv4 Mgmt. IP Ad...	IPv6 Mgmt. IP Ad...	Data Gateway Na...
✓ Yes	cdg-140...	192.168.5.140	-	gnmi-scale-1 ⓘ

c) In the **Pool Resources** pane, you can:

- Add and delete a virtual IP address for every active data gateway needed.
- Change the number of standby Crosswork Data Gateway VMs.
- Add and remove Crosswork Data Gateway VMs from the pool.
- Enable or disable FQDN for the pool.

d) Click **Save** after you have completed making your changes.

Step 3 **Delete a Crosswork Data Gateway Pool**:

a) Select the pool you want to delete and click 🗑.
b) Click **Delete** in the **Delete High Availability (HA) Pool** window to delete the pool.

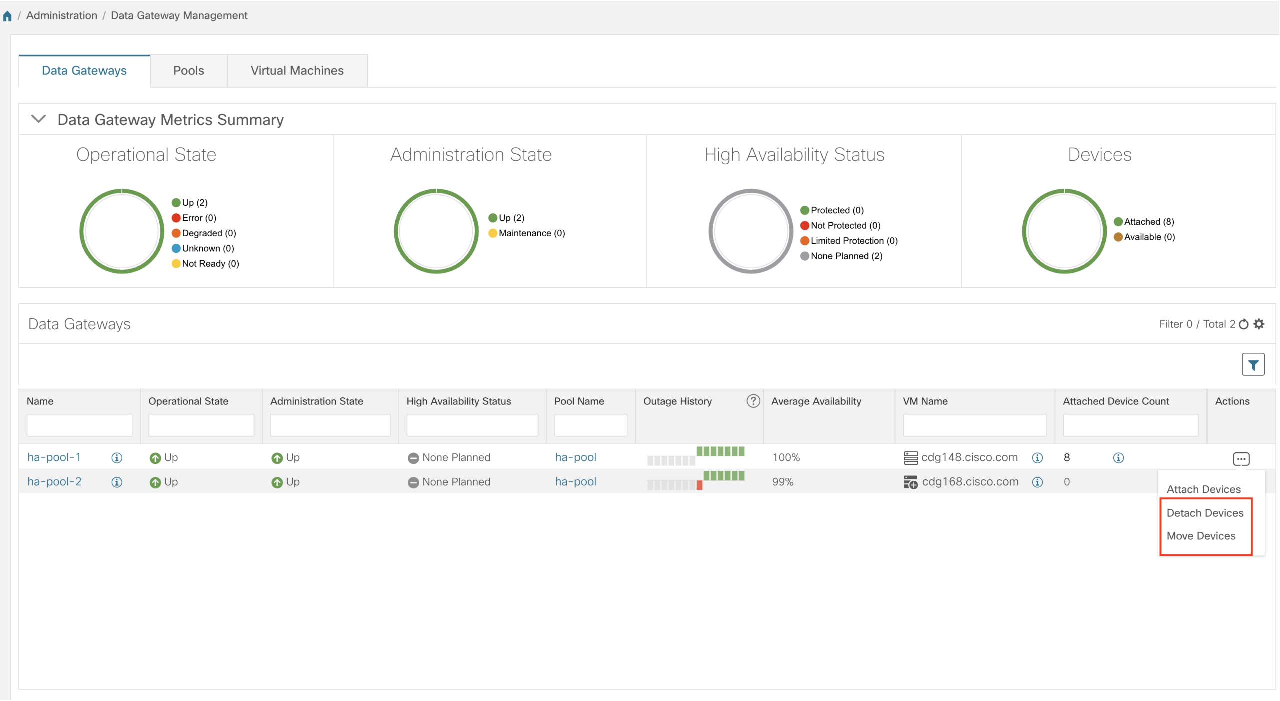
Manage Cisco Crosswork Data Gateway Device Assignments

Follow these guidelines when you move or detach devices from a Crosswork Data Gateway.

- A device can be attached to only one Crosswork Data Gateway.
- When moving devices to a Crosswork Data Gateway in different pool, ensure that the Gateway of the pool is same as the Gateway of the current pool. Moving devices to a Crosswork Data Gateway with mismatching Gateway will result in failed collections.
- Detaching a device from Cisco Crosswork Data Gateway deletes all collection jobs corresponding to the device. If you do not want to lose the collection jobs submitted for the device you wish to detach, move the device to another Cisco Data Gateway instead.

Follow the steps below to move or detach devices from a Crosswork Data Gateway pool. To add devices to the pool, see Attach Devices to a Crosswork Data Gateway, on page 33.

Step 1 From the Cisco Crosswork Main Menu, navigate to **Administration** > **Data Gateway Management** > **Data Gateways**.

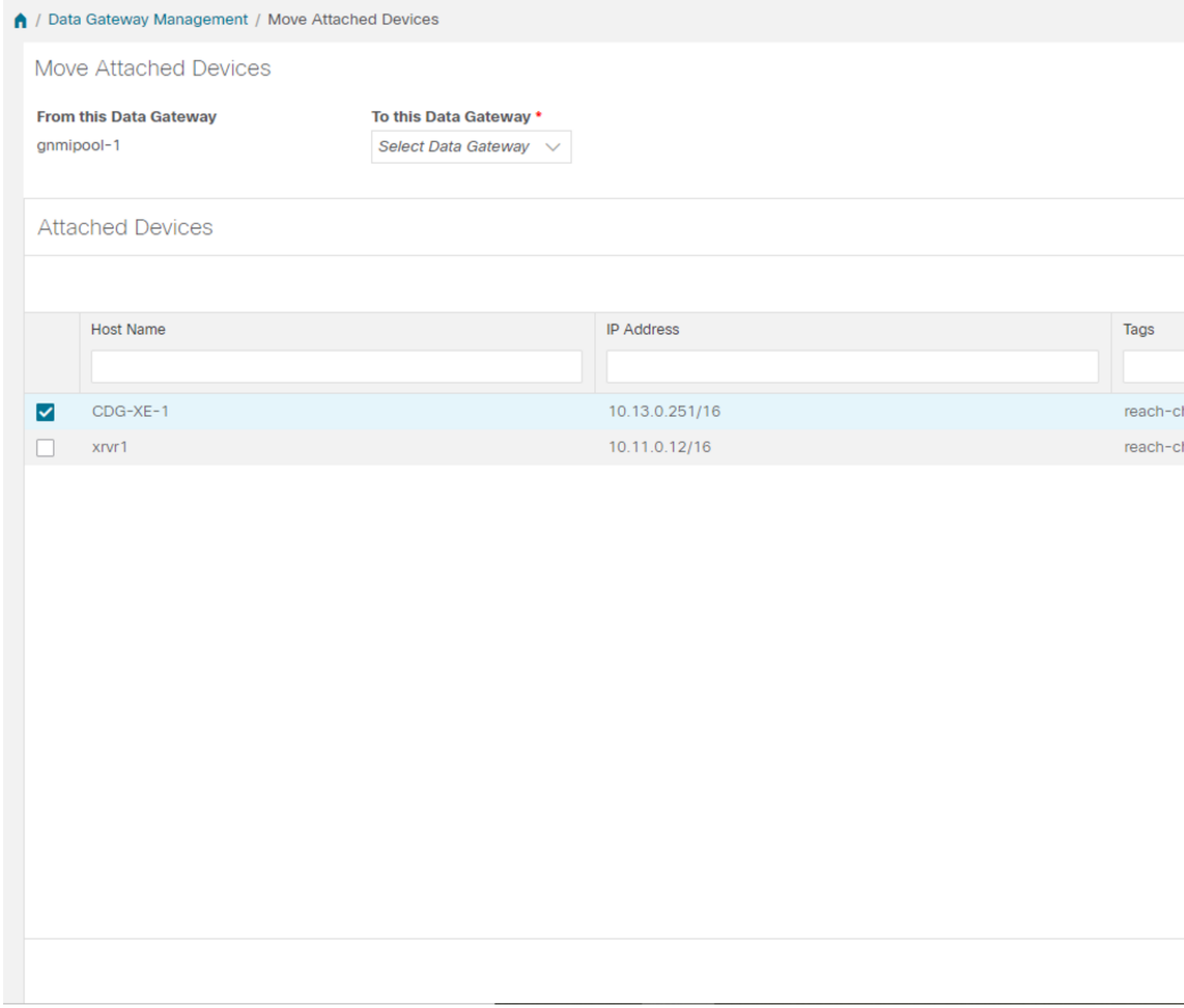


Name	Operational State	Administration State	High Availability Status	Pool Name	Outage History	Average Availability	VM Name	Attached Device Count	Actions
ha-pool-1	Up	Up	None Planned	ha-pool		100%	cdg148.cisco.com	8	⋯
ha-pool-2	Up	Up	None Planned	ha-pool		99%	cdg168.cisco.com	0	

Step 2 **Move Devices**:

a) For the Crosswork Data Gateway from which you want to move devices, under **Actions** column, click ⋯ and select **Move Devices**. The **Move Attached Devices** window opens showing all the devices available for moving.

b) From the **To this Data Gateway** dropdown, select the data gateway to which you want to move the devices.



/ Data Gateway Management / Move Attached Devices

Move Attached Devices

From this Data Gateway
gnmipool-1

To this Data Gateway *
Select Data Gateway

Attached Devices

	Host Name	IP Address	Tags
☑	CDG-XE-1	10.13.0.251/16	reach-cl
☐	xrvr1	10.11.0.12/16	reach-cl

c) To move all the devices, click **Move All Devices**. Otherwise, select the devices you want to move and click **Move Selected Devices**.

d) In **Confirm - Move Devices** window, click **Move**.

Step 3 **Detach Devices**:

a) For the Crosswork Data Gateway from which you want to detach devices, under **Actions** column, click ⋯ and select **Detach Devices**. The Detach Devices window opens showing all attached devices.

b) To detach all the devices, click **Detach All Devices**. Otherwise, select the devices you want to detach and click **Detach**

c) In **Confirm - Detach Devices** window, click **Detach**

Verify that your changes are successful by checking the **Attached Device Count** under the **Data Gateways** pane. Click the *i* icon next to the attached device count to see the list of all devices attached to the selected Crosswork Data Gateway.

Maintain Crosswork Data Gateway VMs

This section explains the maintenance tasks of the Crosswork Data Gateway VM.

- Change the Administration State of Cisco Crosswork Data Gateway VM, on page 40
- Delete Cisco Crosswork Data Gateway VM from Cisco Crosswork, on page 41
- Redeploy a Crosswork Data Gateway VM, on page 42

Change the Administration State of Cisco Crosswork Data Gateway VM

To perform upgrades or other maintenance within the data center is may become necessary to suspend operations between Cisco Crosswork platform and the Cisco Crosswork Data Gateway. This can be done by placing the Cisco Crosswork Data Gateway into **Maintenance** mode. During downtime, admin can do modifications to Cisco Crosswork Data Gateway, such as updating the certificates, etc.

Note If the maintenance activities are affecting the communication between Crosswork and Crosswork Data Gateway, the collection is interrupted and resumes when the communication is restored. Similarly if the maintenance activities are affecting the communication between Crosswork Data Gateway and external destinations (Kafka/gRPC), the collection is interrupted and resumes when the communication is restored.

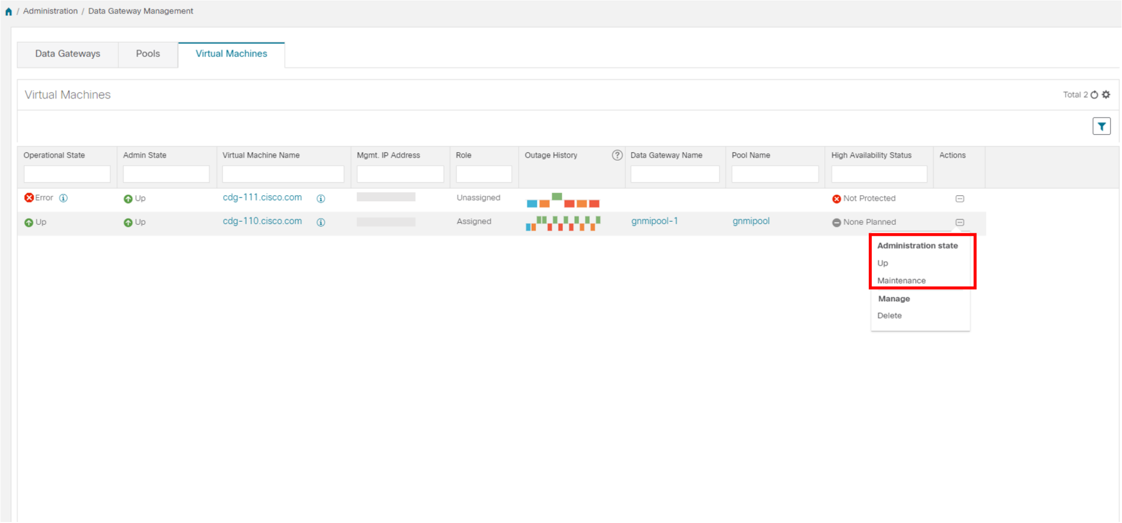
Once changes are done, admin can change the administration state to **Up**. Once the Crosswork Data Gateway VM is up, Cisco Crosswork resumes sending jobs to it.

Note Maintenance (work done on the network or network outages) do not stop collections even though they may fail. In case of a Crosswork Data Gateway VM with the **Administration state** as **Maintenance**, the collections stop gracefully and resume when the VM returns to having the Administration state as **Up**.

Follow the steps below to change the administration state of a Crosswork Data Gateway VM:

Step 1 From the main menu, choose **Administration** > **Data Gateway Management** > **Virtual Machines**.

Step 2 For the Cisco Crosswork Data Gateway whose adminstrative state you want to change, click on ⋯ under **Actions** column.



Operational State	Admin State	Virtual Machine Name	Mgmt. IP Address	Role	Outage History	Data Gateway Name	Pool Name	High Availability Status	Actions
Error	Up	cdg-111.cisco.com	[redacted]	Unassigned				Not Protected	
Up	Up	cdg-110.cisco.com	[redacted]	Assigned		gnmipool-1	gnmipool	None Planned	

Step 3 Select the adminstration state to which you want to switch to.

Delete Cisco Crosswork Data Gateway VM from Cisco Crosswork

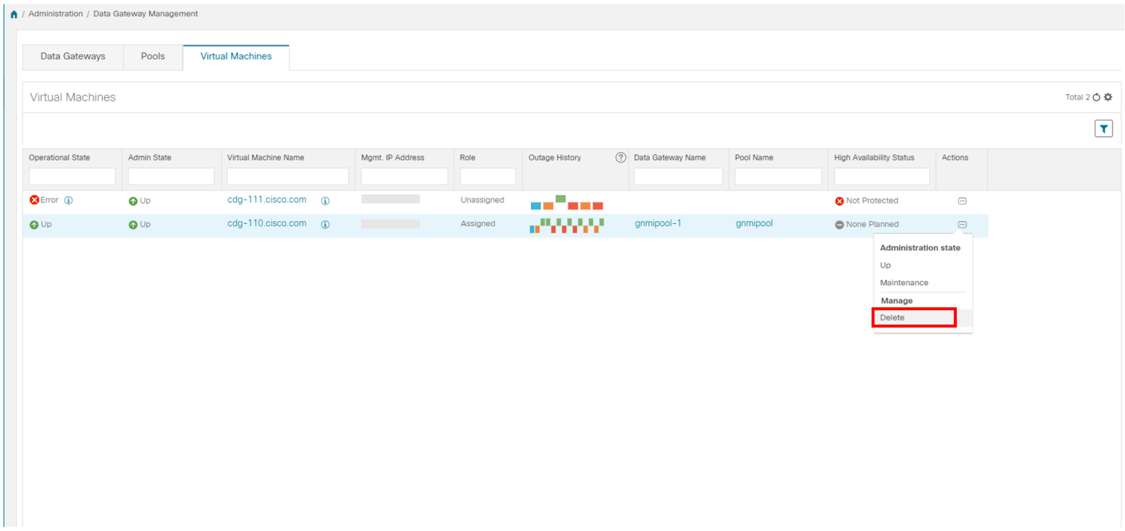
Follow the steps below to delete a Cisco Crosswork Data Gateway VM from Cisco Crosswork:

Before you begin

It is recommended that you move the attached devices to another data gateway to not lose any jobs corresponding to these devices. If you detach the devices from Cisco Crosswork Data Gateway VM, then the corresponding jobs are deleted.

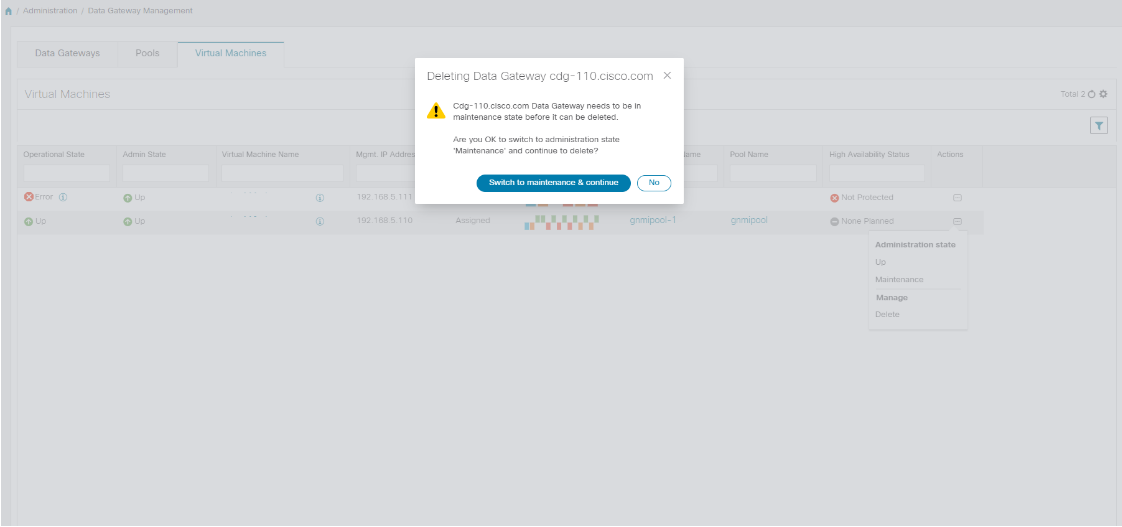
Step 1 From the main menu, choose **Administration** > **Data Gateway Management** > **Virtual Machines**.

Step 2 For the Crosswork Data Gateway that you want to delete, click ⋯ under **Actions** column and click **Delete**.



Operational State	Admin State	Virtual Machine Name	Mgmt. IP Address	Role	Outage History	Data Gateway Name	Pool Name	High Availability Status	Actions
Error	Up	cdg-111.cisco.com	[redacted]	Unassigned				Not Protected	
Up	Up	cdg-110.cisco.com	[redacted]	Assigned		gnmipool-1	gnmipool	None Planned	

Step 3 The Cisco Crosswork Data Gateway VM must be in maintenance mode to be deleted. Click **Switch & Continue** when prompted to switch to **Maintenance** mode..



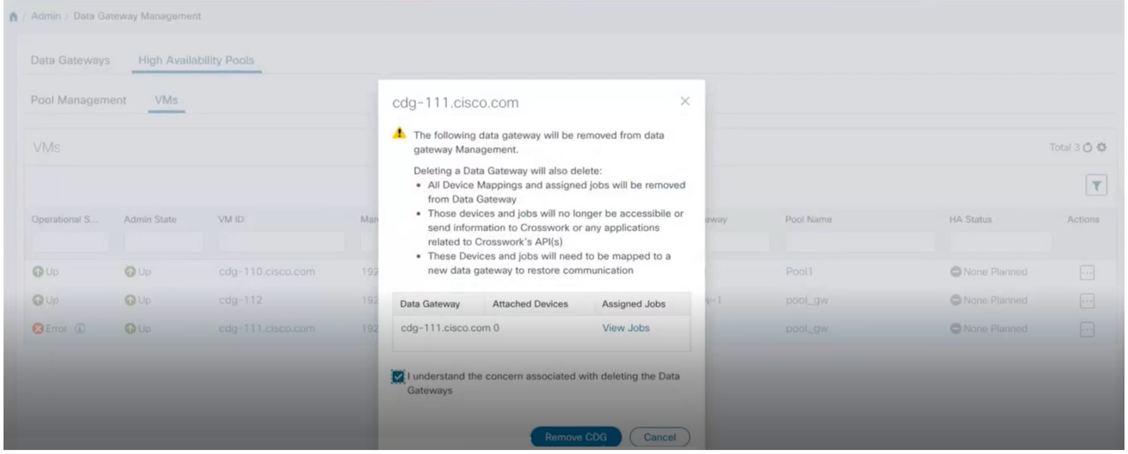
Deleting Data Gateway cdg-110.cisco.com

Cdg-110.cisco.com Data Gateway needs to be in maintenance state before it can be deleted.

Are you OK to switch to administration state 'Maintenance' and continue to delete?

Switch to maintenance & continue | No

Step 4 Check the check box for "I understand the concern associated with deleting the Data Gateways." and click **Remove CDG**.



cdg-111.cisco.com

The following data gateway will be removed from data gateway Management.

Deleting a Data Gateway will also delete:

- All Device Mappings and assigned jobs will be removed from Data Gateway
- Those devices and jobs will no longer be accessibile or send information to Crosswork or any applications related to Crosswork's API(s)
- These Devices and jobs will need to be mapped to a new data gateway to restore communication

Data Gateway	Attached Devices	Assigned Jobs
cdg-111.cisco.com	0	View Jobs

☑ I understand the concern associated with deleting the Data Gateways

Remove CDG | Cancel

Redeploy a Crosswork Data Gateway VM

If a Crosswork Data Gateway VM has gone down and can no longer be used, then delete the old VM and install a new one. For details on how to install a new Crosswork Data Gateway VM, refer to Section: *Install Cisco Crosswork Data Gateway* in the *Cisco Crosswork Infrastructure 4.1 and Applications Installation Guide*.

Note If the Crosswork Data Gateway VM was already enrolled with Cisco Crosswork and you have installed the VM again with the same name, change the Administration State of the Crosswork Data Gateway VM to **Maintenance** for auto-enrollment to go through.

If a Crosswork Data Gateway VM was already enrolled with Cisco Crosswork and Cisco Crosswork was installed again, re-enroll the existing Crosswork Data Gateway VM with Cisco Crosswork. See Re-enroll Crosswork Data Gateway, on page 333.

Configure Crosswork Data Gateway Global Settings

This section describes how to configure global settings for Cisco Crosswork Data Gateway. These settings include:

- Create and Manage External Data Destinations, on page 43.
- Manage Custom Device Packages, on page 48.
- Configure Crosswork Data Gateway Global Parameters, on page 50.
- Crosswork Data Gateway Dynamic Resource Allocation, on page 52.

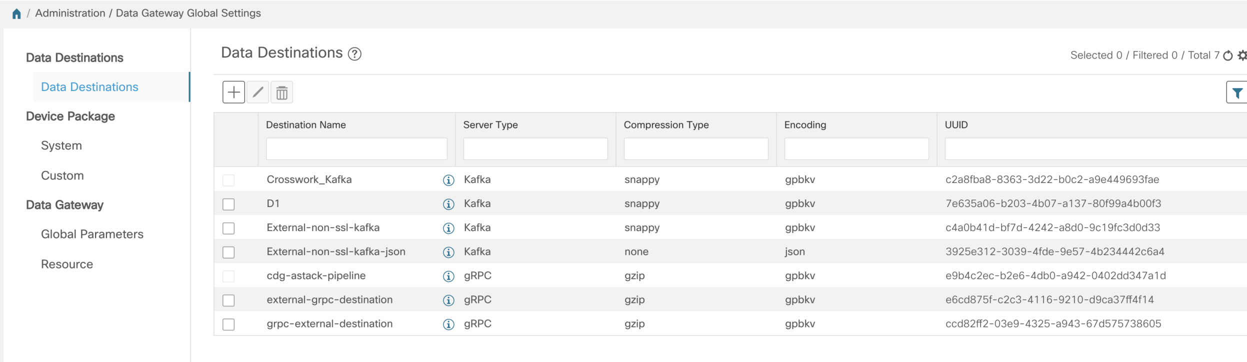
Create and Manage External Data Destinations

Cisco Crosswork allows you to create external data destinations (Kafka or external gRPC) that can be used by collection jobs to deposit data.

It can be accessed by navigating to **Administration** > **Data Gateway Global Settings** > **Data Destinations**. You can add a new data destination, update the settings configured for an existing data destination, and delete a data destination.

The table in the **Data Destinations** page lists the approved data destinations that can be used by the collection jobs to deposit their data.

Note The **Crosswork_Kafka** and **cd-astack-pipeline** are internal data destinations and cannot be updated or deleted.



	Destination Name	Server Type	Compression Type	Encoding	UUID
□	Crosswork_Kafka	Kafka	snappy	gpbkv	c2a8fba8-8363-3d22-b0c2-a9e449693fae
□	D1	Kafka	snappy	gpbkv	7e635a06-b203-4b07-a137-80f99a4b00f3
□	External-non-ssl-kafka	Kafka	snappy	gpbkv	c4a0b41d-bf7d-4242-a8d0-9c19fc3d0d33
□	External-non-ssl-kafka-json	Kafka	none	json	3925e312-3039-4fde-9e57-4b234442c6a4
□	cdg-astack-pipeline	gRPC	gzip	gpbkv	e9b4c2ec-b2e6-4db0-a942-0402dd347a1d
□	external-grpc-destination	gRPC	gzip	gpbkv	e6cd875f-c2c3-4116-9210-d9ca37ff4f14
□	grpc-external-destination	gRPC	gzip	gpbkv	ccd82ff2-03e9-4325-a943-67d575738605

The UUID is the Unique identifier for the data destination. Cisco Crosswork automatically generates this ID when an external data destination is created. When creating collection jobs using the Cisco Crosswork UI the destination for the data is selected using a drop-down list of the configured destinations. When creating a collection job via the API, you will need to know the UUID of the destination where the collector is to send the data it collects.

To view details of a data destination, in the Data Destinations pane, click ⓘ icon next to the data destination name whose details you want to see.

Licensing Requirements for External Collection Jobs

To be able to create collection jobs that can forward data to external data destinations, ensure that you meet the following licensing requirements:

1. From the main menu, go to **Administration** > **Application Management** > **Smart License**.
2. Select **Crossword Platform Services** in the application field.
3. Ensure that the status is as follows:
   - **Registration Status - Registered**

     Indicates that you have registered with Cisco Smart Software Manager (CSSM) and are authorized to use the reserved licensed features.
   - **License Authorization Status - Authorized** (In Compliance).

     Indicates that you have not exceeded the device count in the external collection jobs.
   - Under Smart Licensing Usage, **CW_EXTERNAL_COLLECT** has status as **In Compliance**.

If you do not register with Cisco Smart Software Manager (CSSM) after the Evaluation period has expired or you have exceeded the device count in external collection jobs (**License Authorization Status** is **Out of Compliance**), you will not be able to create external collection jobs. However, you can still view and delete any existing collection jobs.

Add or Edit a Data Destination

Follow the steps below to add a new data destination. You can then use this data destination to forward data to. You can add multiple data destinations.

Few points to note when adding an external data destination are:

- If you re-install an already existing external Kafka data destination with the same IP address, then the collectors need to be restarted for changes to take effect.
- You can secure the communication channel between Cisco Crosswork and the specified data destination that is, either Crosswork Kafka or external Kafka. (See **Step 6** in this procedure). However, enabling security can impact performance.
- If your external data destination requires a TLS connection, keep the public certificate ready or if it requires client authentication, keep the client certificate and key files ready. The client key might be password-encrypted which will need to be configured as part of the data destination provisioning. Currently, Crosswork Data Gateway supports IP-based certificates only.
- Ensure that the certificates are PEM encoded and the key file is in PKCS#8 format when generating them with your Certificate Authority.
- Ensure that you create the Kafka topics before you submit the job in Cisco Crosswork. Depending on the external Kafka and how topics are managed in that external Kafka, Cisco Crosswork logs may show the following exception if the topic does not exist at the time of dispatching the collected data to that

specific external Kafka / topic. This could be because the topic is not created yet or the topic was deleted before the collection job was complete.

```
destinationContext: topicmdt4
org.apache.kafka.common.errors.UnknownTopicOrPartitionException: This server does not
host this topic-partition.
```

- Check and validate the port connectivity for the data destination. If the port is unreachable in the destination, it will lead to a failed collection.
- Crosswork Data Gateway allows you to configure custom values in the destination properties for a Kafka destination (see Step 4 in this procedure).

Note This feature is not supported on a gRPC destination.

Global properties entered in the **Destination Details** pane are mandatory and will be applied to the Kafka destination by default unless there are custom values specified at the individual collector level. Custom values that you specify for a collector will apply only to that collector.

Before you begin

If you are using an external Kafka server for data collection, ensure the following:

- You have configured the following properties on the external Kafka server:

  Note Refer your Kafka documentation for description and usage of these properties as this explanation is out of scope of this document.

  - `num.io.threads = 8`
  - `num.network.threads = 3`
  - `message.max.bytes= 30000000`
- You have created Kafka topics that you want to be used for data collection.

Step 1 From the main menu, choose **Administration** > **Data Gateway Global Settings** > **Data Destinations**.

Step 2 In the **Data Destinations** page, click + button. The **Add Destination** page opens.

If you want to edit an existing destination, click ✎ button to open **Edit Destination** page and edit the parameters.

Note Updating a data destination causes the Cisco Crosswork Data Gateway using it to re-establish a session with that data destination. Data collection will be paused and resumes once the session is re-established.

Step 3 Enter or modify the values for the following parameters:

Field	Value
Destination Name	Enter a descriptive data destination name. The name can contain a maximum of 128 alphanumeric characters, plus underscores ("_") or hyphens ("-"). No other special characters are allowed. If you have many data destinations, make the name as informative as possible to be able to distinguish later.
Server Type	From the drop down, select the server type of your data destination (Kafka/gRPC).
Encoding	From the drop down, select the encoding (json/gpbkv).
Compression Type	From the drop down, select the compression type: Compression types supported for Kafka are snappy, gzip, lz4, zstd, and none) **Note** zstd compression type is supported only for Kafka 2.0 or higher. Compression types supported for gRPC are snappy, gzip, and deflate.
Maximum Message Size (bytes) (Kafka-only)	Enter the maximum message size in bytes. • **Default Value**: 100000000 bytes/ 30 MB • **Min**: 1000000 bytes/1 MB • **Max**: 100000000 bytes/ 30 MB
Buffer Memory (Kafka only)	Enter the required buffer memory in bytes. • **Default Value**: 52428800 bytes • **Min**: 52428800 bytes • **Max**: 314572800 bytes
Batch Size (bytes) (Kafka-only)	Enter the required batch size in bytes. • **Default Value**: 6400000 bytes/6.4 MB • **Min**: 16384 bytes/ 16.38 KB • **Max**: 6400000 bytes/6.4 MB
Linger (milliseconds) (Kafka-only)	Enter the required linger time in milliseconds. • **Default Value**: 5000 ms • **Min**: 0 ms • **Max**: 5000 ms

For telemetry based collection, it is recommended to use the destination settings of **Batch size** as 16384 bytes and **linger** as 500 ms, for optimal results.

Step 4 (Optional) To configure custom values that are different from global properties for a Kafka destination, in the **Customize Collector Settings** pane,and

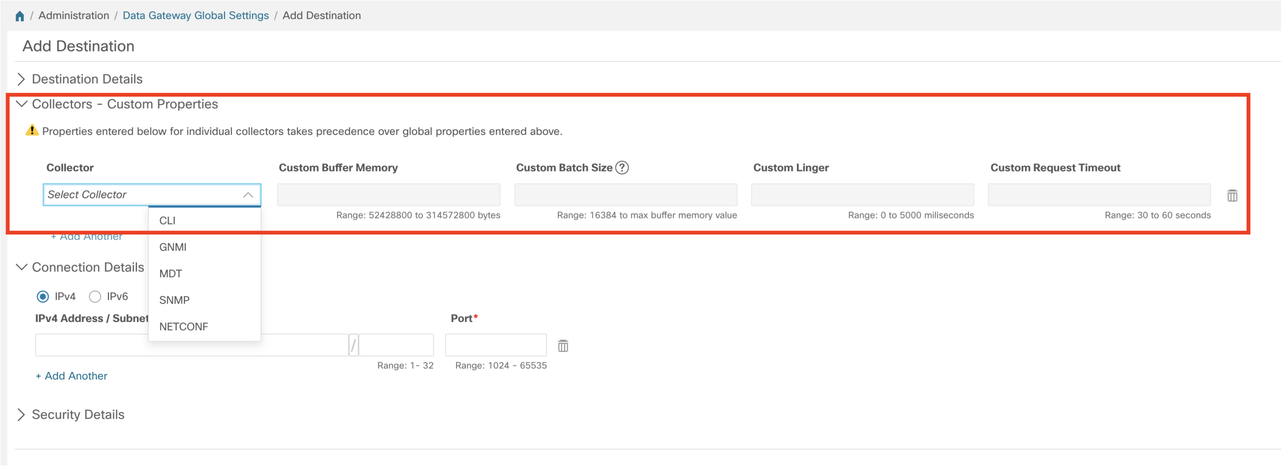
a) Select a **Collector**.

b) Enter values for the following fields

- **Custom Buffer Memory**
- **Custom Batch Size**

  Note The **Custom Batch Size** cannot exceed the value of the **Custom Buffer Memory** at run time. In case, you do not provide a value in the **Custom Buffer Memory** field, the **Custom Batch Size** will be validated against the value in the **Buffer Memory** field.

- **Custom Linger**
- **Custom Request Timeout**



⚠ Properties entered below for individual collectors takes precedence over global properties entered above.

c) Click **+ Add Another** to repeat this step and add custom settings for another collector.

Note Properties entered here for individual collectors will take precedence over the global settings entered in Step 3. If you do not enter values in any field here, the values for the same will be taken from the Global properties entered in Step 3.

Step 5 Select a TCP/IP stack from the **Connection Details** options. IPv4 and IPv6 are supported.

Step 6 Complete the **Connection Details** fields as described in the following table. The fields displayed will vary with the connectivity type you chose. The values you enter must match the values configured on the external Kafka or gRPC server.

Connectivity Type	Fields
IPv4	Enter the required **IPv4 Address/ Subnet Mask**, and **Port**. You can add multiple IPv4 addresses by clicking **+ Add Another** IPv4 subnet mask ranges from 1 to 32 and port range from 1024 to 65535.
IPv6	Enter the required **IPv6 Address/ Subnet Mask**, and **Port**. You can add multiple IPv6 addresses by clicking **+ Add Another**. IPv6 subnet mask ranges from 1 to 128 and port range from 1024 to 65535.

Step 7 (Optional) To connect securely to the data destination, enable the **Enable Secure Communication** option under **Security Details**.

Step 8 Click **Save**.

What to do next

If you have enabled the **Enable Secure Communication** option, navigate to the **Certificate Management** page in the Cisco Crosswork UI (**Administration > Certificate Management**) and add the relevant certificate for the newly added data destination. This step is mandatory to establish a secure communication to the device. See Manage Certificates, on page 259 for more information.

Note If you do not add the certificate for the data destination after enabling the **Enable Secure Communication** option, Cisco Crosswork still connects to the destination in non-secure mode for any collection jobs.

Delete a Data Destination

Follow the steps to delete a data destination:

Before you begin

A data destination can only be deleted if it is not associated with any collection job. We recommend to check in the **Collection Jobs** view to see if any collection jobs are using the data destination.

Step 1 From the main menu, choose **Administration** > **Data Gateway Global Settings** > **Data Destinations**.

Step 2 Select the Data destination(s) you want to delete from the list of destinations that is displayed and click 🗑 button.

Step 3 In **Delete Data Destination(s)** pop up, click **Delete** to confirm.

Manage Custom Device Packages

You can upload Custom Device Packages to Cisco Crosswork, for example, when required to extend device coverage and collection capabilities to third-party devices. System Device and MIB Packages are bundled in the Crosswork software and are automatically downloaded to the system instances. You cannot modify system device and MIB packages.

You can upload three types of custom device packages to Cisco Crosswork:

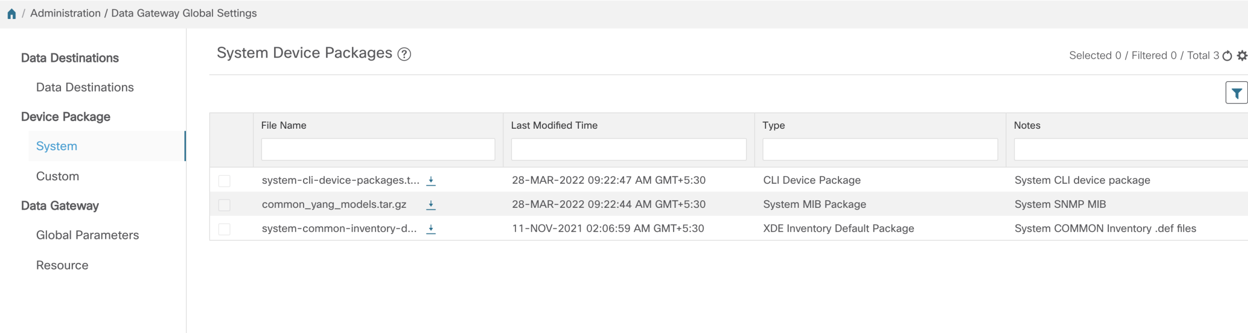
1. **CLI Device Package**: To use CLI-based KPIs to monitor device health for third-party devices. All custom CLI device packages along with their corresponding YANG models should be included in file `custom-cli-device-packages.tar.xz`. Multiple files are not supported.

2. **Custom MIB Packages**: Custom MIBs and device packages can be specific to third-party devices or be used to filter the collected data or format it differently for Cisco devices. These packages can be edited. All custom SNMP MIB packages along with YANG models should be included in file `custom-mib-packages.tar.xz`. Multiple files are not supported.

Note Cisco Crosswork Data Gateway enables SNMP polling on third party devices for standard MIBs already included in the system. Proprietary MIBs are required only if the collection request references MIB TABLE names or SCALAR names from a proprietary MIB. However, if the requests are OID-based, then MIBs are not required.

3. **SNMP Device Package**: Cisco Crosswork Data Gateway allows you to extend the SNMP coverage by uploading custom SNMP device packages with any additional MIB and YANG descriptions you require.

Device Packages pane can be accessed via **Adminstration** > **Data Gateway Global Settings** > **Device Packages**.



	File Name	Last Modified Time	Type	Notes
□	system-cli-device-packages.t... ⤓	28-MAR-2022 09:22:47 AM GMT+5:30	CLI Device Package	System CLI device package
□	common_yang_models.tar.gz ⤓	28-MAR-2022 09:22:44 AM GMT+5:30	System MIB Package	System SNMP MIB
□	system-common-inventory-d... ⤓	11-NOV-2021 02:06:59 AM GMT+5:30	XDE Inventory Default Package	System COMMON Inventory .def files

To download a device package, click on the ⤓ button next to its name in the **File Name** column.

Add a Custom Device Package

This is a list of guidelines about uploading device packages to Cisco Crosswork.

1. You can upload one or more xar file in a single device package tar.gz file.
2. Cisco Crosswork doesn't allow Custom MIB package files to overwrite the System MIB Package files. It results in a failed upload attempt.
3. Ensure that the custom device package TAR file has just the device package folders and none of the parent folder or hierarchy of folders as part of the TAR file. If not imported properly, Cisco Crosswork throws exceptions when executing the job with custom device package.
4. Cisco Crosswork does not validate the files being uploaded other than checking the file extension.

Follow these steps to upload a custom software package:

Before you begin

When uploading new MIBs as a part of Custom MIB Package, ensure that those new MIBs files can be uploaded within collectors along with existing System MIB files i.e., all dependencies in the files are resolved properly.

Note Performance of collection jobs executing the custom device packages depends on how optimized the custom device packages are. Ensure that you validate that the device package are optimized for the scale you want to deploy them for before uploading to Cisco Crosswork.

For information on how to validate custom MIBs and Yangs i.e., to check if they can be uploaded to Cisco Crosswork, see Use Custom MIBs and Yangs on Cisco DevNet.

Step 1 From the main menu, choose **Administration** > **Data Gateway Global Settings**.

Step 2 In **Custom Device Packages** pane, click ⊞.

To update the existing Custom CLI Device Package, click the upload icon next to the File name in the table.

Step 3 In the **Add Device Package** window that appears, select the type of custom device package you want to import from the **Type** drop-down.

Step 4 Click in the blank field of **File Name** to open the file browser window and select the device package to import and click **Open**.

Step 5 Add a description of the custom device package in the **Notes** field. This is recommended if you have many packages, to be able to distinguish among them.

Step 6 Click **Upload**.

What to do next

Restart all impacted services to get the latest custom MIB package updates.

Delete a Custom Device Package

Deleting a custom device package causes deletion of all YANG and XAR files from Cisco Crosswork. This impacts all collection jobs using the custom device package.

Follow the steps to delete a custom device package:

Step 1 From the main menu, choose **Administration** > **Data Gateway Global Settings** > **Device Packages** > **Custom**.

Step 2 From the list displayed in the **Custom Device Packages** pane, select the custom device package you want to delete and click 🗑.

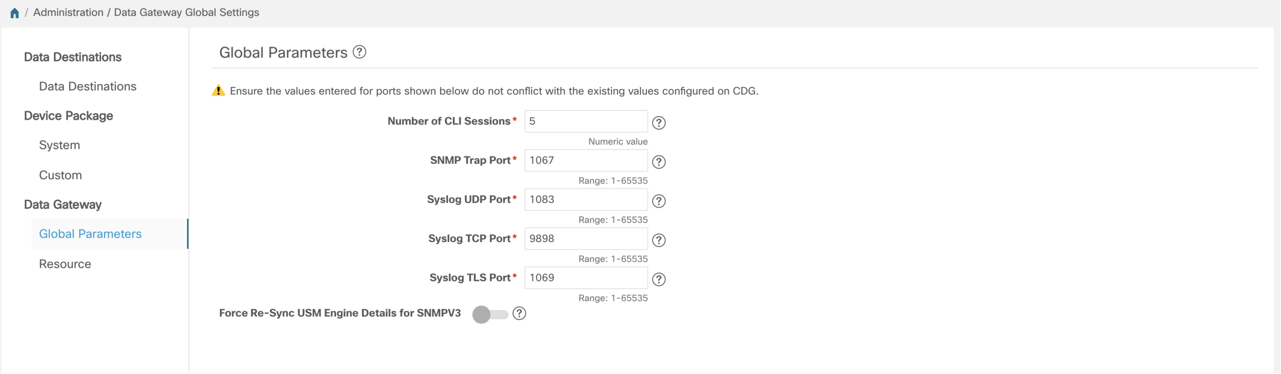
Step 3 In the **Delete Custom Device Package** window that appears, click **Delete** to confirm.

Configure Crosswork Data Gateway Global Parameters

Crosswork Data Gateway allows you to update the following parameters across all Crosswork Data Gateways in the network.

Note These settings can only be accessed by an admin user.

Step 1 Navigate to **Administration** > **Data Gateway Global Settings** > **Data Gateway** > **Global Parameters**.



/ Administration / Data Gateway Global Settings

Global Parameters

Ensure the values entered for ports shown below do not conflict with the existing values configured on CDG.

Number of CLI Sessions* 5 (Numeric value)

SNMP Trap Port* 1067 (Range: 1-65535)

Syslog UDP Port* 1083 (Range: 1-65535)

Syslog TCP Port* 9898 (Range: 1-65535)

Syslog TLS Port* 1069 (Range: 1-65535)

Force Re-Sync USM Engine Details for SNMPV3

Step 2 Change one of more of the following parameters.

Note Ensure that the port values that you wish to update with are valid ports and do not conflict with the existing port values. Same port values must be configured on the device.

Parameter Name	Description
Number of CLI sessions	Maximum number of CLI sessions between a Crosswork Data Gateway and devices. The default value is 3. **Note** This value overrides any internal configuration set for the same parameter.
SNMP Trap Port	Default value is 1062.
Syslog UDP Port	Default value is 9514.
Syslog TCP Port	Default value is 9898.
Syslog TLS Port	Default value is 6514.
Force Re-Sync USM Engine Details for SNMPV3	USM details change whenever a device is rebooted or re-imaged. SNMPV3 collections stop working whenever there is a change in any of the USM details. Enable this option to sync the USM details automatically whenever there is a change, after the very first collection failure. The default value is False.

Step 3 If you are updating ports, select **Yes** in the **Global Parameters** window that appears to confirm that collectors can be restarted. Updating ports causes the collectors to restart and pause any collection jobs that are running. The jobs resume automatically once the restart is complete.

Step 4 Click **Save** to apply your changes.

A window appears indicating if the parameters update on Crosswork Data Gateways in the network was successful or not.

1. If all the Crosswork Data Gateways were updated successfully, a success message appears in the UI indicating that the update was successful.
2. If any of the Crosswork Data Gateways in the network could not be updated, an Error window appears in the UI. Crosswork Data Gateway will automatically try to update the parameters on the failed Crosswork Data Gateway during recovery. Some of the collectors might be restarted as part of recovery.

Note One of the reasons the global parameters fail to update on a Crosswork Data Gateway could be that the OAM channel is down. After the OAM channel is re-established, Crosswork Data Gateway tries sending these parameters to the Crosswork Data Gateway again (that is not in sync) and updates the values after comparison with the existing values.

What to do next

If you have updated any of the ports, navigate to **Administration** > **Data Gateway Management** > **Data Gateways** tab and verify that all Crosswork Data Gateways have the **Operational State** as **Up**.

Crosswork Data Gateway Dynamic Resource Allocation

Crosswork Data Gateway allows you to dynamically configure and allocate memory at run time for collector services. You can allocate more memory to a heavily-used collector or adjust the balance of resources from the UI.

Note These settings can only be accessed by an admin user.

Memory and CPU sets that are currently configured for collector services are displayed in this page. Any changes that you make to the memory values in this page will apply to currently enrolled and future Crosswork Data Gateways.

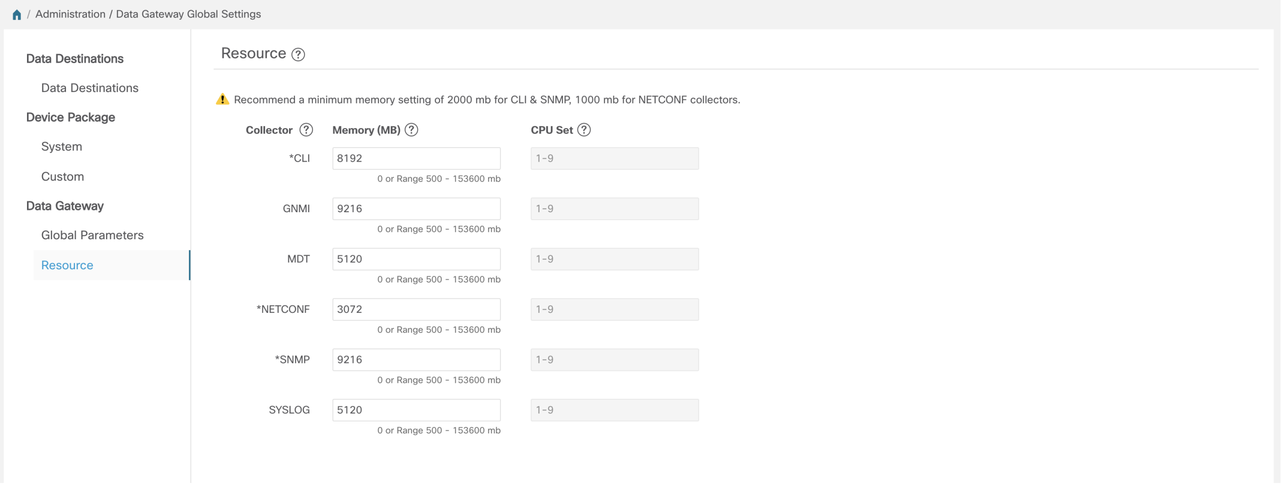
Note The list of collectors that is displayed in this page is dynamic, that is, it is specific to the deployment.

To update resource allocation for collectors:

Note We recommend that you do not make any changes to these settings unless you are working with the Cisco Customer Experience (CX) team.

Step 1 Navigate to **Administration** > **Data Gateway Global Settings** > **Data Gateway** > **Resource**.

The list of collectors and the resources consumed by each of them is displayed here.



Resource

Recommend a minimum memory setting of 2000 mb for CLI & SNMP, 1000 mb for NETCONF collectors.

Collector	Memory (MB)	CPU Set
*CLI	8192 0 or Range 500 - 153600 mb	1-9
GNMI	9216 0 or Range 500 - 153600 mb	1-9
MDT	5120 0 or Range 500 - 153600 mb	1-9
*NETCONF	3072 0 or Range 500 - 153600 mb	1-9
*SNMP	9216 0 or Range 500 - 153600 mb	1-9
SYSLOG	5120 0 or Range 500 - 153600 mb	1-9

Step 2 Enter the updated values in the **Memory** field for the collectors for which you wish to change the memory allocation.

Step 3 Click **Save** once you are finished making the changes.

Updating the values for a collector causes the collector to restart and pause any collection jobs that are running. The jobs resume automatically once the restart is complete.

Manage Crosswork Data Gateway Collection Jobs

A collection job is a task that Cisco Crosswork Data Gateway is expected to perform. Applications request data collection via collection jobs. Cisco Crosswork then assigns these collection jobs to a Cisco Crosswork Data Gateway to serve the request.

Crosswork Data Gateway supports multiple data collection protocols including CLI, MDT, SNMP, gNMI (dial-in), syslog, and NETCONF. Crosswork Data Gateway can collect any type of data as long as it can be forwarded over one of the supported protocols.

There are two types of data collection requests in Cisco Crosswork:

1. Data collection request to forward data for internal processes within Cisco Crosswork. Cisco Crosswork creates system jobs for this purpose. You cannot create or edit system jobs.

2. Data collection request to forward data to external data destinations.

You can forward collected data to an external data destination and Cisco Crosswork Health Insights in a single collection request by adding the external data destination when creating a KPI profile. For more information, see Section: *Create a New KPI Profile* in the *Cisco Crosswork Change Automation and Health Insights 4.3 User Guide.*

Note

1. Cisco Crosswork Data Gateway drops incoming traffic if there is no corresponding (listening) collection job request for the same. It also drops data, syslog events, and SNMP traps received from an unsolicited device (that is, not attached to Crosswork Data Gateway).

2. Polled data cannot be requested from the device until Cisco Crosswork Data Gateway is ready to process and transmit the data.

You can view collection jobs currently active on all the Crosswork Data Gateway instances enrolled with Cisco Crosswork from the **Collection Jobs** page.

In the Cisco Crosswork UI, from the left navigation bar, choose **Administration** > **Collection Jobs**.

The left pane in the **Collection Jobs** page has two tabs, **Bulk Jobs** and **Parametrized Jobs**. **Bulk Jobs** list all the collection jobs that are created by the system, or from the UI and API here. The **Parametrized Jobs** pane lists all active jobs that are created by the Cisco Crosswork Service Health application.

Note The **Parametrized Jobs** pane has no data and remains empty if Cisco Crosswork Service Health has not been deployed.

For more information, see Monitor Collection Jobs, on page 92.

Types of Collection Jobs

You can create the following list of collection jobs from the Cisco Crosswork UI (CLI/SNMP only) or using APIs to request data.

- CLI Collection Job, on page 55
- SNMP Collection Job, on page 56
- MDT Collection Job, on page 63
- Syslog Collection Job, on page 65
- gNMI Collection Job, on page 75
- NETCONF Collection Job, on page 85

For each collection job that you create, Cisco Crosswork Data Gateway executes the collection request and forwards the collected data to the preferred data destination.

This chapter describes how to create collection jobs from the Cisco Crosswork UI. To create collection jobs using APIs, see Crosswork Data Gateway APIs on Cisco Devnet.

The initial status for all the collection jobs in the Cisco Crosswork UI is Unknown. Upon receiving a collection job, Cisco Crosswork Data Gateway performs basic validations on it. If the collection job is valid, its status changes to **Successful**, else it changes to **Failed**.

The value of **Cadence** is in seconds. This value can be set between 10 seconds and 2764800 seconds (i.e. at most 32 days) max, depending on how frequently configured sensor data should be collected.

Note We recommend a cadence of 60 seconds.

When collection from a device is skipped due to previous execution still in progress, Cisco Crosswork Data Gateway raises a warning log. No alert is generated for this scenario.

CLI Collection Job

Cisco Crosswork Data Gateway supports CLI-based data collection from the network devices. Following commands are supported for this type of collection job:

- `show` and the short version `sh`
- `traceroute`
- `dir`

Devices should not have any banner configuration for CLI collection to work properly. Please refer to device documentation on how to turn this off.

You can create a CLI collection job from the Cisco Crosswork UI or using APIs. See Create a Collection Job from Cisco Crosswork UI, on page 87 or Cisco DevNet for more information.

Following is a sample payload of CLI collection job for a Kafka external destination. In this example, take note of two values in particular.

1. The device is identified with a UUID rather than an IP address.
2. The destination is also referenced by a UUID. For collections jobs built using the UI, Cisco Crosswork looks up the UUIDs. When you create your own collection jobs, you will need to look up these values.

```
{
  "collection_job": {
    "application_context": {
      "context_id": "collection-job1",
      "application_id": "APP1"
    },
    "collection_mode": {
      "lifetime_type": "APPLICATION_MANAGED",
      "collector_type": "CLI_COLLECTOR"
    },
    "job_device_set": {
      "device_set": {
        "devices": {
          "device_ids": [
            "658adb03-cc61-448d-972f-4fcec32cbfe8"
          ]
        }
      }
    },
    "sensor_input_configs": [
      {
        "sensor_data": {
          "cli_sensor": {
            "command": "show platform"
          }
        },
        "cadence_in_millisec": "tel:60000"
      }
```

```
        ],
        "sensor_output_configs": [
         {
            "sensor_data": {
              "cli_sensor": {
                "command": "show platform"
              }
            },
            "destination": {
              "destination_id": "1e71f2fb-ea65-4242-8efa-e33cec71b369",
              "context_id": "topic1"
            }
          }
        ]
      }
    }
```

SNMP Collection Job

Cisco Crosswork Data Gateway supports SNMP-based data collection based on the OIDs supported on the devices.

The SNMP collector makes a poll request to Cisco Crosswork to get its configuration profile (a list of MIB objects to collect and a list of devices to fetch from). It determines the corresponding OIDs by looking up the pre-packaged list of MIB modules or the custom list of MIB modules.

Note Cisco Crosswork Data Gateway enables SNMP polling on third party devices for standard MIBs already included in the system. Proprietary MIBs are required only if the collection request references MIB TABLE names or SCALAR names from a proprietary MIB. However, if the requests are OID-based, then MIBs are not required.

After the OIDs are resolved, they are provided as input to the SNMP collectors.

The device packages can be imported into the Crosswork Data Gateway VM as described in Section Add a Custom Device Package, on page 49.

Supported SNMP versions for data polling and traps are:

- Polling Data
  - SNMP V1
  - SNMP V2
  - SNMP V3 (no auth nopriv, auth no priv, authpriv)
  - Supported auth protocols – SHA-1,MD5
  - Supported priv protocols – DES, 3DES, AES128, AES192, AES256, CiscoAES192, CiscoAES256
- Traps
  - SNMP V1
  - SNMP V2
  - SNMP V3 (no auth nopriv, auth no priv, authpriv)

Sample Configurations on Device:

The following table lists sample commands to enable various SNMP functions. Please refer to the platform-specific documentation for more information.

Table 4: Sample Configuration to enable SNMP on device

Version	Command	To...

V1	`snmp-server group <group_name> v1`
	`snmp-server user <user_name> <group_name> v1`
		Define the SNMP version, user/user group details.

	`snmp-server host <host_ip> traps <community_string> udp-port 1062`
	For example,
	`snmp-server host a.b.c.d traps test udp-port 1062`
		Define the destination to which trap data must be forwarded.

	`snmp-server traps snmp linkup`
	`snmp-server traps snmp linkdown`
		Enable traps to notify link status.

V2c	`snmp-server group <group_name> v2c`
	`snmp-server user <user_name> <group_name> v2c`
		Define the SNMP version, user/user group details.

	`snmp-server host <host_ip> traps SNMP version <community_string> udp-port 1062`
	`snmp-server host a.b.c.d traps version 2c v2test udp-port 1062`
		Define the destination to which trap data must be forwarded.
		Note The IP address mentioned here must be the virtual IP address of the Crosswork Data Gateway.

	`snmp-server traps snmp linkup`
	`snmp-server traps snmp linkdown`
		Enable traps to notify link status.

Version	Command	To...
V3 **Note** Password for a SNMPv3 user must be at least 8 bytes.	`snmp-server host <host_IP> traps version 3 priv <user_name> udp-port 1062`	Define the destination to which trap data must be forwarded. **Note** The IP address mentioned here must be the virtual IP address of the Crosswork Data Gateway.
	`snmp-server user <user_name> <group_name> v3 auth md5 <password> priv aes 128 <password>`	Configures the SNMP server group to enable authentication for members of a specified named access list.
	`snmp-server view <user_name> < MIB > included`	Define what must be reported.
	`snmp-server group <group_name> v3 auth notify <user_name> read <user_name> write <user_name>`	Define the SNMP version, user/user group details.
	`snmp-server enable traps snmp [authentication ] [linkup ] [linkdown ] [warmstart ] [coldstart ]`	• When used without any of the optional keywords, enables authenticationFailure, linkUp, linkDown, warmStart, and coldStart traps. • When used with keywords, enables only the trap types specified. For example, to globally enable only linkUp and linkDown SNMP traps for all interfaces, use the **snmp-server enable traps snmp linkup linkdown** form of this command.

The SNMP Collector supports the following operations:

- SCALAR

Note If a single collection requests for multiple scalar OIDs, you can pack multiple SNMP GET requests in a single `getbulkrequestquery` to the device.

- TABLE
- WALK

- COLUMN

These operations are defined in the sensor config (see payload sample below).

Note There is an optional **deviceParams** attribute **snmpRequestTimeoutMillis** (not shown in the sample payloads) that should be used if the device response time is more than 1500 milliseconds. It's not recommended to use **snmpRequestTimeoutMillis** unless you are absolutely certain that your device response time is very high.

The value for snmpRequestTimeoutMillis should be specified in milliseconds:

The default and minimum value is 1500 milliseconds. However, there is no limitation on the maximum value of this attribute.

Following is an SNMP collection job sample:

```
{
  "collection_job": {
    "application_context": {
      "context_id": "collection-job1",
      "application_id": "APP1"
    },
    "collection_mode": {
      "lifetime_type": "APPLICATION_MANAGED",
      "collector_type": "SNMP_COLLECTOR"
    },
    "job_device_set": {
      "device_set": {
        "devices": {
          "device_ids": [
            "c70fc034-0cbd-443f-ad3d-a30d4319f937",
            "8627c130-9127-4ed7-ace5-93d3b4321d5e",
            "c0067069-c8f6-4183-9e67-1f2e9bf56f58"
          ]
        }
      }
    },
    "sensor_input_configs": [
      {
        "sensor_data": {
          "snmp_sensor": {
            "snmp_mib": {
              "oid": "1.3.6.1.2.1.1.3.0",
              "snmp_operation": "SCALAR"
            }
          }
        },
        "cadence_in_millisec": "60000"
      },
      {
        "sensor_data": {
          "snmp_sensor": {
            "snmp_mib": {
              "oid": "1.3.6.1.2.1.31.1.1",
              "snmp_operation": "TABLE"
            }
          }
        },
        "cadence_in_millisec": "60000"
      }
    ],
    "sensor_output_configs": [
      {
        "sensor_data": {
          "snmp_sensor": {
            "snmp_mib": {
              "oid": "1.3.6.1.2.1.1.3.0",
              "snmp_operation": "SCALAR"
            }
          }
        },
        "destination": {
          "destination_id": "4c2ab662-2670-4b3c-b7d3-b94acba98c56",
          "context_id": "topic1_461cb8aa-a16a-44b8-b79f-c3daf3ea925f"
        }
      },
      {
        "sensor_data": {
          "snmp_sensor": {
            "snmp_mib": {
              "oid": "1.3.6.1.2.1.31.1.1",
              "snmp_operation": "TABLE"
            }
          }
        },
        "destination": {
          "destination_id": "4c2ab662-2670-4b3c-b7d3-b94acba98c56",
          "context_id": "topic2_e7ed6300-fc8c-47ee-8445-70e543057f8a"
        }
      }
    ]
  }
}
```

SNMP Traps Collection Job

SNMP Traps Collection jobs can be created only via API. Trap listeners listen on a port and dispatch data to recipients (based on their topic of interest).

Crosswork Data Gateway listens on UDP port 1062 for Traps.

Note Before submitting SNMP Trap collection jobs, SNMP TRAPS need to configured properly on the device to be sent to virtual IP address of the Crosswork Data Gateway.

SNMP Trap Collection Job Workflow

On receiving a SNMP trap, Cisco Crosswork Data Gateway :

1. Checks if any collection job is created for the device.

2. Checks the trap version and community string.

3. For SNMP v3, also validates for user auth and priv protocol and credentials.

Note SNMPV3 auth-priv traps are dependent on the engineId of the device or router to maintain local USM user tables. Therefore, there will be an interruption in receiving traps whenever the engineId of the device or router changes. Please detach and attach the respective device to start receiving traps again.

Crosswork Data Gateway filters the traps based on the trap OID mentioned in the sensor path and sends only those requested.

If the collection job is invalid, there is missing configuration on the device, or no trap is received, the status of the job remains "Unknown". For list of supported Traps and MIBs, see List of Pre-loaded Traps and MIBs for SNMP Collection, on page 337.

Crosswork Data Gateway supports three types of non-yang/OID based traps:

Table 5: List of Supported Non-Yang/OID based Traps

sensor path	purpose
*	To get all the traps pushed from the device without any filter.
MIB level traps	OID of one MIB notifications (Ex: 1.3.6.1.2.1.138.0 to get all the isis-mib level traps)
Specific trap	OID of the specific trap (Ex: 1.3.6.1.6.3.1.1.5.4 to get the linkUp trap)

Following is an SNMP-Trap collection job sample:

```
{
  "collection_job": {
    "application_context": {
      "context_id": "collection-job1",
      "application_id": "APP1"
    },
    "collection_mode": {
      "lifetime_type": "APPLICATION_MANAGED",
      "collector_type": "TRAP_COLLECTOR"
    },
    "job_device_set": {
      "device_set": {
        "devices": {
          "device_ids": [
            "a9b8f43d-130b-4866-a26a-4d0f9e07562a",
            "8c4431a0-f21d-452d-95a8-84323a19e0d6",
            "eaab2647-2351-40ae-bf94-6e4a3d79af3a"
          ]
        }
      }
    },
    "sensor_input_configs": [
      {
        "sensor_data": {
          "trap_sensor": {
            "path": "1.3.6.1.6.3.1.1.4"
          }
        },
        "cadence_in_millisec": "60000"
      }
    ],
    "sensor_output_configs": [
      {
        "sensor_data": {
          "trap_sensor": {
            "path": "1.3.6.1.6.3.1.1.4"
          }
        },
        "destination": {
          "destination_id": "4c2ab662-2670-4b3c-b7d3-b94acba98c56",
          "context_id": "topic1_696600ae-80ee-4a02-96cb-3a01a2415324"
        }
      }
    ]
  }
}
```

Enabling Traps forwarding to external applications

We recommended selectively enabling only those traps that are needed by Crosswork on the device .

To identify the type of trap from the data received on the destination, look for *oid* (OBJECT_IDENTIFIER, for example, `1.3.6.1.6.3.1.1.4.1.0`) and *strValue* associated to the *oid* in the OidRecords (application can match the OID of interest to determine the kind of trap).

Below are some sample values and a sample payload to forward traps to external applications:

- Link up

  ```
  1.3.6.1.6.3.1.1.4.1.0 = 1.3.6.1.6.3.1.1.5.4
  ```

- Link Down

  ```
  1.3.6.1.6.3.1.1.4.1.0 = 1.3.6.1.6.3.1.1.5.3
  ```

- Syslog

  ```
  1.3.6.1.6.3.1.1.4.1.0 = 1.3.6.1.4.1.9.9.41.2.0.1
  ```

- Cold Start

  ```
  1.3.6.1.6.3.1.1.4.1.0 = 1.3.6.1.6.3.1.1.5.1
  ```

```
{
  "nodeIdStr": "BF5-XRV9K1.tr3.es",
  "nodeIdUuid": "C9tZ5lJoSJKf5OZ67+U5JQ==",
  "collectionId": "133",
  "collectionStartTime": "1580931985267",
  "msgTimestamp": "1580931985267",
  "dataGpbkv": [
    {
      "timestamp": "1580931985267",
      "name": "trapsensor.path",
      "snmpTrap": {
        "version": "V2c",
        "pduType": "TRAP",
        "v2v3Data": {
          "agentAddress": "172.70.39.227",
          "oidRecords": [
            {
              "oid": "1.3.6.1.2.1.1.3.0",
              "strValue": "7 days, 2:15:17.02"
            },
            {
              "oid": "1.3.6.1.6.3.1.1.4.1.0",  // This oid is the Object Identifier.
              "strValue": "1.3.6.1.6.3.1.1.5.3" // This is the value that determines the
kind of trap.
            },
            {
              "oid": "1.3.6.1.2.1.2.2.1.1.8",
              "strValue": "8"
            },
```

```
            {
              "oid": "1.3.6.1.2.1.2.2.1.2.8",
              "strValue": "GigabitEthernet0/0/0/2"
            },
            {
              "oid": "1.3.6.1.2.1.2.2.1.3.8",
              "strValue": "6"
            },
            {
              "oid": "1.3.6.1.4.1.9.9.276.1.1.2.1.3.8",
              "strValue": "down"
            }
          ]
        }
      }
    }
  ],
  "collectionEndTime": "1580931985267",
  "collectorUuid": "YmNjZjEzMTktZjFlOS00NTE5LWI4OTgtY2Y1ZmQxZDFjNWExOlRSQVBfQ09MTEVDVE9S",
  "status": {
    "status": "SUCCESS"
  },
  "modelData": {},
  "sensorData": {
    "trapSensor": {
      "path": "1.3.6.1.6.3.1.1.5.4"
    }
  },
  "applicationContexts": [
    {
      "applicationId": "APP1",
      "contextId": "collection-job-snmp-traps"
    }
  ]
}
```

MDT Collection Job

Crosswork Data Gateway supports data collection from network devices using Model-driven Telemetry (MDT) to consume telemetry streams directly from devices (for IOS-XR based platforms only).

Crosswork Data Gateway supports data collection for the following transport mode:

- MDT TCP Dial-out Mode

Cisco Crosswork leverages NSO to push the required MDT configuration to the devices and will send the corresponding collection job configuration to the Crosswork Data Gateway.

Note

- If there is some change (update) in existing MDT jobs between backup and restore operations, Cisco Crosswork does not replay the jobs for config update on the devices as this involves NSO. You have to restore configs on NSO/devices. Cisco Crosswork only restores the jobs in database.
- Before using any YANG modules, check if they are supported. See Section: List of Pre-loaded YANG Modules for MDT Collection , on page 345

Following is a sample of MDT collection payload:

```
{
 "collection_job": {
  "job_device_set": {
   "device_set": {
    "device_group": "mdt"
   }
  },
  "sensor_output_configs": [{
    "sensor_data": {
     "mdt_sensor": {
      "path":
"Cisco-IOS-XR-infra-statsd-oper:infra-statistics/interfaces/interface/latest/generic-counters"

     }
    },
    "destination": {
     "context_id": "cw.mdt_sensor.cisco-ios-xr-infra-statsd-oper.gpb",
     "destination_id": "c2a8fba8-8363-3d22-b0c2-a9e449693fae"
    }
   },
   {
    "sensor_data": {
     "mdt_sensor": {
     "path": "Cisco-IOS-XR-infra-statsd-oper:infra-statistics/interfaces/interface/data-rate"

     }
    },
    "destination": {
     "context_id": "cw.mdt_sensor.cisco-ios-xr-infra-statsd-oper.gpb",
     "destination_id": "c2a8fba8-8363-3d22-b0c2-a9e449693fae"
    }
   }
  ],
  "sensor_input_configs": [{
    "sensor_data": {
     "mdt_sensor": {
     "path": "Cisco-IOS-XR-infra-statsd-oper:infra-statistics/interfaces/interface/data-rate"

     }
    },
    "cadence_in_millisec": "70000"
   }, {
    "sensor_data": {
     "mdt_sensor": {
      "path":
"Cisco-IOS-XR-infra-statsd-oper:infra-statistics/interfaces/interface/latest/generic-counters"

     }
    },
    "cadence_in_millisec": "70000"
   }
  ],
  "application_context": {
   "context_id": "c4",
   "application_id": "a4-mdt"
  },
  "collection_mode": {
   "lifetime_type": "APPLICATION_MANAGED",
   "collector_type": "MDT_COLLECTOR"
  }
 }
}
```

MDT Collection Job Workflow

When an MDT based KPI is activated on a device, Cisco Crosswork

1. Sends a configuration request to NSO to enable the data collection on the target devices.
2. Send a collection job create request to the Crosswork Data Gateway.
3. Crosswork Data Gateway creates a distribution to send the data collected to the destination you specify.

Syslog Collection Job

Crosswork Data Gateway supports Syslog-based events collection from devices. Following Syslog formats are supported:

- RFC5424 syslog format
- RFC3164 syslog format

Note In order to gather syslog data from devices in the network, you must configure the devices to send syslog data to the Crosswork Data Gateway. Refer to the platform-specific documentation.

For sample device configuration, see Configure Syslog (Non-Secure) on Device, on page 71. Cisco Crosswork also allows you to setup secure syslog communication to the device. See sample device configuration at Configure Secure Syslog on Device, on page 72.

Syslog Data Collection

Syslog data can be filtered by specifying either PRI-based SyslogSensor or Filters-based SyslogSensor. Only those syslog events that match the filters mentioned in the payload are sent to the specified destination.

Following is a sample Syslog collection payload with PRI-based SyslogSensor filter.

```
{
  "collection_job": {
      "job_device_set": {
      "device_set": {
        "devices": {
          "device_ids": [
            "c6f25a33-92e6-468a-ba0d-15490f1ce787"
          ]
        }
      }
    },
    "sensor_output_configs": [
      {
        "sensor_data": {
          "syslog_sensor": {
            "pris": {
                "facilities": [0, 1, 3, 23,4],
                "severities": [0, 4, 5, 6, 7]
            }
        }
        },
        "destination": {
          "context_id": "syslogtopic",
          "destination_id": "c2a8fba8-8363-3d22-b0c2-a9e449693fae"
        }
      }
    ],
    "sensor_input_configs": [
      {
        "sensor_data": {
          "syslog_sensor": {
            "pris": {
                "facilities": [0,1, 3, 23,4],
                "severities": [0,4, 5, 6, 7]
            }
          }
        },
        "cadence_in_millisec": "60000"
      }
    ],
    "application_context": {
      "context_id": "demomilesstone2syslog",
      "application_id": "SyslogDemo2"
    },
    "collection_mode": {
      "lifetime_type": "APPLICATION_MANAGED",
      "collector_type": "SYSLOG_COLLECTOR"
    }
  }
}
```

The Filters-based SyslogSensor is based on Regex , PRI and severity-facility. You can specify and combine multiple filters (maximum 3 filters) using AND or OR. By default, an AND condition is applied if there is no logical operator specified. Following is a sample Syslog collection payload with Filters-based SyslogSensor filter.

```
{
      "collection_job": {
      "job_device_set": {
      "device_set": {
      "devices": {
      "device_ids": [
      "ce33ad3c-d6d0-42b7-b24b-67dfa77c6ee8"
                ]
              }
           }
       },
      "sensor_output_configs": [{
        "sensor_data": {
          "syslog_sensor": {
            "filters": {
              "filter": [{
                "syslog_filter": {
                  "severity_facility": {
                      "severity": {
                        "op": "LESSER_THAN",
                         "value": 7
                                  },
                          "facility": {
                          "op": "EQUALS",
                          "value": 23
                           }
                      }
                   }
                },
                {
                  "syslog_filter": {
                   "pri_filter": {
                    "value": {
                      "op": "GREATER_THAN",
              "value": 180
                          }
                        }
                      }
                },
               {
                 "syslog_filter": {
                  "regex_filter": {
                  "pattern": "SSHD\\[\\d+\\]"
                                  }
                                }
                              }
                              ],
                    "operator": "AND"
                           }
                         }
                    },
   "destination": {
   "context_id": "3filtersand",
    "destination_id": "c2a8fba8-8363-3d22-b0c2-a9e449693fae"
                  }
                }],
"sensor_input_configs": [{
"sensor_data": {
 "syslog_sensor": {
       "filters": {
          "filter": [{
              "syslog_filter": {
                  "severity_facility": {
                      "severity": {
                          "op": "LESSER_THAN",
                              "value": 7
                                    },
                          "facility": {
                           "op": "EQUALS",
                            "value": 23
                                      }
                                    }
                                   }
                                  },
                            {
                          "syslog_filter": {
                          "pri_filter": {
                            "value": {
                            "op": "GREATER_THAN",
                            "value": 180
                                    }
                                  }
                                }
                              },
                            {
                        "syslog_filter": {
                        "regex_filter": {
                        "pattern": "SSHD\\[\\d+\\]"
                            }
                          }
                        }
                      ],
                "operator": "AND"
                    }
                  }
                },
    "cadence_in_millisec": "60000"
            }],
          "application_context": {
          "context_id": "AND_syslog.3Filters_oneofeach",
          "application_id": "testing.postman.syslog.3Filters_oneofeach_AND"
              },
         "collection_mode": {
         "lifetime_type": "APPLICATION_MANAGED",
         "collector_type": "SYSLOG_COLLECTOR"
          }
       }
}
```

Syslog Collection Job Output

When you onboard a device from Cisco Crosswork UI (**Device Management** > **Network Devices** > **Device Details**), the value you choose in the **Syslog Format** field configures the format in which syslog events received from the device should be parsed by the Syslog Collector. You can choose either **UNKNOWN**, **RFC5424** or **RFC3164**.

Following is the sample output for each of the options:

1. **UNKNOWN** - Syslog Collection Job output contains syslog events as received from device.

Note If the device is configured to generate syslog events in RFC5424/RFC3164 format but no format is specified in the **Syslog Format** field, by default this is considered as **UNKNOWN**.

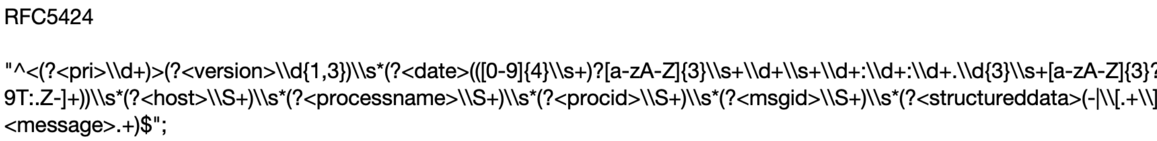
Sample output:

```
node_id_str: "xrv9k-VM8"
node_id_uuid: ":i\300\216>\366BM\262\270@\337\225\2723&"
collection_id: 1056
collection_start_time: 1616711596200
msg_timestamp: 1616711596201
data_gpbkv {
  timestamp: 1616711596201
  name: "syslogsensor.path"
  fields {
    name: "RAW"
    string_value: "<6>1 Mar 25 15:34:41.321 PDT - SSHD_ 69570 - - 98949:
RP/0/RP0/CPU0:SSHD_[69570]: %SECURITY-SSHD-6-INFO_SUCCESS : Successfully authenticated
user \'admin\' from \'40.40.40.116\' on \'vty0\'(cipher \'aes128-ctr\', mac \'hmac-sha1\')
 \n"
  }
  fields {
    name: "DEVICE_IP"
    string_value: "40.40.40.30"
  }
}
collection_end_time: 1616711596200
collector_uuid: "17328736-b726-4fe3-b922-231a4a30a54f:SYSLOG_COLLECTOR"
status {
  status: SUCCESS
}
model_data {
}
sensor_data {
  syslog_sensor {
    pris {
      facilities: 0
      facilities: 3
      facilities: 4
```

```
        facilities: 23
        severities: 0
        severities: 5
        severities: 6
        severities: 7
      }
    }
  }
  application_contexts {
    application_id: "SyslogApp-xr-8-job1"
    context_id: "xr-8-job1"
  }
  version: "1"
```

2. **RFC5424** - If the device is configured to generate syslog events in RFC5424 format and the RFC5424 format is selected in the **Syslog Format** field, the Syslog Job Collection output contains syslog events as received from device (RAW) and the RFC5424 best-effort parsed syslog events from the device.

Note The syslog collector will parse the syslog event on best efforts as per the following Java RegEx pattern:



RFC5424

"^<(?<pri>\\d+)>(?<version>\\d{1,3})\\s*(?<date>(([0-9]{4}\\s+)?[a-zA-Z]{3}\\s+\\d+\\s+\\d+:\\d+:\\d+.\\d{3}\\s+[a-zA-Z]{3}?
9T:.Z-]+))\\s*(?<host>\\S+)\\s*(?<processname>\\S+)\\s*(?<procid>\\S+)\\s*(?<msgid>\\S+)\\s*(?<structureddata>(-|\\[.+\\]
<message>.+)$";

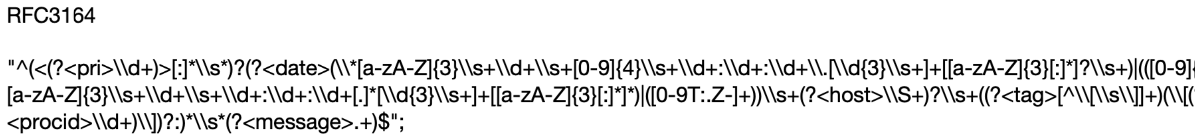
Sample output:

```
....
....


collection_start_time: 1596307542398
msg_timestamp: 1596307542405
data_gpbkv {
  timestamp: 1596307542405
  name: "syslogsensor.path"
  fields {
    name: "RAW"
    string_value: "<13>1 2020 Aug  1 12:03:32.461 UTC:  iosxr254node config 65910 - -
2782: RP/0/RSP0/CPU0:2020 Aug  1 12:03:32.461 UTC: config[65910]: %MGBL-SYS-5-CONFIG_I
: Configured from console by admin on vty0 (10.24.88.215) \n"
  }
  fields {
    name: "RFC5424"
    string_value: "pri=13,  severity=5,  facility=1,  version=1,
date=2020-08-01T12:03:32.461,  remoteAddress=/172.28.122.254,  host=\'iosxr254node\',
message=\'2782: RP/0/RSP0/CPU0:2020 Aug  1 12:03:32.461 UTC: config[65910]:
%MGBL-SYS-5-CONFIG_I : Configured from console by admin on vty0 (10.24.88.215) \',
messageId=null, processName=config, structuredDataList=null"
  }
  fields {
    name: "DEVICE_IP"
    string_value: "172.28.122.254"
  }
}
collection_end_time: 1596307542404
collector_uuid: "ac961b09-8f67-4c93-a99a-31eef50f7fa9:SYSLOG_COLLECTOR"
```

```
status {
  status: SUCCESS
}
...
...
```

3. **RFC3164** - If the device is configured to generate syslog events in RFC3164 format and the RFC3164 format is selected in **Syslog Format** field, the Syslog Job Collection output contains both RAW (as received from device) syslog events and the RFC3164 best-effort parsed syslog events from the device.

Note The syslog collector will parse the syslog event on best efforts as per the following Java RegEx pattern:



RFC3164

```
"^(<(?<pri>\\d+)>[:]*\\s*)?(?<date>(\\*[a-zA-Z]{3}\\s+\\d+\\s+[0-9]{4}\\s+\\d+:\\d+:\\d+\\.[\\d{3}\\s+]+[[a-zA-Z]{3}[:]*]?\\s+)|(([0-9]
[a-zA-Z]{3}\\s+\\d+\\s+\\d+:\\d+:\\d+[.]*[\\d{3}\\s+]+[[a-zA-Z]{3}[:]*]*)|([0-9T:.Z-]+))\\s+(?<host>\\S+)?\\s+((?<tag>[^\\[\\s\\]]+)(\\[(
<procid>\\d+)\\])?:)*\\s*(?<message>.+)$";
```

Sample output:

```
....
.....
collection_id: 20
collection_start_time: 1596306752737
msg_timestamp: 1596306752743
data_gpbkv {
  timestamp: 1596306752743
  name: "syslogsensor.path"
  fields {
    name: "RAW"
    string_value: "<14>2020 Aug  1 11:50:22.799 UTC:  iosxr254node 2756:
RP/0/RSP0/CPU0:2020 Aug  1 11:50:22.799 UTC: config[65910]: %MGBL-CONFIG-6-DB_COMMIT :
Configuration committed by user \'admin\'. Use \'show configuration commit changes
1000000580\' to view the changes. \n"
  }
  fields {
    name: "RFC3164"
    string_value: "pri=14,  severity=6,  facility=1,  version=null,
date=2020-08-01T11:50:22.799,  remoteAddress=/172.28.122.254,  host=\'iosxr254node\',
message=\'RP/0/RSP0/CPU0:2020 Aug  1 11:50:22.799 UTC: config[65910]:
%MGBL-CONFIG-6-DB_COMMIT : Configuration committed by user \'admin\'. Use \'show
configuration commit changes 1000000580\' to view the changes. \', tag=2756"
  }
  fields {
    name: "DEVICE_IP"
    string_value: "172.28.122.254"
  }
}
collection_end_time: 1596306752742
collector_uuid: "ac961b09-8f67-4c93-a99a-31eef50f7fa9:SYSLOG_COLLECTOR"
status {
  status: SUCCESS
}
....
....
```

If the Syslog Collector is unable to parse the syslog events according to the format specified in the **Syslog Format** field, then the Syslog Collection Job output contains syslog events as received from device (RAW).

Configure Syslog (Non-Secure) on Device

This section lists sample configuration to configure syslog in the RFC3164 or RFC5424 format on the device.

Configure RFC3164 Syslog format

Note The configuration highlighted in the code below is required to avoid formatting issues in the parsed output.

For Cisco IOS XR devices:

```
logging <CDG IP> port 9514 OR logging <CDG IP> vrf <vrfname> port 9514
logging trap [severity]
logging facility [facility value]
logging suppress duplicates
service timestamps log datetime msec show-timezone year
logging hostnameprefix <some host related prefix e.g.iosxrhost2>
```

For Cisco IOS XE Devices:

```
no logging message-counter syslog
logging trap <serverity>
logging facility <facility>
logging host <CDG IP> transport tcp port 9898 session-id string <sessionidstring> --> To
use TCP channel
OR
logging host <CDG IP> transport udp port 9514 session-id string <sessionidstring> ---> To
use UDP channel
OR
logging host <CDG IP> vrf Mgmt-intf transport udp port 9514 session-id string
<sessionidstring> --> To use UDP via vrf
service timestamps log datetime msec year show-timezone
```

Configure RFC5424 Syslog format

For Cisco IOS XR devices:

```
logging <CDG IP> port 9514 OR logging <server 1> vrf <vrfname> port 9514
logging trap [severity]
logging facility [facility value]
logging suppress duplicates
service timestamps log datetime msec show-timezone year
logging hostnameprefix <some host related prefix e.g.iosxrhost2>
logging format rfc5424
```

For Cisco IOS XE Devices:

```
no logging message-counter syslog
logging trap <serverity>
logging facility <facility>
logging host <CDG IP> transport tcp port 9898 session-id string <sessionidstring> --> To
use TCP channel
OR
logging host <CDG IP> transport udp port 9514 session-id string <sessionidstring> ---> To
use UDP channel
OR
logging host <CDG IP> vrf Mgmt-intf transport udp port 9514 session-id string
<sessionidstring> --> To use UDP via vrf
service timestamps log datetime msec year show-timezone
logging trap syslog-format 5424 --> if applicable
```

Configure Secure Syslog on Device

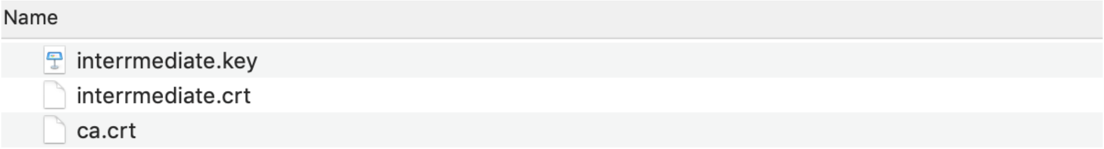
Follow these steps to establish a secure syslog communication to the device.

1. Download the Cisco Crosswork trust chain from the **Certificate Management UI** page in Cisco Crosswork.
2. Configure device with the Cisco Crosswork trust chain.

Download Syslog Certificates

1. In the Cisco Crosswork UI, go to **Administration** > **Certificate Management**.
2. Click *i* in the '**crosswork-device-syslog**' row.
3. Click **Export All** to download the certificates.

   The following files are downloaded to your system.



Name
interrmediate.key
interrmediate.crt
ca.crt

Configure Cisco Crosswork Trustpoint on Device

Sample XR Device Configuration to enable TLS

```
RP/0/RSP0/CPU0:ASR9k(config)#crypto ca trustpoint syslog-root
RP/0/RSP0/CPU0:ASR9k(config-trustp)#enrollment terminal
RP/0/RSP0/CPU0:ASR9k(config-trustp)#crl optional
RP/0/RSP0/CPU0:ASR9k(config-trustp)#commit
RP/0/RSP0/CPU0:ASR9k(config-trustp)#end
RP/0/RSP0/CPU0:ASR9k#
RP/0/RSP0/CPU0:ASR9k#crypto ca authenticate syslog-root
Fri Jan 22 11:07:41.880 GMT


Enter the base 64 encoded certificate.
End with a blank line or the word "quit" on a line by itself

-----BEGIN CERTIFICATE-----
MIIGKzCCBBOgAwIBAgIRAKfyU89yjmrXVDRKBWuSGPgwDQYJKoZIhvcNAQELBQAw
bDELMAkGA1UEBhMCVVMxCzAJBgNVBAgTAkNBMREwDwYDVQQHEwhTYW4gSm9zZTEa
................................................................
................................................................
jPQ/UrO8N3sC1gGJX7CIIh5cE+KIJ51ep8i1eKSJ5wHWRTmv342MnG2StgOTtaFF
vrkWHD02o6jRuYXDWEUptDOg8oEritZb+SNPXWUc/2mbYog6ks6EeMC69VjkZPo=
-----END CERTIFICATE-----

Read 1583 bytes as CA certificate
  Serial Number  : A7:F2:53:CF:72:8E:6A:D7:54:34:4A:05:6B:92:18:F8
  Subject:
                CN=Crosswork Device Root CA,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Issued By      :
                CN=Crosswork Device Root CA,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Validity Start : 02:37:09 UTC Sat Jan 16 2021
  Validity End   : 02:37:09 UTC Thu Jan 15 2026
  SHA1 Fingerprint:
                209B3815271C22ADF78CB906F6A32DD9D97BBDBA
```

```
Fingerprint: 2FF85849EBAAB9B059ACB9F5363D5C9CDo you accept this certificate? [yes/no]: yes
RP/0/RSP0/CPU0:ASR9k#config
RP/0/RSP0/CPU0:ASR9k(config)#crypto ca trustpoint syslog-inter
RP/0/RSP0/CPU0:ASR9k(config-trustp)#enrollment terminal
RP/0/RSP0/CPU0:ASR9k(config-trustp)#crl optional
RP/0/RSP0/CPU0:ASR9k(config-trustp)#commit
RP/0/RSP0/CPU0:ASR9k#crypto ca authenticate syslog-inter
Fri Jan 22 11:10:30.090 GMT


Enter the base 64 encoded certificate.
End with a blank line or the word "quit" on a line by itself

-----BEGIN CERTIFICATE-----
MIIGFDCCA/ygAwIBAgIRAkhqHQXcJzQzeQK6U2wn8PIwDQYJKoZIhvcNAQELBQAw
bDELMAkGA1UEBhMCVVMxCzAJBgNVBAgTAkNBMREwDwYDVQQHEwhTYW4gSm9zZTEa
................................................................
................................................................
5lBk617z6cxFER5c+/PmJFhcreisTxXg1aJbFdnB5C8f+0uUIdLghykQ/zaZGuBn
AAB70c9r9OeKGJWzvv1e2U8HH1pdQ/nd
-----END CERTIFICATE-----

Read 1560 bytes as CA certificate
  Serial Number  : 02:48:6A:1D:05:DC:27:34:33:79:02:BA:53:6C:27:F0:F2
  Subject:
                CN=device-syslog,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Issued By      :
                CN=Crosswork Device Root CA,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Validity Start : 02:37:11 UTC Sat Jan 16 2021
  Validity End   : 02:37:11 UTC Mon Jan 16 2023
  SHA1 Fingerprint:
                B06F2BFDE95413A8D08A01EE3511BC3D42F01E59

CA Certificate validated using issuer certificate.
RP/0/RSP0/CPU0:ASR9k#show crypto ca certificates
Fri Jan 22 15:45:17.196 GMT


Trustpoint       : syslog-root
==================================================
CA certificate
  Serial Number  : A7:F2:53:CF:72:8E:6A:D7:54:34:4A:05:6B:92:18:F8
  Subject:
        CN=Crosswork Device Root CA,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Issued By      :
        CN=Crosswork Device Root CA,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Validity Start : 02:37:09 UTC Sat Jan 16 2021
  Validity End   : 02:37:09 UTC Thu Jan 15 2026
  SHA1 Fingerprint:
         209B3815271C22ADF78CB906F6A32DD9D97BBDBA


Trustpoint       : syslog-inter
==================================================
CA certificate
  Serial Number  : 02:48:6A:1D:05:DC:27:34:33:79:02:BA:53:6C:27:F0:F2
  Subject:
        CN=device-syslog,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Issued By      :
        CN=Crosswork Device Root CA,O=CISCO SYSTEMS INC,L=San Jose,ST=CA,C=US
  Validity Start : 02:37:11 UTC Sat Jan 16 2021
  Validity End   : 02:37:11 UTC Mon Jan 16 2023
  SHA1 Fingerprint:
         B06F2BFDE95413A8D08A01EE3511BC3D42F01E59
```

```
RP/0/RSP0/CPU0:ASR9k(config)#logging tls-server syslog-tb131
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#tls-hostname 10.13.0.159
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#trustpoint syslog-inter
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#severity debugging
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#vrf default
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#commit
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#exit
RP/0/RSP0/CPU0:ASR9k(config)#exit
RP/0/RSP0/CPU0:ASR9k#exit
RP/0/RSP0/CPU0:ASR9k#show running-config logging
Fri Jan 22 11:17:19.385 GMT
logging tls-server syslog-tb131
vrf default
severity debugging
trustpoint syslog-inter
tls-hostname <CDG Southbound IP>
!
logging trap debugging
logging format rfc5424
logging facility user
logging hostnameprefix ASR9k
logging suppress duplicates

RP/0/RSP0/CPU0:ASR9k#
```

Sample XE Device Configuration to enable TLS

```
csr8kv(config)#crypto pki trustpoint syslog-root
csr8kv(ca-trustpoint)#enrollment terminal
csr8kv(ca-trustpoint)#revocation-check none
csr8kv(ca-trustpoint)#chain-validation stop
csr8kv(ca-trustpoint)#end
csr8kv(config)#crypto pki authenticate syslog-root

Enter the base 64 encoded CA certificate.
End with a blank line or the word "quit" on a line by itself

-----BEGIN CERTIFICATE-----
MIIFPjCCAyYCCQCO6pK5AOGYdjANBgkqhkiG9w0BAQsFADBhMQswCQYDVQQGEwJV
UzELMAkGA1UECAwCQ0ExETAPBgNVBAcMCE1pbHBpdGFzMQ4wDAYDVQQKDAVDaXNj
................................................................
................................................................
JbimOpXAncoBLo14DXOJLvMVRjn1EULE9AXXCNfnrnBx7jL4CV+qHgEtF6oqclFW
JEA=
-----END CERTIFICATE-----

Certificate has the following attributes:
       Fingerprint MD5: D88D6D8F E53750D4 B36EB498 0A435DA1
      Fingerprint SHA1: 649DE822 1C222C1F 5101BEB8 B29CDF12 5CEE463B

% Do you accept this certificate? [yes/no]: yes
Trustpoint CA certificate accepted.
% Certificate successfully imported


csr8kv(config)#crypto pki trustpoint syslog-intermediate
csr8kv(ca-trustpoint)#enrollment terminal
csr8kv(ca-trustpoint)#revocation-check none
csr8kv(ca-trustpoint)#chain-validation continue syslog-root
csr8kv(ca-trustpoint)#end
csr8kv(config)#crypto pki authenticate syslog-intermediate

Enter the base 64 encoded CA certificate.
End with a blank line or the word "quit" on a line by itself
```

```
-----BEGIN CERTIFICATE-----
MIIFfTCCA2WgAwIBAgICEAAwDQYJKoZIhvcNAQELBQAwXDELMAkGA1UEBhMCVVMx
EzARBgNVBAgMCkNhbGlmb3JuaWExDjAMBgNVBAoMBUNpc2NvMQ4wDAYDVQQLDAVT
................................................................
................................................................
Nmz6NQynD7bxdQa9Xq9kyPuY3ZVKXkf312IRH0MEy2yFX/tAen9JqOeZ1g8canmw
TxsWA5TLzy1RmxqQh88f0CM=
-----END CERTIFICATE-----
Trustpoint 'syslog-intermediate' is a subordinate CA.
but certificate is not a CA certificate.
Manual verification required
Certificate has the following attributes:
       Fingerprint MD5: FE27BDBE 9265208A 681670AC F59A2BF1
      Fingerprint SHA1: 03F513BD 4BEB689F A4F4E001 57EC210E 88C7BD19

csr8kv(config)#logging host <CDG Southbound IP> transport tls port 6514
csr8kv(config)#logging trap informational syslog-format rfc5424
csr8kv(config)#logging facility user
csr8kv(config)#service timestamps log datetime msec year show-timezone

csr8kv(config)#logging tls-profile tlsv12
```

Syslog configuration to support FQDN

Run the following commands in addition to the sample device configuration to enable TLS to support FQDN.

1. Configure Domain name and DNS IP has to be configured on device.

```
RP/0/RSP0/CPU0:ASR9k#config
RP/0/RSP0/CPU0:ASR9k(config)#domain name <DNS domain name>
RP/0/RSP0/CPU0:ASR9k(config)#domain name-server <DNS server IP>
```

2. Configure CDG VIP FQDN for tls-hostname

```
RP/0/RSP0/CPU0:ASR9k(config)#logging tls-server syslog-tb131
RP/0/RSP0/CPU0:ASR9k(config-logging-tls-peer)#tls-hostname <CDG VIP FQDN>
```

gNMI Collection Job

Cisco Crosswork supports gRPC Network Management Interface (gNMI) based telemetry data collection via Cisco Crosswork Data Gateway. It supports only gNMI Dial-In (gRPC Dial-In) streaming telemetry data based on subscription and relaying subsequent subscription response (notifications) to the requested destinations.

Note gNMI collection is supported as long as the models are supported by the target device platform. gNMI must be configured on devices before you can submit gNMI collection jobs. Check platform-specific documentation.

To configure gNMI on the device, see Sample Device Configuration - gNMI, on page 81.

In gNMI, both secure and insecure mode can co-exist on the device. Cisco Crosswork gives preference to secure mode over non-secure mode based on the information passed in the inventory.

If a device reloads, gNMI collector ensures that the existing subscriptions are re-subscribed to the device.

gNMI specification does not have a way to mark end of message. Hence, Destination and Dispatch cadence is not supported in gNMI collector.

Cisco Crosswork Data Gateway supports the following types of subscribe options for gNMI:

Table 6: gNMI Subscription Options

Type	Subtype	Description
Once		Collects and sends the current snapshot of the system configuration only once for all specified paths
Stream	SAMPLE	Cadence-based collection.
	ON_CHANGE	First response includes the state of all the elements for the subscribed path, followed by subsequent updates to the changes leaf values.
	TARGET_DEFINED	Router/Device chooses the mode of subscription on a per-leaf basis based on the subscribed path (i.e. one of SAMPLE or ON_CHANGE)

Crosswork Data Gateway supports the ability to subscribe to multiple subscription paths in a single subscription list to the device. For example, you can specify a combination of ON_CHANGE and subscription mode ONCE collection jobs. ON_CHANGE mode collects data only on change of any particular element for the specified path, while subscription mode ONCE collects and sends current system data only once for the specified path.

Note

- Crosswork Data Gateway relies on the device to declare the support of one or more modes.
- gNMI sensor path with default values does not appear in the payload. This is a known protobuf behavior.

  For boolean the default value is false. For enum, it is gnmi.proto specified.

  Example 1:

  ```
  message GNMIDeviceSetting {
  bool suppress_redundant = 1;
  bool allow_aggregation = 4;
  bool updates_only = 6;
  }
  ```

  Example 2:

  ```
  enum SubscriptionMode {
  TARGET_DEFINED = 0; //default value will not be printed
  ON_CHANGE = 1;
  SAMPLE = 2;
  }
  ```

Following is a sample gNMI collection payload. In this sample you see two collections for the device group "milpitas". The first collects interface statistics, every 60 seconds using the "mode" = "SAMPLE". The second job captures any changes to the interface state (up/down). If this is detected it is simply sent "mode" = "STREAM" to the collector.

```
{
    "collection_job": {
        "job_device_set": {
            "device_set": {
                "device_group": "milpitas"
            }
        },
        "sensor_output_configs": [{
            "sensor_data": {
                "gnmi_standard_sensor": {
                    "Subscribe_request": {
                        "subscribe": {
                            "subscription": [{
                                "path": {
                                    "origin": "openconfig-interfaces",
                                    "elem": [{
                                        "name": "interfaces/interface/state/ifindex"
                                    }]
                                },
                                "mode": "SAMPLE",
                                "sample_interval": 10000000000
                            }, {
                                "path": {
                                    "origin": "openconfig-interfaces",
                                    "elem": [{
                                        "name":
"interfaces/interfaces/state/counters/out-octets"
                                    }]
                                },
                                "mode": "ON_CHANGE",
                                "sample_interval": 10000000000
                            }],
                            "mode": "STREAM",
                            "encoding": "JSON"
                        }
                    }
                }
            },
            "destination": {
                "context_id": "hukarz",
                "destination_id": "c2a8fba8-8363-3d22-b0c2-a9e449693fae"
            }
        }],
        "sensor_input_configs": [{
            "sensor_data": {
                "gnmi_standard_sensor": {
                    "Subscribe_request": {
                        "subscribe": {
                            "subscription": [{
                                "path": {
                                    "origin": "openconfig-interfaces",
                                    "elem": [{
                                        "name": "interfaces/interface/state/ifindex"
                                    }]
                                },
                                "mode": "SAMPLE",
                                "sample_interval": 10000000000
                            }, {
                                "path": {
                                    "origin": "openconfig-interfaces",
                                    "elem": [{
                                        "name":
"interfaces/interfaces/state/counters/out-octets"
                                    }]
                                },
                                "mode": "ON_CHANGE",
                                "sample_interval": 10000000000
                            }],
                            "mode": "STREAM",
                            "encoding": "JSON"
                        }
                    }
                }
            },
            "cadence_in_millisec": "60000"
        }],
        "application_context": {
            "context_id": "testing.group.gnmi.subscription.onchange",
            "application_id": "testing.postman.gnmi.standard.persistent"
        },
        "collection_mode": {
            "lifetime_type": "APPLICATION_MANAGED",
            "collector_type": "GNMI_COLLECTOR"
        }
    }
}
```

Enable Secure gNMI communication between Device and Crosswork Data Gateway

Cisco Crosswork can only use one rootCA certificate (self-signed or signed by a trusted root CA) which means all device certificates must be signed by same CA.

If you have certificates signed by a different a trusted root CA, you can skip the first step and start from Step 2 to import the rootCA certificate in Cisco Crosswork.

Follow these steps to enable secure gNMI between Cisco Crosswork and the devices:

1. Generate the certificates. See Generate Device Certificates, on page 78.

   .

2. Upload the certificates to the Crosswork Certificate Management UI in Cisco Crosswork. See Configure gNMI Certificate, on page 79.

3. Update device configuration with secure gNMI port details from Cisco Crosswork UI. See Update Protocol on Device from Cisco Crosswork, on page 80

4. Enable gNMI on the device. See Sample Device Configuration - gNMI, on page 81

5. Configure the certificates and device key on the device. Import Certificates on Device, on page 84.

Generate Device Certificates

This section explains how to create certificates with OpenSSL.

Steps to generate certificates have been validated with Open SSL and Microsoft. For the purpose of these instructions, we have explained the steps to generate device certificates with Open SSL.

> **Note** To generate device certificates with a utility other than Open SSL or Microsoft, please work with the Cisco Support Team.

1. **Create the rootCA**

```
# openssl genrsa -out rootCA.key
# openssl req -subj /C=/ST=/L=/O=/CN=CrossworkCA -x509 -new -nodes -key rootCA.key -sha256
 -out rootCA.pem -days 1024
```

In the above command, the `days` attribute determines the how long the certificate is valid. The minimum value is 30 days which means you will need to update the certificates every 30 days. We recommend setting the value to 365 days.

2. **Create device key and certificate**

```
# openssl genrsa -out device.key
# openssl req -subj /C=/ST=/L=/O=/CN=Crosswork -new -key device.key -out device.crs
# openssl x509 -req -extfile <(printf "subjectAltName=IP.0: 10.58.56.18") -in device.csr
 -CA rootCA.pem -CAkey rootCA.key -CAcreateserial -sha256 -out device3.crt -days 1024
```

If you have multiple devices, instead of creating multiple device certificates, you can specify multiple device IP addresses separated by a comma in the `subjectAltName`.

```
# openssl x509 -req -extfile <(printf "subjectAltName=IP.0: 10.58.56.18, IP.1:
10.58.56.19, IP.2: 10.58.56.20 ..... ") -in device.csr -CA rootCA.pem -CAkey rootCA.key
 -CAcreateserial -sha256 -out device.crt -days 1024
```

Configure gNMI Certificate

Crosswork Data Gateway acts as the gNMI client while the device acts as gNMI server. Crosswork Data Gateway validates the device using a trust chain. It is expected that you have a global trust chain for all the devices. If you have multiple trust chains, add all the device trust chains (single or multiple vendors) in a single .pem file and upload this .pem file to the Crosswork Certificate Management UI.

Note You can upload only one gNMI Certificate to Crosswork.

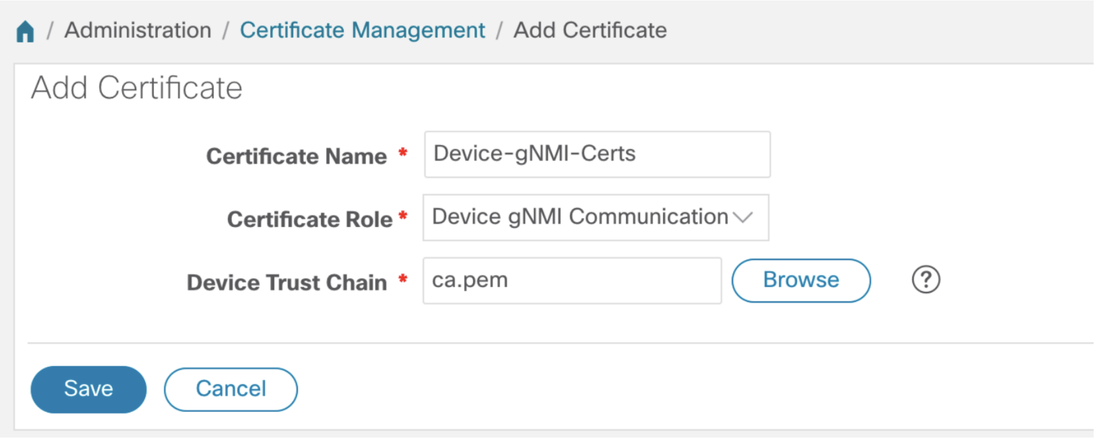
To configure the gNMI Certificate:

Step 1 From the Cisco Crosswork UI, go to **Administration** > **Certificate Management**.

Step 2 Click the + icon to add certificate.

Step 3 In **Add Certificate** window, enter the following details:

- **Device Certificate Name** - Enter a name for the certificate.
- **Certificate Role** - Select **Device gNMI Communication** from the drop-down list.
- **Device Trust Chain** - Browse your local file system to the location of the rootCA file and upload it.



Certificate Name * Device-gNMI-Certs

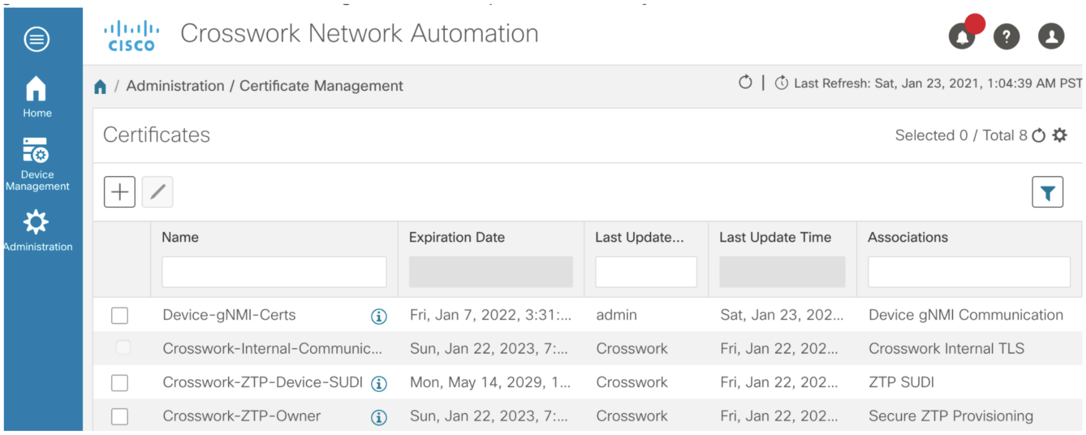
Certificate Role * Device gNMI Communication

Device Trust Chain * ca.pem

Note If gNMI certificate is already configured and you wish to onboard a device with a different trust chain, update the existing .pem file to include details of the new CA. Select the existing gNMI certificate from the list, click the Edit icon and upload the new .pem file.

Step 4 Click **Save**.

The gNMI Certificate is listed in the configured certificates once it has been added successfully.



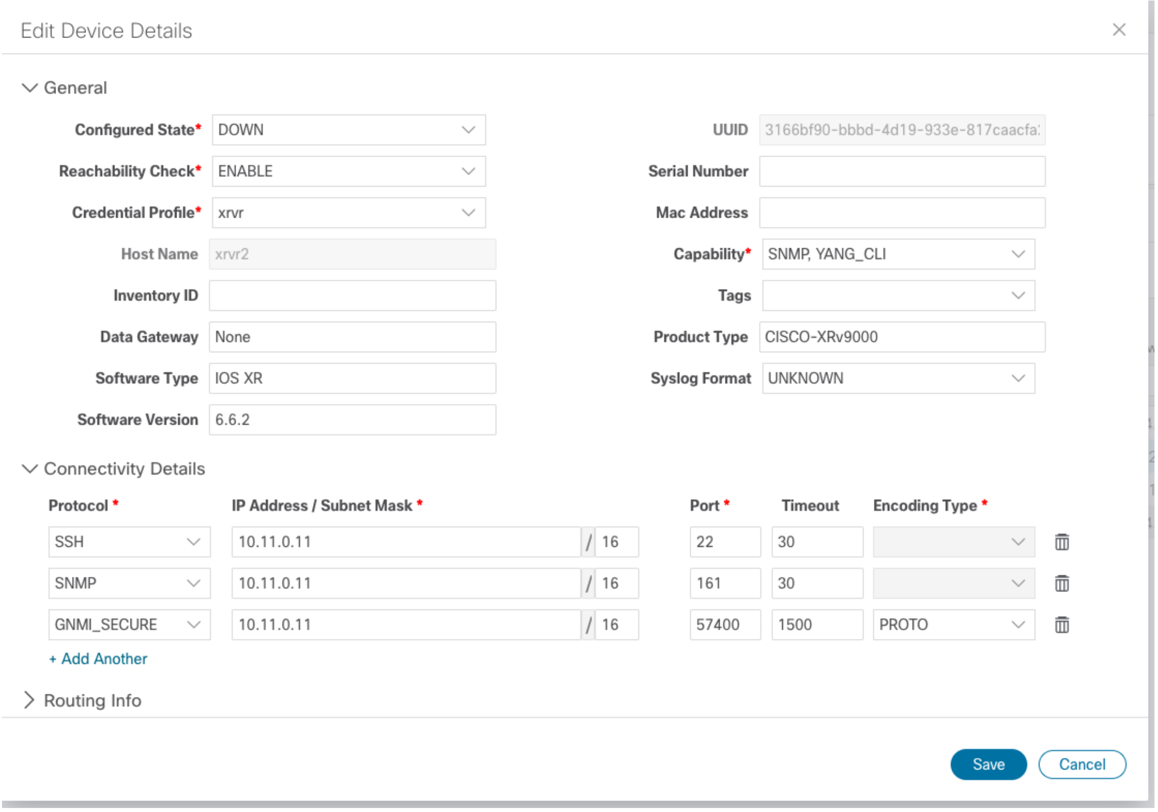
Crosswork Network Automation
Home
Device Management
Administration
/ Administration / Certificate Management
Last Refresh: Sat, Jan 23, 2021, 1:04:39 AM PST
Certificates
Selected 0 / Total 8

	Name	Expiration Date	Last Update...	Last Update Time	Associations
□	Device-gNMI-Certs ⓘ	Fri, Jan 7, 2022, 3:31:...	admin	Sat, Jan 23, 202...	Device gNMI Communication
	Crosswork-Internal-Communic...	Sun, Jan 22, 2023, 7:...	Crosswork	Fri, Jan 22, 202...	Crosswork Internal TLS
□	Crosswork-ZTP-Device-SUDI ⓘ	Mon, May 14, 2029, 1...	Crosswork	Fri, Jan 22, 202...	ZTP SUDI
□	Crosswork-ZTP-Owner ⓘ	Sun, Jan 22, 2023, 7:...	Crosswork	Fri, Jan 22, 202...	Secure ZTP Provisioning

Update Protocol on Device from Cisco Crosswork

After you have configured the gNMI certificate in the Cisco Crosswork, update the device with secure protocol details either from the Cisco Crosswork UI(**Device Management** > **Network Devices**) or by specifying the protocol details as **GNMI_SECURE Port** in the .csv file.

The following image shows the updated secure Protocol details for a device.



Edit Device Details

General

Configured State*	DOWN	UUID	3166bf90-bbbd-4d19-933e-817caacfa
Reachability Check*	ENABLE	Serial Number	
Credential Profile*	xrvr	Mac Address	
Host Name	xrvr2	Capability*	SNMP, YANG_CLI
Inventory ID		Tags	
Data Gateway	None	Product Type	CISCO-XRv9000
Software Type	IOS XR	Syslog Format	UNKNOWN
Software Version	6.6.2		

Connectivity Details

Protocol *	IP Address / Subnet Mask *		Port *	Timeout	Encoding Type *
SSH	10.11.0.11	16	22	30	
SNMP	10.11.0.11	16	161	30	
GNMI_SECURE	10.11.0.11	16	57400	1500	PROTO

Sample Device Configuration - gNMI

Cisco IOS XR devices

1. Enable gRPC over an HTTP/2 connection.

```
Router#configure
Router(config)#grpc
Router(config-grpc)#port <port-number>
```

The port number ranges from 57344 to 57999. If a port number is unavailable, an error is displayed.

2. Set the session parameters.

```
Router(config)#grpc{ address-family | dscp | max-request-per-user | max-request-total |
 max-streams |
max-streams-per-user | no-tls | service-layer | tls-cipher | tls-mutual | tls-trustpoint
 | vrf }
```

where:

- `address-family`: set the address family identifier type
- `dscp`: set QoS marking DSCP on transmitted gRPC
- `max-request-per-user`: set the maximum concurrent requests per user
- `max-request-total`: set the maximum concurrent requests in total
- `max-streams`: set the maximum number of concurrent gRPC requests. The maximum subscription limit is 128 requests. The default is 32 requests

- max-streams-per-user: set the maximum concurrent gRPC requests for each user. The maximum subscription limit is 128 requests. The default is 32 requests
- no-tls: disable transport layer security (TLS). The TLS is enabled by default.
- service-layer: enable the grpc service layer configuration
- tls-cipher: enable the gRPC TLS cipher suites
- tls-mutual: set the mutual authentication
- tls-trustpoint: configure trustpoint
- server-vrf: enable server vrf

3. Enable TPA (Traffic Protection for Third-Party Applications).

```
tpa
vrf default
  address-family ipv4
   default-route mgmt
   update-source dataports MgmtEth0/RP0/CPU0/0
```

Cisco IOS XE Devices

The following example shows how to enable the gNMI server in insecure mode:

```
Device# configure terminal
Device(config)# gnmi-yang
Device(config)# gnmi-yang server
Device(config)# gnmi-yang port 50000 <The default port is 50052.>
Device(config)# end
Device
```

The following example shows how to enable the gNMI server in secure mode:

Certs and trustpoint are only required for secure gNMI servers.

```
Device# configure terminal
Device(config)# gnmi-yang server
Device(config)# gnmi-yang secure-server
Device(config)# gnmi-yang secure-trustpoint trustpoint1
Device(config)# gnmi-yang secure-client-auth
Device(config)# gnmi-yang secure-port 50001 <The default port is 50051.>
Device(config)# end
Device
```

Device certificates

Certs and trustpoint are only required for secure gNMI servers.

Creating Certs with OpenSSL on Linux

The following example shows how to create Certs with OpenSSL on a Linux machine:

```
# Setting up a CA
openssl genrsa -out rootCA.key 2048
openssl req -subj /C=/ST=/L=/O=/CN=rootCA -x509 -new -nodes -key rootCA.key -sha256 -out
rootCA.pem

# Setting up device cert and key
openssl genrsa -out device.key 2048
openssl req -subj /C=/ST=/L=/O=/CN=<hostnameFQDN> -new -key device.key -out device.csr
openssl x509 -req -in device.csr -CA rootCA.pem -CAkey rootCA.key -CAcreateserial -out
```

```
device.crt -sha256
# Encrpyt device key - needed for input to IOS
openssl rsa -des3 -in device.key -out device.des3.key -passout pass:<password - remember
this for later>

# Setting up client cert and key
openssl genrsa -out client.key 2048
openssl req -subj /C=/ST=/L=/O=/CN=gnmi_client -new -key client.key -out client.csr
openssl x509 -req -in client.csr -CA rootCA.pem -CAkey rootCA.key -CAcreateserial -out
client.crt -sha256
```

Installing Certs on a Cisco IOS XR Device

To install certs on Cisco IOS XR, replace files in the following path:

1. Login into XR machine.
2. Type run command on terminal prompt.

   ```
   RP/0/RP0/CPU0:xrvr-7.2.1#run
   ```
3. Navigate to the following directory:

   ```
   cd /misc/config/grpc
   ```
4. Replace the content of the following files:
   - replace contents of ems.pem with device.crt
   - replace contents of ems.key with device.key
   - replace contents of ca.cert with rootCA.pem

Installing Certs on a Cisco IOS XE Device

The following example shows how to install certs on a Cisco IOS XE device:

```
# Send:
Device# configure terminal
Device(config)# crypto pki import trustpoint1 pem terminal password password1

# Receive:
% Enter PEM-formatted CA certificate.
% End with a blank line or "quit" on a line by itself.

# Send:
# Contents of rootCA.pem, followed by newline + 'quit' + newline:
-----BEGIN CERTIFICATE-----
<snip>
-----END CERTIFICATE-----
quit

# Receive:
% Enter PEM-formatted encrypted private General Purpose key.
% End with "quit" on a line by itself.

# Send:
# Contents of device.des3.key, followed by newline + 'quit' + newline:
-----BEGIN RSA PRIVATE KEY-----
Proc-Type: 4,ENCRYPTED
DEK-Info: DES-EDE3-CBC,D954FF9E43F1BA20
<snip>
-----END RSA PRIVATE KEY-----
quit
```

```
# Receive:
% Enter PEM-formatted General Purpose certificate.
% End with a blank line or "quit" on a line by itself.

# Send:
# Contents of device.crt, followed by newline + 'quit' + newline:
-----BEGIN CERTIFICATE-----
<snip>
-----END CERTIFICATE-----
quit

# Receive:
% PEM files import succeeded.
Device(config)#

# Send:
Device(config)# crypto pki trustpoint trustpoint1
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# end
Device#
```

Import Certificates on Device

Install Certificates on a Cisco IOS XR Device

To install certificates on a Cisco IOS XR device,

1. Copy rootCA.pem, device.key and device.crt to the device under /tmp folder.
2. Login into the IOS XR device.
3. Use the run command to enter the VM shell.

   ```
   RP/0/RP0/CPU0:xrvr-7.2.1#run
   ```
4. Navigate to the following directory:

   ```
   cd /misc/config/grpc
   ```
5. Create or replace the content of the following files:

   Note If TLS was previously enabled on your device, the following files will already be present in which case replace the content of these files as explained below. If this is the first time, you are enabling TLS on the device, copy the files from the /tmp folder to this folder.

   - ems.pem with device.crt
   - ems.key with device.key
   - ca.cert with rootCA.pem
6. Restart TLS on the device for changes to take effect. This can be done disabling TLS with "no-tls" command and re-enabling it with "no no-tls" config command on the device.

Installing Certs on a Cisco IOS XE Device

The following example shows how to install certs on a Cisco IOS XE device:

```
# Send:
Device# configure terminal
Device(config)# crypto pki import trustpoint1 pem terminal password password1
```

```
# Receive:
% Enter PEM-formatted CA certificate.
% End with a blank line or "quit" on a line by itself.

# Send:
# Contents of rootCA.pem, followed by newline + 'quit' + newline:
-----BEGIN CERTIFICATE-----
<snip>
-----END CERTIFICATE-----
quit

# Receive:
% Enter PEM-formatted encrypted private General Purpose key.
% End with "quit" on a line by itself.

# Send:
# Contents of device.des3.key, followed by newline + 'quit' + newline:
-----BEGIN RSA PRIVATE KEY-----
Proc-Type: 4,ENCRYPTED
DEK-Info: DES-EDE3-CBC,D954FF9E43F1BA20
<snip>
-----END RSA PRIVATE KEY-----
quit

# Receive:
% Enter PEM-formatted General Purpose certificate.
% End with a blank line or "quit" on a line by itself.

# Send:
# Contents of device.crt, followed by newline + 'quit' + newline:
-----BEGIN CERTIFICATE-----
<snip>
-----END CERTIFICATE-----
quit

# Receive:
% PEM files import succeeded.
Device(config)#

# Send:
Device(config)# crypto pki trustpoint trustpoint1
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# end
Device#
```

NETCONF Collection Job

Crosswork Data Gateway supports Network Configuration Protocol (NETCONF) based data collection from network devices.

For NETCONF collection, Crosswork Data Gateway leverages the following device packages that are loaded for the CLI Collection job.

- System device packages – system device packages that are downloaded once the Crosswork Data Gateway boots up.
- Custom device packages – custom device packages uploaded from UI or API.

NETCONF collector supports two types of data collection:

- Pull-based collection

Supports cadence-based collection and on-demand collection.

Note NETCONF command-based collection is not supported.

- Event-based collection

  Supports NETCONF event notifications as mentioned in https://tools.ietf.org/html/rfc5277 document. On-demand collection is not supported for this type of collection and the cadence specified for these collection jobs is ignored.

NETCONF Collection Job Workflow

1. NETCONF collection job is submitted to the collection service (Helios/Magellan) specifying the cadence or number of collections requested or with the event notification RPC.
2. The collection service (Helios/Magellan) sends collection job to Crosswork Data Gateway's NETCONF collector.
3. Depending on type of collection, that is event-based or pull-based collection, NETCONF collector initiates collection from the device.
4. The collected data is forwarded to specified data destinations (gRPC/Kafka).

Sample payload:

```
{
  "createUpdateJob": {
    "jobId": {
      "deviceId": "6fa90381-95f3-4a95-ac32-37754e002225",
      "sensorPath": {
        "netconfSensor": {
          "devicePackage": {
            "devicePackageName": "optical_inventory_svo_mne",
            "functionName": "getRawNodeInfo"
          }
        }
      },
      "collectionType": "PERSISTENT_COLLECTION_TYPE"
    },
    "collectionType": "PERSISTENT_COLLECTION_TYPE",
    "deviceId": "6fa90381-95f3-4a95-ac32-37754e002225",
    "sensorConfig": {
      "sensorPath": {
        "netconfSensor": {
          "devicePackage": {
            "devicePackageName": "optical_inventory_svo_mne",
            "functionName": "getRawNodeInfo"
          }
        }
      },
      "cadenceInMillisec": "60000"
    },
    "destinationSensorConfigs": [
      {
        "jobDestinationId": {
          "destinationId": "6dbc2a4c-e827-438f-9bab-bbeb508c06e2",
          "destinationContextId": "NativeNetconfTopic"
        },
        "destinationId": "6dbc2a4c-e827-438f-9bab-bbeb508c06e2",
        "destinationContextId": "NativeNetconfTopic",
        "sensorConfigHandler": {
          "action": "NORMAL"
        },
        "applicationContext": [
          {
            "applicationId": "EPNM-APP",
            "contextId": "Native-Netconf"
          }
        ]
      }
    ]
  }
}
```

Troubleshoot NETCONF Collector issues

NETCONF Collector restarts continuously

Check the docker logs for the NETCONF collector by running the following command:

```
docker logs netconf-collector
```

If you see the message as **invalid or corrupt jar**, then this means that the docker image downloaded for the container was corrupted.

Follow these steps as a workaround to mitigate the issue:

1. Log in to the Crosswork Data Gateway VM.
2. Select **5 Troubleshooting** from the Interactive Console.
3. Select **3 Remove all Collectors and Reboot VM**.

   This removes the containers that were downloaded after installation (collectors and offload), removes the images from docker, removes collector data, configuration, reboots the VM and returns the VM to a state just after initial configuration is complete with only infrastructure containers running. After Crosswork Data Gateway reboots, the containers are downloaded again from Cisco Infrastructure.

Create a Collection Job from Cisco Crosswork UI

Follow the steps to create a collection job:

Note Collection jobs created through the Cisco Crosswork UI page can only be published once.

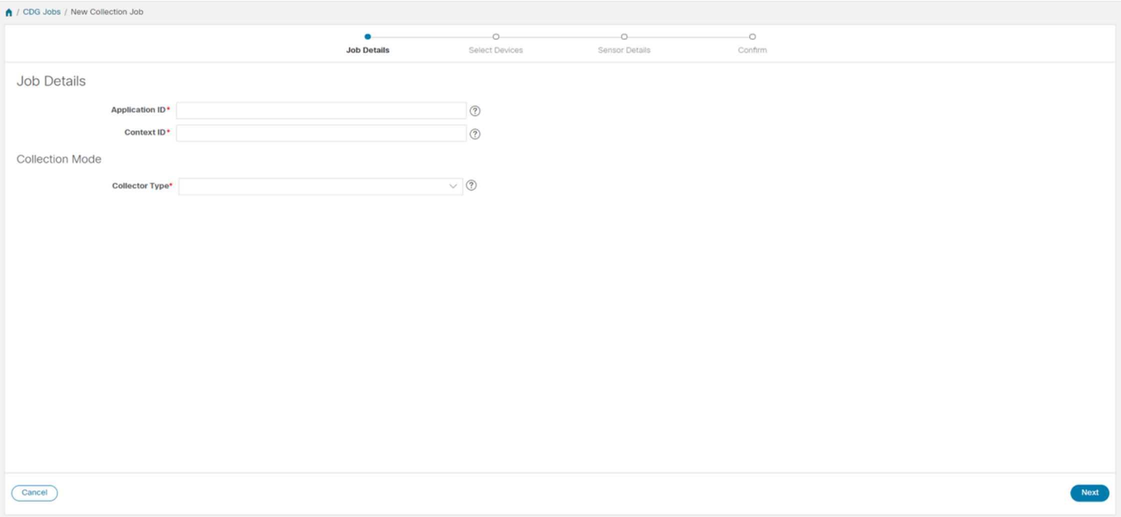
Before you begin

Ensure that a data destination is created (and active) to deposit the collected data. Also, have details of the sensor path and MIB that you plan to collect data from.

Step 1 From the main menu, go to **Administration** > **Collection Jobs** > **Bulk Jobs**

Step 2 In the left pane, click ⊞ button.

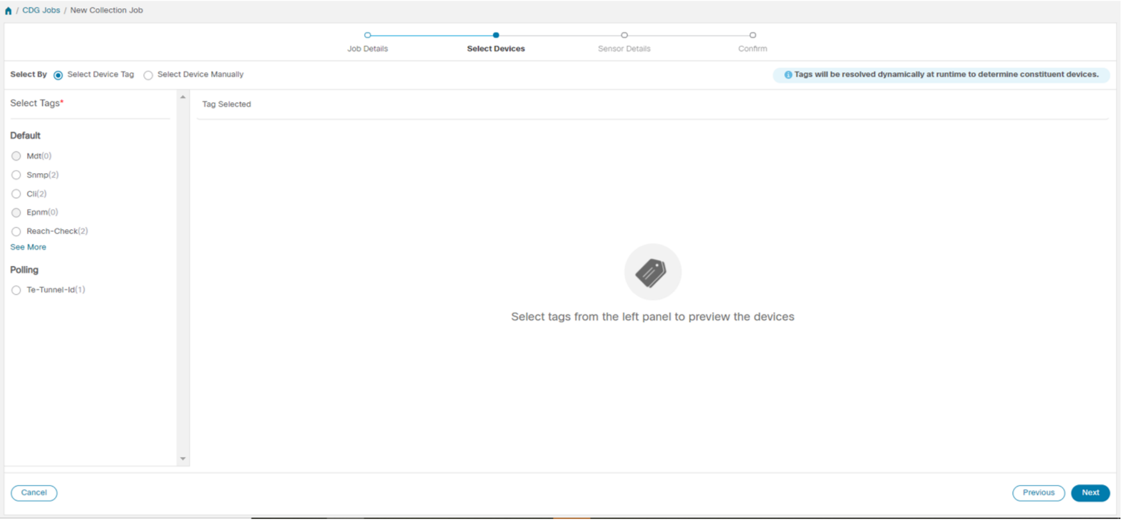
Step 3 In the **Job details** page, enter values for the following fields:



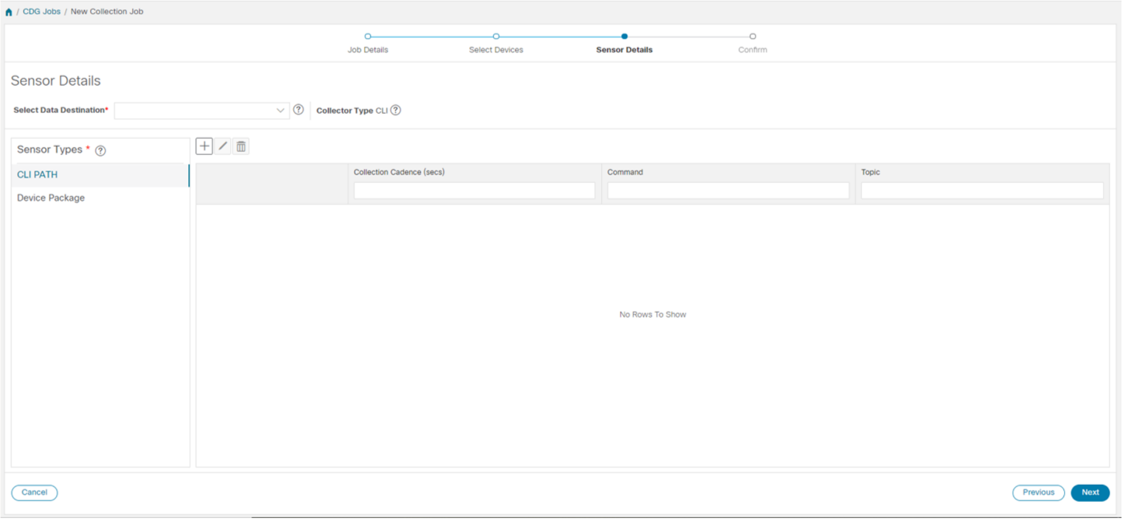
- Application ID: A unique identifier for the application.
- Context: A unique identifier to identify your application subscription across all collection jobs.
- Collector Type: Select the type of collection - CLI or SNMP.

Click **Next**.

Step 4 Select the devices from which the data is to be collected. You can either select based on device tag or manually. Click **Next**.

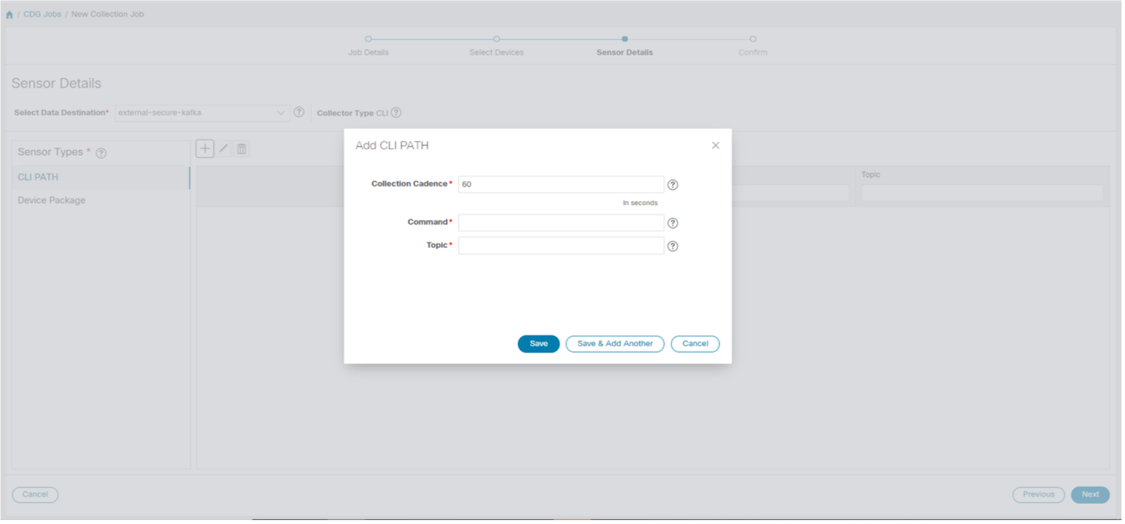


Step 5 (Applicable only for CLI collection) Enter the following sensor details:



- Select data destination from **Select Data Destination** drop-down.
- Select sensor type from **Sensor Types** pane on the left.

If you selected **CLI PATH**, Click ⊞ button and enter the following paramters in the **Add CLI Path** dialog box:



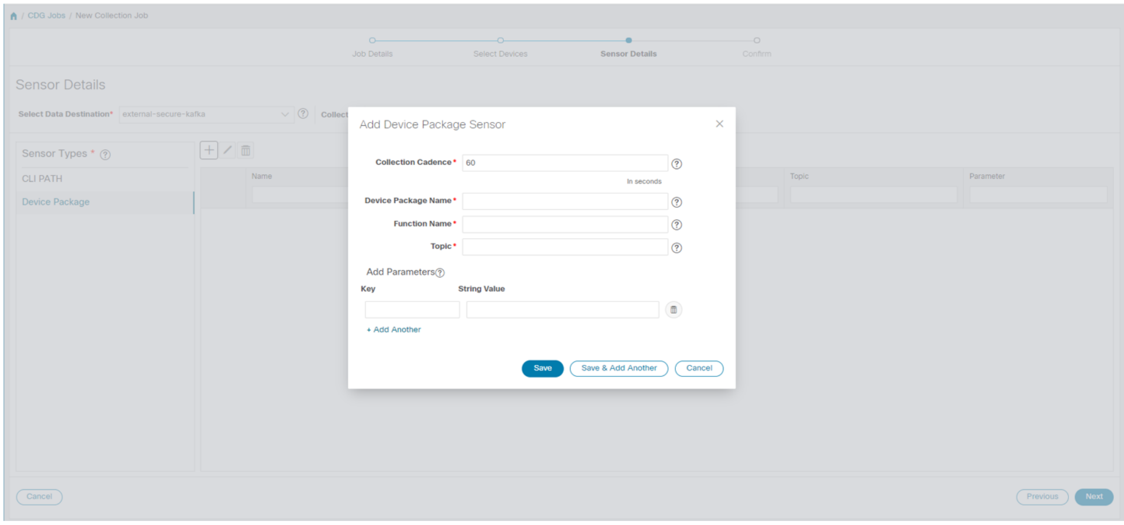
Select Data Destination*: external-secure-kafka

Collection Cadence *: 60 In seconds

- Collection Cadence: Push or poll cadence in seconds.
- Command: CLI command
- Topic: Topic associated with the output destination.

  Note Topic can be any string if using an external gRPC server.

If you selected **Device Package**, click ⊞ button and enter values for the following parameters in the **Add Device Package Sensor** dialog box:



Select Data Destination* external-secure-kafka

Add Device Package Sensor

Collection Cadence* 60 (In seconds)

Device Package Name*

Function Name*

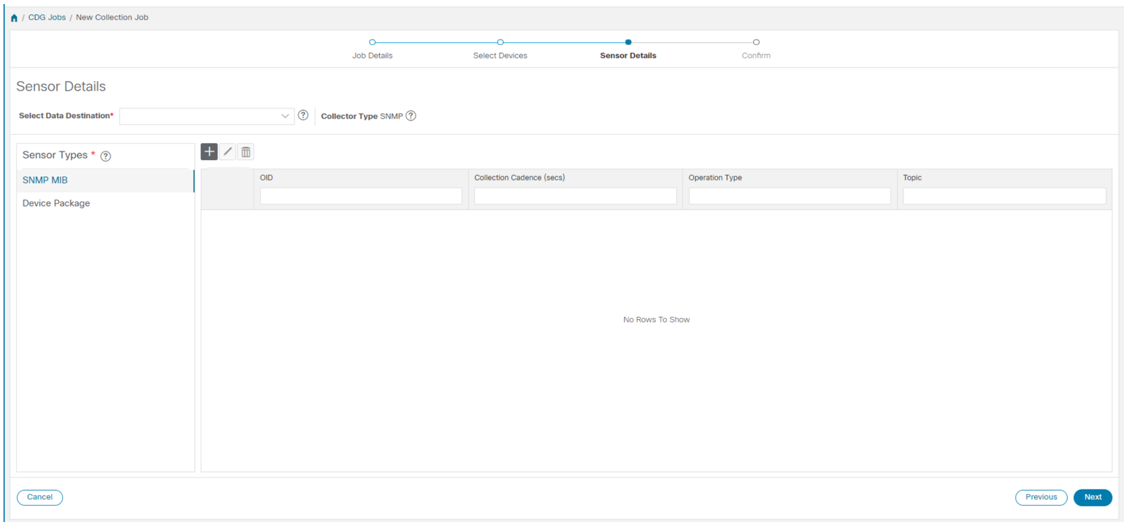
Topic*

- Collection cadence: Push or poll cadence in seconds.
- Device Package Name: Custom XDE device package ID used while creating device package.
- Function name: Function name within custom XDE device package.
- Topic: Topic associated with the output destination.

Enter Key and String value for the paramters.

Click **Save**.

Step 6 (Applicable only for SNMP collection) Enter the following sensor details:



Select Data Destination*

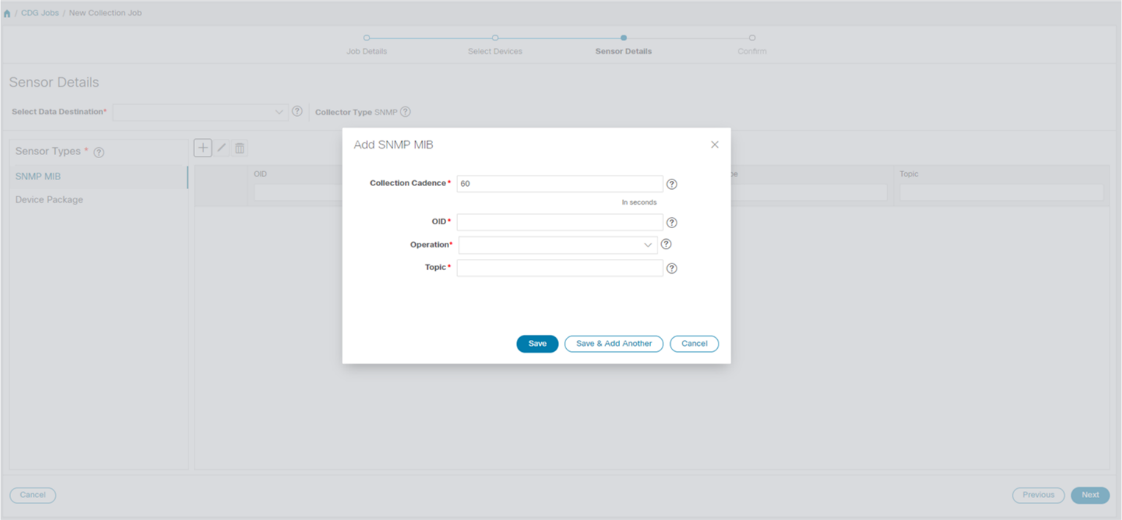
Collector Type SNMP

	OID	Collection Cadence (secs)	Operation Type	Topic

No Rows To Show

- Select data destination from **Select Data Destination** drop-down.
- Select sensor type from **Sensor Types** pane on the left.

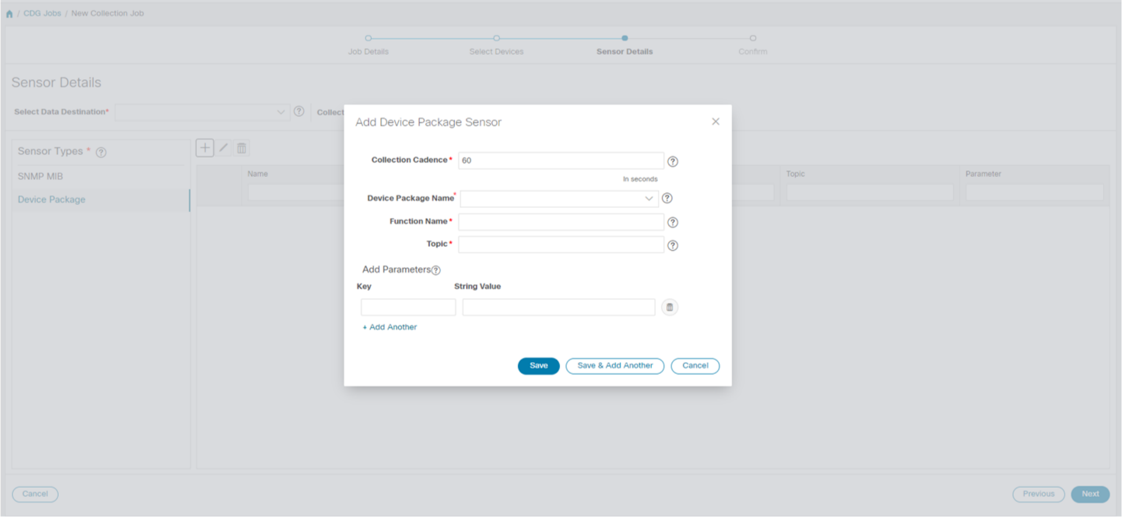
If you selected **SNMP MIB**, Click ⊞ button and enter the following parameters in the **Add SNMP MIB** dialog box:



Collection Cadence* 60 In seconds

- Collection Cadence: Push or poll cadence in seconds.
- OID
- Operation: Select the operation from the list.
- Topic: Topic associated with the output destination.

If you selected **Device Package**, click ⊞ button and enter values for the following parameters in the **Add Device Package Sensor** dialog box:



Collection Cadence* 60 In seconds

- Collection Cadence: Push or poll cadence in seconds.
- Device Package Name: Custom device package ID used while creating device package.
- Function name: Function name within custom device package.
- Topic: Topic associated with the output destination.

Enter Key and String value for the paramters.

Click **Save**.

Step 7 Click **Create Collection Job**.

Note When a collection job is submitted for an external Kafka destination i.e., unsecure Kafka, the dispatch job to Kafka fails to connect. The error seen in collector logs is `org.apache.kafka.common.errors.TimeoutException: Topic cli-job-kafka-unsecure not present in metadata after 60000 ms`. In Kafka logs, the error seen is `SSL authentication error "[2021-01-08 22:17:03,049] INFO [SocketServer brokerId=0] Failed authentication with /80.80.80.108 (SSL handshake failed) (org.apache.kafka.common.network.Selector)`.

This happens because port is blocked on external Kafka VM. You can use the following command to check if port is listening on Kafka docker/server port:

```
netstat -tulpn
```

Fix the problem on the Kafka server and restart the Kafka server process.

Monitor Collection Jobs

You can monitor the status of the collection jobs currently active on all the Crosswork Data Gateway instances enrolled with Cisco Crosswork from the **Collection Jobs** page.

In the Cisco Crosswork UI, from the left navigation bar, choose **Administration** > **Collection Jobs**.

This left pane lists all active collection jobs along with their Status, App ID, and Context ID. The **Job Details** pane shows the details of all collection tasks associated with a particular job in the left pane. The overall status of the Collection job in the **Collection Jobs** pane is the aggregate status of all the collection tasks in the **Jobs Details** pane.

When you select a job in the **Collection Jobs** pane, the following details are displayed in the **Job Details** pane:

- Application name and context associated with the collection job.
- Status of the collection job.

Note

- The status of a collection task associated with a device after it is attached to a Crosswork Data Gateway, is **Unknown**.
- A job could have status as **Unknown** for one of the following reasons:
    - Crosswork Data Gateway has not yet reported its status.
    - Loss of connection between Crosswork Data Gateway and Cisco Crosswork.
    - Crosswork Data Gateway has received the collection job, but actual collection is still pending. For example, traps are not being sent to Crosswork Data Gateway southbound interface, or device is not sending telemetry updates.
    - The trap condition in a SNMP trap collection job which we are monitoring has not occurred. For example, if you are looking for Link Up or Link down transitions and the link state has not changed since the collector was established, then the state will report as **Unknown**. To validate that trap-based collections are working it is therefore necessary to actually trigger the trap.
- After the collection job is processed, the status changes to 'Successful' if the processing was successful or else it changes to 'Failed'.
- If a collection job is in degraded state, one of the reasons might be that the static routes to the device have been erased from Crosswork Data Gateway.
- Collections to a destination that is in an Error state do not stop. The destination state is identified in background. If the destination is in an Error state, the error count is incremented. Drill down on the error message that is displayed in the **Distribution** status to identify and resolve the issue by looking at respective collector logs.
- Cisco Crosswork Health Insights - KPI jobs must be enabled only on devices mapped to an extended Crosswork Data Gateway VM. Enabling KPI jobs on devices that are mapped to a standard Crosswork Data Gateway VM reports the collection job status as **Degraded** and the collection task status as **Failed** in the **Jobs Details** pane.

- Job configuration of the collection job that you pass in the REST API request. Click ⓘ icon next to **Config Details** to view the job configuration. Cisco Crosswork lets you view configuration in two modes:
    - View Mode
    - Text Mode
- Collection type
- Time and date of last modification of the collection job.

- Collections (x): x refers to requested input collections that span device by sensor paths. The corresponding **(y) Issues** is the count of input collections that are in UNKNOWN or FAILED state.
- Distributions (x): x refers to requested output collections that span device by sensor paths. The corresponding **(y) Issues** is the count of output collections that are in UNKNOWN or FAILED state.

Cisco Crosswork also displays the following details for collections and distributions:

Field	Description
Collection/Distribution Status	Status of the collection/distribution. It is reported on a on change basis from Crosswork Data Gateway. Click ⓘ next to the collection/distribution status for details.
Hostname	Device hostname with which the collection job is associated.
Device Id	Unique identifier of the device from which data is being collected.
Sensor Data	Sensor path Click ⓘ to see collection/distribution summary. From the sensor data summary pop up you can copy the sensor data by clicking **Copy to Clipboard**. Click 📊 to see collection/distribution metrics summary. The metrics are reported on cadence-basis i.e., once every 10 minutes by default. It shows the following metrics for a collection: • last_collection_time_msec • total_collection_message_count • last_device_latency_msec • last_collection_cadence_msec It shows the following metrics for a collection: • total_output_message_count • last_destination_latency_msec • last_output_cadence_msec • last_output_time_msec • total_output_bytes_count
Destination	Data destination for the job.

Field	Description
Last Status Change Reported Time	Time and date on which last status change was reported for that device sensor pair from Crosswork Data Gateway

Note

- `Create Failed` error means out of N devices, some devices failed to setup. However, the collection would happen on the devices that were successfully setup. You can identify the device(s) causing this error by using `Control Status` API.
- If job creation failed on a particular device because of NSO errors, after fixing NSO errors , you have to manually change the administration state of the device first to "Down" and then "Up". However, doing so resets the collection on the device.

Note

Create/Delete failed errors are shown in a different screen pop up. Click ⓘ next to the job status to see details of the error.

- You may also try recreating the job using PUT collection job API with the same payload.

Collection Status for Event-based collection jobs

1. When data collection is successful, status of the Collection job changes from **Unknown** to **Success** in the **Collection Jobs** pane.
2. When a device is detached from the Crosswork Data Gateway, all corresponding collection jobs are deleted and collection job status is displayed as **Success** in the **Collection Jobs** pane. There are no devices or collection tasks displayed in the **Job Details** pane.
3. When a device is attached to a Crosswork Data Gateway, Crosswork Data Gateway receives a new collection job with the status set to **Unknown** that changes to **Success** after receiving events from the device.
4. If the device configuration is updated incorrectly on a device that is already attached to a Crosswork Data Gateway and after the Crosswork Data Gateway has received the job and events, there is no change in status of the collection task in the **Jobs Details** pane.
5. If the device inventory is updated with incorrect device IP, the collection task status in the **Jobs Details** pane is **Unknown** as expected.

Delete a Collection Job

System jobs (default jobs created by various Crosswork Applications) should not be deleted as it will cause issues. Jobs created by Health Insights should only be deleted by disabling the KPI profile which will remove the collection jobs it deployed. Use this procedure to delete external collection jobs from the **Collection Jobs** page.

Follow the steps to delete a collection job:

Step 1 Go to **Administration** > **Collection Jobs.**

Step 2 Select either the **Bulk Jobs** tab or **Parmaterized Jobs** tab.

Step 3 In the **Collection Jobs** pane on the left hand side, select the collection job that you want to delete.

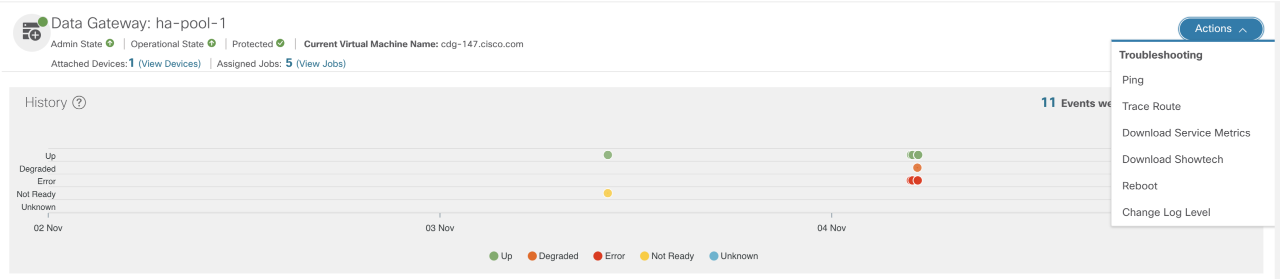
Step 4 Click 🗑.

Step 5 Click **Delete** when prompted for confirmation.

Troubleshoot Crosswork Data Gateway

You can troubleshoot the Crosswork Data Gateway from the UI or from the Interactive Console of the Crosswork Data Gateway VM.

This section explains the various troubleshooting options that are available from the Cisco Crosswork UI.



For details on troubleshooting options available from the Interactive Console of the Crosswork Data Gateway VM, see Troubleshooting Crosswork Data Gateway VM, on page 329.

Check Connectivity to the Destination

To check connectivity to a destination from the Cisco Data Gateway, use the **Ping** and **Traceroute** options from Troubleshooting Menu.

Note Ping traffic should be enabled on the network to ping the destination successfully.

1. Go to **Administration** > **Data Gateway Management** > **Data Gateways**.
2. Click the Cisco Crosswork Data Gateway name from which you want to check the connectivity.
3. In the Crosswork Data Gateway details page, on the top right corner, click **Actions** and choose: **Ping** or **Traceroute**.
    - **Ping** - Enter details in the **Number of Packets**, and **Destination Address** fields and click **Ping**.
    - **Traceroute** - Enter the **Destination Address**, and click **Traceroute**.

4. If the destination is reachable, Cisco Crosswork displays details of the **Ping** or **Traceroute** test in the same window.

Download Service Metrics

Use this procedure to download the metrics for all collection jobs for a Crosswork Data Gateway from the Cisco Crosswork UI.

Step 1 Go to **Administration** > **Data Gateway Management** > **Data Gateways**.

Step 2 Click the Crosswork Data Gateway name for which you want to download the service metrics.

Step 3 In the Crosswork Data Gateway details page, on the top right corner, click **Actions** > **Download Service Metrics**.

Step 4 Enter a passphrase.

Note Ensure that you make a note of this passphrase. This passphrase will be used later to decrypt the file.

Step 5 Click **Download Service Metrics**. The file is downloaded to the default download folder on your system in an encrypted format.

Step 6 After the download is complete, run the following command to decrypt it:

Note In order to decrpyt the file, you must use openssl version 1.1.1i. Use the command `openssl version` to check the openssl version on your system.

```
openssl enc -d -aes-256-ctr -pbkdf2 -md sha3-512 -iter 100000 -in <service metrics file> -out <decrypted
filename> -pass pass:<encrypt string>
```

Download showtech Logs

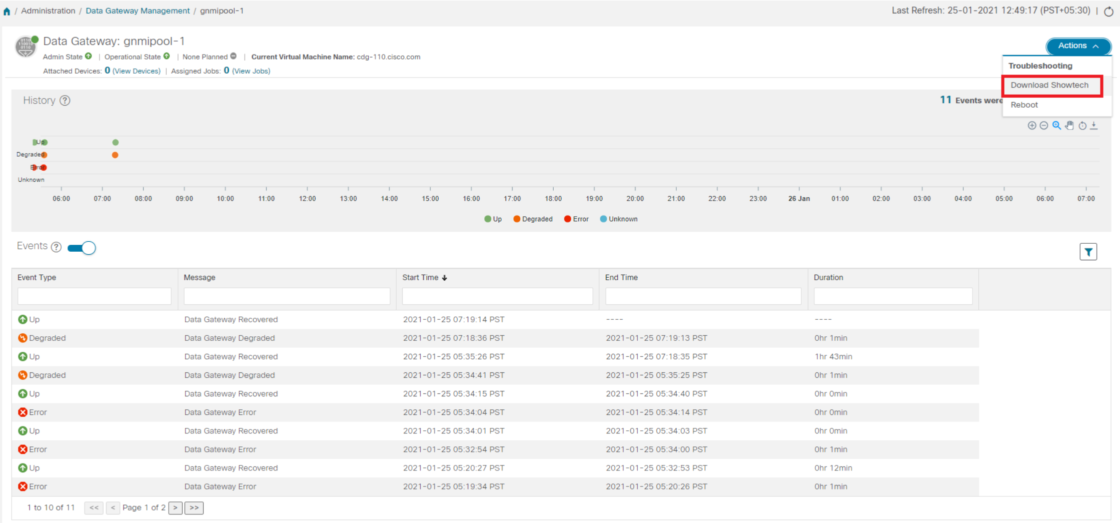
Follow the steps to download showtech logs from Cisco Crosswork UI:

Note Showtech logs cannot be collected from the UI if the Crosswork Data Gateway is in an ERROR state. In the DEGRADED state of the Cisco Crosswork Data Gateway, if the OAM-Manager service is running and not degraded, you will be able to collect logs.

Step 1 Go to **Administration** > **Data Gateway Management** > **Data Gateways**.

Step 2 Click the Crosswork Data Gateway name for which you want to download showtech.

Step 3 In the Crosswork Data Gateway details page, on the top right corner, click **Actions** and click **Download Showtech**.


/ Administration / Data Gateway Management / gnmipool-1
Last Refresh: 25-01-2021 12:49:17 (PST+05:30)
Actions
Troubleshooting
Download Showtech
Reboot
History
11 Events were
Up
Degraded
Error
Unknown
06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 26 Jan 01:00 02:00 03:00 04:00 05:00 06:00 07:00
Events

Data Gateway: gnmipool-1

Admin State | Operational State | None Planned | **Current Virtual Machine Name:** cdg-110.cisco.com

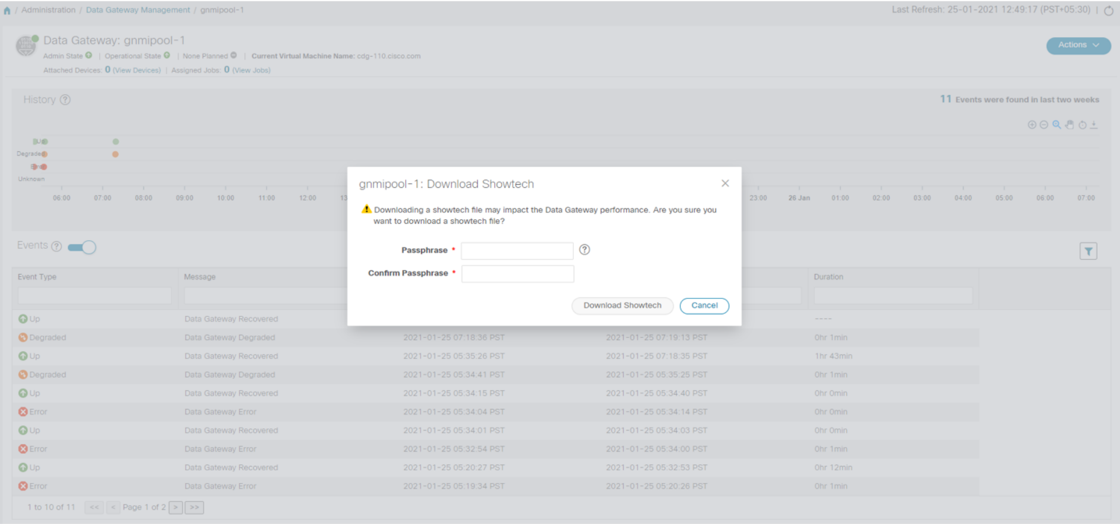
Attached Devices: 0 (View Devices) | Assigned Jobs: 0 (View Jobs)

Event Type	Message	Start Time ↓	End Time	Duration
Up	Data Gateway Recovered	2021-01-25 07:19:14 PST	----	----
Degraded	Data Gateway Degraded	2021-01-25 07:18:36 PST	2021-01-25 07:19:13 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:35:26 PST	2021-01-25 07:18:35 PST	1hr 43min
Degraded	Data Gateway Degraded	2021-01-25 05:34:41 PST	2021-01-25 05:35:25 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:34:15 PST	2021-01-25 05:34:40 PST	0hr 0min
Error	Data Gateway Error	2021-01-25 05:34:04 PST	2021-01-25 05:34:14 PST	0hr 0min
Up	Data Gateway Recovered	2021-01-25 05:34:01 PST	2021-01-25 05:34:03 PST	0hr 0min
Error	Data Gateway Error	2021-01-25 05:32:54 PST	2021-01-25 05:34:00 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:20:27 PST	2021-01-25 05:32:53 PST	0hr 12min
Error	Data Gateway Error	2021-01-25 05:19:34 PST	2021-01-25 05:20:26 PST	0hr 1min

1 to 10 of 11 << < Page 1 of 2 > >>

Step 4 Enter a passphrase.

Note Ensure that you make a note of this passphrase. You will need to enter this passphrase later to decrypt the showtech file.



gnmipool-1: Download Showtech

⚠ Downloading a showtech file may impact the Data Gateway performance. Are you sure you want to download a showtech file?

Passphrase *

Confirm Passphrase *

Step 5 Click **Download Showtech**. The showtech file downloads in an encrypted format.

Note Depending on how long the system was in use, it may take several minutes to download the showtech file.

Step 6 After the download is complete run the following command to decrypt it:

Note In order to decrpyt the file, you must use OpenSSL version 1.1.1i. Use the command `openssl version` to check the openssl version on your system.

To decrypt the file on a MAC, you must install OpenSSL 1.1.1+. This is because LibreSSL's `openssl` command does not support all the switches supported by OpenSSL's `openssl` command.

```
openssl enc -d -aes-256-ctr -pbkdf2 -md sha3-512 -iter 100000 -in <showtech file> -out <decrypted
filename> -pass pass:<encrypt string>
```

Reboot Cisco Crosswork Data Gateway VM

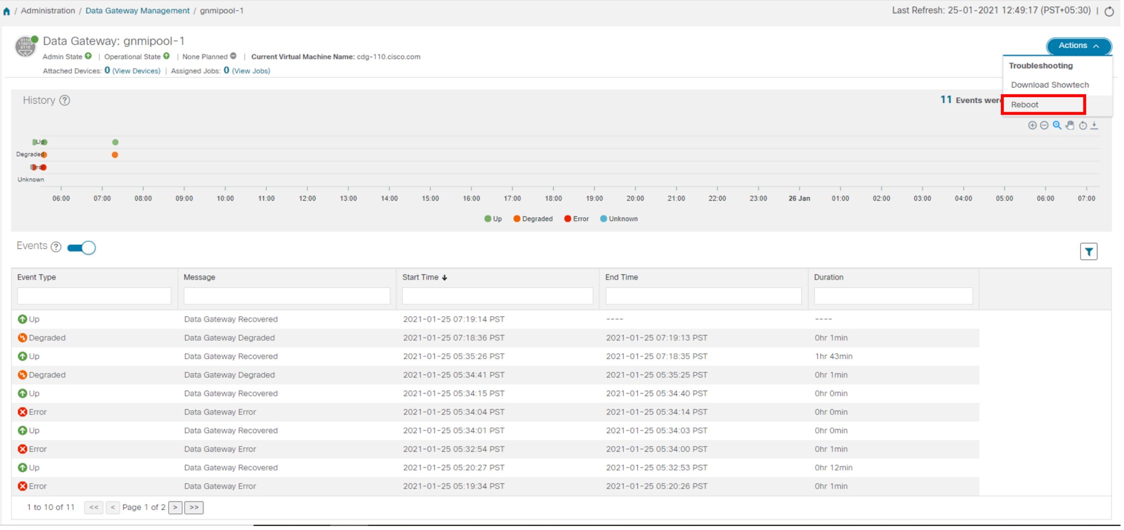
Follow the steps to reboot a Crosswork Data Gateway from Cisco Crosswork UI:

Note Rebooting the Crosswork Data Gateway pauses its functionality until it is up again.

Step 1 Go to **Administration** > **Data Gateway Management** > **Data Gateways**.

Step 2 Click the Cisco Crosswork Data Gateway name that you want to reboot.

Step 3 In the Crosswork Data Gateway details page, on the top right corner, click **Actions**, and click **Reboot**.



Administration / Data Gateway Management / gnmipool-1

Last Refresh: 25-01-2021 12:49:17 (PST+05:30)

Data Gateway: gnmipool-1

Admin State | Operational State | None Planned | **Current Virtual Machine Name:** cdg-110.cisco.com

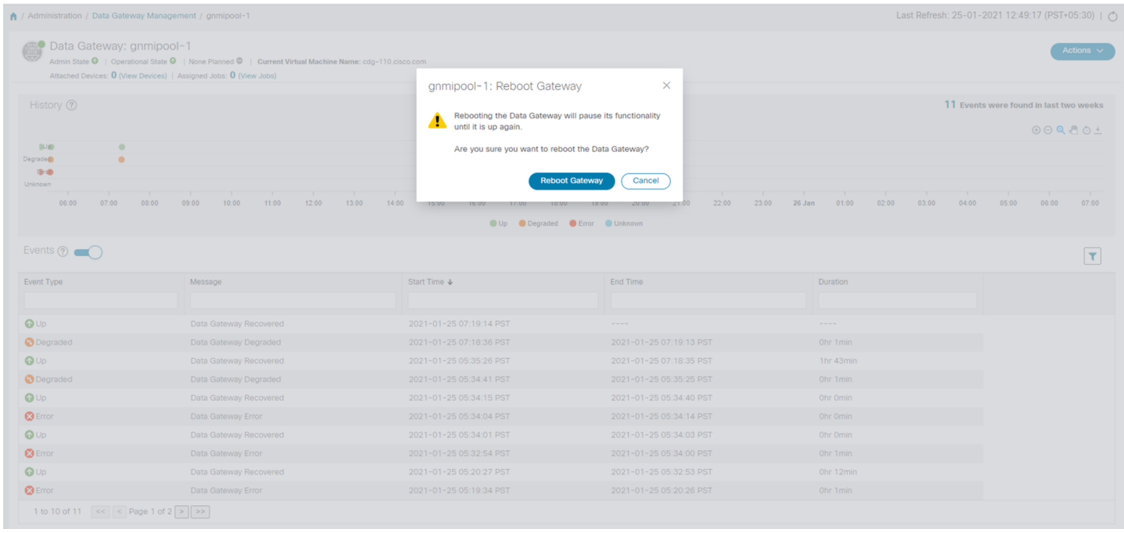
Attached Devices: 0 (View Devices) | Assigned Jobs: 0 (View Jobs)

11 Events were

Event Type	Message	Start Time	End Time	Duration
Up	Data Gateway Recovered	2021-01-25 07:19:14 PST	----	----
Degraded	Data Gateway Degraded	2021-01-25 07:18:36 PST	2021-01-25 07:19:13 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:35:26 PST	2021-01-25 07:18:35 PST	1hr 43min
Degraded	Data Gateway Degraded	2021-01-25 05:34:41 PST	2021-01-25 05:35:25 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:34:15 PST	2021-01-25 05:34:40 PST	0hr 0min
Error	Data Gateway Error	2021-01-25 05:34:04 PST	2021-01-25 05:34:14 PST	0hr 0min
Up	Data Gateway Recovered	2021-01-25 05:34:01 PST	2021-01-25 05:34:03 PST	0hr 0min
Error	Data Gateway Error	2021-01-25 05:32:54 PST	2021-01-25 05:34:00 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:20:27 PST	2021-01-25 05:32:53 PST	0hr 12min
Error	Data Gateway Error	2021-01-25 05:19:34 PST	2021-01-25 05:20:26 PST	0hr 1min

1 to 10 of 11 | Page 1 of 2

Step 4 Click **Reboot Gateway**.



Administration / Data Gateway Management / gnmipool-1
Last Refresh: 25-01-2021 12:49:17 (PST+05:30)
Data Gateway: gnmipool-1
Actions
Admin State | Operational State | None Planned | Current Virtual Machine Name: cdg-110.cisco.com
Attached Devices: 0 (View Devices) | Assigned Jobs: 0 (View Jobs)
History
11 Events were found in last two weeks
Up
Degraded
Error
Unknown
06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 26 Jan 01:00 02:00 03:00 04:00 05:00 06:00 07:00
Up Degraded Error Unknown
Events
Reboot Gateway
Cancel
1 to 10 of 11
Page 1 of 2

gnmipool-1: Reboot Gateway

Rebooting the Data Gateway will pause its functionality until it is up again.

Are you sure you want to reboot the Data Gateway?

Event Type	Message	Start Time	End Time	Duration
Up	Data Gateway Recovered	2021-01-25 07:19:14 PST	----	----
Degraded	Data Gateway Degraded	2021-01-25 07:18:36 PST	2021-01-25 07:19:13 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:35:26 PST	2021-01-25 07:18:35 PST	1hr 43min
Degraded	Data Gateway Degraded	2021-01-25 05:34:41 PST	2021-01-25 05:35:25 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:34:15 PST	2021-01-25 05:34:40 PST	0hr 0min
Error	Data Gateway Error	2021-01-25 05:34:04 PST	2021-01-25 05:34:14 PST	0hr 0min
Up	Data Gateway Recovered	2021-01-25 05:34:01 PST	2021-01-25 05:34:03 PST	0hr 0min
Error	Data Gateway Error	2021-01-25 05:32:54 PST	2021-01-25 05:34:00 PST	0hr 1min
Up	Data Gateway Recovered	2021-01-25 05:20:27 PST	2021-01-25 05:32:53 PST	0hr 12min
Error	Data Gateway Error	2021-01-25 05:19:34 PST	2021-01-25 05:20:26 PST	0hr 1min

Once the reboot is complete, check the operational status of the Cisco Crosswork Data Gateway in the **Administration** > **Data Gateway Management** > **Virtual Machines** window.

Change Log Level of Crosswork Data Gateway Components

Cisco Crosswork UI offers the option to change the log level of a Crosswork Data Gateway's components, for example collectors (cli-collector) and infra services (oam-manager). Log level changes apply only to the Crosswork Data Gateway on which you are making the change.

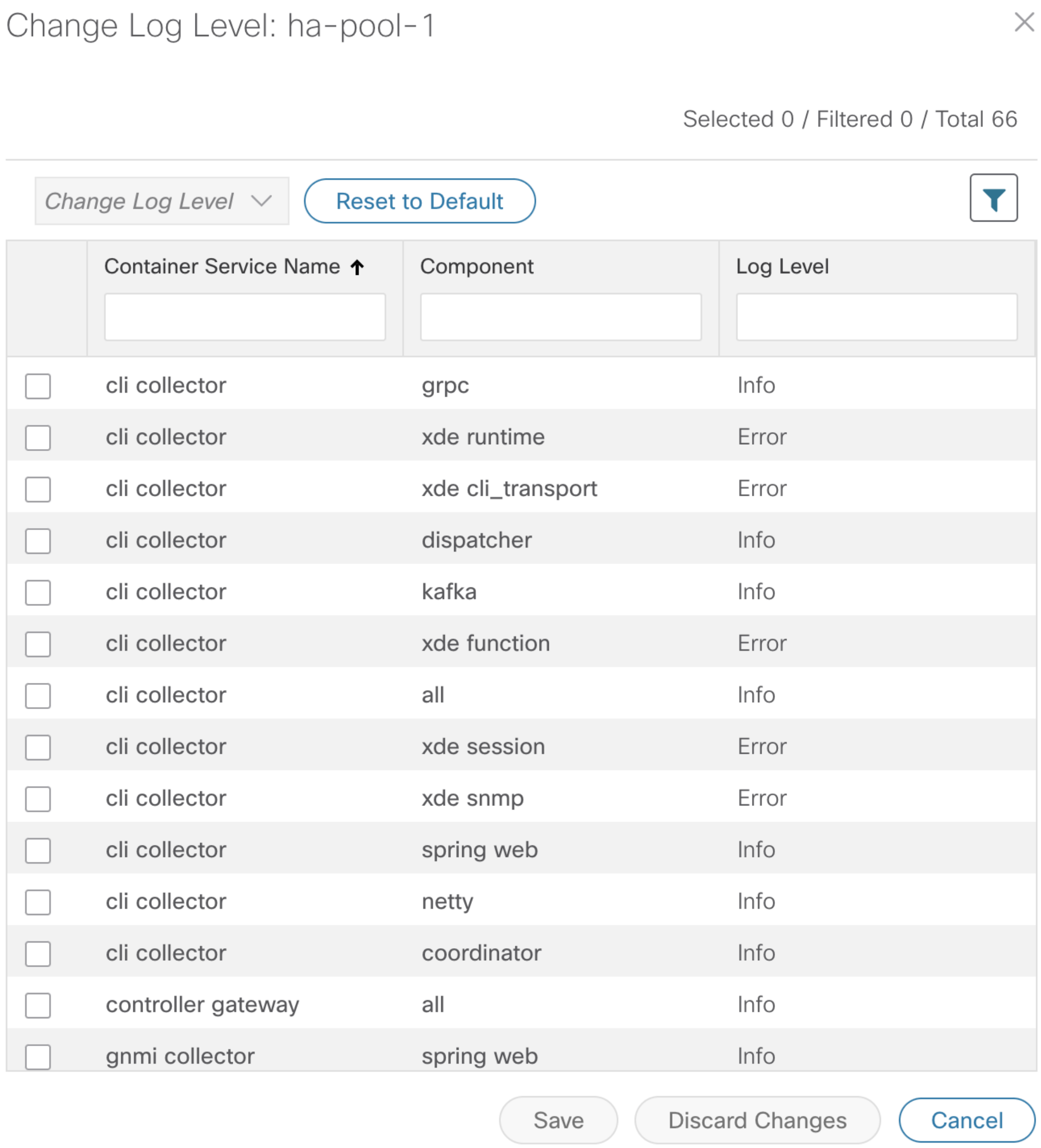
Note Changing the log level for offload services is not supported.

Step 1 Go to **Administration** > **Data Gateway Management** > **Data Gateways**.

Step 2 Click the Crosswork Data Gateway name on which you wish to change the log level for the collectors of Crosswork Infrastructure services.

Step 3 In the Crosswork Data Gateway details page, on the top right corner, click **Actions** > **Change Log Level**.

The **Change Log Level** window appears, indicating the current log level of each container service.



Change Log Level: ha-pool-1

Selected 0 / Filtered 0 / Total 66

	Container Service Name ↑	Component	Log Level
□	cli collector	grpc	Info
□	cli collector	xde runtime	Error
□	cli collector	xde cli_transport	Error
□	cli collector	dispatcher	Info
□	cli collector	kafka	Info
□	cli collector	xde function	Error
□	cli collector	all	Info
□	cli collector	xde session	Error
□	cli collector	xde snmp	Error
□	cli collector	spring web	Info
□	cli collector	netty	Info
□	cli collector	coordinator	Info
□	controller gateway	all	Info
□	gnmi collector	spring web	Info

Step 4 Select the check box of the container service for which you wish to change the log level.

Step 5 From the **Change Log Level** drop-down list at the top of the table, select a log level from **Debug**, **Trace**, **Warning**, **Info** and **Error**.

Note To reset the log level of all logs to the default log level (**Info**), click **Reset to Default**.

Step 6 Click **Save** to save the log level change.

After you click **Save**, a UI message appears indicating that the log level of the component was changed successfully.

CHAPTER 4

Manage Backups

This section contains the following topics:

Manage Cisco Crosswork Backup and Restore

Cisco Crosswork's backup and restore features help prevent data loss and preserve your installed applications and settings.

Crosswork offers multiple ways to perform a backup:

1. **Backup:** Preserves the Crosswork configuration
2. **Data Backup:** Preserves the data only. Application binaries are not backed up.
3. **Backup with NSO:** Preserves NSO data along with the Crosswork configuration.

The process for the first and second options (**Backup** and **Data Backup**) are mostly similar and is explained in this topic. The third option (Backup with NSO) is explained in detail in Backup Cisco Crosswork with Cisco NSO, on page 108.

Attention

- Bulding a target machine for the backup is out of scope for this document. The operator is expected to have the server in place, to know the credentials for the server, and to have a target directory with adequate space for the backups in place.
- Crosswork does not manage the backups. It is up to the operator to periodically delete old backups from the target server to make room for future backups.
- If you are making a **Data Backup**, note down the build version of the installed applications in your cluster. Before performing the **Data Restore**, the exact versions of those applications must be installed and available in your cluster. Any mismatch in the build versions of the applications can result in data loss and failure of the data restore job.

When you create backups for a Cisco Crosswork cluster, or restore a cluster from a backup, follow these guidelines:

- Crosswork backup process depends on having SCP access to a server with sufficient amount of storage space. The storage required each backup will vary based on the your cluster size, applications in the cluster, and the scale requirements.
- During your first login, configure a destination SCP server to store backup files. This configuration is a one-time activity. You can't take a backup or initiate a restore operation until you complete this task.
- We recommend that you perform backup or restore operations during a scheduled maintenance window only. Users shouldn't attempt to access Cisco Crosswork while these operations are running. Backups will take the system offline for about 10 minutes, but restore operations can be lengthy. Both will pause other applications until they are complete. These pauses can affect data-collection jobs.
- When performing a normal restore, Cisco Crosswork applications and data are restored to the same version as when you took the backup. When performing a *disaster* restore, you must use the same Cisco Crosswork software image that you used when creating the backup. You can't perform a disaster restore using a backup created using a different version of the software.
- Use the dashboard to monitor the progress of the backup or restore process, until the process completes. If you attempt to use the Cisco Crosswork system during the process, you may see incorrect content or errors, since various services pause and restart frequently.
- You can run only one backup or restore operation at a given time.
- Both the Cisco Crosswork cluster and the SCP server must be in the same IP environment. For example: If Cisco Crosswork is communicating over IPv6, so must the backup server.
- To save space on your backup server, you may delete older backups, but they will still appear in the job list in this version.
- Operators that make more changes should back up more often (possibly daily) while others might be comfortable with doing a backup once a week or before major system upgrades.
- By default, Crosswork will not allow you to make a backup of a system that it does not consider as healthy. However, there are provisions to override this protection to facilitate the sharing of an image with Cisco for additional analysis or other troubleshooting efforts.

Before you begin

Before you begin, ensure that you have:

- The hostname or IP address and the port number of the secure SCP server. Ensure that the server has sufficient storage available.
- A file path on the SCP server, to use as the destination for your backup files.
- User credentials for an account with file read and write permissions to the remote path on the destination SCP server.
- If you are making a data backup, note down the build version of the installed applications. Before performing the data restore, you must install the exact versions of those applications. Any mismatch in the build versions of the applications can result in data loss and failure of the data restore job.

Step 1 **Configure an SCP backup server:**

a) From the main menu, choose **Administration** > **Backup and Restore**.

b) Click **Destination** to display the **Edit Destination** dialog box. Make the relevant entries in the fields provided.

c) Click **Save** to confirm the backup server details.

Step 2 **Create a backup:**

a) From the main menu, choose **Administration** > **Backup and Restore**.

b) Click **Actions** > **Backup** to display the **Backup** dialog box with the destination server details prefilled.

Note To create a Data Backup, click **Actions** > > **Data Backup**. The rest of the procedure in Step 2 remains the same.

c) Provide a relevant name for the backup in the **Job Name** field.

d) If you want to create the backup despite any Cisco Crosswork application or microservice issues, check the **Force** check box.

e) Uncheck the **Backup NSO** checkbox if you don't want to include Cisco NSO data in the backup.

If you do want to include Cisco NSO data in the Cisco Crosswork backup process, follow the instructions given in Backup Cisco Crosswork with Cisco NSO, on page 108 instead of the instructions here.

f) Complete the remaining fields as needed.

If you want to specify a different remote server upload destination: Edit the pre-filled **Host Name**, **Port**, **Username**, **Password** and **Remote Path** fields to specify a different destination.

g) (Optional) Click **Verify Backup Readiness** to verify that Cisco Crosswork has enough free resources to complete the backup. If the check is successful, Cisco Crosswork displays a warning about the time-consuming nature of the operation. Click **OK** to continue.

h) Click **Start Backup** to start the backup operation. Cisco Crosswork creates the corresponding backup job set and adds it to the job list. The Job Details panel reports the status of each backup step as it is completed.

i) To view the progress of a backup job: Enter the job details (such as Status or Job Type) in the search fields in the **Backup Restore Job Sets** table. Then click on the job set you want.

The **Job Details** panel displays information about the selected job set, such as the job Status, Job Type, and Start Time. If there’s a failed job, hover the mouse pointer over the icon near the **Status** column to view the error details.

j) If the backup fails during upload to the remote server: In the **Job Details** panel, just under the Status icon, click the **Upload backup** button to retry the upload.

If the upload failed due to problems with the remote server, either fix the issue with the remote server (for example, clean old backups to free up space) or use the **Destination** button to specify a different remote server and path before clicking **Upload backup**.

Step 3 **To restore from a backup file:**

a) From the main menu, choose **Administration** > **Backup and Restore**.

b) In the **Backup and Restore Job Sets** table, select the backup file to be used for the restore. The **Job Details** panel shows information about the selected backup file.

c) With the backup file selected, click the **Restore** button shown on the **Job Details** panel to start the restore operation. Cisco Crosswork creates the corresponding restore job set and adds it to the job list.

To view the progress of the restore operation, click the link to the progress dashboard.

Note The procedure to restore a data backup is similar. Select the data backup file in the **Backup and Restore Job Sets** table. With the data backup file selected, click the **Data Restore** button shown on the **Job Details** panel to start the data restore operation.

Restore Cisco Crosswork After a Disaster

A disaster recovery is a restore operation that you use after a natural or human-caused disaster has destroyed a Cisco Crosswork cluster. You must deploy a new cluster first, following the instructions in the *Cisco Crosswork Infrastructure and Applications Installation Guide*.

If your cluster only has one malfunctioning hybrid node, or one or more worker nodes, don't perform a disaster recovery. Instead, use cluster management features to redeploy these nodes, or replace them with new nodes, as explained in the Manage the Crosswork Cluster, on page 7 chapter in this guide.

If you have more than one malfunctioning hybrid node, the system will not be in a functional state. Even if you replace or reboot the failed hybrid nodes, there is no guarantee that the system will recover correctly. In this case, you can deploy a new cluster, and then recover the entire system using a recent backup taken from the old cluster. For more information, see the Manage the Crosswork Cluster, on page 7 chapter in this guide.

When conducting a disaster recovery, note the following:

- The new Cisco Crosswork cluster to which you restore the backup must use the same IP addresses as the one where you took the backup. This guideline is important, as internal certificates use the IP addresses of the original cluster.
- The new cluster must have the same number and types of nodes as the cluster where you took the backup.
- The new cluster must use the same Cisco Crosswork software image that you used when creating the backup. You can’t restore the cluster using a backup that was created using a different version of the software.
- If you have made a data backup (**Actions** > > **Data Backup)** instead of a full backup, you can perform a **Data Disaster Restore** which is quicker than a regular disaster restore. Before performing the **Data Disaster Restore**, the exact versions of the applications that were present in your old Crosswork cluster (when you made the data backup) must be installed and available in your new Crosswork cluster. Any mismatch in the build versions of the applications can result in data loss and failure of the restore job.
- Keep your backups current, so that you can recover the true state of your system as it existed before the disaster. The restore operation restores all applications that are installed at the time the backup was made. If you have installed more applications or patches since your last backup, take another backup.
- If the disaster recovery fails, contact Cisco Customer Experience.
- Smart licensing registration for Crosswork applications are not restored during a disaster restore operation, and must be registered again.

To perform a disaster recovery:

Before you begin

Get from the SCP backup server the full name of the backup file you want to use in your disaster recovery. This file is normally the most recent backup file you have made. Cisco Crosswork backup filenames have the following format:

`backup_JobName_CWVersion_TimeStamp.tar.gz`

Where:

- *JobName* is the user-entered name of the backup job.
- *CWVersion* is the Cisco Crosswork platform version of the backed-up system.
- *TimeStamp* is the date and time when Cisco Crosswork created the backup file.

For example: `backup_Wednesday_4-0_2021-02-31-12-00.tar.gz`.

Step 1 From the main menu of the newly deployed cluster, choose **Administration** > **Backup and Restore**.

Step 2 **To perform a disaster restore:**

Click **Actions** > **Disaster Restore** to display the **Disaster Restore** dialog box with the remote server details pre-filled.

Step 3 **To perform a data disaster restore:**

Click **Actions** > **Data Disaster Restore** to display the **Data Disaster Restore** dialog box with the remote server details pre-filled.

Step 4 In the **Backup File Name** field, enter the file name of the backup from which you want to restore.

Step 5 Click **Start Restore** to initiate the recovery operation.

To view the progress of the operation, click the link to the progress dashboard.

Resolve Missing SR-TE (SR-MPLS and SRv6) Policies and RSVP-TE Tunnels

The information in this topic is applicable only when Cisco Crosswork Optimization Engine is installed.

The Configuration Database contains all SR-TE policies and RSVP-TE tunnels of which Cisco Crosswork is aware. Cisco Crosswork updates the Configuration Database whenever you provision, modify or delete an SR-TE policy or RSVP-TE tunnel. You can use the Configuration Database CLI tool to do the following:

- Read and write CSV files to the Configuration Database.
- Populate SR-TE policy and RSVP-TE tunnel information from the Configuration Database to create a CSV file.

The Configuration Database CLI tool is especially useful when trying to recover missing SR-TE policies and RSVP-TE tunnels after a restore operation. For example, the `--dump-missing` option produces a CSV file which lists the SR-TE policies and RSVP-TE tunnels that are missing. Use this CSV file to determine which

SR-TE policies and RSVP-TE tunnels are missing. Then load them back into the topology using the `--load` option. See the CLI tool help for more information.

Step 1 Enter the **optima-pce-dispatcher** container:

```
kubectl exec -it optima-pce-dispatcher-XXXXXXX-XXXX bash
```

Step 2 You can run the following commands:

a) Show CLI tool help text.

```
python3 /opt/optima/pce_dispatcher/config_db/csv_util.py --help
```

b) Save all SR-TE policies and RSVP-TE tunnels that are in the Configuration Database to a CSV file.

```
python3 /opt/optima/pce_dispatcher/config_db/csv_util.py --dump /<PathToFile>/dump_file.csv
```

c) Load the contents from the provided CSV file and write policies to the Configuration Database.

```
python3 /opt/optima/pce_dispatcher/config_db/csv_util.py --load /<PathToFile>/load_file.csv
```

Note This command overwrites any duplicate SR-TE policies or RSVP-TE tunnels that it finds, and adds only valid TE tunnels to the Configuration Database. Duplicate SR-TE policies have the same combination of headend, endpoint, and color. Duplicate RSVP-TE tunnels have the same combination of headend and tunnel name.

d) After the CSV load completes, synchronize the Cisco Crosswork Optimization Engine UI with the Configuration Database by restarting Optimization Engine, as follows:

1. From the main menu, select **Administration** > > **Crosswork Manager** > **Crosswork Health** > **Optimization Engine**.
2. Select **optima-ui-service** > > **Action** > **Restart**. Restart takes approximately five minutes.

e) After the restart, compare SR-TE policies and RSVP-TE tunnels that are currently in the topology with the Configuration Database contents. Save the missing SR policies and RSVP-TE tunnels to a CSV file. You can then use this CSV file and the following command to load the missing policies into the Configuration Database:

```
python3 /opt/optima/pce_dispatcher/config_db/csv_util.py –dump-missing /<PathToFile>/dump_file.cs
```

Backup Cisco Crosswork with Cisco NSO

Restore from the NSO backup file is a manual process, currently.

Before you begin

Before you begin, be sure:

- You have the hostname or IP address and the port number of a secure SCP server.
- You have a file path on the SCP server, to use as the destination for your backup files.
- You have the user credentials for an account with read and write permissions to the storage folder on the destination SCP server.

Also ensure that the NSO provider, the Cisco Crosswork credential profile that is associated with the NSO provider, and the NSO server meet the following prerequisites:

- The NSO provider configuration includes an SSH connection. If you don't enable SSH on the provider, Cisco Crosswork displays a warning alarm. Cisco Crosswork creates a backup for its own data, but not for NSO.
- The NSO provider's credential profile contains the user ID and password of a user with `sudo` privileges on the NSO server.
- The NSO server has NCT (NSO Cluster Tools) installed, and the user in the credential profile for the NSO provider can execute `nct` commands.
- The NSO server has Python version 3.x installed, and the user in the credential profile for the NSO provider can execute `python3` commands.
- The user in the NSO provider's credential profile has full access to the NSO server's backup folder and the files in it. This requirement usually means full read and write access to the NSO server's `/var/opt/ncs/backups/` folder.

Failure to meet any of these Cisco NSO requirements means that all or part of the backup job will fail.

In addition to these special requirements, the normal guideliness for backups discussed in Manage Cisco Crosswork Backup and Restore, on page 103 also apply to backups containing NSO data.

Step 1 **Configure an SCP backup server:**

a) From the main menu, choose **Administration** > **Backup and Restore**.
b) Click **Destination** to display the **Edit Destination** dialog box. Make the relevant entries in the fields provided.
c) Click **Save** to confirm the backup server details.

Step 2 **Create Cisco Crosswork and Cisco NSO backups:**

a) From the main menu, choose **Administration** > **Backup and Restore**.
b) Click **Actions** > **Backup** to display the **Backup** dialog box with the destination server details prefilled.
c) Provide a relevant name for the backup in the **Job Name** field.
d) If you want to create the backup despite any Cisco Crosswork application or microservice issues, check the **Force** check box.
e) Leave the **Backup NSO** check box checked.
f) Complete the remaining fields as needed.

   If you want to specify a different remote server upload destination: Edit the pre-filled Host Name, Port, Username, Password and Remote Path fields to specify a different destination.

g) (Optional) Click **Verify Backup Readiness** to verify that Cisco Crosswork has enough free resources to complete the backup. If the check is successful, Cisco Crosswork displays a warning about the time-consuming nature of the operation. Click **OK** to continue.
h) Click **Start Backup** to start the backup operation. Cisco Crosswork creates the corresponding backup job set adds it to the job list, and begins processing the backup. The Job Details pane reports the status of each backup step as it is completed.
i) To view the progress of a backup job: Enter the job details (such as Status or Job Type) in the search fields in the **Backup Restore Job Sets** table. Then click on the job set you want.

   The **Job Details** panel displays information about the selected job set, such as the job Status, Job Type, and Start Time. If there’s a failed job, hover the mouse pointer over the icon near the **Status** column to view the error details.

j) If the backup fails during upload to the remote server: In the **Job Details** panel, just under the Status icon, click the **Upload backup** button to retry the upload.

If the upload failed due to problems with the remote server, use the **Destination** button to specify a different remote server and path before clicking **Upload backup**.

Restore Cisco Crosswork with Cisco NSO

When you restore a Cisco Crosswork cluster and its associated Cisco NSO cluster from a backup, follow these guidelines:

- We recommend that you perform restore operations during a scheduled maintenance window only. Users shouldn't attempt to access Cisco Crosswork or Cisco NSO while these operations are running. Cisco Crosswork restore operations are lengthy, and will pause other Cisco Crosswork applications until they are complete. Cisco NSO must be stopped completely during restores.
- You can run both a Cisco Crosswork and a Cisco NSO restore operation at the same time.

Before you begin

Get from the SCP server the full name of the backup file you want to restore. This file will contain both the Cisco Crosswork and Cisco NSO backups. Backup filenames have the following format:

`backup_`*`JobName`*`_`*`CWVersion`*`_`*`TimeStamp`*`.tar.gz`

Where:

- *JobName* is the user-entered name of the backup job.
- *CWVersion* is the Cisco Crosswork platform version of the backed-up system.
- *TimeStamp* is the date and time when Cisco Crosswork created the backup file.

For example: `backup_Wed_4-0_2021-02-31-12-00.tar.gz`.

Step 1 Log in (if needed) to the remote SCP backup server. Using the Linux command line, access the backup destination directory and find the backup file containing Cisco NSO information that you want to restore. For example:

```
[root@localhost~]# ls -ltr
-rw-rw-r--. 1 root root 8265938605 backup_Wed_4-0_2021-02-31-12-00.tar.gz
```

Step 2 Use `tar -xzvf` to extract the Cisco NSO backup from the Cisco Crosswork backup file in the destination folder. For example:

```
[root@localhost~]# tar -xzvf backup_Wed_4-0_2021-02-31-12-00.tar.gz
...
[root@localhost~]# ls -ltr
-rw-rw-r--. 1 root root 8265938605 backup_Wed_4-0_2021-02-31-12-00.tar.gz
-rw-r--r--. 1 root root 8267798605 468c4715-ea09-4c2b-905e-98999d.tar.gz
```

Step 3 Un-tar the Cisco NSO backup file in the destination folder. You will see Cisco NSO files being extracted to a folder structure under `/nso/`*`ProviderName`*`/`, where `/nso/`*`ProviderName`*`/` is the name of the Cisco NSO provider as configured in Cisco Crosswork. In the following example, the Cisco NSO provider is named `nso121`:

```
tar -xvsf 468c4715-ea09-4c2b-905e-98999d.tar.gz
468c4715-ea09-4c2b-905e-98999d/nso/
468c4715-ea09-4c2b-905e-98999d/nso/nso121/
468c4715-ea09-4c2b-905e-98999d/nso/nso121/log/
468c4715-ea09-4c2b-905e-98999d/nso/nso121/log/nso_backup_result_nso121_Wed.log
468c4715-ea09-4c2b-905e-98999d/nso/nso121/NSO_RESTORE_PATH_nso121
468c4715-ea09-4c2b-905e-98999d/nso/nso121/ncs-5.4.2@backup_Wed_nso121.backup.gz
...
```

Step 4 Locate the file with a backup.gz extension in the `/nso/`*`ProviderName`*`/`folder. This is the generated Cisco NSO backup file. In the example in the previous step, the file name is highlighted.

Step 5 Log in to Cisco NSO as a user with root privileges and access the command line. Then copy or move the generated Cisco NSO backup file from the SCP server to the specified restore path location of the Cisco NSO cluster. For example:

```
[root@localhost nsol21]# ls
log ncs-5.4.2@backup_Wed_nso121.backup.gz NS0_REST0RE_PATH_nso121
[root@localhost nso121]# more NS0_REST0RE_PATH_nso121
/var/opt/ncs/backups/
[root@localhost nso121]#
...
```

Step 6 You can perform Cisco NSO restore operations only while NSO is not running. At the Cisco NSO cluster command line, run the following command to stop Cisco NSO:

```
$/etc/init.d/ncs stop
```

Step 7 Once NCS has stopped, start the restore operation using the following command and the name of the generated Cisco NSO backup file. For example:

```
#ncs-backup --restore ncs-5.4.2@backup_Wed_nso121.backup.gz
```

If you have trouble running this command, first give yourself `sudo su` permission.

Step 8 Once the restore completes, restart Cisco NSO using the following command. This command may take a few minutes to complete.

```
$/etc/init.d/ncs start
```

Step 9 Once you have restored both Cisco Crosswork and Cisco NSO clusters from backups, re-add the Cisco NSO provider to Cisco Crosswork.

Migrate Data Using Backup and Restore

Using data migration backup and restore is a pre-requisite when upgrading your Cisco Crosswork installation to a new software version, or moving your existing data to a new installation.

As with normal backups, follow these guidelines whenever you create a data migration backup:

- Ensure that you have configured a destination SCP server to store the data migration files. This configuration is a one-time activity.
- Both the Cisco Crosswork cluster and the SCP server must be in the same IP environment. For example: If Cisco Crosswork is communicating over IPv6, so must the backup server.
- We recommend that you create a data migration backup only when upgrading your Cisco Crosswork installation, and that you do so during a scheduled upgrade window only. Users shouldn’t attempt to access Cisco Crosswork while the data migration backup or restore operations are running.

Before you begin

Before you begin, ensure that you have:

- The hostname or IP address and the port number of a secure SCP server.
- A file path on the SCP server, to use as the destination for your data migration backup files.
- User credentials for an account with file read and write permissions to the remote path on the destination SCP server.

Step 1 **Configure an SCP backup server:**

a) From the main menu, choose **Administration** > **Backup and Restore**.
b) Click **Destination** to display the **Edit Destination** dialog box. Make the relevant entries in the fields provided.
c) Click **Save** to confirm the backup server details.

Step 2 **Create a backup:**

a) Log in as an administrator to the Cisco Crosswork installation whose data you want to migrate to another installation.
b) From the main menu, choose **Administration** > **Backup and Restore**.
c) Click **Actions** > **Backup** to display the **Backup** dialog box with the destination server details prefilled.
d) Provide a relevant name for the backup in the **Job Name** field.
e) If you want to create the backup despite any Cisco Crosswork application or microservice issues, check the **Force** check box.
f) Complete the remaining fields as needed.

   If you want to specify a different remote server upload destination: Edit the pre-filled **Host Name**, **Port**, **Username**, **Password** and **Remote Path** fields to specify a different destination.

g) Click **Start Backup** to start the backup operation. Cisco Crosswork creates the corresponding backup job set and adds it to the **Backup and Restore Job Sets** table. The Job Details panel reports the status of each backup step as it is completed.
h) To view the progress of a backup job: Enter the job details (such as Status or Job Type) in the search fields in the **Backup and Restore Job Sets** table. Then click on the job set you want.

   The **Job Details** panel displays information about the selected job set, such as the job Status, Job Type, and Start Time. If there’s a failed job, hover the mouse pointer over the icon near the **Status** column to view the error details.

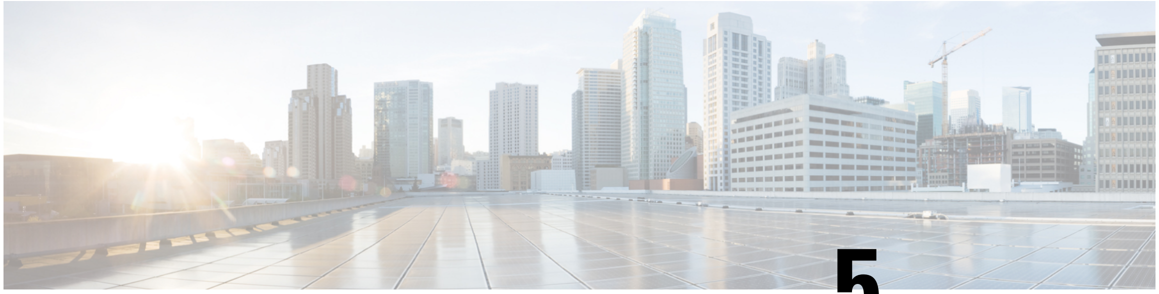
i) If the backup fails during upload to the remote server: In the **Job Details** panel, just under the Status icon, click the **Upload backup** button to retry the upload.

   If the upload failed due to problems with the remote server, use the **Destination** button to specify a different remote server and path before clicking **Upload backup**.

Step 3 **Migrate the backup to the new installation:**

a) Log in as an administrator on the Cisco Crosswork installation to which you want to migrate data from the backup.
b) From the main menu, choose **Administration** > **Backup and Restore**.
c) Click **Actions** > **Data Migration** to display the **Data Migration** dialog box with the remote server details pre-filled.
d) In the **Backup File Name** field, enter the file name of the backup from which you want to restore.
e) Click **Start Migration** to initiate the data migration. Cisco Crossworkcreates the corresponding migration job set and adds it to the job list.

To view the progress of the data migration operation, click the link to the progress dashboard.



CHAPTER 5

Prepare Infrastructure for Device Management

This section contains the following topics:

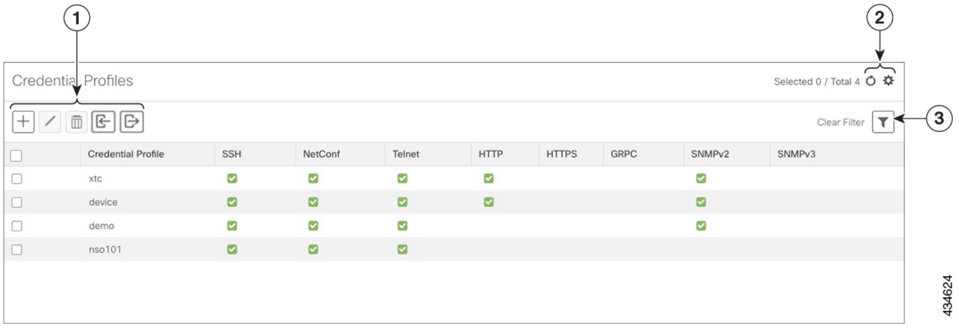
Manage Credential Profiles

Credential profiles are collections of credentials for SNMP, Telnet, SSH, HTTP, and other network protocols. You can have multiple protocols and credentials in a single credential profile.

Using credential profiles lets you automate device configuration changes and monitoring, and communicate with providers. When you add or import devices, or create providers, you specify the credential profile.

From the **Credential Profiles** window, you can create a new credential profile, update the settings configured for an existing profile, or delete a profile. To open this window, choose **Device Management** > **Credential Profiles** from the main menu.

Figure 13: Credentials Profile window



□	Credential Profile	SSH	NetConf	Telnet	HTTP	HTTPS	GRPC	SNMPv2	SNMPv3
□	xtc	✓	✓	✓	✓			✓	
□	device	✓	✓	✓	✓			✓	
□	demo	✓	✓	✓				✓	
□	nso101	✓	✓	✓					

Item	Description
1	Click ⊞ to add a credential profile. See Create Credential Profiles, on page 116.
	Click ✎ to edit the settings for the selected credential profile. See Edit Credential Profiles, on page 120.
	Click 🗑 to delete the selected credential profile. See Delete Credential Profiles, on page 121.
	Click ⇤ to import new credential profiles from a CSV file. You can also download a CSV file template by clicking this icon. The template includes sample data that you can use as a guide for building your own CSV file. See Import Credential Profiles, on page 118.
	Click ⇥ to export credential profiles to a CSV file. See Export Credential Profiles, on page 120.
2	Click ↻ to refresh the **Credential Profiles** window.
	Click ⚙ to choose the columns to make visible in the **Credential Profiles** window.
3	Click ▼ to set filter criteria on one or more columns in the **Credential Profiles** window.
	Click the **Clear Filter** link to clear any filter criteria you may have set.

Create Credential Profiles

Follow the steps below to create a new credential profile. You can then use the profile to apply credentials consistently when you add new devices or providers. You can add as many protocols and corresponding credentials to the profile as you want.

If you have many credential profiles to add, you may find it more efficient to put the information in a CSV file and import the file. See Import Credential Profiles, on page 118.

When creating device credential profiles that contain SNMP credentials, Cisco recommends that the profile contain credentials for the version of SNMP actually enabled on the device, and that version only. For example: If SNMPv3 is not enabled in the device configuration, do not include SNMPv3 credentials in the device credential profile.

If you plan to use the import and export features and CSV files to create credential profiles in bulk, please note that:

- All the characters in each password or community string entry in every credential profile exported to a CSV file are replaced with asterisks (Export Credential Profiles, on page 120).
- You cannot import credential profiles if the passwords and community strings in the CSV file are blank (see Import Credential Profiles, on page 118).

To maintain network security, Cisco recommends that you use asterisks in place of real passwords and community strings in any CSV file you plan to import. After the import, follow the steps in Edit Credential Profiles, on page 120 to replace the asterisks with actual passwords and community strings.

Step 1 From the main menu, choose **Device Management** > **Credential Profiles**.

Step 2 Click ⊞.

Step 3 In the **Profile Name** field, enter a descriptive profile name. The name can contain a maximum of 128 alphanumeric characters, plus dots (.), underscores ("_") or hyphens ("-"). No other special characters are allowed.

If you will have many credential profiles, make the name as informative as possible because that information will be displayed on the Credential Profiles panel.

Step 4 Select a protocol from the **Connectivity Type** dropdown.

Step 5 Complete the credentials fields described in the following table. The required and optional fields displayed will vary with the connectivity type you chose. The values you enter must match the values configured on the device.

Connectivity Type	Fields
SSH	Enter the required **User Name**, **Password**, and **Confirm Password**. The **Enable Password** is optional.
SNMPv2	Enter the required SNMPv2 **Read Community** string. The **Write Community** string is optional.
NETCONF	Enter the required **User Name**, **Password**, and **Confirm Password**.
TELNET **Note** There may be some security limitations when using this protocol.	Enter the required **User Name**, **Password**, and **Confirm Password**. The **Enable Password** is optional.
HTTP	Enter the required **User Name**, **Password**, and **Confirm Password**.
HTTPS	Enter the required **User Name**, **Password**, and **Confirm Password**.
GRPC	Enter the required **User Name**, **Password**, and **Confirm Password**.
gNMI	Enter the required **User Name**, **Password**, and **Confirm Password**.
TL1	Enter the required **User Name**, **Password**, and **Confirm Password**.

Connectivity Type	Fields
SNMPv3	Choose the required **Security Level** and enter the **User Name**. If you chose the NO_AUTH_NO_PRIV **Security Level** of AUTH_NO_PRIV or AUTH_PRIV, the remaining fields are optional. If you chose the AUTH_NO_PRIV **Security Level**, you must choose an **Auth Type** and enter an **Auth Password**. If you chose the AUTH_PRIV **Security Level**, you must choose an **Auth Type** and **Priv Type**, and enter an **Auth Password** and **Priv Password**. Only the following SNMPv3 Privacy Types are supported • CFB_AES_128 • CBC_DES_56 The following Privacy Types are not supported: • AES192 • AES256 • 3DES

Step 6 (Optional) Click **+ Add Another** and repeat the above steps, as needed, for all other protocols and corresponding credentials you want to add to this credential profile.

Step 7 Click **Save**.

Import Credential Profiles

Complete the steps below to create a CSV file that specifies multiple credential profiles and then import it into the Cisco Crosswork application.

Importing credential profiles from a CSV file adds any profiles not already in the database. You cannot import a credential profile that already exists.

If you are re-importing a credential profile CSV file that you previously exported and modified, remember that all the passwords and community strings in the exported credential profile CSV file are replaced with asterisks. You cannot re-import an exported credential profile CSV file with blank passwords. To maintain security, Cisco recommends that you use asterisks in place of real passwords and community strings in the CSV file. After the import, follow the steps in Edit Credential Profiles, on page 120 to replace the asterisks with actual passwords and community strings.

Step 1 From the main menu, choose **Device Management** > **Credential Profiles**.

Step 2 Click ⇦ to open the dialog box.

Step 3 If you have not already created a credential profile CSV file to import:

a) Click the **Download sample 'Credential template (*.csv)' file** link and save the CSV file template to your local disk.

b) Open the template using your preferred tool. Begin adding rows to the file, one row for each credential profile.

Use a semicolon to separate multiple entries in the same field. Use two semicolons with no space between them to indicate that you are leaving the field blank. When you separate multiple entries with semicolons, remember that the order in which you enter values in each field is important. For example, if you enter **`SSH;NETCONF;TELNET`** in the **Connectivity Type** field and you enter **`UserTom;UserDick;UserHarry;`** in the **User Name** field, the order of entry determines the mapping between the two fields:

- SSH: UserTom
- NETCONF: UserDick
- TELNET: UserHarry

Also note:

- Be sure to enter SNMP community string information exactly as currently entered on your devices.
- Password and community string information associated with a user ID are stored in plain text in the CSV file you prepare. Be aware of the security implications of this, and apply appropriate safeguards.

Field	Entries	Required or Optional
Credential Profile	The name of the credential profile. For example: .	Required
Connectivity Type	Valid values are: **`SSH`**, **`SNMPv2`**, **`NETCONF`**, **`TELNET`**, **`HTTP`**, **`HTTPS`**, **`GRPC`** or **`SNMPv3`**	
User Name	For example:	Required if **Connectivity Type** is **`SSH`**, **`NETCONF`**, **`TELNET`**, **`HTTP`**, **`HTTPS`**, **`SNMPv3`** or **`GRPC.`**
Password	The password for the preceding **User Name**.	Required if **Connectivity Type** is **`SSH`**, **`NETCONF`**, **`TELNET`**, **`HTTP`**, **`HTTPS`** or **`GRPC`**
Enable Password	Use an Enable password. Valid values are: **`ENABLE`**, **`DISABLE`**	
Enable Password Value	Specify the Enable password to use.	
SNMPV2 Read Community	For example: **`readprivate`**	Required if **Connectivity Type** is **`SNMPv2`**
SNMPV2 Write Community	For example: **`writeprivate`**	
SNMPV3 User Name	For example: **`DemoUser`**	Required if **Connectivity Type** is **`SNMPv3`**
SNMPV3 Security Level	Valid values are **`noAuthNoPriv`**, **`AuthNoPriv`** or **`AuthPriv`**	Required if **Connectivity Type** is **`SNMPv3`**

Field	Entries	Required or Optional
SNMPV3 Auth Type	Valid values are `HMAC_MD5` or `HMAC_SHA`	Required if **Connectivity Type** is `SNMPv3` and **SnmpV3 Security Level** is `AuthNoPriv` or `AuthPriv`
SNMPV3 Auth Password	The password for this authorization type.	Required if **Connectivity Type** is `SNMPv3` and **SnmpV3 Security Level** is `AuthNoPriv` or `AuthPriv`
SNMPV3 Priv Type	Valid values are `CFB_AES_128` or `CBC_DES_56` The following SNMPv3 privacy types are not supported: AES192, AES256, 3DES	Required if **Connectivity Type** is `SNMPv3` and **SnmpV3 Security Level** is `AuthPriv`
SNMPV3 Priv Password	The password for this privilege type.	Required if **Connectivity Type** is `SNMPv3` and **SnmpV3 Security Level** is `AuthPriv`

Be sure to delete the sample data rows before saving the file or they will be imported along with the data you want. The column header row can stay, as it is ignored during import.

c) When you are finished, save the new CSV file.

Step 4 Click **Browse** to navigate to the CSV file you just created and then click **Open** to select it.

Step 5 With the CSV file selected, click **Import**.

The credential profiles you imported should now be displayed in the **Credential Profiles** window.

Edit Credential Profiles

A credential profile can be shared by multiple devices, even hundreds of devices in a large network. Complete the following procedure to edit credential profile settings.

Before editing any credential profile, it is always good practice to export a CSV backup of the profiles you want to change (see Export Credential Profiles, on page 120).

Step 1 From the main menu, choose **Device Management** > **Credentials**.

Step 2 From the left-hand side of the **Credential Profiles** window, select the profile you want to update, and click ✎.
The **Edit Profile** window of the selected credential is displayed.

Step 3 Make the necessary changes and then click **Save**.

Export Credential Profiles

Exporting credential profiles stores all the profiles you selected in a CSV file. This is a quick way to make backup copies of your credential profiles. You can also edit the CSV file as needed, and re-import it to add new or modify credential profile data.

The exported credential profiles CSV file does not contain real passwords or community strings. All the characters in the passwords and community strings entries in the credential profiles are replaced with asterisks in the exported CSV file. If you plan on modifying your exported CSV file and then re-importing it, Cisco recommends that you use asterisks in place of real passwords and community strings. After the import, follow the steps in Edit Credential Profiles, on page 120 to replace the asterisks with actual passwords and community strings.

Step 1 From the main menu, choose **Device Management** > **Credential Profiles**.

Step 2 (Optional) In the **Credential Profiles** window, filter the credential profile list as needed.

Step 3 Check the check boxes for the profiles you want to export. Check the check box at the top of the column to select all the profiles for export.

Step 4 Click ⇨. Depending on your browser, you will be prompted to select a path and file name to use when saving the CSV file, or to open it immediately

Delete Credential Profiles

Follow the steps below to delete a credential profile.

Note You cannot delete a credential profile that is associated with one or more devices or providers.

Step 1 Export a backup CSV file containing the credential profile you plan to delete (see Export Credential Profiles, on page 120).

Step 2 Check whether any devices or providers are using the credential profile you plan to delete. You can do this by filtering on the **Credential Profile** column, which is available on both the **Devices** window (choose **Device Management** > **Credential Profiles**) and the Providers window (choose **Administration** > **Manage Provider Access**).

Step 3 Reassign the devices or providers to a different credential profile (for help with this task, see Change the Credential Profile for Multiple Devices, on page 121 and Edit Providers, on page 147).

Step 4 After all devices and providers have had their credential profiles reassigned: From the main menu, choose **Device Management** > **Credential Profiles**.

Step 5 In the **Credential Profiles** window, choose the profile that you want to delete and then click 🗑.

Change the Credential Profile for Multiple Devices

If you want to change the credential profile for a large number of network devices, you may find it more efficient to make the change by editing a devices CSV file. The basic method is:

1. Export a CSV file containing the devices whose credential profiles you want to change (see Export Device Information to a CSV File, on page 164).

2. Edit the CSV file, changing the credential profile for each device (this credential profile must already exist). Save the edited file.

You will need to make sure that the credential profile to which you are changing already exists. If you have not yet created that credential profile, the CSV import will fail. The credential profile you associate with these devices must also have the authorization credentials for every protocol that was configured for these devices during onboarding. If any credential for a specific protocol configured on the devices is missing from or incorrect in the credential profile, then the CSV import will succeed, but reachability checks will fail for these devices.

Step 1 From the main menu, choose **Device Management** > **Devices**.

Step 2 Choose the devices whose credential profiles you want to change. Your options are:

- Click ⇨ to include all devices.
- Filter the device list by entering text in the **Search** field or by filtering specific columns. Then click ⇨ to include only the filtered list of devices.
- Check the boxes next to the device records you want to change. Then click ⇨ to include only the devices that have been checked.

Step 3 Edit and save the new CSV file using the tool of your choice. Be sure to enter the correct credential profile name in the **Credential Profile** field for each device.

Step 4 Click ⇦.

Step 5 In the **Import** dialog box, click **Browse**, choose the new CSV file, and click **Import**.

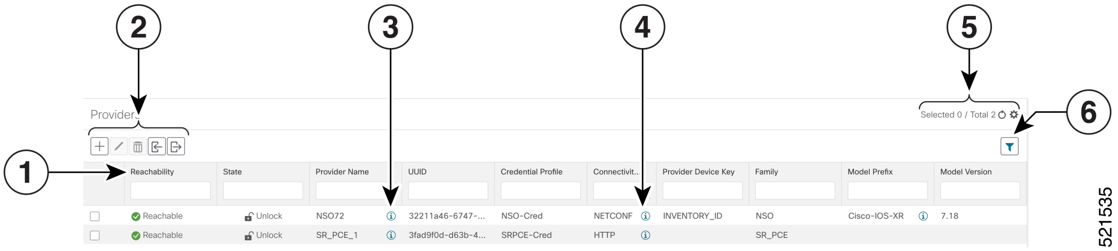
Manage Providers

Cisco Crosswork applications communicate with external providers. Cisco Crosswork stores the provider connectivity details and makes that information available to applications. For more information, see Before You Begin, on page 1.

From the **Providers** window, you can add a new provider, update the settings configured for an existing provider, and delete a particular provider. To open this window, choose **Administration** > **Manage Provider Access**.

Note Wait until the application responds between performing a succession of updates. For example, wait for some time between adding, deleting, or readding providers. Topology services may not receive these changes if you perform these actions too quickly. However, if you find that topology is out of sync, restart the topology service.

Figure 14: Providers Window



Providers

+ ✎ 🗑 ⇦ ⇨

Selected 0 / Total 2 ↻ ⚙

	Reachability	State	Provider Name		UUID	Credential Profile	Connectivit...		Provider Device Key	Family	Model Prefix		Model Version
□	✓ Reachable	Unlock	NSO72	ⓘ	32211a46-6747-...	NSO-Cred	NETCONF	ⓘ	INVENTORY_ID	NSO	Cisco-IOS-XR	ⓘ	7.18
□	✓ Reachable	Unlock	SR_PCE_1	ⓘ	3fad9f0d-d63b-4...	SRPCE-Cred	HTTP	ⓘ		SR_PCE			

Item	Description
1	The icon shown next to the provider in this column indicates the provider's **Reachability**. See Device State, on page 166.
2	Click + to add a provider. See About Adding Providers, on page 125.
	Click ✎ to edit the settings for the selected provider. See Edit Providers, on page 147.
	Click 🗑 to delete the selected provider. See Delete Providers, on page 147.
	Click ⇦ to import new providers or update existing providers from a CSV file. You can also download a CSV file template by clicking this icon. The template includes sample data that you can use as a guide for building your own CSV file. See Import Providers, on page 145.
	Click ⇨ to export a provider to a CSV file. See Export Providers, on page 148.
3	Click ⓘ next to the provider in the **Provider Name** column to open the **Properties for** pop-up window, showing the details of any startup session key/value pairs for the provider.
4	Click ⓘ next to the provider in the **Connectivity Type** column to open the **Connectivity Details** pop-up window, showing the protocol, IP, and other connection information for the provider.
5	Click ↻ to refresh the **Providers** window.
	Click ⚙ to choose the columns to make visible in the Providers window (see).
6	Click ▼ to set filter criteria on one or more columns in the **Providers** window.
	Click the **Clear Filter** link to clear any filter criteria you may have set.

About Provider Families

Cisco Crosswork supports different types, or families, of providers. Each provider family supplies its own mix of special services, and each comes with unique requirements and options.

The currently supported provider families are shown in the following table.

Table 7: Supported Provider Families

Provider Family	Description
NSO	Instances of Cisco Network Services Orchestrator (Cisco NSO), used to configure network devices. See Add Cisco NSO Providers, on page 127.
SR-PCE	Instances of Cisco Segment Routing Path Computation Elements (Cisco SR-PCE) containing the configuration information needed to allow Cisco Crosswork applications to communicate with and retrieve segment routing information for the network. See Add Cisco SR-PCE Providers, on page 130.
WAE	Instances of Cisco WAN Automation Engine (Cisco WAE) provide "what if" analysis used to evaluate network changes. See Add Cisco WAE Providers, on page 141 .
Syslog Storage	Instances of storage servers (remote or on the Cisco Crosswork application VM itself) where you want store syslogs and other data retrieved from devices by KPIs and Playbooks. See Add Syslog Storage Providers, on page 142.
Alert	Instances of providers (such as Cisco Crosswork Situation Manager) to which alerts collected during KPI monitoring are to be forwarded. See Add an Alert Provider, on page 143
Proxy	Instances of proxy providers. See Add Proxy Providers, on page 144

Provider Dependency

This section explains the provider configurations required for each Cisco Crosswork application and for Cisco Crosswork Network Controller.

Cisco Crosswork Network Controller is an integrated solution that combines Cisco Crosswork Active Topology and Cisco Crosswork Optimization Engine. You can also optionally integrate Crosswork Network Controller with Crosswork Change Automation, Crosswork Health Insights, and Crosswork Zero Touch Provisioning.

Table 8: Provider Dependency matrix

Cisco Crosswork Product	Cisco NSO Provider	Cisco SR-PCE Provider	Cisco WAE Provider	Syslog Storage Provider	Alert Provider
Crosswork Network Controller	Mandatory Required protocols are HTTPS and NETCONF. Provider property key **forward** must be set as *true*.	Mandatory Required protocol is HTTP.	Optional	Optional	Optional
Crosswork Optimization Engine	Optional	Mandatory Required protocol is HTTP.	Optional	Optional	Optional
Crosswork Change Automation	Mandatory Required protocol is NETCONF. Provider property key **forward** must be set as *true*.	Optional	Optional	Optional	Optional
Crosswork Health Insights					
Crosswork Zero Touch Provisioning	Optional	Optional	Optional	Optional	Optional

About Adding Providers

Cisco Crosswork depends on a variety of providers to perform various functions. For example, Cisco Network Services Orchestrator provides segment routing policies and device information. Features that depend on new providers may be added in the future, and you may need to communicate with more than one instance of a single provider. To access each provider's services, the provider must be added to the Cisco Crosswork application's system configuration.

There are two ways to add providers:

1. **Adding providers via the UI**: This method is explained in Add Providers Through the UI, on page 126. Although this method is the most time-consuming, it is more often used because most deployments will not need a lot of provider instances.
2. **Importing providers from a providers CSV file**: This method is explained in Import Providers, on page 145. Importing a CSV file is useful when you have a lot of provider instances to add or update at one time.

Note that both methods require that you:

- Create a corresponding credential profile, beforehand, so that the Cisco Crosswork applications can access the provider. For help, see Create Credential Profiles, on page 116.
- Know the protocol, IP address, port number, and other information needed to connect with the provider.

- Know any special properties the provider may require during the session startup.

Add Providers Through the UI

Use this procedure to add a new external provider. You can then map the provider to devices.

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⊞.

Step 3 Enter values for the provider as listed in the following table.

Step 4 When you have complete entries in all of the required fields, click **Save** to add the new provider.

Step 5 (Optional) Repeat to add more providers.

Table 9: Add Provider Fields (=required)*

Field	Description
*** Provider Name**	The name for the provider that will be used to refer to it in the Cisco Crosswork application. For example: **`Linux_Server`**. The name can contain a maximum of 128 alphanumeric characters, plus dots (.), underscores ("_") or hyphens ("-"). No other special characters are allowed.
*** Credential Profile**	Select the name of the credential profile that is used by the Cisco Crosswork application to connect to the provider.
*** Family**	Select the provider family. Choices are: **`NSO`**, **`WAE`**, **`SR-PCE`**, **`ALERT`** and **`SYSLOG_STORAGE`**.
Connection Type(s)	
*** Protocol**	Select the principal protocol that the Cisco Crosswork application will use to connect to the provider. Options include: **`HTTP`**, **`HTTPS`**, **`SSH`**, **`SNMP`**, **`NETCONF`**, **`TELNET`**, and more. To add more connectivity protocols for this provider, click ⊕ at the end of the first row. To delete a protocol you have entered, click ⊗shown next to that row. You can enter as many sets of connectivity details as you want, including multiple sets for the same protocol.
*** IP Address/ Subnet Mask**	Enter the IP address (IPv4 or IPv6) and subnet mask of the provider's server.
*** Port**	Enter the port number to use to connect to the provider's server. This is the port corresponding to the protocol being configured. For example, if the protocol used to communicate with the provider server is SSH, the port number is usually 22.
Timeout	Enter the amount of time (in seconds) to wait before the connection times out. The default is 30 seconds.
Model Prefix Info	

Field	Description

*** Model**	Required only if you are adding a Cisco NSO provider: Select the model prefix that matches the NED CLI used by Cisco NSO. Valid values are:
	`Cisco-IOS-XR`
	`Cisco-NX-OS`
	`Cisco-IOS-XE`
	For telemetry, only **`Cisco-IOS-XR`** is supported.
	To add more model prefix information for this Cisco NSO provider, click the ⊕ at the end of any row in the **Model Prefix Info** section. To delete a model prefix you have entered, click the ⊗ shown next to that row.

*** Version**	Required only if you are adding a Cisco NSO provider: Enter the Cisco NSO NED driver version used on the NSO server.
Provider Properties	
Property Key	Enter the name of the key for the special provider property you want to configure. Provider properties control how the Cisco Crosswork application interacts with the provider. Not all providers need them, and the number and type of properties vary with the provider family. These properties are documented in topics about adding specific providers elsewhere in this Guide. Please note, however, that the Cisco Crosswork application does not validate provider properties. Make sure the properties you enter are valid for the provider. **Note** In a two network interface configuration, the Cisco Crosswork applications default to communicating with providers using the Management Network Interface (**`eth0`**). You can change this behavior by adding **Property Key** and **Property Value** as **`outgoing-interface`** and **`eth1`** respectively. This is most often necessary when creating the SR-PCE provider, as its management interface may reside on the data network instead of the management network.
Property Value	Enter the value to assign to the property key. To add more special properties for this provider, click ⊕ at the end of any key/value pair in the **Provider Properties** section. To delete a key/value pair you have entered, click ⊗ shown next to that pair.

Add Cisco NSO Providers

The Cisco Network Services Orchestrator (Cisco NSO) provider supplies the following functionality:

- Network services and device configuration services to Cisco Crosswork applications.
- Device management and configuration maintenance services.

Note Crosswork supports Cisco NSO Layered Service Architecture (LSA) deployment. The LSA deployment is constructed from multiple NSO providers, that function as the customer-facing service (CFS) NSO containing all the services, and the resource-facing service (RFS), which contains the devices. Crosswork automatically identifies the NSO provider as CFS or RFS. Only one CFS is allowed. On the **Manager Provider Access** page, the **Type** column identifies the NSO provider as CFS.

Note The Cisco NSO sample function packs are provided as a starting point for VPN service provisioning functionality in Cisco Crosswork Network Controller. While the samples can be used “as is” in some limited network configurations, they are intended to demonstrate the extensible design of Cisco Crosswork Network Controller. Answers to common questions can be found on Cisco Devnet and Cisco Customer Experience representatives can provide answers to general questions about the samples. Support for customization of the samples for your specific use cases can be arranged through your Cisco account team.

Before you begin

You will need to:

- Create a credential profile for the Cisco NSO provider (see Create Credential Profiles, on page 116).
- Know the name you want to assign to the Cisco NSO provider.
- Know the Cisco NSO NED device models and driver versions used in your topology.

  Note You can find the Cisco NSO version using the `version` command, as shown in the below example:

  ```
  admin@ncs# show ncs-state version
  ncs-state version 5.5.2.9
  ```

- Know the Cisco NSO server IP address and hostname. When NSO is configured with HA, the IP address would be management VIP address.
- Confirm Cisco NSO device configurations. For more information, see Sample Configuration for Cisco NSO Devices, on page 158.
- To enable Cisco NSO LSA deployment, please follow the instructions in Enable Layered Service Architecture (LSA), on page 287.

Follow the steps below to add a Cisco NSO provider through the UI. Note that you can import several providers at the same time by preparing a CSV file with the details of all the providers and importing it into Crosswork (see Import Providers, on page 145).

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⊞.

Step 3 Enter the following values for the Cisco NSO provider fields:

a) Required fields:

- **Provider Name**: Enter a name for the provider.
- **Credential Profile**: Select the previously created Cisco NSO credential profile.
- **Family**: Select `NSO`.
- Under Connection Type(s), **Protocol**: Select the protocol that Cisco Crosswork applications will use to connect to the provider. `NETCONF` is usually preferred. Enable both `HTTPS` (required when using the Cisco Crosswork Network Controller solution) and `NETCONF` (required when applications communicate to NSO as a southbound access) protocols. For more information, see Provider Dependency, on page 124
- **IP Address/Subnet Mask**: Enter the IP address and subnet mask of the Cisco NSO server.
- **Port**:
  - For Netconf: Enter the port to use to connect to the Cisco NSO server. The default is `2022`.
  - For HTTPS, enter the port that corresponds with what is configured on the NSO VM in etc/ncs/ncs.conf to access NSO using HTTPS. NSO uses 8888 as default port.
- **Model**: Select the model (**Cisco-IOS-XR**, **Cisco-NX-OS**, or **Cisco-IOS-XE**) from the drop-down list and enter its associated NED driver version. Add a model for each type of device that will be used in the topology. If you have more than one, add another supported model.
- **Version**: Enter the NED software version installed for the device model in NSO.

b) Optional values:

- **Timeout**: The amount of time (in seconds) to wait before timing out the connection to the Cisco NSO server. The default is 30 seconds.

Step 4 Under Provider Properties, enter a **Property Key** of `forward` and a **Property Value** of `true`. This property is necessary when using the Cisco Crosswork Network Controller solution to allow provisioning operations within the UI and to enable the northbound interface to NSO via the Crosswork API gateway.

Note Cisco Crosswork provides the option to cross launch the NSO application from the Crosswork UI (this feature is not available for user roles with read-only permissions). To enable the cross launch feature, add Cisco NSO as a provider with one of the following settings:

- The **Property Key** `nso_crosslaunch_url` has a valid URL entered in the **Property Key** field.
- Protocol is `HTTP` or `HTTPS`, and the provider is reachable.

If any of the above settings are present, the cross launch icon (↗) is displayed in the **Provider Name** column. Alternately, you can cross launch the NSO application using the launch icon located at the top right corner of the window.

Step 5 When you have completed entries in all of the required fields, click **Save** to add Cisco NSO as a provider.

Step 6 In the Providers window, select the NSO provider you created and click **Actions** > **Edit Policy Details**.

The **Edit Policy Details** window for the selected NSO provider is displayed.

Step 7 Edit the configuration fields to match the requirements of your environment. Click **Save** to save your changes.

Add Cisco SR-PCE Providers

Cisco Segment Routing Path Computation Elements (Cisco SR-PCE) providers supply device discovery, management, configuration-maintenance and route-calculation services to the Cisco Crosswork applications. At least one SR-PCE provider is required in order to learn and discover SR policies, Layer 3 links, and devices. You have the option to configure a second SR-PCE as a backup. Both SR-PCE devices must be connected to the same network as does not support managing more than one domain.

Note To enable Cisco Crosswork application access to an SR-PCE as an SDN controller on the management domain, SR-PCE needs to be added as a provider.

Follow the steps below to add (through the UI) one or more instances of Cisco SR-PCE as providers.

Before you begin

You will need to:

- Create a credential profile for the Cisco SR-PCE provider (see Create Credential Profiles, on page 116). This should be a basic HTTP text-authentication credential (currently, MD5 authentication is not supported). If the Cisco SR-PCE server you are adding does not require authentication, you must still supply a credential profile for the provider, but it can be any profile that does not use the HTTP protocol.
- Know the name you want to assign to the Cisco SR-PCE provider. This is usually the DNS hostname of the Cisco SR-PCE server.
- Know the Cisco SR-PCE server IP address.
- Know the interface you want to use to communicate between Cisco SR-PCE and the Cisco Crosswork application server.
- Determine whether you want to auto-onboard the devices that Cisco SR-PCE discovers and, if so, whether you want the new devices to have their management status set to **`off`**, **`managed`** or **`unmanaged`** when added.
- If you plan to auto-onboard devices that the Cisco SR-PCE provider discovers, and set them to a managed state when they are added to the database:
  - Assign an existing credential profile for communication with the new managed devices.
  - The credential profile must be configured with an SNMP protocol.
- For high availability, ensure that you set up two separate Cisco SR-PCE providers with unique names and IP addresses, but with matching configurations .

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⊞.

Step 3 Enter the following values for the SR-PCE provider fields:

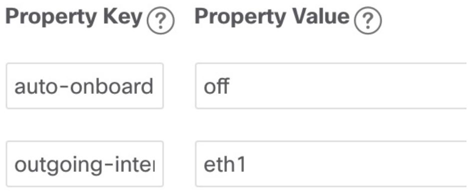
a) Required fields:

- **Provider Name**: Name of the SR-PCE provider.
- **Credential Profile**: Select the previously created Cisco SR-PCE credential profile.
- **Family**: Select **SR_PCE**. All other options should be ignored.
- **Protocol**: Select **HTTP**.
- **IP Address/ Subnet Mask**: Enter the IP address (IPv4 or IPv6) and subnet mask of the server.
- **Port**: Enter 8080 for the port number.
- **Provider Properties**: Enter one of the following key/value pairs in the first set of fields:

Property Key	Value
auto-onboard	**off** **Note** Use this option if you plan to manually (via UI or CSV import) enter all of your network devices. When devices are discovered, the device data is recorded in the Cisco SR-PCE database, but is not registered in Cisco Crosswork Inventory Management database.
auto-onboard	**unmanaged** If this option is enabled, all devices that Cisco Crosswork discovers will be registered in the Cisco Crosswork Inventory Management database, with their configured state set to **unmanaged**. SNMP polling will be disabled for these devices, and no management IP information will be included. To get these devices into the **managed** state later, you will need to either edit them via the UI or export them to a CSV make modifications and then import the updated CSV. You can also assign credential profiles by adding them to the device CSV file before import (the credential profiles must already exist).

Property Key	Value
`auto-onboard`	**`managed`** This option is only available for IPv4 deployments. If this option is enabled, all devices that Cisco SR-PCE discovers will be registered in the Cisco Crosswork Inventory Management database, with their configured state set to **`managed`**. SNMP polling will be enabled for these devices, and Cisco SR-PCE will also report the management IP address (Router ID). The devices will be added with the credential profile associated with the device-profile key in the SR-PCE provider configuration. **Note** If you enable this option for an IPv6 deployment, devices will still register as **unmanaged** in the inventory.
`device-profile`	The name of a credential profile that contains SNMP credentials for all the new devices. **Note** This field is necessary only if **`auto-onboard`** is set to **`managed`** or **`unmanaged`**.
`outgoing-interface`	**`eth1`** **Note** You have to set this only if you want to enable Cisco Crosswork application access to SR-PCE via the data network interface when using the two NIC configuration.
`topology`	**`off`** or **`on`**. This is an optional property. If not specified, the default value is **`on`**. If value is specified as **`off`**, it means that L3 topology is not accessible for the SR-PCE provider.
`pce`	**`off`** or **`on`**. This is an optional property. If not specified, the default value is **`on`**. If value is specified as **`off`**, it means that LSPs and policies are not accessible for the SR-PCE provider.

Figure 15: Provider Property Key and Value Example



Property Key ?	Property Value ?
auto-onboard	off
outgoing-inter	eth1

Note If **managed** or **unmanaged** options are set and you want to delete a device later, you must do one of the following:.

- Reconfigure and remove the devices from the network before deleting the device from Cisco Crosswork. This avoids Cisco Crosswork from rediscovering and adding the device back.
- Set auto-onboard to **off**, and then delete the device from Cisco Crosswork. However, doing so will not allow Cisco Crosswork to detect or auto-onboard any new devices in the network.

b) Optional values:

- **Timeout**: The amount of time (in seconds) to wait before timing out the connection to the SR-PCE server. The default is 30 seconds.

Step 4 When you have completed entries in all of the required fields, click **Save** to add the SR-PCE provider.

Step 5 Confirm that the SR-PCE provider shows a green Reachability status without any errors. You can also view the Events window (**Administration** > **Events**) to see if the provider has been configured correctly.

Step 6 Repeat this process for each SR-PCE provider.

Note It is not recommended to modify auto-onboard options once set. If you need to modify them, do the following:

1. Delete the provider and wait until deletion confirmation is displayed in the Events window.
2. Re-add the provider with the updated auto-onboard option.
3. Confirm the provider has been added with the correct auto-onboard option in the Events window.

What to do next

- If you entered the **`auto-onboard`**/**`off`** pair, navigate to **Device Management** > **Network Devices** to add a devices.
- If you opted to automatically onboard devices, navigate to **Device Management** > **Network Devices** to view the device list. To add more node information such as geographical location details, export the device list (.csv), update it, and import it back. If geographical location data is missing, you will only be able to see device topology using the logical map.

Cisco SR-PCE Reachability Issues

You can find reachability issues raised in the Events table and reachability status in the **Providers** window (see Get Provider Details, on page 146). If the SR-PCE goes down, all links in the topology will display with the last known state since the SR-PCE cannot send any notification updates. When the SR-PCE becomes reachable again, a message will show in the **Events** table (⚑) that SR-PCE is reconnected and the topology will be updated accordingly. If you find that the SR-PCE goes down for an extended amount of time, it is not syncing, updates are not happening, then delete the SR-PCE and add it back (when connectivity returns) using the UI:

1. Execute the following command:

```
# process restart pce_server
```

2. From the UI, navigate to **Administration** > **Manage Provider Access** and delete the SR-PCE provider and then add it back again.

You can also troubleshoot reachability as follows:

Step 1 Check device credentials.

Step 2 Ping the provider host.

Step 3 Attempt a connection using the protocols specified in the connectivity settings for the provider. For an SR-PCE provider, it is typically HTTP and port 8080.

Step 4 Check your firewall setting and network configuration.

Step 5 Check the Cisco SR-PCE host or intervening devices for Access Control List settings that might limit who can connect.

Multiple Cisco SR-PCE HA Pairs

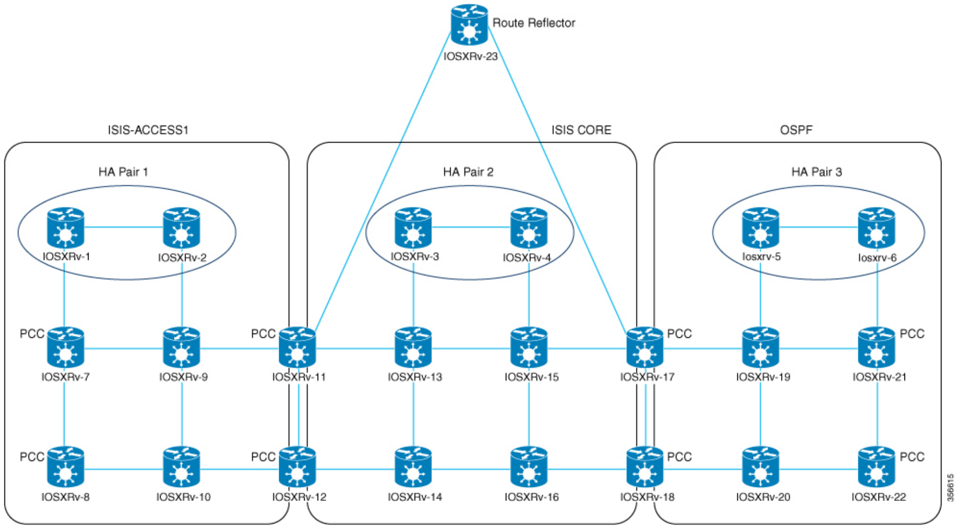
You can set up to six Cisco SR-PCE HA pairs (total of 12 SR-PCEs) to ensure high availability (HA). Each HA pair of Cisco SR-PCE providers must have matching configurations, supporting the same network topology. In HA, if the primary SR-PCE becomes unreachable, Cisco Crosswork Optimization Engine uses the secondary SR-PCE to discover the network topology. If this pair fails, then the next HA pair takes over and so forth. The network topology will continue to be updated correctly and you can view SR-PCE connectivity events in the Events table (⚑).

Multiple HA Pairs

In the case of multiple SR-PCE HA pairs, each SR-PCE pair sees the same topology but manages and only knows about tunnels created from its Path Computation Clients (PCCs). The following figure is a sample of a three SR-PCE HA pair topology. Note the following:

- HA Pair 1—PCE iosxrv-1 and iosxrv-2 provisions and discovers *only* tunnels whose headends are iosxrv-7 and iosxrv-8. Note that iosxrv-9 and iosxrv-10 are not PCC routers.
- HA Pair 2—PCE iosxrv-3 and iosxrv-4 provisions and discovers *only* tunnels whose headends are iosxrv-11, iosxrv-12, iosxrv-17, and iosxrv-18. Note that iosxrv-13, iosxrv-14, iosxrv-15, and iosxrv-16 are not PCC routers.
- HA Pair 3—PCE iosxrv-5 and iosxrv-6 provisions and discovers *only* about tunnels whose headends are iosxrv-21, and iosxrv-22. Note that iosxrv-19, and iosxrv-20 are not PCC routers.

Figure 16: Sample 3 HA Pair Topology



Note If any of the SR-PCEs are included in a *subset* of the main network topology, then that SR-PCE provider must be added with the Property Key as **topology** and the Property Value as **off**. When this value is set, then this SR-PCE will not be used to learn the topology.

Configure HA

The following configurations must be done to enable each pair of HA Cisco SR-PCE providers to be added in Cisco Crosswork Optimization Engine.

Note There must be resilient IPv4 connectivity between both SR-PCEs to enable HA. The PCE IP address of the other SR-PCE should be reachable by the peer at all times.

Issue the following commands on *each* of the Cisco SR-PCE devices:

Enable the interface:

```
# interface <interface><slot>/<port>
ipv4 address <sync-link-interface-ip-address> <subnet-mask>
no shut
```

Enable HA:

```
# pce rest sibling ipv4 <other-node-pce-address>
```

Establish a sync link between the two SR-PCEs:

```
# router static
address-family ipv4 unicast
<other-node-pce-ip-address>/<subnet-mask-length> <remote-sync-link-ip-address>
```

(Optional) `# pce segment-routing traffic-eng peer ipv4 <other-node-pce-ip-address>`

It should be entered for each PCC and not for other PCE nodes.

Issue the following command on the PCC:

For SR Policies: `# segment-routing traffic-eng pcc redundancy pcc-centric`

For RSVP-TE Tunnels: `# mpls traffic-eng pce stateful-client redundancy pcc-centric`

Confirm Sibling SR-PCE Configuration

From the SR-PCE, enter the `show tcp brief` command to verify synchronization between SR-PCEs in HA are intact:

```
#show tcp brief | include <remote-SR-PCE-router-id>
```

Confirm that following information is correct:

Local Address	Foreign Address	State
<local-SR-PCE-router-id>:8080	*<remote-SR-PCE-router-id>*:*<any-port-id>*	ESTAB
<local-SR-PCE-router-id>:*<any-port-id>*	*<remote-SR-PCE-router-id>*:8080	ESTAB

For example:

```
RP/0/0/CPU0:iosxrv-1#sh tcp brief | i 192.168.0.2:
Mon Jun 22 18:43:09.044 UTC
0x153af340 0x60000000 0 0 192.168.0.1:47230 192.168.0.2:8080 ESTAB
0x153aaa6c 0x60000000 0 0 192.168.0.1:8080 192.168.0.2:16765 ESTAB
```

In this example, 192.168.0.2 is the remote SR-PCE IP.

SR-PCE Delegation

Depending on where an SR-TE policy is created, the following SR-PCE delegation occurs:

- SR-PCE initiated—Policies configured on a PCE. SR-TE policies are delegated back to the source SR-PCE.

Note
- The policy can be PCE initiated even if it is created using the UI, but in that case it is not configured explicitly on SR-PCE.
- RSVP-TE tunnels cannot be configured directly on a PCE.

- PCC initiated—An SR-TE policy or RSVP-TE tunnel that is configured directly on a device. The SR-PCE configured with the lowest precedence is the delegated SR-PCE. If precedence is not set, then SR-PCE with the lowest PCE IP address is the delegated SR-PCE. The following configuration example, shows that **10.0.0.1** is assigned a precedence value of 10 and will be the delegated SR-PCE.

```
segment-routing
  traffic-eng
    pcc
      source-address ipv4 10.0.0.2
      pce address ipv4 10.0.0.1
        precedence 10
       !
      pce address ipv4 10.0.0.8
        precedence 20
       !
       report-all
       redundancy pcc-centric
```

For RSVP-TE Tunnel:

```
mpls traffic-eng
interface GigabitEthernet0/0/0/0
!
interface GigabitEthernet0/0/0/1
!
interface GigabitEthernet0/0/0/2
!
pce
  peer source ipv4 192.168.0.02
  peer ipv4 192.168.0.9
    precedence 10
  !
  peer ipv4 192.168.0.10
    precedence 20
  !
  stateful-client
   instantiation
   report
   redundancy pcc-centric
   autoroute-announce
  !
!
auto-tunnel pcc
  tunnel-id min 1000 max 5000
```

- Cisco Crosswork SR-PCE initiated—An SR-TE policy that is configured using Cisco Crosswork. SR-PCE delegation is random per policy.

Note Only SR-TE policies or RSVP-TE tunnels created by Cisco Crosswork Optimization Engine can be modified or deleted by Cisco Crosswork Optimization Engine.

HA Notes and Limitations

- It is assumed that all PCCs are PCEP connected to both SR-PCEs.
- When an SR-PCE is disconnected only from Cisco Crosswork, the following occurs:
  - SR-PCE delegation assignments remain, but the SR-PCE that has been disconnected will not appear in Cisco Crosswork.
  - You are not able to modify Cisco Crosswork SR-PCE initiated SR-TE policies if the disconnected SR-PCE is the delegated PCE.
- In some cases, when an SR-TE policy that was created via the UI is automatically deleted (intentional and expected) from Cisco Crosswork Optimization Engine, a warning message does not appear. For example, if the source PCC is reloaded, the UI created SR policy disappears and the user is not informed.
- In an extreme case where one SR-PCE fails on all links (to PCCs/topology devices) except the up-link to Cisco Crosswork Optimization Engine, then topology information will not be accurate in Cisco

Crosswork Optimization Engine. When this happens, fix the connectivity issue or delete both SR-PCEs from the Provider page and re-add the one that is reachable.

SR-PCE Configuration Examples

The following configurations are *examples* to guide you in a multiple SR-PCE setup for HA. Please modify accordingly.

Sample redundant SR-PCE configuration (on PCE with Cisco IOS-XR 7.x.x)

```
pce
 address ipv4 192.168.0.7
 state-sync ipv4 192.168.0.6
 api
  sibling ipv4 192.168.0.6
```

Sample redundant SR-PCE Configuration (PCC)

```
segment-routing
 traffic-eng
  pcc
   source-address ipv4 192.0.2.1
   pce address ipv4 192.0.2.6
    precedence 200
   !
   pce address ipv4 192.0.2.7
    precedence 100
   !
   report-all
   redundancy pcc-centric
```

Sample redundant SR-PCE Configuration (on PCC) for RSVP-TE

Note `Loopback0` represents the TE router ID.

```
ipv4 unnumbered mpls traffic-eng Loopback0
!
mpls traffic-eng
 pce
  peer source ipv4 209.165.255.1
  peer ipv4 209.165.0.6
   precedence 200
  !
  peer ipv4 209.165.0.7
   precedence 100
  !
  stateful-client
   instantiation
   report
   redundancy pcc-centric
   autoroute-announce
  !
 !
 auto-tunnel pcc
  tunnel-id min 1000 max 1999
 !
!
```

Sample SR-TM Configuation

```
telemetry model-driven
 destination-group crosswork
  address-family ipv4 198.18.1.219 port 9010
   encoding self-describing-gpb
   protocol tcp
  !
 !
 sensor-group SRTM
  sensor-path Cisco-IOS-XR-infra-tc-oper:traffic-collector/afs/af/counters/tunnels
  sensor-path
Cisco-IOS-XR-infra-tc-oper:traffic-collector/vrf-table/default-vrf/afs/af/counters/prefixes

 !
 subscription OE
  sensor-group-id SRTM sample-interval 60000
  destination-id crosswork
  source-interface Loopback0
!
traffic-collector
 interface GigabitEthernet0/0/0/3
 !
 statistics
  history-size 10
```

Note The destination address uses the southbound data interface (eth1) address of the Cisco Crosswork Data Gateway VM.

It is required to push sensor path on telemetry configuration via NSO to get prefix and tunnel counters. It is assumed that the Traffic Collector has been configured with all the traffic ingress interface. This configuration is needed for demands in the Bandwidth on Demand and Bandwidth Optimization function packs to work.

Telemetry Sensor Path

```
sensor-path Cisco-IOS-XR-infra-tc-oper:traffic-collector/afs/af/counters/tunnels/tunnel
sensor-path
Cisco-IOS-XR-infra-tc-oper:traffic-collector/vrf-table/default-vrf/afs/af/counters/prefixes/prefix
```

Telemetry configuration pushed by Cisco Crosswork Optimization Engine to all the headend routers via NSO

```
telemetry model-driven
  destination-group CW_43dc8a5ea99529715899b4f5218408a785e40fce
    vrf default
    address-family ipv4 172. 19.68.206 port 31500
      encoding self-describing-gpb
      protocol top
    !
  !
destination-group CW_4b3c69a200668b0a8dc155caff295645c684a8f8
  vrf default
  address-family ipv4 172. 19.68.206 port 31500
    encoding self-describing-gpb
    protocol top
  !
!
sensor-group CW_43dc8a5ea99529715899b4f5218408a785e40fce
  sensor-path Cisco-IOS-XR-infra-tc-oper:traffic-collector/afs/af/counters/tunnels/tunnel
!
```

```
sensor-group CW_4b3c69a200668b0a8dc155caff295645c684a8f8
  sensor-path
Cisco-IOS-XR-infra-tc-oper:traffic-collector/vrf-table/default-vrf/afs/af/counters/prefixes/prefix
!
subscription CW_43dc8a5ea99529715899b4f5218408a785e40fce
  sensor-group-id CW_43dc8a5ea99529715899b4f5218408a785e40fce sample-interval 300000
  destination-id CW_43dc8a5ea99529715899b4f5218408a785e40fce
!
subscription CW_4b3c69a200668b0a8dc155caff295645c684a8f8
  sensor-group-id CW_4b3c69a200668b%a8dc155caff295645c684a8f8 sample-interval 300000
  destination-id CW_463c69a200668b0a8dc155caff295645c684a8f8
  !
!
```

Traffic Collector configurations (all Ingress traffic interface to be added below in the Traffic Collector)

```
RP/0/RSP0/CPU0:PE1-ASR9k#sh running-config traffic-collector
Fri May 22 01:14:35.845 PDT
traffic-collector
  interface GigabitEthernet0/0/0/0
  !
  statistics
    history-size 1
    collection-interval 1
    history-timeout 1
    history-minute-timeout
  !
!
```

Add BGP neighbor next-hop-self for all the prefix (to show TM rate counters)

```
bgp router-id 5.5.5.5
address-family ipv4 unicast
  network 5.5.5.5/32
  redistribute static
!
address-family link-state link-state
!
neighbor 1.1.1.1
  remote-as 65000
  update-source Loopback0
  address-family ipv4 unicast
   next-hop-self
  !
!
```

Traffic collector tunnel and prefix counters

```
RP/0/RSP0/CPU0:PE1-ASR9k#show traffic-collector ipv4 counters prefix
Fri May 22 01:13:51.458 PDT
Prefix              Label         Base rate         TM rate        State
                                  (Bytes/sec)       (Bytes/sec)
-----------------  -------------  ---------------  --------------  -----------------
1.1.1.1/32          650001         3                0              Active
2.2.2.2/32          650002         3                0              Active
3.3.3.3/32          650003         6                0              Active
4.4.4.4/32          650004         1                0              Active
6.6.6.6/32          650200         6326338          6326234        Active
7.7.7.7/32          650007         62763285         62764006       Active
8.8.8.8/32          650008         31129168         31130488       Active
9.9.9.9/32          650009         1                0              Active
10.10.10.10/32      650010         1                0              Active
RP/0/RSP0/CPU0:PE1-ASR9k#stt
RP/0/RSP0/CPU0:PE1-ASR9k#show traffic-collector ipv4 counters tunnel
Fri May 22 01:13:52.169 PDT
RP/0/RSP0/CPU0:PE1-ASR9k#]
```

Path Computation Client (PCC) Support

PCCs can support delegation and reporting of both RSVP-TE tunnels and SR policies to SR-PCE. In order for both to be supported on the same PCC, two separate PCEP connections must be established with the SR-PCEs. Each PCEP connection must have a distinct source IP address (Loopback) on the PCC.

The following is a Cisco IOS-XR configuration example of PCEP connections for RSVP-TE, where 192.168.0.2 is the PCEP session source IP for RSVP-TE tunnels delegated and reported to SR-PCE. It is a loopback address on the router. Two SR-PCEs are configured for PCEP sessions, where the first will be preferred for delegation of RSVP-TE tunnels due to precedence. Auto-tunnel PCC is configured with a range of tunnel IDs that will be used for assignment to PCE-initiated RSVP-TE tunnels like those created in Cisco Crosswork Optimization Engine.

```
mpls traffic-eng
interface GigabitEthernet0/0/0/2
admin-weight 1
!
interface GigabitEthernet0/0/0/3
admin-weight 1
  pce
    peer source ipv4 192.168.0.2
    peer ipv4 192.168.0.1
      precedence 10
     !
    peer ipv4 192.168.0.8
      precedence 11
     !
    stateful-client
      instantiation
      report
     !
   !
   auto-tunnel pcc
    tunnel-id min 10 max 1000
   !
!
ipv4 unnumbered mpls traffic-eng Loopback0

rsvp
interface GigabitEthernet0/0/0/2
bandwidth 1000000
!
interface GigabitEthernet0/0/0/3
bandwidth 1000000
!
!
```

Add Cisco WAE Providers

Cisco WAN Automation Engine (Cisco WAE) providers supply traffic and topology analysis to the Cisco Crosswork applications. The foundation software is Cisco WAE Planning, which provides a cross-sectional view of traffic, topology, and equipment state. It takes advantage of a predictive model that performs "what if" analysis of failure impacts.

Follow the steps below to use the UI to add one or more instances of Cisco WAE as providers. You can also add providers using CSV files (see Import Providers, on page 145).

Before you begin

You will need to:

- Create a credential profile for the Cisco WAE provider (see Create Credential Profiles, on page 116). This should be a basic HTTP/HTTPS text-authentication credential (currently, MD5 authentication is not supported). If the Cisco WAE server you are adding does not require authentication, you must still supply a credential profile for the provider, but it can be any profile that does not use the HTTP/HTTPS protocol.
- Know the name you want to assign to the provider. This is usually the DNS hostname of the Cisco WAE server.
- Know the Cisco WAE server IP address and port. The connection protocol will be HTTP or HTTPS.

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⊞.

Step 3 Enter the following values for the provider fields:

a) Required fields:

- **Provider Name**: Name of the Cisco WAE provider.
- **Credential Profile**: Select the previously created credential profile.
- **Family**: Select **`WAE`**.
- **Protocol**: Select **`HTTP`** or **`HTTPS`** respectively as per the credential profile you are using.
- **IP Address/ Subnet Mask**: Enter the IP address (IPv4 or IPv6) and subnet mask of the server.
- **Port**: Enter the port number (usually, `8080` for HTTP, and `8843` for HTTPS).

b) Optional values:

- **Timeout**: The amount of time (in seconds) to wait before timing out the connection to the server. The default is 30 seconds.

Step 4 When you have completed entries in all of the required fields, click **Save** to add the provider.

Add Syslog Storage Providers

Storage providers supply storage for data collected during Playbook execution.

Follow the steps below to use the UI to add one or more storage providers. You can also add providers using CSV files (see Import Providers, on page 145).

Before you begin

You will need to:

- Create a credential profile for the storage provider (see Create Credential Profiles, on page 116). This should be an SSH credential.
- Know the name you want to assign to the storage provider. This is usually the DNS hostname of the server.

- Know the storage provider's server IPv4 address and port. The connection protocol will be SSH.
- Know the destination directory on the storage provider's server. You will need to specify this using the **Provider Properties** fields.

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⊞.

Step 3 Enter the following values for the provider fields:

a) Required fields:

- **Provider Name**: Name of the storage provider.
- **Credential Profile**: Select the previously created storage credential profile.
- **Family**: Select `SYSLOG_STORAGE`.
- **Protocol**: Select `SSH` to be protocol that Cisco Crosswork application will use to connect to the provider.
- **IP Address/ Subnet Mask**: Enter the IP address (IPv4 or IPv6) and subnet mask of the server.
- **Port**: Enter the port number (usually, `22` for SSH.
- **Provider Properties**: Enter the following key/value pair in these fields:

Property Key	Property Value
`DestinationDirectory`	The absolute path where the collected data will be stored on the server. For example: `/root/cw-syslogs`

b) Optional values:

- **Timeout**: The amount of time (in seconds) to wait before timing out the connection to the storage server.

Step 4 When you have completed entries in all of the required fields, click **Save** to add the syslog storage provider.

Add an Alert Provider

An Alert provider is a destination to which you want to forward alerts collected during KPI monitoring (such as Cisco Crosswork Situation Manager). An alert provider must be capable of receiving and processing incoming alert packages.

Follow the steps below to use the UI to add an alert provider. You can also add the alert provider by importing a CSV file (see Import Providers, on page 145).

Currently, only one alert provider is supported.

Before you begin

You will need to:

- Create a credential profile for the alert provider (see Create Credential Profiles, on page 116). This should be a basic HTTP text-authentication credential (currently, MD5 authentication is not supported). If the provider does not require authentication, you must still supply a credential profile for the provider, but it can be any profile that does not use the HTTP protocol.
- Know the name you want to assign to the alert provider. This is usually the DNS hostname of the server.
- Know the alert server IPv4 address and port. The connection protocol will be HTTP.
- Know the URL of the alert server endpoint. You will need to specify this using the **Property Value** field.

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⊞.

Step 3 Enter the following values for the provider fields:

a) Required fields:

- **Provider Name**: Name of the alert provider.
- **Credential Profile**: Select the previously created alert provider credential profile.
- **Family**: Select **`ALERT`**.
- **Protocol**: **`HTTP`** is pre-selected.
- **IP Address/ Subnet Mask**: Enter the IP Address (IPv4 or IPv6) and subnet mask of the alert server.
- **Port**: Enter the port number (usually, 80 for HTTP).
- **Provider Properties**: The **`alertEndpointUrl`** property key name is pre-entered. In the Property Value field, enter the alert server endpoint only. For example, if the complete path to the endpoint is **`http://aws.amazon.com:80/myendpoint/bar1/`**, you would enter **`/myendpoint/bar1/`** only.

b) Optional values:

- **Timeout**: The amount of time (in seconds) to wait before timing out the connection to the alert server.

Step 4 When you have completed entries in all of the required fields, click **Save** to add the alert provider.

Add Proxy Providers

Follow the steps below to use the UI to add one or more instances of Proxy as providers. You can also add providers using CSV files (see Import Providers, on page 145).

Before you begin

You will need to:

- Create a credential profile for the Proxy provider (see Create Credential Profiles, on page 116). This should be a basic HTTPS text-authentication credential.
- Know the name you want to assign to the provider. This is usually the DNS hostname of the Proxy server.

- Know the Proxy server IP address and port. The connection protocol will be HTTPS.

Step 1 From the main menu, choose **Admin** > **Providers**.

Step 2 Click ⊞.

Step 3 Enter the following values for the provider fields:

a) Required fields:

- **Provider Name**: Name of the Proxy provider.
- **Credential Profile**: Select the previously created credential profile.
- **Family**: Select `PROXY`.
- **Protocol**: Select `HTTPS`.
- **IP Address/ Subnet Mask**: Enter the IP address (IPv4 or IPv6) and subnet mask of the server.
- **Port**: Enter the port number (usually, `30603` for HTTPS).

b) Optional values:

- **Timeout**: The amount of time (in seconds) to wait before timing out the connection to the server. The default is 30 seconds.

Step 4 When you have completed entries in all of the required fields, click **Save** to add the provider.

Import Providers

Complete the steps below to create a CSV file that specifies providers and then import it into the Cisco Crosswork application.

Importing providers from a CSV file adds any providers not already in the database, and updates any providers with the same name as an imported provider. For this reason, it is a good idea to export a backup copy of all your current providers before an import (see Export Providers, on page 148).

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 Click ⇤ to open the **Import CSV File** dialog box.

Step 3 If you have not already created a provider CSV file to import:

a) Click the **Download sample 'Provider template (*.csv)' file** link and save the CSV file template to a local storage resource.

b) Open the template using your preferred tool. Begin adding rows to the file, one row for each provider.

Use a semicolon to separate multiple entries in the same field. Use two semicolons with no space between them to indicate that you are leaving the field blank. When you separate entries with semicolons, the order in which you enter values is important. For example, if you enter `SSH;SNMP;NETCONF;TELNET` in the **connectivity_type** field and you enter `22;161;830;23` in the **connectivity_port** field, the order of entry determines the mapping between the two fields:

- SSH: port 22

- SNMP: port 161
- NETCONF: port 830
- Telnet: port 23

Be sure to delete the sample data rows before saving the file, or they will be imported along with the data you want. The column header row can stay, as it is ignored during import.

c) When you are finished, save the new CSV file.

Step 4 Click **Browse** to navigate to the CSV file you just created and then click **Open** to select it.

Step 5 With the CSV file selected, click **Import**.

The provider information you imported should now be displayed in the **Providers** window.

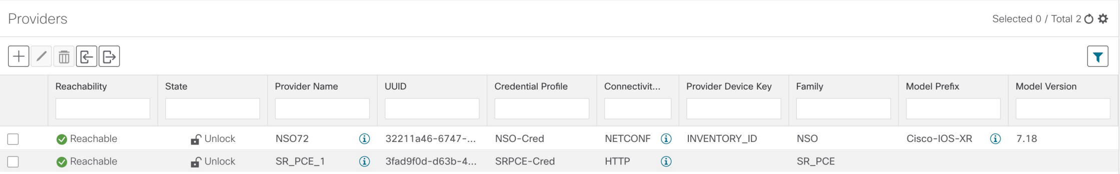
Step 6 Resolve any errors reported during the import and check provider details to confirm connection.

Get Provider Details

Use the **Providers** window to get details about your providers and to check on their reachability.

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.
For each provider configured in the Cisco Crosswork application, the **Providers** window lists information such as the provider's name, universally unique identifier (UUID), associated credential profile and more, as shown in the figure below.

Figure 17: Providers Window



Providers

Selected 0 / Total 2

	Reachability	State	Provider Name	UUID	Credential Profile	Connectivit...	Provider Device Key	Family	Model Prefix	Model Version
□	✓ Reachable	Unlock	NSO72 ⓘ	32211a46-6747-...	NSO-Cred	NETCONF ⓘ	INVENTORY_ID	NSO	Cisco-IOS-XR ⓘ	7.18
□	✓ Reachable	Unlock	SR_PCE_1 ⓘ	3fad9f0d-d63b-4...	SRPCE-Cred	HTTP ⓘ		SR_PCE		

Step 2 The icons in the **Reachability** column indicate whether a provider is reachable via the listed connectivity protocols. For more information, see Device State, on page 166.

Cisco Crosswork application checks provider reachability immediately after a provider is added or modified. Other than these events, Crosswork Change Automation and Health Insights checks reachability every 5 minutes and Crosswork Optimization Engine checks SR-PCE reachability about every 10 seconds.

Step 3 Get additional details for any provider, as follows:

a) In the **Provider Name** column, click the ⓘ to view provider-specific key/value properties.

b) In the **Connectivity Type** column, click the ⓘ to view detailed connectivity information for the provider, such as provider-specific protocol, IP format, IP address, port, and timeout information.

c) In the **Model Prefix** column, click the ⓘ to view the supported NED version(s) for a Cisco Network Services Orchestrator (Cisco NSO) provider's configured NED model prefix(es).

d) When you are finished, click ✕ to close the details window.

If you are running into Cisco SR-PCE reachability problems, see Cisco SR-PCE Reachability Issues, on page 134. Check that HTTP and port 8080 is set.

For general provider reachability problems, you can troubleshoot as follows:

a. Ping the provider host.

b. Attempt a connection using the protocols specified in the connectivity settings for the provider. .

The following CLI command can be used to perform this check:

```
curl -v -H "X-Subscribe: stream" "http://<ip-address>:8080/
bwod/subscribe/json?keepalive-30&priority=5"
```

c. Check your firewall setting and network configuration.

d. Check the provider host or intervening devices for Access Control List settings that might limit who can connect.

Edit Providers

When editing provider settings, be aware that a provider can be mapped to many devices, even thousands of devices in a large network.

Note

- Before making any changes to a provider configuration you should be certain that you understand the full impact of the change. If you are unsure about the potential risk of making a change, contact Cisco services for guidance.
- See Add Cisco SR-PCE Providers, on page 130 before modifying an SR-PCE provider. There are additional steps that must be done when editing an SR-PCE provider.

.

Before editing any provider, it is always good practice to export a CSV backup of the providers you want to change (see Export Providers, on page 148).

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 In the **Providers** window, choose the provider you want to update and click ✎.

Step 3 Make the necessary changes and then click **Save**.

Step 4 Resolve any errors and confirm provider reachability.

Delete Providers

Follow the steps below to delete a provider.

You are alerted when you try to delete a provider that is associated with one or more devices or credential profiles.

Step 1 Export a backup CSV file containing the provider you plan to delete (see Export Providers, on page 148).

Step 2 (Optional) Check whether any devices are mapped to the provider and change the provider before deletion.

a) From the main menu, choose **Device Management** > **Network Devices**. The **Network Devices** tab is displayed by default.
b) In the **Network Devices** window, enter the obsolete provider name in the **Search** field.
c) Check the check box for the device that is mapped to the obsolete provider, and click ✎.
d) Choose a different provider from the **Provider** drop-down list.
e) Click **Save**.

Step 3 Delete the provider as follows:

a) From the main menu, choose **Administration** > **Manage Provider Access**.
b) In the **Providers** window, choose the provider(s) that you want to delete and click 🗑.
c) In the confirmation dialog box, click **Delete**.

Export Providers

You can quickly export provider data to a CSV file. This is a handy way to keep backup copies of your provider information.

Note You cannot edit a CSV file and then re-import it to update existing providers.

Step 1 From the main menu, choose **Administration** > **Manage Provider Access**.

Step 2 (Optional) In the **Providers** window, filter the provider list as needed.

Step 3 Check the check boxes for the providers you want to export. Check the check box at the top of the column to select all the providers for export.

Step 4 Click ⇨. Depending on your browser, you will be prompted to select a path and file name to use when saving the CSV file, or to open it immediately.

Manage Tags

Use the **Tag Management** window to manage the tags available for assignment to the devices in your network. Tags can provide information such as the device's physical location and its administrator's email ID, and are used to group devices.

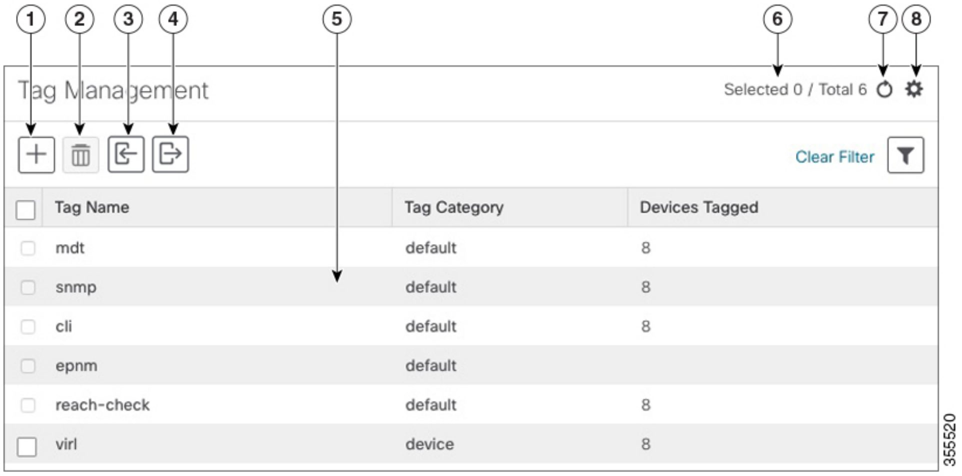
To open this window, choose **Administration** > **Tags**.

Note Cisco Crosswork applications automatically create a default set of tags and assign them to every device they manage:

- cli
- mdt
- reach-check
- snmp
- clock-drift-check

You cannot select, edit, delete, or manually associate these default tags with any device.

Figure 18: Tag Management Window



Tag Management

Selected 0 / Total 6

Clear Filter

Tag Name	Tag Category	Devices Tagged
mdt	default	8
snmp	default	8
cli	default	8
epnm	default	
reach-check	default	8
virl	device	8

Item	Description
1	Click + to create new device tags. See Create Tags, on page 150.
2	Click 🗑 to delete currently selected device tags. See Delete Tags, on page 152.
3	Click ⇦ to import the device tags defined in a CSV file into the Cisco Crosswork application. See Import Tags, on page 151. You can also download a CSV file template by clicking this icon. The template includes sample data that you can use as a guide for building your own CSV file.
4	Click ⇨ to export a CSV file that lists the tags that are currently configured and their attributes. You can update this file and import it back into the Cisco Crosswork application to quickly add or edit multiple tags. See Export Tags, on page 152.
5	Displays the tags and their attributes currently available in the Cisco Crosswork application.

Item	Description
6	Indicates the number of tags that are currently selected in the table.
7	Click ⟳ to refresh the **Tag Management** window.
8	Click ⚙ to choose the columns to make visible in the **Tag Management** window.
	Click ⏷ to set filter criteria on one or more columns in the **Tag Management** window.
	Click the **Clear Filter** link to clear any filter criteria you may have set.

Create Tags

You can create as many tags and tag categories as you want. If you will have many tags, it might be quicker to list them in a CSV file and import the file, instead of creating each tag individually. See Import Tags, on page 151.

Note

- Tag and tag category names are case-insensitive and can contain a maximum of 128 alphanumeric characters, plus dots (.), underscores ("_") or hyphens ("-"). No other special characters are allowed.
- The maximum number of tags that you can create is 100.

Step 1 From the main menu, choose **Administration** > **Tags**. The **Tag Management** window opens.

Step 2 Click ⊞. The **Create New Tags** pane opens.

Step 3 In the **Category** area:

- To associate your new tags with an existing category: Choose the category from the drop-down list.
- To associate your new tags with a new category: Click the **New Category** link, enter the new category's name in the text field, and click **Save**.

All the new tags you create after this step will be assigned to the category you selected or created.

Step 4 In the **Tags** area: Start entering the names of the new tags that you want to create. Press **Return** after you type each tag.

To keep from entering duplicate tags, click the **Show Tags** link. The **Create New Tags** window will list only the tags that already exist in your currently selected category.

Step 5 When you are finished entering new tags, click **Save**.

What to do next

Add tags to devices. See Apply or Remove Device Tags, on page 151.

Import Tags

Complete the steps below to create a CSV file that lists the tags you want to apply to your devices, and then import it into the Cisco Crosswork applications. This is the easiest way to create a lot of new tags and tag categories quickly.

When you import the CSV file, any tags not already in the database will be added. Tags with the same name as an imported tag will be overwritten. For this reason, it is a good idea to export a backup copy of all your current tags before import (see Export Tags, on page 152).

Step 1 From the main menu, choose **Admin** > **Tags**.

Step 2 Click to open the **Import CSV File** dialog box.

Step 3 If you have not already created a CSV file to import:

a) Click the **Download sample 'Tags template (*.csv)' file** link and save the CSV file template to a local storage resource.

b) Open the template using your preferred tool. Begin adding rows to the file, one row for each tag. Use a comma to delimit each field within a row. Use a semicolon to separate multiple entries in the same field.

Field	Description	Required or Optional
Tag Name	Enter the name of the tag. For example: `SanFrancisco` or `Spine/Leaf`.	Required
Tag Category	Enter the tag category. For example: `City` or `Network Role`.	Required

Note **Tag Name** and **Tag Category** fields are case-insensitive and can contain a maximum of 128 alphanumeric characters, plus dots (.), underscores ("_") or hyphens ("-"). No other special characters are allowed.

Be sure to delete the sample data rows before saving the file, or they will be imported along with the data you want. The column header row can stay, as it is ignored during import.

c) When you are finished, save the new CSV file.

Step 4 Click **Browse** to navigate to the CSV file you just created and then click **Open** to select it.

Step 5 With the CSV file selected, click **Import**.

The tags and tag categories that you imported should now be displayed in the **Tag Management** window.

What to do next

Add tags to devices. See Apply or Remove Device Tags, on page 151.

Apply or Remove Device Tags

Tags and their categories are your main tool for grouping devices. Once you have tagged a set of devices with the same tag, they are considered part of a group, and you can manage them more easily.

In order to apply a tag to a device or group of devices, the tag must already exist (see).

For efficiency, Cisco Crosswork automatically updates inventory data, including topology, for all the devices in a tagged group, as a single set of inventory collection jobs. But please note that tag-group membership is static for other functions.

You can apply a maximum of 15 tags to any one device.

To apply tags to a device or set of devices, do the following:

Step 1 From the main menu, choose **Device Management** > **Network Devices**. The **Network Devices** tab is displayed, showing the list of devices.

Step 2 (Optional) If the list is long, click ▼ to set one or more filters and narrow the list to only those devices you want to tag.

Step 3 Check the check box next to the device(s) you want to tag. If you select multiple devices, any changes you make will be applied to all the devices you selected.

Step 4 From the toolbar, click 🏷. The **Modify Tags** window opens, showing the tags currently applied to the device(s) you selected.

Step 5 Click in the **Type to autocomplete item** field to display the list of existing tags, or begin typing the name of the tag you want.

Step 6 Click on individual tags in the list to add them to the list of tags applied to the device(s). To delete an applied tag, click the X icon shown next to that tag.

Delete Tags

To delete device tags, do the following:

Note If the tag is mapped to any devices, then the tag cannot be deleted.

Step 1 Export a backup CSV file containing the tags you plan to delete (see Export Tags, on page 152).

Step 2 From the main menu, choose **Administration** > **Tags**. The **Tag Management** window is displayed.

Step 3 Check the check box next to the tags you want to delete.

Step 4 From the toolbar, click 🗑.

Step 5 The confirmation dialog box will list the number of devices currently using the tag(s) you are about to delete. Click **Delete** to confirm deletion.

Export Tags

You can quickly export tags and tag categories to a CSV file. This will allow you to keep backup copies of your tags. You can also edit the CSV file as needed, and re-import it to overwrite existing tags. Note that you will need to re-associate devices and tags in some cases.

Step 1 From the main menu, choose **Administration** > **Tags**.

Step 2 (Optional) In the **Tag Management** window, filter the tag list as needed.

Step 3 Check the check boxes for the tags you want to export. Check the check box at the top of the column to select all the tags for export.

Step 4 Click ⇨. Depending on your browser, you will be prompted to select a path and file name to use when saving the CSV file, or to open it immediately.

CHAPTER 6

Onboard and Manage Devices

This section contains the following topics:

Add Devices to the Inventory

There are different ways to add devices to Crosswork. Each has its own set of prerequisites, which you must fulfill if the device addition is to succeed. Ensure that your devices are configured properly for communication and telemetry. See guidelines and example configurations in Telemetry Prerequisites for New Devices, on page 157 and Sample Configuration for Cisco NSO Devices, on page 158.

In order of preference for most users, the methods and their prerequisites are:

1. **Importing devices using the Crosswork APIs:** : This is the fastest and most efficient of all the methods, but requires programming skills and API knowledge. For more, see the Inventory Management APIs On Cisco Devnet.

2. **Importing devices from a Devices CSV file**: This method is time-consuming and error-prone, as you must create and format all of the data yourself beforehand (including not only devices, but also the providers, credential profiles and tags), and then ensure all of these items are properly associated with the devices after the CSV import. To succeed with this method, you must first:

   - Create the provider(s) that will be associated with the devices. See About Adding Providers, on page 125.

   - Create corresponding credential profiles for all of the devices and providers listed in the CSV file. See Create Credential Profiles, on page 116.

   - Create tags for use in grouping the new devices. See Create Tags, on page 150.

   - Download the CSV template file from Crosswork and populate it with all the devices you will need.

3. **Adding them via the UI**: This method is the least error-prone of the three methods, as all data is validated during entry. It is also the most time-consuming, being suitable only for adding a few devices at a time. Note that the providers, credential profiles and tags you want to apply to them must exist beforehand. For more information, see Add Devices Through the UI, on page 158.
4. **Auto-onboarding from a Cisco SR-PCE provider**: This method is highly automated and relatively simple. Note that the device and provider credential profiles and tags you want to apply to these devices must exist beforehand. After onboarding devices from this source, you will need to edit each device to add device information that is not automatically discovered. For more information, see the provider properties in Add Cisco SR-PCE Providers, on page 130.
5. **Auto-onboarding using Zero Touch Provisioning**: This method is automated, but requires that you create device entries first and modify your installation's DHCP server. Note that the device and provider credential profiles and tags you want to apply to these devices must exist beforehand. After provisioning and onboarding devices using this method, you will need to edit each device to add information that is not automatically supplied. For more information, see Zero Touch Provisioning, on page 175.

Note Cisco Crosswork only supports single-stack deployment modes. The devices can be onboarded with either an IPv4 address or an IPv6 address, not both.

If a device onboarded in Cisco Crosswork is on the same subnet as a Cisco Crosswork Data Gateway interface, then it must be on the Cisco Crosswork Data Gateway's southbound network. This is because Cisco Crosswork Data Gateway implements RPF checks and the source address of devices cannot be on the management or northbound networks if multitple NICs (2 or 3 NIC) are deployed.

Note IOS XR devices (version 7.3.2 or 7.4.1) used for Crosswork Network Controller 3.0 requires NETCONF NED to be configured on Cisco NSO. By default, the NSO policy onboards devices to NSO with CLI NED. You can change to NETCONF NED using the following methods:

- **Before device onboarding:** Change the policy using the API request. For more information, see https://developer.cisco.com/docs/crosswork/#!cat-fp-deployment-manager-api.
- **After device onboarding:**
  1. Change device-type on NSO via cli command (For example, `set devices device <device-name> device-type NETCONF ned-id cisco-iosxr-nc-7.3`).
  2. Perform a device Sync-from operation (For example, `request devices device <device-name> sync-from`).

     Note Service provisioning may malfunction if the sync operation is not performed (for example, provisioning may display a successful status even when the configuration is not pushed to the device).

Telemetry Prerequisites for New Devices

Before onboarding new devices, you must ensure that the devices are configured to collect and transmit telemetry data successfully with Cisco Crosswork. The following sections provide sample configurations for several telemetry options, including SNMP, NETCONF, SSH and Telnet. Use them as a guide to configuring the devices you plan to manage.

Note Only SNMPv2 and SNMPv3 (NoAuth/NoPriv) traps are supported.

Pre-Onboarding Device Configuration

The following commands provide a sample pre-onboarding device configuration that sets the correct SNMPv2 and NETCONF configuration, and SSH and Telnet rate limits. The NETCONF setting is only needed if the device is MDT-capable.

```
logging console debugging
logging monitor debugging
telnet vrf default ipv4 server max-servers 100
telnet vrf default ipv6 server max-servers 100
crypto key generate rsa
 exec-timeout 0 0
 width 107
 length 37
 absolute-timeout 0
!
snmp-server community public RO
snmp-server community robot-demo2 RO
snmp-server ifindex persist
ntp
 server <NTPServerIPAddress>
!
ssh server v2
ssh server vrf default
ssh server netconf vrf default
ssh server logging
ssh server rate-limit 100
ssh server session-limit 100
!
netconf agent tty
!
netconf-yang agent
 ssh
!
```

SNMPv3 Pre-Onboarding Device Configuration

If you want to enable SNMPv3 data collection, repeat the SNMPv2 configuration commands in the previous section, and add the following commands:

```
snmp-server group grpauthpriv v3 priv notify v1default
snmp-server user <user-ID> grpauthpriv v3 auth md5 <password> priv aes 128 <password>
```

Sample Configuration for Cisco NSO Devices

If you plan to use Cisco Network Services Orchestrator (Cisco NSO) as a provider to configure devices managed by Cisco Crosswork, be sure that the Cisco NSO device configurations observe the guidelines in the following example.

This example shows a Cisco NSO configuration that uses the hostname as the device ID. If you are using a CSV file to import devices, use **`ROBOT_PROVDEVKEY_HOST_NAME`** as the enum value for the provider_node_key field. The example hostname **`RouterFremont`** used here must match the hostname for the device in the CSV file.

```
configure
set devices device RouterFremont address 198.18.1.11 port 22
set devices device RouterSFO address 198.18.1.12 port 830
```

In the following example, we are creating an authgroup called "cisco", with a remote name and password of "cisco". Next, we are setting all the devices that have a name starting with "Router" to a device type of "netconf" using the ned-id "cisco-iosxr-nc-6.6". Finally, we are assigning all of the devices with a name starting with "Router" to the "cisco" authgroup. Edit these settings to match your environment:

```
set devices authgroups group cisco default-map remote-name cisco remote-password cisco
set devices device Router* device-type netconf ned-id cisco-iosxr-nc-6.6
set devices device Router* authgroup cisco
```

The following CLI commands unlock and retrieve the SSH keys from all of the devices. Cisco NSO synchronizes itself with the devices by uploading each device's current configuration and then storing the present configuration. It is important to use these commands to ensure that the devices, Cisco NSO, and your Cisco Crosswork applications are starting from a common configuration:

```
set devices device Router* state admin-state unlocked
request devices device Router* ssh fetch-host-keys
request devices device Router* sync-from
commit
```

Add Devices Through the UI

Follow the steps below to add devices one by one, using the UI. Under normal circumstances, you will want to use this method only when adding a few devices.

Step 1 From the main menu, choose **Device Management** > **Network Devices**.

Step 2 Click ⊞.

Step 3 Enter values for the new device, as listed in the table below.

Step 4 Click **Save**. The Save button is disabled until all mandatory fields are completed.

Step 5 (Optional) Repeat these steps to add more devices.

Table 10: Add New Device Window (=Required)*

Field	Description
*** Administration State**	The management state of the device. Options are • **UNMANAGED**—Crosswork is not monitoring the device. • **DOWN**—The device is being managed and is down. • **UP**—The device is being managed and is up.
*** Reachability Check**	Determines whether Crosswork performs reachability checks on the device. Options are: • **ENABLE** (In CSV: **REACH_CHECK_ENABLE**)—Checks for reachability and then updates the Reachability State in the UI automatically. • **DISABLE** (In CSV: **REACH_CHECK_DISABLE**)—The device reachability check is disabled. Cisco recommends that you always set this to **ENABLE**. This field is optional if **Configured State** is marked as **UNMANAGED**.
*** Credential Profile**	The name of the credential profile to be used to access the device for data collection and configuration changes. For example: **nso23** or **srpce123**. This field is optional if **Configured State** is marked as **UNMANAGED**.
Host Name	The host name of the device.
Inventory ID	Inventory ID value for the device. The value can contain a maximum of 128 alphanumeric characters, and can include dots (.), underscores ("_"), colons (":"), or hyphens ("-"). No other special characters are allowed. Choose the device Host Name or an easily identifiable name for Inventory ID as this will be used to sync the device to Crosswork with the Inventory ID used as the device name.
Software Type	Software type of the device.
Software Version	Software version of the device.
UUID	Universally unique identifier (UUID) for the device.
Serial Number	Serial number for the device.
MAC Address	MAC address of the device.
*** Capability**	The capabilities that allow collection of device data and that are configured on the device. You must select at least **SNMP** as this is a required capability. The device will not be onboarded if **SNMP** is not configured. Other options are **YANG_MDT**, **YANG_CLI**, **TL1**, and **GNMI**. The capabilities you select will depend on the device software type and version. **Note** For devices with MDT capability, do not select YANG_MDT at this stage.
Tags	The available tags to assign to the device for identification and grouping purposes. Use device tags to group devices for monitoring, and to provide additional information that might be of interest to other users, such as the device's physical location or its administrator's email ID.

Field	Description
Product Type	Product type of the device.
Syslog Format	The format in which syslog events received from the device should be parsed by the Syslog Collector. The options are: - **`UNKNOWN`** - Choose this option if you are uncertain or if you do not want any parsing to be done by the Syslog Collector. The Syslog Collection Job output will contain syslog events as received from device. - **`RFC5424`** - Choose this option to parse syslog events received from the device in RFC5424 format. - **`RFC3164`** - Choose this option to parse syslog events received from the device in RFC5424 format. Refer to Section: Syslog Collection Job Output, on page 68 for more details.
Connectivity Details	
Protocol	The connectivity protocols used by the device. Choices are: **`SNMP`**, **`NETCONF`**, **`TELNET`**, **`HTTP`**, **`HTTPS`**, **`GNMI`**, **`TL1`**, and **`GRPC`**. **Note** Toggle the **Secure Connection** slider to secure the GNMI protocol that you have selected. To add more connectivity protocols for this device, click + at the end of the first row in the **Connectivity Details** panel. To delete a protocol you have entered, click × shown next to that row in the panel. You can enter as many sets of connectivity details as you want, including multiple sets for the same protocol. You must enter details for at least **`SSH`** and **`SNMP`**. If you do not configure **`SNMP`**, the device will not be added. If you want to manage the device (or you are managing XR devices), you must enter details for **`NETCONF`**. **`TELNET`** connectivity is optional.
*** IP Address / Subnet Mask**	Enter the device's IP address (IPv4 or IPv6) and subnet mask. **Note** Please ensure that the subnets chosen for the IP networks (including devices and destinations) do not have overlapping address space (subnets/supernets) as it may result in unpredictable connectivity issues. **Note** If you have multiple protocols with same IP address and subnet mask, you can instruct Crosswork to autofill the details in the other fields.

Field	Description
*** Port**	The port used for this connectivity protocol. Each protocol is mapped to a port, so be sure to enter the port number that corresponds to the **Protocol** you chose. The standard port assignments for each protocol are: • SSH: 22 • SNMP: 161 • NETCONF: 830 • TELNET: 23 • HTTP: 80 • HTTPS: 443 GNMI and GNMI_SECURE: The port values range between 57344 to 57999. Ensure that the port number you enter here matches with the port number configured on the device.
Timeout	The elapsed time (in seconds) before communication attempts using this protocol will time out. The default value is 30 seconds. For XE devices using NETCONF, the recommended minimum timeout value is 90 seconds. For all other devices and protocols, the recommended minimum timeout value is 60 seconds.
Encoding Type	This field is only applicable for **GNMI** and **GNMI_SECURE** protocols. The options are **`PROTO`** and **`JSON IETF`**. Based on device capability, only one encoding format is supported at a time in a device.
Routing Info	
ISIS System ID	The device's IS-IS system ID. This ID identifies the router in an IS-IS topology, and is required for SR-PCE integration.
OSPF Router ID	The device's OSPF router ID. This ID identifies the router in an OSPF topology, and is required for SR-PCE integration.
***TE Router ID**	The traffic engineering router ID for the respective IGP. **Note** For visualizing L3 links in topology, devices should be onboarded to Cisco Crosswork with the **TE Router ID** field populated.
IPv6 Router ID	IPv6 router ID for the device. This field is a configurable parameter, and cannot be auto-discovered by Crosswork.
Streaming Telemetry Config	
Vrf	Name of the VRF within which Model Driven Telemetry (MDT) traffic is routed.
Source Interface	The range of loopback in the device type. This field is optional. **Note** This field can be edited only when the device is in DOWN or UNMANAGED state.

Field	Description
Opt Out MDT Config	Enabling this checkbox skips Crosswork from pushing telemetry configuration to the device via NSO. The default setting state is Disabled (which allows Crosswork to push telemetry configuration to the device via NSO). The device must be in ADMIN DOWN state to toggle this setting. Any out of band configuration setup needs to be cleared before moving the setting from Enabled to Disabled.
Location All location fields are optional, with the exception of **Longitude** and **Latitude**, which are required for the geographical view of your network topology.	
Longitude, **Latitude**	Longitude and latitude values are required so that the geographical map can present the correct geographical location of the device and its links to other devices. Enter the longitude and latitude in Decimal Degrees (DD) format.
Altitude	The altitude, in feet or meters, at which the device is located. For example, `123`.
Providers and Access To add more providers for this device, click + at the end of the first row in the **Providers and Access** panel. To delete a provider you have entered, click × shown next to that row in the panel.	
Provider Family	Provider type used for topology computation. Choose a provider from the list.
Provider Name	Provider name used for topology computation. Choose a provider from the list. **Note** For Cisco NSO LSA deployment, the user can select the resource-facing service (RFS) node to which they want to assign the device.
Credential	The Credential profile used for the provider. This field is read-only and is auto-populated based on the provider you select.

Add Devices By Import From CSV File

Complete the steps below to create a CSV file that specifies multiple devices and then import it into Crosswork.

Importing devices from a CSV file adds any devices not already in the database, and overwrites the data in any device record with an Inventory Key Type field value that matches those of an imported device (this excludes the UUID, which is set by the system and not affected by import). For this reason, it is a good idea to export a backup copy of all your current devices before an import

Note

- While importing large number of devices via a CSV file, value for the **TE Router ID** field should be populated.
- Importing large number of devices with incorrect CSV values using a Firefox browser may render the window unusable. If this happens, login to Cisco Crosswork in a new tab or window, and onboard devices with correct CSV values.

Step 1 From the main menu, choose **Device Management** > **Network Devices**. The **Network Devices** tab is displayed by default.

Step 2 Click ⎘ to open the **Import CSV File** dialog box.

Step 3 If you have not already created a device CSV file to import:

a) Click the **Download sample 'Device Management template (*.csv)' file** link and save the CSV file template to a local storage resource.

b) Open the template using your preferred tool. Begin adding rows to the file, one row for each device.

Note

- Confirm that the TE router ID value for each device is populated. This value is used to uniquely identify the device in the topology which is learned from SR-PCE. Without a valid TE router ID for each device, the topology will not be displayed.

- After importing a device or onboarding a device, the TE Router ID should not be changed. If it is necessary to change the TE Router ID of a device after it has been imported then then do the following:

  1. The device should be removed from Crosswork.
  2. All SR-PCE Providers should be removed.
  3. Onboard the device again with the new TE Router ID.
  4. Add the SR-PCE providers again.

Use a semicolon to separate multiple entries in the same field. Use two semicolons with no space between them to indicate that you are leaving the field blank. When you separate multiple entries with semicolons, remember that the order in which you enter values in each field is important. For example, if you enter `SSH;SNMP;NETCONF` in the **Connectivity Type** field and you enter `22;161;830` in the **Connectivity Port** field, the order of entry determines the mapping between the two fields:

- SSH: port 22
- SNMP: port 161
- NETCONF: port 830

For a list of the fields and the mandatory values you must enter, see the "Add New Device" field table in Add Devices Through the UI, on page 158.

Be sure to delete the sample data rows before saving the file, or they will be imported along with the data you want. The column header row can stay, as it is ignored during import.

c) When you are finished, save the new CSV file.

Step 4 Click **Browse** to navigate to the CSV file you just created and then click **Open** to select it.

Step 5 With the CSV file selected, click **Import**.

Note While importing devices or providers via UI using a CSV file, user should wait for the operation to complete. Clicking the **Import** button while the operation is in progress will lead to duplicate entries for each device or provider.

Step 6 Resolve any errors and confirm device reachability.

It is normal for devices to show as unreachable or not operational when they are first imported. However, if they are still displayed as unreachable or not operational after 30 minutes, there may be an issue that needs to be investigated. To investigate, select **Device Management** > **Job History** and click on any error icon you see in the **Status** column. Common issues include failure to ensure the associated credential profile contains the correct credentials. You can test this by opening a terminal window on the server and then trying to access the device using the protocol and credentials specified in the associated credential profile.

Step 7 Once you have successfully onboarded the devices, you must map them to a Cisco Crosswork Data Gateway instance.

Export Device Information to a CSV File

When you export the device list, all device information is exported to a CSV file. Exporting the device list is a handy way to keep a record of all devices in the system at one time. You can also edit the CSV file as needed, and re-import it to overwrite existing device data.

The exported device CSV file will contain only the name of the credential profile for each device, not the credentials themselves.

Step 1 From the main menu, choose **Device Management** > **Network Devices**. The **Network Devices** tab is displayed by default.

Step 2 (Optional) Filter the device list as needed.

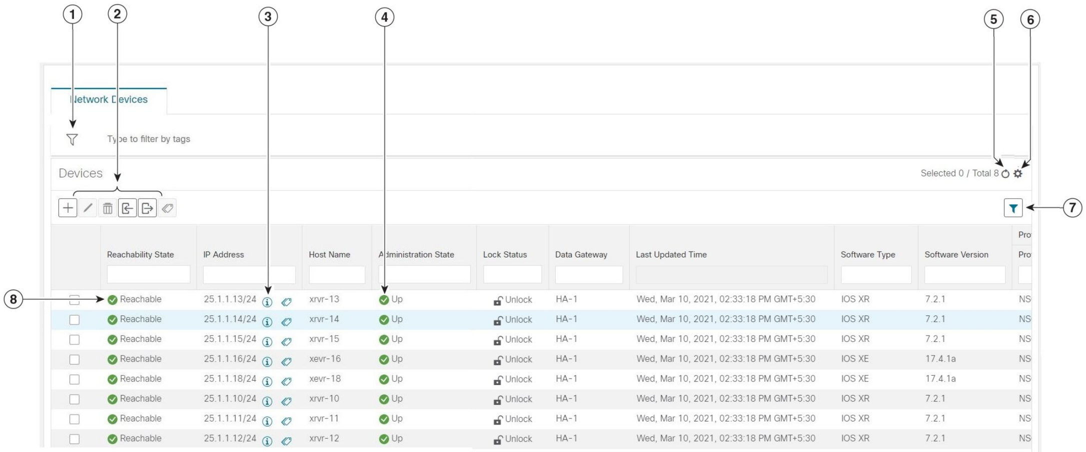
Step 3 Check the check boxes for the devices you want to export. Check the check box at the top of the column to select all the devices for export.

Step 4 Click the ⇨. Your browser will prompt you to select a path and the file name to use when saving the CSV file, or to open it immediately

Manage Network Devices

Cisco Crosswork's **Network Devices** window gives you a consolidated list of all your devices and their status. To view the **Network Devices** window, select **Device Management** > **Network Devices**. The **Network Devices** tab is displayed by default.

Figure 19: Network Devices Window



Network Devices

Type to filter by tags

Devices

Selected 0 / Total 8

	Reachability State	IP Address	Host Name	Administration State	Lock Status	Data Gateway	Last Updated Time	Software Type	Software Version	Pro
□	Reachable	25.1.1.13/24	xrvr-13	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XR	7.2.1	NS
□	Reachable	25.1.1.14/24	xrvr-14	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XR	7.2.1	NS
□	Reachable	25.1.1.15/24	xrvr-15	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XR	7.2.1	NS
□	Reachable	25.1.1.16/24	xevr-16	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XE	17.4.1a	NS
□	Reachable	25.1.1.18/24	xevr-18	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XE	17.4.1a	NS
□	Reachable	25.1.1.10/24	xrvr-10	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XR	7.2.1	NS
□	Reachable	25.1.1.11/24	xrvr-11	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XR	7.2.1	NS
□	Reachable	25.1.1.12/24	xrvr-12	Up	Unlock	HA-1	Wed, Mar 10, 2021, 02:33:18 PM GMT+5:30	IOS XR	7.2.1	NS

Item	Description
1	The **Filter by tags** field lets you filter the devices by the tags applied to them. Type the name of the tag that has been applied to the device that you are trying to find.
2	Click the ＋ to add a new device to the device inventory.
	Click the ✎ to edit the information for the currently selected devices. .
	Click the 🗑 to delete the currently selected devices.
	Click the ⇦ to import new devices and update existing devices, using a CSV file. You can also download a CSV file template by clicking this icon. The template includes sample data that you can use as a guide for building your own CSV file.
	Click the ⇨ to export information for selected devices to a CSV file.
	Click the 🏷 to modify tags applied to the selected devices. See .
3	Click the ⓘ to open the **Device Details** pop-up window, where you can view important information for the selected device.
4	Icons in the **Administration State** column show whether a device is operational or not.
5	Click the ⟳ to refresh the Devices list.
6	Click the ⚙ to select which columns to display in the Devices list.
7	Click ▼ to set filter criteria on one or more columns in the Devices list.
	Click the **Clear Filter** link to clear any filter criteria you may have set.
8	Icons in the **Reachability State** column show whether a device is reachable or not.

Device State

Cisco Crosswork computes the Reachability State of the providers it uses and devices it manages, as well as the Operational and NSO States of reachable managed devices. It indicates these states using the icons in the following table.

Table 11: Device State Icons

This Icon...	Indicates...
Reachability State icons show whether a device or a provider is reachable or not	
✅	Reachable: The device or provider can be reached by all configured protocols configured for it.
🟠	Reachability Degraded: The device or provider can be reached by at least one protocol, but is not reachable by one or more of the other protocols configured for it.
❌	Unreachable: The device or provider cannot be reached by reachable by any protocol configured for it.
❓	Reachability Unknown: Cisco Crosswork cannot determine if the device is reachable, degraded, or unreachable . This state can also occur if the device is not connected to Cisco Crosswork Data Gateway.
Operational State icons show whether a device is operational or not.	
⬆	The device is operational and under management, and all individual protocols are "OK" (also known as "up").
⬇	The device is not operational ("down"). The same icon is used when the device has been set "administratively down" by an operator.
❓	The device's operational or configuration state is unknown.
🟠	The device's operational or configuration state is degraded.

This Icon...	Indicates...
✖①	The device's operational or configuration state is in an error condition. It is either not up, or unreachable, or both, due to errors encountered while attempting to reach it and compute its operational state. The number in the circle shown next to the icon indicates the number of recent errors. Click on the number to see a list of these errors. (Note that the icon badging for errors is not available in the Network Topology application).
⋯	The device's operational state is currently being checked.
✖	The device is being deleted.
⊖	The device is unmanaged.
NSO State icons show whether a device is synced with Cisco NSO or not. **Note** In the initial sync between Cisco Crosswork and NSO after onboarding a device, the NSO state column in the device will be blank. This occurs because Cisco Crosswork has not determined if the device needs to sync with NSO based on the policy, and cannot select the default state in the initial sync.	
✓	The device is in sync with Cisco NSO.
!	The device is out of sync with Cisco NSO.

The Reachability State of a device is computed as follows:

1. Reachability is always computed for each device as long as the device's configured state (as configured by users) is UP. It is not computed if the device is administratively DOWN or UNMANAGED.
2. Reachability state is always either REACHABLE, UNREACHABLE, or UNKNOWN.
    - The Reachability state is REACHABLE if there is at least one route to the device via at least one protocol AND the device is discoverable.
    - The Reachability state is UNREACHABLE if there are no routes to the device via one protocol OR the device does not respond.
    - The Reachability state is UNKNOWN if the device is UNMANAGED.

The Operational State of a device is computed as follows:

1. Operational state is always computed for each device as long as the device's configured state (as configured by users) is UP. It is not computed if the device is administratively DOWN or UNMANAGED.
2. Operational state is always OK or ERROR.
3. For a device to be Operational=OK, the device must be REACHABLE and discoverable. Any other Reachability state is ERROR.

4. For XR or XE devices only, Operational=OK also requires that Clock Drift difference between the Crosswork host and device clocks is <=the default Drift Value, currently 2 minutes.

Note Some timezone settings are known to result in Clock Drift errors when no clock drift actually exists. To work around this issue set your devices to use UTC time.

Filter Network Devices by Tags

By creating a tag and assigning it to a particular device, you can easily provide additional information that might be of interest to other users, such as the device's physical location and its administrator's email ID. You can also use tags to find and group devices with the same or similar tags in any window that lists devices.

To filter devices by tags:

Step 1 From the main menu, choose **Device Management** > **Network Devices**.

Step 2 In the **Type to filter by tags** bar at the top of the user interface, type all or part of the name of a tag.

The **Type to filter by Tags** bar has a type-ahead feature: As you start typing, the field shows a drop-down list of tags that match all the characters you have typed so far. To force the drop-down list to display all available tags, type *****.

Step 3 Choose the name of the tag you want to add to the filter. The filter appears in the **Type to filter by tags** filter bar. The table or map shows only the devices with that tag.

Step 4 If you want to filter on more than one tag:

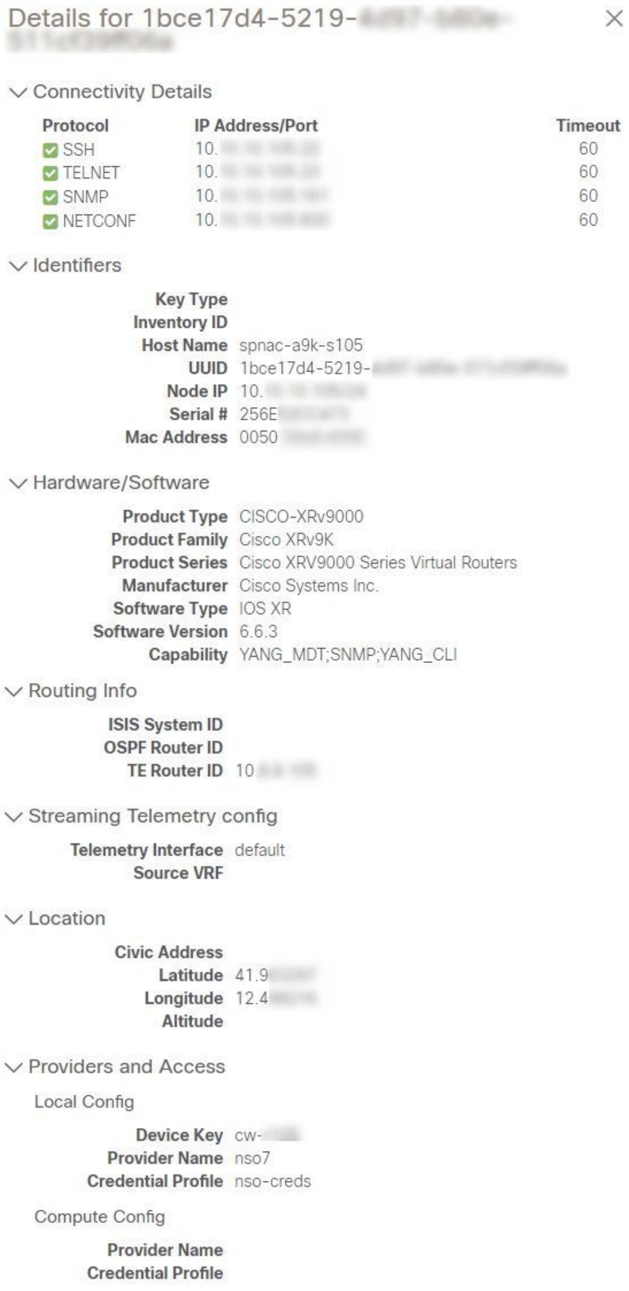
a) Repeat Steps 2 and 3 for each additional tag you want to set as part of the filter.
b) When you have selected all the tags you want, click **Apply Filters**. The table or map shows only the devices with tags that match **all** the tags in your filter.

Step 5 To clear all tag filters, click the **Clear Filters** link. To remove a tag from a filter containing multiple tags, click the **X** icon next to that tag's name in the filter.

Get More Information About a Device

Whenever you select **Device Management** > **Network Devices** and display the list of devices under the **Network Devices** tab, you can click the ⓘ next to any listed device to get more information about that device. Clicking this icon opens the **Details for DeviceName** pop-up window, as shown in the following example:

Figure 20: Details for DeviceName Window



Details for 1bce17d4-5219-[redacted]

∨ Connectivity Details

Protocol	IP Address/Port	Timeout
☑ SSH	10.[redacted]	60
☑ TELNET	10.[redacted]	60
☑ SNMP	10.[redacted]	60
☑ NETCONF	10.[redacted]	60

∨ Identifiers

Key Type	
Inventory ID	
Host Name	spnac-a9k-s105
UUID	1bce17d4-5219-[redacted]
Node IP	10.[redacted]
Serial #	256E[redacted]
Mac Address	0050[redacted]

∨ Hardware/Software

Product Type	CISCO-XRv9000
Product Family	Cisco XRv9K
Product Series	Cisco XRV9000 Series Virtual Routers
Manufacturer	Cisco Systems Inc.
Software Type	IOS XR
Software Version	6.6.3
Capability	YANG_MDT;SNMP;YANG_CLI

∨ Routing Info

ISIS System ID	
OSPF Router ID	
TE Router ID	10[redacted]

∨ Streaming Telemetry config

Telemetry Interface	default
Source VRF	

∨ Location

Civic Address	
Latitude	41.9[redacted]
Longitude	12.4[redacted]
Altitude	

∨ Providers and Access

Local Config

Device Key	cw-[redacted]
Provider Name	nso7
Credential Profile	nso-creds

Compute Config

Provider Name	
Credential Profile	

Expand the **Connectivity Details** area at the top of the pop-up window (if it is not already expanded). This area shows the reachability status for all transport types.

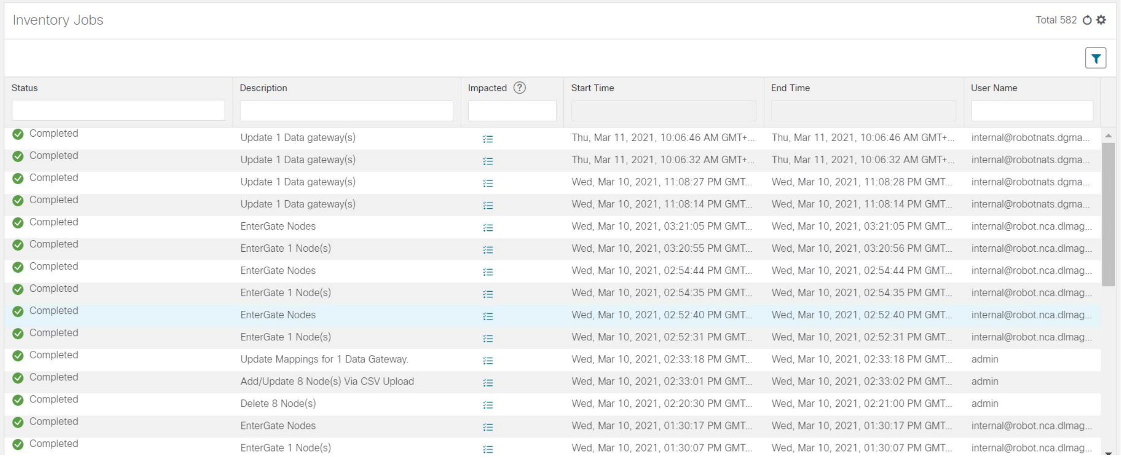
Expand and collapse the other areas of the pop-up window, as needed. Click the × to close the window.

View Device Job History

Cisco Crosswork collects and stores information about device-related jobs. Follow the steps below to track all create, update and delete activities.

Step 1 From the main menu, choose **Device Management** > **Inventory Jobs**. The **Inventory Jobs** window opens displaying a log of all device-related jobs, like the one shown below.

Figure 21: Inventory Jobs window



Inventory Jobs

Total 582

Status	Description	Impacted	Start Time	End Time	User Name
✓ Completed	Update 1 Data gateway(s)	☰	Thu, Mar 11, 2021, 10:06:46 AM GMT+...	Thu, Mar 11, 2021, 10:06:46 AM GMT+...	internal@robotnats.dgma...
✓ Completed	Update 1 Data gateway(s)	☰	Thu, Mar 11, 2021, 10:06:32 AM GMT+...	Thu, Mar 11, 2021, 10:06:32 AM GMT+...	internal@robotnats.dgma...
✓ Completed	Update 1 Data gateway(s)	☰	Wed, Mar 10, 2021, 11:08:27 PM GMT...	Wed, Mar 10, 2021, 11:08:28 PM GMT...	internal@robotnats.dgma...
✓ Completed	Update 1 Data gateway(s)	☰	Wed, Mar 10, 2021, 11:08:14 PM GMT...	Wed, Mar 10, 2021, 11:08:14 PM GMT...	internal@robotnats.dgma...
✓ Completed	EnterGate Nodes	☰	Wed, Mar 10, 2021, 03:21:05 PM GMT...	Wed, Mar 10, 2021, 03:21:05 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	EnterGate 1 Node(s)	☰	Wed, Mar 10, 2021, 03:20:55 PM GMT...	Wed, Mar 10, 2021, 03:20:56 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	EnterGate Nodes	☰	Wed, Mar 10, 2021, 02:54:44 PM GMT...	Wed, Mar 10, 2021, 02:54:44 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	EnterGate 1 Node(s)	☰	Wed, Mar 10, 2021, 02:54:35 PM GMT...	Wed, Mar 10, 2021, 02:54:35 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	EnterGate Nodes	☰	Wed, Mar 10, 2021, 02:52:40 PM GMT...	Wed, Mar 10, 2021, 02:52:40 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	EnterGate 1 Node(s)	☰	Wed, Mar 10, 2021, 02:52:31 PM GMT...	Wed, Mar 10, 2021, 02:52:31 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	Update Mappings for 1 Data Gateway.	☰	Wed, Mar 10, 2021, 02:33:18 PM GMT...	Wed, Mar 10, 2021, 02:33:18 PM GMT...	admin
✓ Completed	Add/Update 8 Node(s) Via CSV Upload	☰	Wed, Mar 10, 2021, 02:33:01 PM GMT...	Wed, Mar 10, 2021, 02:33:02 PM GMT...	admin
✓ Completed	Delete 8 Node(s)	☰	Wed, Mar 10, 2021, 02:20:30 PM GMT...	Wed, Mar 10, 2021, 02:21:00 PM GMT...	admin
✓ Completed	EnterGate Nodes	☰	Wed, Mar 10, 2021, 01:30:17 PM GMT...	Wed, Mar 10, 2021, 01:30:17 PM GMT...	internal@robot.nca.dlmag...
✓ Completed	EnterGate 1 Node(s)	☰	Wed, Mar 10, 2021, 01:30:07 PM GMT...	Wed, Mar 10, 2021, 01:30:07 PM GMT...	internal@robot.nca.dlmag...

The jobs display in descending order of creation time. The most recent job is shown first. To sort the data in the table, click a column heading. Click the column heading again to toggle between ascending and descending sort order.

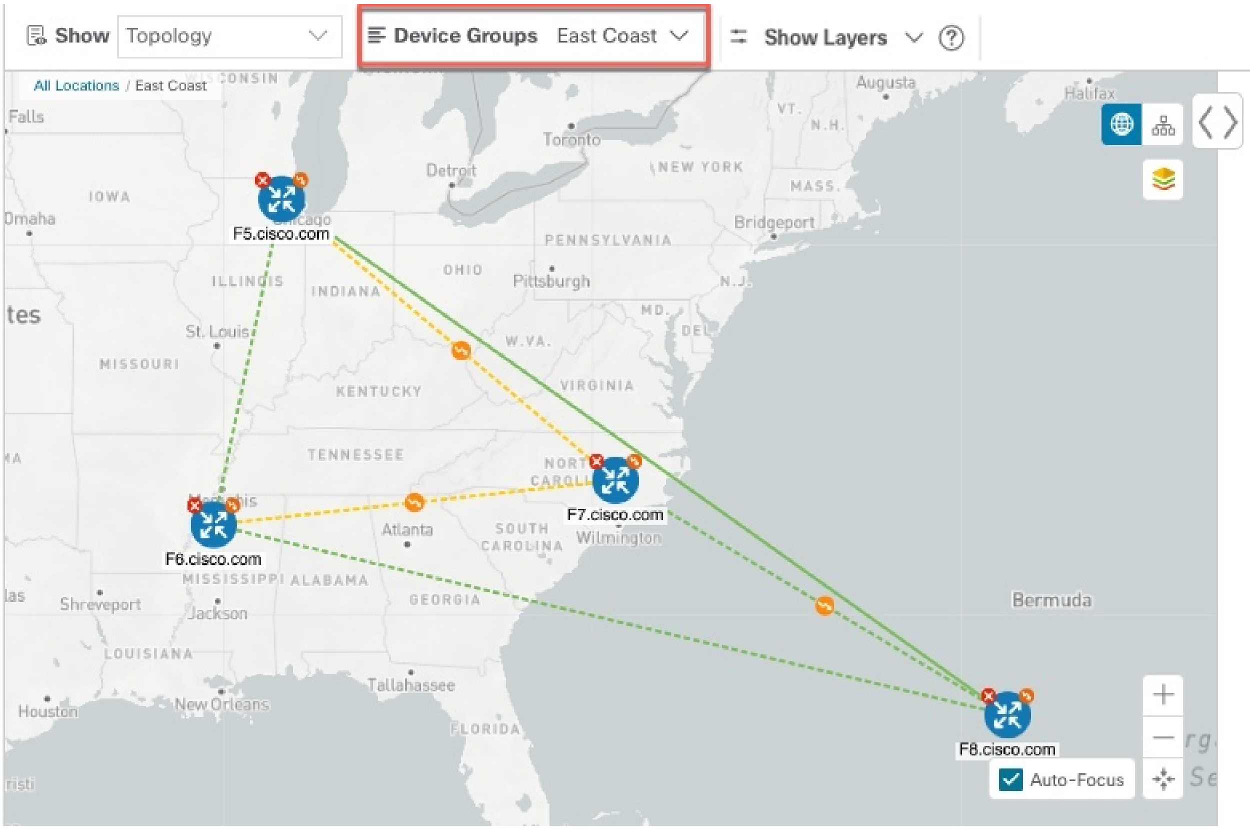
Step 2 The **Status** column shows the types of states: completed, failed, running, partial, and warning. For any failed or partial job, click the ⓘ shown next to the error for more information.

Note The status may be displayed as **Successful** even when the device is not reachable. You can verify that the status of the jobs that is displayed is correct by also looking into the status of the device (**Device Management** > **Network Devices**).

Use Device Groups to Filter Your Topology View

To help you identify, find, and group devices for a variety of purposes, you can create device groups. Device Groups allow you to visualize and zoom in on data specific to that device group. It reduces the clutter on your screen and allows you to focus on data that is most important to you. For example, as shown in the following figure, we see that the East Coast device group has been selected and is zoomed in on the Topology map. Also note that only the devices belonging to the East Coast device group are listed in the Devices table.

Figure 22: Device Group Selection on Topology Map



Show: Topology

Device Groups: East Coast

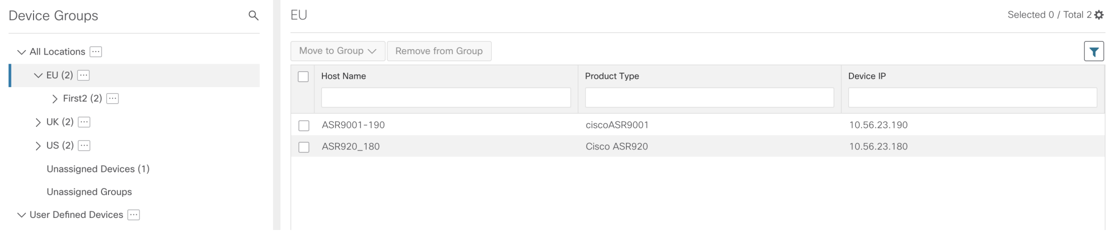
Show Layers

All Locations / East Coast

☑ Auto-Focus

The **Device Groups** window (**Device Management** > **Groups**) allows you to create and manage device groups. By default, all devices initially appear in the **Unassigned Devices** group.

Figure 23: Device Groups



Device Groups

- All Locations
  - EU (2)
    - First2 (2)
  - UK (2)
  - US (2)
  - Unassigned Devices (1)
  - Unassigned Groups
- User Defined Devices

EU

Selected 0 / Total 2

Move to Group | Remove from Group

Host Name	Product Type	Device IP
ASR9001-190	ciscoASR9001	10.56.23.190
ASR920_180	Cisco ASR920	10.56.23.180

Sdat

Create and Modify Device Groups

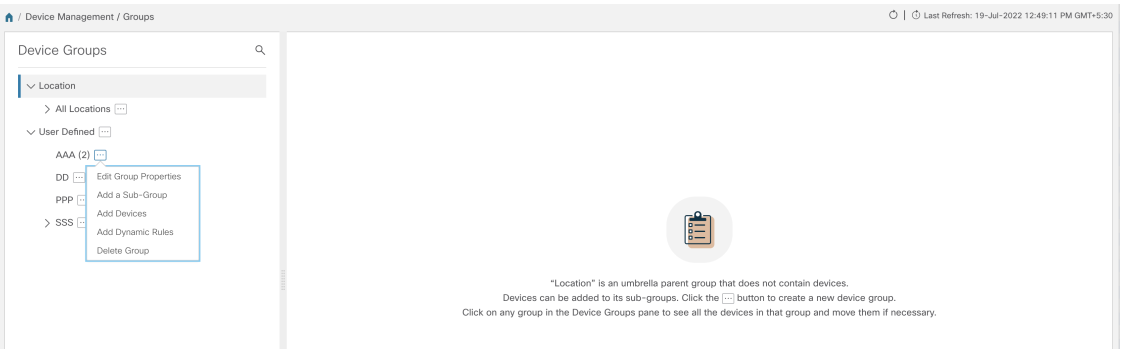
Device groups and assignment of devices to the groups can be done either manually (as described in this section) or automatically (as described in the next section).

Step 1 From the main menu choose **Device Management** > **Groups**.

Step 2 To add a new sub-group, click ⋯ next to **All Locations**.
A new sub-group gets added under **All Locations**.

Step 3 To add a device to a group, from the right-pane, under **Unassigned Devices**, select a device and then from the **Move to Group**drop-down, select the appropriate group.

Step 4 To edit, delete, or add a sub-group under an existing group, from the Device Groups tree, click ⋯ next to a group.



"Location" is an umbrella parent group that does not contain devices.
Devices can be added to its sub-groups. Click the ⋯ button to create a new device group.
Click on any group in the Device Groups pane to see all the devices in that group and move them if necessary.

Step 5 Choose to add, delete, or edit (rename or move) a group. If you delete a group, all devices that belong to that group are moved to the Unassigned Devices group. Also, deleting a group deletes all the sub-groups under it.

Note Devices can belong to only one device group.

Step 6 Click **Save**.

Enable Dynamic Device Grouping

You can create a rule to dynamically create device groups and automatically add unassigned devices to these groups using a Regular Expression (regex) on the device hostname. Any newly added or discovered devices that match the rule will be placed in the appropriate group.

Note Dynamic rules do not apply to devices that already belong to groups. You must move them to Unassigned Devices if you want them to be considered by the rule.

Before you begin

While you can follow examples given in the Dynamic Groups dialog, it is helpful to be familiar with Regular Expressions.

Step 1 From the main menu choose **Device Management** > **Groups**.

Step 2 Click ⋯ next to **All Locations > Manage Dynamic Grouping Rule**.

Step 3 Click **Show more details and examples** to help you fill out the required Host Name and Group Name fields.

Step 4 If there are any existing devices in the Unassigned Devices group, click **Test Rule** to view a sampling of what type of group names will be created.

Step 5 Turn the **Enable Rule** toggle ON to enable the rule. After the rule is enabled, the system checks for unassigned devices every minute and will assign them to the appropriate group based on the rule.

Step 6 Click **Save**.

Step 7 Groups that are created this way initially appear under Unassigned Groups (created when a rule is enabled for the first time). Move newly created groups to the desired group hierarchy.

Step 8 To move newly created Unassigned groups to the correct group, do the following:

a) Click … next to All Locations and click **Add a Sub-Group**.
b) Enter the New Group details and click **Create**.
c) Click on the unassigned devices from the left pane.
d) From the right pane, select the devices you want to move and click **Move to Group** to move to an appropriate group.

Edit Devices

Complete the following procedure to update a device's information.

Before editing any device, it is always good practice to export a CSV backup of the devices you want to change.

Step 1 From the main menu, choose **Device Management** > **Network Devices**.

Step 2 (Optional) Filter the list of devices by filtering specific columns.

Step 3 Check the check box of the device you want to change, then click the ✎.

Step 4 Edit the values configured for the device, as needed.

Note In addition to the existing fields, you can also view the **Data Gateway** configured for the selected device. This field is read-only.

Step 5 Click **Save**. The Save button remains dimmed until all required fields are completed.

Step 6 Resolve any errors and confirm device reachability.

Delete Devices

Complete the following procedure to delete devices.

Before you begin

- If you set the autoonboard **managed** or **unmanaged** options for an SR-PCE provider, set autoonboard for one or more SR-PCEs to **off**.
- Confirm that the device is disconnected and powered off before deleting the device.
- If devices are mapped to Cisco NSO with MDT capability, and telemetry configuration is pushed, then those configurations will be removed from the device.
- If autoonboard isn’t set to **off**, and it’s still functional and connected to the network, the device will be rediscovered as unmanaged when it’s deleted.

Step 1 Export a backup CSV file containing the devices that you plan to delete.

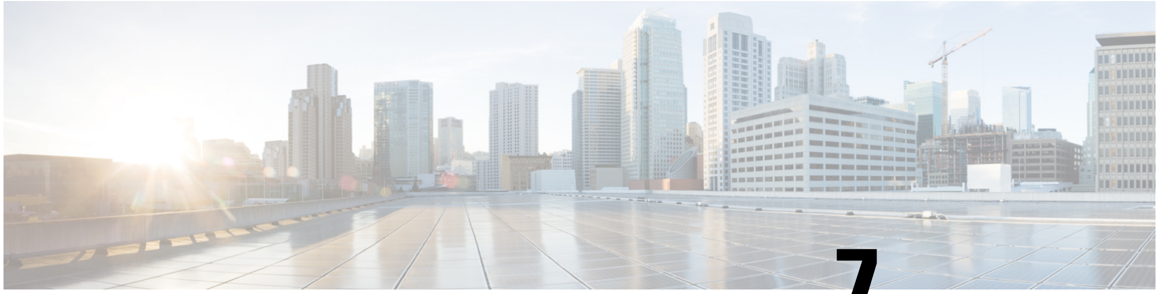
Step 2 From the main menu, choose **Device Management** > **Network Devices**.

Step 3 (Optional) In the **Devices** window, filter the list of devices by entering text in the **Search** field or filtering specific columns.

Step 4 Check the check boxes for the devices you want to delete.

Step 5 Click the 🗑.

Step 6 In the confirmation dialog box, click **Delete**.



CHAPTER 7

Zero Touch Provisioning

This section contains the following topics:

Zero Touch Provisioning Concepts

The Cisco Crosswork Zero Touch Provisioning (ZTP) application allows you to ship factory-fresh devices to a branch office or remote location and provision them once physically installed. Local operators can cable these devices to the network without installing an image or configuring them. To use ZTP, you first establish an entry for each device in the DHCP server and in the ZTP application. You can then activate ZTP processing by connecting the device to the network and powering it on or reloading it. The device will download and apply a software image and configurations to the device automatically (you can also apply configurations only). Once configured, ZTP onboards the new device to the Cisco Crosswork device inventory. You can then use other Cisco Crosswork applications to monitor and manage the device.

Cisco Crosswork ZTP uses the following basic terms and concepts:

- **Classic ZTP**: A process to download and apply software and configuration files to devices. It uses iPXE firmware and HTTP to boot the device and perform downloads. It's not suitable for use over public networks.

- **Secure ZTP**: A secure process to download and apply software images and configuration files to devices. It uses secure transport protocols and certificates to verify devices and perform downloads.

- **PnP ZTP**: A secure process to download and apply software images and configuration files to Cisco devices. It uses Cisco Plug and Play (Cisco PnP) to verify devices and perform downloads over a secure, encrypted channel.

- **Evaluation License Countdown**: You can use ZTP to onboard devices without licenses for 90 days. After this evaluation period expires, you cannot use ZTP to onboard new devices until you purchase and install a license bundle with enough capacity to cover all prior devices onboarded using ZTP, as well as your projected future needs.

- **Image file**: A binary software image file, used to install the network operating system on a device. For Cisco devices, these files are the supported versions of Cisco IOS images. Software image installation is an optional part of ZTP processing. When configured to do so, the ZTP process downloads the image from Cisco Crosswork to the device, and the device installs it. If you must also install SMUs, ZTP can install them as part of configuration processing in Classic and Secure ZTP (SMUs are not supported in PnP ZTP).

- **Cisco Plug and Play (Cisco PnP)**: Cisco's proprietary zero-touch provisioning solution, bundled in most IOS software images. Cisco PnP uses a software PnP agent and a PnP server to distribute images and configurations to devices. To ensure communications are secure, the server and agent communicate using HTTPS.
- **Configuration file**: A file used to set the operating parameters of the newly imaged or re-imaged device. Depending on the ZTP mode you plan to use, the file may be a Python script, Linux shell script, or a sequence of Cisco IOS CLI commands stored as ASCII text (not all of these are supported in all ZTP modes). The ZTP process downloads the configuration file to the newly imaged device, which then executes it. ZTP processing requires configuration files. Secure ZTP also supports up to three different configuration files, which are applied during onboarding in the following order: pre-configuration, day-zero, and post-configuration.
- **Configuration handling method**: A Secure ZTP user option. It allows you to specify whether you want to merge a new configuration into the existing device configuration or to overwrite it. It is only available when implementing Secure ZTP.
- **Credential profile**: Collections of passwords and community strings that are used to access devices via SNMP, SSH, HTTP, and other network protocols. Cisco Crosswork uses credential profiles to access your devices, automating device access. All credential profiles store passwords and community strings in encrypted format.
- **Bootfile name**: The explicit path to and name of a software image that is stored in the ZTP repository. For each device you plan to onboard using ZTP, specify the bootfile name as part of the device configuration in DHCP.
- **HTTPS/TLS**: Hypertext Transport Protocol Secure (HTTPS) is a secure form of the HTTP protocol. It wraps an encrypted layer around HTTP. This layer is the Transport Layer Security (TLS) (formerly Secure Sockets Layer, or SSL).
- **iPXE**: The open-source boot firmware iPXE is the popular implementation of the Preboot eXecution Environment (PXE) client firmware and boot loader. iPXE allows devices without built-in PXE support to boot from the network. The iPXE boot process is a normal part of Classic ZTP processing only.
- **Owner certificate**: The CA-signed end-entity certificate for your organization, which binds a public key to your organization. You install owner certificates on your devices as part of Secure ZTP processing.
- **Ownership Voucher**: Nonceless audit vouchers that verify that devices onboarded with ZTP are bootstrapping into a domain your organization owns. Cisco supplies OVs in response to requests from your organization.
- **Cisco PnP agent**: A software agent embedded in Cisco IOS-XE devices. Whenever a device that supports PnP agent powers up for the first time without a startup configuration file, the agent tries to find a Cisco PnP server. The agent can use various means to discover the server's IP address, including DHCP and DNS.
- **Cisco PnP server**: A central server for managing and distributing software images and configurations to Cisco PnP-enabled devices. Cisco Crosswork ZTP has an embedded PnP server, which is configured to communicate with PnP agents using HTTPS.
- **SUDI**: The Secure Unique Device Identifier (SUDI) is a certificate with an associated key pair. The SUDI contains the device's product identifier and serial number. Cisco inserts the SUDI and key pair in the device hardware Trust Anchor module (TAm) during manufacturing, giving the device an immutable

identity. During Secure ZTP processing, the back-end system challenges the device to validate its identity. The router responds using its SUDI-based identity. This exchange, and the TAm encryption services, permit the back-end system to provide encrypted image and configuration files. Only the validated router can open these encrypted files, ensuring confidentiality in transit over public networks.

- **SUDI Root CA Certificates**: A root authority certificate for SUDIs, issued and signed by a Certificate Authority (CA), used to authenticate subordinate SUDI certificates.
- **UUID**: The Universal Unique Identifier (UUID) uniquely identifies an image file that you have uploaded to Cisco Crosswork. You use the UUID of the software image file in the DHCP bootfile URL with Classic and Secure ZTP.
- **ZTP asset**: ZTP requires access to several types of files and information in order to onboard new devices. We refer to these files and information collectively as "ZTP assets." You load these assets as part of ZTP setup, before initiating ZTP processing.
- **ZTP profile**: A Cisco Crosswork storage construct that combines (normally) one image and one configuration into a single unit. Cisco Crosswork uses ZTP profiles to automate imaging and configuration processes. Using ZTP profiles is optional, but we recommended them. They are an easy way to organize ZTP images and configurations around device families, classes, and roles, and help maintain consistent ZTP use.
- **ZTP repository**: The location where Cisco Crosswork stores image and configuration files.

Platform Support for ZTP

This topic details Cisco Crosswork Zero Touch Provisioning support for Cisco and third-party software and devices.

Platform Support for Classic ZTP

The following platforms support Classic ZTP:

- **Software**: Cisco IOS-XR versions 6.6.3, 7.0.1, 7.0.2, 7.0.12, and 7.3.1 or later.
- **Hardware**:
  - Cisco Network Convergence Systems (NCS) 540 Series Routers
  - Cisco NCS 1000-1004 Series Routers
  - Cisco NCS 5500 Series Routers
  - Cisco NCS 8000 and 8800 Series Routers (Spitfire fixed mode)

Classic ZTP doesn't support third-party devices or software.

Platform Support for Secure ZTP

The following platforms support Secure ZTP:

- **Software**: Cisco IOS-XR version 7.3.1 or later, with the exception of releases 7.3.2 and 7.4.1, which are not supported in this release.

  You can upgrade from IOS-XR 6.6.3 to 7.3.1 as a single image installation.

- **Hardware**:
  - Cisco Network Convergence Systems (NCS) 540 Series
  - Cisco NCS 1000-1004 Series
  - Cisco NCS 5500 Series
  - Cisco NCS 8000 and 8800 Series (Spitfire fixed mode)

Secure ZTP supports provisioning for third-party devices only if the third-party devices:

- Are 100-percent compliant with the Secure ZTP RFC 8572(https://tools.ietf.org/html/rfc8572).
- Match Cisco format guidelines for serial numbers in device certificates and ownership vouchers. For details, see the section Secure ZTP: Guidelines for Third-Party Device Certificates and Ownership Vouchers, on page 178.

Platform Support for PnP ZTP

The following platforms support PnP ZTP:

- **Software**: Cisco IOS-XE version 16.12 and 17.4.1.

  Version 16.12.5 is the recommended version for customers.
- **Hardware**:
  - Cisco Network Convergence Systems (NCS) 520 Series Routers
  - Cisco Aggregation Services Router (ASR) 903
  - Cisco ASR 907
  - Cisco ASR 920

PnP ZTP doesn't support third-party devices or software.

If you plan on using PnP ZTP, check that the minimum license boot-level on each IOS-XE device is set to **metroipaccess** or **advancedmetroipaccess before** you trigger ZTP processing. If the boot level has been set properly, the output of the IOS-XE `#sh run | sec license` CLI command on the device should contain statements showing either of these two license levels: `license boot level advancedmetroipaccess` or `license boot level metroipaccess`. If the command output shows any other license level, especially one lower than these two, the Cisco PnP cryptographic functionality will not be enabled. This will cause certificate installation to fail, which will then cause PnP ZTP device provisioning to fail.

Secure ZTP: Guidelines for Third-Party Device Certificates and Ownership Vouchers

Secure ZTP processing for any device starts with a successful HTTPS/TLS handshake between the device and Cisco Crosswork. After the handshake, Secure ZTP must extract a serial number from the device certificate. Secure ZTP then validates the extracted serial number against its internal "allowed" list of serial numbers. You create the allowed list by uploading device serial numbers to Cisco Crosswork. A similar serial-number validation step occurs later, when validating downloads using ownership vouchers.

Unlike Cisco IOS-XR devices, the format of the serial number in third-party vendors' device certificates is not standardized across vendors. Typically, a third-party vendor's device certificate has a `Subject` field or section. The `Subject` contains multiple key-value pairs that the vendor decides upon. One of the key-values pairs is usually a `serialNumber` key. This key's value contains the actual device serial number as a string, which is preceded by the string `SN:`. For example: Let's suppose that the third-party device certificate's `Subject` section contains the following key and value: `serialNumber = PID:NCS-5501 SN:FOC2331R0CW`. Secure ZTP will take the value after the `SN:` string and match that to one of the serial numbers in the allowed list.

If the third-party vendor's device certificate has a different format, validation failures can occur. The degree of failure depends on the degree of difference. The vendor certificate may not match this format at all. The certificate's `Subject` field may not contain a `serialNumber` key with a value that contains the `SN:` string. In this case, Secure ZTP processing falls back to using the whole string value of the `serialNumber` key (if present) as the device serial number. It will then try to match that value to one in the allowed list of serial numbers. These two methods – string matching and the fallback – are the only means Secure ZTP has for determining the third-party device's serial number. If the vendor certificate differs from this expectation sufficiently, Secure ZTP may be unable to validate the device at all.

Secure ZTP has similar format expectations for ownership vouchers. Cisco tools generate ownership vouchers with filenames in the format *`SerialNumber`*`.vcj`, where *`SerialNumber`* is the device's serial number. Secure ZTP extracts the serial number from the filename and then attempts to match it to one in the allowed list. For multivendor support, we assume that third-party vendor tools generate OV files with file names in the same format. If this expectation isn't met, validation failures are likely.

ZTP Implementation Decisions

As a best practice, always choose the most secure implementation for the devices you have. That said, ZTP offers a range of implementation choices and cost vs. benefit tradeoffs worth considering in advance:

- **When to Use Classic ZTP**: Classic ZTP is easier to implement than Secure ZTP. It needs no PDC, owner certificates, or ownership vouchers. It’s less subject to processing errors, as device and server verification is less stringent and setup is less complex. It’s your only choice if your Cisco devices run IOS-XR versions earlier than 7.3.1, as Secure and PnP ZTP don't support them. Although Classic ZTP now includes a device serial-number check, it remains insecure at the transport layer. It's not recommended if routes to your remote devices cross a metro or otherwise unsecured network.

- **When to Use Secure ZTP**: Use Secure ZTP when you must traverse public networks and you have devices that support Secure ZTP. The additional security that it provides requires a more complex setup than Classic ZTP. This complexity can make processing error-prone if you’re new to the setup tasks. Secure ZTP setup also requires a certificates and ownership vouchers from the device manufacturer. Use it if your devices are from third-party manufacturers, as Classic ZTP doesn't support third-party hardware. Third-party devices and their software must be 100-percent compliant with RFCs 8572 and 8366. Device certificates for third-party devices must contain the device serial number. Third-party ownership vouchers must be in a format that uses the device serial number as the filename. Cisco can’t guarantee Secure ZTP compatibility with all third-party devices. For more details on third-party device support, see Platform Support for ZTP, on page 177.

- **When to Use PnP ZTP**: Use PnP ZTP when you want a secure provisioning setup for Cisco IOS-XE devices that support the Cisco PnP protocol. Less complicated to set up than Secure ZTP, but only slightly more complicated than Classic ZTP, it's your best choice when your network devices happen to meet these base requirements.

- **Use ZTP With Imaged Devices**: There’s no need to specify a software image when you use any of the ZTP modes. This feature allows you the option of shipping to your remote location one or more devices on which you have already installed a software image. You can then connect to these devices and trigger ZTP processing remotely. Depending on how you set up things, you can apply:

    - A configuration only

- One or more images or SMUs, with more configurations.

Secure ZTP offers more flexibility with pre-imaged devices because it offers pre-configuration, day-zero, and post-configuration script execution capability. While both Classic and Secure ZTP modes can chain configuration files, Classic ZTP's ability to execute additional scripts will be limited to the support for script execution allowed on specific devices. PnP ZTP can only execute CLI commands, which doesn't allow for script execution.

In all cases, the result is to onboard the device. Once onboarded to Cisco Crosswork, you will want to avoid using ZTP to configure the device again (see Reconfigure Onboarded ZTP Devices, on page 235for details).

- **Organize Configurations**: Keep your configurations as consistent as possible across devices. Consistency makes solving problems easier. It minimizes the amount of extra configuration you must perform to bring new devices online. It also reduces the number of "special" things to keep in mind when it comes time to reconfigure or upgrade your devices. Start by ensuring that all devices from the same device family and with similar roles have the same or similar basic configurations.

  How you define the role that a device plays depends on your organization, its operational practices, and the complexity of your network environment. For example: Suppose that your organization is a financial services enterprise. It has three types of branches: Sidewalk ATMs, retail branches open during standard business hours, and private trading offices. You could define three sets of basic profiles covering all the devices at each type of branch. You can map your configuration files to each of these profiles.

  Another method of enforcing consistency is to develop basic script configurations for similar types of devices, then use the script logic to call, or chain, other scripts for devices with special roles. If you’re using Classic ZTP, the script is in the specified configuration file. To extend our example, that script would apply a common configuration, then download and apply other scripts depending on the branch type. If using Secure ZTP, you have even more flexibility, as you can specify pre-configuration and post-configuration scripts in addition to the day-zero configuration script.

ZTP Processing Logic

Cisco Crosswork ZTP processing differs depending on whether you choose to implement Classic ZTP, Secure ZTP, or PnP ZTP.

The following illustrations and text provide details on each step of ZTP processing for each ZTP mode.

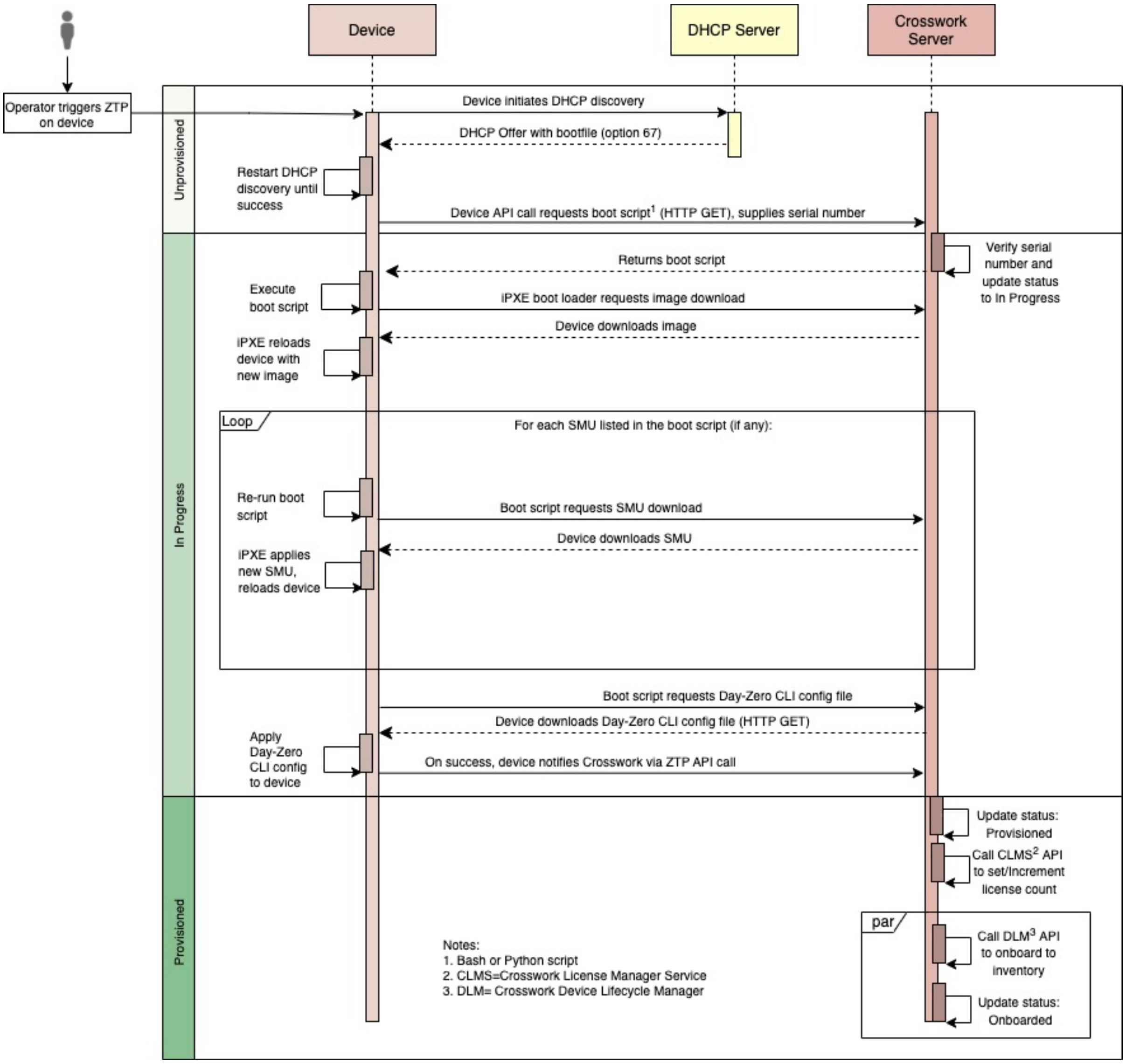
Once initiated by a device reset or reload, the ZTP process proceeds automatically. Crosswork also updates the Zero Touch Devices window with status messages showing the state each device reaches as it is processed. The three figures indicate each of these state transitions with blocks in shades of green on the left side of each diagram (the Onboarded is not shown, as reaching the Onboarding state only happens at the end of ZTP processing).

As indicated in the figures, the configuration scripts you use with ZTP must report device state changes to Cisco Crosswork using Cisco Crosswork API calls. If your configurations fail to do this, Crosswork can't register state changes when they occur, resulting in failed ZTP provisioning and onboarding. To see examples of these calls, select **Device Management** > **ZTP Configuration Files**, then click **Download Sample Script**.

Classic ZTP Processing

The following illustration shows the process logic that Classic ZTP uses to provision and onboard devices.

Figure 24: Classic ZTP Processing

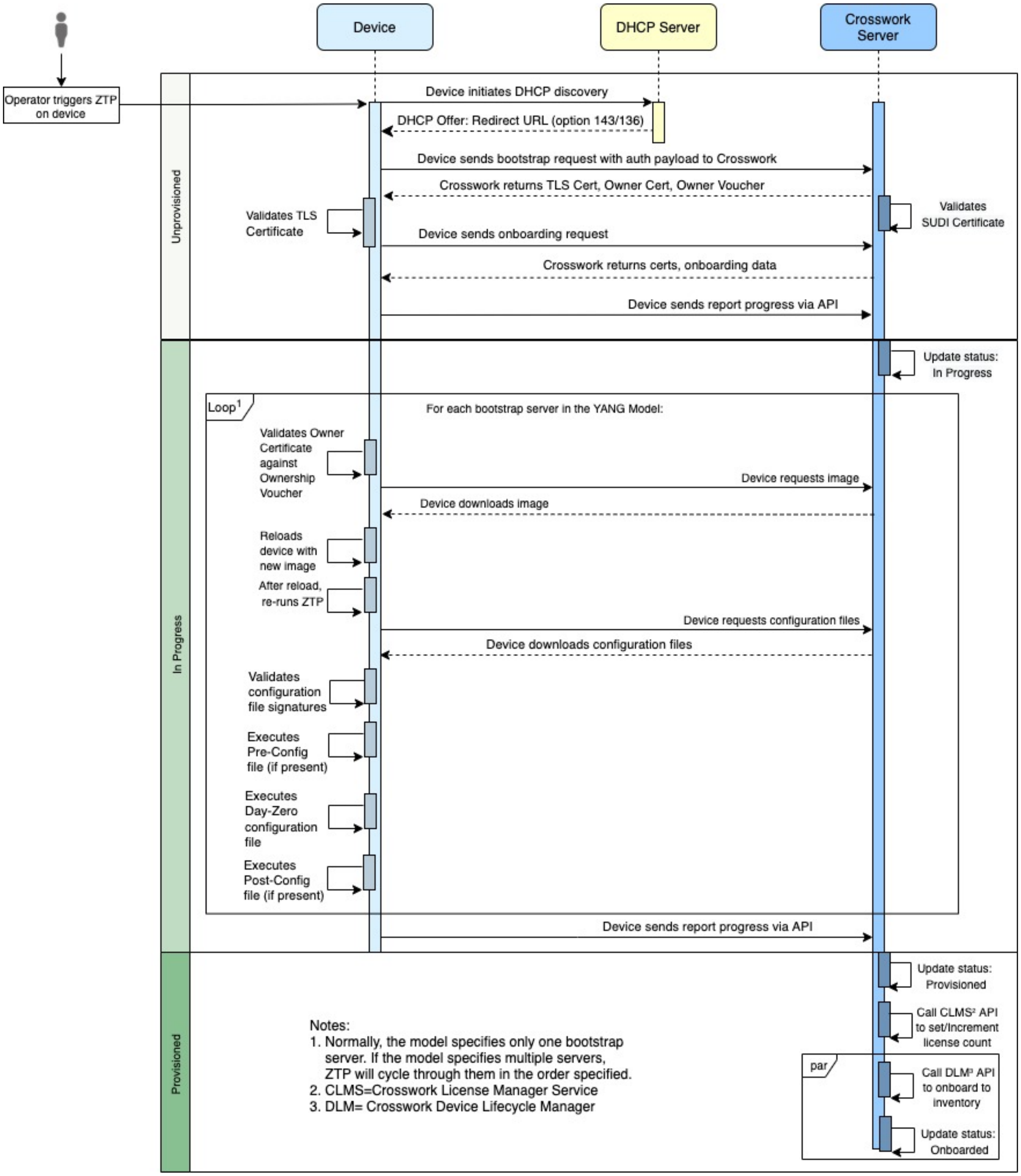

Device
DHCP Server
Crosswork Server
Operator triggers ZTP on device
Unprovisioned
Device initiates DHCP discovery
DHCP Offer with bootfile (option 67)
Restart DHCP discovery until success
Device API call requests boot script1 (HTTP GET), supplies serial number
In Progress
Verify serial number and update status to In Progress
Returns boot script
Execute boot script
iPXE boot loader requests image download
Device downloads image
iPXE reloads device with new image
Loop
For each SMU listed in the boot script (if any):
Re-run boot script
Boot script requests SMU download
Device downloads SMU
iPXE applies new SMU, reloads device
Boot script requests Day-Zero CLI config file
Device downloads Day-Zero CLI config file (HTTP GET)
Apply Day-Zero CLI config to device
On success, device notifies Crosswork via ZTP API call
Provisioned
Update status: Provisioned
Call CLMS2 API to set/Increment license count
par
Call DLM3 API to onboard to inventory
Update status: Onboarded
Notes:
1. Bash or Python script
2. CLMS=Crosswork License Manager Service
3. DLM= Crosswork Device Lifecycle Manager

The DHCP server verifies the device identity based on the device serial number, then offers downloads of the boot file and image. Once ZTP images the device, the device downloads the configuration file and executes it.

Secure ZTP Processing

The following illustration shows the process logic that Secure ZTP uses to provision and onboard devices.

Figure 25: Secure ZTP Processing

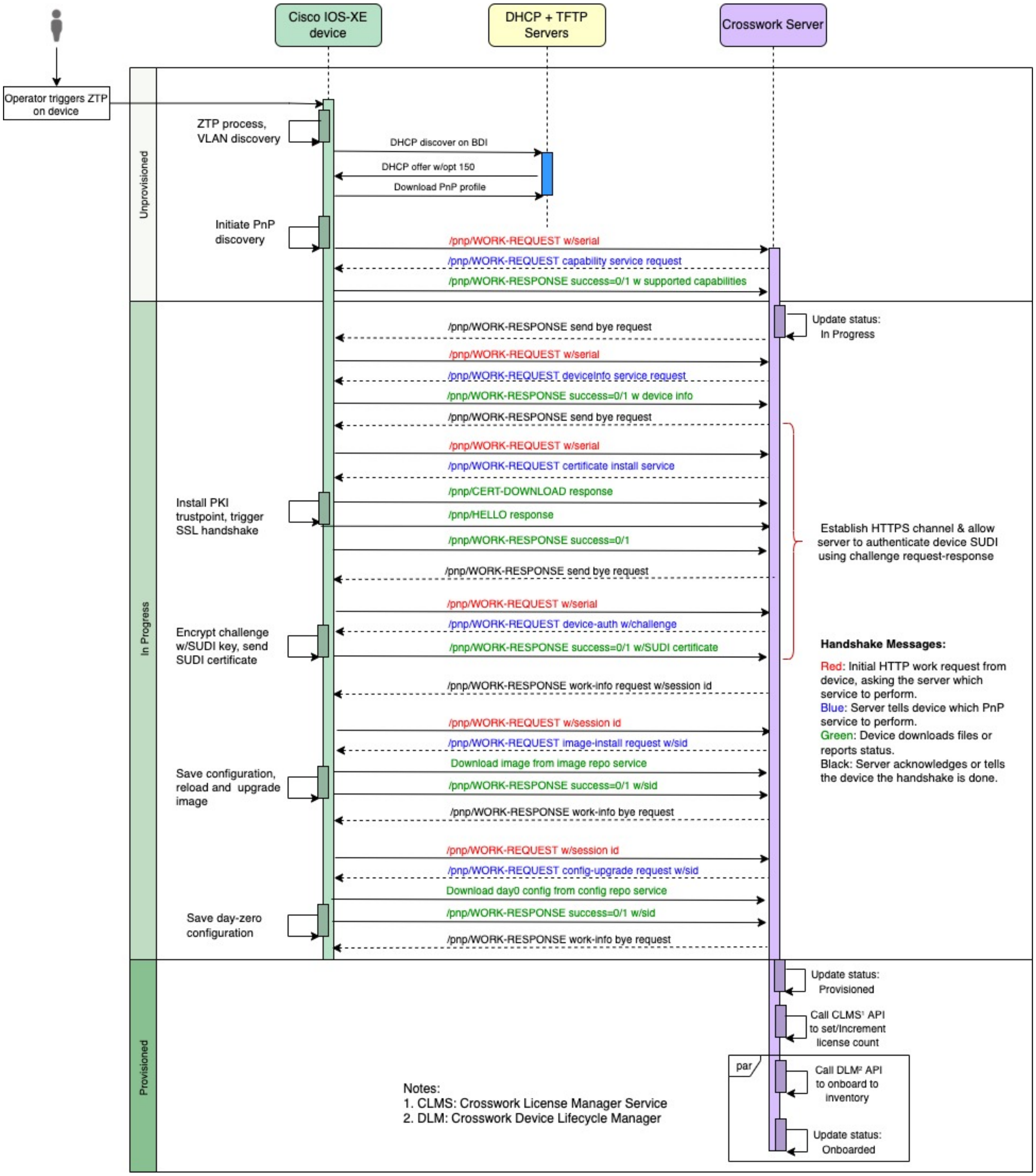

Device
DHCP Server
Crosswork Server
Operator triggers ZTP on device
Unprovisioned
Device initiates DHCP discovery
DHCP Offer: Redirect URL (option 143/136)
Device sends bootstrap request with auth payload to Crosswork
Crosswork returns TLS Cert, Owner Cert, Owner Voucher
Validates TLS Certificate
Validates SUDI Certificate
Device sends onboarding request
Crosswork returns certs, onboarding data
Device sends report progress via API
Update status: In Progress
In Progress
Loop1
For each bootstrap server in the YANG Model:
Validates Owner Certificate against Ownership Voucher
Device requests image
Device downloads image
Reloads device with new image
After reload, re-runs ZTP
Device requests configuration files
Device downloads configuration files
Validates configuration file signatures
Executes Pre-Config file (if present)
Executes Day-Zero configuration file
Executes Post-Config file (if present)
Device sends report progress via API
Provisioned
Update status: Provisioned
Call CLMS2 API to set/Increment license count
par
Call DLM3 API to onboard to inventory
Update status: Onboarded
Notes:
1. Normally, the model specifies only one bootstrap server. If the model specifies multiple servers, ZTP will cycle through them in the order specified.
2. CLMS=Crosswork License Manager Service
3. DLM= Crosswork Device Lifecycle Manager

The device and the ZTP bootstrap server authenticate each other using the Secure Unique Device Identifier (SUDI) on the device and server certificates over TLS/HTTPS. Over a secure HTTPS channel, the bootstrap server lets the device download signed image and configuration artifacts. These artifacts must adhere to the RFC 8572 YANG schema. Once the device installs the new image (if any) and reloads, the device downloads configuration scripts and executes them.

PnP ZTP Processing

The following illustration shows the process logic that PnP ZTP uses to provision and onboard devices.

Figure 26: PnP ZTP Processing


Cisco IOS-XE device
DHCP + TFTP Servers
Crosswork Server
Operator triggers ZTP on device
Unprovisioned
ZTP process, VLAN discovery
DHCP discover on BDI
DHCP offer w/opt 150
Download PnP profile
Initiate PnP discovery
/pnp/WORK-REQUEST w/serial
/pnp/WORK-REQUEST capability service request
/pnp/WORK-RESPONSE success=0/1 w supported capabilities
In Progress
Update status: In Progress
/pnp/WORK-RESPONSE send bye request
/pnp/WORK-REQUEST w/serial
/pnp/WORK-REQUEST deviceInfo service request
/pnp/WORK-RESPONSE success=0/1 w device info
/pnp/WORK-RESPONSE send bye request
/pnp/WORK-REQUEST w/serial
/pnp/WORK-REQUEST certificate install service
Install PKI trustpoint, trigger SSL handshake
/pnp/CERT-DOWNLOAD response
/pnp/HELLO response
/pnp/WORK-RESPONSE success=0/1
/pnp/WORK-RESPONSE send bye request
Establish HTTPS channel & allow server to authenticate device SUDI using challenge request-response
/pnp/WORK-REQUEST w/serial
/pnp/WORK-REQUEST device-auth w/challenge
Encrypt challenge w/SUDI key, send SUDI certificate
/pnp/WORK-RESPONSE success=0/1 w/SUDI certificate
Handshake Messages:
Red: Initial HTTP work request from device, asking the server which service to perform.
Blue: Server tells device which PnP service to perform.
Green: Device downloads files or reports status.
Black: Server acknowledges or tells the device the handshake is done.
/pnp/WORK-RESPONSE work-info request w/session id
/pnp/WORK-REQUEST w/session id
/pnp/WORK-REQUEST image-install request w/sid
Download image from image repo service
Save configuration, reload and upgrade image
/pnp/WORK-RESPONSE success=0/1 w/sid
/pnp/WORK-RESPONSE work-info bye request
/pnp/WORK-REQUEST w/session id
/pnp/WORK-REQUEST config-upgrade request w/sid
Download day0 config from config repo service
Save day-zero configuration
/pnp/WORK-RESPONSE success=0/1 w/sid
/pnp/WORK-RESPONSE work-info bye request
Provisioned
Update status: Provisioned
Call CLMS1 API to set/Increment license count
par
Call DLM2 API to onboard to inventory
Update status: Onboarded
Notes:
1. CLMS: Crosswork License Manager Service
2. DLM: Crosswork Device Lifecycle Manager

Once an operator triggers PnP ZTP processing, the device performs VLAN discovery and creates a BDI interface, on which DHCP discovery is initiated. As part of the DHCP discovery, the device also fetches the external TFTP server IP address using the DHCP Option 150 configuration. The device downloads the PnP

Profile from the TFTP server without authentication and copies it to the device's running configuration. The PnP Profile is a CLI text file. The profile activates the device's PnP agent and sends work requests to the embedded Crosswork PnP server over HTTP on port 30620. The PnP server then validates the device's serial number against Crosswork's "allowed" list of serial numbers (previously uploaded to Crosswork) and then initiates a PnP capability service request. A successful PnP work response from the device changes the device provisioning status from Unprovisioned to In Progress. Thereafter, the PnP server initiates a series of service requests, including requests for device information, certificate installation, image installation, configuration upgrade, and so on. Each of these service requests involves a four-way handshake between the PnP server and PnP agent. As part of certificate-install request, Crosswork PnP server shares its certificate with the device. Successful installation of this trustpoint on the device changes the PnP profile configuration to start using HTTPS and port 30603 on Crosswork. Subsequent image and config download requests use HTTPS to secure transactions. There is currently no SUDI certificate authentication support on the device. Once the device downloads and installs a new image (if any) and reloads, the PnP process will continue to download CLI configuration files and apply them to device running configuration. The device status is then set to Provisioned and the;license count is updated in Crosswork. The device status is then set to Onboarded, and the device stops communicating with the PnP server.

ZTP and Evaluation Licenses

All Cisco Crosswork applications can be used for 90 days without a license. Any time users log into the system, Crosswork displays a banner showing the number of days left in the trial period. When the trial expires, the banner will indicate it. At that point, no more devices will be able to complete the ZTP onboarding process. ZTP licensing follows a consumption-based model with licenses sold in blocks. In order to regain the ability to onboard devices using ZTP, you must install a license block that covers both the number of devices you onboarded during the trial period as well as the new devices you expect to onboard with ZTP in the future. For example: If you onboard 10 devices during the trial and then install a license bundle for 10 devices on day 91, you have no licenses left to use, and must install at least one more license block before onboarding another device. You can add more license blocks as needed. Operators should monitor license consumption to avoid running out of licenses unexpectedly. To see how many licenses you have used and are still available, check the Cisco Smart Licensing Site.

Your onboarded ZTP devices are always associated with either:

- A serial number, or
- The values of the Option 82 location ID attributes (remote ID and circuit ID).

Serial numbers and location IDs form an "allowed" list. ZTP uses this list when deciding to onboard a device and assign it a license. If you delete an onboarded ZTP device from inventory, and then onboard it again later, use the same serial number or location ID. If you use a different serial number or location ID, you may consume an extra license. The current release provides no workaround for this scenario. In any case, you can't have two different ZTP devices with the same serial number or location ID active at the same time.

ZTP Setup Workflow

Zero touch provisioning requires you to complete the following setup tasks first, before you can trigger ZTP boot and configuration:

1. Make sure that your environment meets ZTP prerequisites for security, provider configuration, and device connectivity.

2. Assemble the assets ZTP needs for processing. These assets include:
   - The software image to install (optional).
   - The configurations to apply.
   - Credentials to access the device.
   - Device serial numbers.

   If you're using Secure ZTP, these assets also include device owner certificates, the pinned domain certificate, and ownership vouchers, and the SUDI device certificate.
3. Prepare configurations for the devices you plan to onboard.
4. Load into Cisco Crosswork the ZTP assets you have assembled.
5. Create credential profiles using the credential assets that you assembled.
6. Prepare ZTP device entry files. These files create the Cisco Crosswork device entries that ZTP uses to onboard the devices to the Cisco Crosswork device inventory. If you have many devices to onboard, create the entries in bulk by importing a CSV file. If you have only a few devices to onboard, it's more convenient to prepare these entries one by one, using the Cisco Crosswork UI. You can also use Crosswork APIs to onboard devices.

Irrespective of the ZTP mode you have chosen, ZTP setup has a simple two-part structure: Load device-related assets into Crosswork, and configure one or more external servers to establish communications between Crosswork and the device being onboarded. The actual assets and server configurations vary with each ZTP mode, and you can finish each part in any order. But all the tasks in both parts must be completed before triggering ZTP processing.

To help illustrate this, the following three figures diagram details of the workflow involved in setting up properly for each of the ZTP modes. The remaining topics in this section then explain how to perform each task. You may find these figures a helpful reference while completing the setup tasks.

Figure 27: Classic ZTP Setup Workflow

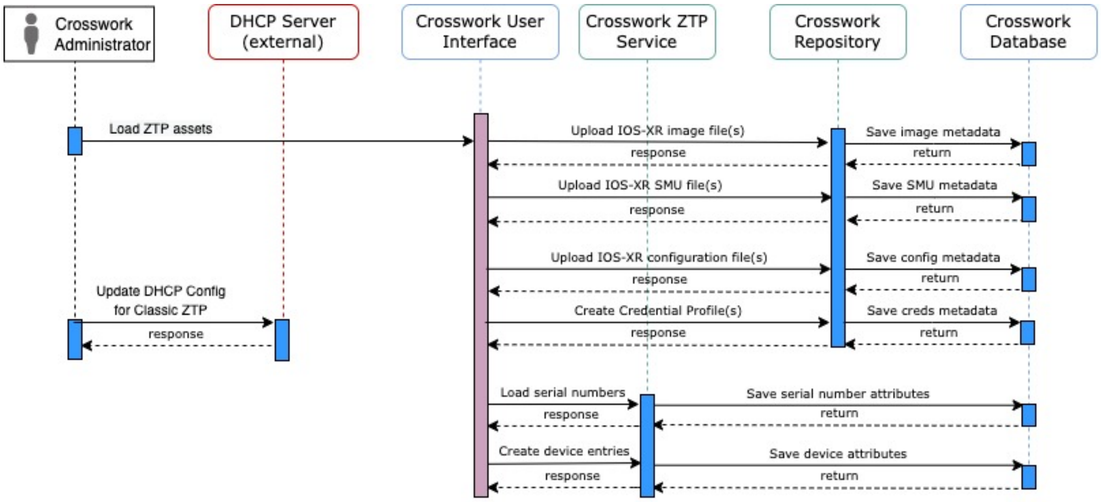


Figure 28: Secure ZTP Setup Workflow

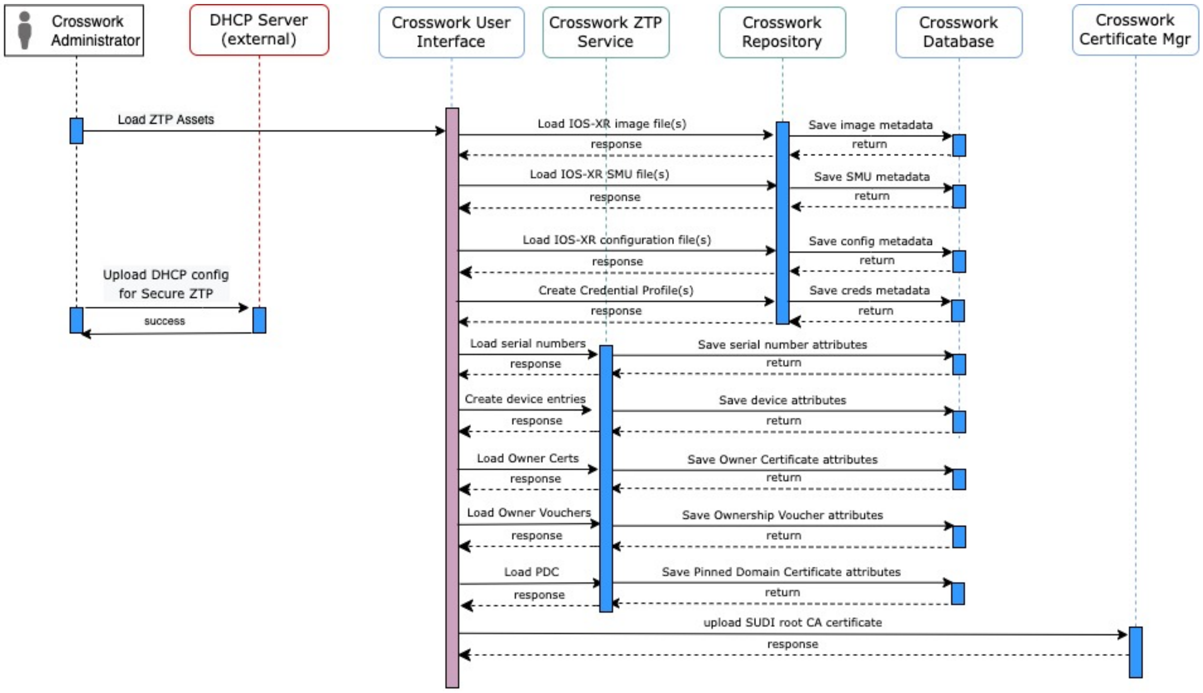
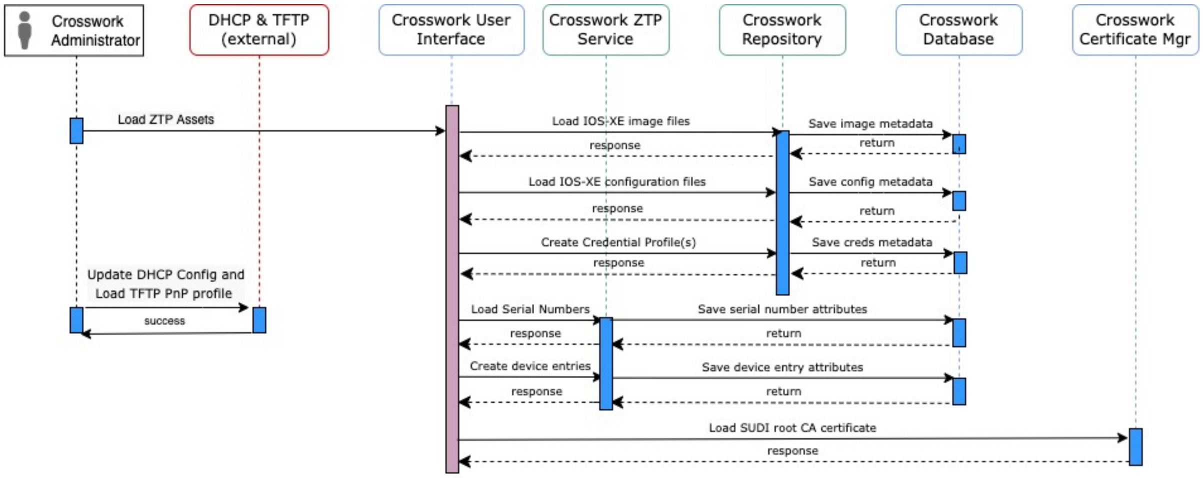


Figure 29: PnP ZTP Setup Workflow



Meet ZTP Prerequisites

For compatibility with ZTP, your Cisco Crosswork installation must meet the following prerequisites:

- If you want ZTP to onboard your devices to Cisco NSO, configure NSO as a Cisco Crosswork provider. Be sure to set the NSO provider property key to `forward` and the property value to `true`.
- The Cisco Crosswork cluster nodes must be reachable from the devices, and the nodes from the devices, over either an out-of-band management network or an in-band data network. For a general indication of

the scope of these requirements, see the network diagrams in the "Network Requirements" section of the *Cisco Crosswork Infrastructure and Applications Installation Guide*. Enabling this kind of access may require you to change firewall configurations.

- If your Crosswork cluster nodes and the devices you want to onboard using Crosswork ZTP are in completely different subnets, you will need to set up one or more static routes from your Crosswork nodes to the device subnet. To do this from the main menu, select **Administration** > **Settings** > **Static Routes**. Click the ⊞, enter the destination subnet IP address and mask (in slash notation), then click **Add**.

Assemble ZTP Assets

The term "ZTP Assets" refers to the files, credentials and other assets listed in the following table. Depending on the ZTP mode you plan to use, some of them are required.

Table 12: ZTP Asset Types

ZTP Asset Type	Classic ZTP	Secure ZTP	PnP ZTP	Description
Software image	Optional	Optional	Optional	Download from the Cisco Support & Downloads page for the devices supported for the ZTP mode you want to use. Software image loading is optional. You can load configurations without a software image.
Configurations	Required	Required. Supports multiple configurations.	Required	Your organization's library of configuration files.
Software Maintenance Updates (SMUs)	Optional	Optional	Not Supported	Download from the Cisco Support & Downloads page for the device and NOS you want to onboard.
Device Credentials	Required	Required	Required	Your organization's device credentials library.
Serial Numbers	Required	Required	Required	Your Cisco account team can supply these on request.

ZTP Asset Type	Classic ZTP	Secure ZTP	PnP ZTP	Description
Owner Certificates (with owner key)	Not Used	Required	Not used	Your Cisco account team can supply these on request. Your request must include the serial numbers of the devices you want to onboard.
Pinned Domain Certificate (PDC)	Not Used	Required	Not used	Your Cisco account team can supply these on request. Your request must include the serial numbers of the devices you want to onboard.
Ownership Voucher	Not Used	Required	Not used	Your Cisco account team can supply these on request. Your request must include the serial numbers of the devices you want to onboard.
SUDI Root Certificate	Not used	Required	Not used in this release	Download from https://www.cisco.com/security/pki/policies/index.html

Cisco Crosswork ZTP uses the following ZTP assets:

- **Software images**: The installable network operating system software (such as Cisco IOS-XR or, for PnP ZTP, Cisco IOS-XE) that enables the network device to function. Software images are required only if the device is un-imaged, or you want to upgrade the network OS. Cisco distributes IOS-XR images as TAR, ISO, BIN, or RPM files. Cisco always distributes IOS-XE images as BIN files. Each image file represents a single release of the given network OS for a given device platform or family. Upload image files to Cisco Crosswork one at a time, and enter the MD5 checksum for each software image file when preparing the upload. Cisco Crosswork uses the MD5 checksum to validate the integrity of the file. Be sure to record the checksum when you download device images from Cisco or any third-party manufacturer. You can also generate your own MD5 checksum for an image you want to upload. Note that ZTP does not require you to apply a software image to a device that is already imaged.

- **Software Maintenance Updates (SMUs)**. SMUs are Cisco software packages that provide point fixes for one or more critical issues in a given software release. Cisco distributes SMUs in nonbootable format with a readme.txt file explaining the associated issues. Cisco rolls SMU contents into the next maintenance release of a software image. For Classic and Secure ZTP, be sure to apply SMUs using configuration files, not during software image download, and upload them to Cisco Crosswork one at a time. For PnP ZTP, SMU files are not supported for Cisco IOS-XE.

- **Configurations**: Classic and Secure ZTP use configuration files to configure the features of the installed software image on a given device, including upgrading the software using SMUs. Configuration files used with these two ZTP modes can be Linux shell scripts (SH), Python scripts (PY), or device operating system CLI commands stored in an ASCII text file (TXT). Cisco PnP ZTP supports only day-zero configuration TXT files on Cisco ASR 900 and Cisco NCS 520 devices. Your PnP ZTP configuration files must use IOS-XE CLI commands. PnP ZTP does not support Linux shell (SH) or Python (PY) script files. Your organization or consultants create these configurations. Upload configuration files to Cisco Crosswork one at a time.
- **Device credentials**: All Cisco Crosswork ZTP modes require user names and passwords to access devices and update or configure them. You load these as Cisco Crosswork credential profiles. Cisco Crosswork stores credentials in encrypted form. You can create credential profiles one at a time using the GUI, or load them in bulk by downloading and modifying a credential profile CSV file.
- **Serial numbers**: The serial numbers of the devices you plan to onboard using ZTP. Enter serial numbers for each device you're planning to onboard using any of the ZTP modes. Load serial numbers in bulk, by importing a CSV file, before creating device entries. If you're planning to use Secure ZTP, submit the serial numbers to Cisco when requesting ownership vouchers.
- **Owner certificates**: Load both the owner certificates and the owner key to Cisco Crosswork, so it can generate leaf certificates for each of your devices.
- **Pinned Domain Certificate (PDC)**: Load the PDC to Cisco Crosswork along with your owner certificates. You also submit the PDC to Cisco when requesting ownership vouchers.
- **Ownership vouchers (OVs)**: Load your OVs with the other certificates. Submit your PDC and device serial numbers when you request OVs from Cisco or third party manufacturers. Cisco returns the OVs to you when they are ready, as one or more VCJ files in a Tarball. This exchange takes place using a secure method agreed upon by you and your Cisco account team. If you're using vouchers for third-party devices, the VCJ files the manufacturer supplies must follow the naming convention `serial.vcj`, where `serial` is the serial number of the corresponding device. Cisco Crosswork requires this file naming convention in order to map the ownership voucher to the device.
- **SUDI Root CA certificates**. You load SUDI Root CA certificates at the same time as other certificates and (in the case of Secure ZTP) OVs. Cisco SUDI root certificates are available for customer download at the Cisco PKI: Policies, Certificates, and Documents page (https://www.cisco.com/security/pki/policies/index.html).

Some organizations maintain libraries of approved versions of many of these assets. If your organization has a library like this, ensure that these assets are easily accessible from your client desktop. Doing so makes it easier for you to complete ZTP setup.

Prepare Configuration Files

The following sections provide guidelines for preparing custom configuration files for use in configuring your devices using any of the ZTP onboarding modes:

- Download the Sample Configuration File, on page 190
- Preview Configuration Files, on page 191
- Use Default Replaceable Parameters in Configuration Files, on page 191
- Use Custom Replaceable Parameters in Configuration Files, on page 192

- Sample ZTP Configuration Scripts, on page 193

Note that Secure ZTP allows you to apply up to three configuration files during onboarding: one for pre-configuration preparation, a second that is the day-zero or main configuration, and a third post-configuration file to be applied after the day-zero configuration is complete. Only the day-zero configuration is required. The order of application is fixed.

Download the Sample Configuration File

The contents of your configuration code will vary greatly, depending on the devices you use and how your organization uses them. A complete description of all the options available to you is therefore beyond the scope of this document.

The main guidelines to remember are:

1. Your custom configuration code can use both default and custom replaceable (or "placeholder") parameters. This allows you to insert values at runtime using the **Configuration Attributes** field when importing device entries in bulk or creating them one at a time.

2. You can create new, custom replaceable parameters as needed. You can name them anything you like, as long as they do not use the same names as the default parameters and follow the variable naming convention. If you do use the default replaceable parameters, their runtime values will be inserted from the sources described in Use Default Replaceable Parameters in Configuration Files, on page 191 instead of the values you set in the device entry's **Configuration Attributes** field.

3. Replaceable parameter names are case-sensitive, and must include the braces and dollar sign. They must not include spaces (use underscores instead).

4. Be sure all of your custom replaceable parameters have a runtime value specified in the **Configuration Attributes** field. If you fail to specify a runtime value for even one of your custom replaceable parameters, the device configuration process will fail.

5. If you're using Secure ZTP, you can use custom replaceable parameters for the day-zero configuration only. Custom replaceable parameters are not supported for pre-configuration and post-configuration files.

6. Your configurations must use Cisco Crosswork API calls to complete some tasks. In particular, the code must use API calls to notify the Cisco Crosswork server when the device transitions from one ZTP state to another.

7. While any configuration file can call another configuration file and run it (if it can be successfully downloaded to the device), only Secure ZTP lets you specify separate pre-configuration, post-configuration, and day-zero configuration files as part of the initial, secure download.

8. Configuration file names cannot contain more than one period, and must use underscores in place of spaces. Additional file restrictions are noted in the sample configuration file discussed below.

For examples of how to use the configuration parameters and API calls, see the sample ZTP configuration file for Cisco IOS-XR devices supplied with the Cisco Crosswork ZTP application. To download the sample ZTP configuration file from Cisco Crosswork, select **Device Management** > **ZTP Configuration Files**, then click **Download Sample Script (XR)**. The sample configuration script is commented and provides examples of the more commonly used APIs and parameters.

For more details on replaceable parameters, see the following sections, Use Default Replaceable Parameters in Configuration Files, on page 191 and Use Custom Replaceable Parameters in Configuration Files, on page 192.

For more details on the API calls, see the section on ZTP device and configuration APIs in the "Crosswork API References" menu, available on the Cisco Developer Network (DevNet) site for Cisco Crosswork. The sample configuration scripts in this topic also display examples of how to use the relevant Crosswork APIs.

Preview Configuration Files

To preview the contents of any configuration file previously uploaded to Cisco Crosswork, select **Device Management** > **ZTP Configuration Files**, then click the configuration file name. The pop-up preview includes code syntax styling for important code features, as shown in the following table.

Table 13: Code Syntax Colors in ZTP Config File Preview

These code features...	... are shown in this color
Punctuation, Operator, Entity, URL, Variable, Class Name, Constant	Black
Comment	Gray
Property, Tag, Boolean, Function Name, Symbol	Orange
Selector, Attribute Name, Char, Builtin, Inserted	Dark Green
Function	Purple
Keyword, Attribute Value	Blue
Regex, Important	Brown
String	Green
Number, Ethernet Address, MAC Address	Magenta

Use Default Replaceable Parameters in Configuration Files

The following table lists the default replaceable parameters you can use in your custom configuration files. At runtime, for each of these placeholders, Cisco Crosswork substitutes the appropriate values for each device. For an example of the use of these placeholders, download the sample configuration script from Cisco Crosswork: **Device Management** > **ZTP Configuration Files** > **Download Sample Script (XR)**. For examples showing how to use these default replaceable parameters, see Sample ZTP Configuration Scripts, on page 193

Table 14: Default Parameters in ZTP Configuration Files

Cisco Crosswork substitutes this placeholder...	...Using the value from the...
{$HOSTNAME}	Host name of the device as specified in the ZTP device entry.
{$IP_ADDRESS}	IP address of the device as specified in the ZTP device entry.
{$SSH_USERNAME}	The value of the **User Name** field in the credential profile (when the **Connectivity Type** is **SSH**).

Cisco Crosswork substitutes this placeholder...	...Using the value from the...
{$SSH_PASSWORD}	The value of the **Password** field in the credential profile (when the **Connectivity Type** is **SSH**).
{$SSH_ENPASSWORD}	The value of the **Enable Password** field in the credential profile (when the **Connectivity Type** is **SSH**)
{$SNMP_READ_COM}	The value of the **Read Community** field in the credential profile (when the **Connectivity Type** is **SNMPv2**).
{$SNMP_WRITE_COM}	The value of the **Write Community** field in the credential profile (when the **Connectivity Type** is **SNMPv2**).
{$SNMP_SEC_LEVEL}	The value of the **Security Level** field in the credential profile (when the **Connectivity Type** is **SNMPv3**).
{$SNMP_USERNAME}	The value of the **User Name** field in the credential profile (when the **Connectivity Type** is either **SNMPv2** or **SNMPv3**).
{$SNMP_AUTH_TYPE}	The value of the **User Name** field in the credential profile (when the **Connectivity Type** is **SNMPv3** and **Security Level** is **AUTH_NO_PRIV**) or **AUTH_PRIV**).
{$SNMP_AUTH_PASS}	The value of the **User Name** field in the credential profile (when the **Connectivity Type** is **SNMPv3** and **Security Level** is **AUTH_NO_PRIV** or **AUTH_PRIV**).
{$SNMP_PRIV_TYPE}	The value of the **User Name** field in the credential profile (when the **Connectivity Type** is **SNMPv3** and **Security Level** is **AUTH_PRIV**).
{$SNMP_PRIV_PASS}	The value of the **Priv Password** field in the credential profile (when the **Connectivity Type** is **SNMPv3** and **Security Level** is **AUTH_PRIV**).

Use Custom Replaceable Parameters in Configuration Files

You can create your own custom replaceable parameters in configuration files, as shown in the following sample. You can use custom and default replaceable parameters in the same configuration file, as shown in the sample.

You can assign any name you want to a custom replaceable parameter, so long as you:

- Follow the given variable definition format (for example, {$MyParm})
- Substitute an underline character in place of spaces in the parameter name.
- Don't re-use the same names and capitalization as any of the default replaceable parameters.
- Supply values for each of your custom parameters in the **Configuration Attributes** field in the device entry file. To use the following sample CLI configuration file and its custom parameters with a ZTP device entry file, you would need to specify a value for the *{$LOOPBACK0_IP}* custom parameter in each device's **Configuration Attributes** field in the ZTP device entry file. If you forget to specify values for any custom parameter, the configuration will fail.

If you’re using Secure ZTP, custom replaceable parameters are supported for the day-zero configuration file only.

The first line in this sample script is required in CLI scripts for IOS-XR devices. It allows ZTP to verify whether the file is a CLI script or bash/Python script. Be sure to update the version number as appropriate. No such line is required for IOS-XE devices.

Figure 30: Sample IOS-XR CLI Configuration Script With Mixed Replaceable Parameters

```
!! IOS XR Configuration 7.3.1
!
hostname {$HOSTNAME}
username {$SSH_USERNAME}
 group root-lr
 group cisco-support
 password 0 {$SSH_PASSWORD}
!
cdp
!
line console
exec-timeout 0 0
!
line default
exec-timeout 0 0
session-timeout 120
!

call-home
 service active
 contact smart-licensing
 profile CiscoTAC-1
  active
  destination transport-method http
 !
!
interface Loopback0
 ipv4 address {$LOOPBACK0_IP} 255.255.255.255
!
interface MgmtEth0/RP0/CPU0/0
 description OOB Management ZTP
 ipv4 address {$IP_ADDRESS}
!
end
```

Sample ZTP Configuration Scripts

The following samples contain examples of tested, commented configuration files.

Figure 31: Classic ZTP Day-Zero Configuration Script for IOS XR Devices

```
#!/bin/bash

#################################################################################
#
# ztpSampleScriptFile.sh
#
# Purpose: This sample script is required to notify Crosswork of the status of
# ZTP processing on an IOS XR device, and to update the device's IP address and
# hostname in Crosswork. It is also used to download a day0 config file from
# Crosswork config repository and apply this initial configuration to the device.
#
# To use: Modify the sample script as needed, following the comment guidance.
# Then upload the modified script to the Crosswork config repository.
# Next, copy the URL of this file from the repository and set that
# value in the DHCP server boot filename for ZTP config download. When ZTP is
# triggered on the device, it will download and run the script, then notify
# Crosswork.
#
# Replace the following variables with valid values & upload to Crosswork config
# repository. Sample values are provided for reference.
# - XRZTP_INTERFACE_NAME: e.g., MgmtEth0/RP0/CPU0/0 interface where ZTP triggered
# - CW_HOST_IP: Crosswork VM management or data network IP address,
# - CW_PORT: 30604 for HTTP & 30603 only for HTTPS download of config file
# - CW_CONFIG_UUID: Replace with UUID of day0 config file from Crosswork repo,
#   assuming user has already uploaded device day-0 config file.
#
# This script has been tested and is known to work on Cisco NCS5501, NCS540l,
# ASR9901, and 8800 routers.
#
#################################################################################


export LOGFILE=/disk0:/ztp/customer/user-script.log

XRZTP_INTERFACE_NAME="MgmtEth0/RP0/CPU0/0"
# ZTP helper library is assumed to be installed in IOS-XR linux shell
source /pkg/bin/ztp_helper.sh
interfacedata=$(xrcmd "show interface ${XRZTP_INTERFACE_NAME}")

CW_HOST_IP="192.168.100.248"
CW_PORT="30604"
CW_CONFIG_UUID="e04661f8-0169-4ad3-82b8-a7c26c4f2565"

# Send logging information to log file on device disk0:/ztp/user-script.log
function ztp_log() {

    echo "$(date +"%b %d %H:%M:%S") "$1 >> $LOGFILE
}

#
# Get chassis serial number of the device, required by ZTP process.
# This works on Cisco NCS5501, NCS540l, 8800 series routers.
#
function get_serialkey(){

    local sn=$(dmidecode | grep -m 1 "Serial Number:" | awk '{print $NF}');
    if [ "$sn" != "Not found" ]; then
           ztp_log "Serial $sn found.";
           # The value of $sn from dmidecode should be same as serial number
           # of XR device chassis.
           DEVNAME=$sn;
           return 0
    else
        ztp_log "Serial $sn not found.";
        return 1
    fi
}

#
# Get chassis serial number of the device, required by ZTP process.
# This is tested and works on Cisco ASR 9901, but not other devices.
#
function get_serialkey_asr9901(){

     udi=$(xrcmd "show license udi")
     sn="$(cut -d':' -f4 <<<"$udi")"
     pid="$(cut -d':' -f3 <<<"$udi")"
     pid="$(cut -d',' -f1 <<<"$pid")"
     echo "Serial Number $sn"
     echo "product id $pid"
}

#
# Get IP address and subnet mask from device. IP address is assigned from DHCP
# server on interface where ZTP was triggered.
#
function get_ipaddress(){

    local ipvar=($(echo $interfacedata | awk -F "Internet address is " '{sub(/
.*/,"",$2);print $2}'));
    local ipv4addr=$(xrcmd "sh run interface ${XRZTP_INTERFACE_NAME} | i ipv4 address" |
awk '{print $3}')
    local ipv6addr=$(xrcmd "sh run interface ${XRZTP_INTERFACE_NAME} | i ipv6 address" |
awk '{print $3}')
    local ipaddress=($(echo $ipvar | awk -F "/" '{sub(/ .*/,"",$1);print $1}'));
    local mask=($(echo $ipvar | awk -F "/" '{sub(/ .*/,"",$2);print $2}'));
    local maskv6=($(echo $ipv6addr | awk -F "/" '{sub(/ .*/,"",$2);print $2}'));

    ztp_log "### Value of interfacedata => $interfacedata ###"
    ztp_log "### Value of ipvar => $ipvar ###"
    ztp_log "#####IPv4 address $ipaddress and mask $mask found. #####";

    IPADDR=$ipaddress
    MASK=$mask
    MASKV6=$maskv6

    return 0
}

#
# Fetch hostname from device configuration.
#
function get_hostname(){

    hostnamedata=$(xrcmd "show running-config hostname")
    local hostname=($(echo $hostnamedata | awk -F "hostname " '{sub(/ .*/,"",$2);print
$2}'));

    ztp_log "#####hostname $hostname found.";
    HOSTNAME=$hostname;
    return 0;
}

#
# Download day-0 config file from Crosswork config repository using values
# set for CW_HOST_IP, CW_PORT and CW_CONFIG_UUID.
# The MESSAGE variable is optional, can be used to display a suitable message
# based on the ZTP success/failure log.
#
function download_config(){

    ztp_log "### Downloading system configuration ::: ${DEVNAME} ###";
    ztp_log "### ip address passed value ::: ${IPADDR} ###";
    ip netns exec global-vrf /usr/bin/curl -k --connect-timeout 60 -L -v --max-filesize
104857600
http://${CW_HOST_IP}:${CW_PORT}/crosswork/configsvc/v1/configs/device/files/${CW_CONFIG_UUID}
 -H X-cisco-serial*:${DEVNAME} -H X-cisco-arch*:x86_64 -H X-cisco-uuid*: -H
X-cisco-oper*:exr-config -o /disk0:/ztp/customer/downloaded-config 2>&1

    if [[ "$?" != 0 ]]; then
        STATUS="ProvisioningError"
        ztp_log "### status::: ${STATUS} ###"
        ztp_log "### Error downloading system configuration, please review the log ###"
        MESSAGE="Error downloading system configuration"
    else
        STATUS="Provisioned"
        ztp_log "### status::: ${STATUS} ###"
        ztp_log "### Downloading system configuration complete ###"
        MESSAGE="Downloading system configuration complete"
    fi
}

#
# Apply downloaded configuration to the device and derive ZTP status based on
# success/failure of ZTP process. The MESSAGE variable is optional, can be used
# to display a suitable message based on the ZTP success/failure log.
#
function apply_config(){
    ztp_log "### Applying initial system configuration ###";
    xrapply_with_reason "Initial ZTP configuration" /disk0:/ztp/customer/downloaded-config
 2>&1 >> $LOGFILE;
    ztp_log "### Checking for errors ###";
    local config_status=$(xrcmd "show configuration failed");
    if [[ $config_status ]]; then
        echo $config_status  >> $LOGFILE
        STATUS="ProvisioningError"
        ztp_log "### status::: ${STATUS} ###"
        ztp_log "!!! Error encountered applying configuration file, please review the log
!!!!";
        MESSAGE="Error encountered applying configuration file, ZTP process failed"
    else
       STATUS="Provisioned"
       ztp_log "### status::: ${STATUS} ###"
       ztp_log "### Applying system configuration complete ###";
       MESSAGE="Applying system configuration complete, ZTP process completed"
   fi
}

#
# Call Crosswork ZTP API to update device ZTP status, IP address, hostname.
# Without this function, device status will remain in "In Progress" and not
# be updated in Crosswork.
#
# Using this API, device SSH/SNMP connectivity details can also be updated.
# Values for connectivity details values can be added as part of
# "connectivityDetails" array in below curl command. Sample snippet provided:
#
#   "connectivityDetails": [{
#     "protocol": "SSH",
#     "inetAddr": [{
#       "inetAddressFamily": "IPV4/IPV6",
#       "ipaddrs": "<ssh/snmp ipaddress>",
#       "mask": <ipaddress mask(Integer).>,
#       "type": "CONNECTIVITYINFO"
#     }],
#     "port": <ssh/snmp port(Integer)>,
#     "timeout": <ssh/snmp timeout(Integer). default to 60sec>
#   }]
#
function update_device_status() {

     echo "'"$IPADDR"'"
     echo "'"$MASK"'"
     echo "'"$DEVNAME"'"
     echo "'"$STATUS"'"
     echo "'"$HOSTNAME"'"
     echo "'"$MESSAGE"'"


    curl -d '{
       "ipAddress":{
            "inetAddressFamily": "IPV4",
            "ipaddrs": "'"$IPADDR"'",
            "mask":  '$MASK'
        },
       "serialNumber":"'"$DEVNAME"'",
       "status":"'"$STATUS"'",
       "hostName":"'"$HOSTNAME"'",
       "message":"'"$MESSAGE"'"
   }' -H "Content-Type: application/json" -X PATCH
http://${CW_HOST_IP}:${CW_PORT}/crosswork/ztp/v1/deviceinfo/status
}


# ==== Script entry point ====
STATUS="InProgress"
get_serialkey;
#get_serialkey_asr9901; // For Cisco ASR9901, replace get_serialkey with
get_serialkey_asr9901.
ztp_log "Hello from ${DEVNAME} !!!";
get_ipaddress;
ztp_log "Starting autoprovision process...";
download_config;
apply_config;
get_hostname;
update_device_status;

ztp_log "Autoprovision complete...";
exit 0
```

Figure 32: Sample Secure ZTP Post-Configuration Script

```
#!/bin/bash

#################################################################################
#
# Secure ZTP post-configuration script. It updates the hostname and
# ipaddress for the device input, serial key and Crosswork host and port
#
#################################################################################


export LOGFILE=/disk0:/ztp/customer/user-script.log

XRZTP_INTERFACE_NAME="MgmtEth0/RP0/CPU0/0"
# ZTP helper library is assumed to be installed in IOS-XR linux shell
source /pkg/bin/ztp_helper.sh
interfacedata=$(xrcmd "show interface ${XRZTP_INTERFACE_NAME}")

CW_HOST_IP="192.168.100.248"   #update from the post script prepare code
CW_PORT="30603"           #update from the post script prepare code


# Send logging information to log file on device disk0:/ztp/user-script.log
function ztp_log() {

    echo "$(date +"%b %d %H:%M:%S") "$1 >> $LOGFILE
}
```

```
#
# Get IP address and subnet mask from device. IP address is assigned from DHCP
# server on interface where ZTP was triggered.
#
function get_ipaddress(){

    local ipvar=($(echo $interfacedata | awk -F "Internet address is " '{sub(/
.*/,"",$2);print $2}'));
    local ipv4addr=$(xrcmd "sh run interface ${XRZTP_INTERFACE_NAME} | i ipv4 address" |
awk '{print $3}')
    local ipv6addr=$(xrcmd "sh run interface ${XRZTP_INTERFACE_NAME} | i ipv6 address" |
awk '{print $3}')
    local ipaddress=($(echo $ipvar | awk -F "/" '{sub(/ .*/,"",$1);print $1}'));
    local mask=($(echo $ipvar | awk -F "/" '{sub(/ .*/,"",$2);print $2}'));
    local maskv6=($(echo $ipv6addr | awk -F "/" '{sub(/ .*/,"",$2);print $2}'));

    ztp_log "### Value of interfacedata => $interfacedata ###"
    ztp_log "### Value of ipvar => $ipvar ###"
    ztp_log "#####IPv4 address $ipaddress and mask $mask found. #####";

    IPADDR=$ipaddress
    MASK=$mask
    MASKV6=$maskv6

    return 0
}

#
# Fetch hostname from device configuration.
#
function get_hostname(){

    hostnamedata=$(xrcmd "show running-config hostname")
    local hostname=($(echo $hostnamedata | awk -F "hostname " '{sub(/ .*/,"",$2);print
$2}'));

    ztp_log "#####hostname $hostname found.";
    HOSTNAME=$hostname;
    return 0;
}



#
# Call Crosswork ZTP API to update device ZTP status, IP address, hostname.
# Without this function, device status will remain in "In Progress" and not
# be updated in Crosswork.
#
# Using this API, device SSH/SNMP connectivity details can also be updated.
# Values for connectivity details values can be added as part of
# "connectivityDetails" array in below curl command. Sample snippet provided:
#
#   "connectivityDetails": [{
#     "protocol": "SSH",
#     "inetAddr": [{
#       "inetAddressFamily": "IPV4/IPV6",
#       "ipaddrs": "<ssh/snmp ipaddress>",
#       "mask": <ipaddress mask(Integer).>,
#       "type": "CONNECTIVITYINFO"
#     }],
#     "port": <ssh/snmp port(Integer)>,
#     "timeout": <ssh/snmp timeout(Integer). default to 60sec>
#   }]
#
```

```
function update_device_status() {

     echo "'"$IPADDR"'"
     echo "'"$MASK"'"
     echo "'"$SERIAL_KEY"'"
     echo "'"$HOSTNAME"'"


    curl -d '{
       "ipAddress":{
            "inetAddressFamily": "IPV4",
            "ipaddrs": "'"$IPADDR"'",
            "mask":  '$MASK'
        },
       "serialNumber":"'"$SERIAL_KEY"'",
       "hostName":"'"$HOSTNAME"'",
       "message":"Post config script updated succssfully"
   }' -H "Content-Type: application/json" -X PATCH
http://${CW_HOST_IP}:${CW_PORT}/crosswork/ztp/v1/deviceinfo/status
}

function get_sudi_serial() {
   local rp_card_num=`ip netns exec xrnns /pkg/bin/show_platform_sysdb | grep Active  | cut
 -d ' ' -f 1`
   echo $rp_card_num
   xrcmd "show platform security tam all location $rp_card_num" > tamfile.txt
   local sudi_serial=$(sed -n -e '/Device Serial Number/ s/.*\- *//p' tamfile.txt)
   echo $sudi_serial
   SERIAL_KEY=$sudi_serial
   return 0
}

function ztp_disable()
{
 xrcmd "ztp disable noprompt"
}

function ztp_enable()
{
 xrcmd "ztp enable noprompt"
}

# ==== Script entry point ====
get_sudi_serial;
ztp_log "Hello from ${SERIAL_KEY} !!!";
get_ipaddress;
get_hostname;
update_device_status;

ztp_log "Autoprovision complete...";
ztp_log "Disabling secure mod"
ztp_disable;
exit 0
```

Load ZTP Assets

Upload the ZTP assets you assembled, per the requirements of the ZTP mode you want to use.

Classic ZTP requires you to load:

- Configuration files (TXT, SH, or PY files)
- Device serial numbers

Secure ZTP requires you to load:

- Configuration files (TXT, SH, or PY)
- Device serial numbers
- Pinned domain certificate
- Ownership certificates
- Ownership Vouchers
- SUDI Root Certificates

PnP ZTP requires you to load:

- Configuration files (TXT only)
- Device serial numbers

If you plan to image, re-image, or update the device operating system software as part of ZTP onboarding, you must also load software images and SMUs, as follows:

- Classic ZTP: TAR, ISO, BIN, or RPM image files, and SMUs
- Secure ZTP: TAR, ISO, BIN, or RPM image files, and SMUs
- PnP ZTP: BIN only. SMUs are not supported.

You may use a mapped network drive to upload software images, SMUs, and configuration files.

Cisco Crosswork checks uploaded serial numbers for duplicates and merges them into single entries automatically. Cisco Crosswork also associates all uploaded ownership vouchers with existing serial numbers automatically.

You can upload images, SMUs, configuration files, and serial numbers in any order. Load certificates and ownership vouchers only after loading serial numbers.

Step 1 (Optional) Upload software images and SMUs:

a) From the main menu, select **Device Management** > **Software Images** and then click the ⊞.
b) Enter the required image or SMU file information and then click **Add**.

   You must enter the MD5 checksum for the file.

   You can also click **Browse** to select the software image file.

c) Click ⊞ and repeat step 1b until you have loaded all the image and SMU files.

Step 2 Upload configuration files:

a) From the main menu, select **Device Management** > **ZTP Configuration Files** and then click the ⊞.
b) Enter the required configuration information and then click **Add**.

   Click **Browse** to select a configuration file.

   If you’re implementing Secure ZTP, use the **Type** dropdown to specify whether the configuration file you are adding is a **Pre-config**, **Day0-config**, or **Post-config**. For Classic and PnP ZTP, always select **Day0-config**.

c) Click ⊞ and repeat step 2b until you have loaded all the configuration files.

Step 3 Upload device serial numbers:

a) From the main menu, select **Device Management** > **Serial Number and Voucher**, then click **Add Serial Number**.
b) Click **Upload CSV**, then click the **serialnumber.csv** link to download the sampleSerialnumber.csv template file.
c) Using your choice of CSV file editor, enter into the template the serial numbers for all the devices you plan to onboard using ZTP. Save the updated CSV file template under a new name.
d) Select **Add Serial Number** again. Click **Browse** to select the updated CSV file, then click **Add Serial Number** to import the serial numbers.

Step 4 Continue with the following steps only if you plan to implement Secure ZTP.

Step 5 Update the default ownership certificate, Pinned Domain Certificate, Owner Key, Owner Certificate, and Owner Passphrase:

a) From the main menu, select **Administration** > **Certificate Management**.
b) Under **Certificates**, click the ··· next to **Crosswork-ZTP-Owner**, then click **Update Certificate**.
c) Click **Browse** to select the Pinned Domain Certificate (PEM or CRT file). With the file selected, click **Save**.
d) Click **Browse** to select the Owner Key (PEM, KEY, CRT file). With the file selected, click **Save**.
e) Click **Browse** to select the Owner Certificate (PEM or CRT file). With the file selected, click **Save**.
f) In **Owner Passphrase** enter the owner passphrase.
g) Click **Save**.

Step 6 Update the default ownership voucher certificate:

a) From the main menu, select **Administration** > **Certificate Management**
b) Under **Certificates**, click the ··· next to **Crosswork-ZTP-Owner**.
c) Click **Update Certificate**.
d) Click **Browse** to select the TAR or VCJ file you want to use to update the default ownership voucher.
e) Click **Save**.

Step 7 Update the default SUDI device certificate:

a) From the main menu, select **Administration** > **Certificate Management**.
b) Under **Certificates**, click the ··· next to **Crosswork-ZTP-Device-SUDI**.
c) Click **Update Certificate**.
d) Click **Browse** to select the SUDI device certificate file you want to use to update the default SUDI certificate.
e) Click **Save**.

Step 8 Upload additional ownership vouchers, as needed:

a) From the main menu, select **Device Management** > **Serial Number & Voucher**.
b) Click **Add Voucher**.
c) Click **Browse** to select the TAR or VCJ voucher file you want to upload.

   If you are uploading vouchers for third party devices, ensure that the uploaded VCJ file or files in the Tarball follow the name convention `serial.vcj`, where *serial* is the serial number of the corresponding device. Cisco Crosswork requires this type of naming in order to map the ownership voucher to the device.

d) Click **Upload**.

Create Credential Profiles for ZTP

Cisco Crosswork ZTP requires credential profiles in order to access and configure your devices. The following steps show how to add them in bulk using a CSV file.

You can also add credential profiles one at a time. To do so, select **Device Management** > **Credential Profiles**, then click the ⊞.

Credential profiles allow you to specify different credentials for each protocol the device supports. When creating device credential profiles that contain SNMP credentials, we recommend that the profile contain credentials for the version of SNMP actually enabled on the device, and that version only. For example: If SNMPv3 is not enabled in the device configuration, do not include SNMPv3 credentials in the device credential profile.

Step 1 From the main menu, choose **Device Management** > **Credential Profiles**.

Step 2 Click the ⇤.

Step 3 Click the **Download sample 'Credential template (*.csv)' file** link and save the CSV file template locally.

Step 4 Open the CSV template using your preferred editor. Begin adding rows to the file, one row for each credential profile you want to create.

As you do, observe these guidelines:

- If the **Password** column for any credential profile is blank, you can’t import the CSV file. If you wish, you can enter the actual passwords in these fields. Cisco Crosswork stores them in encrypted form. If you choose this method, be sure to destroy the CSV file immediately after upload. We recommend using asterisks to fill the **Password** column in the CSV file and then importing it. After successful import, you can use the Cisco Crosswork GUI to edit each profile and enter the actual passwords, as explained in the following steps.

- Use a semicolon to separate multiple entries in the same field.

- When you separate multiple entries with semicolons, remember that the order in which you enter values in each field is important. The first entry in one column will map to the first entry in the next column, and so on. For example: Suppose you enter in **Password Type** this list of password types: **`ROBOT_USERPASS_SSH;ROBOT_USERPASS_TELNET;ROBOT_USERPASS_NETCONF`**. You then enter in the **User Name** column **`Tom;Dick;Harry;`** and in the **Password** column **`root;MyPass;Turtledove;`**. The order of entry in these columns sets the following mapping between the three password types and the three user names and three passwords you entered:

  - ROBOT_USERPASS_SSH; Tom ; root

  - ROBOT_USERPASS_NETCONF; Dick ; MyPass

  - ROBOT_USERPASS_TELNET; Harry; Turtledove

- Be sure to delete sample data rows before saving the file. You can ignore the column header row.

Step 5 When you’re finished, save the CSV file to a new name.

Step 6 If necessary, choose **Device Management** > **Credential Profiles** again, then click the ⇤.

Step 7 Click **Browse** to navigate to the CSV file and select it.

Step 8 With the CSV file selected, click **Import**.

Step 9 When the import is complete:

a) From the left-hand side of the **Credential Profiles** window, select the profile you want to update, then click the ✎.
b) Enter the passwords and community strings for the credential profile and then click **Save**.
c) Repeat these steps as needed until you have entered all passwords and community strings.

Create ZTP Profiles

Cisco Crosswork uses ZTP profiles to automate imaging and configuration processes. While ZTP profiles are optional, we strongly recommend creating them, as they can help simplify the ZTP imaging and configuration process. Use ZTP profiles to help organize defined sets of image and configuration files you can apply to devices in a particular class or device family.

If you're implementing Classic ZTP, each ZTP profile can have only one image file and one configuration file associated with it. Secure ZTP allows you to specify pre-configuration, post-configuration, and day-zero configuration files.

ZTP profiles don't require that you specify an image file.

You can create as many ZTP profiles as you like. We recommend that you create only one ZTP profile for each device family, use case, or network role.

Step 1 From the main menu, choose **Device Management** > **Zero Touch Profiles**.

Step 2 Click **+ New Profile**.

Step 3 Enter the required values for the new ZTP profile. You don't need to specify a software image for the profile.

Step 4 If you're implementing Secure ZTP: Move the **Secure ZTP** slider to **Enabled**. Then enter the names of the pre- and post-configuration files.

Secure ZTP is not available if you select IOS-XE as the OS Version.

Step 5 Click **Save** to create the new ZTP profile.

Prepare ZTP Device Entry Files

Cisco Crosswork uses ZTP device entries to let you specify in advance the IP addresses, protocols, and other information for the devices you want to provision. Cisco Crosswork populates these imported entries with more information once ZTP processing completes successfully.

You can create ZTP device entries in bulk by importing a device-entry CSV file.

The following topics explain how to download a template for a device entry CSV file and create properly formatted ZTP device entries.

We recommend that you experiment with the device entry CSV file format until you get used to it. Add only one or two device entries in a copy of the template, then import it. You can then see how to get the results you want.

You can also create ZTP device entries one by one, using the Cisco Crosswork UI, as explained in Prepare Single ZTP Device Entries, on page 209.

Download and Edit the ZTP Device Entry Template

1. From the main menu, choose **Device Management** > **Devices**.
2. Click the **Zero Touch Devices** tab.
3. Click the ⎘.
4. Click the **Download 'devices import' template (.csv)** link and then **Save** it to a local storage resource. Click **Cancel** to clear the dialog box.
5. Open the CSV template with the application of your choice and save it to a new name. In each row, create an entry for each of the devices you plan to onboard using ZTP. Refer to the next topic section for help on the values to enter in each column.

ZTP Device Entry CSV Template Reference

The following table explains how to use the columns in the template. We mark columns that require entries with an asterisk (*) next to the column name.

The four "Connectivity" columns allow multiple entries, so you can specify multiple connectivity protocols for a single device. If you use this option, use semicolons between entries, and enter the values in the next three columns in the same order. For example: Suppose you enter `SSH;NETCONF;` in the **Connectivity Protocol** column. If you enter `23;830;` in the **Connectivity Port** column, the entries in the two columns map like this:

- SSH: 22
- NETCONF: 830

Table 15: ZTP Device Entry Template Column Reference

Template Column	Usage
Serial Number *	Enter the device serial number. You can enter up to three serial numbers for the same device. These must be the same serial number for each device that you loaded into Cisco Crosswork previously. ZTP requires a serial number entry for all normal deployments. If you’re using DHCP option 82 to implement a relay agent, you can leave this field blank, but you must specify a Remote Id and Circuit ID to identify the device.
Location Enabled	Enter TRUE if you plan to identify the device using a location ID. Enter FALSE if you plan to identify it by serial number. If you enter TRUE, enter a Remote ID and a Circuit ID in the corresponding columns. If you enter FALSE, enter a Serial Number in the corresponding column.
Remote ID *	If implementing Secure ZTP and using option 82: Identify the name of the remote host acting as the bootstrap server. If you’re using DHCP option 82 to implement a relay agent, this entry is required. You must enter a combination of the device RemoteID and CircuitID. If you’re not using option 82, you can leave this field blank but you must specify the device serial number.

Template Column	Usage
Circuit ID *	If implementing Secure ZTP and using option 82: Identify the interface or VLAN on which the bootstrap server receives requests. If you're using DHCP option 82 to implement a relay agent, this entry is required. You must enter a combination of the device RemoteID and CircuitID. If you're not using option 82, you can leave this field blank but you must specify the device serial number.
Host Name *	Enter the host name you want to assign to the device.
Credential Profile *	Enter the name of the credential profile you want Cisco Crosswork to use to access and configure the device. The name you enter must match the the name of the credential profile as specified in Cisco Crosswork.
OS Platform *	Enter the OS platform for the device. For example: IOS XR. Note that you must enter Cisco IOS platform names with a space, not a hyphen.
Version *	Enter the OS platform version for the device software image. The platform version should be the same version as the ones specified for the image and configuration files you use to provision it. Required only if you don't specify a ZTP profile in the Profile Name column.
Device Family *	Enter the device family for the device. The device family must match the device family in the image and configuration files ZTP uses to provision it. Required only if you don't specify a ZTP profile in the Profile Name column.
Config ID *	Enter the Cisco Crosswork-assigned ID for the configuration file you want to use when configuring the device. Cisco Crosswork assigns a unique ID for every configuration file during upload. Required only if you don't specify a ZTP profile in the Profile Name column.
Profile Name *	Enter the name of the ZTP profile you want to use to provision this device. Required only if you want to use a ZTP profile to specify things like the configuration ID, image ID, OS platform, and so on.
Product ID *	Enter the Cisco-assigned PID (product identifier) coded into the device hardware. You can retrieve the PID from the UDI (Unique Device Identifier) information printed on the label affixed to every Cisco networking device when it leaves the factory. Please note that, in this release, no verification is performed on the PID. We recommend that you supply a correct PID anyway, in case of future requirements.
UUID	You can choose to generate and specify a Universally Unique Identifier (UUID) to be assigned to the device when it is onboarded. If you choose this option, enter the 128-bit UUID in this column. Otherwise, leave the field blank and Cisco Crosswork will assign a random UUID when it onboards the device.
MAC Address	Enter the device's MAC address.

Template Column	Usage
IP Address	Enter the device's IP address (IPv4 or IPv6), along with its subnet mask in slash notation.
Configuration Attributes	Enter the values you want Cisco Crosswork to use for the custom replaceable parameters in the configuration file for the device. If you are using only the default replaceable paramters, leave this field blank. If you're using Secure ZTP, you can use custom replaceable paramters only for day-zero configuration file parameters.
Connectivity Protocol	The connectivity protocols needed to monitor the device or to support Cisco Crosswork applications and features. Choices are: **`SSH`**, **`SNMPv2`**, **`NETCONF`**, **`TELNET`**, **`HTTP`**, **`HTTPS`**, **`GRPC`**, and **`SNMPv3`**.
Connectivity IP Address	Enter the IP address (IPv4 or IPv6) and subnet mask for the connectivity protocol. Required only if you chose to set up a connectivity protocol.
Connectivity Port	Enter the port used for this connectivity protocol. Each protocol maps to a port. Be sure to enter the port number that maps to the protocol you chose. Specify at least one port and protocol for every device, except if you want to: • Set the status of the onboarded device as unmanaged or down. • Disable Cisco Crosswork reachability checks for the onboarded device. You may need to specify more than one protocol and port per device. The number of protocols and ports you specify depends on how you have configured Cisco Crosswork and the Crosswork applications you're using. See the table in the following section, Crosswork Connectivity Protocol Requirements, on page 207.
Connectivity Timeout	Enter the elapsed time (in seconds) before an attempt to communicate using this protocol times out. The default value is 30 seconds; the recommended timeout value is 60 seconds.
Provider Name	Enter the name of the provider to which you want to onboard the new ZTP devices. The name you enter must match exactly the name of the provider managing the device, as specified in Cisco Crosswork.
Inventory ID	Enter the inventory ID you want to assign to the device.
Secure ZTP Enabled	Enter TRUE if you want to provision the device using Secure ZTP, or FALSE if not.
Secure ZTP Encrypted	Currently unsupported. Enter FALSE.
Image ID	Cisco Crosswork assigns a unique ID for every software image file during upload. Enter the Cisco Crosswork-assigned ID for the software image file you want to install on the device. Required only if you want to include installation of a software image during onboarding, and you did not specify a ZTP profile with this software image in the Profile Name column.

Template Column	Usage
PreConfig ID	Cisco Crosswork assigns a unique ID for every configuration file during upload. Enter the Cisco Crosswork ID of the configuration script you want to run before running the configuration file specified in the Config ID column. Required only if you want to run a pre-configuration file during onboarding.
PostConfig ID	Cisco Crosswork assigns a unique ID for every configuration file during upload. Enter the Cisco Crosswork ID of the configuration script you want to run immediately after running the configuration file specified in the Config ID column. Required only if you want to run a post-configuration file during onboarding.
SZTP Config Mode	Enter **`merge`** if you want Secure ZTP to merge the configuration files you specify in the Config ID, PreConfig ID, and PostConfig ID columns with a pre-existing configuration on the device. Leave this column blank if you want to overwrite any existing configuration with the content of the specified configuration files (overwrite is the default specified by leaving the column blank).
Version ID	The version ID of the configuration. Required only if you specified a pre-configuration and a post-configuration file to run during onboarding.
routingInfo.globalospfrouterid	If implementing OSPF on the device: Enter the OSPF Router ID for the device. Otherwise, leave this field blank.
routingInfo.globalisissystemid	If implementing IS-IS on the device: Enter the IS-IS System ID for the device. Otherwise, leave this field blank.
routingInfo.teRouterid	If implementing Traffic Engineering on the device: Enter the TE router ID for the device. Otherwise, leave this field blank.

Crosswork Connectivity Protocol Requirements

Cisco Crosswork applications require you to enable a range of connectivity protocols for each device. The following table identifies these requirements for each supported connectivity protocol. If you use the applications listed in this table, be sure to enable these protocols on your devices. You must enable at least one of these protocols on each device in order to onboard it; you cannot onboard a device without at least one of these protocols.

Table 16: Connectivity Protocol Requirements for Applications and Features

Protocol	Port	Crosswork Application	Application Feature
GRPC	9090	• Cisco Crosswork Network Controller • Cisco Crosswork Change Automation and Health Insights • Cisco Crosswork Optimization Engine	Cisco Crosswork API communication
HTTP	80	• Cisco Crosswork Network Controller • Cisco Crosswork Change Automation and Health Insights • Cisco Crosswork Optimization Engine	Onboarding of the device to Cisco Network Services Orchestrator
HTTPS	443	• Cisco Crosswork Network Controller	Onboarding of the device to Cisco Network Services Orchestrator
NETCONF	830	• Cisco Crosswork Network Controller • Cisco Crosswork Change Automation and Health Insights • Cisco Crosswork Optimization Engine	Onboarding of the device to Cisco Network Services Orchestrator
SNMPv2	161	• Cisco Crosswork Network Controller • Cisco Crosswork Change Automation and Health Insights • Cisco Crosswork Optimization Engine	SNMPv2 data collection

Protocol	Port	Crosswork Application	Application Feature
SNMPv3	161	• Cisco Crosswork Network Controller • Cisco Crosswork Change Automation and Health Insights • Cisco Crosswork Optimization Engine	SNMPv3 data collection
SSH	22	• Cisco Crosswork Network Controller • Cisco Crosswork Change Automation and Health Insights • Cisco Crosswork Optimization Engine	• CLI data collection • SSH access to devices

Prepare Single ZTP Device Entries

If you have only a few devices to onboard using ZTP, you may find it easier to create the device entries one by one. Use the ZTP user interface and the following instructions to create single ZTP device entries.

Step 1 From the main menu, choose **Device Management** > **Devices**.

Step 2 Click the **Zero Touch Devices** tab.

Step 3 Click the ⊞.

Step 4 Enter values for the new ZTP device entry.

For reference on the information called for each device entry, see the template reference in Prepare ZTP Device Entry Files, on page 203.

After ZTP onboards your devices, Cisco Crosswork will display fields calling for more information about the device, such as its geographical location. You will need to supply this additional information by editing the device's inventory record, as explained in Complete Onboarded ZTP Device Information, on page 234.

Step 5 Click **Save**.

ZTP Provisioning Workflow

Once you complete ZTP setup, you can provision your devices and maintain them, as follows:

1. Set up DHCP so that Cisco Crosswork can download image and configuration software securely after you trigger ZTP processing.

2. Upload to Cisco Crosswork the ZTP device entry CSV file you created. Importing the file creates the device entries that ZTP populates during onboarding. If you're onboarding only a few ZTP devices, create device entries using the ZTP user interface instead.
3. Trigger ZTP processing by power-cycling or performing a CLI reboot for each device.
4. Complete the information for the onboarded devices. Edit them and supply (for example) geographical location information that ZTP couldn't discover during provisioning.

After completing this core workflow, you can perform ongoing maintenance of your ZTP devices using the advice and methods in the following topics:

- Update ZTP devices with additional information.
- Reconfigure your ZTP devices after onboarding, using other applications or by deleting and re-onboarding the devices.
- Retire or replace ZTP devices without consuming more device licenses.
- Perform housekeeping on the ZTP assets you used to onboard your devices.
- Troubleshoot issues with ZTP processing and devices.

The remaining topics in this section discuss how to perform each of these tasks.

Upload ZTP Device Entries

The following steps explain how to create multiple ZTP device entries by importing your previously prepared ZTP device-entry CSV file.

Imported ZTP device entries always appear in the **Zero Touch Devices** tab with their **Status** set to `Unprovisioned`. They remain `Unprovisioned` until you trigger ZTP processing.

Step 1 From the main menu, choose **Device Management** > **Network Devices**.

Step 2 Click the **Zero Touch Devices** tab.

Step 3 Click the ⇦.

Step 4 Click **Browse** to navigate to the ZTP device entry CSV file you created and then select it.

Step 5 With the CSV file selected, click **Import**.

Set Up DHCP for Crosswork ZTP

Before triggering ZTP processing, you must update your DHCP (and, for PnP ZTP, TFTP) server configuration with information that permits Cisco Crosswork to communicate with your devices and respond to their requests for downloads.

The following topics provide examples showing how to update your server configurations to meet this requirement. The instructions and examples you follow depend on the ZTP mode you want to use:

- For Classic ZTP, see Set Up DHCP for Classic ZTP, on page 211
- For Secure ZTP, see Set Up DHCP for Secure ZTP, on page 214

- For PnP ZTP, see Set Up DHCP and TFTP for PnP ZTP, on page 217
- For a set of configuration scripts for Classic ZTP and Cisco PNR, see Classic ZTP DHCP Setup Scripts for Cisco Prime Network Registrar (CPNR), on page 218

Set Up DHCP for Classic ZTP

Before triggering ZTP processing, update your DHCP configuration file with information that identifies your ZTP devices and the software applied to them. This information permits Cisco Crosswork and DHCP to identify the ZTP devices and respond to requests for network connection and file downloads.

The following topics provide examples showing how to update DHCP server configurations to meet this requirement. The examples in these topics assume the DHCP context settings shown in the following figure. The figure shows example settings for the Internet Systems Consortium DHCP server.

Figure 33: Classic ZTP DHCP Context

```
#
authoritative;

default-lease-time 7200;
max-lease-time 7200;

subnet 192.168.100.0 netmask 255.255.255.0 {
  option routers 192.168.100.1;
  option domain-name "cisco.com";
  option domain-name-servers 171.70.168.183;
  option subnet-mask 255.255.255.0;
  range 192.168.100.105 192.168.100.195;
}
```

Examples: DHCP Setup for Classic ZTP

We strongly recommend that you use Classic ZTP to provision devices over secure network domains only.

Cisco devices supported by Classic ZTP allow iPXE software image downloads via HTTP only. These same devices support download of configuration files via either HTTP or HTTPS. These options require entry of DHCP bootfile URLs in the DHCP server configuration for your organization.

If you want to use HTTP for both image and configuration file downloads, these URLs must specify the HTTP protocol and port 30604. For help, see the examples in figures 1 and 2.

If you want to use HTTPS for configuration file downloads only, the URL must specify the HTTPS protocol and port 30603. Specify the -k option before the HTTPS protocol in the URL. For help, see the examples in figures 3 and 4.

ZTP permits use of DHCP option 82 for configuration downloads. Option 82, also known as the DHCP Relay Agent Information Option, helps protect your devices from attacks using IP and MAC spoofing or DHCP address starvation. Option 82 allows you to specify an intermediary, or relay, router located between the device you're onboarding and the DHCP server resolving device requests. To use this option, specify a location ID. The location ID consists of a circuit ID (interface or VLAN ID) and remote ID (host name). Specify these values as parameters of the configuration download URL, as shown in the examples in figures 2 and 4. For more information about option 82, see RFC 3046 (http://tools.ietf.org/html/rfc3046).

When following these examples:

- Be sure to replace <*CW_HOST_IP*> with the IP address of your Cisco Crosswork cluster.

- Replace *<IMAGE_UUID>* with the UUID of the software image file in the ZTP repository. For help with using bootfile names and UUIDs, see the following section, #unique_165 unique_165_Connect_42_CopyBootfileNamesAndUUIDsForDHCPSetup, on page 214.
- Configuration files do not require UUIDs.

Figure 34: Classic ZTP DHCP Setup, Using HTTP

```
host cztp1 {
 hardware ethernet 00:a7:42:86:54:f1;
  if exists user-class and option user-class = "iPXE" {
    filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/<IMAGE_UUID>";

  } else if exists user-class and option user-class ="exr-config" {
     filename = "http://<CW_HOST_IP>:30604/crosswork/configsvc/v1/file";
  }
}
```

Figure 35: Classic ZTP DHCP Setup, Using HTTP and Option 82

```
host cztp2 {
 hardware ethernet 00:a7:42:86:54:f2;
  if exists user-class and option user-class = "iPXE" {
    filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/<IMAGE_UUID>";

  } else if exists user-class and option user-class ="exr-config" {
     filename =
"http://<CW_HOST_IP>:30604/crosswork/configsvc/v1/file?circuitid=Gig001&remoteid=MAR1";
  }
}
```

Figure 36: Classic ZTP DHCP Setup, Using HTTPS

```
host cztp3 {
 hardware ethernet 00:a7:42:86:54:f3;
  if exists user-class and option user-class = "iPXE" {
    filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/<IMAGE_UUID>";

  } else if exists user-class and option user-class ="exr-config" {
     filename = "-k https://<CW_HOST_IP>:30603/crosswork/configsvc/v1/file";
  }
}
```

Figure 37: Classic ZTP DHCP Setup, Using HTTPS and Option 82

```
host cztp4 {
 hardware ethernet 00:a7:42:86:54:f4;
  if exists user-class and option user-class = "iPXE" {
    filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/<IMAGE_UUID>";

  } else if exists user-class and option user-class ="exr-config" {
     filename = "-k
https://<CW_HOST_IP>:30603/crosswork/configsvc/v1/file?circuitid=Gig001&remoteid=MAR1";
  }
}
```

Examples: Generic Internet Systems Consortium (ISC) DHCP Setup for Classic ZTP

The following figures show examples of the type of host entries you would make for Classic ZTP in the `/etc/dhcp/dhcp.conf` configuration file of an Internet Systems Consortium (ISC) DHCP server.

Other third-party DHCP servers differ in overall implementation, but many use options and formats similar to these ISC examples.

Be sure to reload or restart the ISC DHCP server once you have finished creating these new entries.

Figure 38: Classic ZTP ISC IPv4 DHCP Configuration Example

```
host NCS5k-l
{
    option dhcp-client-identifier "FOC2302R09H";
    hardware ethernet 00:cc:fc:bb:be:6a;
    fixed-address 105.1.1.16;
    if exists user-class and option user-class = "iPXE" {
        filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/vl/device/files/
           <IMAGE_UUID>
    } else if exists user-class and option user-class = "exr-config" {
        filename = "http://<CW_HOST_IP>:30604/crosswork/configsvc/vl/file";
    }
}
```

Figure 39: Classic ZTP ISC IPv6 DHCP Configuration Example

```
host 5501
{
    host-identifier option dhcp6.client-id
00:02:00:00:00:09:46:4f:43:32:33:30:38:52:30:53:33:00;
    fixed-address6 fc00:15:2::36;
    if exists dhcp6.user-class and substring(option dhcp6.user-class, 2, 4) = "iPXE" {
     option dhcp6.bootfile-url "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/

        <IMAGE_UUID>";
    } else {if exists dhcp6.user-class and substring(option dhcp6.user-class, 0, 10) =
"exr-config" {
      option dhcp6.bootfile-url
"http://<CW_HOST_IP>:30604/crosswork/crosswork/configsvc/vl/file";
    }
}
```

The following table describes each line in the IPv4 ISC DHCP device entry examples given, and the source of the values used. Descriptions for the entries in the IPv6 example are identical, but adapted for the IPv6 addressing scheme.

Table 17: ISC IPv4 DHCP Configuration Host Entries and Values (Classic ZTP)

IPv4 Entry	Description
`host NCS5k-l`	The device entry host name. The host name can be the same as the actual assigned host name, but need not be.
`option dhcp-client-identifier`	The unique ID of the device entry. The value `"FOC2302R09H"` shown in the IPv4 example is the serial number of the device. You can find the serial number on the device chassis. If you don't have physical access to the device, the IOS-XR `show inventory` command provides the serial number.

`hardware ethernet`
`00:cc:fc:bb:be:6a`
	The MAC address of the Ethernet NIC port on the device. This address is the address on which you trigger the ZTP process. The address can be a management or data port, as long as it's reachable from Cisco Crosswork.

IPv4 Entry	Description
`fixed-address 105.1.1.16`	The IP address to be assigned to the device during configuration. The example is for a static IP, but you can also use standard DHCP IP pool assignment commands.
`option user-class = "iPXE"` and `filename =`	This line checks that the incoming ZTP request contains the `"iPXE"` option. Classic ZTP uses this option to image the device. If the request includes this option, then the device downloads the image file matching the UUID and path specified in the `filename =` parameter.
`option user-class = "exr-config"` and `ffl filename =`	This line checks that the incoming ZTP request contains the `"exr-config"` option. ZTP uses this option to configure the device. If the request includes this option, then the device downloads the configuration file matching the path specified in the `filename =` parameter.

Copy Bootfile Names and UUIDs for DHCP Setup

When modifying your DHCP server configuration file, specify the bootfile name and UUID for each software image. You can quickly copy both to your clipboard directly from the list of software images that you have already uploaded to Cisco Crosswork. No UUID is required for configuration files.

To copy software image bootfile names and UUIDs:

1. From the main menu, choose **Device Management** > **Software Images**.
2. If you want to copy:
    - The bootfile name and UUID of the software image: Click the ⧉ in the **Image/SMU Name** column.
    - Only the UUID of the software image: Click the ⧉ in the **Image UUID** column.

    Cisco Crosswork copies the bootfile name and/or UUID to your clipboard. You can now paste it into your DHCP host entry.

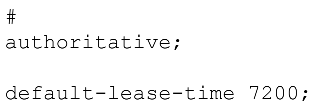
    When using the copied file path to create DHCP host entries, replace the *IP* variable with the IP address and port of your Cisco Crosswork server.

Set Up DHCP for Secure ZTP

Before triggering ZTP processing, update your DHCP configuration file with information that identifies your ZTP devices and the software applied to them. This information permits Cisco Crosswork and DHCP to identify the ZTP devices and respond to requests for network connection and file downloads.

The following topics provide examples showing how to update DHCP server configurations to meet this requirement. The examples in these topics assume the DHCP context settings shown in the following figure. The following figure shows example settings for the Internet Systems Consortium DHCP server. The line enabling the `sztp-redirect` option is required for Secure ZTP.

Figure 40: Secure ZTP DHCP Context



```
#
authoritative;

default-lease-time 7200;
```

```
max-lease-time 7200;
# Next line is required for Secure ZTP;
option sztp-redirect code 143 = text;

subnet 192.168.100.0 netmask 255.255.255.0 {
  option routers 192.168.100.1;
  option domain-name "cisco.com";
  option domain-name-servers 171.70.168.183;
  option subnet-mask 255.255.255.0;
  range 192.168.100.105 192.168.100.195;
}
```

Examples: DHCP Setup for Secure ZTP

Secure ZTP allows you to provision devices over both secure and insecure network domains. Use HTTPS for the configuration file download, and specify `option sztp-redirect` for configuration artifacts. Add a remote ID and circuit ID if you want to use option 82. The remote ID identifies the remote host acting as the bootstrap server, and the circuit ID identifies the interface or VLAN on the remote host. For help with using bootfile names and UUIDs, see the related topic, #unique_165 unique_165_Connect_42_CopyBootfileNamesAndUUIDsForDHCPSetup, on page 214.

Figure 41: Secure ZTP DHCP Setup, Using HTTPS

```
host sztp1 {
 hardware ethernet 00:a7:42:86:54:f4;
  if exists user-class and option user-class = "iPXE" {
    filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/<IMAGE_UUID>";

  } else {
     option sztp-redirect
"https://<CW_HOST_IP>:30617/restconf/operations/ietf-sztp-bootstrap-server:get-bootstrap-data";

  }
}
```

Figure 42: Secure ZTP DHCP Setup, Using HTTPS and Option 82

```
host sztp2 {
 hardware ethernet 00:a7:42:86:54:f5;
  if exists user-class and option user-class = "iPXE" {
    filename = "http://<CW_HOST_IP>:30604/crosswork/imagesvc/v1/device/files/<IMAGE_UUID>";

  } else if exists user-class and option user-class ="exr-config" {
     option sztp-redirect
"https://<CW_HOST_IP>:30617/restconf/operations/ietf-sztp-bootstrap-server:get-bootstrap-data?circuitid=Gig001&remoteid=MAR1";

  }
}
```

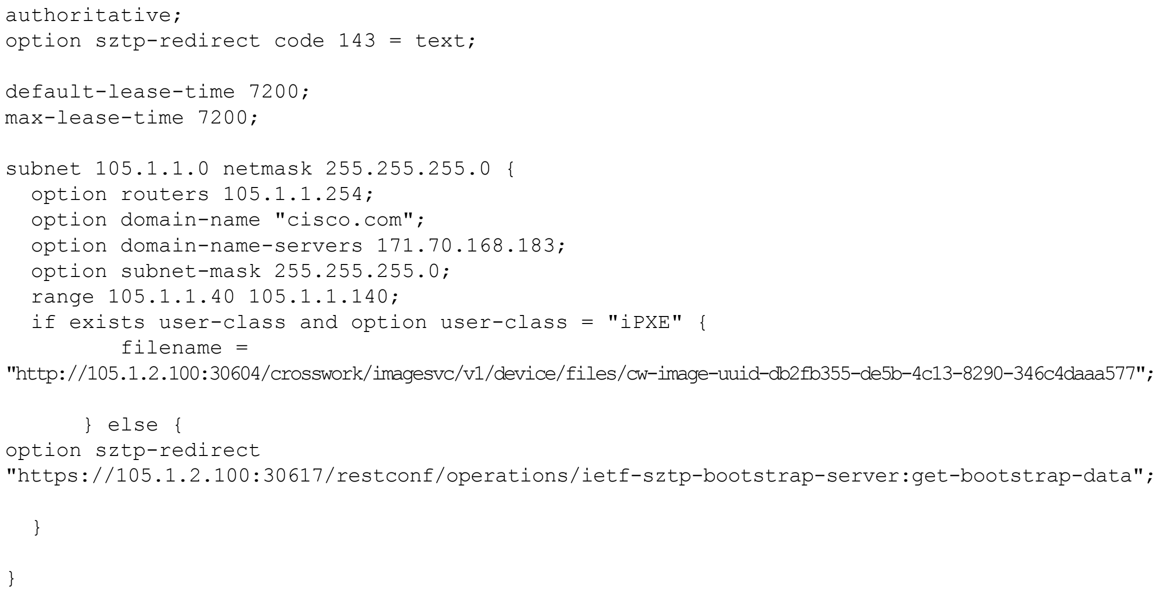
Examples: Generic Internet Systems Consortium (ISC) DHCP Setup for Secure ZTP

The following figures show examples of the type of host entries you would make for Secure ZTP in the `/etc/dhcp/dhcp.conf` configuration file of an Internet Systems Consortium (ISC) DHCP server.

Other third-party DHCP servers differ in overall implementation, but many use options and formats similar to these ISC examples.

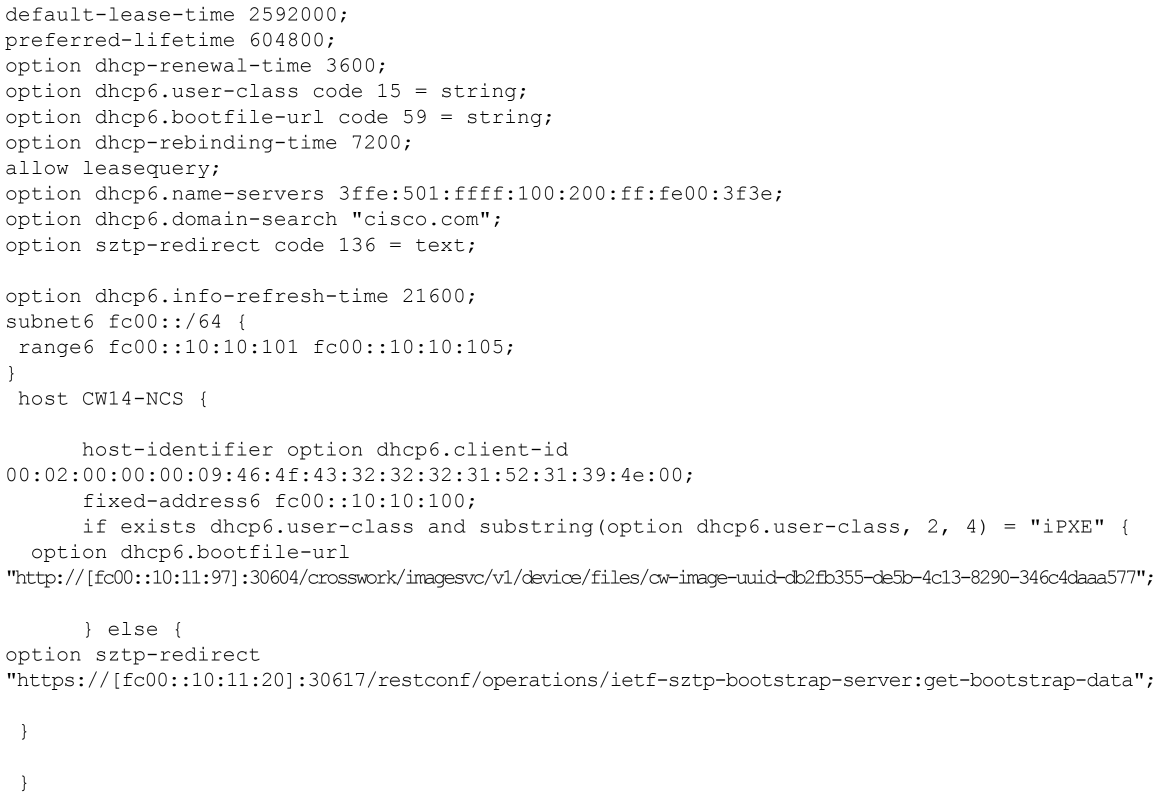
Be sure to reload or restart the ISC DHCP server once you have finished creating these new entries.

Figure 43: Secure ZTP ISC IPv4 DHCP Configuration Example



```
authoritative;
option sztp-redirect code 143 = text;

default-lease-time 7200;
max-lease-time 7200;

subnet 105.1.1.0 netmask 255.255.255.0 {
  option routers 105.1.1.254;
  option domain-name "cisco.com";
  option domain-name-servers 171.70.168.183;
  option subnet-mask 255.255.255.0;
  range 105.1.1.40 105.1.1.140;
  if exists user-class and option user-class = "iPXE" {
         filename =
"http://105.1.2.100:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-db2fb355-de5b-4c13-8290-346c4daaa577";

      } else {
option sztp-redirect
"https://105.1.2.100:30617/restconf/operations/ietf-sztp-bootstrap-server:get-bootstrap-data";

  }

}
```

Figure 44: Secure ZTP ISC IPv6 DHCP Configuration Example



```
default-lease-time 2592000;
preferred-lifetime 604800;
option dhcp-renewal-time 3600;
option dhcp6.user-class code 15 = string;
option dhcp6.bootfile-url code 59 = string;
option dhcp-rebinding-time 7200;
allow leasequery;
option dhcp6.name-servers 3ffe:501:ffff:100:200:ff:fe00:3f3e;
option dhcp6.domain-search "cisco.com";
option sztp-redirect code 136 = text;

option dhcp6.info-refresh-time 21600;
subnet6 fc00::/64 {
 range6 fc00::10:10:101 fc00::10:10:105;
}
 host CW14-NCS {

      host-identifier option dhcp6.client-id
00:02:00:00:00:09:46:4f:43:32:32:32:31:52:31:39:4e:00;
      fixed-address6 fc00::10:10:100;
      if exists dhcp6.user-class and substring(option dhcp6.user-class, 2, 4) = "iPXE" {
  option dhcp6.bootfile-url
"http://[fc00::10:11:97]:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-db2fb355-de5b-4c13-8290-346c4daaa577";

      } else {
option sztp-redirect
"https://[fc00::10:11:20]:30617/restconf/operations/ietf-sztp-bootstrap-server:get-bootstrap-data";

 }

 }
```

The following table describes each line in the IPv4 ISC DHCP device entry examples given, and the source of the values used. Descriptions for the entries in the IPv6 example are identical to the ones for IPv4, but adapted for the IPv6 addressing scheme.

Table 18: ISC IPv4 DHCP Configuration Host Entries and Values (Secure ZTP)

IPv4 Entry	Description
`host NCS5k-1`	The device entry host name. The host name can be the same as the actual assigned host name, but need not be.
`option dhcp-client-identifier`	The unique ID of the device entry. The value `"FOC2302R09H"` shown in the Classic ZTP and IPv4 example is the serial number of the device. You can find the serial number on the device chassis. If you don't have physical access to the device, the IOS-XR `show inventory` command provides the serial number.
`hardware ethernet 00:cc:fc:bb:be:6a`	The MAC address of the Ethernet NIC port on the device. This address is the address on which you trigger the ZTP process. The address can be a management or data port, as long as it's reachable from Cisco Crosswork.
`fixed-address 105.1.1.16`	The IP address to be assigned to the device during configuration. The example is for a static IP, but you can also use standard DHCP IP pool assignment commands.
`option user-class = "iPXE"` and `filename =`	This line checks that the incoming ZTP request contains the `"iPXE"` option. Classic ZTP uses this option to image the device. If the request includes this option, then the device downloads the image file matching the UUID and path specified in the `filename =` parameter.
`option sztp-redirect code 143=text`	This line checks that the incoming ZTP request contains the `"exr-config"` option. Secure ZTP uses this option to configure the device. If the request includes this option, then the device downloads the configuration file matching the path specified in the `filename =` parameter.

Set Up DHCP and TFTP for PnP ZTP

Before triggering PnP ZTP processing, you must:

1. Set up an external TFTP server that is reachable by your ASR 900 and NCS 520 devices.
2. Upload PnP profle to the external TFTP server.
3. Update your DHCP configuration file with information pointing to the location of the Cisco Crosswork PnP Server.

This information permits Cisco Crosswork and.

The following topics provide examples showing how to perform each of these tasks.

Set Up the External TFTP server

An external TFTP server is required for all of the supported Cisco ASR 900-series and NCS 520-series routers. The server must be active on port 69 UDP.

Upload the PnP Profile to TFTP

The PnP profile is a simple generic configuration file. Uploading the PnP profile to the configuration service on the TFTP repository is a one-time activity.

The profile's contents must specify use of the Crosswork cluster's virtual data port. In this example, the IP address 192.168.100.211 is the data VIP for the embedded Cisco Crosswork PnP server and 30620 is the PnP server external port.

Figure 45: Example: Generic PnP Profile

```
pnp profile cwpnp-data
transport http ipv4 192.168.100.211 port 30620
```

Configure the DHCP Server

The DCHCP entry redirects traffic from the PnP agent on the device to the IP address of the external TFTP server.

Figure 46: Sample PnP ZTP DHCP Setup

```
option tftp code 150 = text;
host cztp1 {
 hardware ethernet 00:a7:42:86:54:f1;
  option tftp150 "192.168.100.205":
   }
```

Classic ZTP DHCP Setup Scripts for Cisco Prime Network Registrar (CPNR)

Following are two sets of scripts that allow you to add Classic ZTP device, image and configuration file entries to the CPNR DHCP server configuration file. There’s one set of three scripts for IPv4, and a separate set of five scripts for IPv6.

Note The following scripts are for use with Classic ZTP only. You can't use them with Secure ZTP or PnP ZTP.

To use these scripts:

1. Copy and paste the contents of the scripts into local text files with the names given here.
2. Modify the device, image, and configuration entries in the `ztp-v4-setup-vi-nrcmd.txt` script, or the `ztp-v6-setup-vi-nrcmd.txt` script, to fit your needs, as explained in the script comments.
3. Copy the script files you want to use to the root folder of your local CPNR server.
4. Execute the scripts on the CPNR server using the following command:

   ```
   [root@cpnr-local ~]#/opt/nwreg2/local/usrbin/nrcmd -N username -P password
   <ztp-IPVersion-setup-via-nrcmd.txt
   ```

   Where:

   - *username* is the name of a user ID with administrator privileges on the CPNR server.
   - *password* is the password for the corresponding CPNR admin user ID.
   - *IPVersion* is either `v4` for the IPv4 version of the scripts, or `v6` for the IPv6 version of the scripts.

Figure 47: IPv4 Script 1 of 3: ztp-v4-setup-vi-nrcmd.txt

```
#
# Create the scope
#
scope ztp-ncs-5501-mgmt create 192.0.20.0/24

# Add the dynamic range
scope ztp-ncs-5501-mgmt addrange 200 225

# Default the routers option. Note: No need to do subnet-mask. It is automatically provided.
scope-policy ztp-ncs-5501-mgmt setoption routers 10.10.10.1

# Set the lease time for clients on this scope
scope-policy ztp-ncs-5501-mgmt setoption dhcp-lease-time 216000
#
# Load the option 43 definitions
import option-set ztp-v4-option-set.txt
#
# Set the client classing expression and enable use of client-class
dhcp set client-class-lookup-id=@ztp-v4-client-class-expr.txt
dhcp enable client-class
#
# Load the client classes - these are used to lookup the correct client details
# depending on whether an iso or script is requested by the client.
client-class ztp-iso create
client-class ztp-iso set client-lookup-id="(or (try (concat (as-string
    (request get option 61)) \"-iso\")) (request macaddress-string))"
#
client-class ztp-script create
client-class ztp-script set client-lookup-id="(or (try (concat (as-string
    (request get option 61)) \"-script\")) (request macaddress-string))"
#
# Clients that are not ztp will fall into the ztp-none class
# and should not be offered service so they are excluded.
#
client-class ztp-none create
client-class ztp-none set action=exclude
#
# Create a default client that will prevent service to unknown clients.
client default create
client default set action=exclude
#
# Create some ZTP clients
#
# For each ZTP client we create two clients based on their serial number.
# (See above for the client-lookup-id expressions.)
# One has "-iso" added to the end that will be used when the client's
# request includes "iPXE" in option 77.
# The other has "-script" added to the end that will be used when the
# client's request includes "exr-config" in option 77.
#

### Device-1 Settings ####
client <device-1-serial-num>-iso create
client-policy <device-1-serial-num>-iso set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-d3930e13-b081-4905-b2e5-051249d9b0cb"


client <device-1-serial-num>-script create
client-policy <device-1-serial-num>-script set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/configsvc/v1/configs/device/files/d1d7b441-3a27-47d1-aef0-39c3087d34c1"
```

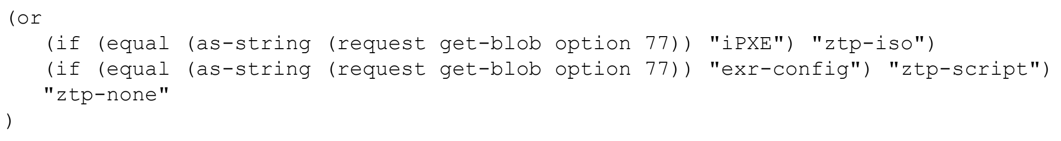
```
client-policy <device-1-serial-num>-script setvendoroption 43 Cisco-ZTP "(1 exr-config)(2
0)"

### Device-2 Settings ####
client <device-2-serial-num>--iso create
client-policy <device-2-serial-num>-iso set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-d3930e13-b081-4905-b2e5-051249d9b0cb"


client <device-2-serial-num>-script create
client-policy <device-2-serial-num>-script set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/configsvc/v1/configs/device/files/d1640deb-8252-47b6-aab1-a843c0c7757b"
client-policy <device-2-serial-num>-script setvendoroption 43 Cisco-ZTP "(1 exr-config)(2
0)"

#
# Create more as needed using the above as models.
# Note: For those that need option 67 (boot file), you can use:
#   client-policy <name> setoption boot-file "<file-url>"
#
# The next line is optional. Uncomment it if you want to log what the script is doing.
# dhcp set log-settings=+incoming-packet-detail,outgoing-packet-detail,client-detail

# Assure that the server is up-to-date with this configuration
dhcp reload
```

Figure 48: IPv4 Script 2 of 3: ztp-v4-setup-vi-nrcmd.txt

```
#
# Create the scope
#
scope ztp-ncs-5501-mgmt create 192.0.20.0/24

# Add the dynamic range
scope ztp-ncs-5501-mgmt addrange 200 225

# Default the routers option. Note: No need to do subnet-mask. It is automatically provided.
scope-policy ztp-ncs-5501-mgmt setoption routers 10.10.10.1

# Set the lease time for clients on this scope
scope-policy ztp-ncs-5501-mgmt setoption dhcp-lease-time 216000
#
# Load the option 43 definitions
import option-set ztp-v4-option-set.txt
#
# Set the client classing expression and enable use of client-class
dhcp set client-class-lookup-id=@ztp-v4-client-class-expr.txt
dhcp enable client-class
#
# Load the client classes - these are used to lookup the correct client details
# depending on whether an iso or script is requested by the client.
client-class ztp-iso create
client-class ztp-iso set client-lookup-id="(or (try (concat (as-string
    (request get option 61)) \"-iso\")) (request macaddress-string))"
#
client-class ztp-script create
client-class ztp-script set client-lookup-id="(or (try (concat (as-string
    (request get option 61)) \"-script\")) (request macaddress-string))"
#
# Clients that are not ztp will fall into the ztp-none class
# and should not be offered service so they are excluded.
#
client-class ztp-none create
```

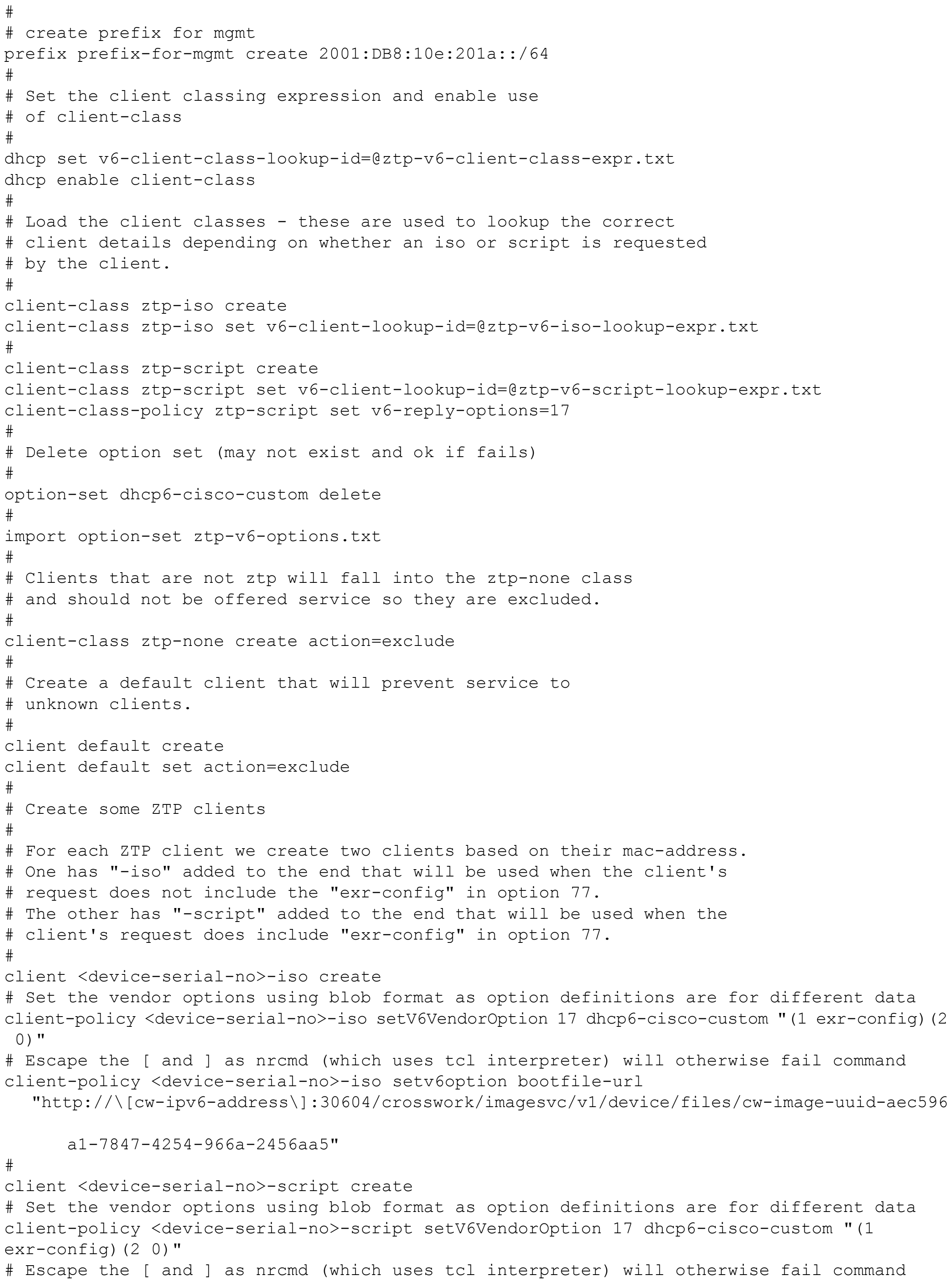
```
client-class ztp-none set action=exclude
#
# Create a default client that will prevent service to unknown clients.
client default create
client default set action=exclude
#
# Create some ZTP clients
#
# For each ZTP client we create two clients based on their serial number.
# (See above for the client-lookup-id expressions.)
# One has "-iso" added to the end that will be used when the client's
# request includes "iPXE" in option 77.
# The other has "-script" added to the end that will be used when the
# client's request includes "exr-config" in option 77.
#

### Device-1 Settings ####
client <device-1-serial-num>-iso create
client-policy <device-1-serial-num>-iso set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-d3930e13-b081-4905-b2e5-051249d9b0cb"


client <device-1-serial-num>-script create
client-policy <device-1-serial-num>-script set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/configsvc/v1/configs/device/files/d1d7b441-3a27-47d1-aef0-39c3087d34c1"
client-policy <device-1-serial-num>-script setvendoroption 43 Cisco-ZTP "(1 exr-config)(2
0)"

### Device-2 Settings ####
client <device-2-serial-num>--iso create
client-policy <device-2-serial-num>-iso set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-d3930e13-b081-4905-b2e5-051249d9b0cb"


client <device-2-serial-num>-script create
client-policy <device-2-serial-num>-script set packet-file-name=

"http://<cw-ipv4-address>:30604/crosswork/configsvc/v1/configs/device/files/d1640deb-8252-47b6-aab1-a843c0c7757b"
client-policy <device-2-serial-num>-script setvendoroption 43 Cisco-ZTP "(1 exr-config)(2
0)"

#
# Create more as needed using the above as models.
# Note: For those that need option 67 (boot file), you can use:
#   client-policy <name> setoption boot-file "<file-url>"
#
# The next line is optional. Uncomment it if you want to log what the script is doing.
# dhcp set log-settings=+incoming-packet-detail,outgoing-packet-detail,client-detail

# Assure that the server is up-to-date with this configuration
dhcp reload
```

Figure 49: IPv4 Script 3 of 3: ztp-v4-client-class-expr.txt



```
(or
   (if (equal (as-string (request get-blob option 77)) "iPXE") "ztp-iso")
   (if (equal (as-string (request get-blob option 77)) "exr-config") "ztp-script")
   "ztp-none"
)
```

Figure 50: IPv6 Script 1 of 5: ztp-v6-setup-vi-nrcmd.txt



```
#
# create prefix for mgmt
prefix prefix-for-mgmt create 2001:DB8:10e:201a::/64
#
# Set the client classing expression and enable use
# of client-class
#
dhcp set v6-client-class-lookup-id=@ztp-v6-client-class-expr.txt
dhcp enable client-class
#
# Load the client classes - these are used to lookup the correct
# client details depending on whether an iso or script is requested
# by the client.
#
client-class ztp-iso create
client-class ztp-iso set v6-client-lookup-id=@ztp-v6-iso-lookup-expr.txt
#
client-class ztp-script create
client-class ztp-script set v6-client-lookup-id=@ztp-v6-script-lookup-expr.txt
client-class-policy ztp-script set v6-reply-options=17
#
# Delete option set (may not exist and ok if fails)
#
option-set dhcp6-cisco-custom delete
#
import option-set ztp-v6-options.txt
#
# Clients that are not ztp will fall into the ztp-none class
# and should not be offered service so they are excluded.
#
client-class ztp-none create action=exclude
#
# Create a default client that will prevent service to
# unknown clients.
#
client default create
client default set action=exclude
#
# Create some ZTP clients
#
# For each ZTP client we create two clients based on their mac-address.
# One has "-iso" added to the end that will be used when the client's
# request does not include the "exr-config" in option 77.
# The other has "-script" added to the end that will be used when the
# client's request does include "exr-config" in option 77.
#
client <device-serial-no>-iso create
# Set the vendor options using blob format as option definitions are for different data
client-policy <device-serial-no>-iso setV6VendorOption 17 dhcp6-cisco-custom "(1 exr-config)(2
 0)"
# Escape the [ and ] as nrcmd (which uses tcl interpreter) will otherwise fail command
client-policy <device-serial-no>-iso setv6option bootfile-url
   "http://\[cw-ipv6-address\]:30604/crosswork/imagesvc/v1/device/files/cw-image-uuid-aec596

      a1-7847-4254-966a-2456aa5"
#
client <device-serial-no>-script create
# Set the vendor options using blob format as option definitions are for different data
client-policy <device-serial-no>-script setV6VendorOption 17 dhcp6-cisco-custom "(1
exr-config)(2 0)"
# Escape the [ and ] as nrcmd (which uses tcl interpreter) will otherwise fail command
```

```
client-policy <device-serial-no>-script setv6option bootfile-url
   "http://\[cw-ipv6-address\]:30604/crosswork/configsvc/v1/configs/device/files/8eb6b7e1
      -bd54-40bb-84e0-89f11a60128b"
#

# Assure the server is up-to-date with this configuration
dhcp reload
```

Figure 51: IPv6 Script 2 of 5: ztp-v6-client-class-expr.txt

```
(or (try (if (equal (as-string (request get option 15)) "exr-config") "ztp-script"))
    (try (if (equal (as-string (request get option 15)) "iPXE") "ztp-iso"))
   "ztp-none"
)
```

Figure 52: IPv6 Script 3 of 5: ztp-v6-iso-lookup-expr.txt

```
(let (id)
  (setq id (request get option 1))
  (or
# First try extracting the serial number from DUID
      (try (if (equali (substring id 0 6) 00:02:00:00:00:09)
               (concat (as-string (substring id 6 128)) "-script")
           )
      )
# If that fails, use normal client-id (DUID) lookup
     (concat (to-string id) "-iso")

  )
)
```

Figure 53: IPv6 Script 4 of 5: ztp-v6-script-lookup-expr.txt

```
(let (id)
  (setq id (request get option 1))
  (or
# First try extracting the serial number from DUID
      (try (if (equali (substring id 0 6) 00:02:00:00:00:09)
               (concat (as-string (substring id 6 128)) "-script")
           )
      )
# If that fails, use normal client-id (DUID) lookup
     (concat (to-string id) "-script")
  )
)
```

Figure 54: IPv6 Script 5 of 5: ztp-v6-options.txt

```
# Option Definition Set Export/Import Utility
# Version: 1
#
{
  ( name = dhcp6-cisco-custom )
  ( desc = Cisco Systems, Inc. )
  ( vendor-option-enterprise-id = 9 )
  ( id-range = 2 )
  ( option-list = [
    {
      ( name = cisco-17 )
      ( id = 17 )
      ( base-type = AT_VENDOR_OPTS )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = clientID )
          ( id = 1 )
          ( base-type = AT_NSTRING )
          ( sepstr = , )
          ( desc = ZTP - clientID )
        }
        {
          ( name = authCode )
          ( id = 2 )
          ( base-type = AT_INT8 )
          ( sepstr = , )
          ( desc = ZTP - authCode )
        }
        {
          ( id = 3 )
          ( name = md5sum )
          ( base-type = AT_NSTRING )
          ( desc = ZTP - md5sum )
        }
        {
          ( name = cnr-leasequery )
          ( id = 13 )
          ( base-type = AT_BLOB )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
          ( option-list = [
            {
              ( name = oro )
              ( id = 1 )
              ( base-type = AT_SHORT )
              ( flags = AF_IMMUTABLE )
              ( repeat = ZERO_OR_MORE )
              ( sepstr = , )
            }
            {
              ( name = dhcp-state )
              ( id = 2 )
              ( base-type = AT_INT8 )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = data-source )
              ( id = 3 )
              ( base-type = AT_INT8 )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = start-time-of-state )
              ( id = 4 )
              ( base-type = AT_TIME )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = base-time )
              ( id = 5 )
              ( base-type = AT_DATE )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = query-start-time )
              ( id = 6 )
              ( base-type = AT_DATE )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = query-end-time )
              ( id = 7 )
              ( base-type = AT_DATE )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = client-class-name )
              ( id = 8 )
              ( base-type = AT_NSTRING )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = partner-last-transaction-time )
              ( id = 9 )
              ( base-type = AT_TIME )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = client-creation-time )
              ( id = 10 )
              ( base-type = AT_TIME )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = limitation-id )
              ( id = 11 )
              ( base-type = AT_BLOB )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = binding-start-time )
              ( id = 12 )
              ( base-type = AT_TIME )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = binding-end-time )
              ( id = 13 )
              ( base-type = AT_STIME )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
            }
            {
              ( name = fwd-dns-config-name )
              ( id = 14 )
              ( base-type = AT_NSTRING )
              ( flags = AF_IMMUTABLE )
              ( sepstr = , )
```

```
}
{
  ( name = rev-dns-config-name )
  ( id = 15 )
  ( base-type = AT_NSTRING )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = lookup-key )
  ( id = 16 )
  ( base-type = AT_BLOB )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = user-defined-data )
  ( id = 17 )
  ( base-type = AT_NSTRING )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = prefix-name )
  ( id = 18 )
  ( base-type = AT_NSTRING )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = failover-state-serial-number )
  ( id = 19 )
  ( base-type = AT_INT )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = reservation-key )
  ( id = 20 )
  ( base-type = AT_BLOB )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = failover-partner-lifetime )
  ( id = 21 )
  ( base-type = AT_STIME )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = failover-next-partner-lifetime )
  ( id = 22 )
  ( base-type = AT_STIME )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
{
  ( name = failover-expiration-time )
  ( id = 23 )
  ( base-type = AT_STIME )
  ( flags = AF_IMMUTABLE )
  ( sepstr = , )
}
```

```
    {
      ( name = client-oro )
      ( id = 24 )
      ( base-type = AT_SHORT )
      ( flags = AF_IMMUTABLE )
      ( repeat = ZERO_OR_MORE )
      ( sepstr = , )
    }
  ] )
}
{
  ( name = failover )
  ( id = 21 )
  ( base-type = AT_BLOB )
  ( flags = AF_NO_CONFIG_OPTION,AF_SUPPORTS_ENCAP_OPTION,AF_IMMUTABLE )
  ( sepstr = , )
  ( option-list = [
    {
      ( name = server-state )
      ( id = 1 )
      ( base-type = AT_INT8 )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = server-flags )
      ( id = 2 )
      ( base-type = AT_INT8 )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = binding-status )
      ( id = 3 )
      ( base-type = AT_INT8 )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = binding-flags )
      ( id = 4 )
      ( base-type = AT_INT8 )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = start-time-of-state )
      ( id = 5 )
      ( base-type = AT_DATE )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = state-expiration-time )
      ( id = 6 )
      ( base-type = AT_DATE )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = failover-expiration-time )
      ( id = 7 )
      ( base-type = AT_DATE )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = bndupd-serial )
      ( id = 8 )
      ( base-type = AT_INT )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = bndack-serial )
      ( id = 9 )
      ( base-type = AT_INT )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = client-flags )
      ( id = 10 )
      ( base-type = AT_INT )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = vpn-id )
      ( id = 11 )
      ( base-type = AT_INT )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = lookup-key )
      ( id = 12 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = type )
          ( id = 0 )
          ( base-type = AT_INT8 )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = data )
          ( id = 0 )
          ( base-type = AT_BLOB )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
      ] )
    }
    {
      ( name = user-defined-data )
      ( id = 13 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = reconfigure-data )
      ( id = 14 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = time )
          ( id = 0 )
          ( base-type = AT_DATE )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = key )
          ( id = 0 )
          ( base-type = AT_BLOB )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
      ] )
    }
    {
      ( name = requested-fqdn )
      ( id = 15 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = flags )
          ( id = 0 )
          ( base-type = AT_INT8 )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = domain-name )
          ( id = 0 )
          ( base-type = AT_DNSNAME )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
      ] )
    }
    {
      ( name = forward-dnsupdate )
      ( id = 16 )
      ( base-type = AT_NSTRING )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = reverse-dnsupdate )
      ( id = 17 )
      ( base-type = AT_NSTRING )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = partner-raw-cltt )
      ( id = 18 )
      ( base-type = AT_DATE )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = client-class )
      ( id = 19 )
      ( base-type = AT_NSTRING )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = status-code )
      ( id = 20 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = status-code )
          ( id = 0 )
          ( base-type = AT_SHORT )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = status-message )
          ( id = 0 )
          ( base-type = AT_NSTRING )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
      ] )
    }
    {
      ( name = dns-info )
      ( id = 21 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = flags )
          ( id = 0 )
          ( base-type = AT_SHORT )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = host-label-count )
          ( id = 0 )
          ( base-type = AT_INT8 )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = name-number )
          ( id = 0 )
          ( base-type = AT_INT8 )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
      ] )
    }
    {
      ( name = base-time )
      ( id = 22 )
      ( base-type = AT_DATE )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = relationship-name )
      ( id = 23 )
      ( base-type = AT_NSTRING )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = protocol-version )
      ( id = 24 )
      ( base-type = AT_INT )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = mclt )
      ( id = 25 )
      ( base-type = AT_INT )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
    }
    {
      ( name = dns-removal-info )
      ( id = 26 )
      ( base-type = AT_BLOB )
      ( flags = AF_IMMUTABLE )
      ( sepstr = , )
      ( option-list = [
        {
          ( name = host-name )
          ( id = 1 )
          ( base-type = AT_RDNSNAME )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = zone-name )
          ( id = 2 )
          ( base-type = AT_DNSNAME )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = flags )
          ( id = 3 )
          ( base-type = AT_SHORT )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = forward-dnsupdate )
          ( id = 4 )
          ( base-type = AT_NSTRING )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = reverse-dnsupdate )
          ( id = 5 )
          ( base-type = AT_NSTRING )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
```

```
            }
          ] )
        }
        {
          ( name = max-unacked-bndupd )
          ( id = 27 )
          ( base-type = AT_INT )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = receive-timer )
          ( id = 28 )
          ( base-type = AT_INT )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = hash-bucket-assignment )
          ( id = 29 )
          ( base-type = AT_BLOB )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = partner-down-time )
          ( id = 30 )
          ( base-type = AT_DATE )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = next-partner-lifetime )
          ( id = 31 )
          ( base-type = AT_DATE )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = next-partner-lifetime-sent )
          ( id = 32 )
          ( base-type = AT_DATE )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
        {
          ( name = client-oro )
          ( id = 33 )
          ( base-type = AT_SHORT )
          ( flags = AF_IMMUTABLE )
          ( repeat = ZERO_OR_MORE )
          ( sepstr = , )
        }
        {
          ( name = requested-prefix-length )
          ( id = 34 )
          ( base-type = AT_INT8 )
          ( flags = AF_IMMUTABLE )
          ( sepstr = , )
        }
      ] )
    }
  ] )
}
```

```
        ] )
    }
```

Trigger ZTP Device Bootstrap

With device entries imported to Cisco Crosswork and DHCP configured, you can initiate ZTP processing by restarting each of the devices.

Before you begin

Before triggering ZTP bootstrap on any of your devices, ensure that you have finished:

- All of the preliminary setup tasks explained in ZTP Setup Workflow, on page 184.
- Creating ZTP device entries for the devices you want to bootstrap, as explained in
- DHCP setup, as appropriate for your choice of ZTP mode and servers, as explained in

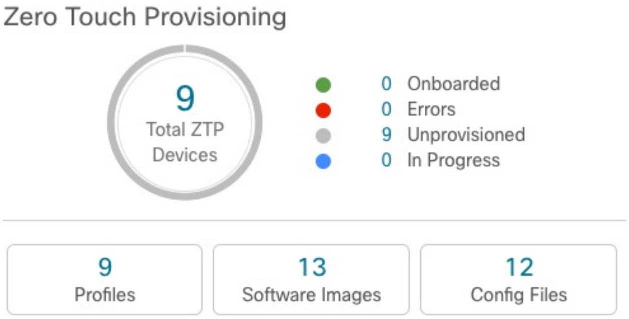
Note If you are using PnP ZTP, be sure to set the minimum license boot-level on each IOS-XE device to **metroipaccess** or **advancedmetroipaccess before** you trigger ZTP processing. If the boot level has been set properly, the output of the IOS-XE `#sh run | sec license` CLI command on the device should contain statements showing either of these two license levels: `license boot level advancedmetroipaccess` or `license boot level metroipaccess`. If the command output shows any other license level lower than these two, the Cisco PnP cryptographic functionality will not be enabled. This will cause certificate installation to fail, which will then cause PnP ZTP device provisioning to fail.

Step 1 Initiate ZTP processing as appropriate for the ZTP mode you are using:

- For Classic and Secure ZTP, use one of these options:
  - Power-cycle the device to restart it.
  - Using a pin, press the chassis reset button at the back of the device. Press for 15 seconds, or until the power light on the device starts flashing.
  - For a previously imaged device: Connect to it via Telnet, then issue a **ztp initiate** command.
- For PnP ZTP, use the option appropriate for your devices:
  - On Cisco ASR 903, ASR 907, and NCS 520 devices: Connect to it via Telnet, then issue a **write erase** command, followed by a **reload** command.
  - On Cisco ASR 920 devices: Press the ZTP button on the chassis for 8 seconds.

Repeat this step as needed for each of the devices you plan to provision during this session. You can restart all or as few devices as needed during a single session.

Step 2 Monitor the progress of ZTP processing using the Zero Touch Provisioning status tile shown in the following figure. To view the tile, click the **Home** icon on the main menu.



The tile provides a summary view of your current ZTP processing status. It gives a count of all the ZTP profiles, images, and configuration files currently in use. The tile also shows the number of devices in each of the possible ZTP processing states.

Complete Onboarded ZTP Device Information

ZTP devices, once onboarded, are automatically part of the shared Cisco Crosswork device inventory. You can edit them like any other device. The following steps explain two ways to add information to devices onboarded using ZTP.

Before editing any device, it's always good practice to export a CSV backup of the devices you want to change. You can do this using the export function described in Step 2.

Before you begin

Some information needed for a complete device inventory record is either not necessary or not available via automation. For example: Geographical data, indicating that a device is located in a building at a given address, or at a set of GPS coordinates. Location data like this is a requirement for most organizations with active networks, and can only be added by a human operator.

Still other kinds of inventory information are useful when you use other applications to manage your network. For example: Cisco Crosswork tags make it easier to apply Cisco Crosswork Health Insights KPIs to particular devices. Similarly, associating an SRE policy with devices makes it easier to use Cisco Crosswork Network Controller or Cisco Crosswork Optimization Engine. Some Cisco Crosswork providers, such as Cisco NSO, base convenient functions on this kind of extended device information. All of it needs update from humans.

You can add this kind of information using functions in the other Cisco Crosswork applications and providers. For more information on this topic, see the user documentation for the application. You can also add much of it using Cisco Crosswork ZTP.

Step 1 To update the inventory record for a ZTP device:

a) From the main menu, choose **Device Management** > **Network Devices**.
b) Click the **ZTP Devices** tab.
c) Select the device you want to change, then click the ✎.
d) Change the value of the **Status** field to **`Unprovisioned`**.
e) Edit the other values configured for the device, as needed.
f) Click **Save**.

Step 2 To update the inventory records for devices in bulk, including devices onboarded using ZTP:

a) From the main menu, choose **Device Management** > **Devices**.

b) Click the ⇨. Save the CSV file.

c) Open the CSV template with the application of your choice and edit the device information you want to add or update. It’s a good idea to delete rows for devices you don’t want to update.

d) When you’re finished, save the edited CSV file.

e) If needed: Choose **Device Management** > **Devices**, then click the **Zero Touch Devices** tab.

f) Click the ⇦.

g) Click **Browse** to navigate to the CSV file you created and then select it.

h) With the CSV file selected, click **Import**.

Reconfigure Onboarded ZTP Devices

The purpose of Cisco Crosswork ZTP is to onboard new devices quickly and easily, without requiring you to locate experts on site with the new devices. ZTP performs imaging and configuration as part of that task, and can run scripts as part of device configuration. But it’s not designed as an all-purpose device configuration utility, and shouldn’t be used in that way.

If you need to reconfigure a device onboarded using ZTP, use:

- A Cisco Crosswork Change Automation Playbook, which allows you to roll out configuration changes to devices on demand.
- The configuration change functions of Cisco Network Services Orchestrator (Cisco NSO), or any of the other Cisco Crosswork providers you’re using.
- A direct connection to the device and the device OS command line interface.

If you can't use any of these methods, the best approach is to delete the device. You can onboard the device again, this time with the correct configuration.

To delete a ZTP device, select **Device Management** > **Devices** > **Zero Touch Devices**, select the device in the table, then click the 🗑.

Retire or Replace Devices Onboarded With ZTP

Sometimes you must retire a Cisco device that was onboarded using ZTP. Device licenses are associated with the device serial number that you entered at the time of onboarding. ZTP permits association of a single device with up to three different serial numbers. You can use this fact to remove a failed or obsolete device from your network and from Cisco Crosswork inventory. You can replace it later without consuming an extra license.

This rule applies not only to devices with a chassis, but also to line cards and other pluggable device modules. Each of these modules has its own serial number. If you need to RMA a module, associate the old license with the serial number of the new module. But first remove the old line card and its serial number from inventory, as explained in the following steps.

1. Select **Device Management** > **Devices** > **Zero Touch Devices**.
2. Find the old device in the table and make a record of its serial number.

3. Select the device and then click the 🗑 to delete it.

   After you delete the device, Cisco Crosswork will still count the license associated with this serial number as consumed. Track this license as part of any new or RMA replacement device purchase, so you can return the license for the old device to active use.

   Cisco Crosswork won't allow two active devices with the same license. You must delete the old device before you can onboard a new or replacement device.

4. When it's time to onboard the new device:

   a. When you create a ZTP device entry for the new device, enter both the new and old serial numbers.

   b. If you're using Secure ZTP: Submit both the old and new device serial numbers with the Ownership Voucher request for the new device. Cisco associates the old and new serial numbers with the in-use license in the regenerated Ownership Voucher.

   c. Onboard the new device as you would any other ZTP device. Only the old device license is consumed.

ZTP Asset Housekeeping

Once you have completed onboarding your devices with ZTP, you can delete offline copies of some of the ZTP assets you assembled. Retain others, depending on the policies and best practices of your organization. We recommend:

- **ZTP profiles**: Usually, it's safe to delete ZTP profiles after onboarding is complete. To delete a ZTP profile, select **Device Management** > **Zero Touch Profiles** . On the tile representing the ZTP profile you want to delete, click the ⋯ and then select **Delete** from the dropdown menu.
- **ZTP device entry CSV file**: You may want to retain an offline copy of this file for use as a template. This file can be handy if, say, you have many branch offices sharing the same network architecture and device types. Otherwise, you can simply delete it from the file system. You can download the CSV file template at any time. You may find it more useful to export a backup CSV file containing all the data for your ZTP devices, including data you entered after onboarding. To export a CSV device backup, select **Device Management** > **Devices** > **Zero Touch Devices** . Then click the ⇨ and save the CSV file.
- **Software images and SMUs**: Save the production versions of these files offline, and delete older ones per the policies of your organization. Don't delete the uploaded image files from Cisco Crosswork if you plan to use them to image more devices of the same family. To delete obsolete images, select **Device Management** > **Software Images**, select the file in the table, then click the ⇨.
- **Configuration files**: You need not retain configurations you already uploaded to Cisco Crosswork, but the policy of your organization may differ. Don't delete uploaded configuration files if you plan to configure more devices of the same family using ZTP. When configurations change, you can easily update the stored version. Prepare the new configuration file or script, select **Device Management** > **Configuration Files**, select the file in the table, and then click the ✎. You can then browse to the new script file you created, and copy/paste the new configuration. If a configuration becomes obsolete, delete it: Select **Device Management** > **Configuration Files**, select the file in the table, then click the 🗑.

- **Credential profiles**: You can delete an imported credential profile CSV file immediately. Don’t delete the uploaded credential profiles. When user names and passwords change, update the credential profiles:

  Select **Device Management** > **Credentials**, select the credential profile in the table, then click the ✎.

Troubleshoot ZTP Issues

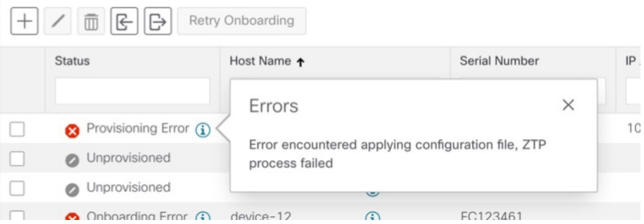
Normally, Cisco Crosswork ZTP provisioning and onboarding happen quickly and automatically. Issues do occur at times, so the following topics explain how to diagnose and remedy issues, including both common issues and issues specific to each of the ZTP modes.

Third-party devices that conform 100 percent to the Secure ZTP RFC are the only third-party devices you can onboard using Cisco Crosswork ZTP.

Diagnose ZTP Issues Using the Status Column

The **Status** column in the Zero Touch Devices window displays the ⓘ next to every device entry whose ZTP processing finished with a **`Provisioning Error`**, **`Onboarding Error`** or (for Secure ZTP only) **`ZTP Error`**. Click on the ⓘ to display a popup window with information about the error, as in the following example. When you’re finished viewing the popup window, click the ✕ to close it.

Figure 55: Provisioning Error Popup Window



Error encountered applying configuration file, ZTP process failed

You can also diagnose problems using the ZTP error logs, as explained in the next two sections.

Diagnose ZTP Issues Using Error Logs

You can access ZTP error log files directly, by SSH login to one or more of the virtual machines running Crosswork, and to one of the instances of the Crosswork ZTP service Kubernetes pod running on that VM. Follow these steps:

1. Log in to the VM using an Secure Shell command like the following:

```
ssh admin@VMIP
```

Where:

- `admin` is the Crosswork administrator ID. For example: cw-admin.
- `VMIP` is the IP address of the virtual machine running Crosswork. For example: 192.168.100.102.

2. Access the cw-ztp-service Kubernetes pod using a command like the following:

```
# kubectl exec -it PodID# bash
```

Where `PodID#` is the ID of the cw-ztp-service Kubernetes pod. Change the pod ID number as needed to match the number of the pod you want to access (pod 0 is always the first). For example: `cw-ztp-service-0`, `cw-ztp-service-1`, `cw-ztp-service-2`, and so on.

Change to the log folder with a command like the following: `cd /var/log/robot/`. You can then open any of the following ZTP-specific files in the folder:

- `cw-image-service_stdout.log`
- `cw-image-service_stderr.log`
- `cw-config-service_stdout.log`
- `cw-config-service_stderr.log`

Request ZTP Error Logs

You can request copies of ZTP error log files using the Crosswork user interface. Follow these steps:

1. Using an ID with administrator privileges, log into the Crosswork user interface.

2. Select **Administration** > **Crosswork Manager**

3. With the **Crosswork Summary** page displayed, click on the **Zero Touch Provisioning** tile. Crosswork displays details for the ZTP application.

4. With the application details displayed, select **Showtech Options** > **Request Logs**. Then select **Showtech Requests**. You can retrieve your log files from the dashboard when the request is completed.

Note If you are having issues with the onboarding phase of processing, you may want to request logs for the Crosswork inventory manager application (dlminvmgr) in addition to the logs for ZTP. You can do that by selecting **Platform Infrastructure** instead of **Zero Touch Provisioning** during step 3, above.

Troubleshoot Common ZTP Issues

The following identifies remedies for common issues that can occur with any of the ZTP modes.

Table 19: Common ZTP Issues and Fixes

Phase	Issue	Symptoms	Remedy
Setup	Image, configuration, or SMU file upload fails	Error messages displayed in the user interface during upload	Make sure that the MD5 checksum for the file is correct. If the file information is correct, image uploads can still fail due to slow network connections. If you're running into this problem, retry the upload.
	Uploaded files aren't in the drop-down menu when creating ZTP device entries or ZTP profiles	Files missing from the dropdown list	The drop-down menu selects files based on the device family and IOS release number you specify in your device entry or ZTP profile. Make sure that the file information matches the information for the device entry or profile you're creating.
	Errors during device entry CSV file import	Errors are displayed indicating issues with fields in the CSV file. This can be downloaded as an errors CSV file and used to fix the devices import CSV file	If devices in inventory have the same serial numbers as the devices you're importing, check that the devices are in the **`Unprovisioned`** state before import. All the devices imported using CSV files have their status set to **`Unprovisioned`** on import. Before import, make sure the configurations, images, and ZTP profiles mentioned in the CSV file exist. You can edit device image and configuration files by exporting a device CSV file and reimporting it with changes. If you use this edit method, make sure the CSV file has the correct UUIDs before import.
Unprovisioned	DHCP is unresponsive or offer execution fails	No message	Test that DHCP server is running and properly configured, and reachable from the Crosswork cluster. As the DHCP server is external to Crosswork, users must be responsible for ensuring that the DHCP server is properly configured.

Phase	Issue	Symptoms	Remedy
In Progress	Image or SMU file download fails	Status column and log file errors	Check that there’s network connectivity between Cisco Crosswork and the device. Make sure that the device is getting its IP address from the DHCP server. Ensure that the UUID of the software image given in the configuration file of the DHCP server is correct. If you must correct the image UUID specified in the configuration file, make sure you restart the DHCP server before initiating ZTP processing again.
	Cannot apply image or SMU to device	In Progress message doesn't clear; log file errors	Check that the image or SMU are compatible with the device and pass file checksums. Upload to Crosswork repository again.
	Configuration file download fails	Log file errors	Check that there’s network connectivity between Cisco Crosswork and the device. Make sure that the device is getting its IP address from the DHCP server. Ensure that the UUID of the software image given in the DHCP server configuration file is correct. If you must correct the image UUID specified in the DHCP configuration file, make sure you restart the DHCP server before re-initiating ZTP processing. Make sure that the device serial number matches the serial number on the chassis of the device. Ensure that the status of the device is either **`Unprovisioned`** or **`In Progress`** before initiating ZTP processing. Configuration downloads continue to fail as long as the device is in any other state.
	Configuration file execution fails	Log file errors	Edit configuration files as needed.

Phase	Issue	Symptoms	Remedy
Onboarded	Device state is showing **`Onboarded`** and not **`Provisioned`**	Status column did not show **`Provisioned`**	**`Provisioned`** is an intermediate state in ZTP processing. When the device state changes to **`Provisioned`**, Cisco Crosswork attempts to onboard the device immediately. The status changes to **`Onboarded`** or **`Onboarding Error`** after.
	Onboarding Error	Status column shows **`Onboarding Error`**	The default Cisco Crosswork device life-cycle management (DLM) policy for identifying devices uniquely is the IP address. If you import a new device with an IP address that matches an existing device, the device status changes to **`Provisioned`**, then to **`Onboarding Error`**. If the IP address of the new device is blank, you get the same result. These same issues apply if your installation uses an OSPF ID, ISIS ID, or other DLM policy for determining device IDs. Onboarding can only succeed when you fill all the DLM policy fields with unique, non-blank values. If onboarding fails, inspect the popup error message, update the corresponding fields and retry onboarding.

CHAPTER 8

Set Up Maps

This section contains the following topics:

Get a Quick View in the Dashboard

The Home page displays a customizable collection of dashlets which provide an at-a-glance operational summary of the network being managed, including reachability and operational status of devices. The Dashboard is made of a series of dashlets, and each dashlet represents different types of data belonging to the same category.

Figure 56: Crosswork Home page

Callout No.	Description
1	**Main Menu**: The main menu allows you to navigate to installed Cisco Crosswork applications and device management and administrative tasks. Menu options may look slightly different depending on what Cisco Crosswork applications are installed.
2	**Dashlets**: Information varies depending on what Cisco Crosswork applications are installed. • To drill down for more information within a dashlet, click on a value. A window appears displaying only the filtered data you clicked on. • To add or change the layout of dashlets, click **Customize View**. Move the dashlets to your desired layout and click **Save**.

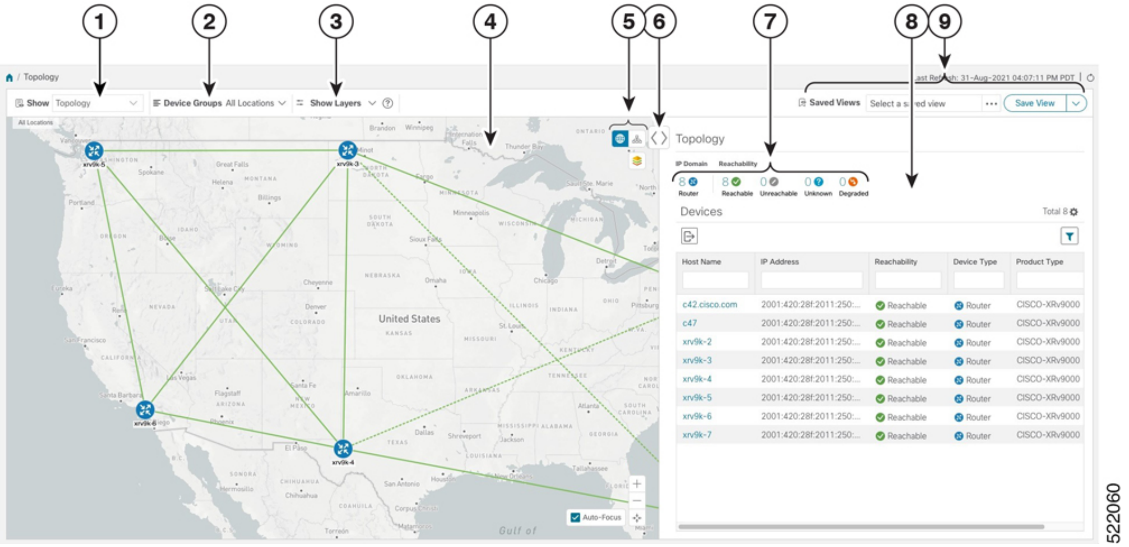
Callout No.	Description
3	Settings icons: The **Alerts** icon notifies you of any current error conditions related to the system operations which require attention, and provides a link to detailed information about those conditions. The **Events** icon notifies you of new events related to system operation, and also provides access to the history of all system events. The **About** icon displays the current version of the Cisco Crosswork product. The **User Account** icon lets you view your username, change your password, and log out.

View Devices and Links on the Topology Map

To view the network topology map, from the main menu choose **Topology**.

For more information, see View Device and Link Details, on page 246.

Figure 57: Cisco Crosswork UI and Topology Map



Host Name	IP Address	Reachability	Device Type	Product Type
c42.cisco.com	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
c47	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
xrv9k-2	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
xrv9k-3	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
xrv9k-4	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
xrv9k-5	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
xrv9k-6	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000
xrv9k-7	2001:420:28f:2011:250:...	Reachable	Router	CISCO-XRv9000

Callout No.	Description
1	**Topology Map View**: From the **Show** drop-down list, click the option that displays the data that you would like to see on the map. If **Topology** is selected, devices and links in the network are displayed.
2	**Device Groups**: From the drop-down list, click the group of devices you want displayed on the map. All other device groups will be hidden.

Callout No.	Description
3	**Show Hide**: From the drop-down list, click the network layers you want displayed on the map. All devices and links that belong to the selected layers are then displayed. By default, all layers are displayed.
4	**Topology Map**: The network topology can be displayed on a logical map or a geographical map, where the devices and links are shown in their geographic context. From the map, you can drill down to get detailed information about devices and links. **Devices:** • To view a device configuration summary, hover the mouse cursor over the device icon. A pop up window displaying the host name, state, node ID, and device type appears. • To view device details, click on the device icon. • If devices are in close physical proximity, the geographical map shows them as a cluster. The number in a blue circle (4) indicates the number of devices in the cluster. Displaying devices in this manner helps prevent overlap and clutter on the map. **Links:** • A solid line indicates a *single link* between two devices. If there is more than one link between two devices, or between a device and a cluster of devices, the line is shown dashed instead. A dashed line indicates an *aggregated* link that represents more than one link, or the use of multiple protocols (for example, IPv4 and IPv6) on the same physical link. • A and Z indicates headend and endpoint, respectively. • To view link information details, click on the link. **Note** Although aggregated, dual stack links show as one single line.
5	🖧: The logical map shows devices and their links, positioned according to an automatic layout algorithm, ignoring their geographical location. You can change the layout algorithm. 🌐: The geographical map shows single devices, device clusters, links, and tunnels, superimposed on a map of the world. Each device location on the map reflects the device's GPS coordinates (longitude and latitude) as defined in the device inventory. ≋: The Display Preferences window allows you to change display settings for devices, links, .
6	**Expand/Collapse/Hide Side Panel**: Expand or collapse the contents of the side panel. Close the side panel to get a larger view of the topology map.

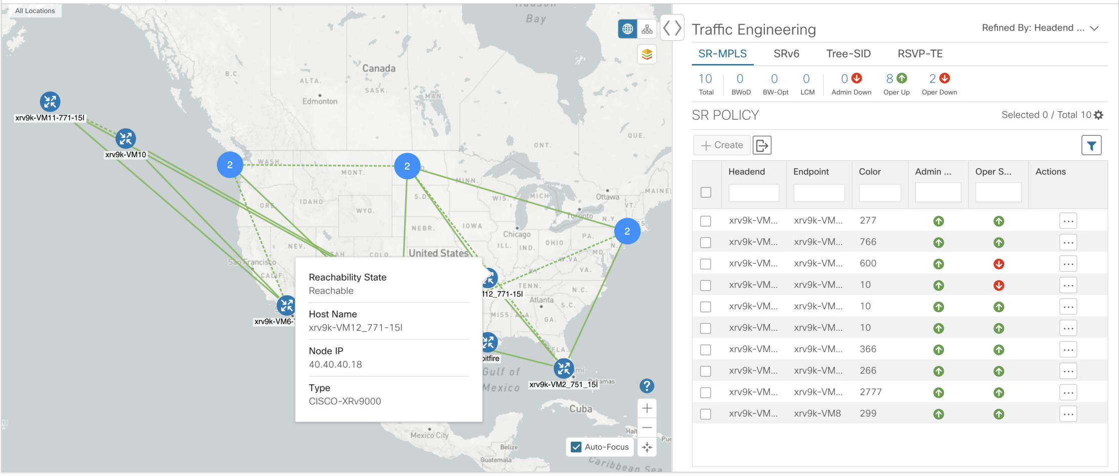
Callout No.	Description
7	The **Mini Dashboard** provides a summary of the IP Domain and device reachability status. If filters are applied, the **Mini Dashboard** is updated to reflect what is displayed in the Devices table. **Note** If the Alarm Status feature is enabled, you will also see Alarm information here. To view the Alarm Status, you must install the Common EMS Services application and configure host information for Syslog and SNMP traps on the devices you want to view alarms for. The Alarm Status feature is available for select licensing packages.
8	The content of this window changes depending on what **Show** is set to for the Topology Map and if you have selected to view more information on a
9	**Saved Custom Map Views**: Lets you create a named custom view using the settings and layout for your current map, settings of the tables saved in the saved views, or display a custom view you have created previously.

View Device and Link Details

This example shows how you can view device and link details using the topology map.

Step 1 From the main menu choose **Topology**.

Step 2 To quickly view the host name, reachability state, IP address and type of device, hover the mouse over the device icon.



Reachability State
Reachable

Host Name
xrv9k-VM12_771-15l

Node IP
40.40.40.18

Type
CISCO-XRv9000

Traffic Engineering

Refined By: Headend ...

SR-MPLS SRv6 Tree-SID RSVP-TE

10 Total | 0 BWoD | 0 BW-Opt | 0 LCM | 0 Admin Down | 8 Oper Up | 2 Oper Down

SR POLICY

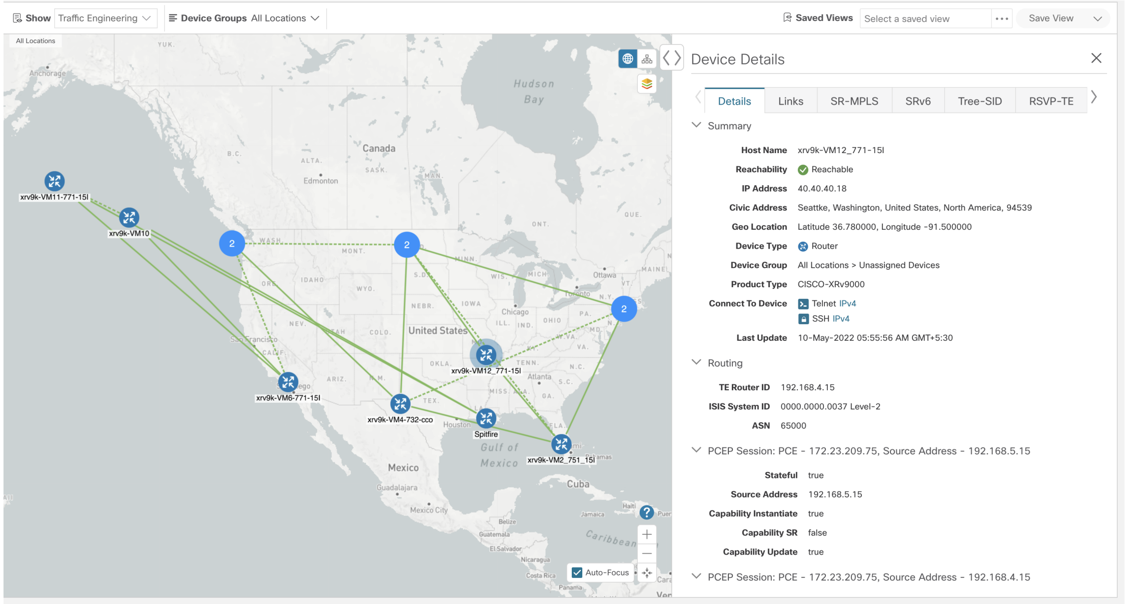
Selected 0 / Total 10

+ Create

□	Headend	Endpoint	Color	Admin ...	Oper S...	Actions
□	xrv9k-VM...	xrv9k-VM...	277	↑	↑	...
□	xrv9k-VM...	xrv9k-VM...	766	↑	↑	...
□	xrv9k-VM...	xrv9k-VM...	600	↑	↓	...
□	xrv9k-VM...	xrv9k-VM...	10	↑	↓	...
□	xrv9k-VM...	xrv9k-VM...	10	↑	↑	...
□	xrv9k-VM...	xrv9k-VM...	10	↑	↑	...
□	xrv9k-VM...	xrv9k-VM...	366	↑	↑	...
□	xrv9k-VM...	xrv9k-VM...	266	↑	↑	...
□	xrv9k-VM...	xrv9k-VM...	2777	↑	↑	...
□	xrv9k-VM...	xrv9k-VM8	299	↑	↑	...

Step 3 To view more device details, click on the device icon.

a) The following examples show the Device details from the Topology map.



Device Details

Details | Links | SR-MPLS | SRv6 | Tree-SID | RSVP-TE

Summary

Host Name	xrv9k-VM12_771-15I
Reachability	✓ Reachable
IP Address	40.40.40.18
Civic Address	Seattke, Washington, United States, North America, 94539
Geo Location	Latitude 36.780000, Longitude -91.500000
Device Type	Router
Device Group	All Locations > Unassigned Devices
Product Type	CISCO-XRv9000
Connect To Device	Telnet IPv4 SSH IPv4
Last Update	10-May-2022 05:55:56 AM GMT+5:30

Routing

TE Router ID	192.168.4.15
ISIS System ID	0000.0000.0037 Level-2
ASN	65000

PCEP Session: PCE - 172.23.209.75, Source Address - 192.168.5.15

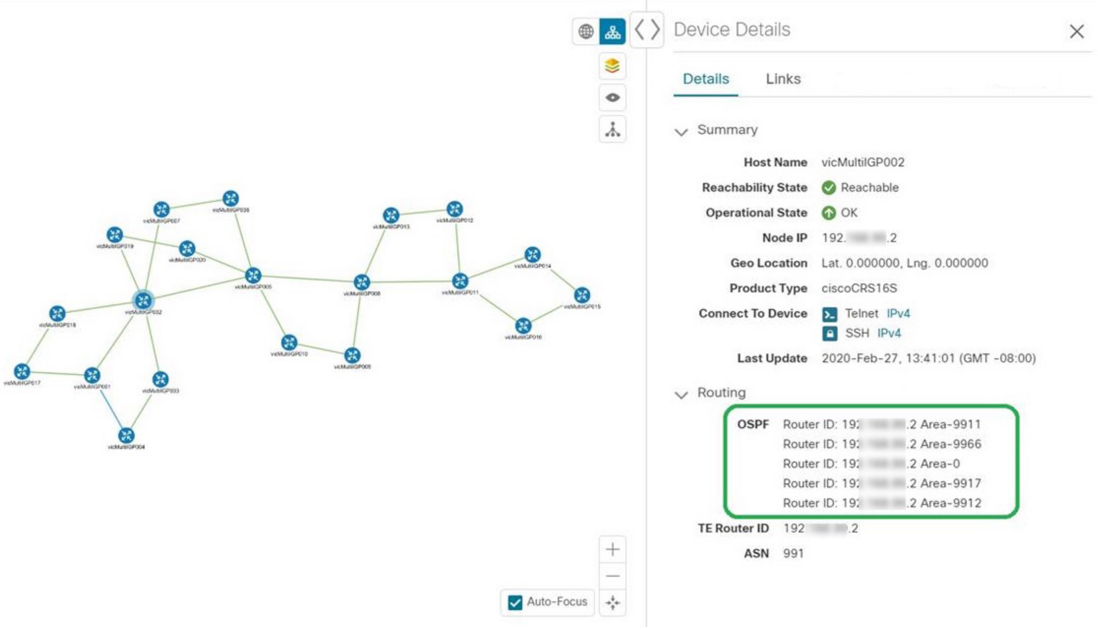
Stateful	true
Source Address	192.168.5.15
Capability Instantiate	true
Capability SR	false
Capability Update	true

PCEP Session: PCE - 172.23.209.75, Source Address - 192.168.4.15

Note If the Alarm Status feature is enabled, you will also see Alarm information here. To view the Alarm Status, you must install the Common EMS Services application and configure host information for Syslog and SNMP traps on the devices you want to view alarms for. The Alarm Status feature is available for select licensing packages.

In a multiple IGP setup, you can also view all the IGP, IS-IS, and OSPF processes in the Routing details. See the following examples:

Figure 58: Multiple IGP: OSPF Processes



Device Details

Details | Links

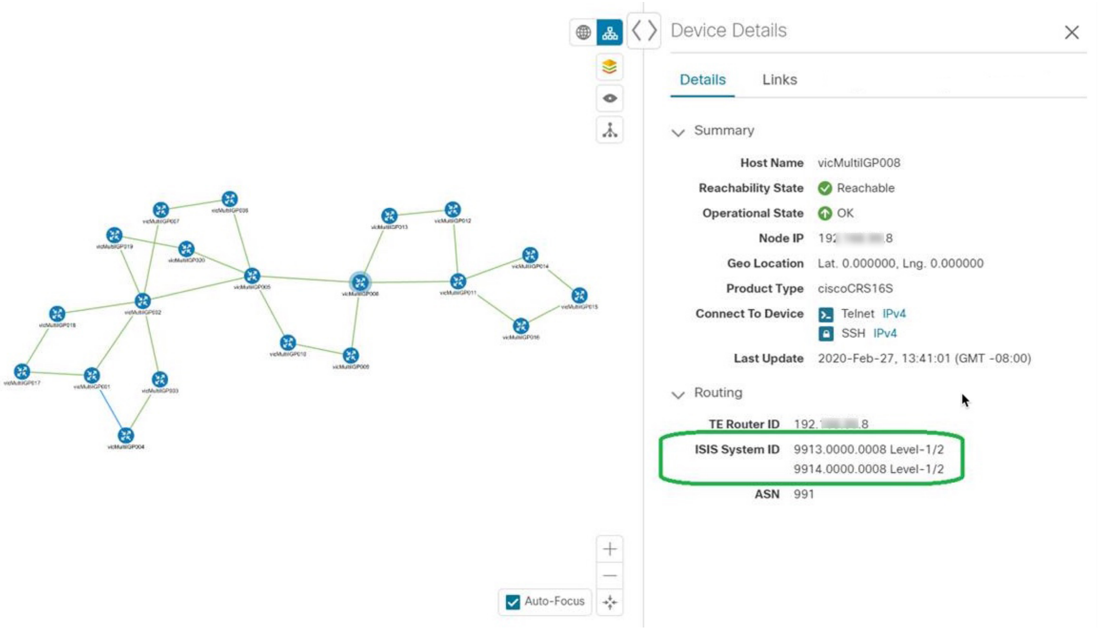
Summary

Host Name	vicMultiIGP002
Reachability State	✓ Reachable
Operational State	OK
Node IP	192.[redacted].2
Geo Location	Lat. 0.000000, Lng. 0.000000
Product Type	ciscoCRS16S
Connect To Device	Telnet IPv4 SSH IPv4
Last Update	2020-Feb-27, 13:41:01 (GMT -08:00)

Routing

OSPF	Router ID: 19[redacted].2 Area-9911 Router ID: 19[redacted].2 Area-9966 Router ID: 19[redacted].2 Area-0 Router ID: 19[redacted].2 Area-9917 Router ID: 19[redacted].2 Area-9912
TE Router ID	192[redacted].2
ASN	991

Figure 59: Multiple IGP: ISIS Processes



Summary

Host Name vicMultiIGP008

Reachability State Reachable

Operational State OK

Node IP 192[redacted]8

Geo Location Lat. 0.000000, Lng. 0.000000

Product Type ciscoCRS16S

Connect To Device Telnet IPv4 SSH IPv4

Last Update 2020-Feb-27, 13:41:01 (GMT -08:00)

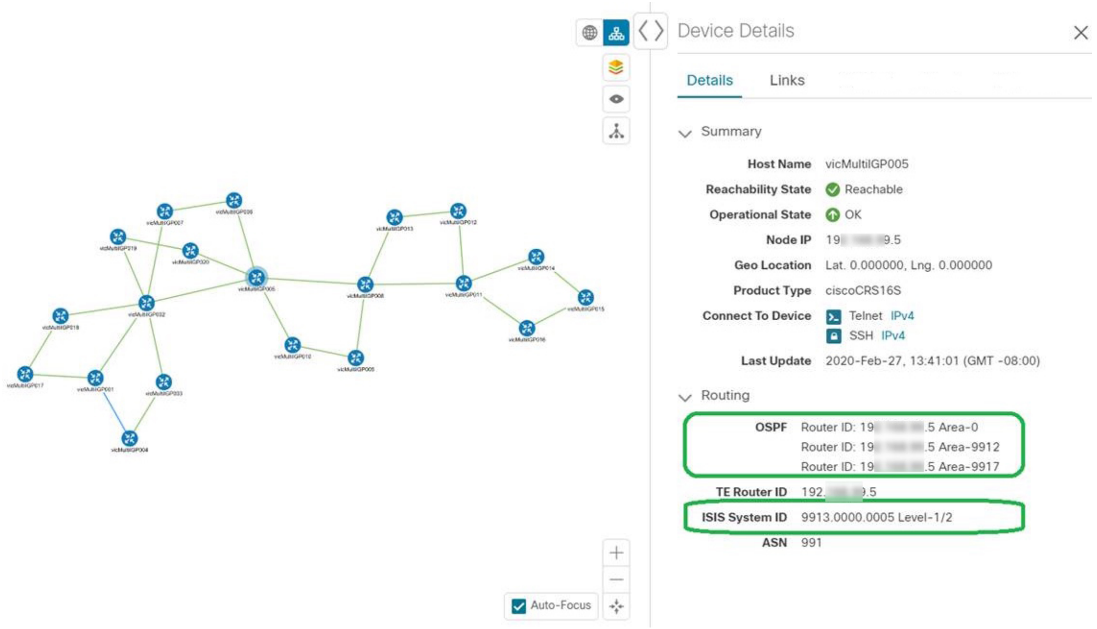
Routing

TE Router ID 192.[redacted].8

ISIS System ID 9913.0000.0008 Level-1/2
9914.0000.0008 Level-1/2

ASN 991

Figure 60: Multiple IGP: OSPF and ISIS Processes



Summary

Host Name vicMultiIGP005

Reachability State Reachable

Operational State OK

Node IP 19[redacted]9.5

Geo Location Lat. 0.000000, Lng. 0.000000

Product Type ciscoCRS16S

Connect To Device Telnet IPv4 SSH IPv4

Last Update 2020-Feb-27, 13:41:01 (GMT -08:00)

Routing

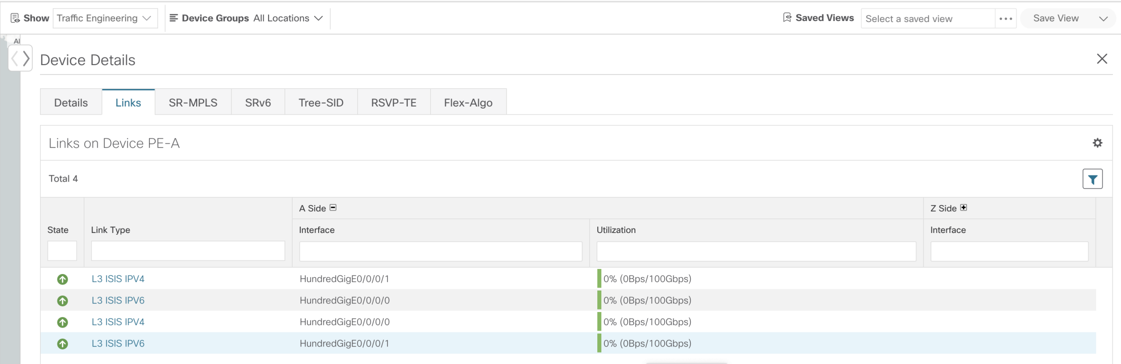
OSPF Router ID: 19[redacted].5 Area-0
Router ID: 19[redacted].5 Area-9912
Router ID: 19[redacted].5 Area-9917

TE Router ID 192.[redacted].5

ISIS System ID 9913.0000.0005 Level-1/2

ASN 991

Step 4 To view links on the device, click the **Links** tab and expand the right panel to see all the link details.



Device Details

Links on Device PE-A

Total 4

		A Side ⊟		Z Side ⊞
State	Link Type	Interface	Utilization	Interface
⬆	L3 ISIS IPV4	HundredGigE0/0/0/1	0% (0Bps/100Gbps)	
⬆	L3 ISIS IPV6	HundredGigE0/0/0/0	0% (0Bps/100Gbps)	
⬆	L3 ISIS IPV4	HundredGigE0/0/0/0	0% (0Bps/100Gbps)	
⬆	L3 ISIS IPV6	HundredGigE0/0/0/1	0% (0Bps/100Gbps)	

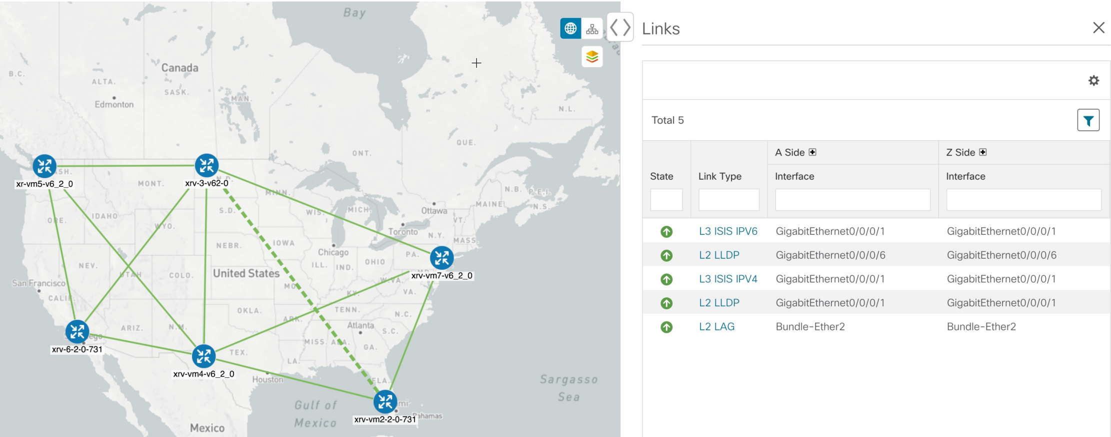
Step 5 To view the utilization, expand **A side**or **Z side**.

The utilization shown on ipv4 and ipv6 links represents the aggregate traffic on the interface or sub-interface, not specific to each address family.The utilization shown on sub-interface links represents the bandwidth utilization on the main interface of the sub-interface's traffic.

Step 6 Collapse the side panel and close the **Device Details** window.

Step 7 Click on a dashed line. A dashed line indicates an aggregated link that represents more than one link.

Note Dual stack links (although aggregate) are shown as one single line.



Links

Total 5

		A Side ⊞	Z Side ⊞
State	Link Type	Interface	Interface
⬆	L3 ISIS IPV6	GigabitEthernet0/0/0/1	GigabitEthernet0/0/0/1
⬆	L2 LLDP	GigabitEthernet0/0/0/6	GigabitEthernet0/0/0/6
⬆	L3 ISIS IPV4	GigabitEthernet0/0/0/1	GigabitEthernet0/0/0/1
⬆	L2 LLDP	GigabitEthernet0/0/0/1	GigabitEthernet0/0/0/1
⬆	L2 LAG	Bundle-Ether2	Bundle-Ether2

Define Map Display Settings

The network topology can be displayed on a logical map or a geographical map (geo map), where the devices and links are shown in their geographic context. The logical map shows devices and their links, positioned according to an automatic layout algorithm, ignoring their geographical location. The geo map shows single devices, device clusters, links, and tunnels, superimposed on a map of the world. Each device location on the map reflects the device's GPS coordinates (longitude and latitude).

The logical map is automatically rendered with no intervention required. The geographical map is rendered by default using map tiles from an external map provider (Mapbox). Internet access is required when using an external map provider. If there is no Internet access, you can download map files from Cisco.com and upload them into the system. These map files will be accessed internally in order to render the geo map. See Use Internal Maps Offline for Geographical Map Display, on page 250.

When setting up maps, administrators can also define display settings, for example, colors representing changes in link bandwidth utilization.

To set up your maps and define display settings, see:

- Use Internal Maps Offline for Geographical Map Display, on page 250
- Define Color Thresholds for Link Bandwidth Utilization, on page 251

Use Internal Maps Offline for Geographical Map Display

The system is set up by default to get the geo map tiles from a specific Mapbox URL through a direct Internet connection. If you do not have an Internet connection and therefore the system cannot access an external map provider to retrieve geographical map tiles, you can upload internal map files to represent the areas of the world you require for your network. These map files must be downloaded from Cisco.com and then uploaded into the system. The name of the map file indicates the area of the world it contains, for example, **africa-geomaps-1.0.0-for-Crosswork-4.1.0-signed.tar.gz**. If you will be managing a network in a specific part of the world, upload only the relevant map files. You do not need to upload all available map files.

Note If you choose to work offline with internal maps and you do not upload map files, your geographical map will display as a generic world map without details of cities, streets, and so on.

To use internal maps to display the geographical map:

Before you begin

Download the required map files from Cisco.com and place them on an accessible server. The server must support SCP protocol for file transfer.

Step 1 From the main menu, choose **Administration** > **Settings** > **System Settings**.

Step 2 Under **Topology**, click the **Map** option.

Step 3 Select the **Work offline with internal maps** radio button and click **Manage**.

Step 4 In the Manage Internal Maps dialog, click to upload a new map file. Note that you can upload one file at a time.

Step 5 In the Upload Map File dialog, browse to the location of the map file you downloaded so that the system can access the file.

Step 6 Click **Upload**.
The system uploads the map from the specified location. The upload process might take some time and must not be interrupted by closing the browser or clicking Cancel. When the process is complete, the new map appears under **Uploaded Maps** in the Manage Internal Maps dialog.

Step 7 Upload additional maps, as required.

Define Color Thresholds for Link Bandwidth Utilization

Link bandwidth utilization can be visualized and monitored in the logical and geographical maps. Links are colored based on the percentage of total bandwidth currently utilized on the link. Following is the default set of bandwidth utilization thresholds (percentage ranges) and corresponding color indicators. These color thresholds can be customized by administrators.

- Green—0–25% usage
- Yellow—25–50% usage
- Orange—50–75% usage
- Red—75–100% usage

To define color thresholds for link bandwidth utilization:

Step 1 From the main menu, choose **Administration** > **Settings** > **System Settings**.

Step 2 Under **Topology**, click the **Bandwidth Utilization** option.

Step 3 In the **Polling Interval** field, enter a whole number from 5 to 60 (minutes) to specify how often links will be polled for bandwidth utilization. By default, link bandwidth is polled every 5 minutes.

Step 4 In the **Link Coloring Thresholds** area, define the criteria for coloring the links. Each row defines a color and the bandwidth percentage range that the color will represent. Note that:

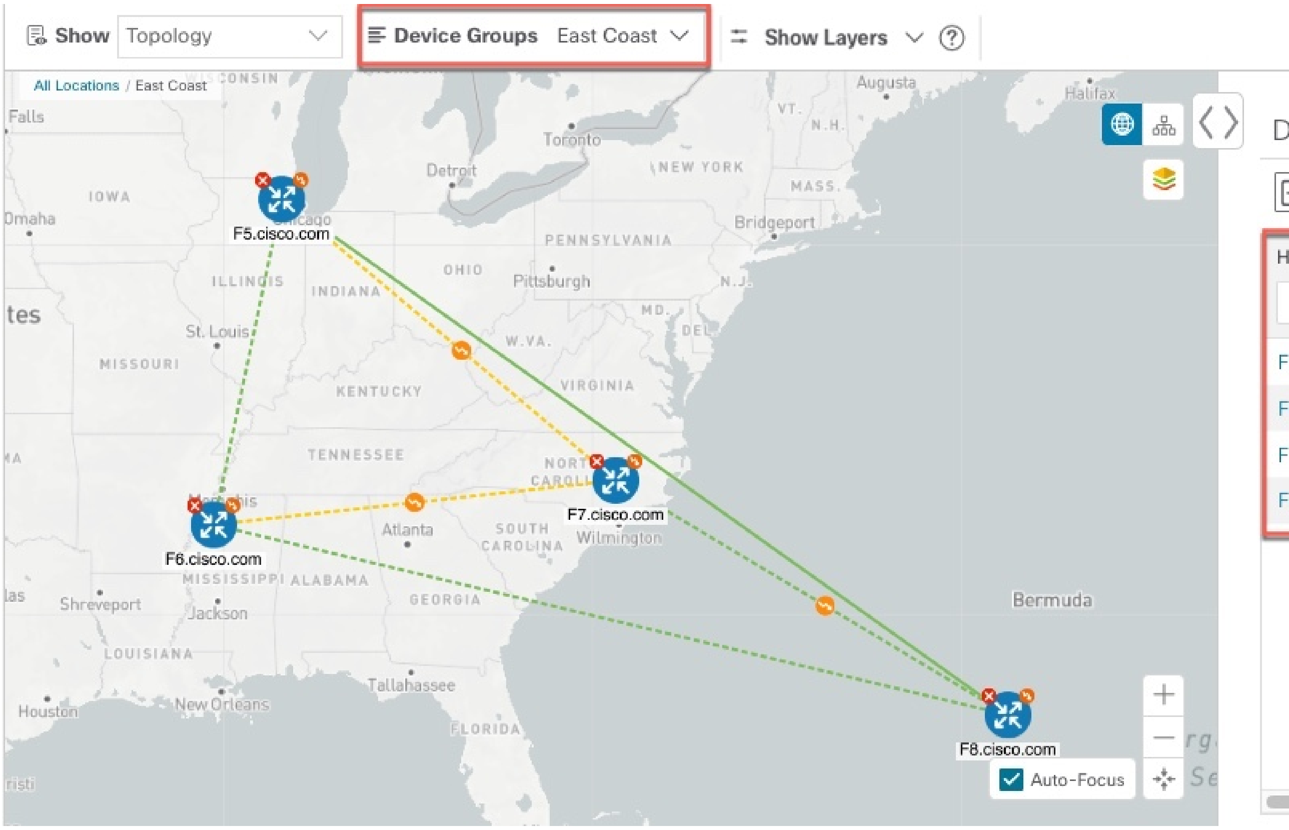
- You can enter values in the "To" fields only. Each row begins automatically from the end of the previous row's range.
- The thresholds must be sequential, meaning that each row's range must follow on from the previous row's range. For example, if the range in the first row is 0-25%, the second row's range must end with a value greater than 25.
- You cannot use the same color for multiple thresholds. For example, you cannot choose **Green** for both the first and second rows.

Step 5 Click **Save**.

Use Device Groups to Filter Your Topology View

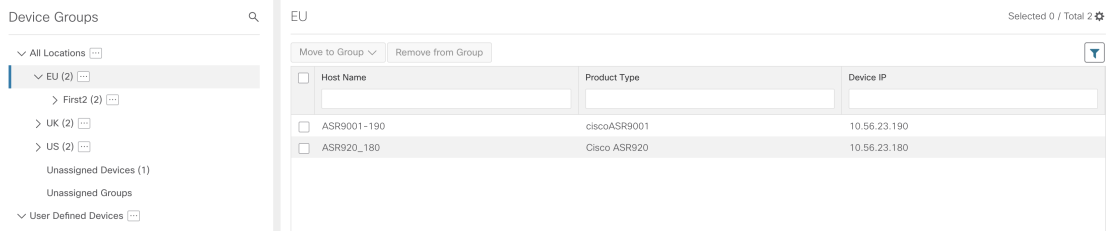
To help you identify, find, and group devices for a variety of purposes, you can create device groups. Device Groups allow you to visualize and zoom in on data specific to that device group. It reduces the clutter on your screen and allows you to focus on data that is most important to you. For example, as shown in the following figure, we see that the East Coast device group has been selected and is zoomed in on the Topology map. Also note that only the devices belonging to the East Coast device group are listed in the Devices table.

Figure 61: Device Group Selection on Topology Map



The **Device Groups** window (**Device Management** > **Groups**) allows you to create and manage device groups. By default, all devices initially appear in the **Unassigned Devices** group.

Figure 62: Device Groups


Device Groups

- All Locations
  - EU (2)
    - First2 (2)
  - UK (2)
  - US (2)
  - Unassigned Devices (1)
  - Unassigned Groups
- User Defined Devices

EU

Selected 0 / Total 2

Move to Group | Remove from Group

□	Host Name	Product Type	Device IP
□	ASR9001-190	ciscoASR9001	10.56.23.190
□	ASR920_180	Cisco ASR920	10.56.23.180

Sdat

Create and Modify Device Groups

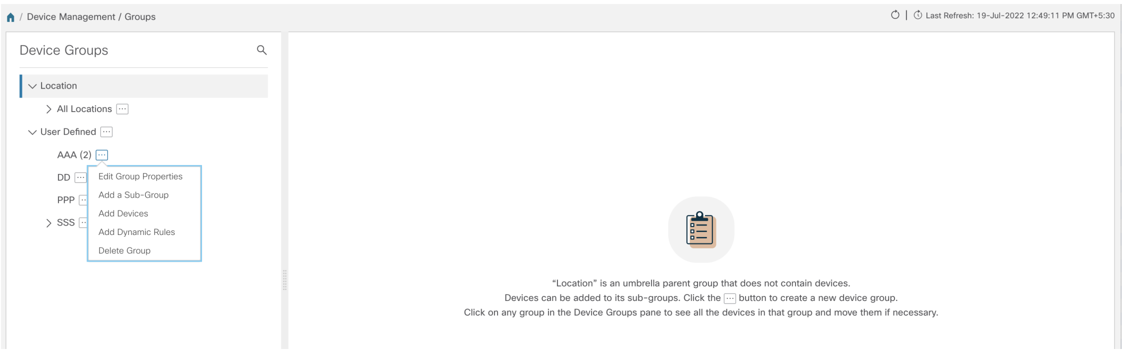
Device groups and assignment of devices to the groups can be done either manually (as described in this section) or automatically (as described in the next section).

Step 1 From the main menu choose **Device Management** > **Groups**.

Step 2 To add a new sub-group, click ⋯ next to **All Locations**.
A new sub-group gets added under **All Locations**.

Step 3 To add a device to a group, from the right-pane, under **Unassigned Devices**, select a device and then from the **Move to Group**drop-down, select the appropriate group.

Step 4 To edit, delete, or add a sub-group under an existing group, from the Device Groups tree, click next to a group.



/ Device Management / Groups

Last Refresh: 19-Jul-2022 12:49:11 PM GMT+5:30

"Location" is an umbrella parent group that does not contain devices.
Devices can be added to its sub-groups. Click the button to create a new device group.
Click on any group in the Device Groups pane to see all the devices in that group and move them if necessary.

Step 5 Choose to add, delete, or edit (rename or move) a group. If you delete a group, all devices that belong to that group are moved to the Unassigned Devices group. Also, deleting a group deletes all the sub-groups under it.

Note Devices can belong to only one device group.

Step 6 Click **Save**.

Enable Dynamic Device Grouping

You can create a rule to dynamically create device groups and automatically add unassigned devices to these groups using a Regular Expression (regex) on the device hostname. Any newly added or discovered devices that match the rule will be placed in the appropriate group.

Note Dynamic rules do not apply to devices that already belong to groups. You must move them to Unassigned Devices if you want them to be considered by the rule.

Before you begin

While you can follow examples given in the Dynamic Groups dialog, it is helpful to be familiar with Regular Expressions.

Step 1 From the main menu choose **Device Management** > **Groups**.

Step 2 Click next to **All Locations > Manage Dynamic Grouping Rule**.

Step 3 Click **Show more details and examples** to help you fill out the required Host Name and Group Name fields.

Step 4 If there are any existing devices in the Unassigned Devices group, click **Test Rule** to view a sampling of what type of group names will be created.

Step 5 Turn the **Enable Rule** toggle ON to enable the rule. After the rule is enabled, the system checks for unassigned devices every minute and will assign them to the appropriate group based on the rule.

Step 6 Click **Save**.

Step 7 Groups that are created this way initially appear under Unassigned Groups (created when a rule is enabled for the first time). Move newly created groups to the desired group hierarchy.

Step 8 To move newly created Unassigned groups to the correct group, do the following:

a) Click … next to All Locations and click **Add a Sub-Group**.
b) Enter the New Group details and click **Create**.
c) Click on the unassigned devices from the left pane.
d) From the right pane, select the devices you want to move and click **Move to Group** to move to an appropriate group.

Customize Map Display Settings

You can configure visual settings on the topology map based on your needs and preferences. You can do the following:

- Customize the Display of Links and Devices, on page 254

Customize the Display of Links and Devices

To set device and link map display preferences, choose **Topology** and click ☰ on the topology map.

- Click **Links** to show aggregated links and how links should be colored so that you can easily see their state and utilization status. By default, aggregated links will be differentiated from single links on the map and links will be colored based on link utilization thresholds. Administrators can change the utilization thresholds and their corresponding colors.

- Click **Devices** to show the device state and how the devices should be labeled. By default, the device state is shown on the map and the host name is used to label devices.

Configure TE Timeout Settings

To configure timeout settings for the provisioning and retrieval of data for SR-TE policies, RSVP-TE tunnels, Bandwidth on Demand and IGP paths, select **Administration** > **System Settings** > **Traffic Engineering** > **General Settings** tab. Enter the timeout duration options. For more information, click ?.

Note Timeouts change the response time of each of the actions if SR-PCE is slow in responding. You can modify the settings for a large scale topology or to address slow SR-PCE response due to latency or load.

Enable or Disable Topology Link Discovery

You can adjust the system settings to enable or disable the discovery of L2 topology links for LLDP, CDP and LAG protocols. By default, the topology discovery option is disabled. When disabled, the links of the selected protocols, including previously discovered links, will not be displayed on the maps.

To enable topology discovery:

Before you begin

- Make sure all pods are healthy before changing the settings.

Step 1 From the main menu, choose **Administration** > **Settings** > **System Settings**.

Step 2 Under **Topology**, click the **Discovery** option.

Step 3 Select the checkbox of the protocols for which you want to enable discovery.

Step 4 Click **Save** to save your changes.

A message "Enabling Protocol" is displayed next to the protocol that you selected. Please wait while the system completes the discovery operation.

When you enable discovery, the collection jobs will be created. The table below lists the collections jobs created for each protocol setting along with the sensor paths.

Table 20: Collection Jobs for each setting

L2 Configuration Setting	Helios collection Jobs ID	Context ID	MIBs collected	Sensor paths

None (default)	cw.topo_svc	cw.toposvc.snmp
		cw.toposvc.snmptraps
			IF-MIB, IP-MIB,
			IF-MIB:notification
				IF-MIB:IF-MIB/ifTable/ifEntry
				IP-MIB:IP-MIB/ipAddressTable/ipAddressEntry
				IF-MIB:notifications

CDP	cw.topo_svc	cw.toposvc.cdp	IF-MIB, CDP-MIB	IF-MIB:IF-MIB/ifTable/ifEntry CISCO-CDP-MIB:CISCO-CDP-MIB/cdpCacheTable/cdpCacheEntry CISCO-CDP-MIB:CISCO-CDP-MIB/cdpInterfaceTable/cdpInterfaceEntry
LLDP	cw.topo_svc	cw.toposvc.lldp	IF-MIB, LLDP-MIB	IF-MIB:IF-MIB/ifTable/ifEntry LLDP-MIB:LLDP-MIB/lldpLocPortTable/lldpLocPortEntry LLDP-MIB:LLDP-MIB/lldpRemTable/lldpRemEntry
LAG	cw.topo_svc	cw.toposvc.lag	IF-MIB, LAG-MIB	IF-MIB:IF-MIB/ifTable/ifEntry IEEE8023-LAG-MIB:IEEE8023-LAG-MIB/dot3adAggTable/dot3adAggEntry IEEE8023-LAG-MIB:IEEE8023-LAG-MIB/dot3adAggPortTable/dot3adAggPortEntry

The table below lists the common errors when enabling or disabling topology discovery:

Table 21: Common error scenarios:

Possible Error Scenario	Cause	Cause Recommended Action
After disabling, some of the disabled links are displayed in the maps.	This occurs if you try to disable a protocol quickly after enabling it. This could result in killing the collection job created for the previous enable job before the SNMP processors have completed it. Due to the timing issue, the disabled links will continue to be displayed.	Enable and disable the protocol again with sufficient wait time in between, or restart `toposvc`.
When you try to enable discovery, the helios job fails and settings are disabled from further editing.	This can occur if the helios pod is not healthy. This can result being stuck in the unsuccessful state since Crosswork disables users from editing while the collection job is being created.	Ensure that the pods are healthy, and then enable and disable the protocol with sufficient wait time in between, or restart `toposvc`.
When you change the discovery settings, the TopoUI or TopoSvc crashes resulting in an unpredictable status.	The mechanism to disable users from further editing while the collection job is being created or deleted, relies on pods communicating via ETCD. If any pod crashes during this time, the ETCD key is not set correctly.	

Save Topology Views for Easy Access

When you rearrange the devices and links on a map, your changes are not normally saved. To easily access a useful map layout, you can save it as a named custom view and quickly retrieve it, without having to rearrange the map each time. This is especially useful when managing large networks with many devices.

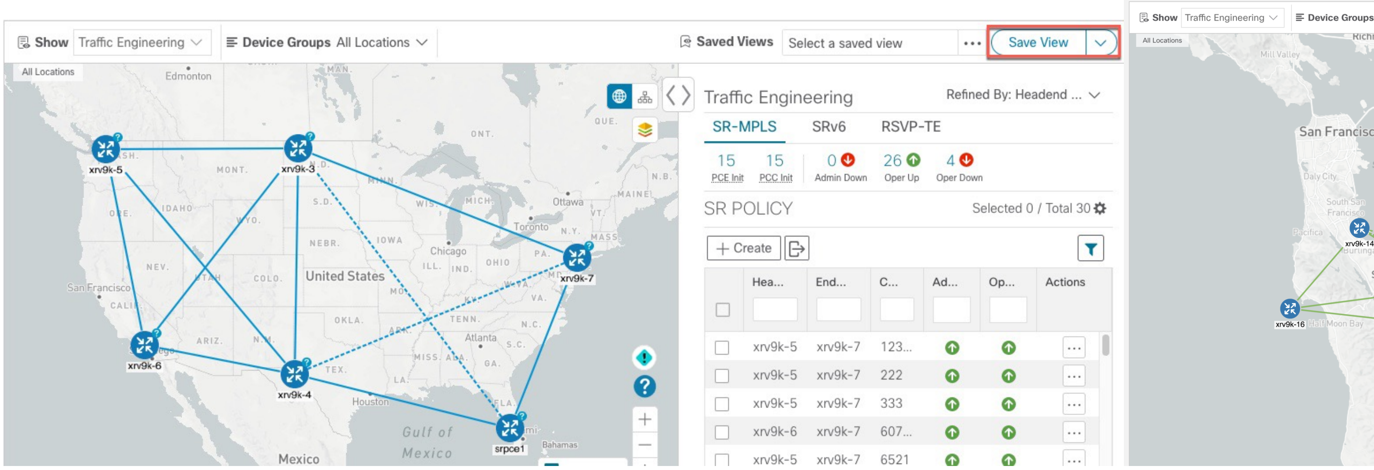
When you save a custom view, the following settings will be saved:

- Whether it is a geographical or logical map.
- Device positions in the logical map layout.
- Device and link display settings

Note All custom views can be seen by all users. However, only users with the admin role or users that created the custom view can modify the view.

Step 1 Customize the current map view until it contains only the information you want and until the layout meets your needs.

Step 2 When you have the view the way you want it, click **Save View**.



☐	Hea...	End...	C...	Ad...	Op...	Actions
☐	xrv9k-5	xrv9k-7	123...	⬆	⬆	...
☐	xrv9k-5	xrv9k-7	222	⬆	⬆	...
☐	xrv9k-5	xrv9k-7	333	⬆	⬆	...
☐	xrv9k-6	xrv9k-7	607...	⬆	⬆	...
☐	xrv9k-5	xrv9k-7	6521	⬆	⬆	...

Step 3 Enter a unique name for the new custom view and click **Save**. You can later modify the view (click **Select a saved view**) and choose to edit the topology, rename, or delete the view.

CHAPTER 9

Manage System Access and Security

This section contains the following topics:

Manage Certificates

What is a Certificate?

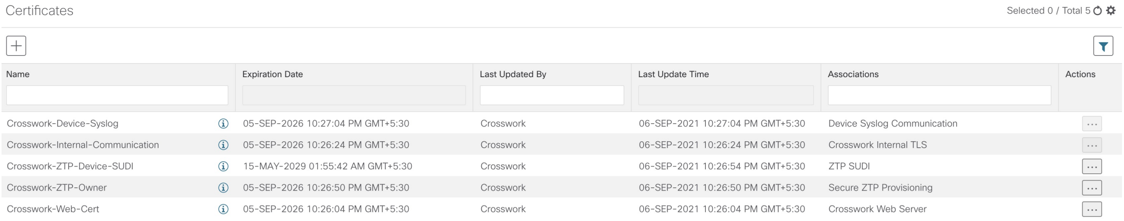
A certificate is an electronic document that identifies an individual, a server, a company, or another entity, and associates that entity with a public key. When a certificate is created with a public key, a matching private key is also generated. In TLS, the public key is used to encrypt data being sent to the entity and the private key is used to decrypt. A certificate is signed by an issuer or a "parent" certificate (Certificate Authority) - i.e. signed by the parent's private key. Certificates can also be self-signed. In a TLS exchange, a hierarchy of certificates is used to verify the validity of the certificate's issuer. This hierarchy is called a trust-chain and consists of 3 types of entities: a root CA certificate (self-signed), possibly multiple levels of intermediate CA certificates, and a server (or client) certificate (end-entity). The intermediate certificates act as a “link of trust” linking the server certificates to the CA’s root certificate and providing additional layers of security. Starting from the root certificate's private key, the private key for each certificate in the trust chain signs and issues the next certificate in the chain until finally signing an end entity certificate. The end-entity certificate is the last certificate in the chain and is used as a client or server certificate. For more details about these protocols, see X.509 Certificates, on page 284 and HTTPS, on page 283.

How are Certificates Used in Crosswork?

Communication between Crosswork applications and devices as well as between various Crosswork components are secured using the TLS protocol. TLS uses X.509 certificates to securely authenticate devices and encrypt data to ensure its integrity from source to destination. Crosswork uses a mix of generated and client uploaded certificates. Uploaded certificates can be purchased from Certificate authorities (CA) or can be self-signed. For example, the Cisco Crosswork VM-hosted web server and the client browser-based user interface communicate with each other using Crosswork generated X.509 certificates exchanged over TLS.

The Crosswork Cert Manager is a proxy for multiple microservices and services within the distributed framework and manages all the Crosswork certificates. The Certificate Management UI (**Administration** > **Certificate Management**) allows you to view, upload, and modify certificates. The following figure displays the default certificates provided by Cisco Crosswork.

Figure 63: Certificate Management UI



Certificates

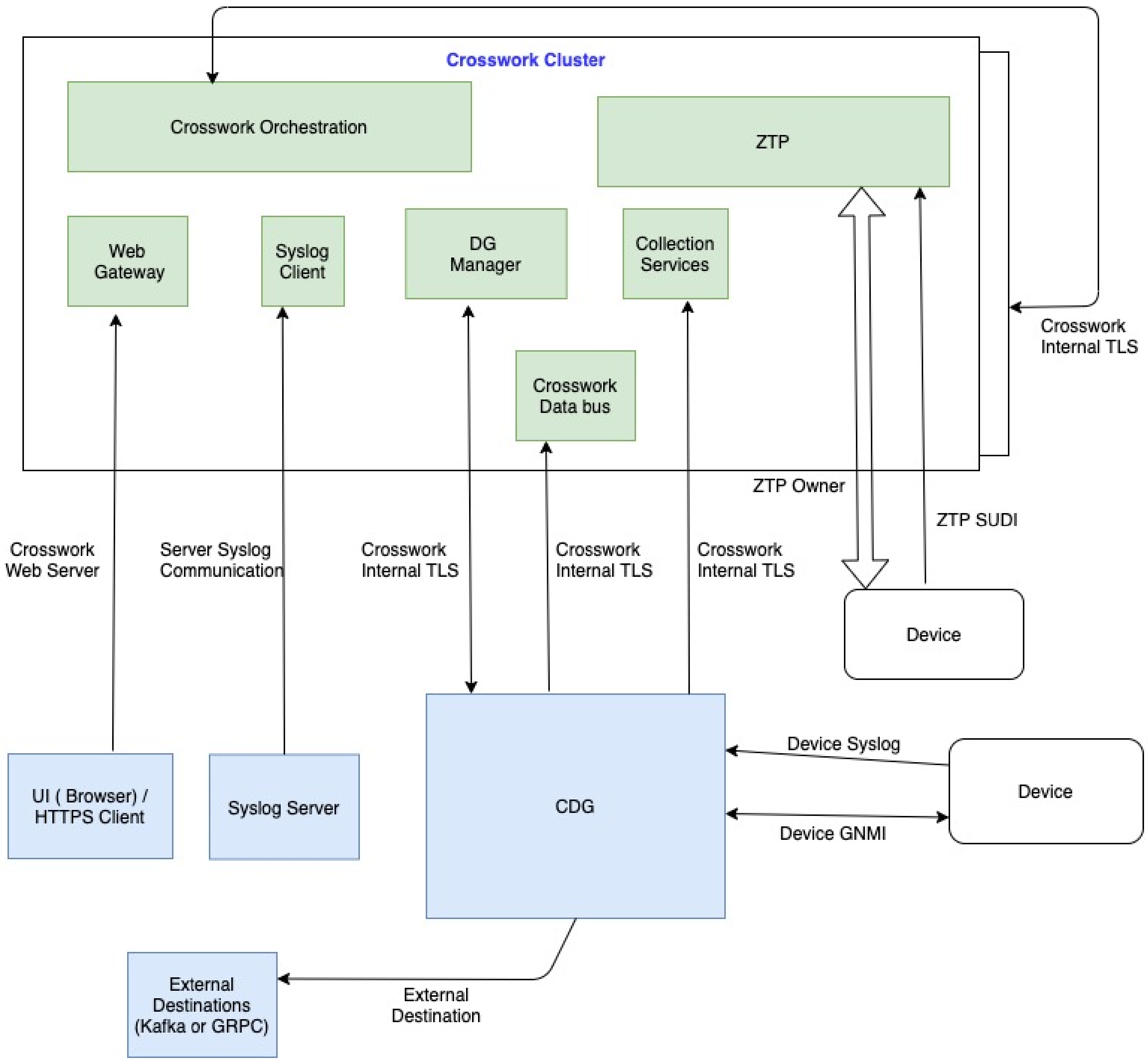
Selected 0 / Total 5

Name	Expiration Date	Last Updated By	Last Update Time	Associations	Actions
Crosswork-Device-Syslog	05-SEP-2026 10:27:04 PM GMT+5:30	Crosswork	06-SEP-2021 10:27:04 PM GMT+5:30	Device Syslog Communication	...
Crosswork-Internal-Communication	05-SEP-2026 10:26:24 PM GMT+5:30	Crosswork	06-SEP-2021 10:26:24 PM GMT+5:30	Crosswork Internal TLS	...
Crosswork-ZTP-Device-SUDI	15-MAY-2029 01:55:42 AM GMT+5:30	Crosswork	06-SEP-2021 10:26:54 PM GMT+5:30	ZTP SUDI	...
Crosswork-ZTP-Owner	05-SEP-2026 10:26:50 PM GMT+5:30	Crosswork	06-SEP-2021 10:26:50 PM GMT+5:30	Secure ZTP Provisioning	...
Crosswork-Web-Cert	05-SEP-2026 10:26:04 PM GMT+5:30	Crosswork	06-SEP-2021 10:26:04 PM GMT+5:30	Crosswork Web Server	...

Certificate Types and Usage

The following figure shows how Crosswork uses certificates for various communication channels.

Figure 64: Certificates in Cisco Crosswork



These certificates are classified into various roles with different properties depending on their use case as shown in the following table.

Role	UI Name	Description	Server	Client	Allowed operations	Default Expiry	Allowed Expiry
Crosswork (CW) Internal TLS	CW- Internal-Communication	• Generated and provided by Crosswork. • This trust-chain is available in the UI (including the server and client leaf certificatess) and are created by Crosswork during initialization. They are used for interprocess communications between Crosswork and CDG as well as communication between internal Crosswork components. • Allows mutual and server authentication.	CW	• CDG • CW	Download	5 years	—
CW Web Server	CW-Web-Certificate Server Authentication	• Generated and provided by Crosswork. • Provides communication between the user browser and Crosswork. • Allows server authentication.	CW Web Server	User Browser or API Client	• Upload • Download	5 years	30 day - 5 years

Role	UI Name	Description	Server	Client	Allowed operations	Default Expiry	Allowed Expiry
ZTP SUDI	CW-ZTP-Device-SUDI	• A public Cisco certificate that is provided as part of Crosswork. • Provides ZTP protocol communication channel between the ZTP application and device. • Allows server authentication.	CW ZTP	Device	• Upload • Download	100 days	30 day - User defined
Secure ZTP Provisioning	CW-ZTP-Owner	• Generated and provided by Crosswork. • Forwarded by ZTP to devices and used for second layer of encryption.	CW ZTP	Device	• Upload • Download	5	30 day - User defined
Device Syslog	CW-Device-Syslog	• Generated and provided by Crosswork. • Provides Syslog telemetry communications between devices and CDG. • Allows server authentication.	CDG	Device	Download	5 years	—
Device gNMI Communication	—	Provides GNMI telemetry communications between devices and CDG.	CDG	Device	• Upload • Download	Not Applicable	30 day - User defined

Role	UI Name	Description	Server	Client	Allowed operations	Default Expiry	Allowed Expiry
Server Syslog	Not Applicable	• Allows syslog events and logs from Crosswork to an external Syslog server. • Allows server authentication.	External Syslog Server	Crosswork	• Upload **Note** You can upload multiple certificates associated with different servers. • Download	—	30 - User defined
External Destination	—	Exports telemetry data from CDG to external destinations (Kafka or GRPC).	External Destinations (Kafka or GRPC)	CDG	• Upload **Note** You can upload multiple certificates associated with different destinations. • Download	—	30 - User defined

There are two category roles in Crosswork:

- Roles which allow you to upload or download trust chains only
- Roles that allow upload or download of both the the trust chain and an intermediate certificate and key

Add a New Certificate

You can add certificates for the following roles:

- **External Destination**: Certificates uploaded for this role are used to secure communication between CDG and external destinations like Kafka servers. To enable mutual authentication, the user uploads a **CA Certificate Trustchain** that will be common to both CDG and the external server. This trust chain contains a root CA certificate and any number of optional intermediate CA certificates. The last intermediate certificate in the chain and its corresponding private key is uploaded separately in the UI using **Intermediate key**, **Intermediate certificate**, and optionally **Passphrase** (if one was used for generating the intermediate key). Crosswork will internally create a client certificate using this intermediate key for the CDGs that will connect to the external destination. The destination (for example: Kafka) server certificate trust needs to be derived from the same root CA certificate.
- **Syslog Server Communication**: The user uploads the trust chain of the Syslog server certificate. This trust chain is used by Crosswork to authenticate the Syslog server. Once this trust chain is uploaded and

propagated within Crosswork, the user can add the syslog server (**Administration** > **Settings** > **Syslog Server Configuration**) and associate the certificate to enable TLS. For more informaton, see Configure a Syslog Server, on page 286.

- **Devices gNMI communication**: The user uploads a bundle of trust chains used by CDG to authenticate the devices connecting to it. This trust chain and the device gNMI certificate must also be configured on the device. The trust chain file that is uploaded can contain multiple hierarchies of trust certificates as needed to allow all the devices in the network to connect. For more information, see Configure gNMI Certificate, on page 79.
- **Secure LDAP Communication**: The user uploads the trust chain of the secure LDAP certificate. This trust chain is used by Crosswork to authenticate the secure LDAP server. Once this trust chain is uploaded and propagated within Crosswork, the user can add the LDAP server (see Manage LDAP Servers, on page 281) and associate the certificate.

Note Cisco Crosswork does not receive a web certificate directly. It accepts an intermediate CA and intermediate Key to create a new web certificate, and apply it to the Web Gateway.

If you prefer to upload your own ZTP (Zero Touch Provisioning Concepts, on page 175) and web certificates (instead of using the default certificates provided within Cisco Crosswork), use the Edit function (see Edit Certificates.

Before you begin

- For information on certificate types and usage, see Certificate Types and Usage, on page 260.
- All certificates that are uploaded must be in Privacy Enhanced Mail (PEM) format. Note where these certificates are in the system so that you can navigate to them easily.
- Trust chain files that are uploaded may contain the entire hierarchy (root CA and intermediate certificates) in the same file. In some cases, multiple chains are also allowed in the same file.
- Intermediate Keys need to be either PKCS1 or PKCS8 format.
- A data destination must be configured prior to adding a new certificate for an external destination. For more information, see Add or Edit a Data Destination, on page 44.

Step 1 From the main menu, choose **Administration** > **Certificate Management** and click ⊞.

Step 2 Enter a unique name for the certificate.

Step 3 From the **Certificate Role** drop-down menu, select the purpose for which the certificate is to be used. For more information, see Manage Certificates, on page 259.

Step 4 Click **Browse**, and navigate to the certificate trustchain.

Step 5 In the case of an External Destination certificate, you must select one or more destinations and provide the CA certificate trustchain, intermediate certificate and intermediate key. The passphrase field is optional and is used to create the intermediate key (if applicable).

Step 6 Click **Save**.

Note Once uploaded, the Crosswork Cert manager accepts, validates, and generates the server certificate. Upon successful validation, an alarm ("Crosswork Web Server Restart") will indicates that the certificate is about to be applied. The Certificate Management UI then logs out automatically and applies the certificate to the Web Gateway. The new certificate can be checked by clicking the lock <Not Secure>/<secure> icon next to the https://<crosswork_ip>:30603.

Edit Certificates

You can edit a certificate to add or remove connection destinations, upload, and replace expired or misconfigured certificates. User provided certificates and ZTP and web certificates can be edited. Other system certificates that are provided by Cisco Crosswork cannot be modified and will not be available for selection.

You can also “remove” a certificate by following this procedure to replace the certificate or by disabling security (disable **Enable Secure Communication** option) for any assigned destinations (see Add or Edit a Data Destination, on page 44). Permanently deleting a certificate from the Cisco Crosswork system is not supported.

Note For information about ZTP certificates, see the following:

- Assemble ZTP Assets, on page 187
- Load ZTP Assets, on page 199

Step 1 From the main menu, choose **Administration** > **Certificate Management**. and check the certificate that you want to modify.

Step 2 Click ⋯ on the certificate that you want to modify and select **Update Certificate**.

Step 3 Update the necessary options.

Note While updating a CW Web Server Certificate, provide relevant values for the following fields:

- **Crosswork Web CA**: Trust chain file (in PEM format) containing the root CA certificate and zero or more intermediate certificates.
- **Crosswork Web Intermediate**: An intermediate CA certificate signed with the root CA certificate.
- **Crosswork Web Intermediate Key**: The key associated with the intermediate CA certificate.
- **Crosswork Web Passphrase**: This is an optional field.

Upon successful validation, the Certificate Management UI logs out automatically and applies the certificate to the Web Gateway.

Step 4 Click **Save**.

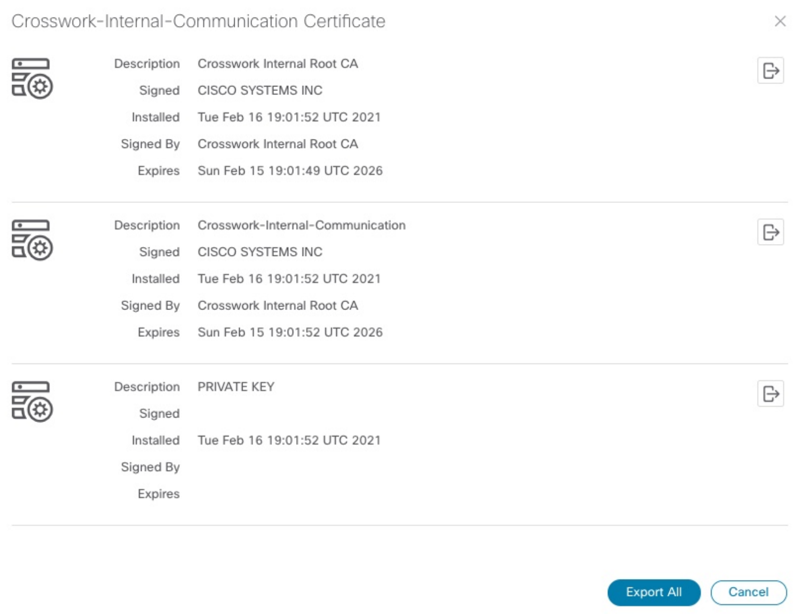
Download Certificates

To export certificates, do the following:

Step 1 From the main menu, choose **Administration** > **Certificate Management**.

Step 2 Click ⓘ for the certificate you want to download.

Figure 65: Export Certificates



Crosswork-Internal-Communication Certificate

Description	Crosswork Internal Root CA
Signed	CISCO SYSTEMS INC
Installed	Tue Feb 16 19:01:52 UTC 2021
Signed By	Crosswork Internal Root CA
Expires	Sun Feb 15 19:01:49 UTC 2026

Description	Crosswork-Internal-Communication
Signed	CISCO SYSTEMS INC
Installed	Tue Feb 16 19:01:52 UTC 2021
Signed By	Crosswork Internal Root CA
Expires	Sun Feb 15 19:01:52 UTC 2026

Description	PRIVATE KEY
Signed	
Installed	Tue Feb 16 19:01:52 UTC 2021
Signed By	
Expires	

Step 3 To separately download the root certificate, intermediate certificate, and the private key, click ⇨. To download the certificates and private key all at once, click **Export All**.

Renew Certificates

Certificates are valid for 1 year before they expire. The below procedure needs to be executed sequentially on each node (hybrid and worker) in the cluster. After renewing the certificates in one node, ensure that the pods are healthy before proceeding to the next node.

Note When renewing certificates before expiry, it is recommended to perform this activity during a maintenance window as the cluster is in an operational state.

To renew a certificate, perform the following:

Step 1 In the node, run command to move to root user.

```
sudo -i
```

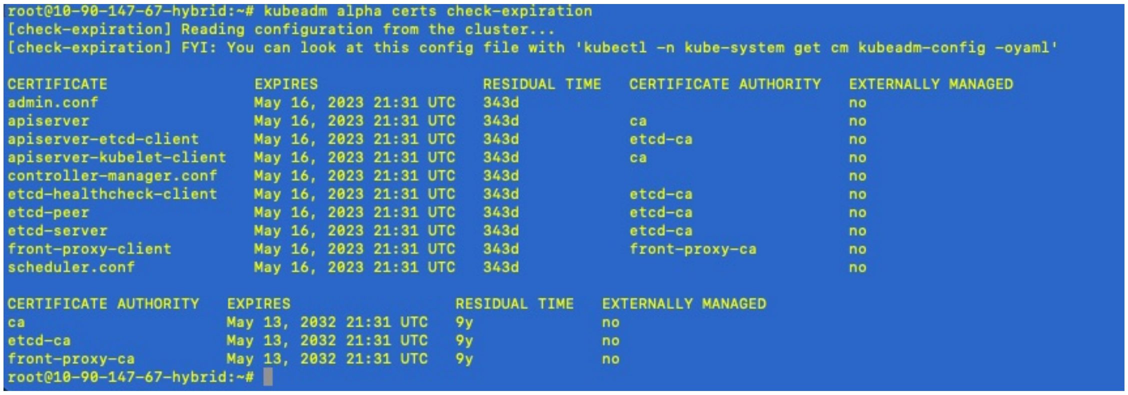
You will be prompted to enter your password. Enter the `cw-admin` user password.

Step 2 Verify if the certificate date has expired.

```
kubeadm alpha certs check-expiration
```

The following image is a sample of the output:

Figure 66: Certificate expiration sample output



```
root@10-90-147-67-hybrid:~# kubeadm alpha certs check-expiration
[check-expiration] Reading configuration from the cluster...
[check-expiration] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -oyaml'

CERTIFICATE                EXPIRES                  RESIDUAL TIME   CERTIFICATE AUTHORITY   EXTERNALLY MANAGED
admin.conf                 May 16, 2023 21:31 UTC   343d                                    no
apiserver                  May 16, 2023 21:31 UTC   343d            ca                      no
apiserver-etcd-client      May 16, 2023 21:31 UTC   343d            etcd-ca                 no
apiserver-kubelet-client   May 16, 2023 21:31 UTC   343d            ca                      no
controller-manager.conf    May 16, 2023 21:31 UTC   343d                                    no
etcd-healthcheck-client    May 16, 2023 21:31 UTC   343d            etcd-ca                 no
etcd-peer                  May 16, 2023 21:31 UTC   343d            etcd-ca                 no
etcd-server                May 16, 2023 21:31 UTC   343d            etcd-ca                 no
front-proxy-client         May 16, 2023 21:31 UTC   343d            front-proxy-ca          no
scheduler.conf             May 16, 2023 21:31 UTC   343d                                    no

CERTIFICATE AUTHORITY   EXPIRES                  RESIDUAL TIME   EXTERNALLY MANAGED
ca                      May 13, 2032 21:31 UTC   9y              no
etcd-ca                 May 13, 2032 21:31 UTC   9y              no
front-proxy-ca          May 13, 2032 21:31 UTC   9y              no
root@10-90-147-67-hybrid:~#
```

Step 3 Make a backup of the certificates and conf files.

```
mkdir $HOME/Old-K8-Certs
mkdir $HOME/Old-K8-Certs/pki
cp -p /etc/kubernetes/pki/*.* $HOME/Old-K8-Certs/pki
cp -p /etc/kubernetes/*.conf $HOME/Old-K8-Certs
~#
```

Step 4 Run command to renew the certificate.

```
kubeadm alpha certs renew all
```

Step 5 Repeat step 2 to verify the creation of new certificates.

Step 6 Run command to restart the `kubelet`.

```
systemctl stop kubelet
```

Note The restart occurs on all the nodes and the refreshed certificates don’t take effect until the `kubelet` and `kube-apiserver` are restarted. It is recommended to stop any operations from the applications from running when the restart occurs.

Ensure that `kube-apiserver` is not running. If it is still running, kill it. It will be restarted when `kubelet` is restarted.

```
ps -ef | grep kube-apiserver
systemctl daemon-reload&&systemctl start kubelet
```

The node will first move to `degraded` state, and then to `down` state.

Note he syslog may continue to show traffic even after the node has moved to `down` state.

```
10-90-147-67-hybrid kernel: [1897091.695393] ll header: 00000000: ff ff ff ff ff ff fa 51 56
 a2 9c 7c 08 0
10-90-147-67-hybrid kernel: [1897091.695414] IPv4: martian source 169.254.1.1 from
10.244.215.17, on dev calieff0340c649
10-90-147-67-hybrid kernel: [1897091.695416] ll header: 00000000: ff ff ff ff ff ff 72 e8 75
 10 bb 64 08 06
```

Step 7 Verify if all the pods are healthy and running.

```
kubectl get pods -A -o wide
```

It also verifies the running pods on the hybrid node that you have restarted.

Step 8 Verify if the certificate has been renewed.

Step 9 If the issue is still seen, change the conf file.

```
sudo kubeadm alpha kubeconfig user --org system:nodes --client-name system:node:$(hostname) >
/etc/kubernetes/kubelet.conf
```

Repeat the above steps for each node in your cluster.

Manage Licenses

Cisco Smart Licensing is a flexible licensing model that provides you with an easier, faster, and more consistent way to purchase and manage software across the Cisco portfolio and across your organization. And it's secure – you control what users can access. With Smart Licensing you get:

- **Easy Activation:** Smart Licensing establishes a pool of software licenses that can be used across the entire organization—no more PAKs (Product Activation Keys).
- **Unified Management:** My Cisco Entitlements (MCE) provides a complete view into all of your Cisco products and services in an easy-to-use portal, so you always know what you have and what you are using.
- **License Flexibility:** Your software is not node-locked to your hardware, so you can easily use and transfer licenses as needed.

To use Smart Licensing, you must first set up a Smart Account on Cisco Software Central (software.cisco.com). A **Cisco Smart Account** provides the repository for Smart enabled products and enables you to activate Cisco licenses, monitor license usage and track Cisco purchases. The **Cisco Smart Software Manager (CSSM)** enables you to manage all your Cisco Smart software licenses from one centralized website. With Cisco Smart Software Manager, you may create and manage multiple virtual accounts within your Smart Account to manage licenses. For a more detailed overview on Cisco Licensing, go to cisco.com/go/licensingguide.

From the main menu, select **Administration** > **Smart Licensing Registration** to display the **Smart Software Licensing** window. Using this window, you can register your Cisco Crosswork application, edit the transport settings, renew the license, and de-register your application.

Prerequisites for Smart Licensing Registration

You should have:

- A Cisco Smart Account.
- Purchased licenses for the Cisco Crosswork application.

Configure Transport Settings

You can configure the transport settings to decide how Cisco Crosswork communicates with the Cisco servers.

- **Direct**: The application directly connects with Cisco Smart Software Manager (CSSM).
- **Transport Gateway**: The application communicates via a Transport Gateway or CSSM on-prem, which replicates the cloud-based user experience but keeps all communication on premises.

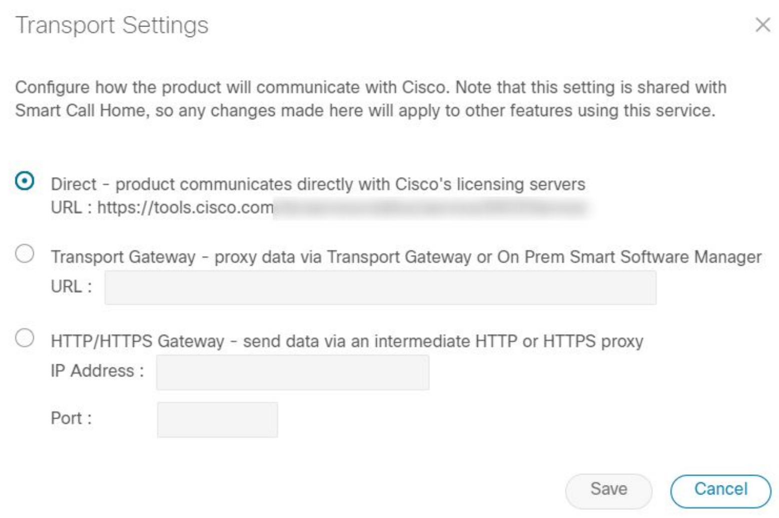
  Note For more information on the CSSM on-prem option, see the Smart Software Manager guide.

- **HTTP/HTTPS Gateway**: The application connects via an intermediate proxy server. This is applicable only for Direct mode.

Note Transport Settings cannot be changed while the Cisco Crosswork is in Registered mode. You have to de-register to change them.

Step 1 In the **Smart Software Licensing** window, the Transport Settings display the current transport mode selected. To modify, click **View/Edit**.

The **Transport Settings** dialog box is displayed.



Transport Settings ×

Configure how the product will communicate with Cisco. Note that this setting is shared with Smart Call Home, so any changes made here will apply to other features using this service.

◉ Direct - product communicates directly with Cisco's licensing servers
URL : https://tools.cisco.com[redacted]

○ Transport Gateway - proxy data via Transport Gateway or On Prem Smart Software Manager
URL :

○ HTTP/HTTPS Gateway - send data via an intermediate HTTP or HTTPS proxy
IP Address :
Port :

Step 2 Select the relevant transport mode and make relevant entries in the fields provided.

Step 3 Click **Save**.

Register Cisco Crosswork Application

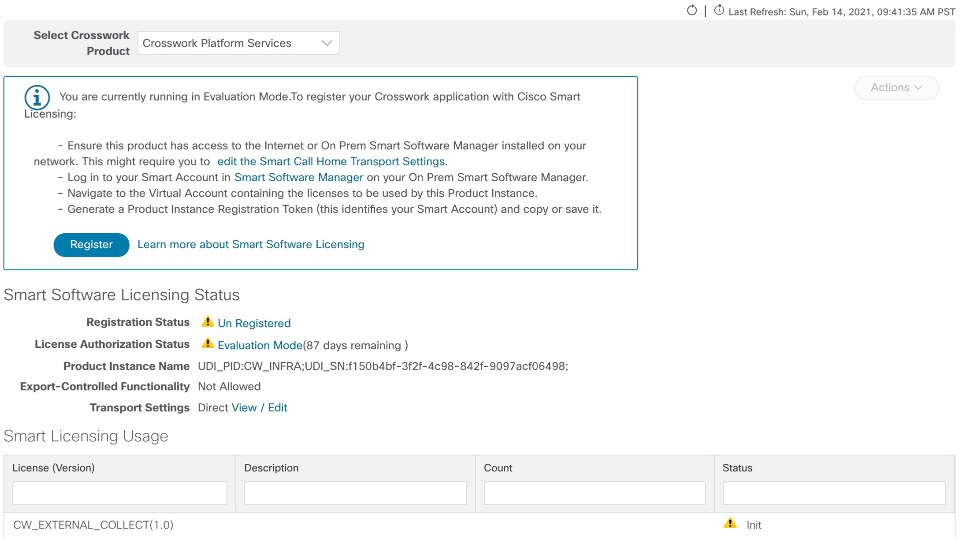
To enable licensed features, the Cisco Crosswork application must be registered to CSSM using a registration ID token. Once registered, an Identity Certificate is saved securely in the Smart Account and used for all ongoing communications. The certificate is valid for one year and will be renewed automatically after six months to ensure continuous operation.

Note For information on generating the registration token, please refer to the support resources provided in the Smart Software Manager webpage.

Step 1 From the main menu, select **Administration** > **Smart Licensing Registration** to display the **Smart Software Licensing** window. The registration status

The registration status and license authorization status will be **Unregistered** and **Evaluation mode** respectively.

Figure 67: Smart Software Licensing Unregistered Example



Last Refresh: Sun, Feb 14, 2021, 09:41:35 AM PST

Select Crosswork Product: Crosswork Platform Services

You are currently running in Evaluation Mode.To register your Crosswork application with Cisco Smart Licensing:

- Ensure this product has access to the Internet or On Prem Smart Software Manager installed on your network. This might require you to edit the Smart Call Home Transport Settings.
- Log in to your Smart Account in Smart Software Manager on your On Prem Smart Software Manager.
- Navigate to the Virtual Account containing the licenses to be used by this Product Instance.
- Generate a Product Instance Registration Token (this identifies your Smart Account) and copy or save it.

Smart Software Licensing Status

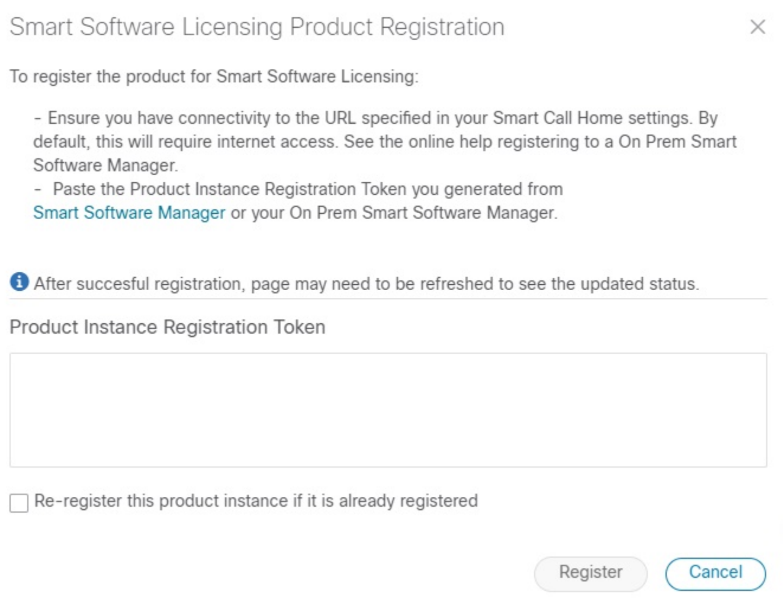
Registration Status	⚠ Un Registered
License Authorization Status	⚠ Evaluation Mode(87 days remaining)
Product Instance Name	UDI_PID:CW_INFRA;UDI_SN:f150b4bf-3f2f-4c98-842f-9097acf06498;
Export-Controlled Functionality	Not Allowed
Transport Settings	Direct View / Edit

Smart Licensing Usage

License (Version)	Description	Count	Status
CW_EXTERNAL_COLLECT(1.0)			⚠ Init

Step 2 In the **Smart Software Licensing** window, click **Register**.

The **Smart Software Licensing Product Registration** dialog box is displayed.



Smart Software Licensing Product Registration

To register the product for Smart Software Licensing:

- Ensure you have connectivity to the URL specified in your Smart Call Home settings. By default, this will require internet access. See the online help registering to a On Prem Smart Software Manager.
- Paste the Product Instance Registration Token you generated from Smart Software Manager or your On Prem Smart Software Manager.

After succesful registration, page may need to be refreshed to see the updated status.

Product Instance Registration Token

□ Re-register this product instance if it is already registered

Step 3 In the **Product Instance Registration Token** field, enter the registration token generated from your Smart Account. Make sure the token ID is accurate and within validity period. For more information, see https://www.cisco.com/c/en_in/products/software/smart-accounts/software-licensing.html.

Step 4 (Optional) If you are re-registering the application, check the **Re-register this product registration if it is already registered** checkbox.

Note After a backup restore or disaster restore operation, you must manually re-register the Cisco Crosswork VM to CSSM. This is applicable in case of a Cisco Crosswork VM that has been already registered while taking the backup which is used in the restore operations.

Step 5 Click **Register**. It may take a few minutes to process the registration. If successful, the 'Product Registration completed successfully' message is displayed.

The registration status and license authorization status will be updated as **Registered** and **Authorized** respectively.

Note

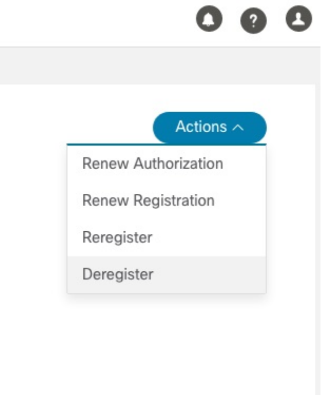
- If you encounter a registration error (for example, "`Communication send error`" or "`Invalid response from licensing cloud`"), please wait for some time and retry the registration. If the error persists after multiple attempts, please contact the Cisco Customer Experience team.
- If you encounter a communication timeout error during registration, click **OK** in the error dialog box and the application will reattempt the registration.
- In some cases, after successful registration, the page may need to be refreshed manually to see the updated status.

Manually Perform Licensing Actions

The renewal of registration and authorization are automatically enabled for Cisco Crosswork, by default. However, in the event of a communication failure between the application and the Cisco server, these actions can be manually initiated. You can use the **Actions** drop-down button to manually renew, re-register and de-register the application.

Note In the case of the Cisco Optimization Engine smart license, the node count is tracked during the initial onboarding of devices and during the registration and entitlement of the license. Any further changes to node count are synced with the Smart Licensing server after every 24 hours GMT. If you prefer not to wait, you can reregister the application license to update the node count immediately.

Step 1 In the **Smart License** window, click **Actions** drop-down button and select the relevant option for the following quick actions.



a) **Actions** > **Renew Authorization**: To renew the authorization manually if the automatic renewal service fails at the end of 30 days.
b) **Actions** > **Renew Registration**: To renew the registration manually if the automatic renewal service fails at the end of 6 months.
c) **Actions** > **Re-register**: Re-register the application, for example, on account of the expiry of registration tokens.
d) **Actions** > **De-register**: De-register the application, for example, when the transport settings need to be changed.

Note Once de-registered, the application will be moved to **Evaluation** mode (if evaluation period is available), or **Evaluation Expired** mode. For more information, see License Authorization Statuses, on page 273.

Step 2 The selected action is executed successfully.

License Authorization Statuses

Based on the registration status of your Cisco Crosswork application, you can see the following License Authorization Statuses.

Table 22: License Authorization Statuses

Registration Status	License Authorization Status	Description
Unregistered	Evaluation mode	A 90-day evaluation period during which the licensed features of the application can be freely used. This state is initiated when you use the application for the first time.
	Evaluation Expired	The application has not been successfully registered at the end of the evaluation period. During this state, the application features are disabled, and you must register to continue using the application.
	Registered Expired	The application is unable to contact the CSSM before the expiration of Identity Certificates and has returned to the unregistered state. The application resumes the remaining evaluation period, if available. At this stage, new registration ID token is required to reregister the application.
Registered	Authorized (In Compliance)	The application has been fully authorized to use the reserved licensed features. The authorization is automatically renewed every 30 days.
	Out of Compliance	The associated Virtual Account does not have enough licenses to reserve for the application's current feature use. You must renew the entitlement/usage limit registered with the token to continue using the application.
	Authorization Expired	The application is unable to communicate with the CSSM for 90 days or more, and the authorization has expired.

Manage Users

As a best practice, administrators should create separate accounts for all users. Prepare a list of the people who will use Cisco Crosswork. Decide on their user names and preliminary passwords, and create user profiles for them. During the creation of a user account, you assign a user role to determine the functionality to which the user will have access. If you will be using user roles other than "admin", create the user roles before you add your users (see Create User Roles, on page 277).

Step 1 From the main menu, select **Administration** > **Users and Roles** > **Users** tab. From this window, you can add a new user, edit the settings for an existing user, and delete a user.

Step 2 To add a new user:

a) Click ⊞ and enter the required user details.
b) Click **Save**.

Step 3 To edit a user:

a) Click the checkbox next to the User and click ✎.

b) After making changes, click **Save**.

Step 4 To delete a user:

a) Click the checkbox next to the User and click 🗑.
b) In the **Confirm Deletion** window, click **Delete**.

Step 5 To view audit log for a user:

a) Click the ⋯ icon under the **Actions** column, and select **Audit Log**.

The **Audit Log** window is displayed for the selected user name. For more information on the Audit Logs, see View Audit Log, on page 311.

Administrative Users Created During Installation

During installation, Crosswork creates two special administrative IDs:

1. The **virtual machine administrator**, with the username **`cw-admin`**, and the default password **`admin`**. Data center administrators use this ID to log in to and troubleshoot the VM hosting the Crosswork server.

2. The **Cisco Crosswork administrator**, with the username **`admin`** and the default password **`admin`**. Product administrators use this ID to log in to and configure the user interface, and to perform special operations, such as creating new user IDs.

The default password for both administrative user IDs must be changed the first time they are used. You can also change the Cisco Crosswork administrator password using the following methods:

- Log in as the admin user and edit the admin user password .
- Enter the following command: `admin(config)#` **`username admin`** *`<password>`*

User Roles, Functional Categories and Permissions

The **Roles** window lets users with the appropriate privileges define custom user roles. As with the default *admin* role, a custom user role consists of:

- A unique name, such as “Operator” or “admin”.
- One or more selected, named functional categories, which control whether or not a user with that role has access to the APIs needed to perform specific Cisco Crosswork functions controlled by that API.
- One or more selected permissions, which control the scope of what a user with that role can do in the functional category.

For a user role to have access to a functional category, that category and its underlying API must show as selected on the **Roles** page for that role. If the user role shows a functional category as unselected, then users with this role assigned will have no access to that functional area at all.

Some functional categories group multiple APIs under one category name. For example: The “AAA” category controls access to the Password Change, Remote Authentication Servers Integration, and Users and Role Management APIs. With this type of category, you can deny access to some of the APIs by leaving them unselected, while providing access to other APIs under the category by selecting them . For example: If you want to create an “Operator” role who is able to change his own password, but not see or change the settings for your installation’s integration with remote AAA servers, or create new users and roles, you would select the “AAA” category name, but uncheck the “Remote Authentication Server Integration API” and “Users and Role Management API” checkboxes.

For each role with a selected category, the **Roles** page also lets you define permissions to each underlying functional API:

- **Read** permission lets the user see and interact with the objects controlled by that API, but not change or delete them.
- **Write** permission lets the user see and change the objects controlled by that API, but not delete them.
- **Delete** permission gives the user role delete privileges over the objects controlled by that API. It is useful to remember that delete permission does not override basic limitations set by the Crosswork platform and it applications.

Although you can mix permissions as you wish:

- If you select an API for user access, you must provide at least “Read” permission to that API.
- When you select an API for user access, Cisco Crosswork assumes that you want the user to have all permissions on that API, and will select all three permissions for you, automatically.
- If you uncheck all of the permissions, including “Read”, Cisco Crosswork will assume that you want to deny access to the API, and unselect it for you.

Best Practices:

Cisco recommends that you follow these best practices when creating custom user roles:

- Restrict **Delete** permissions in roles for *admin* users with explicit administrative responsibility for maintenance and management of the Crosswork deployment as a whole.
- Roles for developers working with all the Cisco Crosswork APIs will need the same permissions as *admin* users.
- Apply at least **Read** and **Write** permissions in roles for users who are actively engaged in managing the network using Cisco Crosswork.
- Give read-only access to roles for users who only need to see Cisco Crosswork data to help their work as system architects or planners.

The following table describes some sample custom user roles you should consider creating:

Table 23: Sample custom user roles

Role	Description	Categories/API	Privileges
Operator	Active network manager, triggers Playbooks in response to KPI alerts	All	Read, Write
Monitor	Monitors alerts only	Health Insights, Inventory, Topology	Read only

Role	Description	Categories/API	Privileges
API Integrator	All	All	All

Note Admin role needs to include permissions for Read, Write, and Delete, while read-write roles need to include both Read and Write permissions. Using Zero Touch Provisioning features requires access to all ZTP APIs.

Create User Roles

Local users with administrator privileges can create new users as needed (see Manage Users, on page 274).

Users created in this way can perform only the functions or tasks that are associated with the user role they are assigned.

The local **admin** role enables access to all functionality. It is created during installation and cannot be changed or deleted. However, its privileges can be assigned to new local users. Only local users can create or update user roles; TACACS users cannot.

Follow the steps below to create a new user role.

Step 1 From the main menu, choose **Administration** > **Users and Roles** > **Roles** tab.

The **Roles** window has a **Roles** table on the left side and a corresponding **admin** table on the right side which shows the grouping of user permissions for the selected role.

Step 2 On the **Roles** table, click ⊞ to display a new role entry in the table.

Step 3 Enter a unique name for the new role.

Step 4 Define the user role's privilege settings:

a) Check the check box for every API that users with this role can access. The APIs are grouped logically based their corresponding application.

b) For each API, define whether the user role has **Read**, **Write**, and **Delete** permission by checking the appropriate check box. You can also select an entire API group (such as AAA), and all the APIs under the group will be selected with **Read**,**Write** and **Delete** permissions pre-selected.

Step 5 Click **Save** to create the new role.

To assign the new user role to one or more user IDs, edit the **Role** setting for the user IDs (see Edit User Roles, on page 278).

Clone User Roles

Cloning an existing user role is the same as creating a new user role, except that you need not set privileges for it. If you like, you can let the cloned user role inherit all the privileges of the original user role.

Cloning user roles is a handy way to create and assign many new user roles quickly. Following the steps below, you can clone an existing role multiple times. Defining the cloned user role's privileges is an optional step; you are only required to give the cloned role a new name. If you like, you can assign it a name that indicates the role you want a group of users to perform. You can then edit the user IDs of that group of users to assign them their new role (see Manage Users, on page 274). Later, you can edit the roles themselves to give users the privileges you want (see Edit User Roles, on page 278).

Step 1 From the main menu, choose **Administration** > **Users and Roles** > **Roles** tab.

Step 2 Click on an existing role.

Step 3 Click ⧉ to create a new duplicate entry in the **Roles** table with all the permissions of the original role.

Step 4 Enter a unique name for the cloned role.

Step 5 (Optional) Define the role's settings:

a) Check the check box for every API that the cloned role can access.

b) For each API, define whether the clone role has **Read**, **Write**, and **Delete** permission by checking the appropriate check box. You can also select an entire API group (such as AAA), and all the APIs under the group will be selected with **Read**,**Write** and **Delete** permissions pre-selected.

Step 6 Click **Save** to create the newly cloned role.

Edit User Roles

Users with administrator privileges can quickly change the privileges of any user role other than the default **admin** role.

Step 1 From the main menu, choose **Administration** > **Users and Roles** > **Roles** tab.

Step 2 In the **Roles** table, click on an existing role to select it. The **Admin** table on the right side displays the permission settings for the selected role.

Step 3 Define the role's settings:

a) Check the check box for every API that the role can access.

b) For each API, define whether the role has **Read**, **Write**, and **Delete** permission by checking the appropriate check box. You can also select an entire API group (such as AAA), and all the APIs under the group will be selected with **Read**,**Write** and **Delete** permissions pre-selected.

Step 4 When you are finished, click **Save**.

Delete User Roles

Users with administrator privileges can delete any user role that is not the default **admin** user role or that is not currently assigned to a user ID. If you want to delete a role that is currently assigned to one or more user IDs, you must first edit those user IDs to assign them to a different user role.

Step 1 From the main menu, choose **Administration** > **Users and Roles** > **Roles** tab.

Step 2 Click on the role you want to delete.

Step 3 Click 🗑.

Step 4 Click **Delete** to confirm that you want to delete the user role.

Manage Active Sessions

As an administrator, you can monitor and manage the active sessions in the Cisco Crosswork UI, and perform the following actions:

- Terminate a user session
- View user audit log

Note

- Non-admin users with permission to terminate can terminate their own sessions.
- Non-admin users with read-only permission can only collect the audit log for their sessions.
- Non-admin users without read permissions cannot view the **Active Sessions** window.

Step 1 From the main menu, choose **Administration** > **Users and Roles** > **Active Sessions**.

The **Active Sessions** tab displays all the active sessions in the Cisco Crosswork with details such as user name, login time, and login method.

Step 2 To terminate a user session, click the … icon under the **Actions** column, and select **Terminate Session**. A dialog box is displayed to confirm your action. Select **Terminate** to terminate the session.

Note You are recommended to use caution while terminating a session. A user whose session is terminated will not receive any prior warning and will lose any unsaved work.

Step 3 To view audit log for a user, click the … icon under the **Actions** column, and select **Audit Log**.

The **Audit Log** window is displayed for the selected user name. For more information on the Audit Logs, see View Audit Log, on page 311.

Set Up User Authentication (TACACS+ and LDAP)

In addition to supporting local users, Cisco Crosswork supports TACACS+ and LDAP users through integration with the TACACS+ and LDAP servers. The integration process has the following steps:

- Configure the TACACS+ and LDAP server.
- Create the roles that are referenced by the TACACS+ and LDAP users.
- Configure AAA settings.

Note

- The AAA server page works in bulk update mode wherein all the servers are updated in a single request. It is advised to give write permission for "Remote Authentication Servers Integration api" only to users who have the relevant authorization to delete the servers.
- A user with only Read and Write permissions (without 'Delete' permission) can delete the AAA server details from Cisco Crosswork since delete operations are part of 'Write' permissions. For more information, see Create User Roles, on page 277.
- While making changes to AAA servers (create/edit/delete), you are recommended to wait for few minutes between each change. Frequent AAA changes without adequate intervals can result in external login failures.

Manage TACACS+ Servers

Crosswork supports the use of TACACS+ servers to authenticate users.

Caution Please note that any operation you do following the instructions in this section will affect all new logins to the Crosswork user interface. To minimize session interruption, Cisco recommends that you perform all your TACACS+ changes and submit them in a single session.

Before you begin

You must create the required user role in TACACS+ server, before configuring the same in Cisco Crosswork. You can integrate Crosswork with an application such as Cisco ISE (Identity Service Engine) to authenticate using the TACACS+ protocols. To avail this service, you must configure Crosswork as a client in Cisco ISE. For more information, see the Cisco Identity Services Engine Administrator Guide.

Step 1 From the main menu, select **Administration** > **AAA** > **Servers** > **TACACS+** tab. From this window, you can add, edit settings, and delete a new TACACS+ server.

Step 2 **To add a new TACACS+ server**:

a) Click the ⊞ icon.

b) Enter the required TACACS+ server information.

Note

- You can specify a unique priority value to assign precedence in the authentication request.
- For Crosswork to communicate with the external authentication server, the **Shared Secret** parameter you enter on this page must match with the shared secret value configured on the TACACS+ server.

c) Select the authentication type.

- PAP: Password-based authentication is the protocol where two entities share a password in advance and use the password as the basis of authentication.

- CHAP: Challenge-Handshake Authentication Protocol requires that both the client and server know the plain text of the secret, although it is never sent over the network. CHAP provides greater security than Password Authentication Protocol (PAP).

d) After you enter all the relevant details, click **Add**.

Note The **Policy ID** field corresponds to the user role that you created in the TACACS+ server. If you try to login to Cisco Crosswork as a TACACS+ user before creating the required user role, you will get the error message: `"Key not authorized: no matching policy"`. If this occurs, close the browser. Login as a local admin user and create the missing user roles in the TACACS+ server, and login back to Crosswork using the TACACS+ user credentials.

e) Click **Save All Changes**. You will be prompted with a warning message about restarting the server to update the changes. Click **Save Changes** to confirm.

Step 3 **To edit a TACACS+ server**:

a) Click the checkbox next to the TACACS+ server and click ✎.
b) After making changes, click **Update**.

Step 4 **To delete a TACACS+ server**:

a) Click the checkbox next to the TACACS+ server and click 🗑. The Delete *server-IP-address* dialog box opens.
b) Click **Delete** to confirm.

Manage LDAP Servers

Lightweight Directory Access Protocol (LDAP) is a server protocol used to access and manage directory information. Crosswork supports the use of LDAP servers (OpenLDAP, Active Directory, and secure LDAP) to authenticate users. It manages directories over IP networks and runs directly over TCP/IP using simple string formats for data transfer.

To use secure LDAP protocol, you must add **Secure LDAP Communication** certificate before adding the LDAP server. For more details on adding certificates, see Add a New Certificate, on page 264.

⚠

Caution Please note that any operation you do following the instructions in this section will affect all new logins to the Crosswork user interface. To minimize session interruption, Cisco recommends that you perform all your LDAP server changes and submit them in a single session.

Step 1 From the main menu, select **Administration** > **AAA** > **Servers** > **LDAP** tab. Using this window, you can add, edit settings, and delete a new LDAP server.

Step 2 **To add a new LDAP server**:

a) Click the + icon.
b) Enter the required LDAP server details.

Note

- Like TACACS+ server, you can specify a unique priority value to assign precedence in the authentication request.
- To add a secure LDAP server, enable the **Secure Connection** toggle button and select the relevant secure LDAP certicate from the **Certificate** drop-down list.
- The **Policy ID** field corresponds to the user role that you created in the LDAP server. If you try to login to Cisco Crosswork as a LDAP user before creating the required user role, you will get the error message: `"Login failed, policy not found. Please contact the Network Administrator for assistance."`. To avoid this error, ensure to create the relevant user roles in the LDAP server, before setting up a new LDAP server in Crosswork.

c) Click **Add**.

d) Click **Save All Changes**. You will be prompted with a warning message about restarting the server to update the changes. Click **Save Changes** to confirm.

Step 3 **To edit a LDAP server**:

a) Click the checkbox next to the LDAP server and click ✎.

b) After making changes, click **Update**.

Step 4 **To delete a LDAP server**:

a) Click the checkbox next to the LDAP server and click 🗑.

b) Click **Delete** to confirm.

Configure AAA Settings

Users with relevant AAA permissions can configure the AAA settings.

Step 1 From the main menu, choose **Administration** > **AAA** > **Settings**.

Step 2 Select the relevant setting for **Fallback to Local**. By default, Crosswork prefers external authentication servers over local database authentication.

Note Admin users are always authenticated locally.

Step 3 Select the relevant value for the **Logout All Idle Users After** field. Any user who remains idle beyond the specified limit will be automatically logged out.

Note The default timeout value is 30 minutes. If the timeout value is adjusted, the page will refresh to apply the change.

Step 4 Enter a relevant value for the **Number of Parallel Sessions**.

Note Crosswork supports between 5 to 200 parallel session for concurrent users. If the number of parallel sessions are exceeded, an error is displayed while logging in to Crosswork.

Step 5 Select the relevant settings for the **Local Password Policy**. Certain password settings are enabled by default and cannot be disabled (for example, Change password on first login).

Note Any changes in the password policy is enforced only the next time when the users change their password. Existing passwords are not checked for compliance during login.

Note **Local Password Policy** allows administrators to configure the number of unsuccessful login attempts a user can make before they are locked out of Cisco Crosswork, and the lockout duration. Users can attempt to login with the correct credentials once the wait time is over.

Security Hardening Overview

Security hardening entails making adjustments to ensure that the following components optimize their security mechanisms:

- Cisco Crosswork infrastructure
- Cisco Crosswork storage system (local or external)

Hardening Cisco Crosswork security requires completion of the following tasks:

- Shutting down insecure and unused ports
- Configuring network firewalls
- Hardening the Cisco Crosswork infrastructure, as needed

Although your primary source of information is your Cisco representative, who can provide server hardening guidance specific to your deployment, you can also follow the steps in this section to secure Cisco Crosswork.

Authentication Throttling

Cisco Crosswork throttles the login attempts after a failed login attempt to avoid password guessing and other related abuse scenarios. After a failed login attempt for a username, all authentication attempts for that username would be blocked for 3 seconds. The throttling is applicable to all supported authentication schemes such as TACACS, LDAP and the default local authentication.

Core Security Concepts

If you are an administrator and are looking to optimize the security of your Cisco Crosswork product, you should have a good understanding of the following security concepts.

HTTPS

Hypertext Transfer Protocol Secure (HTTPS) uses Secure Sockets Layer (SSL) or its subsequent standardization, Transport Layer Security (TLS), to encrypt the data transmitted over a channel. Several vulnerabilities have been found in SSL, so Cisco Crosswork now supports TLS only.

Note TLS is loosely referred to as SSL often, so we will also follow this convention.

SSL employs a mix of privacy, authentication, and data integrity to secure the transmission of data between a client and a server. To enable these security mechanisms, SSL relies upon certificates, private-public key exchange pairs, and Diffie-Hellman key agreement parameters.

X.509 Certificates

X.509 certificates and private-public key pairs are a form of digital identification for user authentication and the verification of a communication partner's identity. Certificate Authorities (CAs), such as VeriSign and Thawte, issue certificates to identify an entity (either a server or a client). A client or server certificate includes the name of the issuing authority and digital signature, the serial number, the name of the client or server that the certificate was issued for, the public key, and the certificate's expiration date. A CA uses one or more signing certificates to create SSL certificates. Each signing certificate has a matching private key that is used to create the CA signature. The CA makes signed certificates (with the public key embedded) readily available, enabling anyone to use them to verify that an SSL certificate was actually signed by a specific CA.

In general, setting up certificates in both High Availability (HA) and non-HA environments involves the following steps:

1. Generating an identity certificate for a server.
2. Installing the identity certificate on the server.
3. Installing the corresponding root certificate on your client or browser.

The specific tasks you need to complete will vary depending on your environment.

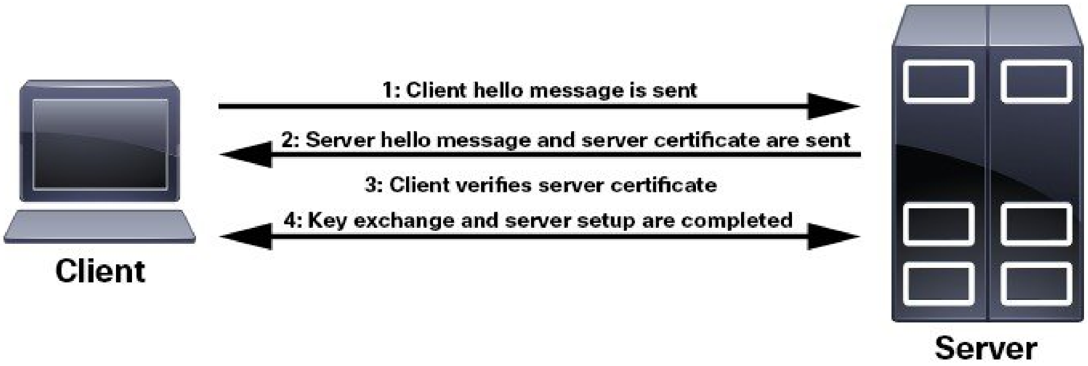
Note the following:

- The start-stop sequencing of servers needs to be done carefully in HA environments.
- Non-HA environments, where a virtual IP address is configured, require the completion of a more complicated certificate request process.

1-Way SSL Authentication

This authentication method is used when a client needs assurance that it is connecting to the right server (and not an intermediary server), making it suitable for public resources like online banking websites. Authentication begins when a client requests access to a resource on a server. The server on which the resource resides then sends its server certificate (also known as an SSL or x.509 certificate) to the client in order to verify its identity. The client then verifies the server certificate against another trusted object: a server root certificate, which must be installed on the client or browser. After the server has been verified, an encrypted (and therefore secure) communication channel is established. At this point, the Cisco Crosswork server prompts for the entry of a valid username and password in an HTML form. Entering user credentials after an SSL connection is established protects them from being intercepted by an unauthorized party. Finally, after the username and password have been accepted, access is granted to the resource residing on the server.

Note A client might need to store multiple server certificates to enable interaction with multiple servers.


1: Client hello message is sent
2: Server hello message and server certificate are sent
3: Client verifies server certificate
4: Key exchange and server setup are completed
Client
Server

To determine whether you need to install a root certificate on your client, look for a lock icon in your browser's URL field. If you see this icon, this generally indicates that the necessary root certificate has already been installed. This is usually the case for server certificates signed by one of the bigger Certifying Authorities (CAs), because root certificates from these CAs are included with popular browsers.

If your client does not recognize the CA that signed a server certificate, it will indicate that the connection is not secure. This is not necessarily a bad thing. It just indicates that the identity of the server you want to connect has not been verified. At this point, you can do one of two things: First, youYou can install the necessary root certificate on your client or browser. A lock icon in your browser's URL field will indicate the certificate was installed successfully. And second, you can install a self-signed certificate on your client. Unlike a root certificate, which is signed by a trusted CA, a self-signed certificate is signed by the person or entity that created it. While you can use a self-signed certificate to create an encrypted channel, understand that it carries an inherent amount of risk because the identity of the server you are connected with has not been verified.

Disable Insecure Ports and Services

As a general policy, any ports that are not needed should be disabled. You need to first know which ports are enabled, and then decide which of these ports can be safely disabled without disrupting the normal functioning of Cisco Crosswork. You can do this by listing the ports that are open and comparing it with a list of ports needed for Cisco Crosswork.

To view a list of all open listening ports:

Step 1 Log in as a Linux CLI admin user and enter the **netstat -aln** command.
The **netstat -aln** command displays the server's currently open (enabled) TCP/UDP ports, the status of other services the system is using, and other security-related configuration information. The command returns output similar to the following:

```
[root@vm ~]# netstat -aln
Active Internet connections (servers and established)
Proto  Recv-Q   Send-Q   Local Address           Foreign Address         State
tcp    0        0        0.0.0.0:111             0.0.0.0:*               LISTEN
tcp    0        0        127.0.0.1:8080          0.0.0.0:*               LISTEN
tcp    0        0        0.0.0.0:22              0.0.0.0:*               LISTEN
tcp    0        0        127.0.0.1:25            0.0.0.0:*               LISTEN
tcp    0        0        127.0.0.1:10248         0.0.0.0:*               LISTEN
tcp    0        0        127.0.0.1:10249         0.0.0.0:*               LISTEN
tcp    0        0        192.168.125.114:40764   192.168.125.114:2379    ESTABLISHED
tcp    0        0        192.168.125.114:48714   192.168.125.114:10250   CLOSE_WAIT
tcp    0        0        192.168.125.114:40798    192.168.125.114:2379    ESTABLISHED
tcp    0        0        127.0.0.1:33392          127.0.0.1:8080          TIME_WAIT
tcp    0        0        192.168.125.114:40814    192.168.125.114:2379    ESTABLISHED
tcp    0        0        192.168.125.114:40780    192.168.125.114:2379    ESTABLISHED
tcp    0        0        127.0.0.1:8080           127.0.0.1:44276         ESTABLISHED
tcp    0        0        192.168.125.114:40836    192.168.125.114:2379    ESTABLISHED
tcp    0        0        192.168.125.114:40768    192.168.125.114:2379    ESTABLISHED
tcp    0        0        127.0.0.1:59434          127.0.0.1:8080          ESTABLISHED
tcp    0        0        192.168.125.114:40818    192.168.125.114:2379    ESTABLISHED
tcp    0        0        192.168.125.114:22       192.168.125.1:45837     ESTABLISHED
tcp    0        0        127.0.0.1:8080           127.0.0.1:48174         ESTABLISHED
tcp    0        0        127.0.0.1:49150          127.0.0.1:8080          ESTABLISHED
tcp    0        0        192.168.125.114:40816    192.168.125.114:2379    ESTABLISHED
tcp    0        0        192.168.125.114:55444    192.168.125.114:2379    ESTABLISHED
```

Step 2 Check the for the table of ports used by Cisco Crosswork, and see if your ports are listed in that table. That table will help you understand which services are using the ports, and which services you do not need—and thus can be safely disabled. In this case, *safe* means you can *safely disable the port without any adverse effects to the product*.

Note If you are not sure whether you should disable a port or service, contact your Cisco representative.

Step 3 If you have firewalls in your network, configure the firewalls to only allow traffic that is needed for Cisco Crosswork to operate.

Harden Your Storage

We recommend that you secure all storage elements that will participate in your Cisco Crosswork installation, such as the database, backup servers, and so on.

- If you are using external storage, contact your storage vendor and your Cisco representative.
- If you are using internal storage, contact your Cisco representative.
- If you ever uninstall or remove Cisco Crosswork, make sure that all VM-related files that might contain sensitive data are digitally shredded (as opposed to simply deleted). Contact your Cisco representative for more information.

Configure System Settings

Administrator users can configure the following system settings:

Configure a Syslog Server

Crosswork allows external syslog consumers to:

- Register on Crosswork and receive system events as syslogs.
- Define and filter which kind of events should be forwarded as a syslog, per consumer.
- Define the rate of which syslogs are forwarded to the consumer.

Note After the Syslog TLS server certificate is added, wait for 5-10 minutes before configuring the syslog server.

Before you begin

Ensure that you have uploaded the Syslog TLS server certificate. For more information, see Add a New Certificate, on page 264.

Step 1 From the main menu, choose **Administration** > **Settings** > **System Settings** tab.

Step 2 Under **Server**, click the **Syslog Configuration** option.

Step 3 Click ⊞.

Step 4 Enter Syslog configuration details. For more information, click ⓘ next to each option.

Use the **Criteria** option to define scope and range of which kind of events should be forwarded as a syslog. For example: **(EventSeverity<2 or EventSeverity>=5) and OriginAppId=capp-infra and EventCategory=1**

The expression will send events as a syslog only if the event originates from the Infrastructure Platform, the category is the system, and the severity is either less than 2 or is equal or above 5.

Caution Expressions are freeform and not validated.

Step 5 Click **Save**.

Configure a Trap Server

Follow the procedure below to manage Trap Servers from the Settings window:

Step 1 From the main menu, choose **Administration** > **Settings** > **System Settings** tab.

Step 2 Under **Server**, click the **Trap servers** option.

Step 3 Click ⊞.

Step 4 Enter Trap server details. For more information, click ⓘ next to each option.

Use the **Criteria** option to define scope and range of which kind of events should be forwarded as a trap.

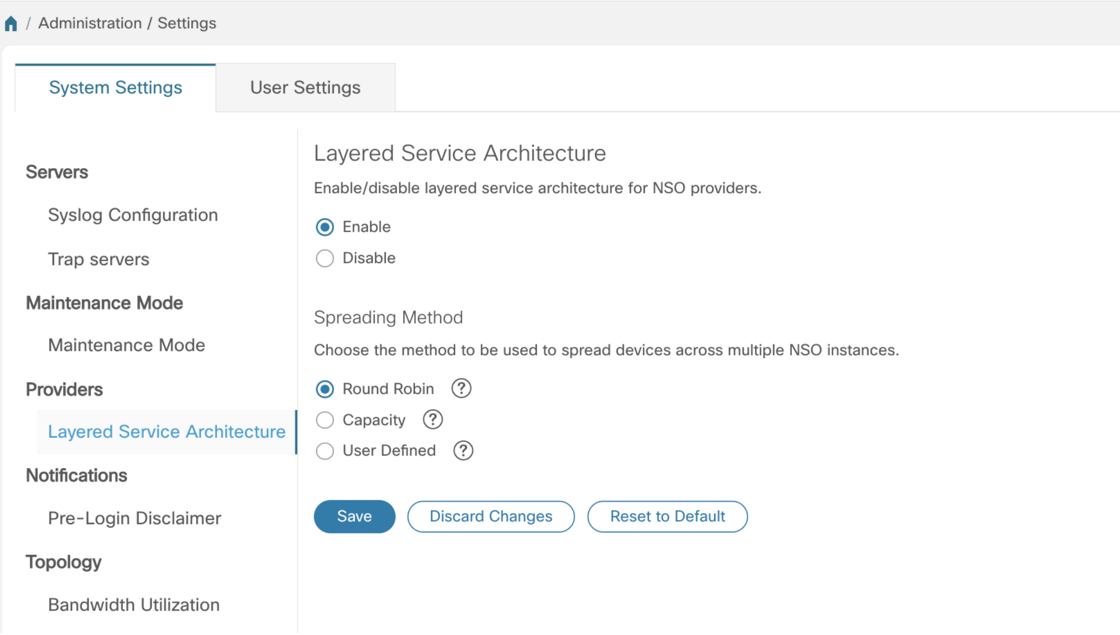
Click **Events and Alarms examples** for more information on the attributes used to raise an event.

Step 5 After entering all the relevant information, click **Add**.

Enable Layered Service Architecture (LSA)

This procedure is applicable only when you have opted for Cisco NSO LSA deployment to add arbitrarily many device nodes for improved memory and provisioning throughput.

Step 1 From the main menu, select **Administration** > **Settings** > **System Settings** > **Layered Service Architecture**.



Layered Service Architecture

Enable/disable layered service architecture for NSO providers.

● Enable
○ Disable

Spreading Method

Choose the method to be used to spread devices across multiple NSO instances.

● Round Robin ?
○ Capacity ?
○ User Defined ?

Step 2 Select **Enable**.

Step 3 Select the method to spread the devices across multiple NSO instances:

- **Round Robin** - Even distribution of devices to RFS nodes in a cyclical manner (for example, Device 1 to RFS1, Device 2 to RFS2, and so on).
- **Capacity** - The number of devices are assigned to each RFS instance based on its total capacity.
- **User Defined** - Devices are assigned to the NSO providers specified for the device in the device settings. For more information, see Add Devices Through the UI, on page 158.

Step 4 Click **Save**.

Note Once you have saved the settings, you cannot disable it without removing all the NSO providers.

Set the Pre-Login Disclaimer

Many organizations require that their systems display a disclaimer message in a banner before users log in. The banner may remind authorized users of their obligations when using the system, or provide warnings to unauthorized users. You can enable such a banner for Crosswork users, and customize the disclaimer message as needed.

Step 1 From the main menu, choose **Administration** > **Settings** > **System Settings** tab.

Step 2 Under **Notifications**, click the **Pre-Login Disclaimer** option.

Step 3 To enable the disclaimer and customize the banner:

a) Check the **Enabled** checkbox.

b) Customize the banner **Title**, the **Icon**, and the **Disclaimer Text** as needed.

c) Optional: While editing the disclaimer, you can

Click **Preview** to see how your changes will look when displayed before the Crosswork login prompt.

Click **Discard Changes** to revert to the last saved version of the banner.

Click **Reset** to revert to the original, default version of the banner.

d) When you are satisfied with your changes, click **Save** to save them and enable display of the custom disclaimer to all users.

Step 4 To turn off the disclaimer display: Select **Administration** > **Settings** > **System Settings** > **Pre-Login Disclaimer**, then uncheck the **Enabled** checkbox.

Manage File Server Settings

Cisco Crosswork provides secure file transfer services (FTP and SFTP) for Crosswork applications that need them. They are disabled by default.

Note This feature is currently only supported for the EPNM application. For more information about the enabling scenarios, please refer to the EPNM user documentation.

Step 1 To enable FTP server:

a) From the main menu, choose **Administration** > **Settings** > **System Settings** > **File Servers**

b) Under FTP, select on the **Enable** radio button.

c) Click **Save** to save your settings.

Step 2 To enable SFTP server:

a) From the main menu, choose **Administration** > **Settings** > **System Settings** > **File Servers**

b) Drag the **Enable Server Upload** slider to **On** position.

Caution SFTP supports upload option that allows write access to the Cisco Crosswork storage from the outside. You are recommended to use caution while enabling the upload, and it should be disabled as soon as it is no longer needed.

c) Click **Save** to save your settings.

CHAPTER 10

Manage System Health

This section contains the following topics:

Monitor System and Application Health

The Crosswork Platform is built on an architecture consisting of microservices. Due to the nature of these microservices, there are dependencies across various services within the Crosswork system. The system and applications are considered Healthy if all services are up and running. If one or more services are down, then the health is considered Degraded. If all services are down, then the health status is Down.

From the main menu, choose **Crosswork Manager** to access the **Crosswork Summary** and **Crosswork Health** windows. Each window provides various views to monitor system and application health. It also supplies tools and information that, with support and guidance from your Cisco Customer Experience account team, you can use to identify, diagnose, and fix issues with the Cisco Crosswork cluster, Platform Infrastructure, and installed applications.

While both windows can give you access to the same type of information, the purpose of each summary and view is different.

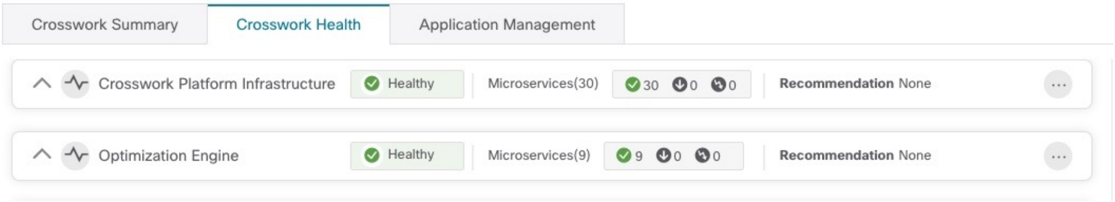
Monitor Cluster Health

At a glance, the **Crosswork Summary** window (**Crosswork Manager** > **Crosswork Summary**) shows a summary of the overall system health. The main purpose of the **Crosswork Summary** window is to view Crosswork Cluster health in terms of hardware resources and VMs. For example, prior to installing or upgrading applications, you may want to check if the hardware resources are healthy and the VMs are running well. After clicking the **Crosswork Cluster** tile, you can visually see resource utilization and drill down on VMs to perform some VM or cluster-related activities. In another case, you may see degrading services or over utilization of hardware resources. At this point, from a hardware point of view, you might find that the number of VMs in the system is insufficient prompting you to add more VMs to scale the system further out. For more information, see Check Cluster Health, on page 8.

In addition to accessing Crosswork Cluster health, you can click on the **Cisco Crosswork Platform Infrastructure** and application tiles to view more details such as microservices and alarms.

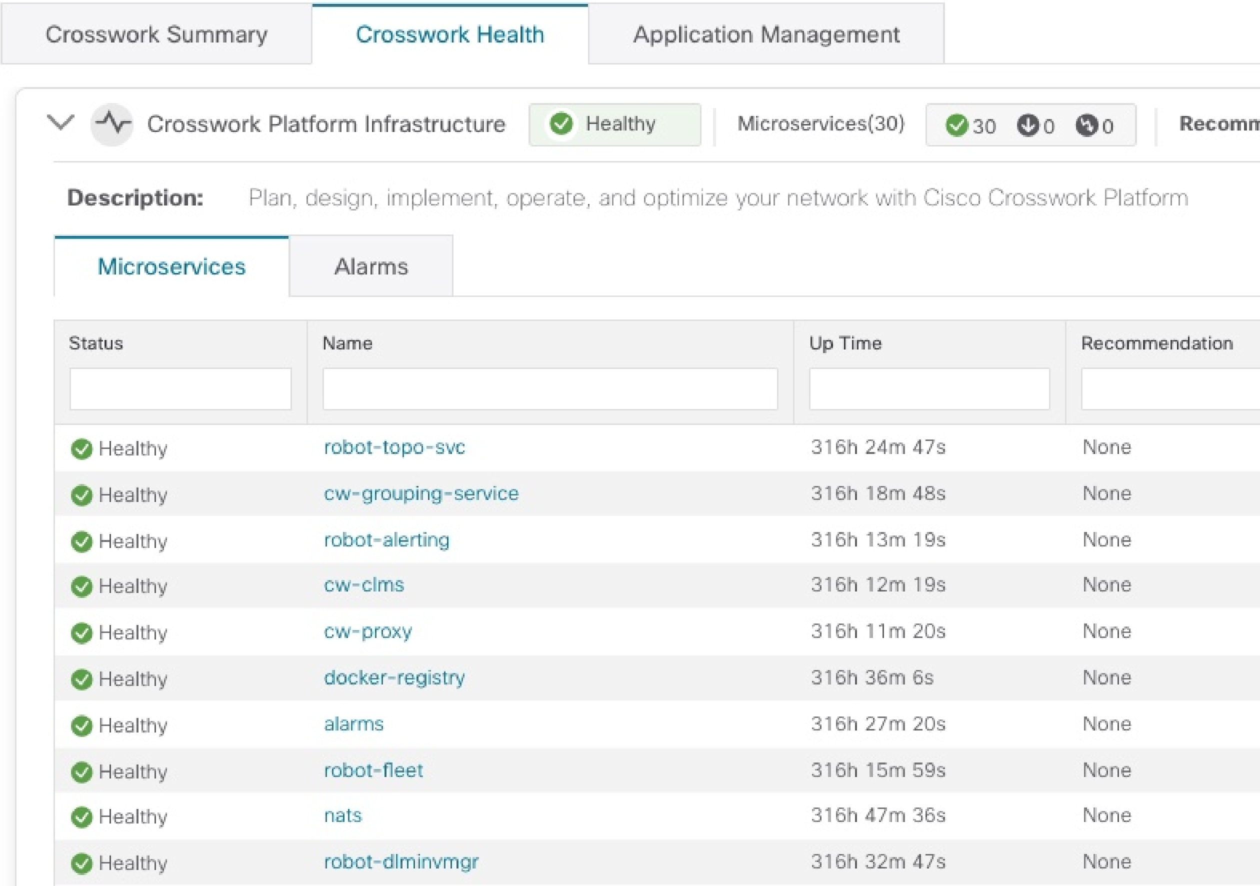
Monitor Platform Infrastructure and Application Health

The **Crosswork Health** window (**Crosswork Manager** > **Crosswork Health** tab) provides health summaries for the Cisco Crosswork Platform Infrastructure and installed applications with the addition of microservice status details.



Crosswork Platform Infrastructure	Healthy	Microservices(30)	✓30 0 0	Recommendation None
Optimization Engine	Healthy	Microservices(9)	✓9 0 0	Recommendation None

Within this window, expand an application row to view Microservice and Alarm information.



Description: Plan, design, implement, operate, and optimize your network with Cisco Crosswork Platform

Status	Name	Up Time	Recommendation
Healthy	robot-topo-svc	316h 24m 47s	None
Healthy	cw-grouping-service	316h 18m 48s	None
Healthy	robot-alerting	316h 13m 19s	None
Healthy	cw-clms	316h 12m 19s	None
Healthy	cw-proxy	316h 11m 20s	None
Healthy	docker-registry	316h 36m 6s	None
Healthy	alarms	316h 27m 20s	None
Healthy	robot-fleet	316h 15m 59s	None
Healthy	nats	316h 47m 36s	None
Healthy	robot-dlminvmgr	316h 32m 47s	None

From the **Microservices** tab:

- View the list of microservices and, if applicable, associated microservices by clicking on the microservice name.
- Click ⋯ to restart or obtain Showtech data and logs per microservice.

Note Showtech logs must be collected separately for each application.

From the **Alarms** tab:

- Click the alarm description to drill down on alarm details.
- Acknowledge, change status, and add notes to alarms.

You can also download *all* of a Cisco Crosswork application or Cisco Crosswork Platform Showtech service logs and perform installation-related operations from the **Application Details** window. Click ⋯ to open the **Application Details** window.

Visually Monitor System Functions in Real Time

You can monitor the health of Cisco Crosswork and any of its functions in real time, using a set of monitoring dashboards you can access from the **Crosswork Manager** window.

Cisco Crosswork uses Grafana to create these dashboards. They give you a graphical view of the product's infrastructure, using metrics collected in its database. You can use these dashboards to diagnose problems you may encounter with individual Cisco Crosswork applications or their underlying services.

There are multiple monitor dashboards, categorized by the type of functionality they monitor and the metrics they provide. The following table lists some categories that may be available depending on whichCisco Crosswork applications are installed.

Table 24: Monitoring Dashboard Categories

This dashboard category...	Monitors...
Change Automation	Playbook functions. Metrics include the number of MOP jobs executed, response latency, API calls, database activity, and so on.
Optima	Feature pack, traffic, and SR-PCE dispatcher functions.
Collection - Manager	Device-data collection functions. Metrics include telemetry collection latencies, total collection operations, memory and database activity related to telemetry, delayed collections, and so on.
Health Insights	Key Performance Indicator functions. Metrics include the number of KPI alerts, API calls, and so on.
Infra	System infrastructure messaging and database activity.
Inventory	Inventory manager functions. These metrics include total numbers of inventory change activities.
Platform	System hardware and communications usage and performance. Metrics include disk and CPU usage, database size, network and disk operations, and client/server communications.
ZTP	Zero Touch Provisioning functions.

To conserve disk space, Cisco Crosswork maintains a maximum of 24 hours of collected metric data.

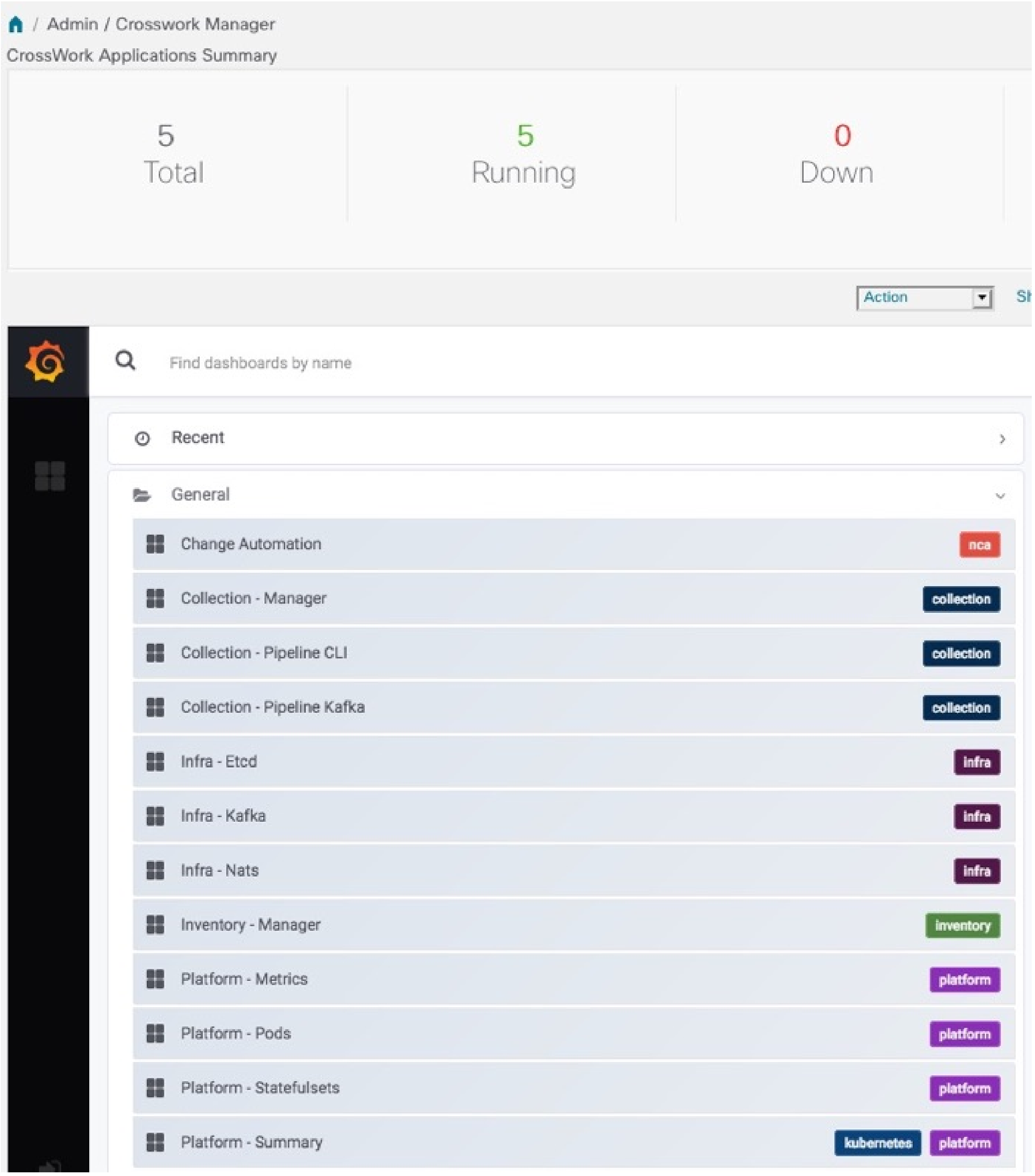
Grafana is an open-source visualization tool. The following provides general information about how to use the Cisco Crosswork implementation of Grafana. For more information about Grafana itself, see https://grafana.com and http://docs.grafana.org

Step 1 From the main menu, choose **Administration** > **Crosswork Manager** > **Crosswork Cluster**.

Step 2 At the top right, click **View more visualizations**.

The Grafana user interface appears.

Step 3 In the Grafana user interface, click **Home**. Grafana displays the list of monitoring dashboards and their categories, as shown in the following example.



Admin / Crosswork Manager

CrossWork Applications Summary

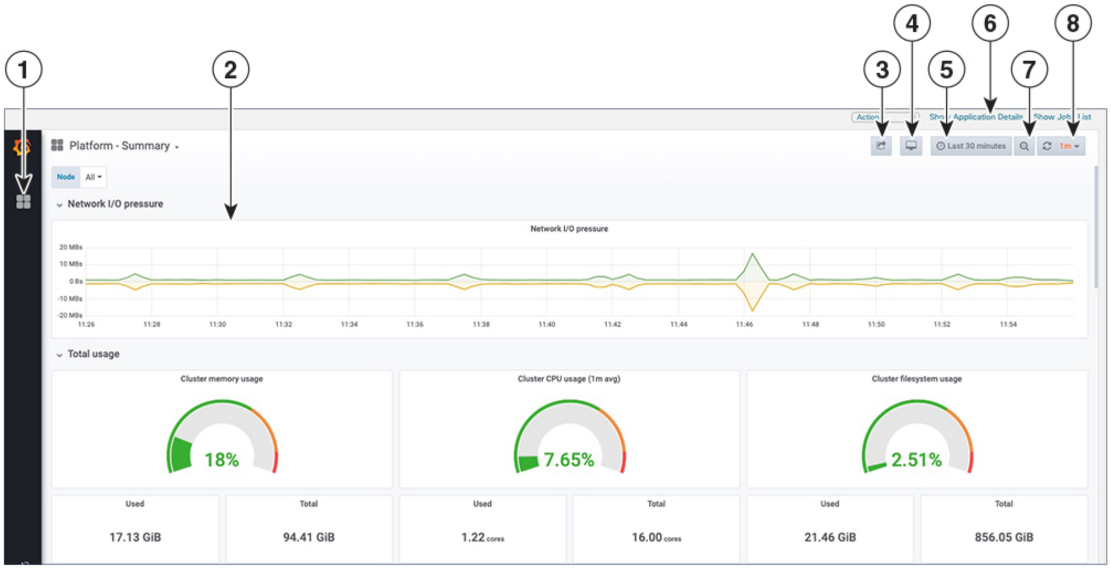
5 Total

5 Running

0 Down

Change Automation	nca
Collection - Manager	collection
Collection - Pipeline CLI	collection
Collection - Pipeline Kafka	collection
Infra - Etcd	infra
Infra - Kafka	infra
Infra - Nats	infra
Inventory - Manager	inventory
Platform - Metrics	platform
Platform - Pods	platform
Platform - Statefulsets	platform
Platform - Summary	kubernetes platform

Step 4 Click the the dashboard you want to view. For example: Clicking on **Platform - Summary** dashboard displays a view like the one shown in the following figure.



Step 5 Scroll the dashboard as needed to display all of the metrics it provides, or select any of the functions described in the following table.

Item	Description
1	**Dashboard Icon**: Click the icon to re-display the dashboard list and select a different dashboard.
2	**Time Series Graph Zoom**: You can zoom in on a specific time period within the graph of any time series data, as follows: **a.** Click a time-period starting point in the graph line and hold down the mouse. **b.** Drag the cursor to the endpoint. Light gray shading will appear in the block you are selecting. When you reach the endpoint, release the mouse. To reset a zoomed time series graph to the default, click the **Zoom Out icon**.
3	**Share Dashboard icon**: Click the icon to make the dashboard you are viewing shareable with other users. Clicking this icon displays a popup window with tabs and options to share the dashboard in your choice of these forms: • **URL Link**: Click the **Link** tab and then click **Copy** to copy the dashboard's URL to your clipboard. You can also choose whether to retain the current time and template settings with the URL. • **Local Snapshot File**: Click the **Snapshot** tab and then click **Local Snapshot**. Grafana creates a local snapshot of the dashboard on the server. When the snapshot is ready, click **Copy Link** to copy the URL of the snapshot to your clipboard. • **Export to JSON File**: Click the **Export** tab and then click **Save to file**. You will be prompted to save or open the exported JSON file. You can also choose to turn data source names in the file into templates by selecting the **Export for sharing externally** checkbox before clicking **Save to file**. • **View JSON File and Copy to Clipboard**: Click the **Export** tab and then click **View JSON** (you can choose to templatize data source names by selecting the **Export for sharing externally** checkbox before clicking **View JSON**). Grafana displays the exported JSON code in a popup window. Click **Copy to Clipboard** to copy the file to your clipboard.

Item	Description
4	**Cycle View Mode icon**: Click this icon to toggle between the default Grafana **TV** view mode and the **Kiosk** mode. The **Kiosk** view hides most of the Grafana menu. Press **Esc** to exit the **Kiosk** view.
5	**Time/Refresh Selector**: Indicates the time period for the metrics displayed in the dashboard and how often the metrics are refreshed. Click the selector to choose a different time range and refresh rate. You can specify a custom pair of time-range start and end points, or choose from one of several predefined ranges, such as **Today so far** or **Last three hours**. You can choose predefined refresh rates from **Off** to **2 Days**. When you have finished making changes, click **Apply**. When making selections, remember only 24 hours of data is stored. If you select time ranges or refresh rates beyond that limit, the dashboard may be blank.
6	**Zoom Out icon**: Click this icon to reset a zoomed time series graph back to the unzoomed state.
7	**Refresh icon**: Immediately or choose time interval to refresh the data shown.

Check System Health Example

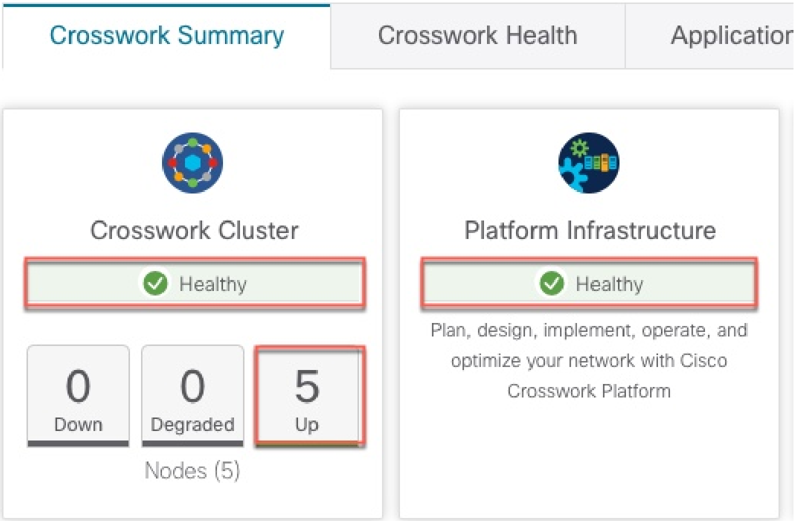
In this example, we navigate through the various windows and what areas should be checked for a healthy Crosswork system.

Step 1 Check overall system health.

a) From the main menu, choose **Administration** > **Crosswork Manager** > **Crosswork Summary** tab.

b) Check that all the nodes are in Operational state (Up) and that the Crosswork Cluster and Platform Infrastructure is Healthy.

Figure 68: Crosswork Summary



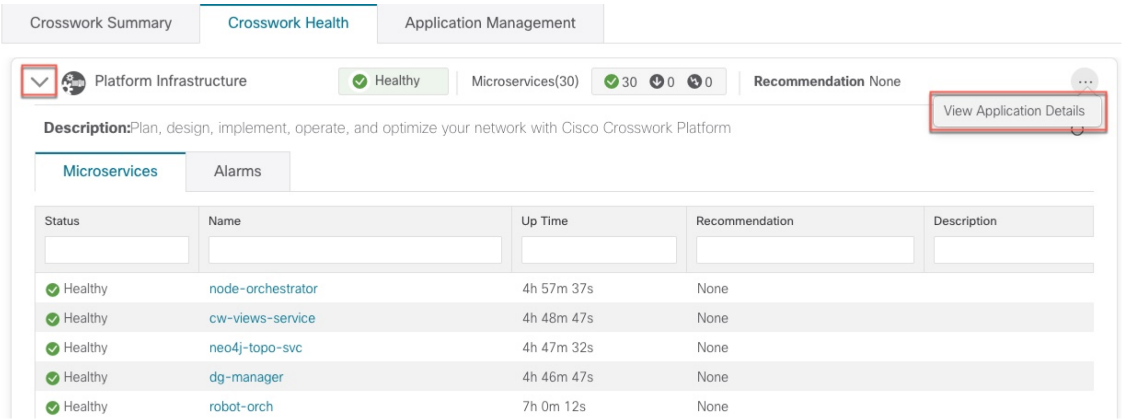
Plan, design, implement, operate, and optimize your network with Cisco Crosswork Platform

Step 2 Check and view detailed information about the microservices that are running as part of the Crosswork Platform Infrastructure.

a) Click the **Crosswork Health** tab.

b) Expand the Crosswork Platform Infrastructure row, click ⋯, and select **Application Details**.

Figure 69: Crosswork Health

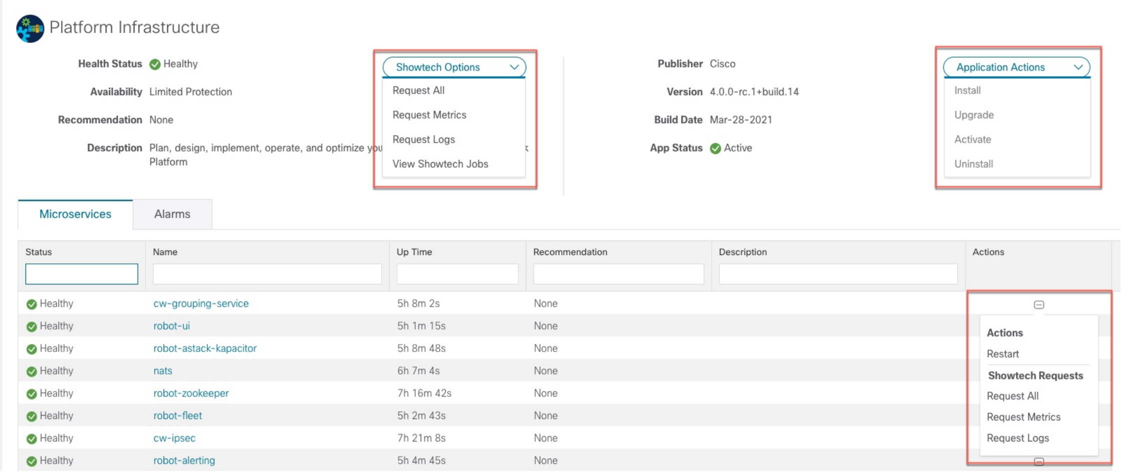


Description: Plan, design, implement, operate, and optimize your network with Cisco Crosswork Platform

Status	Name	Up Time	Recommendation	Description
✓ Healthy	node-orchestrator	4h 57m 37s	None	
✓ Healthy	cw-views-service	4h 48m 47s	None	
✓ Healthy	neo4j-topo-svc	4h 47m 32s	None	
✓ Healthy	dg-manager	4h 46m 47s	None	
✓ Healthy	robot-orch	7h 0m 12s	None	

c) From the **Application Details** window, you can check and review microservice details, restart microservices, and collect showtech information. You can also perform installation-related tasks from this window.

Figure 70: Application Details



Health Status Healthy

Availability Limited Protection

Recommendation None

Description Plan, design, implement, operate, and optimize you Platform

Publisher Cisco

Version 4.0.0-rc.1+build.14

Build Date Mar-28-2021

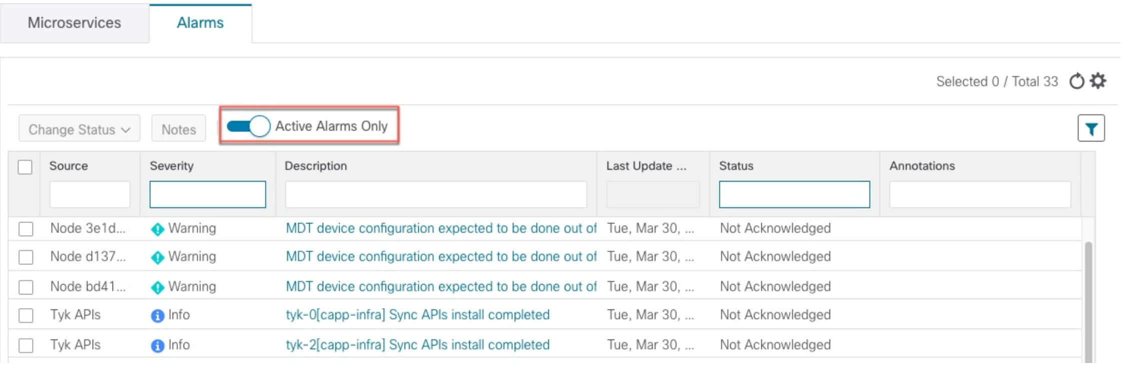
App Status Active

Status	Name	Up Time	Recommendation	Description	Actions
Healthy	cw-grouping-service	5h 8m 2s	None		
Healthy	robot-ui	5h 1m 15s	None		
Healthy	robot-astack-kapacitor	5h 8m 48s	None		
Healthy	nats	6h 7m 4s	None		
Healthy	robot-zookeeper	7h 16m 42s	None		
Healthy	robot-fleet	5h 2m 43s	None		
Healthy	cw-ipsec	7h 21m 8s	None		
Healthy	robot-alerting	5h 4m 45s	None		

Step 3 Check and view alarms related to the microservices.

a) Click the **Alarms** tab. The list only displays Crosswork Platform Infrastructure alarms. You can further filter the list by viewing only active alarms.

Figure 71: Alarms



Selected 0 / Total 33

☐	Source	Severity	Description	Last Update ...	Status	Annotations
☐	Node 3e1d...	Warning	MDT device configuration expected to be done out of	Tue, Mar 30, ...	Not Acknowledged	
☐	Node d137...	Warning	MDT device configuration expected to be done out of	Tue, Mar 30, ...	Not Acknowledged	
☐	Node bd41...	Warning	MDT device configuration expected to be done out of	Tue, Mar 30, ...	Not Acknowledged	
☐	Tyk APIs	Info	tyk-0[capp-infra] Sync APIs install completed	Tue, Mar 30, ...	Not Acknowledged	
☐	Tyk APIs	Info	tyk-2[capp-infra] Sync APIs install completed	Tue, Mar 30, ...	Not Acknowledged	

Step 4 View which Crosswork applications are installed.

a) From the main menu, choose **Administration** > **Crosswork Manager** > **Application Management** tab and click **Applications**. This window displays all applications that have been installed. You can also click **Add File (.tar.gz)** to install more applications.

Step 5 View the status of jobs.

a) Click the **Job History** tab. This window provides the information regarding the status of jobs and the sequence of events that have been executed as part of the job process.

View System and Network Alarms

You can view alarms by navigating to one of the following:

- From the main Crosswork window, click 🔔.
- From the main menu, choose **Administration** > **Alarms**.
- For application specific alarms, choose **Administration** > **Crosswork Manager** > **Crosswork Health** tab. Expand one of the applications and select the **Alarms** tab.

From the **Alarms** window:

- Click the alarm description to drill down on alarm details.
- Acknowledge, change status, and add notes to alarms.

System Events

To help an operator troubleshoot issues, Crosswork Infrastructure has a Syslog feature which forwards system related events to an external server (see Configure a Syslog Server, on page 286). All the events related to the Crosswork platform are classified broadly into three categories: Day 0, Day 1, and Day 2. The following table lists the event categories and sample events or actions within that category.

Table 25: Event Classification

Event Classification	Sample Events and Actions
Day 0 – Events related only to Crosswork Infrastructure installation.	• Checking the status of the cluster • Adding a worker node • Slow disk or latency issues
Day 1 – Events related to Crosswork application installation.	• Restarting a microservice • Restarting a microservice fails • Installing an application successfully • Activating an application successfully • Application is still not healthy within 3 minutes of activation • Node drain fails • Activating an application fails • Removing a worker node

Event Classification	Sample Events and Actions
Day 2 – Events related to system operations and maintenance.	• Node eviction • Node eviction clean up fails • Deactivating an application fails • Uninstallation of an application fails • Slow disk or network • Node removal • Node insertion • Node drain fails • K8S ETCD clean up • Node removal fails • Node deletion fails • Deactivating an application successfully • Uninstalling an application successfully

Sample Day 0, Day 1, and Day 2 Events

The following tables list related information to various Day 0, Day 1, and Day 2 events in a functional system.

Day 0 Events

These checks can help determine whether the system is healthy.

Table 26: Adding a Worker Node

Severity	Major
Description	A VM node has been added. This event occurs when the K8 cluster detects a node.
Sample Alarm	None
Sample Syslog Message	`<time_stamp> <hosting_hybrid_node> <time_stamp> <crosswork_VIP> orchestrator-capp-infra - b54ec903-9e0f-49b8-aaf3-1d72cf644c28 vm4wkr-0 'Successfully added new VM into Inventory: vm4wkr'`
Recommendation	Monitor and confirm that the VM node appears in the UI with a healthy status.

Table 27: Slow Disk or Latency in Network Issues

Severity	Critical
Description	This event occurs when the Infrastructure Capp untar takes more than 1.5 minutes or if the Docker push takes more than 2 minutes to complete. This message can be found in the firstboot.log file.
Sample Alarm	Not applicable
Sample Syslog Message	Not applicable
Recommendation	This issue must be addressed before further operations can be made on the system. Do the following: • Check that disk storage and network SLA requirements are met. • Confirm that the observed bandwidth is the same as what is provisioned between the nodes. • If using RAID, confirm it is RAID 0.

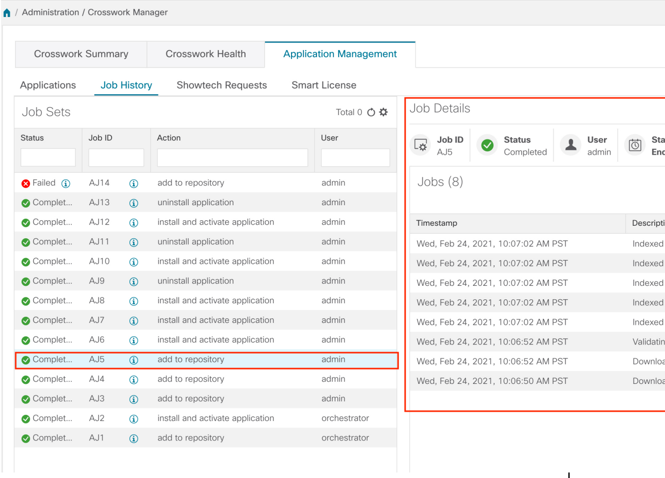
Day 1 Events

Table 28: Removing a Worker Node

Severity	Major
Description	This event occurs when a VM node is erased.
Sample Alarm	None
Sample Syslog Message	`<time_stamp> <hosting_hybrid_node> <time_stamp> <crosswork_VIP> CLUSTER-CLUSTER - 33a5ce0d-6cd0-4e4d-8438-85cfa8fb4ae9 CLUSTER-99 'user=admin,policyId=admin,backend=local,loginTime=2021-02-28T01:38:48Z,Category=VM Manager,RequestId=vm4wkr [Erase VM []]'`
Recommendation	Monitor and confirm that the VM node is no longer seen in the UI. If the erase operation fails, attempt to erase the node again.

Table 29: Adding an Application—Success

Severity	Information
Description	This event occurs when an application is added successfully.

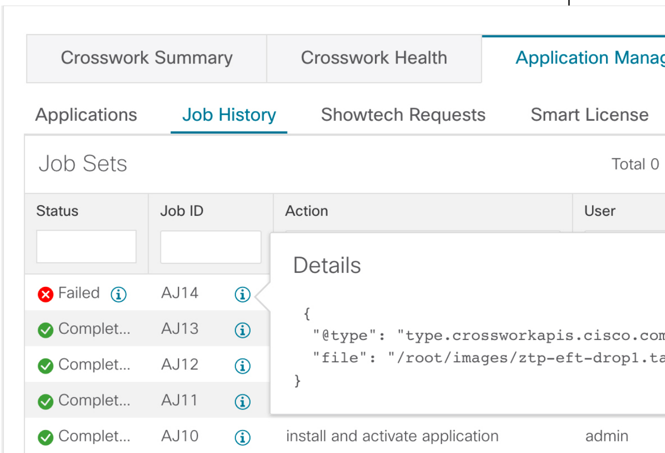
Alarm	 Administration / Crosswork Manager Crosswork Summary · Crosswork Health · Application Management Applications · Job History · Showtech Requests · Smart License Job Sets — Total 0 Status · Job ID · Action · User Failed · AJ14 · add to repository · admin Complet... · AJ13 · uninstall application · admin Complet... · AJ12 · install and activate application · admin Complet... · AJ11 · uninstall application · admin Complet... · AJ10 · install and activate application · admin Complet... · AJ9 · uninstall application · admin Complet... · AJ8 · install and activate application · admin Complet... · AJ7 · install and activate application · admin Complet... · AJ6 · install and activate application · admin Complet... · AJ5 · add to repository · admin Complet... · AJ4 · add to repository · admin Complet... · AJ3 · add to repository · admin Complet... · AJ2 · install and activate application · orchestrator Complet... · AJ1 · add to repository · orchestrator Job Details Job ID AJ5 · Status Completed · User admin · Sta End Jobs (8) Timestamp · Descripti Wed, Feb 24, 2021, 10:07:02 AM PST · Indexed Wed, Feb 24, 2021, 10:07:02 AM PST · Indexed Wed, Feb 24, 2021, 10:07:02 AM PST · Indexed Wed, Feb 24, 2021, 10:07:02 AM PST · Indexed Wed, Feb 24, 2021, 10:07:02 AM PST · Indexed Wed, Feb 24, 2021, 10:06:52 AM PST · Validatin Wed, Feb 24, 2021, 10:06:52 AM PST · Downloa Wed, Feb 24, 2021, 10:06:50 AM PST · Downloa

Syslog Message	*<time_stamp> <hosting_hybrid_node>*
	<time_stamp> <crosswork_VIP>
	`CLUSTER-CLUSTER -`
	`627b2140-a906-4a96-b59b-1af22f2af9f6`
	`CLUSTER-99`
	`'job_type=INSTALL_AND_ACTIVATE_APPLICATION,manager=app_manager:`
	`,user=admin,policyId=admin,backend=local,loginTime=2021-02-`
	`28T09:34:54Z,payload={"package_identifier":{"id":"cappztp","`
	`version":"1.1.0-prerelease.259+build.260"}}`
	`[accepted]'`

Recommendation	None

Table 30: Adding an Application—Failure

Severity	Information
Description	This event occurs when an application cannot be added.

Sample Alarm	
	Crosswork Summary · Crosswork Health · Application Manag
	Applications · Job History · Showtech Requests · Smart License
	Job Sets — Total 0
	Status · Job ID · Action · User
	Failed · AJ14
	Complet... · AJ13
	Complet... · AJ12
	Complet... · AJ11
	Complet... · AJ10 · install and activate application · admin
	Details
	`{`
	`  "@type": "type.crossworkapis.cisco.com`
	`  "file": "/root/images/ztp-eft-drop1.ta`
	`}`

Sample Syslog Message	None
Recommendation	After fixing the error, try adding the application again.

Table 31: Activating an Application—Success

Severity	Information
Description	This event occurs after an application is activated successfully.
Sample Alarm	None
Syslog Message	`<time_stamp> <hosting_hybrid_node> <time_stamp> <crosswork_VIP> orchestrator-Crosswork Health Manager - 010689d1-8842-43c2-8ebd-5d91ded9d2d7 cw-ztp-service-0-0 ' cw-ztp-service-0 is healthy.'`
Recommendation	Activate the application and license.

Table 32: Activating an Application—Failure

Severity	Critical
Description	This event occurs if an application cannot be activated. The activation may fail because microservices or pods do not come up in time.
Sample Alarm	None
Syslog Message	None
Recommendation	Do the following: • Look at the job history and identify where in the activation process it failed. If it fails at the start of one of the pods coming up, restart the pods. • Uninstall the application and then try installing the application again.

Table 33: Application Remains Unhealthy after 3 Minutes

Severity	Major
Description	This event occurs if the application was activated successfully but the components remain unhealthy after 3 minutes after application activation.
Sample Alarm	None
Sample Syslog Message	None
Recommendation	You can wait longer and if it becomes healthy, clear the alarm. Contact Cisco TAC if it still appears unhealthy after some time.

Day 2 Events

Table 34: Node Drain—Cleanup

Severity	Information
Description	A node drain occurs if you erase a VM node or if the node has been unresponsive for more than 5 minutes. During the drain operation, pods running on the node are moved (clustered pods may move or go pending, single instance pods will move to another node).
Sample Alarms	• Node Drain Failed • K8s ETCD Cleanup Failed on Node Removal • Node Delete

Syslog Message	`<time_stamp> <hosting_hybrid_node>`
	`<time_stamp> <crosswork_VIP>`
	`orchestrator-Crosswork Health Manager -`
	`b062232f-54dc-49b2-8283-`
	`506b7bf672a6 astackserver-0-0 ' astackserver-0`
	`health is degraded.'`

Recommendation	Monitor the operation. If the drain is a result of eviction, erase the respective node and insert a new one.

Table 35: Node Drain—Failure

Severity	Major
Description	A node drain occurs if you erase a VM node or if the node has been unresponsive for more than 5 minutes. This event occurs if the node drain operation fails.
Sample Alarm	None

Sample Syslog Message	`<time_stamp> <hosting_hybrid_node>`
	`<time_stamp> <crosswork_VIP>`
	`orchestrator-Crosswork Health Manager -`
	`b062232f-54dc-49b2-8283-`
	`506b7bf672a6 astackserver-0-0 ' astackserver-0`
	`health is degraded.'`

Recommendation	Try erasing the node again.

Table 36: Node Eviction—Failure

Severity	Critical

Description	In this scenario we assume that one of the hybrid nodes fails. This event occurs if the node has been down for more than 5 minutes and it is automatically taken out of service. This event can be triggered if someone stopped or deleted a VM without using Cisco Crosswork or if there is a network outage to that node. K8s automatically start evicting pods on that node (drain eviction operation). The VM node will be marked down during a successful cleanup.
Sample Alarm	• Node Eviction Cleanup Failure • K8S ETCD Cleanup Failed on Node Removal
Syslog Message	None
Recommendation	Erase the faulty node and insert a new VM.

Table 37: Node Eviction—Cleanup Failure

Severity	Critical
Description	This event occurs when the drain eviction fails. The node has been down for more than 5 minutes and K8s automatically start evicting pods on that node.
Sample Alarm	None
Sample Syslog Message	None
Recommendation	Erase the node and attempt another cleanup operation.

Table 38: Resource Footprint Shortage

Severity	Critical
Description	This event occurs when cluster node resources are being highly utilized and there is a lack of a resource footprint.
Sample Alarm	None
Sample Syslog Message	None
Recommendation	Add a new worker node.

Table 39: Deactivating an Application—Success

Severity	Minor

Description	This event occurs when an application is deactivated.
Sample Alarm	None
Sample Syslog Message	<time_stamp> <hosting_hybrid_node> <time_stamp> <crosswork_VIP> CLUSTER-CLUSTER - ade982ea-7f60-4d6b-b7e0-ebafc789edee CLUSTER-99 © 2021 Cisco and/or its affiliates. All rights reserved. Cisco Confidential – DRAFT version 1 'user=admin,policyId=admin,backend=local,loginTime=2021-02- 28T09:34:54Z,job_type=UNINSTALL_APPLICATION,manager=app_manager: ,payload={"application_id":"capp-ztp"} [accepted]'
Recommendation	None

Table 40: Deactivating an Application—Failure

Severity	Critical
Description	This event occurs when an application cannot be deactivated. This can occu if microservices or pods are still running.
Sample Alarm	None
Syslog Message	None
Recommendation	Do the following: • Look at the job history and identify where in the activation process it failed. If it fails at the start of one of the pods coming up, restart the pods. • Uninstall the application and then try installing the application again.

Table 41: Slow Disk or Latency in Network Issues

Severity	Critical
Description	This event occurs when the Infrastructure Capp untar takes more than 1.5 minutes or if the Docker push takes more than 2 minutes to complete. This message can be found in the firstboot.log file.
Sample Alarm	Not applicable
Sample Syslog Message	Not applicable

Recommendation	This issue must be addressed before further operations can be made on the system. Do the following: • Check that disk storage and network SLA requirements are met. • Confirm that the observed bandwidth is the same as what is provisioned between the nodes. • If using RAID, confirm it is RAID 0.

Table 42: ETCD Cleanup

Severity	Information
Description	This event occurs if someone erases a VM node and the ETCD clean membership cleanup operation begins.
Sample Alarms	If ETCD cleanup fails: • K8S ETCD Cleanup Failed on Node Removal • Alarm Node Delete
Syslog Message	None
Recommendation	Monitor operation.

Table 43: K8S ETCD Cleanup Failed on Node Removal

Severity	Major
Description	This event occurs if the ETCD cleanup operation fails.
Sample Alarm	None
Sample Syslog Message	None
Recommendation	Try erasing the node again.

Table 44: Restart Microservices—Failure

Severity	Warning
Description	This event occurs when someone restarts a microservice or pod and the operation fails.
Sample Alarm	None
Sample Syslog Message	None
Recommendation	Restart the microservices or pods. You may have to do this a few times to see if it recovers.

Collect Audit Information

Audit logs map user information with all the critical user actions performed in the system. To view application Showtech logs, see Monitor Platform Infrastructure and Application Health, on page 292.

The audit log includes user actions related to the following operations:

- Device onboarding
- User creation, deletion, and configuration updates
- Crosswork Data Gateway management operations
- Collection job creation
- Administrative tasks (show-tech execution, topology updates, NSO-related actions)
- Cisco Crosswork Change Automation and Health Insights:
  - Manage playbooks (import, export, or delete) and playbook execution.

    Note When a playbook execution request is sent, Change Automation prints an audit log. The audit log includes details like the playbook name, user information, session details, and the execution ID of the job. When Change Automation executes a playbook maintenance task, it also prints an audit log. The maintenance audit log contains details such as the execution ID. If it performs the commit on NSO, the maintenance audit log details also include the commit label. You can use the audit log to identify all the commit labels associated with an execution ID. Use the commit labels to perform a lookup on the NCS CLI. The lookup shows the exact configuration changes that Change Automation pushed to the device.

  - KPIs, KPI Profiles, and Alert group creation, deletion, and configuration updates
  - Enabling and disabling of KPI Profiles
- Cisco Crosswork Optimization Engine:
  - SR-TE policy and RSVP TE tunnel creation, deletion, and configuration updates
  - Affinity mapping configuration
  - Bandwidth on Demand and Bandwidth Optimization function and configuration updates
  - RESTCONF API creation, deletion, and configuration updates

Sample Cisco Crosswork Change Automation and Health Insights Audit Log Entry

The following is a sample audit log entry created when a local admin user runs a playbook.

```
time="2020-06-09 21:24:31.103312" level=info msg="playbook scheduled for execution"
backend=local execution_id=1591737871096-a6699d03-8264-4ea8-8f6f-03e8a58f32a3
latency=11.330355ms loginTime="2020-06-09T20:27:11Z" method=POST
```

```
playbook="router_config_traffic_steering" policyId=admin
set_id=5405fdb1-6b37-41cb-94a3-32b180d3b773 set_name=static-acl-b180d3b773
tag="ROBOT_manager-nca-7689b-fdn8g" user=admin
```

Sample Cisco Crosswork Optimization Engine Audit Log Entries

Crosswork Optimization Engine UI Audit Log Entry Example

```
2020-06-12 02:48:07,990 INFO c.c.s.o.e.AuditLogger [http-nio-8080-exec-3] time=2020-06-12
02:48:07.000990 message=SR Policy created successfully. user=admin policyId=admin
backend=local loginTime=1591929794
{data={"headEnd":"192.168.0.2","endPoint":"192.168.0.6","color":"999","description":"","profileId":"","bindingSid":"333",
 "path":{"type":"dynamic","pathName":"Automation_validating_sr","metric":"IGP",
"affinity":[{"constraintType":"EXCLUDE_ANY","affinity":[31]}],"disjointness":{"disjointType":"",
 "associationGroup":"","subId":""}, "protectedSegment":"SEG_PROTECTED"}}}
```

Crosswork Optimization Engine RESTCONF API Audit Log Entry Example

```
time="2020-06-06 13:49:06,308"
message="action=/operations/cisco-crosswork-optimization-engine-sr-policy-operations:sr-policy-delete,
 input={\"input\": {\"sr-policies\": [{\"head-end\": \"192.168.0.2\", \"end-point\":
\"192.168.0.3\", \"color\": 301}]}},
output={\"cisco-crosswork-optimization-engine-sr-policy-operations:output\":{\"results\":
[{\"head-end\":\"192.168.0.2\",\"end-point\":\"192.168.0.3\",\"color\":301, \"message\":\"SR
 policy  not found in Config DB\",\"state\":\"failure\"}]}}" user=admin policyId=admin
backend=local loginTime=1591451346 method=POST
url=/operations/cisco-crosswork-optimization-engine-sr-policy-operations:sr-policy-delete
```

Table 45: Common Audit Log Entry Fields

Field	Description
time	The time that Crosswork created this audit log.
message	Message sent between applications.
msg	Message sent between applications.
user	Name of the user.
policyId	Role or permission of user (taken from local database, TACACS, or LDAP server).
backend	The server (local database, TACACS, or LDAP) authenticating users.
loginTime	The epoch time when the user has logged in. Epoch time is intentionally selected, as it shorter and independent of time zones.
Other fields	Individual applications use more fields specific to that application. For example: • In the sample audit log entry for Cisco Crosswork Change Automation and Health Insights, the **playbook** field refers to the playbook that Change Automation executed. • In the UI audit log entry for Crosswork Optimization Engine, **data** is a field that refers to the creation details of an SR-TE policy and its attributes.

Audit Log Location

Crosswork stores audit logs in `/var/log/audit/audit.log`, under the respective application pods. For example:

- The sample Change Automation audit log is in the `<robot-nca>` data directory under the pod.
- The sample Crosswork Optimization Engine UI audit log is in the `optima-uiservice` pod; the RESTCONF API audit log is under the `optima-restconf` pod.

In addition to the individual application audit logs, Cisco Crosswork collects all audit log files are once each hour. Crosswork stores them as separate gzipped tar files in the following data directory: `/mnt/robot_datafs/<app-name>/<instance>/auditlogs/auditlogs.tar.gz`

Crosswork collects audit log files based on the specified maximum size and number of backups for each application. For example: **`MaxSize:20 megabytes`** and **`MaxBackups: 5`**.

View Audit Log

The **Audit Log** window tracks the following AAA-related events:

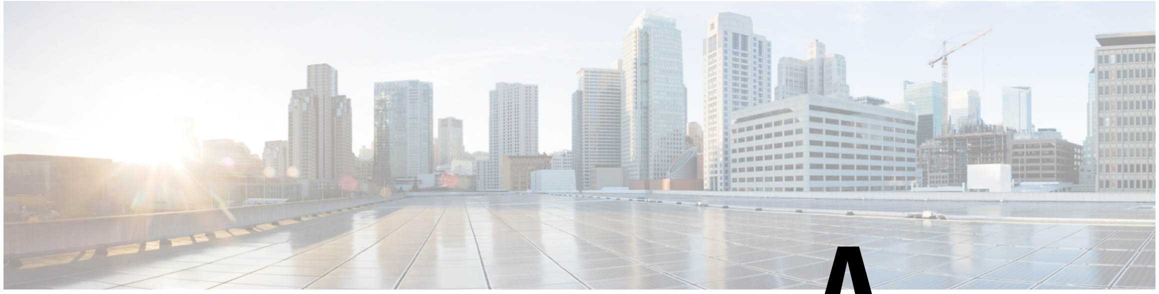
- Create, update, and delete users
- Create, update, and delete roles
- User login activites - login, logout, login failure due to maximum active session limit, and account locked due to maximum login failures.
- Password modification by user

To view the audit log, perform the following steps:

Step 1 From the main menu, choose **Administration** > **Audit Log**.

The **Audit Log** window is displayed.

Step 2 Click ▼ to filter the results based on your query.



APPENDIX A

Configure Crosswork Data Gateway VM

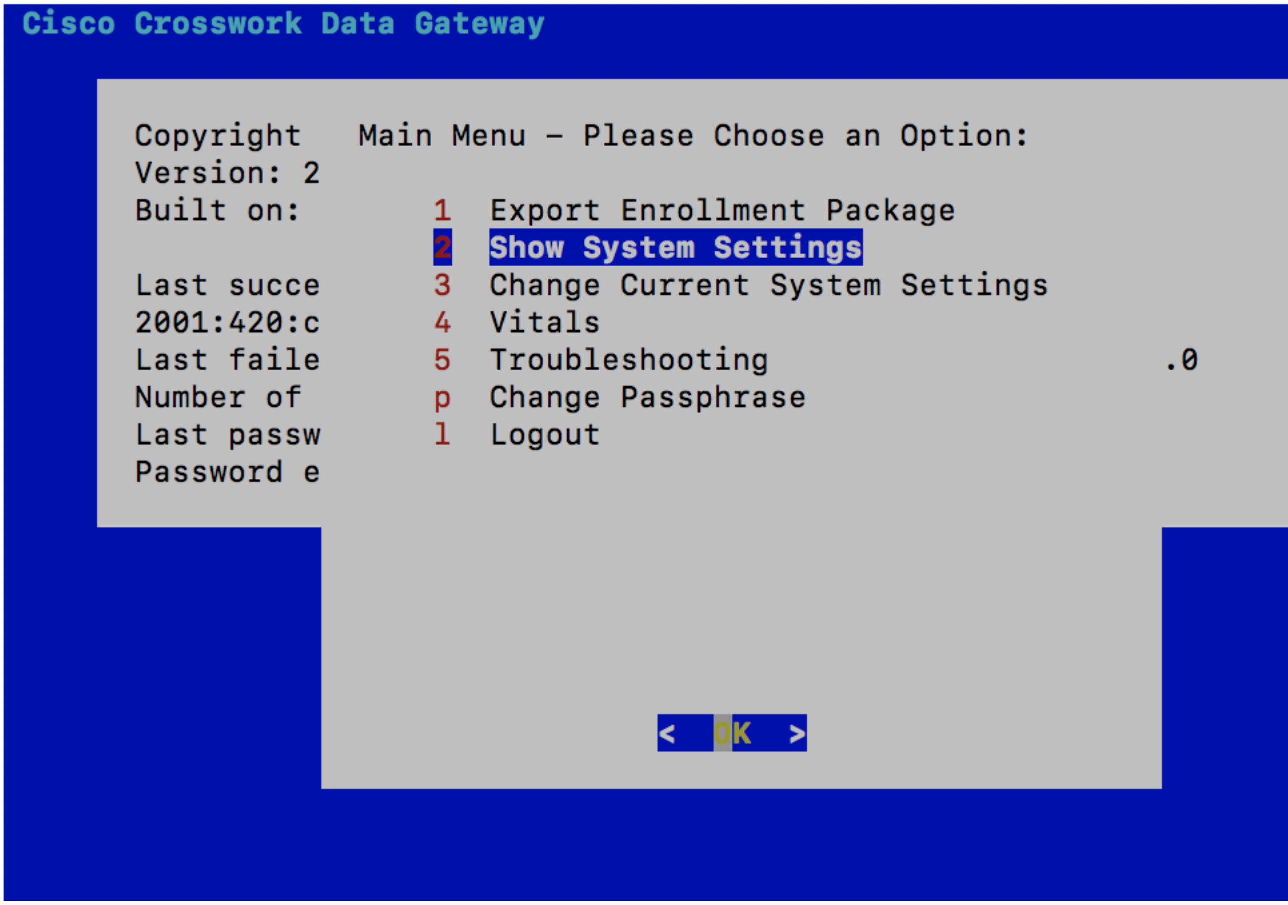
A Cisco Crosswork Data Gateway instance is created as a standalone VM and can be geographically separate from the controller application (the controller application could be Cisco Crosswork Infrastructure or Crosswork Cloud). This VM is capable of connecting to the controller application which will enable data collection from the network.

This chapter contains the following topics:

Use the Interactive Console

Cisco Crosswork Data Gateway launches an interactive console upon successful login. The interactive console displays the **Main Menu** as shown in the following figure:

Note The Main Menu shown here corresponds to **dg-admin** user. It is different for **dg-oper** user as the operator does not have same privileges as the administrator. See Table Table 46: Permissions Per Role, on page 315.



```
Cisco Crosswork Data Gateway

  Copyright   Main Menu - Please Choose an Option:
  Version: 2
  Built on:          1  Export Enrollment Package
                     2  Show System Settings
  Last succe         3  Change Current System Settings
  2001:420:c         4  Vitals
  Last faile         5  Troubleshooting                    .0
  Number of          p  Change Passphrase
  Last passw         l  Logout
  Password e

                              <  OK  >
```

The Main Menu presents the following options:

1. Export Enrollment Package

2. Show System Settings

3. Change Current System Settings

4. Vitals

5. Troubleshooting

p. Change Passphrase

l. Logout

Manage Crosswork Data Gateway Users

This section contains the following topics:

- Supported User Roles, on page 315
- Change Password, on page 317

Supported User Roles

Cisco Crosswork Data Gateway supports only two users with the following user roles:

- **Administrator**: One default **dg-admin** user with administrator role is created when Cisco Crosswork Data Gateway is brought up for the first time. This user cannot be deleted and has both read and write privileges such as starting and shutting down the Cisco Crosswork Data Gateway VM, registering an application, applying authentication certificates, configuring server settings, and performing a kernel upgrade.
- **Operator**: The **dg-oper** user is also created by default during the initial VM bring up. This user can review the health of the Cisco Crosswork Data Gateway, retrieve error logs, receive error notifications and run connectivity tests between Cisco Crosswork Data Gateway instance and the output destination.

Note

- User credentials are configured for both the user accounts during Cisco Crosswork Data Gateway installation.
- Users are locally authenticated.

The following table shows the permissions available to each role:

Table 46: Permissions Per Role

Permissions	Administrator	Operator
Export Enrollment Package	✓	✓
Show system settings		
vNIC Addresses NTP DNS Proxy UUID Syslog Certificates First Boot Provisioning Log Timezone	✓	✓
Change Current System Settings		

Permissions	Administrator	Operator
Configure NTP	✓	×
Configure DNS		
Configure Control Proxy		
Configure Static Routes		
Configure Syslog		
Create new SSH keys		
Import Certificate		
Configure vNIC2 MTU		
Configure Timezone		
Configure Password Requirements		
Configure Simultaneous Login Limits		
Configure Idle Timeout		
Vitals		
Docker Containers	✓	✓
Docker Images		
Controller Reachability		
NTP Reachability		
Route Table		
ARP Table		
Network Connections		
Disk Space Usage		
Linux services		
NTP Status		
System Uptime		
Troubleshooting		
Run Diagnostic Commands	✓	✓
Run show-tech	✓	✓
Remove All Collectors and Reboot VM	✓	×
Reboot VM	✓	×
Export auditd logs	✓	✓
Re-enroll Data Gateway	✓	✓
Enable TAC Shell Access	✓	×

Permissions	Administrator	Operator
Change Passphrase	✓	✓

Change Password

Both adminstrator and operator users can change their own passphrases but not each others'.

Follow these steps to change your passphrase:

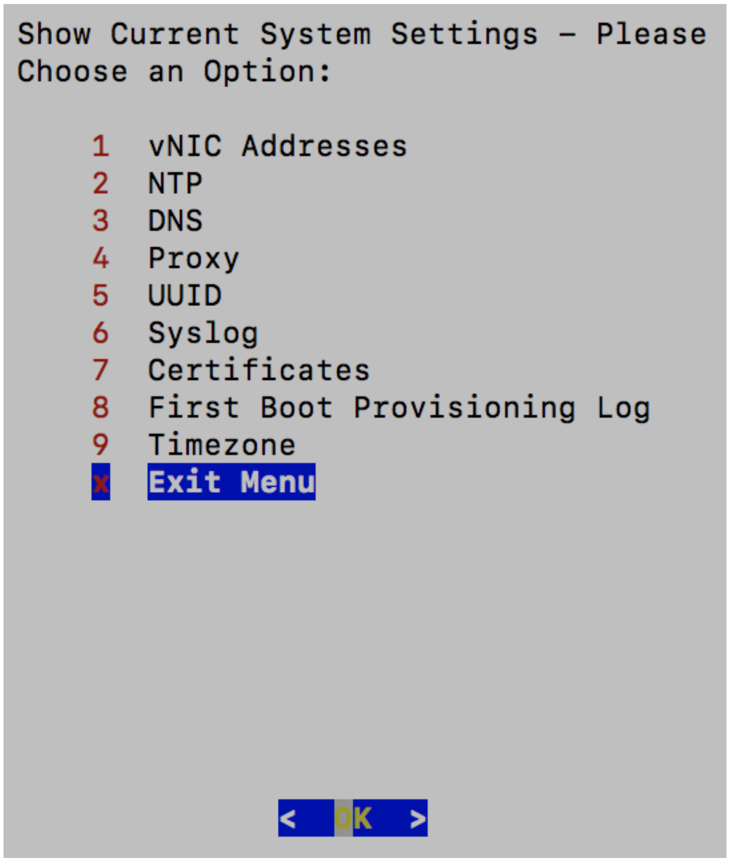
Step 1 From the Main Menu, select **p Change Passphrase** and click **OK**.

Step 2 Input your current password and press Enter.

Step 3 Enter new password and press Enter. Re-type the new password and press Enter.

View Current System Settings

Crosswork Data Gateway allows you to view the following settings:



```
Show Current System Settings - Please
Choose an Option:

    1  vNIC Addresses
    2  NTP
    3  DNS
    4  Proxy
    5  UUID
    6  Syslog
    7  Certificates
    8  First Boot Provisioning Log
    9  Timezone
    x  Exit Menu

               <  OK  >
```

Follow these steps to view the current system settings:

Step 1 From the Main Menu, select **2 Show System Settings**, as shown in the following figure:

Step 2 Click **OK**. The **Show Current System Settings** menu opens.

Step 3 Select the setting you want to view.

Setting Option	Description
1 vNIC Addresses	Displays the vNIC configuration, including address information.
2 NTP	Displays currently configured NTP server details.
3 DNS	Displays DNS server details.
4 Proxy	Displays proxy server details (if any configured).
5 UUID	Displays the system UUID.
6 Syslog	Displays the Syslog forwarding configuration. If no Syslog forwarding is configured, this will display only "# Forwarding configuration follows" on screen.
7 Certificates	Provides options to view the following certificate files: • Crosswork Data Gateway signing certificate file • Controller signing certificate file • Controller SSL/TLS certificate file • Syslog certificate file • Collector certificate file
8 First Boot Provisioning Log	Displays the content of the first boot log file.
9 Timezone	Displays the current timezone setting.

Change Current System Settings

Crosswork Data Gateway allows you to configure the following settings:

- NTP.
- DNS.
- Control proxy.
- Static routes.
- Syslog.

- SSH keys.
- Certificate.
- vNIC2 MTU.
- Timezone.
- Password requirements.
- Simlutaneous login limits.
- Idle timeout.
- Configure auditd.

Note

- Crosswork Data Gateway system settings can only be configured by the administrator.
- In settings options where you require to use SCP, if you are not using the default SCP port 22, you can specify the port as a part of the SCP command. For example,

  ```
  -P55 user@host:path/to/file
  ```

  where 55 is a custom port.

Configure NTP

It is important that NTP time be synchronized with the controller application and its Crosswork Data Gateway instances. If not, then session handshake doesn't happen and functional images are not downloaded. In such cases, error message clock time not matched and sync failed is logged in controller-gateway.log. To access log files, see Run show-tech, on page 332. You can use Controller Reachability and NTP Reachability options from **Main Menu** > **Vitals** to check NTP reachability for the controller application as well as the Crosswork Data Gateway. See View Crosswork Data Gateway Vitals, on page 326. If NTP has been set incorrectly,you will see error Session not established.

When configuring Crosswork Data Gateway to use authentication via a keys file, the chrony.keys file must be formatted in a specific way as documented at https://chrony.tuxfamily.org/doc/3.5/chrony.conf.html#keyfile. For sites that use ntpd and are configured to use a ntp.keys file, it is possible to convert from ntp.keys to chrony.keys using the tool https://github.com/mlichvar/ntp2chrony/blob/master/ntp2chrony/ntp2chrony.py. The tool converts ntpd configuration into a chrony compatible format, but only the keys file is required to be imported into Crosswork Data Gateway.

Follow the steps to configure NTP settings:

Step 1 From the **Change Current System Settings** Menu, select **1 Configure NTP**.

Step 2 Enter the following details for the new NTP server:

- Server list, space delimited
- Use NTP authentication?
- Key list, space delimited and must match in number with server list

- Key file URI to SCP to the VM
- Key file passphrase to SCP to the VM

Step 3 Click **OK** to save the settings.

Configure DNS

Step 1 From the **Change Current System Settings** menu, select **2 Configure DNS** and click **OK**.

Step 2 Enter the new DNS server address(es) and domain.

Step 3 Click **OK** to save the settings.

Configure Control Proxy

If you have not configured a proxy server during installation, avail this option to set up a proxy sever:

Step 1 From the **Change Current System Settings** menu, select **3 Configure Control Proxy** and click **OK**.

Step 2 Click **Yes** for the following dialog if you wish to proceed. Click **cancel** otherwise.

Step 3 Enter the new Proxy server details:

- Server URL
- Bypass addresses
- Proxy username
- Proxy passphrase

Step 4 Click **OK** to save the settings.

Configure Static Routes

The static routes are configured when Crosswork Data Gateway receives add/delete requests from the collectors. The **Configure Static Routes** option from the main menu can be used for troubleshooting purpose.

Note Static routes configured using this option are lost when the Crosswork Data Gateway reboots.

Add Static Routes

Follow the steps to add static routes:

Step 1 From the **Change Current System Settings** menu, select **4 Configure Static Routes**.

Step 2 To add a static route, select **a Add**.

Step 3 Select the interface for which you want to add a static route.

Step 4 Select the IP version.

Step 5 Enter IPv4 or IPv6 subnet in CIDR format when prompted.

Step 6 Click **OK** to save the settings.

Delete Static Routes

Follow the steps to delete a static route:

Step 1 From the **Change Current System Settings** Menu, select **4 Configure Static Routes**.

Step 2 To delete a static route, select **d Delete**.

Step 3 Select the interface for which you want to delete a static route.

Step 4 Select the IP version.

Step 5 Enter IPv4 or IPv6 subnet in CIDR format.

Step 6 Click **OK** to save the settings.

Configure Syslog

Note For any Syslog server configuration with IPv4 or IPv6 support for different Linux distributions, please refer your system administrator and configuration guides.

Follow the steps to configure Syslog:

Step 1 From the **Change Current System Settings** Menu, select **5 Configure Syslog**.

Step 2 Enter the new values for the following syslog attributes:.

- Server address: IPv4 or IPv6 address of a syslog server accessible from the management interface. If you are using an IPv6 addres, it must be surrounded by square brackets ([1::1]).
- Port: Port number of the syslog server
- Protocol: Use UDP, TCP, or RELP when sending syslog.
- Use Syslog over TLS?: Use TLS to encrypt syslog traffic.
- TLS Peer Name: Syslog server's hostname exactly as entered in the server certificate SubjectAltName or subject common name.
- Syslog Root Certificate File URI: PEM formatted root cert of syslog server retrieved using SCP.

- Syslog Certificate File Passphrase: Password of SCP user to retrieve Syslog certificate chain.

Step 3 Click **OK** to save the settings.

Create New SSH Keys

Creating new SSH keys will remove the current keys.

Follow the steps to create new SSH keys:

Step 1 From the **Change Current System Settings** Menu, select **6 Create new SSH keys**.

Step 2 Click **OK**. Crosswork Data Gateway launches an auto-configuration process that generates new SSH keys.

Import Certificate

Updating any certificate other than Controller Signing Certificate causes a collector restart.

Crosswork Data Gateway allows you to import the following certificates:

- Controller signing certificate file
- Controller SSL/TLS certificate file
- Syslog certficate file
- Proxy certificate file

Step 1 From the **Change Current System Settings** Menu, select **7 Import Certificate**.

Step 2 Select the certificate you want to import.

Step 3 Enter SCP URI for the selected certificate file.

Step 4 Enter passphrase for the SCP URI and click **OK**.

Configure vNIC2 MTU

You can change vNIC2 MTU only if you are using 3 NICs.

If your interface supports jumbo frames, the MTU value lies in the range of 60-9000, inclusive. For interfaces that do not support jumbo frames, the valid range is 60-1500, inclusive. Setting an invalid MTU causes Crosswork Data Gateway to revert the change back to the currently configured value. Please verify with your hardware documentation to confirm what the valid range is. An error will be logged into kern.log for MTU change errors which can be viewed after running showtech.

Step 1 From the **Change Current System Settings** menu, select **8 Configure vNIC1 MTU**.

Step 2 Enter vNIC2 MTU value.

Step 3 Click **OK** to save the settings.

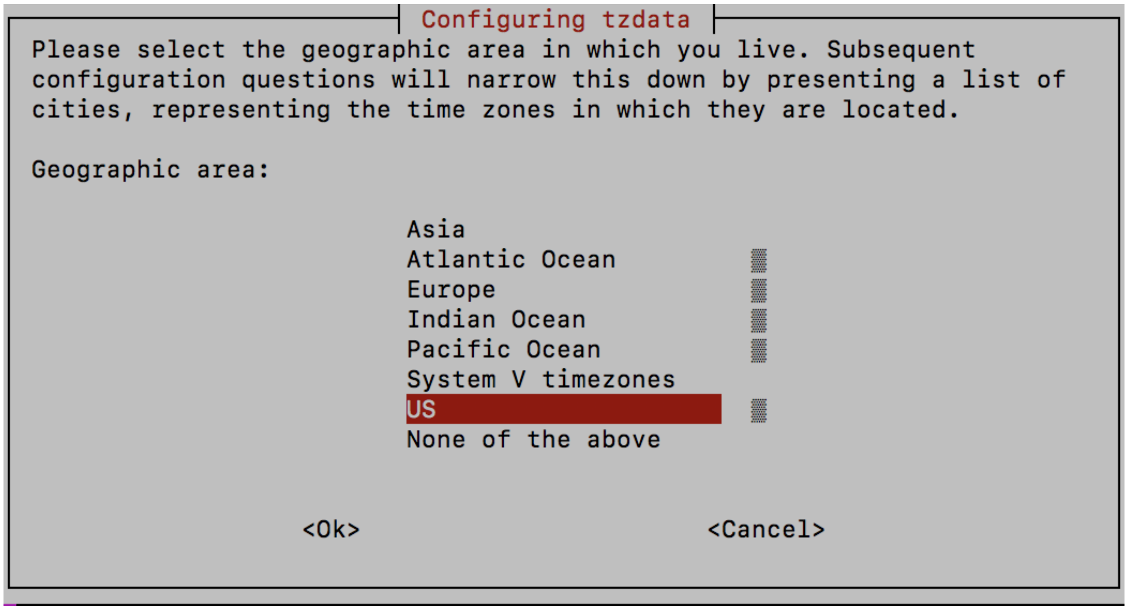
Configure Timezone of the Crosswork Data Gateway VM

The Crosswork Data Gateway VM first launches with default timezone as UTC. Update the timezone with your geographical area so that all Crosswork Data Gateway processes (including the showtech logs) reflect the timestamp corresponding to the location you have chosen.

Step 1 In Crosswork Data Gateway VM interactive menu, select **Change Current System Settings**.

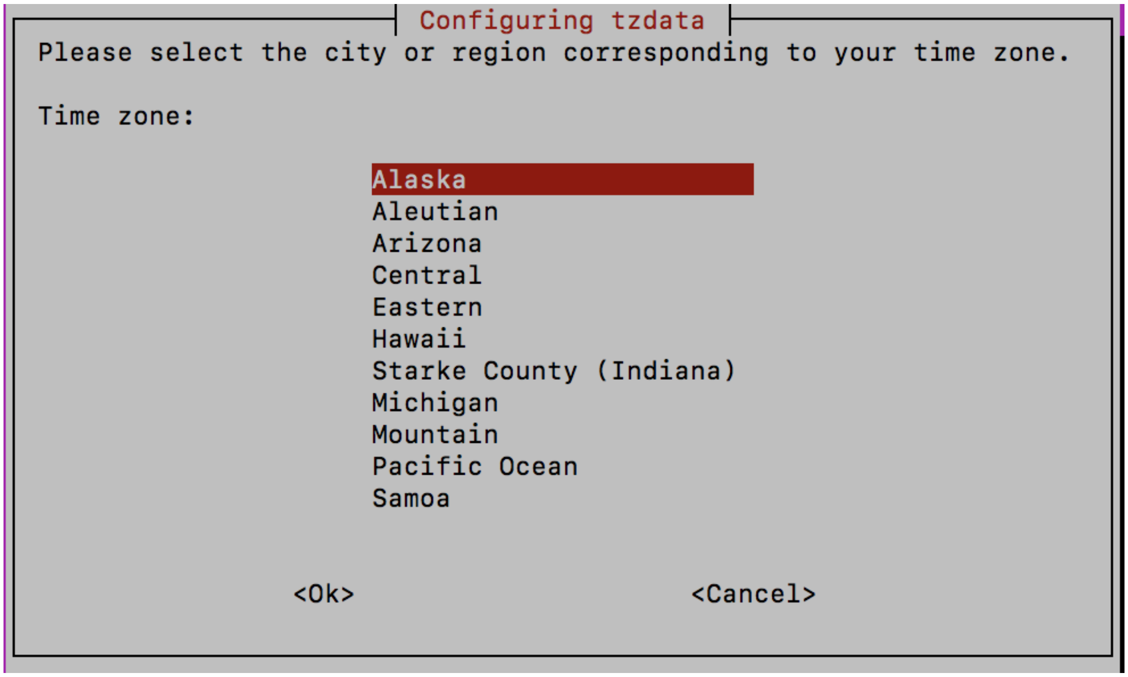
Step 2 Select **9 Timezone**.

Step 3 Select the geographic area in which you live.



```
                        Configuring tzdata
Please select the geographic area in which you live. Subsequent
configuration questions will narrow this down by presenting a list of
cities, representing the time zones in which they are located.

Geographic area:

                         Asia
                         Atlantic Ocean
                         Europe
                         Indian Ocean
                         Pacific Ocean
                         System V timezones
                         US
                         None of the above


                   <Ok>                       <Cancel>
```

Step 4 Select the city or region corresponding to your timezone.



```
                    Configuring tzdata
 Please select the city or region corresponding to your time zone.

 Time zone:

                    Alaska
                    Aleutian
                    Arizona
                    Central
                    Eastern
                    Hawaii
                    Starke County (Indiana)
                    Michigan
                    Mountain
                    Pacific Ocean
                    Samoa


                <Ok>                      <Cancel>
```

Step 5 Select **OK** to save the settings.

Step 6 Reboot the Crosswork Data Gateway VM so that all processes pick up the new timezone.

Step 7 Log out of the Crosswork Data Gateway VM.

Configure Password Requirements

You can configure the following password requirements:

- Password Strength
- Password History
- Password expiration
- Login Failures

Step 1 From **Change Current System Settings** menu, select **0 Configure Password Requirements**.

Step 2 Select the password requirement you want to change.

Set the options you want to change:

- **Password Strength**
  - Min Number of Classes
  - Min Length
  - Min Changed Characters

  - Max Digit Credit
  - Max Upper Case Letter Credit
  - Max Lower Case Letter Credit
  - Max Other Character Credit
  - Max Monotonic Sequence
  - Max Same Consecutive Characters
  - Max Same Class Consecutive Characters

- **Password History**
  - Change Retries
  - History Depth
- **Password expiration**
  - Min Days
  - Max Days
  - Warn Days
- **Login Failures**
  - Login Failures
  - Initial Block Time (sec)
  - Address Cache Time (sec)

Step 3 Click **OK** to save the settings.

Configure Simultaneous Login Limits

By default, Crosswork Data Gateway supports 10 simultaneous sessions for the **dg-admin** and **dg-oper** user on each VM. To change this:

Step 1 From the **Change Current System Settings** menu, select **a Configure Simultaneous Login Limits**.

Step 2 In the window that appears, enter the number of simultaneous sessions for the **dg-admin** and **dg-oper** user.

Step 3 Select **Ok** to save your changes.

Configure Idle Timeout

Step 1 From the **Change Current System Settings** menu, select **b Configure Idle Timeout**.

Step 2 Enter the new value of idle timeout in the window that appears.

Step 3 Enter **Ok** to save your changes.

Configure Remote Auditd Server

Use this procedure to configure the auditd daemon export to a remote server.

Step 1 From the **Change Current System Settings** menu, select **c Configure auditd**.

Step 2 Enter the following details:

- Remote auditd server address.
- Remote auditd server port.

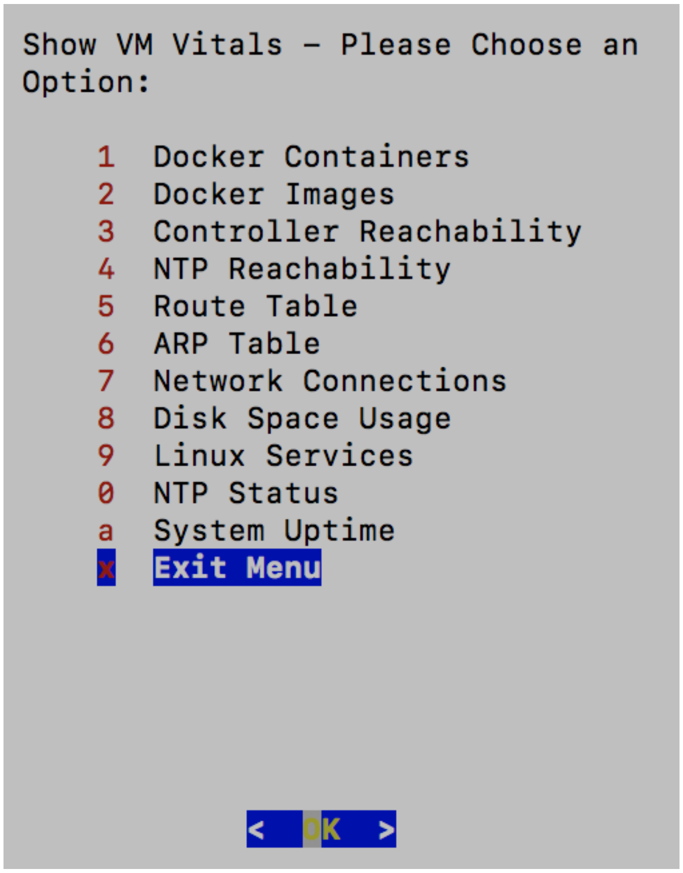
Step 3 Select **OK** to save your changes.

View Crosswork Data Gateway Vitals

Follow these steps to view Cisco Crosswork Data Gateway vitals:

Step 1 From the Main Menu, select **4 Vitals**.

Step 2 From the **Show VM Vitals** menu, select the vital you want to view.



Vital	Description
Docker Containers	Displays the following vitals for the Docker containers currently instantiated in the system: • Container ID • Image • Name • Command • Created Time • Status • Port

Vital	Description
Docker Images	Displays the following details for the Docker images currently saved in the system: • Repository • Image ID • Created Time • Size • Tag
Controller Reachability	Displays the results of controller reachability test run: • Default IPv4 gateway • Default IPv6 gateway • DNS server • Controller • Controller session status
NTP Reachability	Displays the result of NTP reachability tests: • NTP server resolution • Ping • NTP Status • Current system time
Route Table	Displays IPv4 and IPv6 routing tables.
ARP Table	Displays ARP tables.
Network Connections	Displays the current network connections and listening ports.
Disk Space Usage	Displays the current disk space usage for all partitions.
Linux Services	Displays the status of the following Linux services: • NTP • SSH • Syslog • Docker • Cisco Crosswork Data Gateway Infrastructure containers.
Check NTP Status	Displays the NTP server status.

Vital	Description
Check System Uptime	Displays the system uptime.

Troubleshooting Crosswork Data Gateway VM

To access **Troubleshooting** menu, select **5 Troubleshooting** from the Main Menu.

Note The image shows the Troubleshooting Menu corresponding to **dg-admin** user. Few of these options are not available to **dg-oper** user. See Table Table 46: Permissions Per Role, on page 315.

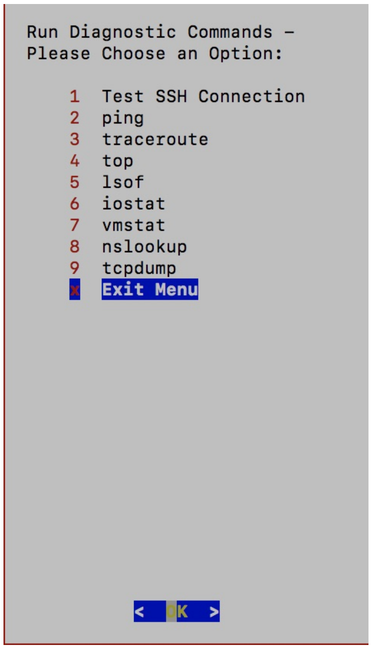
The **Troubleshooting** menu that provides you the following options:

- Run Diagnostic Commands, on page 329
- Run show-tech, on page 332
- Reboot Crosswork Data Gateway VM, on page 332
- Shutdown the Crosswork Data Gateway VM, on page 333
- Export auditd Logs, on page 333
- Enable TAC Shell Access, on page 333

Run Diagnostic Commands

The **Run Diagnostics** menu provides you the following options in the console:

Figure 72: Run Diagnostics Menu



```
Run Diagnostic Commands -
Please Choose an Option:

    1  Test SSH Connection
    2  ping
    3  traceroute
    4  top
    5  lsof
    6  iostat
    7  vmstat
    8  nslookup
    9  tcpdump
    x  Exit Menu

              <  OK  >
```

Ping a Host

Crosswork Data Gateway provides you ping utility that can be used to check reachability to any IP address.

Step 1 From **Run Diagnostics** menu, select **2 ping**.

Step 2 Enter the following information:

- Number of pings
- Destination hostname or IP
- Source port (UDP, TCP, TCP Connect)
- Destination port (UDP, TCP, TCP Connect)

Step 3 Click **OK**.

Traceroute to a Host

Crosswork Data Gateway provides **traceroute** option to help troubleshoot latency issues. Using this option provides you a rough time estimate for the Crosswork Data Gateway to reach the destination.

Step 1 From **Run Diagnostics** menu, select **3 traceroute**.

Step 2 Enter the traceroute destination.

Step 3 Click **OK**.

Command Options to Troubleshoot

Crosswork Data Gateway provides several commands for troubleshooting.

Step 1 Navigate to **5 Troubleshooting** > **1 Run Diagnostics**.

Step 2 Select the command and other option or filters for each of the commands:

- **4 top**
- **5 lsof**
- **6 iostat**
- **7 vmstat**
- **8 nsolookup**

Step 3 Click **Ok**.

Once you have selected all the options, Crosswork Data Gateway clears the screen and runs the command with the specified options.

Download tcpdump

Crosswork Data Gateway provides the tcpdump option that allows you to capture and analyze network traffic.

Note This task can only be performed by a **dg-admin** user.

Step 1 Go to **5 Troubleshooting** > **Run Diagnostics** > **9 tcpdump**.

Step 2 Select an interface to run the tcpdump utility. Select the **All** option to run it for all interfaces.

Step 3 Select the appropriate checkbox to view the packet information on the screen or save the captured packets to a file.

Step 4 Enter the following details and click **Ok**.

- Packet count limit
- Collection time limit
- File size limit
- Filter expression

Depending on the option you choose, Crosswork Data Gateway displays the packet capture information on the screen or saves it to a file. Once the tcpdump utility reaches the specified limit, Crosswork Data Gateway compresses the file and prompts for the SCP credentials to transfer the file to a remote host. The compressesd file is deleted once the transfer is complete or if you've decided to cancel the file transfer before completion.

Run show-tech

Crosswork Data Gateway provides the option **show_tech** to export its log files to a user-defined SCP destination.

The collected data includes the following:

- Logs of all the Data Gateway components running on Docker containers
- VM Vitals

It creates a tarball in the directory where it is executed. The output is a tarball named `DG-<CDG version>-<CDG host name>-year-month-day--hour-minute-second.tar.xz.enc`.

The execution of this command may take several minutes depending on the state of Crosswork Data Gateway.

Step 1 From **Troubleshooting** menu, select **5 Show-tech** and click **OK**.

Step 2 Enter the destination to save the tarball containing logs and vitals.

Step 3 Enter your SCP passphrase and click **OK**.

The showtech file downloads in an encrypted format.

Note Depending on how long the system was in use, it may take several minutes to download the showtech file.

Step 4 After the download is complete run the following command to decrypt it:

Note In order to decrpyt the file, you must use OpenSSL version 1.1.1i. Use the command `openssl version` to check the openssl version on your system.

To decrypt the file on a MAC, you must install OpenSSL 1.1.1+. This is because LibreSSL's `openssl` command does not support all the switches supported by OpenSSL's `openssl` command.

```
openssl enc -d -AES-256-CBC -pbkdf2 -md sha512 -iter 100000 -in <showtech file> -out <decrypted
filename> -pass pass:<password>
```

Reboot Crosswork Data Gateway VM

Note This task can only be performed by **dg-admin** user.

Crosswork Data Gateway gives you two options to reboot the VM:

- **Remove all Collectors and Reboot VM**: Select this option from the **Troubleshooting** menu if you want to stop the containers that were downloaded after installation (collectors and offload), remove the images from docker, remove collector data and configuration and reboot VM. This returns the VM to a state just after initial configuration is complete with only infrastructure containers running.
- **Reboot VM**: Select this option from the **Troubleshooting** menu for a normal reboot.

Shutdown the Crosswork Data Gateway VM

From the **Troubleshooting** Menu, select **5 Shutdown VM** to power off the Crosswork Data Gateway VM.

Export auditd Logs

Follow the steps to export auditd logs:

Step 1 From **Troubleshooting**, select **9 Export audit Logs**.

Step 2 Enter a passphrase for auditd log tarball encryption.

Step 3 Click **OK**.

Re-enroll Crosswork Data Gateway

Follow the steps to re-enroll Crosswork Data Gateway:

Before you begin

The existing Crosswork Data Gateway enrollment must be deleted from the controller prior to re-enrolling.

Step 1 From **Troubleshooting** menu, select **7 Re-enroll Data Gateway**.

Step 2 Click **Yes** in the below dialog box.

Remove Rotated Log Files

Use this procedure to removes all rotated log files (*.gz or *.xz) in the `/var/log` and `/opt/dg/log` folders.

Step 1 From **Troubleshooting** menu, select **8 Remove Rotated Log files**.

Step 2 Select **Yes** in the dialog that appears to save your changes.

Enable TAC Shell Access

The TAC Shell Access function allows a Cisco engineer to directly log in to the Ubuntu shell via multifactor authentication, using a reserved user named **dg-tac**.

Initially, the **dg-tac** user account is locked and password is expired to prevent the user from getting a shell prompt. Once enabled, the dg-tac user is active until the next calendar day, 12:00 a.m UTC (midnight UTC), which is less than 24 hours.

The steps to enable the **dg-tac** user are as follows:

Note Enabling this access requires you to communicate actively with the Cisco engineer.

Before you begin

Ensure that the Cisco engineer who is working with you has access to the SWIMS Aberto tool.

Step 1 Log in to the Data Gateway VM as the **dg-admin** user.

Step 2 From the main menu, select **5 Troubleshooting**.

Step 3 From the **Troubleshooting** menu, select **t Enable TAC Shell Access**.

A dialog appears, warning that the **dg-tac** user login requires a password that you set and a response to a challenge token from TAC. At this point, you may answer **No** to stop the enable process or **Yes** to continue.

Step 4 If you continue, the system prompts for a new password to use and shows the day when the account disables itself.

Step 5 Enter a password to unlock the account in the console menu.

Step 6 Log out of the Crosswork Data Gateway.

Step 7 Follow these steps if the Crosswork Data Gateway VM can be accessed by the Cisco engineer directly. Move to **Step 8** otherwise.

a) Share the password that you had set in Step 5 for the **dg-tac** user with the Cisco engineer who is working with you.

b) The Cisco engineer logs in as the **dg-tac** user Via SSH with the password you had set.

After entering the password, the system presents the challenge token. The Cisco engineer signs the challenge token using the SWIMS Aberto tool and pastes the signed response to the challenge token back at the Crosswork Data Gateway VM.

c) The Cisco engineer logs in successfully as the **dg-tac** user and completes the troubleshooting.

There is a 15-minute idle timeout period for the **dg-tac** user. If logged out, the Cisco engineer needs to sign a new challenge to log in again.

d) After troubleshooting is complete, the Cisco engineer logs out of the TAC shell.

Step 8 If Crosswork Data Gateway VM cannot be accessed directly by the Cisco engineer, start a meeting with the Cisco engineer with desktop sharing enabled.

a) Log in as the **dg-tac** user Via SSH using the following command:

```
ssh dg-tac@<DG hostname or IP>
```

b) Enter the password that you set for the **dg-tac** user.

After entering the password, the system presents the challenge token. Share this token with the Cisco engineer who will then sign the token using the SWIMS Aberto tool and share the response with you.

c) Paste the signed response to the challenge token back to the Crosswork Data Gateway VM and press enter to get the shell prompt.

d) Share your desktop or follow the Cisco engineer's instructions for troubleshooting.

There is a 15-minute idle timeout period for the **dg-tac** user. If logged out, the Cisco engineer needs to sign a new challenge to log in again.

e) Log out of the TAC shell after troubleshooting is complete.

APPENDIX B

List of Pre-loaded Traps and MIBs for SNMP Collection

This section lists the traps and MIBs that the Cisco Crosswork Data Gateway supports for SNMP collection.

Note This list is applicable only when Crosswork is the target application and is not limited when the target is an external application.

Note the following constraints:

- The system cannot extract index values from OIDs of conceptual tables. If any of the columns that define indices in the conceptual table are not populated, the index value is replaced on the data plane with the instance identifier (oid suffix) of the row.
- The system cannot extract index values from conceptual tables that include the **AUGMENT** keyword or refer to indices of other tables.
- Named-number enumerations (using the integer syntax) are sent on the wire using their numeric value.

Table 47: Supported Traps

Trap	OID
linkDown	1.3.6.1.6.3.1.1.5.3
linkUp	1.3.6.1.6.3.1.1.5.4
coldStart	1.3.6.1.6.3.1.1.5.1
isisAdjacencyChange	1.3.6.1.2.1.138.0.17

ADSL-LINE-MIB.mib	CISCO-LWAPP-INTERFACE-MIB.mib	IANA-ITU-ALARM-TC-MIB.mib
ADSL-TC-MIB.mib	CISCO-LWAPP- IPS-MIB.mib	IANA-LANGUAGE- MIB.mib
AGENTX-MIB.mib	CISCO-LWAPP-LINKTEST-MIB.mib	IANA-RTPROTO- MIB.mib

ALARM-MIB.mib	CISCO-LWAPP-LOCAL-AUTH-MIB.mib	IANAifType-MIB.mib
APS-MIB.mib	CISCO-LWAPP- MDNS-MIB.mib	IEEE8021-CFM-MIB.mib
ATM-FORUM-MIB.mib	CISCO-LWAPP-MESH-BATTERY-MIB.mib	IEEE8021-PAE-MIB.mib
ATM-FORUM- TC-MIB.mib	CISCO-LWAPP-MESH-LINKTEST-MIB.mib	IEEE8021-TC-MIB.mib
ATM-MIB.mib	CISCO-LWAPP-MOBILITY-EXT-MIB.mib	IEEE802171-CFM- MIB.mib
ATM-TC-MIB.mib	CISCO-LWAPP-MOBILITY-MIB.mib	IEEE8023-LAG-MIB.mib
ATM2-MIB.mib	CISCO-LWAPP-NETFLOW-MIB.mib	IEEE802dot11-MIB.mib
BGP4-MIB.mib	CISCO-LWAPP- REAP-MIB.mib	IF-INVERTED-STACK-MIB.mib
BRIDGE-MIB.mib	CISCO-LWAPP- RF-MIB.mib	IF-MIB.mib
CISCO-AAA- SERVER-MIB.mib	CISCO-LWAPP- SI-MIB.mib	IGMP-STD-MIB.mib
CISCO-AAA- SESSION-MIB.mib	CISCO-LWAPP- TC-MIB.mib	INET-ADDRESS-MIB.mib
CISCO-AAL5-MIB.mib	CISCO-LWAPP-TRUSTSEC-MIB.mib	INT-SERV-MIB.mib
CISCO-ACCESS-ENVMON-MIB.mib	CISCO-LWAPP- TSM-MIB.mib	INTEGRATED-SERVICES-MIB.mib
CISCO-ATM-EXT -MIB.mib	CISCO-LWAPP- WLAN-MIB.mib	IP-FORWARD-MIB.mib
CISCO-ATM-PVCTRAP-EXTN-MIB.mib	CISCO-LWAPP-WLAN-SECURITY-MIB.mib	IP-MIB.mib
CISCO-ATM- QOS-MIB.mib	CISCO-MEDIA-GATEWAY-MIB.mib	IPMCAST-MIB.mib
CISCO-AUTH-FRAMEWORK-MIB.mib	CISCO-MOTION-MIB.mib	IPMROUTE-MIB.mib
CISCO-BGP-POLICY-ACCOUNTING-MIB.mib	CISCO-MPLS-LSR-EXT-STD-MIB.mib	IPMROUTE-STD -MIB.mib
CISCO-BGP4-MIB.mib	CISCO-MPLS-TC-EXT-STD-MIB.mib	IPV6-FLOW-LABEL-MIB.mib
CISCO-BULK-FILE -MIB.mib	CISCO-MPLS-TE-STD-EXT-MIB.mib	IPV6-ICMP-MIB.mib
CISCO-CBP-TARGET -MIB.mib	CISCO-NAC-TC -MIB.mib	IPV6-MIB.mib
CISCO-CBP-TARGET -TC-MIB.mib	CISCO-NBAR-PROTOCOL-DISCOVERY-MIB.mib	IPV6-MLD-MIB.mib
CISCO-CBP-TC-MIB.mib	CISCO-NETSYNC -MIB.mib	IPV6-TC.mib

CISCO-CCME-MIB.mib	CISCO-NTP-MIB.mib	IPV6-TCP-MIB.mib
CISCO-CDP-MIB.mib	CISCO-OSPF- MIB.mib	IPV6-UDP-MIB.mib
CISCO-CEF-MIB.mib	CISCO-OSPF- TRAP-MIB.mib	ISDN-MIB.mib
CISCO-CEF-TC.mib	CISCO-OTN-IF-MIB.mib	ISIS-MIB.mib
CISCO-CLASS-BASED-QOS-MIB.mib	CISCO-PAE-MIB.mib	ITU-ALARM-MIB.mib
CISCO-CONFIG- COPY-MIB.mib	CISCO-PAGP-MIB.mib	ITU-ALARM-TC- MIB.mib
CISCO-CONFIG- MAN-MIB.mib	CISCO-PIM-MIB.mib	L2TP-MIB.mib
CISCO-CONTENT-ENGINE-MIB.mib	CISCO-PING-MIB.mib	LANGTAG-TC-MIB.mib
CISCO-CONTEXT-MAPPING-MIB.mib	CISCO-POLICY-GROUP -MIB.mib	LLDP-EXT-DOT1 -MIB.mib
CISCO-DATA-COLLECTION-MIB.mib	CISCO-POWER-ETHERNET-EXT-MIB.mib	LLDP-EXT-DOT3 -MIB.mib
CISCO-DEVICE-EXCEPTION-REPORTING-MIB.mib	CISCO-PRIVATE -VLAN-MIB.mib	LLDP-MIB.mib
CISCO-DIAL- CONTROL-MIB.mib	CISCO-PROCESS-MIB.mib	MAU-MIB.mib
CISCO-DOT11-ASSOCIATION-MIB.mib	CISCO-PRODUCTS- MIB.mib	MGMD-STD-MIB.mib
CISCO-DOT11-HT- PHY-MIB.mib	CISCO-PTP-MIB.mib	MPLS-FTN-STD- MIB.mib
CISCO-DOT11-IF-MIB.mib	CISCO-RADIUS- EXT-MIB.mib	MPLS-L3VPN-STD- MIB.mib
CISCO-DOT11-SSID-SECURITY-MIB.mib	CISCO-RF-MIB.mib	MPLS-LDP-ATM-STD-MIB.mib
CISCO-DOT3- OAM-MIB.mib	CISCO-RF-SUPPLEMENTAL-MIB.mib	MPLS-LDP-FRAME-RELAY-STD-MIB.mib
CISCO-DS3-MIB.mib	CISCO-RTTMON-TC -MIB.mib	MPLS-LDP-GENERIC-STD-MIB.mib
CISCO-DYNAMIC-TEMPLATE-MIB.mib	CISCO-SELECTIVE-VRF-DOWNLOAD-MIB.mib	MPLS-LDP-MIB.mib
CISCO-DYNAMIC-TEMPLATE-TC-MIB.mib	CISCO-SESS-BORDER-CTRLR-CALL-STATS-MIB.mib	MPLS-LDP-STD-MIB.mib
CISCO-EIGRP-MIB.mib	CISCO-SESS-BORDER-CTRLR-EVENT-MIB.mib	MPLS-LSR-MIB.mib
CISCO-EMBEDDED-EVENT-MGR-MIB.mib	CISCO-SESS-BORDER-CTRLR-STATS-MIB.mib	MPLS-LSR-STD-MIB.mib
CISCO-ENHANCED-IMAGE-MIB.mib	CISCO-SMI.mib	MPLS-TC-MIB.mib
CISCO-ENHANCED-MEMPOOL-MIB.mib	CISCO-SONET-MIB.mib	MPLS-TC-STD-MIB.mib

CISCO-ENTITY-ASSET -MIB.mib	CISCO-ST-TC.mib	MPLS-TE-MIB.mib
CISCO-ENTITY-EXT -MIB.mib	CISCO-STACKWISE- MIB.mib	MPLS-TE-STD-MIB.mib
CISCO-ENTITY-FRU-CONTROL-MIB.mib	CISCO-STP-EXTENSIONS -MIB.mib	MPLS-VPN-MIB.mib
CISCO-ENTITY- QFP-MIB.mib	CISCO-SUBSCRIBER -IDENTITY-TC-MIB.mib	MSDP-MIB.mib
CISCO-ENTITY-REDUNDANCY-MIB.mib	CISCO-SUBSCRIBER-SESSION-MIB.mib	NET-SNMP-AGENT -MIB.mib
CISCO-ENTITY-REDUNDANCY-TC-MIB.mib	CISCO-SUBSCRIBER-SESSION-TC-MIB.mib	NET-SNMP-EXAMPLES -MIB.mib
CISCO-ENTITY- SENSOR-MIB.mib	CISCO-SYSLOG-MIB.mib	NET-SNMP-MIB.mib
CISCO-ENTITY-VENDORTYPE-OID-MIB.mib	CISCO-SYSTEM-EXT- MIB.mib	NET-SNMP-TC.mib
CISCO-ENVMON-MIB.mib	CISCO-SYSTEM-MIB.mib	NHRP-MIB.mib
CISCO-EPM-NOTIFICATION-MIB.mib	CISCO-TAP2-MIB.mib	NOTIFICATION-LOG-MIB.mib
CISCO-ETHER-CFM- MIB.mib	CISCO-TC.mib	OLD-CISCO-CHASSIS-MIB.mib
CISCO-ETHERLIKE- EXT-MIB.mib	CISCO-TCP-MIB.mib	OLD-CISCO-INTERFACES -MIB.mib
CISCO-FABRIC- C12K-MIB.mib	CISCO-TEMP-LWAPP -DHCP-MIB.mib	OLD-CISCO-SYS- MIB.mib
CISCO-FIREWALL -TC.mib	CISCO-TRUSTSEC -SXP-MIB.mib	OLD-CISCO-SYSTEM -MIB.mib
CISCO-FLASH-MIB.mib	CISCO-TRUSTSEC -TC-MIB.mib	OPT-IF-MIB.mib
CISCO-FRAME- RELAY-MIB.mib	CISCO-UBE-MIB.mib	OSPF-MIB.mib
CISCO-FTP-CLIENT -MIB.mib	CISCO-UNIFIED-COMPUTING-ADAPTOR -MIB.mib	OSPF-TRAP-MIB.mib
CISCO-HSRP-EXT -MIB.mib	CISCO-UNIFIED-COMPUTING-COMPUTE -MIB.mib	OSPFV3-MIB.mib
CISCO-HSRP-MIB.mib	CISCO-UNIFIED-COMPUTING-ETHER -MIB.mib	P-BRIDGE-MIB.mib
CISCO-IETF-ATM2 -PVCTRAP-MIB.mib	CISCO-UNIFIED-COMPUTING-FC- MIB.mib	PIM-MIB.mib
CISCO-IETF-BFD -MIB.mib	CISCO-UNIFIED-COMPUTING-MEMORY -MIB.mib	PIM-STD-MIB.mib
CISCO-IETF-FRR -MIB.mib	CISCO-UNIFIED- COMPUTING -MIB.mib	POWER-ETHERNET -MIB.mib

CISCO-IETF-IPMROUTE -MIB.mib	CISCO-UNIFIED-COMPUTING-NETWORK -MIB.mib	PPP-IP-NCP-MIB.mib
CISCO-IETF-ISIS -MIB.mib	CISCO-UNIFIED-COMPUTING-PROCESSOR -MIB.mib	PPP-LCP-MIB.mib
CISCO-IETF-MPLS-ID -STD-03-MIB.mib	CISCO-UNIFIED-COMPUTING-TC- MIB.mib	PPVPN-TC-MIB.mib
CISCO-IETF-MPLS-TE-EXT-STD-03- MIB.mib	CISCO-VLAN-IFTABLE-RELATIONSHIP -MIB.mib	PTOPO-MIB.mib
CISCO-IETF-MPLS-TE-P2MP-STD-MIB.mib	CISCO-VLAN-MEMBERSHIP-MIB.mib	PerfHist-TC-MIB.mib
CISCO-IETF-MSDP -MIB.mib	CISCO-VOICE-COMMON -DIAL-CONTROL-MIB.mib	Q-BRIDGE-MIB.mib
CISCO-IETF-PIM-EXT -MIB.mib	CISCO-VOICE-DIAL -CONTROL-MIB.mib	RADIUS-ACC-CLIENT -MIB.mib
CISCO-IETF-PIM -MIB.mib	CISCO-VOICE-DNIS -MIB.mib	RADIUS-AUTH-CLIENT -MIB.mib
CISCO-IETF-PW- ATM-MIB.mib	CISCO-VPDN-MGMT -MIB.mib	RFC-1212.mib
CISCO-IETF-PW- ENET-MIB.mib	CISCO-VTP-MIB.mib	RFC-1215.mib
CISCO-IETF-PW-MIB.mib	CISCO-WIRELESS-NOTIFICATION-MIB.mib	RFC1155-SMI.mib
CISCO-IETF-PW- MPLS-MIB.mib	CISCOSB-DEVICEPARAMS -MIB.mib	RFC1213-MIB.mib
CISCO-IETF-PW -TC-MIB.mib	CISCOSB- HWENVIROMENT.mib	RFC1315-MIB.mib
CISCO-IETF-PW -TDM-MIB.mib	CISCOSB-MIB.mib	RFC1398-MIB.mib
CISCO-IETF-VPLS -BGP-EXT-MIB.mib	CISCOSB-Physicaldescription -MIB.mib	RIPv2-MIB.mib
CISCO-IETF-VPLS -GENERIC-MIB.mib	DIAL-CONTROL-MIB.mib	RMON-MIB.mib
CISCO-IETF-VPLS- LDP-MIB.mib	DIFFSERV-DSCP-TC.mib	RMON2-MIB.mib
CISCO-IF-EXTENSION -MIB.mib	DIFFSERV-MIB.mib	RSTP-MIB.mib
CISCO-IGMP-FILTER -MIB.mib	DISMAN-NSLOOKUP -MIB.mib	RSVP-MIB.mib
CISCO-IMAGE-LICENSE -MGMT-MIB.mib	DISMAN-PING-MIB.mib	SMON-MIB.mib
CISCO-IMAGE-MIB.mib	DISMAN-SCHEDULE -MIB.mib	SNA-SDLC-MIB.mib
CISCO-IMAGE-TC.mib	DISMAN-SCRIPT-MIB.mib	SNMP-COMMUNITY -MIB.mib

CISCO-IP-LOCAL- POOL-MIB.mib	DISMAN-TRACEROUTE -MIB.mib	SNMP-FRAMEWORK -MIB.mib
CISCO-IP-TAP-MIB.mib	DOT3-OAM-MIB.mib	SNMP-MPD-MIB.mib
CISCO-IP-URPF-MIB.mib	DRAFT-MSDP-MIB.mib	SNMP-NOTIFICATION -MIB.mib
CISCO-IPMROUTE- MIB.mib	DS0-MIB.mib	SNMP-PROXY-MIB.mib
CISCO-IPSEC-FLOW -MONITOR-MIB.mib	DS1-MIB.mib	SNMP-REPEATER -MIB.mib
CISCO-IPSEC-MIB.mib	DS3-MIB.mib	SNMP-TARGET-MIB.mib
CISCO-IPSEC-POLICY -MAP-MIB.mib	ENTITY-MIB.mib	SNMP-USER-BASED -SM-MIB.mib
CISCO-IPSLA- AUTOMEASURE-MIB.mib	ENTITY-SENSOR-MIB.mib	SNMP-USM-AES -MIB.mib
CISCO-IPSLA- ECHO-MIB.mib	ENTITY-STATE-MIB.mib	SNMP-USM-DH- OBJECTS-MIB.mib
CISCO-IPSLA- JITTER-MIB.mib	ENTITY-STATE- TC-MIB.mib	SNMP-VIEW- BASED-ACM-MIB.mib
CISCO-IPSLA- TC-MIB.mib	ESO-CONSORTIUM -MIB.mib	SNMPv2-CONF.mib
CISCO-ISDN-MIB.mib	ETHER-WIS.mib	SNMPv2-MIB.mib
CISCO-LICENSE- MGMT-MIB.mib	EtherLike-MIB.mib	SNMPv2-SMI.mib
CISCO-LOCAL- AUTH-USER-MIB.mib	FDDI-SMT73-MIB.mib	SNMPv2-TC-v1.mib
CISCO-LWAPP- AAA-MIB.mib	FR-MFR-MIB.mib	SNMPv2-TC.mib
CISCO-LWAPP- AP-MIB.mib	FRAME-RELAY -DTE-MIB.mib	SNMPv2-TM.mib
CISCO-LWAPP- CCX-RM-MIB.mib	FRNETSERV- MIB.mib	SONET-MIB.mib
CISCO-LWAPP- CDP-MIB.mib	GMPLS-LSR- STD-MIB.mib	SYSAPPL-MIB.mib
CISCO-LWAPP-CLIENT -ROAMING-CAPABILITY.mib	GMPLS-TC-STD- MIB.mib	TCP-MIB.mib
CISCO-LWAPP-CLIENT -ROAMING-MIB.mib	GMPLS-TE-STD-MIB.mib	TOKEN-RING-RMON -MIB.mib
CISCO-LWAPP-DHCP -MIB.mib	HC-PerfHist-TC-MIB.mib	TOKENRING-MIB.mib
CISCO-LWAPP-DOT11- CLIENT-CALIB-MIB.mib	HC-RMON-MIB.mib	TRANSPORT-ADDRESS -MIB.mib
CISCO-LWAPP-DOT11- CLIENT-CCX-TC-MIB.mib	HCNUM-TC.mib	TUNNEL-MIB.mib
CISCO-LWAPP-DOT11 -LDAP-MIB.mib	HOST-RESOURCES -MIB.mib	UDP-MIB.mib
CISCO-LWAPP- DOT11-MIB.mib	HOST-RESOURCES -TYPES.mib	VPN-TC-STD-MIB.mib

CISCO-LWAPP -DOWNLOAD-MIB.mib	IANA-ADDRESS-FAMILY-NUMBERS-MIB.mib	VRRP-MIB.mib
CISCO-LWAPP- IDS-MIB.mib	IANA-GMPLS-TC-MIB.mib	

APPENDIX C

List of Pre-loaded YANG Modules for MDT Collection

This section lists the YANG modules that the Cisco Crosswork Data Gateway supports for MDT collection on Cisco IOS XR devices.

cli_xr_bgp_oper.yang	Cisco-IOS-XR-ip-bfd-oper.yang
Cisco-IOS-XR-ipv4-bgp-oper.yang	Cisco-IOS-XR-asr9k-xbar-oper.yang
Cisco-IOS-XR-ipv4-acl-oper.yang	Cisco-IOS-XR-snmp-sensormib-oper.yang
Cisco-IOS-XR-shellutil-filesystem-oper.yang	Cisco-IOS-XR-config-cfgmgr-oper.yang
Cisco-IOS-XR-infra-alarm-logger-oper.yang	Cisco-IOS-XR-infra-fti-oper.yang
Cisco-IOS-XR-icpe-infra-oper.yang	Cisco-IOS-XR-dot1x-oper.yang
Cisco-IOS-XR-fretta-bcm-dpa-stats-oper.yang	Cisco-IOS-XR-sdr-invmgr-diag-oper.yang
Cisco-IOS-XR-cofo-infra-oper.yang	Cisco-IOS-XR-wanphy-ui-oper.yang
Cisco-IOS-XR-man-ems-oper.yang	Cisco-IOS-XR-bundlemgr-oper.yang
Cisco-IOS-XR-mpls-lsd-oper.yang	Cisco-IOS-XR-l2vpn-oper.yang
Cisco-IOS-XR-show-fpd-loc-ng-oper.yang	Cisco-IOS-XR-asr9k-qos-oper.yang
Cisco-IOS-XR-telemetry-model-driven-oper.yang	Cisco-IOS-XR-segment-routing-ms-oper.yang
Cisco-IOS-XR-shellutil-oper.yang	Cisco-IOS-XR-pfi-im-cmd-oper.yang
Cisco-IOS-XR-ip-iep-oper.yang	Cisco-IOS-XR-asic-errors-oper.yang
Cisco-IOS-XR-cdp-oper.yang	Cisco-IOS-XR-lib-keychain-oper.yang
Cisco-IOS-XR-ip-sbfd-oper.yang	Cisco-IOS-XR-sdr-invmgr-oper.yang
Cisco-IOS-XR-tty-management-cmd-oper.yang	Cisco-IOS-XR-ipv4-ospf-oper.yang
Cisco-IOS-XR-upgrade-fpd-oper.yang	Cisco-IOS-XR-pfm-oper.yang
Cisco-IOS-XR-crypto-macsec-secy-oper.yang	Cisco-IOS-XR-config-valid-ccv-oper.yang
Cisco-IOS-XR-ip-iarm-v6-oper.yang	Cisco-IOS-XR-ip-iarm-v4-oper.yang
Cisco-IOS-XR-ipv4-autorp-oper.yang	Cisco-IOS-XR-infra-statsd-oper.yang

Cisco-IOS-XR-pbr-vservice-ea-oper.yang	Cisco-IOS-XR-ipv4-vrrp-oper.yang
Cisco-IOS-XR-ip-domain-oper.yang	Cisco-IOS-XR-cmproxy-oper.yang
Cisco-IOS-XR-ipv4-io-oper.yang	Cisco-IOS-XR-crypto-ssh-oper.yang
Cisco-IOS-XR-ipv4-hsrp-oper.yang	Cisco-IOS-XR-controller-optics-oper.yang
Cisco-IOS-XR-freqsync-oper.yang	Cisco-IOS-XR-atm-vcm-oper.yang
Cisco-IOS-XR-aaa-diameter-oper.yang	Cisco-IOS-XR-dnx-driver-fabric-plane-oper.yang
Cisco-IOS-XR-ip-tcp-oper.yang	Cisco-IOS-XR-asr9k-lc-fca-oper.yang
Cisco-IOS-XR-drivers-media-eth-oper.yang	Cisco-IOS-XR-mpls-vpn-oper.yang
Cisco-IOS-XR-infra-policymgr-oper.yang	Cisco-IOS-XR-asr9k-sc-envmon-oper.yang
Cisco-IOS-XR-fretta-bcm-dpa-hw-resources-oper.yang	Cisco-IOS-XR-es-acl-oper.yang
Cisco-IOS-XR-subscriber-ipsub-oper.yang	Cisco-IOS-XR-evpn-oper.yang
Cisco-IOS-XR-infra-rsi-oper.yang	Cisco-IOS-XR-rptiming-tmg-oper.yang
Cisco-IOS-XR-prm-server-oper.yang	Cisco-IOS-XR-ethernet-lldp-oper.yang
Cisco-IOS-XR-l2rib-oper.yang	Cisco-IOS-XR-ip-ntp-oper.yang
Cisco-IOS-XR-subscriber-pppoe-ma-oper.yang	Cisco-IOS-XR-mediasvr-linux-oper.yang
Cisco-IOS-XR-ocni-local-routing-oper.yang	Cisco-IOS-XR-ipv6-ma-oper.yang
Cisco-IOS-XR-reboot-history-oper.yang	Cisco-IOS-XR-infra-rmf-oper.yang
Cisco-IOS-XR-asr9k-lpts-oper.yang	Cisco-IOS-XR-infra-correlator-oper.yang
Cisco-IOS-XR-infra-serg-oper.yang	Cisco-IOS-XR-mpls-static-oper.yang
Cisco-IOS-XR-rgmgr-oper.yang	Cisco-IOS-XR-snmp-entitymib-oper.yang
Cisco-IOS-XR-ncs1k-mxp-headless-oper.yang	Cisco-IOS-XR-pbr-vservice-mgr-oper.yang
Cisco-IOS-XR-aaa-nacm-oper.yang	Cisco-IOS-XR-pfi-im-cmd-ctrlr-oper.yang
Cisco-IOS-XR-infra-rcmd-oper.yang	Cisco-IOS-XR-fretta-bcm-dpa-resources-oper.yang
Cisco-IOS-XR-crypto-macsec-mka-oper.yang	Cisco-IOS-XR-macsec-ctrlr-oper.yang
Cisco-IOS-XR-tunnel-vpdn-oper.yang	Cisco-IOS-XR-ipv6-nd-oper.yang
Cisco-IOS-XR-ipv4-dhcpd-oper.yang	Cisco-IOS-XR-tunnel-l2tun-oper.yang
Cisco-IOS-XR-ip-rip-oper.yang	Cisco-IOS-XR-infra-dumper-exception-oper.yang
Cisco-IOS-XR-ncs1001-otdr-oper.yang	Cisco-IOS-XR-syncc-oper.yang
Cisco-IOS-XR-asr9k-asic-errors-oper.yang	Cisco-IOS-XR-dnx-driver-oper.yang
Cisco-IOS-XR-pmengine-oper.yang	Cisco-IOS-XR-ncs1k-macsec-ea-oper.yang
Cisco-IOS-XR-linux-os-reboot-history-oper.yang	Cisco-IOS-XR-fretta-bcm-dpa-drop-stats-oper.yang
Cisco-IOS-XR-ppp-ea-oper.yang	Cisco-IOS-XR-infra-sla-oper.yang
Cisco-IOS-XR-asr9k-ptp-pd-oper.yang	Cisco-IOS-XR-ncs1001-ots-oper.yang

Cisco-IOS-XR-ipv4-igmp-oper.yang	Cisco-IOS-XR-nto-misc-shmem-oper.yang
Cisco-IOS-XR-ipv4-bgp-oc-oper.yang	Cisco-IOS-XR-ip-rib-ipv4-oper.yang
Cisco-IOS-XR-ip-pfilter-oper.yang	Cisco-IOS-XR-ipv4-pim-oper.yang
Cisco-IOS-XR-lpts-pre-ifib-oper.yang	Cisco-IOS-XR-pppoe-ea-oper.yang
Cisco-IOS-XR-ipv6-ospfv3-oper.yang	Cisco-IOS-XR-infra-syslog-oper.yang
Cisco-IOS-XR-asr9k-netflow-oper.yang	Cisco-IOS-XR-crypto-sam-oper.yang
Cisco-IOS-XR-infra-xtc-oper.yang	Cisco-IOS-XR-Ethernet-SPAN-oper.yang
Cisco-IOS-XR-sysdb-oper.yang	Cisco-IOS-XR-lpts-ifib-oper.yang
Cisco-IOS-XR-lib-mpp-oper.yang	Cisco-IOS-XR-ethernet-link-oam-oper.yang
Cisco-IOS-XR-infra-xtc-agent-oper.yang	Cisco-IOS-XR-mpls-ldp-oper.yang
Cisco-IOS-XR-ip-rib-ipv6-oper.yang	Cisco-IOS-XR-tty-management-oper.yang
Cisco-IOS-XR-rptiming-dti-oper.yang	Cisco-IOS-XR-lmp-oper.yang
Cisco-IOS-XR-wd-oper.yang	Cisco-IOS-XR-nto-misc-shprocmem-oper.yang
Cisco-IOS-XR-man-xml-ttyagent-oper.yang	Cisco-IOS-XR-procmem-oper.yang
Cisco-IOS-XR-ip-daps-oper.yang	Cisco-IOS-XR-Subscriber-infra-subdb-oper.yang
Cisco-IOS-XR-spirit-install-instmgr-oper.yang	Cisco-IOS-XR-asr9k-np-oper.yang
Cisco-IOS-XR-fretta-grid-svr-oper.yang	Cisco-IOS-XR-ptp-oper.yang
Cisco-IOS-XR-clns-isis-oper.yang	Cisco-IOS-XR-tunnel-nve-oper.yang
Cisco-IOS-XR-ipv4-bgp-oper.yang	Cisco-IOS-XR-ocni-oper.yang
Cisco-IOS-XR-ipv4-ma-oper.yang	Cisco-IOS-XR-ncs6k-acl-oper.yang
Cisco-IOS-XR-l2-eth-infra-oper.yang	Cisco-IOS-XR-manageability-object-tracking-oper.yang
Cisco-IOS-XR-plat-chas-invmgr-oper.yang	Cisco-IOS-XR-ocni-intfbase-oper.yang
Cisco-IOS-XR-dwdm-ui-oper.yang	Cisco-IOS-XR-infra-tc-oper.yang
Cisco-IOS-XR-policy-repository-oper.yang	Cisco-IOS-XR-subscriber-session-mon-oper.yang
Cisco-IOS-XR-ipv6-new-dhcpv6d-oper.yang	Cisco-IOS-XR-ip-udp-oper.yang
Cisco-IOS-XR-subscriber-srg-oper.yang	Cisco-IOS-XR-ipv6-acl-oper.yang
Cisco-IOS-XR-manageability-perfmgmt-oper.yang	Cisco-IOS-XR-crypto-macsec-pl-oper.yang
Cisco-IOS-XR-dnx-port-mapper-oper.yang	Cisco-IOS-XR-aaa-tacacs-oper.yang
Cisco-IOS-XR-mpls-te-oper.yang	Cisco-IOS-XR-man-ipsla-oper.yang
Cisco-IOS-XR-nto-misc-oper.yang	Cisco-IOS-XR-invmgr-oper.yang
Cisco-IOS-XR-ppp-ma-oper.yang	Cisco-IOS-XR-ipv4-arp-oper.yang
Cisco-IOS-XR-config-cfgmgr-exec-oper.yang	Cisco-IOS-XR-aaa-locald-oper.yang
Cisco-IOS-XR-perf-meas-oper.yang	Cisco-IOS-XR-ha-eem-policy-oper.yang

Cisco-IOS-XR-snmp-agent-oper.yang	Cisco-IOS-XR-ascii-ltrace-oper.yang
Cisco-IOS-XR-asr9k-lc-ethctrl-oper.yang	Cisco-IOS-XR-skp-qos-oper.yang
Cisco-IOS-XR-ifmgr-oper.yang	Cisco-IOS-XR-flowspec-oper.yang
Cisco-IOS-XR-iedge4710-oper.yang	Cisco-IOS-XR-icpe-sdacp-oper.yang
Cisco-IOS-XR-controller-otu-oper.yang	Cisco-IOS-XR-fretta-bcm-dpa-npu-stats-oper.yang
Cisco-IOS-XR-subscriber-accounting-oper.yang	Cisco-IOS-XR-alarmgr-server-oper.yang
Cisco-IOS-XR-ncs5500-qos-oper.yang	Cisco-IOS-XR-fia-internal-tcam-oper.yang
Cisco-IOS-XR-skywarp-netflow-oper.yang	Cisco-IOS-XR-tty-server-oper.yang
Cisco-IOS-XR-ncs1k-mxp-lldp-oper.yang	Cisco-IOS-XR-qos-ma-oper.yang
Cisco-IOS-XR-fib-common-oper.yang	Cisco-IOS-XR-aaa-protocol-radius-oper.yang
Cisco-IOS-XR-dnx-netflow-oper.yang	Cisco-IOS-XR-platform-pifib-oper.yang
Cisco-IOS-XR-lpts-pa-oper.yang	Cisco-IOS-XR-asr9k-fsi-oper.yang
Cisco-IOS-XR-ncs1k-mxp-oper.yang	Cisco-IOS-XR-ncs5500-coherent-node-oper.yang
Cisco-IOS-XR-asr9k-sc-invmgr-oper.yang	Cisco-IOS-XR-snmp-ifmib-oper.yang
Cisco-IOS-XR-ptp-pd-oper.yang	Cisco-IOS-XR-ip-mobileip-oper.yang
Cisco-IOS-XR-ethernet-cfm-oper.yang	Cisco-IOS-XR-wdsysmon-fd-oper.yang
Cisco-IOS-XR-pbr-oper.yang	Cisco-IOS-XR-infra-objmgr-oper.yang
Cisco-IOS-XR-ip-rsvp-oper.yang	Cisco-IOS-XR-ipv6-io-oper.yang
Cisco-IOS-XR-terminal-device-oper.yang	Cisco-IOS-XR-plat-chas-invmgr-ng-oper.yang
Cisco-IOS-XR-mpls-oam-oper.yang	Cisco-IOS-XR-ncs5500-coherent-portmode-oper.yang
Cisco-IOS-XR-sse-span-oper.yang	Cisco-IOS-XR-infra-dumper-oper.yang
Cisco-IOS-XR-asr9k-sc-diag-oper.yang	Cisco-IOS-XR-mpls-io-oper.yang