



# Sample End-to-end Configuration

This appendix describes an end-to-end provisioning example for a Routed Optical Networking topology.

- [Sample Configuration, on page 1](#)

## Sample Configuration

This section details the step-by-step approach to build a new Routed Optical Networking based, 75 km fiber span to replace an existing legacy span in a two-node DCI topology.

- [Network Sizing Requirements, on page 1](#)
- [Planning and Design Phase, on page 4](#)
- [Implement Phase, on page 5](#)
- [Operate Phase, on page 59](#)
- [Optimization Phase, on page 71](#)

## Network Sizing Requirements

This section details the sizing requirements for a network. For a small lab installation, three servers with 256 GB of RAM is enough to run the Crosswork, Crosswork Network Controller, Cisco Optical Network Controller, NSO, Crosswork Hierarchical Controller, and EPNM in a non-HA deployment. For a production setup, calculate the total resources required using information in the following tables.

### Network Profiles

Network profiles are defined based on network size, services, and application features.

<b>Network Entity/Feature</b>	<b>Lab (20%)</b>	<b>Production (100%)</b>
Devices	2000	10000
Total number of interfaces	100000	650000
IGP interfaces	20000	100000

<b>Network Entity/Feature</b>	<b>Lab (20%)</b>	<b>Production (100%)</b>
VPN Services (L2, L3)	40000	200000
Endpoints per VPN service	2 to 10	50
Total LSPs (SR policies and RSVP tunnels)	12000	60000
Number of PCEP sessions	2000	10000



**Note** Each SR-PCE pair can only support 2000 PCEP sessions which means only 2000 headends for lab networks and 10000 headends for production networks. While counting headends, LCM nodes must be included.

### Deployment Size per Network Profile

The following table is the recommended deployment sizing requirement for solution using Cisco Crosswork Network Controller.

<b>Package</b>	<b>Contents</b>	<b>Crosswork Data Gateway Deployment</b>	<b>Recommended number of cluster VMs</b>
Cisco Crosswork Network Controller Essentials	Cisco Crosswork Optimization Engine	<b>On-Premise Standard</b> (default): Collectors only.	When Essentials package is installed WITHOUT Element Management Functions:  • <b>3 Hybrid nodes</b>  When Essentials package is installed WITH Element Management Functions:  • <b>3 Hybrid nodes + 1 Worker node</b>
	Cisco Crosswork Active Topology	<b>On-Premise Standard</b> (default): Collectors only.	
	Element Management Functions	<b>On-Premise Standard</b> (default): Collectors only.	
Cisco Crosswork Network Controller Advantage	Cisco Crosswork Service Health	<b>On-Premise Extended:</b> Collectors and offload services.	<b>3 Hybrid nodes + 2 Worker nodes</b>

Package	Contents	Crosswork Data Gateway Deployment	Recommended number of cluster VMs
Add-on Package	Cisco Crosswork Change Automation	<b>On-Premise Extended:</b> Collectors and offload services.	<b>3 Hybrid nodes + 2 Worker nodes</b>
	Cisco Crosswork Health Insights	<b>On-Premise Extended:</b> Collectors and offload services.	
	Cisco Crosswork Zero Touch Provisioning	<b>On-Premise Standard (default):</b> Collectors only.	



**Note** For non-production lab installations without HA, you can use 1 Hybrid node.

### VM Resources

The following table provide the details on CPU, memory, and disk requirements needed for each Crosswork VM and the other VMs in the deployment.

Crosswork VM	Crosswork Data Gateway	NSO	SR-PCE	Crosswork Hierarchical Controller	EPNM
<ul style="list-style-type: none"> <li>• CPU: 12 vCPU</li> <li>• RAM: 96 GB</li> <li>• DISK: 1 TB (SSD)</li> </ul>	<ul style="list-style-type: none"> <li>• CPU: 20 vCPU</li> <li>• RAM: 112 GB</li> <li>• DISK: 0.5 TB</li> </ul>	<ul style="list-style-type: none"> <li>• Small Network Profile               <ul style="list-style-type: none"> <li>• CPU: 8 vCPU</li> <li>• RAM: 64 GB</li> <li>• DISK: 250 GB</li> </ul> </li> <li>• Large Network Profile               <ul style="list-style-type: none"> <li>• CPU: 24 vCPU</li> <li>• RAM: 132 GB</li> <li>• DISK: 1TB</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• CPU: 8 vCPU</li> <li>• RAM: 24 GB</li> <li>• DISK: 45 GB</li> </ul>	<ul style="list-style-type: none"> <li>• CPU: 10 cores</li> <li>• RAM: 96 GB</li> <li>• DISK: 400G SSD (lab) , 3TB SSD (production)</li> </ul>	<ul style="list-style-type: none"> <li>• Professional (Small)               <ul style="list-style-type: none"> <li>• CPU: 16 vCPU</li> <li>• RAM: 64 GB</li> <li>• DISK: 2.8 TB</li> </ul> </li> <li>• Extended (Medium/Large)               <ul style="list-style-type: none"> <li>• CPU: 24 vCPU</li> <li>• RAM: 128 GB</li> <li>• DISK: 4 TB</li> </ul> </li> </ul>



**Note** In Routed Optical Networking 2.1, Cisco Optical Network Controller and Crosswork Network Controller require different Crosswork Infrastructure versions. The Crosswork Infrastructure Cluster for Cisco Optical Network Controller must have:

- 3 VM
- CPU: 12 vCPU
- RAM: 96 GB
- DISK: 1TB SSD

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### Cisco Optical Network Controller Scale Support

Cisco Optical Network Controller supports a maximum of 500 nodes and 600 services. Cisco Optical Network Controller can run on the same cluster. Cisco Optical Network Controller adds more resources incrementally at the maximum supported scale. It is captured in Crosswork VM resources in the table above.

## Planning and Design Phase

The planning and design phase involves:

### 1. Network Planning and Design

**Inputs needed:** Packet layer traffic demands, optical fiber topology, resiliency criteria, and other network constraints.

- WAE can be used to determine a new network build or augmentations to an existing network.
- After the IP network circuits have been determined, Cisco ONP is used to determine the optical layer feasibility and components that are used to support the network.

### Output for a sample configuration:

This topology uses two Cisco 8201 routers, two NCS 2006 terminal nodes with NCS1K-MD-64 add/drop multiplexers, and EDFA-35 bi-directional amplifiers. The span length is 75 kms. Longer spans may require additional ILA nodes for amplification.

### 2. Automation Software Resource Planning

#### Server requirements for the Routed Optical Networking software elements

Determine the servers required for the full solution. See [Network Sizing Requirements, on page 1](#) and [Installation Requirements for Routed Optical Networking Components, on page 4](#).

- For a lab or EFT setup, it is recommended to use three servers each with 384 G of RAM, 32 cores, and two TB SSD.
- The solution requires the use of VMware ESX 6.7 or higher.

## Installation Requirements for Routed Optical Networking Components

The following list points to the installation requirements for different Routed Optical Networking components.

- [Cisco Optical Network Planner 5.1](#)



- [Cisco WAN Automation Engine 7.5.0](#)
- [Cisco NCS 2000 Shelf Virtualization Orchestrator 12.3.x](#)
- [Cisco Crosswork Cluster, Crosswork Data Gateway, and Crosswork Applications](#)
- [Cisco Optical Network Controller 2.1](#)
- [Cisco Evolved Programmable Network Manager 7.0.1](#)
- [Cisco Network Services Orchestrator 6.1](#)
  - [Cisco NSO Routed Optical Networking Core Function Pack 2.1](#)
  - [Cisco NSO Transport-SDN Function Pack Bundle 5.0](#)
  - [Cisco Network Services Orchestrator DLM Service Pack 5.0](#)
- [Cisco Crosswork Hierarchical Controller 7.0](#)
- [Cisco Crosswork Network Controller 5.0](#)

## Implement Phase

The implement phase involves:

### 1. Installation of hardware components

- a. Hardware staging or installation and initial base configuration required for management connectivity.
- b. All onboard software updates must be completed to the required revision.
- c. All associated base wiring must be completed to support the network. This includes connections between the optical elements and connections between routers and optical add/drop end-points to support Routed Optical Networking circuits using ZR/ZR+ optics. See [Deployment Topologies](#).
- d. SVO 12.2 server or line card based installation to support NCS 2000 nodes. See [Install the External Server](#), and [Run the SVO Installation Tool](#).
- e. Create SVO instances for all NCS 2000 nodes. See [Create an SVO Instance](#).

### 2. Installation of the Automation Software Components

- a. Complete all server hardware installation and base configuration to support the solution, including VMWare ESX if not already installed.
- b. Install the following software components to support the Routed Optical Networking solution.
  - [Cisco Optical Network Planner 5.1](#) (for optical planning)
  - [Cisco WAN Automation Engine 7.5.0](#) (for IP planning)
  - [Cisco Crosswork Cluster, Crosswork Data Gateway, and Crosswork Applications](#) (for supporting Crosswork Network Controller)
  - [Cisco Optical Network Controller 2.1](#) (for supporting optical network)
  - [Cisco Evolved Programmable Network Manager 7.0.1](#) (for managing the physical router and the optical network nodes)

- [Cisco Network Services Orchestrator 6.1](#) (base installation to support RON FP)
  - [Cisco NSO Routed Optical Networking Core Function Pack 2.1](#) (for RON ML provisioning)
  - [Cisco NSO Transport-SDN Function Pack Bundle 5.0](#) (for Crosswork Network Controller SR and xVPN provisioning)
  - [Cisco Network Services Orchestrator DLM Service Pack 5.0](#) (for device synchronization between Crosswork Network Controller and NSO)
- [Cisco Crosswork Hierarchical Controller 7.0](#) (for provisioning the Routed Optical Networking ML service using the Crosswork Hierarchical Controller)




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**Note** This is required only if the Routed Optical Networking ML service is provisioned via the Crosswork Hierarchical Controller GUI.

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### 3. Onboarding of Devices

- a. Add devices to Cisco Optical Network Controller. See [Onboard Devices to Cisco Optical Network Controller](#).
- b. Add NSO, SR-PCE, and devices to Crosswork Network Controller. See [Add SR-PCE, NSO, and Routers to Crosswork Network Controller, on page 7](#).
- c. Add routers to NSO using the IOS-XR CLI NED. See Step 3 in [Provision ML Service Using NSO Routed Optical Networking CFP , on page 20](#).
- d. Add Cisco Optical Network Controller to NSO using the ONF TAPI NED.
- e. Add and configure the following Crosswork Hierarchical Controller adapters. See [Configure Adapters for Crosswork Hierarchical Controller, on page 13](#).




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**Note** This step is required only if the Routed Optical Networking ML service is provisioned via the Crosswork Hierarchical Controller GUI.

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- Add and configure the Crosswork Network Controller adapter.
- Create or import sites in Crosswork Hierarchical Controller. See the sections, "Add Sites" and "Export and Import Sites" in the [Cisco Crosswork Hierarchical Controller Administration Guide 5.1](#).
- Add and configure the IOS-XR adapter. Create router devices in Crosswork Hierarchical Controller using the IOS-XR adapter type. After the routers are created, add the Crosswork Network Controller adapter to the router device.
- Add and configure the Cisco Optical Network Controller adapter.

### 4. Provisioning of Services

- a. Ensure all device interconnections are complete.

- b. To provision the Routed Optical Networking ML service, use either one of the procedures:
  1. **Using the NSO GUI:**
    - a. Utilize the Routed Optical Networking FP ML services to provision and end-to-end service. See [Provision ML Service Using NSO Routed Optical Networking CFP](#), on page 20.
    - b. Verify that the end-to-end service has been deployed by checking the NSO service deployment status using the check-sync status.
    - c. Verify the router optics controller state using the CLI or in EPNM. See [Troubleshoot Provisioning Issues](#).
  2. **Using the Crosswork Hierarchical Controller GUI:**
    - a. Utilize the Crosswork Hierarchical Controller GUI to provision and end-to-end Routed Optical Networking ML service. See [Provision Routed Optical Networking ML Service Using Crosswork Hierarchical Controller](#), on page 34.
    - b. Verify the router optics controller state using the Link Assurance tool in Crosswork Hierarchical Controller. See Step 4 in [Provision Routed Optical Networking ML Service Using Crosswork Hierarchical Controller](#), on page 34.

## Add SR-PCE, NSO, and Routers to Crosswork Network Controller

Perform these steps to add SR-PCE providers, NSO providers, and routers to Crosswork Network Controller.



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**Note** When you add or import devices, or create providers, you need to specify the credential profile.

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1. [Log in](#) to the Crosswork user interface.
2. To create a credential profile, choose **Device Management** > **Credential Profiles** from the main menu. See [Manage Credential Profiles](#).
  - a. For the NSO credential profile, the connectivity type must be set to NETCONF and HTTPS. Optionally, HTTP can also be defined if HTTPS is not used in NSO.

Edit Profile nso ×

Profile Name \* nso

Add Credential Protocols

Connectivity Type	User Name *	Password *	Confirm Password *	
NETCONF	nso	.....	.....	🗑️
HTTPS	nso	.....	.....	🗑️

[+ Add Another](#)

[Save](#) [Cancel](#)

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- b. The SR-PCE credential profile requires HTTP credentials to communicate with the SR-PCE Northbound API.

Edit Profile SR-PCE ×

Profile Name \* SR-PCE

Add Credential Protocols

Connectivity Type	User Name *	Password *	Confirm Password *	
HTTP	admin	.....	.....	🗑️

[+ Add Another](#)

[Save](#) [Cancel](#)

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- c. The router credential profile requires at a minimum, the SNMPv2 or SNMPv3 and SSH connectivity types. NETCONF is optional. GNMi is used when utilizing GNMi to configure streaming telemetry sensors on the node.

Edit Profile routers

Profile Name \* routers

Add Credential Protocols

Connectivity Type	Read Community *	Write Community
SNMPv2	*****	*****

Connectivity Type	User Name *	Password *	Confirm Password *
SSH	admin	*****	*****
Enable Password			

Connectivity Type	User Name *	Password *	Confirm Password *
NETCONF	admin	*****	*****

Connectivity Type	User Name *	Password *	Confirm Password *
GNMI	admin	*****	*****

+ Add Another

Save Cancel

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3. Add the providers. See [About Adding Providers](#).
  - a. To add the SR-PCE or NSO provider, choose **Administration > Manage Provider Access** from the main menu. See [Manage Providers](#).
  - b. Add the NSO provider. See [Add Cisco NSO Providers](#).

Select the credential profile created for NSO. Select the family as NSO. The Device Key may be set to either the HOST\_NAME or INVENTORY\_ID depending on the specific deployment.

The following image demonstrates the connectivity to NSO's RESTCONF API over SSL using port 8888 and NETCONF using the default port of 2022. Since the Routed Optical Networking NSO CFP utilizes the XR CLI NED, the Cisco-IOS-XR model is not applicable and may be set to any version.

Edit Provider
✕

**Provider Name \***

**Credential Profile \***

**Family \***

**Device Key \***

Connection Type(s)

Protocol *	IP Address / Subnet Mask *	Port *	Timeout	
HTTPS	172.29.11.58 / 25	8888	60	🗑️
NETCONF	172.29.11.58 / 25	2022	60	🗑️

[+ Add Another](#)

Provider Properties

Property Key	Property Value	
forward	true	🗑️

[+ Add Another](#)

Model Prefix Info

Model *	Version *	
Cisco-IOS-XR	7.3.1	🗑️

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- c. Add the SR-PCE provider. See [Add Cisco SR-PCE Providers](#).

Select the credential profile created for SR-PCE. Select the family type as SR\_PCE. The connectivity type for SR-PCE must be the HTTP. In the following image, the default API port of 8080 is specified. When the Property Key, "auto-onboard" is set to a Property value, "off", Crosswork Network Controller does not automatically add nodes that are discovered via the SR-PCE IGP topology to the device inventory. Devices must be added through the Crosswork Network Controller UI or inventory API.

Edit Provider
✕

**Provider Name \***

**Credential Profile \***

**Family \***

Connection Type(s)

Protocol *	IP Address / Subnet Mask *	Port *	Timeout	
HTTP	172.29.11.54 / 25	8080	60	✕

[+ Add Another](#)

Provider Properties

Property Key ?	Property Value ?	
auto-onboard	off	✕

[+ Add Another](#)

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4. Validate communications with one or more providers. Check on the provider's reachability using the steps in [Get Provider Details](#).
5. Onboard devices. See [Add Devices Through the UI](#).
  - a. The Administration State, Reachability Check, and Credential Profile are mandatory elements. The Host Name must be used if the NSO provider device key is set to the Host Name value. If the NSO provider device key is set to Inventory ID that field must be populated. The Software Type, Software Version, UUID, Serial Number, MAC address, and Product Type are filled by device discovery. Optionally, tags can be applied to the device. The GNMI encoding type can be set to JSON or PROTO.

Add New Device
✕

▼ General

<p>Administration State* <input type="text" value="UP"/></p> <p>Reachability Check* <input type="text" value="ENABLE"/></p> <p>Credential Profile* <input type="text" value="routers"/></p> <p>Host Name <input type="text" value="ron-8201-1"/></p> <p>Inventory ID <input type="text"/></p> <p>Software Type <input type="text"/></p> <p>Software Version <input type="text"/></p>	<p>UUID <input type="text"/></p> <p>Serial Number <input type="text"/></p> <p>Mac Address <input type="text"/></p> <p>Capability* <input type="text" value="YANG_MDT, SNMP, GNMI"/></p> <p>Tags <input type="text"/></p> <p>Product Type <input type="text"/></p> <p>Syslog Format <input type="text"/></p>
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▼ Connectivity Details

Protocol *	IP Address / Subnet Mask *	Port *	Timeout	Encoding Type	
<input type="text" value="SSH"/>	<input type="text" value="172.29.11.20 / 25"/>	<input type="text" value="22"/>	<input type="text" value="60"/>	<input type="text"/>	<input type="text"/>
<input type="text" value="SNMP"/>	<input type="text" value="172.29.11.20 / 25"/>	<input type="text" value="161"/>	<input type="text" value="60"/>	<input type="text"/>	<input type="text"/>
<input type="text" value="GNMI"/>	<input type="text" value="172.29.11.20 / 25"/>	<input type="text" value="57333"/>	<input type="text" value="60"/>	<input type="text" value="PROTO"/>	<input type="text"/>
<input type="text" value="NETCONF"/>	<input type="text" value="172.29.11.20 / 25"/>	<input type="text" value="830"/>	<input type="text" value="60"/>	<input type="text"/>	<input type="text"/>

[+ Add Another](#)

> Routing Info

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Optionally, location information can be entered. Latitude and Longitude information place the node at a specific location on a geographic map.

Add the previously configured NSO provider as a provider for the device.



Add New Device
✕

SNMP	172.29.11.20	/ 25	161	60		
GNMI	172.29.11.20	/ 25	57333	60	PROTO	
NETCONF	172.29.11.20	/ 25	830	60		

+ Add Another

> Routing Info

> Streaming Telemetry config

∨ Location

Building

Street

City

State

Country

Region

Zip

Latitude

Longitude

Altitude

∨ Providers and Access

Provider Family	Provider Name	Credential	Device Key
NSO	nso-58	nso	ron-8201-1

+ Add Another

Save
Cancel

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- b. Attach the devices to an active Cisco Crosswork Data Gateway pool to manage them (device discovery). Review the Data Gateways pane (see [Overview of Cisco Crosswork Data Gateway](#)). The operational state of the Cisco Crosswork Data Gateway pool to which you want to attach devices must be **Up**. Follow the steps in [Attach Devices to Cisco Crosswork Data Gateway](#).

Administration / Data Gateway Management
SHOW ALL

Data Gateways Pools Virtual Machines

∨ Data Gateway Metrics Summary

Operational State

- Up (1)
- Down (0)
- Degraded (0)
- Unknown (0)

Administration State

- Up (1)
- Maintenance (0)

High Availability Status

- Protected (0)
- Not Protected (0)
- Limited Protection (0)
- None Planned (1)

Devices

- Attached (13)
- Available (0)

Data Gateways Total 1

Name	Operational State	Administration State	High Availability Status	Pool Name	Outage History	Average Availability	VM ID	Attached Device Count	Actions
cdg-pool-1-1	Up	Up	None Planned	cdg-pool-1			cdg-socket	13	<ul style="list-style-type: none"> <li>Attach Devices</li> <li>Detach Devices</li> <li>Move Devices</li> </ul>

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## Configure Adapters for Crosswork Hierarchical Controller

### Prerequisite

When you work with Crosswork Hierarchical Controller adapters you are required to use credentials. These credentials are used for authentication when a device is assigned to an adapter. The same credentials may be shared by multiple adapters. The credentials are added under the **Services > Device Manager > Credentials**

tab in the Crosswork Hierarchical Controller GUI. The adapters needed for the Routed Optical Networking solution are:

**Table 1: Routed Optical Networking Adapters**

Adapter	Credential Type
Crosswork Network Controller	HTTP (username/password)
Crosswork Network Controller Crosswork Data Gateway	HTTP (username/password)
Cisco Optical Network Controller	HTTP (username/password)
IOS-XR	SSH - User and password




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**Note** If Cisco Optical Network Controller and Crosswork Network Controller are on the same Crosswork cluster, they can use the same credential profile.

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To add the adapters, perform the following steps:

1. In the applications bar in Crosswork Hierarchical Controller, select **Services > Device Manager > Adapters**.
2. Click **Add new adapter**.
3. Enter the adapter details:
  - **Adapter Type:** Select an adapter type from the list of available adapter types currently installed in Crosswork Hierarchical Controller.
  - **Adapter Name:** Unique user defined name of this adapter type instance (there can be several instances of the same adapter type).
4. To configure the adapter, select the adapter in the Adapters pane. Configure the parameters as displayed in the following images.
  - **Crosswork Network Controller Adapter:**




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**Note** API version for Crosswork Network Controller must be V2.

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**Figure 1: Crosswork Network Controller Adapter Configuration - General Tab**

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**Note** The Full Data Fetch Interval must be set to 300s or higher in a production network.

The following parameters must be configured for Crosswork Network Controller notifications and collection.

**Figure 2: Crosswork Network Controller Adapter Configuration - General Tab**

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• **IOS-XR Adapter**

Figure 3: IOS-XR Adapter - General Tab

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**Note** The Polling Cycle should not be less than 300s in a production network. Concurrency can be increased. The Logging Level must be set to Info if everything is working correctly.

The following collection parameters must be configured. These parameters collect optical power values for the link assurance application.

Figure 4: IOS-XR Adapter - General Tab

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The status of the devices must be **ok** in the Devices tab after the addition and completion of a successful collection cycle.

Figure 5: IOS-XR Adapter - Devices Tab

Name	Status	Status Changes (Last 24 hrs)	Site	Adapter(s)	Host	Port
16 ITEMS						
172.29.11.26	✓ Ok	0	Monterey	cisco-xr, cnc30	172.29.11.26	22
172.29.11.41	✓ Ok	0	Tucson	cisco-xr, cnc30	172.29.11.41	22
172.29.11.23	✓ Ok	2	Las Vegas	cisco-xr, cnc30	172.29.11.23	22
172.29.11.40	✓ Ok	0	Monterey	cisco-xr, cnc30	172.29.11.40	22
172.29.11.29	✓ Ok	0	ST. George	cisco-xr, cnc30	172.29.11.29	22
172.27.227.11	✓ Ok	0	Cedar City	cisco-xr, cnc30	172.27.227.11	22
172.29.11.120	✓ Ok	0	Tucson	cisco-xr, cnc30	172.29.11.120	22
172.29.11.22	✓ Ok	0	Mortero Palms	cisco-xr, cnc30	172.29.11.22	22
172.29.11.28	✓ Ok	0	Albuquerque	cisco-xr, cnc30	172.29.11.28	22
172.29.11.24	✓ Ok	0	San Diego	cisco-xr, cnc30	172.29.11.24	22
172.27.227.10	✓ Ok	0	Santa Fe	cisco-xr, cnc30	172.27.227.10	22
172.29.11.30	✓ Ok	0	ST. George	cisco-xr, cnc30	172.29.11.30	22
172.29.11.21	✓ Ok	0	Las Vegas	cisco-xr, cnc30	172.29.11.21	22
172.29.11.27	✓ Ok	2	San Luis Obispo	cisco-xr, cnc30	172.29.11.27	22
172.29.11.20	✓ Ok	0	Los Angeles	cisco-xr, cnc30	172.29.11.20	22
172.29.11.25	✓ Ok	0	Flagstaff	cisco-xr, cnc30	172.29.11.25	22

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To add routers to Crosswork Hierarchical Controller, click the **Managed Devices** tab and then **+ Add Device**.

Figure 6: IOS-XR Adapter -Add New Device - General Tab

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It is recommended to use the hostname+hco (ron-8201-1-hco) or the device IP address. The device must be assigned a site for it to be displayed in the Explorer UI.

Assign both the IOS-XR and Crosswork Network Controller adapter type to the device. Do not enable discovery for the Crosswork Network Controller adapter.

Figure 7: IOS-XR Adapter -Add New Device - Adapters Tab

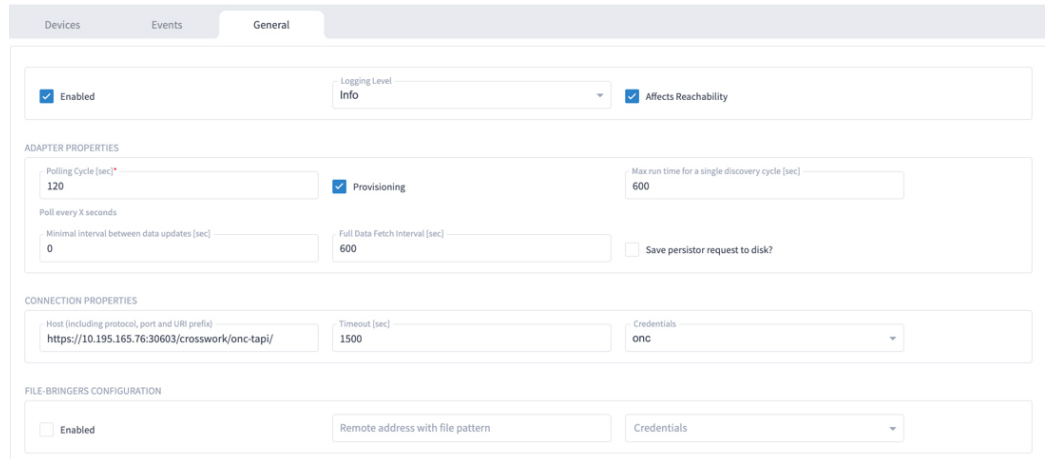
522158

• **Cisco Optical Network Controller Adapter**

**Figure 8: Cisco Optical Network Controller Adapter - General Tab**

The Polling cycle must be set to 300s or higher in a production network. Polling retrieves TAPI SIPs, topology, and connectivity services.

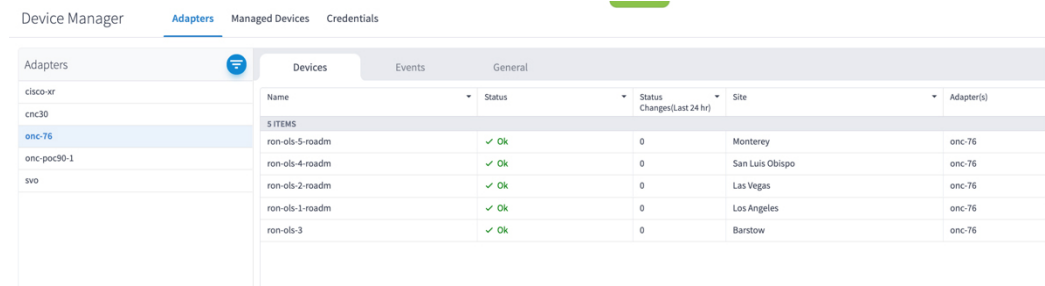
The URL in the following figure is for the Cisco Optical Network Controller cApp installed on the CW cluster.



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The optical nodes are discovered automatically from Cisco Optical Network Controller. Nodes must be assigned a site for it to be displayed in the Explorer UI.

**Figure 9: Cisco Optical Network Controller Adapter - Devices Tab**



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• **Crosswork Network Controller Crosswork Data Gateway Adapter**

Crosswork Network Controller Crosswork Data Gateway adapter is used to collect telemetry data via gNMI to the router. In Crosswork Network Controller, the routers must be configured with the gNMI protocol with the encoding type set to “PROTO” and the GNMI capability enabled. In IOS XR, the routers must be configured for gRPC so that Crosswork Data Gateway can create gNMI telemetry subscriptions.

Figure 10: Crosswork Network Controller Crosswork Data Gateway Adapter

Protocol *	IP Address / Subnet Mask *	Port *	Timeout(sec)	Encoding Type
SSH	172.29.11.40 / 25	22	60	
SNMP	172.29.11.40 / 25	161	60	
Encryption <input type="text"/>				
NETCONF	172.29.11.40 / 25	830	60	
GNMI	172.29.11.40 / 25	57333	60	PROTO

+ Add Another

**Capability\***

YANG MDT  TL1  YANG CLI  YANG EPNM  SNMP  GNMI

> Providers and Access

> Routing Info

> Streaming Telemetry config

> Location

The Crosswork Data Gateway adapter is configured to connect to Crosswork Network Controller controlling Crosswork Data Gateway instance. It can be the same as the Crosswork Network Controller used for the topology or a different Crosswork Network Controller. The collection parameters describe the supported telemetry collection jobs. The statistics show up in the physical interface statistics and in the Link Assurance application.

Figure 11: Crosswork Network Controller Crosswork Data Gateway Adapter - General Tab

Adapters

- eliso-edg
- cisco-wr
- cnc30
- onc-76
- onc-pac90-1
- sv0

Devices Events **General**

Enabled Logging Level: Info

Collector Cadence [sec]: 90 Status Update Interval [sec]: 180

Collector sample cadence in seconds NOTE: You can see missed stats errors if the interval is less than the collector cadence

**CNC CONFIGURATION**

Host\*: 10.195.165.76 Port\*: 30603 Timeout [sec]: 30

Request Retries: 3 Credential\*: ONC

**GRPC LISTENER CONFIGURATION**

IP Address\*: 172.29.11.60 Port\*: 65001 Destination Name\*: netfusion\_cdg

NOTE: Make sure that the address is forwarded (or belongs) to the docker host NOTE: Make sure that a firewall does not block the docker host port NOTE: The name should be unique in the crosswork context

**COLLECTION PARAMETERS**

Missed ports stats error threshold (percentage): 10 Enable Interface Counters Enable Optics Counters: Instant

Threshold in percentages per device ports with no stats to report error

Enable Optics Counters: 30 Seconds  Enable Optics Counters: 15 Minutes  Enable Optics Counters: 24 Hours

Enable OTU Counters: Instant  Enable OTU Counters: 30 Seconds  Enable OTU Counters: 15 Minutes

Enable OTU Counters: 24 Hours

- The device name in Cisco Crosswork Hierarchical Controller must match the device name in Crosswork Network Controller for successful deployment. If successful, you will see Cisco Crosswork Hierarchical Controller as a new destination in Crosswork Network Controller. This is setup by Cisco Crosswork Hierarchical Controller and user interaction is not required. As Crosswork Data Gateway is enabled on devices, new collection jobs are populated. A single collection job is available for each router collecting multiple KPIs.

Figure 12: Crosswork Network Controller Crosswork Data Gateway Adapter - Data Destinations

Destination Name	Server Type	Compression Type	Encoding	UUID
Crosswork_Kafka	Kafka	snappy	gpbkv	c2a8fba8-8363-3d22-b0c2-a9e449693fae
cdg-astack-pipeline	gRPC	gzip	gpbkv	e9b4c2ec-b2e6-4db0-a942-0402dd347a1d
netfusion_cdg	gRPC	gzip	gpbkv	0a088f8b-3fea-4694-a744-54c02fbdda5e

Figure 13: Crosswork Network Controller Crosswork Data Gateway Adapter - Collection Jobs

Status	App ID	Context ID	Action
Successful	netfusion_cdg	non-poc-8201-2	
Successful	cw.dminvmgr0	dmicli-collector/groutf...	
Successful	cw.dminvmgr0	dmicli-collector/groutf...	
Successful	cw.optimatrafic	cw.optimatraficmndt-ctx	
Successful	cw.dminvmgr0	dmicli-collector/groutf...	
Successful	cw.dminvmgr0	dmicli-collector/groutf...	
Successful	cw.topo_svc	cw.topo_svc.snmp	
Successful	netfusion_cdg	non-poc-8201-1	
Successful	cw.optimatrafic	cw.optimatraficmndt-ctx	
Successful	cw.topo-visualization	topo-visualization.colle...	
Degraded	cw.topo_svc	cw.topo_svc.snmptraps	

### • NSO Adapter In Hierarchical Controller

In Hierarchical Controller 8.0 there is an embedded NSO installed when Hierarchical Controller 8.0 is installed. The NSO adapter can use the internal NSO or point to an external NSO instance. Provisioning using the NSO adapter requires adding the NSO adapter to the devices you want to provision.



#### Note

- If using the internal NSO, the Routed Optical Networking 3.0 Core Function Pack must be installed on the NSO instance.
- If using the internal NSO, devices must be added to that NSO, adding them to Hierarchical Controller does not automatically onboard them into the internal NSO.

Figure 14: NSO Adapter - General Tab

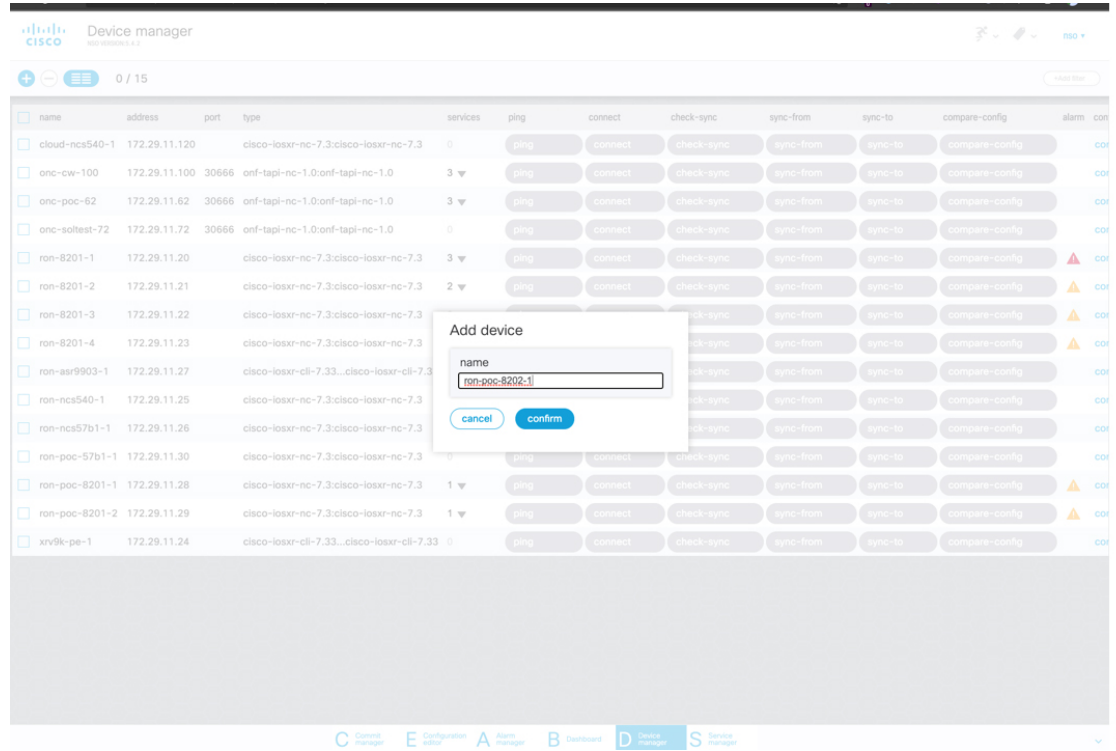
Start configuration with NSO and XR adapters.

## Provision ML Service Using NSO Routed Optical Networking CFP

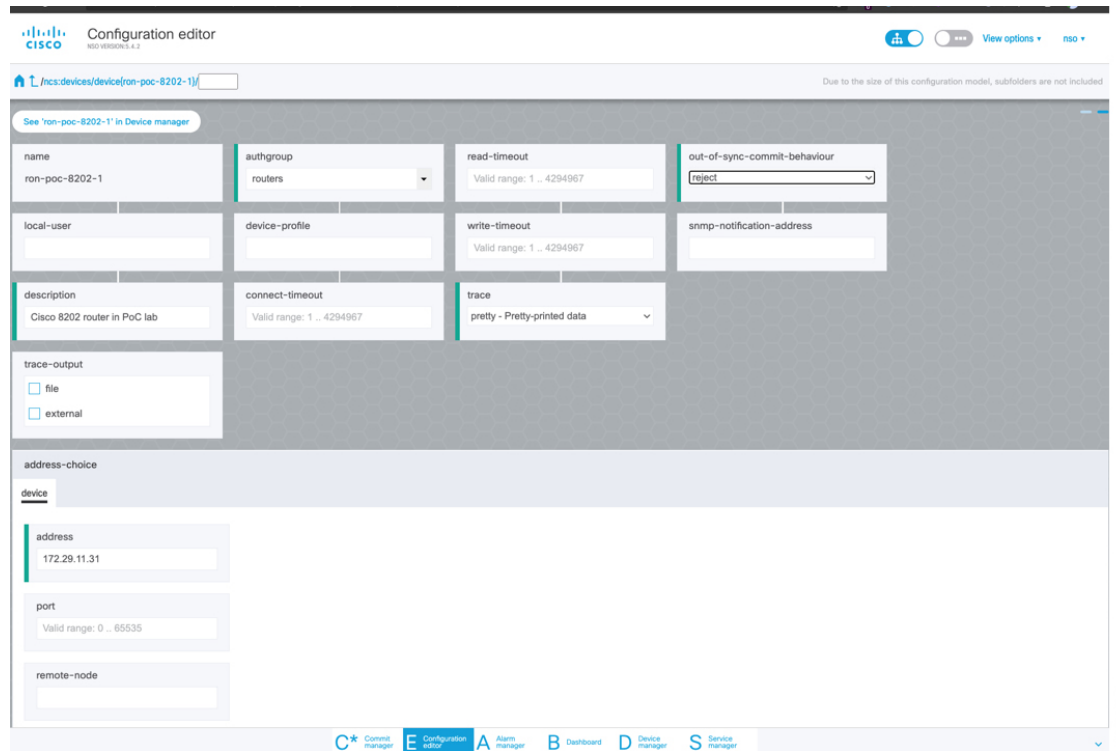
Perform the following steps to provision the Routed Optical Networking ML service using the NSO Web UI.

1. To add a new device, perform these steps:
  - a. In the Device manager, click the + to add a new device. Specify a name for the new device. Click **Confirm**.

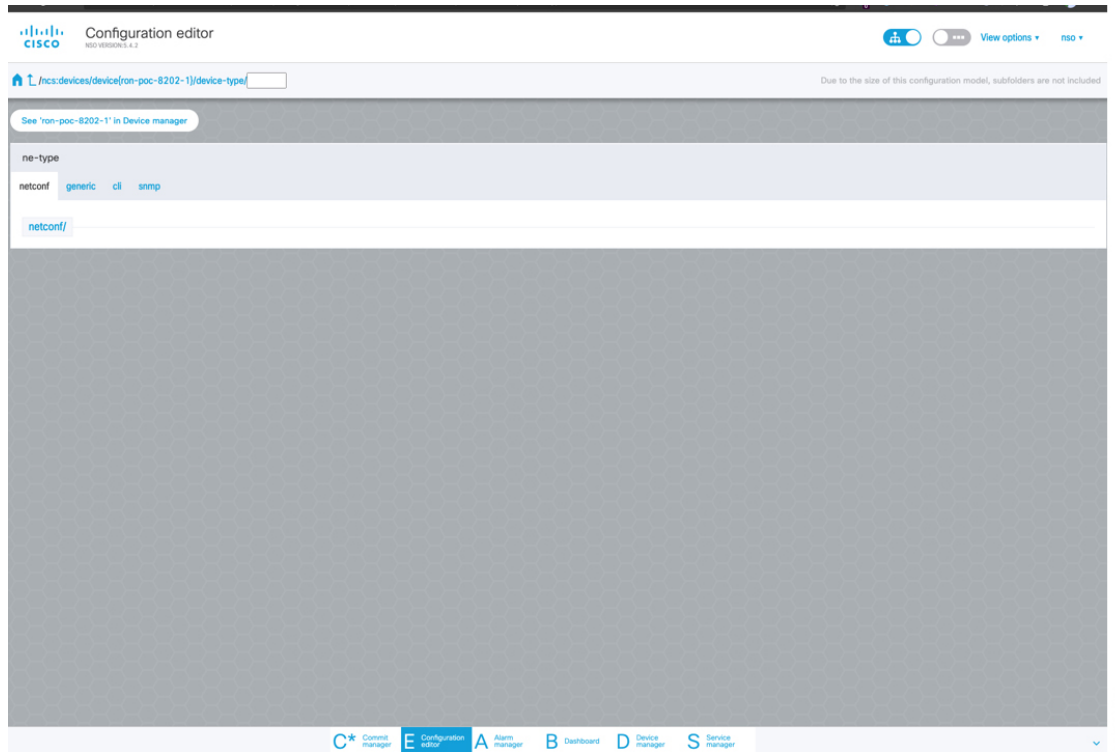




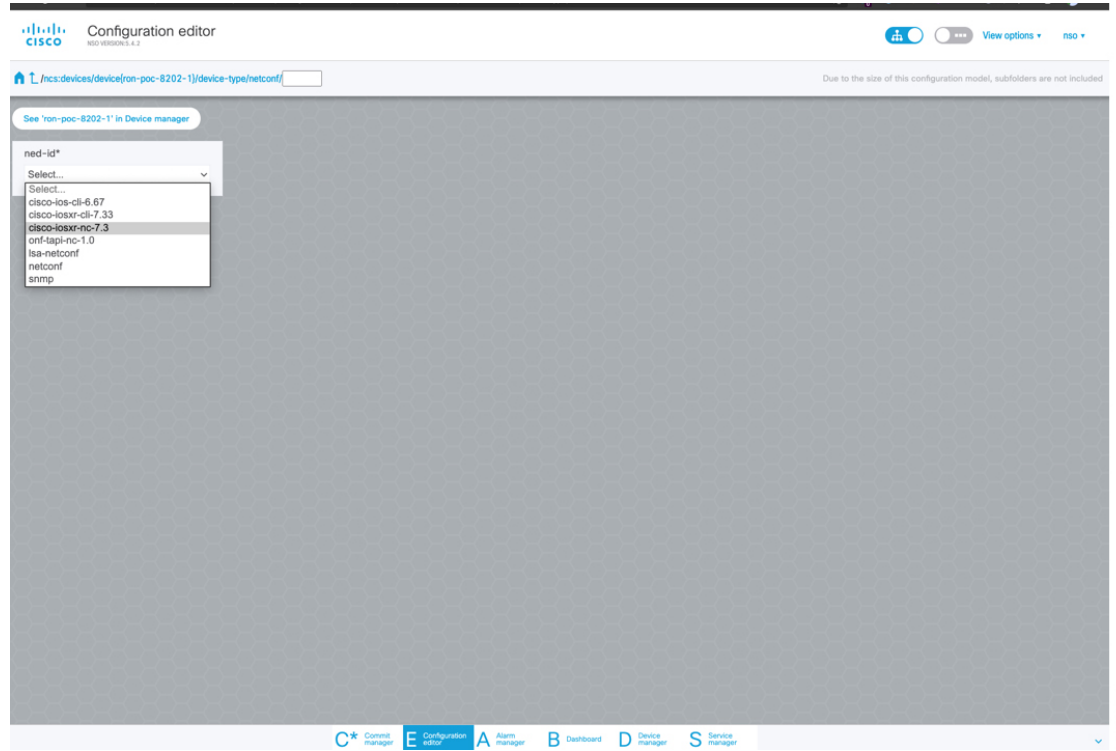
- b. After creating the new device, click the device name to fill required and optional parameters. In this screen, the required parameters are the authgroup and IP address of the device.



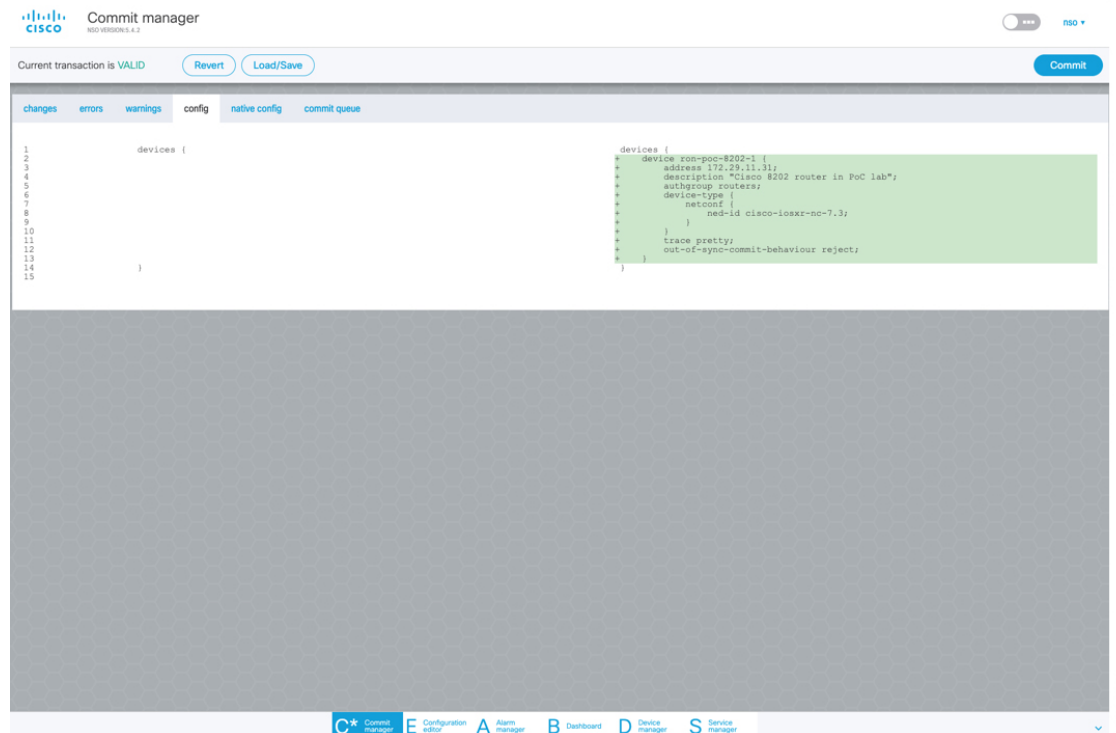
- c. Scroll down in the device configuration screen. Click the “device-type” to bring up the device type selection screen. The device-type that is supported in the Routed Optical Networking ML FP is IOS-XR CLI NED.



- d. Click the blue NETCONF text to select the proper NED. The Routed Optical Networking ML FP requires the use of the **cisco-iosxr-nc-7.3** NED.

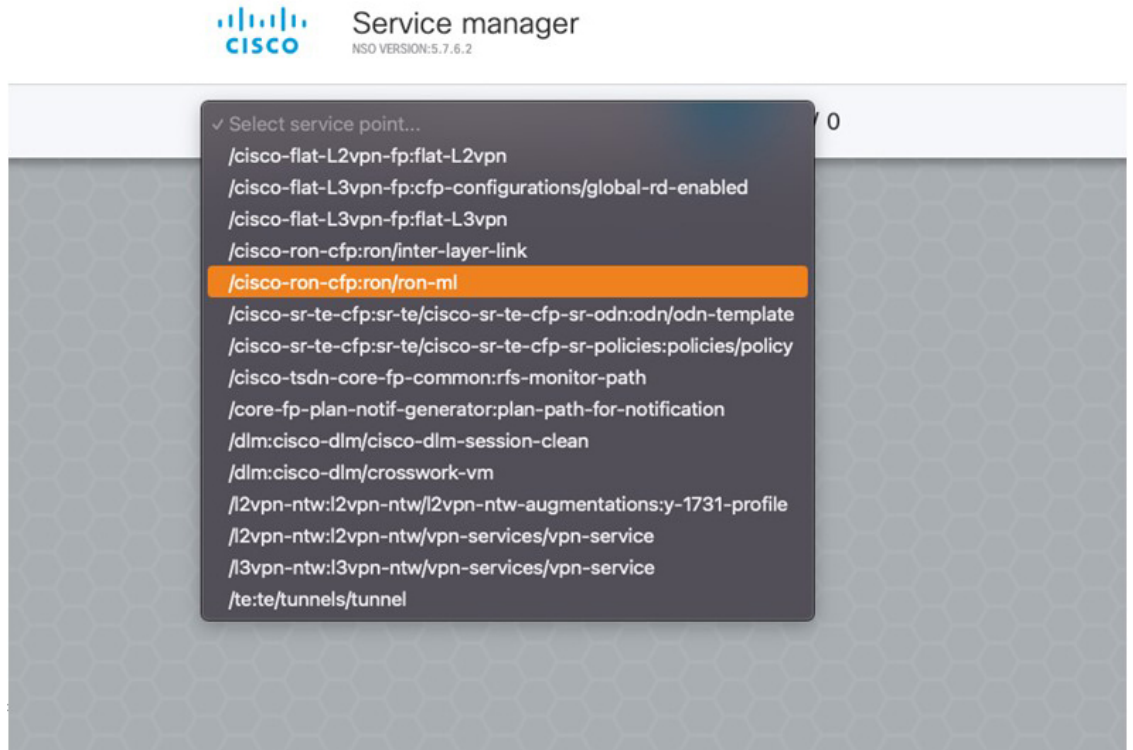


- e. Click the Commit manager to view the NSO CLI configuration being applied. Click **Commit** to save the device configuration to NSO.





**Note** Next we add the multilayer end-to-end service to configure and provision both the optical line system and routers. We recommend you to click **check-sync** in the Device manager to ensure that the device configuration is properly in sync with NSO before provisioning. If the device is out of sync, initial provisioning fails.



2. To create Routed Optical Networking ML service, perform these steps:
  - a. In the Service manager, select the Routed Optical Networking ML service point from the drop-down list. When we create the new Routed Optical Networking ML service, the required components are the service name, mode of the service (transponder or muxponder), and the bandwidth. The bandwidth corresponds to the line rate of the ZR/ZR+ optics. Click **Confirm**.

## Create service

name

mode

bandwidth

- b. In the Configuration editor, click the newly created service name for editing the additional parameters that are required for the service. In this example, we set the circuit-id name in the global parameters. The frequency is set by the optical controller based on the specified optical add/drop port. The dac-rate

is set to the default value.

The screenshot shows the Cisco Configuration Editor interface for a circuit named 'poc\_circuit\_195200'. The configuration fields are as follows:

Field	Value
name	poc_circuit_195200
circuit-id	This is a demo circuit
dac-rate	
mode*	transponder
grid-type	(100mhz-grid)
clear-rollback	
bandwidth*	400
frequency	
end-point	This list is empty
ols-domain/	
service-state	(UNLOCKED)
custom-template	This list is empty

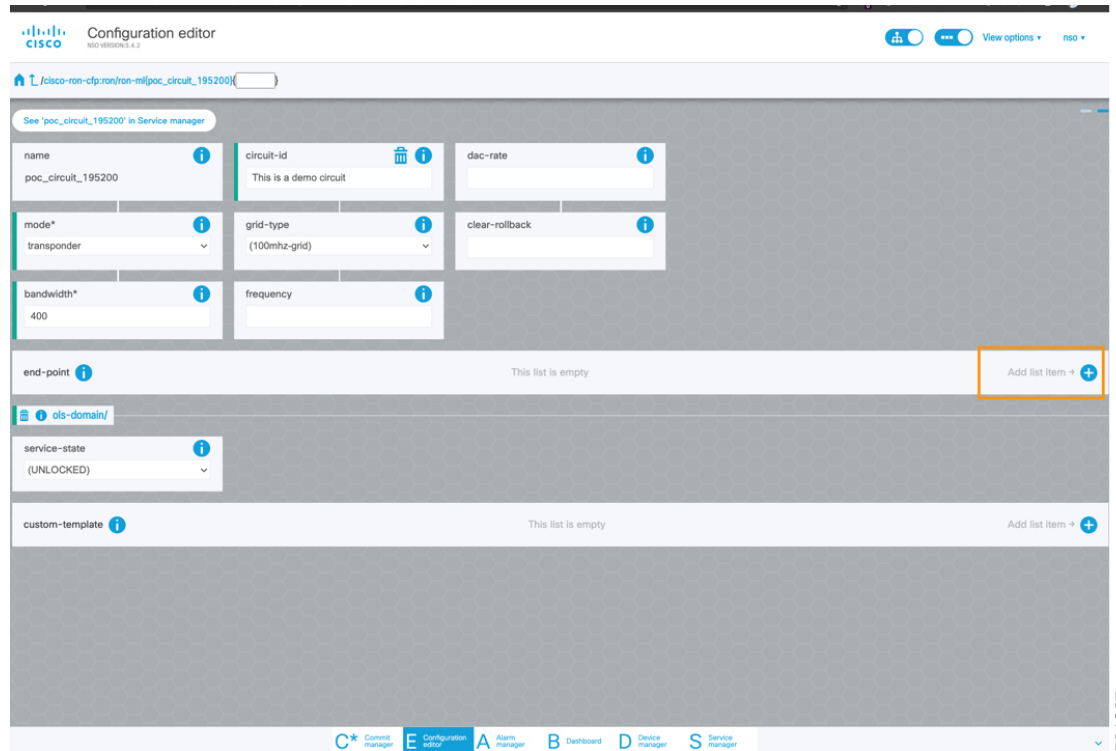
The bottom navigation bar includes: C\* Control Manager, E Configuration editor (active), A Alarm Manager, B Dashboard, D Device Manager, S Service Manager.



#### Note

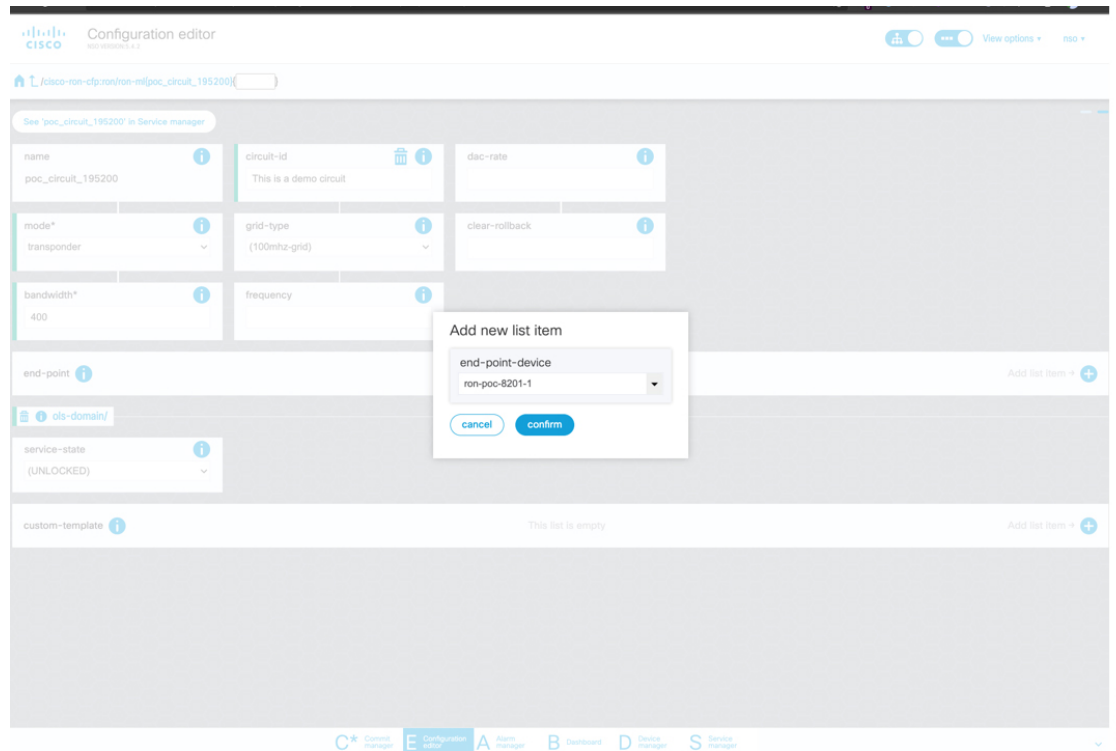
- User configuration global options are frequency and dac-rate
- Dac-rate controls the TX shaping parameters: 1x1.25 = enabled, 1x1 = disabled. Leaving it blank uses system default of enabled, and can be used in most circumstances
- Modulation of 16 QAM is available for 2x100G muxponder mode.

- c. After the ols-domain is added, you must add end-points to the circuit. Two end-points are always required. The end-points are the routers with ZR/ZR+ optics.



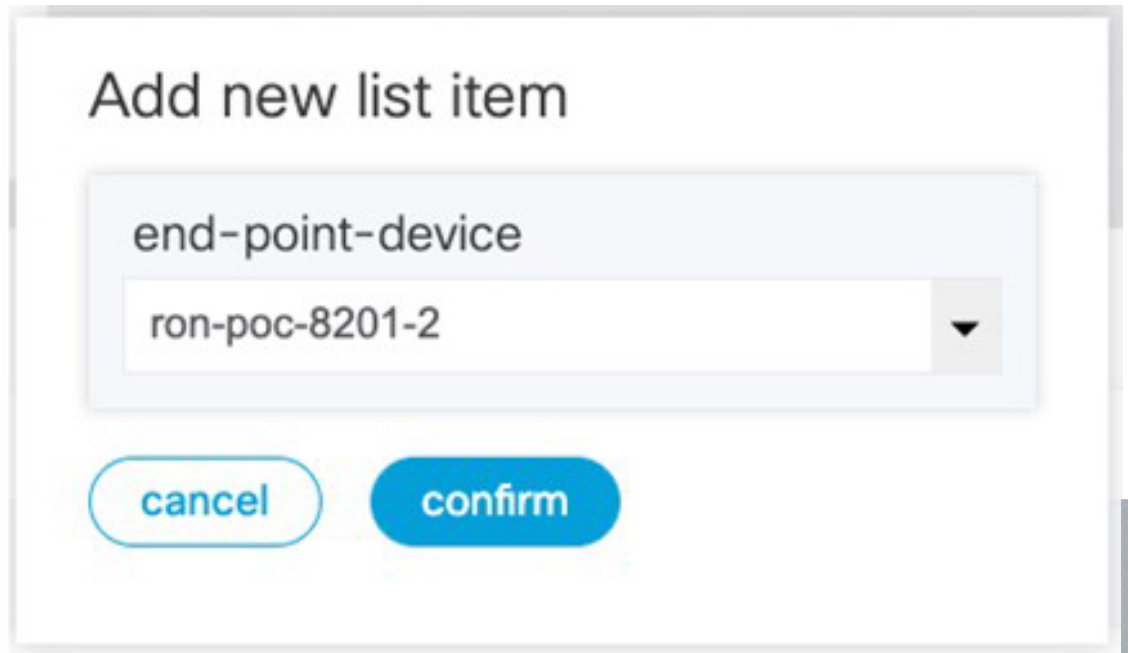
521927

d. Add the end-point-device to the service. Click **Confirm**.



521928

After the end-point is created, click the end-point to edit the end-point parameters. The line-port is a required parameter and refers to the optics port on the router. In this example, this is the same as the line-port specified in the inter-layer-link service for the end-point router.



The screenshot shows a dialog box titled "Add new list item". Inside the dialog, there is a text input field containing the text "end-point-device". Below this field is a dropdown menu with the selected item "ron-poc-8201-2". At the bottom of the dialog, there are two buttons: "cancel" and "confirm".

The transmit-power is an optional parameter for end-to-end provisioning. If it is omitted the optical controller (Cisco Optical Network Controller) will provide the transmit power. Transmit power sets the transmit power, the value is in 100\*value in 0.1dBm increments. For example, -100 is -10dBm. If no value is specified the default of -10dBm is used for QDD-400G-ZR-S or QDD-400G-ZRP-S, or 0dBm for DP04QSDD-HE0 (Bright ZR+). The transceiver-capability field specifies the optic type and is only required if no packet layer configuration is being performed. In this example, you are performing packet layer provisioning so specifying the transceiver capability is not required.

Add the line-port of 0/0/0/20 to the Routed Optical Networking ML service.



The screenshot shows the Cisco Configuration Editor interface. The breadcrumb path is `/cisco-ron-clp/ron/ml[poc_circuit_195200]/end-point[ron-poc-8201-1]`. The configuration tree on the left includes sections for `terminal-device-optical/`, `ols-domain/`, and `terminal-device-packet/`. The `terminal-device-packet/` section is expanded, showing three empty lists: `bundle`, `interface`, and `custom-template`. Each list has an 'Add list item' button with a plus sign. The bottom navigation bar shows tabs for `Config`, `Alarm`, `Dashboard`, `Device`, and `Service`.

521930

- e. Click end-point to go back to the top-level endpoint configuration, click **terminal-device-packet** to configure Ethernet/IP parameters

The screenshot shows the Cisco Configuration Editor interface. The breadcrumb path is `/cisco-ron-clp/ron/ml[poc_8201_1_to_poc_8201_2_20]/end-point[ron-poc-8201-1]/terminal-device-packet/`. The configuration tree on the left shows three empty lists: `bundle`, `interface`, and `custom-template`. Each list has an 'Add list item' button with a plus sign. The bottom navigation bar shows tabs for `Config`, `Alarm`, `Dashboard`, `Device`, and `Service`.

**Note**

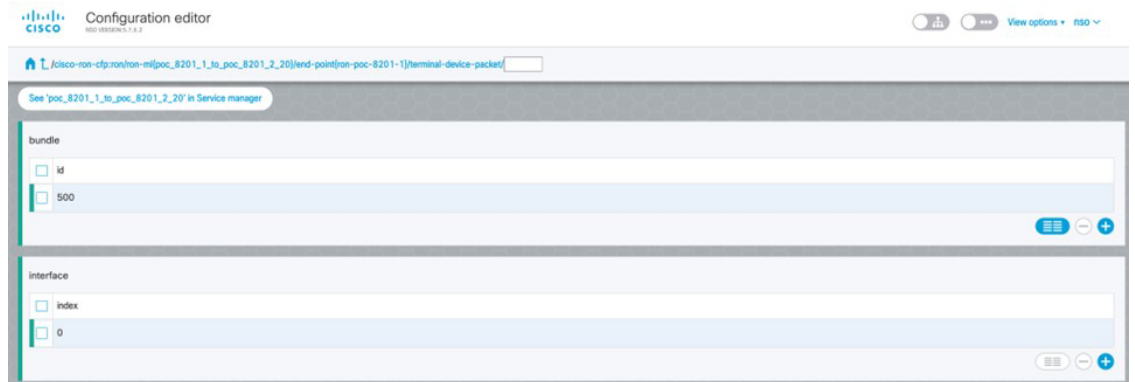
- Ethernet/IP configuration is optional.
- Bundle configuration adds an interface to an existing bundle or creates a new bundle and adds the newly created IP interface to it.

Interface configuration is used for configuring IP address parameters on newly created Ethernet interfaces.

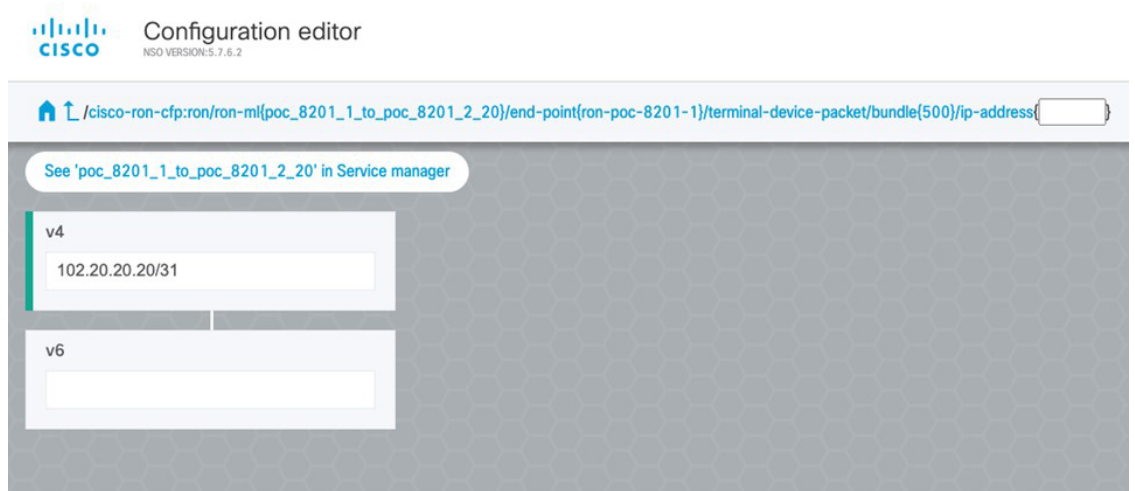
In this example we add a new Bundle and assign an IP address to the Bundle.

- f. Click the plus sign next to bundle to add a bundle, in this case with an identifier of 500. This creates a bundle interface Bundle-Ether 500 on the endpoint router

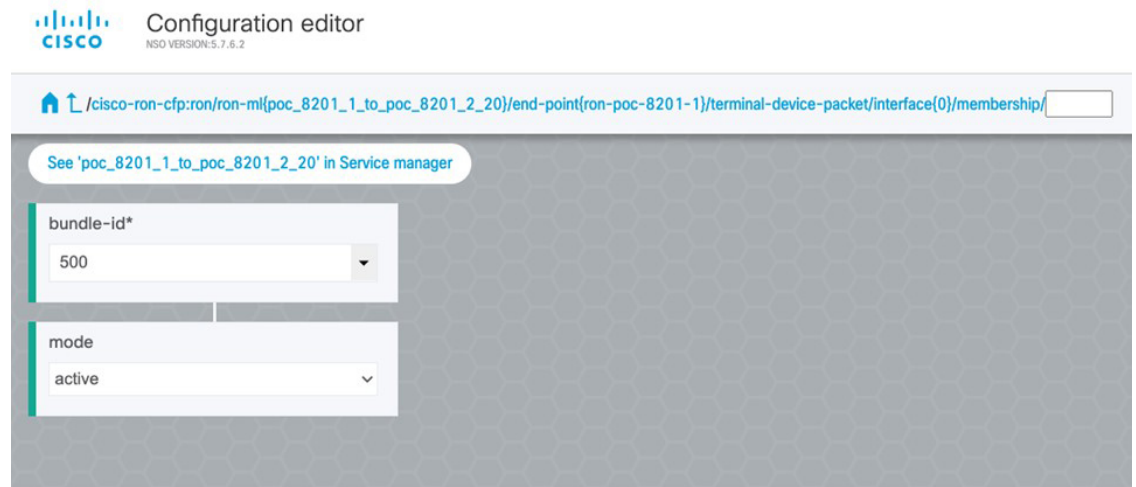
The interface index for a bundle use case is always 0. In case of a non-bundle configuration in muxponder mode, the index can be 0–3 representing the number of interfaces created as part of the muxponder configuration.



- g. Click the bundle number and *ip-address* to configure an IP address on the bundle.



- h. Return to the top-level endpoint configuration, select the index 0 previously created and click **membership** to add the interface to the bundle



Configuration editor  
NSO VERSION: 5.7.6.2

↑ /cisco-ron-cfp:ron/ron-ml{poc\_8201\_1\_to\_poc\_8201\_2\_20}/end-point{ron-poc-8201-1}/terminal-device-packet/interface{0}/membership/

See 'poc\_8201\_1\_to\_poc\_8201\_2\_20' in Service manager

bundle-id\*

500

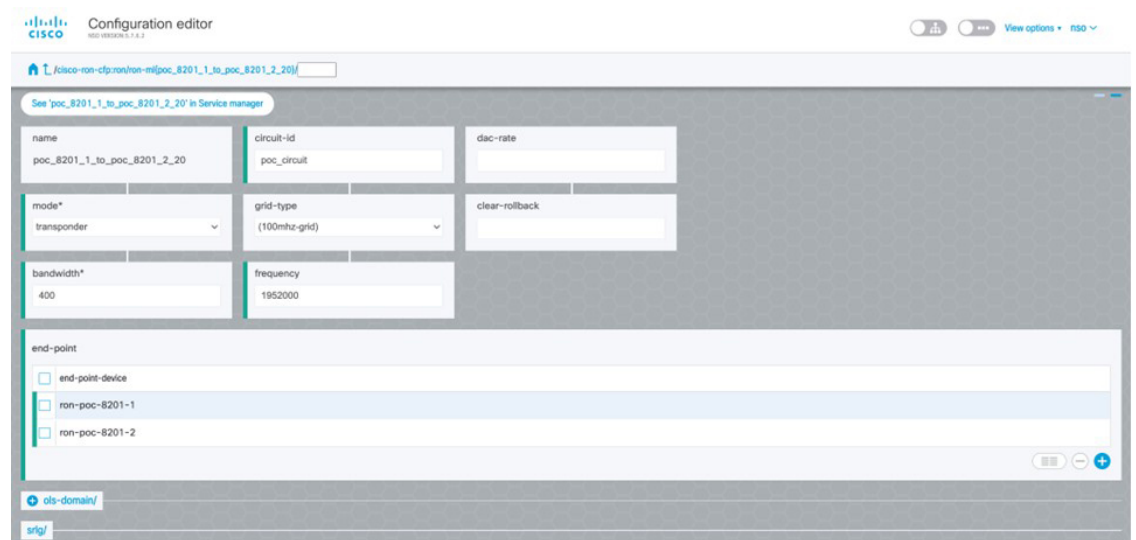
mode

active

**Note**

- Bundle-id selects the previously created bundle.
- Mode sets the bundle LAG signaling mode. Active=LACP, passive=LACP listener only, on=No active signaling, inherit=Inherit signaling from Bundle interface configuration. Default is active.

- Return to the top level of the service configuration and similarly configure the second endpoint.



Configuration editor  
NSO VERSION: 5.7.6.2

↑ /cisco-ron-cfp:ron/ron-ml{poc\_8201\_1\_to\_poc\_8201\_2\_20}/

See 'poc\_8201\_1\_to\_poc\_8201\_2\_20' in Service manager

name  
poc\_8201\_1\_to\_poc\_8201\_2\_20

circuit-id  
poc\_circuit

disc-rate

mode\*  
transponder

grid-type  
(100mhz-grid)

clear-rollback

bandwidth\*  
400

frequency  
1952000

end-point

end-point-device

ron-poc-8201-1

ron-poc-8201-2

ots-domain/

srlg/

- Click **SRLG** to perform SRLG configuration

The screenshot shows the Cisco Configuration editor interface. At the top, it says "Configuration editor" and "NSO VERSION 5.7.4.2". Below that, there's a breadcrumb path: "/cisco-ron-ctp/ron/ron-m/poc\_8201\_1\_to\_poc\_8201\_2\_20/srlg". A notification says "See 'poc\_8201\_1\_to\_poc\_8201\_2\_20' in Service manager". There are three configuration sections: "group" (empty), "value-list" (containing a table with columns "id" and "value"), and "name-list" (empty). The "value-list" table has two rows: one with "id" 10 and "value" 1000, and another with "id" 20 and "value" 2000. There are navigation icons like "Add list item" and "View options" in the top right.

id	value
10	1000
20	2000

**Note**

- Configuration options are to specify a preconfigured group, a list of numeric SRLG values, or a list of SRLG names associated with preconfigured name:value pairs.
- Each type can be populated in the same configuration.
- In this example we specify a list of explicit numeric values. An index is used along with the numeric value.

3. In the Commit manager, click the config tab. The NSO CLI configuration for the end-to-end service is displayed. If the ols-domain component is not specified in the global configuration, no optical line system provisioning is performed, only router provisioning. You can preview and then commit the configuration.

The screenshot shows the Cisco Commit manager interface. At the top, it says "Commit manager" and "NSO VERSION 5.7.4.2". Below that, there's a status bar: "Current transaction is VALID" with buttons for "Revert", "Load/Save", and "Commit". There are tabs for "changes", "errors", "warnings", "config", "native config", and "commit queue". The main area displays the NSO CLI configuration for the end-to-end service. The configuration is shown in a code editor with line numbers on the left. The configuration includes a "ron" block with a "ron-m" sub-block containing "poc\_circuit\_195200" and two "end-point" blocks for "ron-poc-8201-1" and "ron-poc-8201-2".

```

1      ron {
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36      }
37

```

```

ron {
+  ron-m poc_circuit_195200 {
+    mode transponder;
+    bandwidth 400;
+    circuit-id "This is a demo circuit";
+    ols-domain {
+    }
+    end-point ron-poc-8201-1 {
+      terminal-device-optical {
+        line-port 0/0/0/20;
+      }
+      ols-domain {
+      }
+      end-point-state UNLOCKED;
+    }
+    terminal-device-packet {
+      interface 0 {
+        ip-address {
+          v4 51.63.12.1/30;
+        }
+      }
+    }
+  }
+  end-point ron-poc-8201-2 {
+    terminal-device-optical {
+      line-port 0/0/0/20;
+    }
+    terminal-device-packet {
+      interface 0 {
+        ip-address {
+          v4 51.63.12.2/30;
+        }
+      }
+    }
+  }
+ }
}

```

At the bottom, there's a navigation bar with icons for "Commit manager", "Configuration editor", "Alarm manager", "Dashboard", "Device manager", and "Service manager". The page number "521934" is visible in the bottom right corner.

#### 4. Verify status in NSO UI.

You can verify the status by inspecting the plan associated with the service. You can find the plan under the main ron-ml configuration which you can access by clicking the top portion of the service configuration. An example is highlighted in the following image.

The screenshot shows the Cisco NSO Configuration editor interface. The breadcrumb path is `/cisco-ron-cfp:ron/ron-ml(poc_8201_1_to_poc_8201_2_20)/`. A notification says "See 'poc\_8201\_1\_to\_poc\_8201\_2\_20' in Service manager". The configuration is displayed in a grid:

name poc_8201_1_to_poc_8201_2_20	bandwidth* 400	frequency 1952000
plan-location /cisco-ron-cfp:ron/cisco-ron-cfp:ron-ml-plan[cisco-ron-cfp:name='poc_8201_1_to_poc_8201_2_20']	circuit-id poc_circuit	dac-rate
mode* transponder	grid-type (100mhz-grid)	clear-rollback

##### a. Inspect the plan by clicking on the newly created service

The screenshot shows the 'ron-ml-plan' configuration page in the NSO UI. The configuration is as follows:

```

ron-ml-plan
name
682b3df2_30b2_4af2_9438_6dfb7738d0ef
6e2b4907_b08b_4338_8304_a4f2903b3311
f7a00076_d3db_4bd9_9d94_673d4cc462cb
poc_8201_1_to_poc_8201_2_20
  
```

If all steps are green and complete, the service has been properly deployed to the network



##### b. Inspect router configuration.

The **show configuration commit changes last 1** command shows the CLI config applied to the device during the NSO provisioning.

The **show optics controller 0/0/0/20** command verifies the operational status.

```

RP/0/RP0/CPU0:ron-poc-8201-1#show configuration commit changes last 1
Mon Oct 17 09:51:11.625 PDT
Building configuration...
!! IOS XR Configuration 7.7.1
srng
interface Bundle-Ether500
  10 value 1000
  20 value 2000
  !
!
interface Bundle-Ether500
  ipv4 address 102.20.20.20 255.255.255.254
  !
controller Optics0/0/0/20
  description poc_circuit
  transmit-power -100
  fec OFEC
  dwdm-carrier 100MHz-grid frequency 1952000
  DAC-Rate 1x1.25
  !
interface FourHundredGigE0/0/0/20
  bundle id 500 mode active
  !
End

```

```

RP/0/RP0/CPU0:ron-poc-8201-1#show controllers optics 0/0/0/20
Mon Oct 17 09:57:25.475 PDT

Controller State: Up

Transport Admin State: In Service

Laser State: On

LED State: Green

FEC State: FEC ENABLED

Optics Status

  Optics Type: QSFPDD 400G ZRP
  DWDM carrier Info: C BAND, MSA ITU Channel=19, Frequency=195.20THz,
  Wavelength=1535.822nm

Alarm Status:
-----
Detected Alarms: None

```

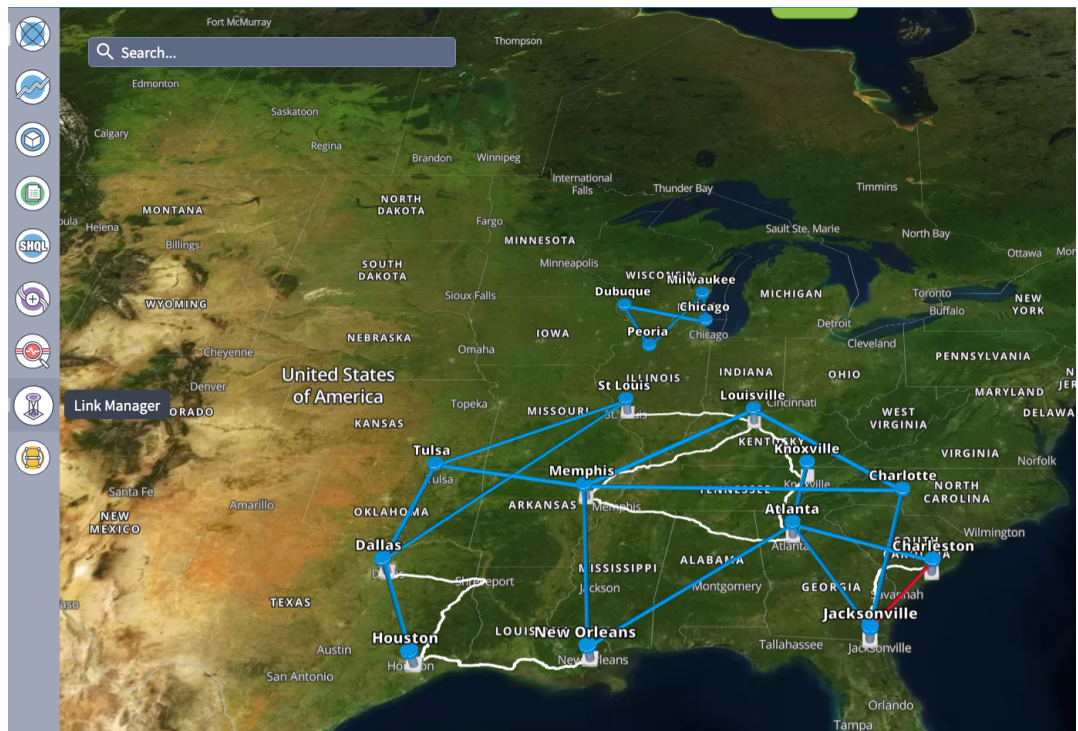
## Provision Routed Optical Networking ML Service Using Crosswork Hierarchical Controller

1. If you are performing both router and optical line system provisioning, you must create NMC Cross Links between router optics port and optical line system add/drop port.

Crosswork Hierarchical Controller 7.0 in Routed Optical Networking 2.1 also supports “router only” provisioning which provisions optical parameters on router optics port and IP layer parameters but does not provision OLS.

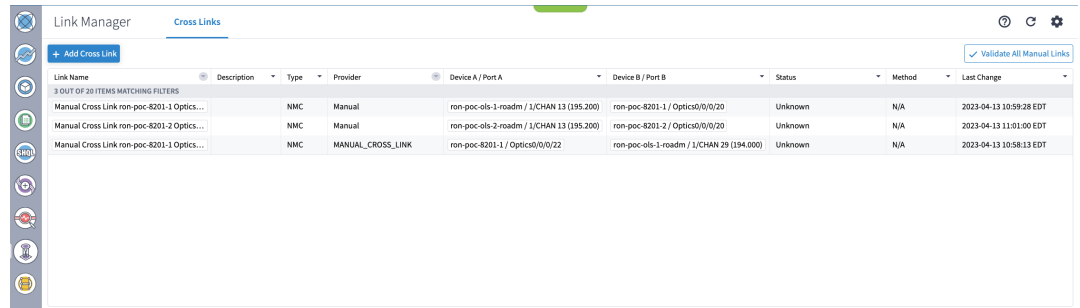
- a. Select **Link Manager** application.

*Figure 15: Crosswork Hierarchical Controller*



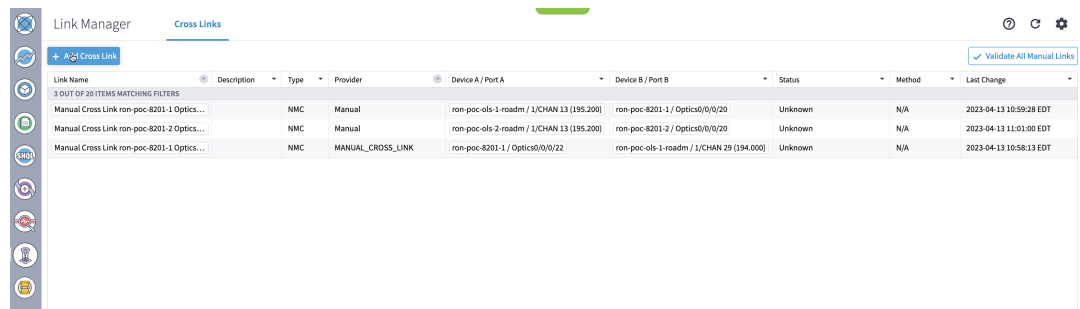
You get the following initial view that shows the list of Cross Links.



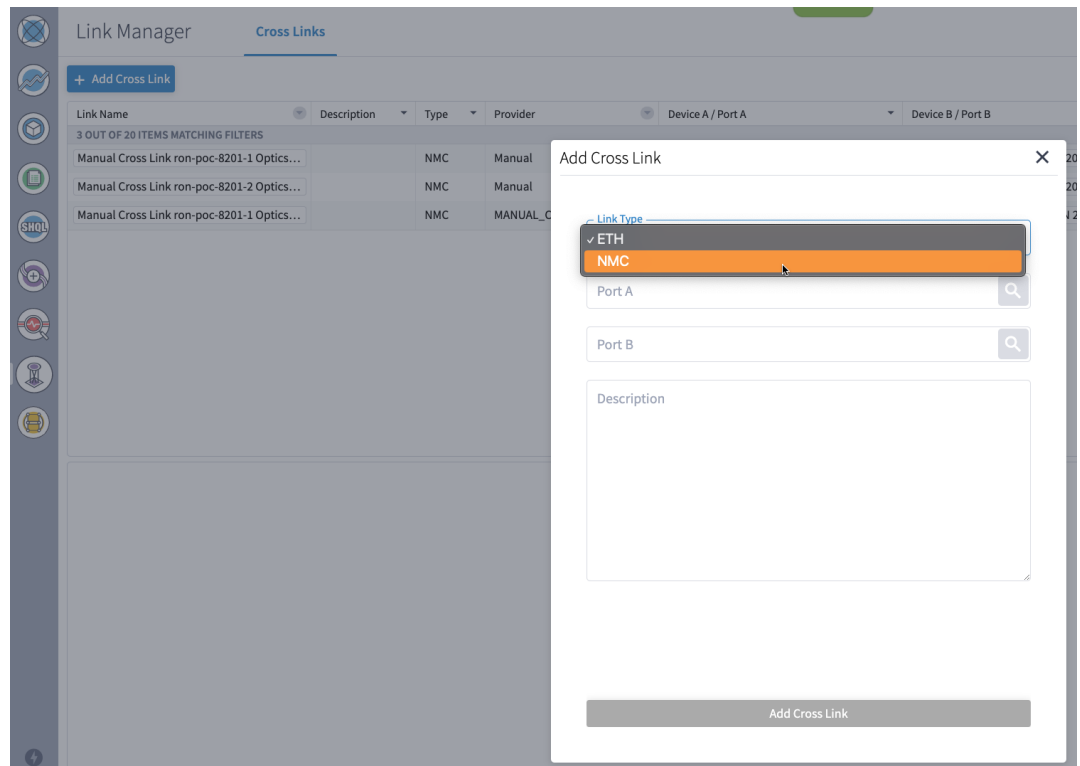


b. Click Add Cross Link.

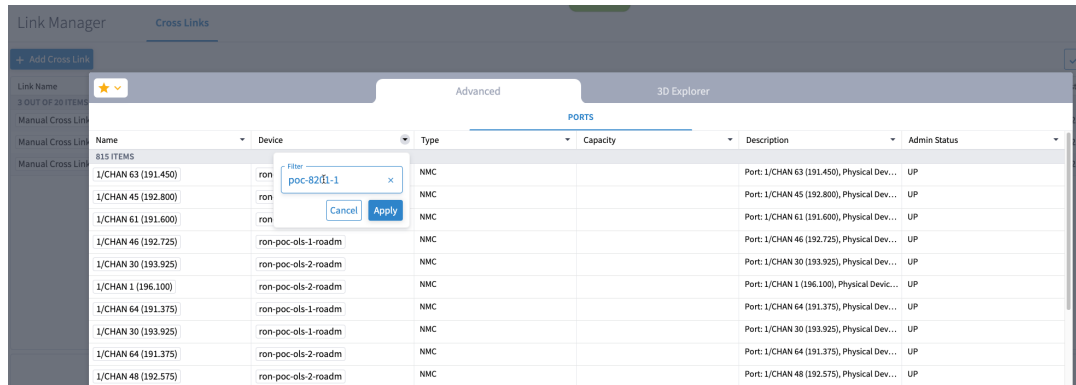
Figure 16:



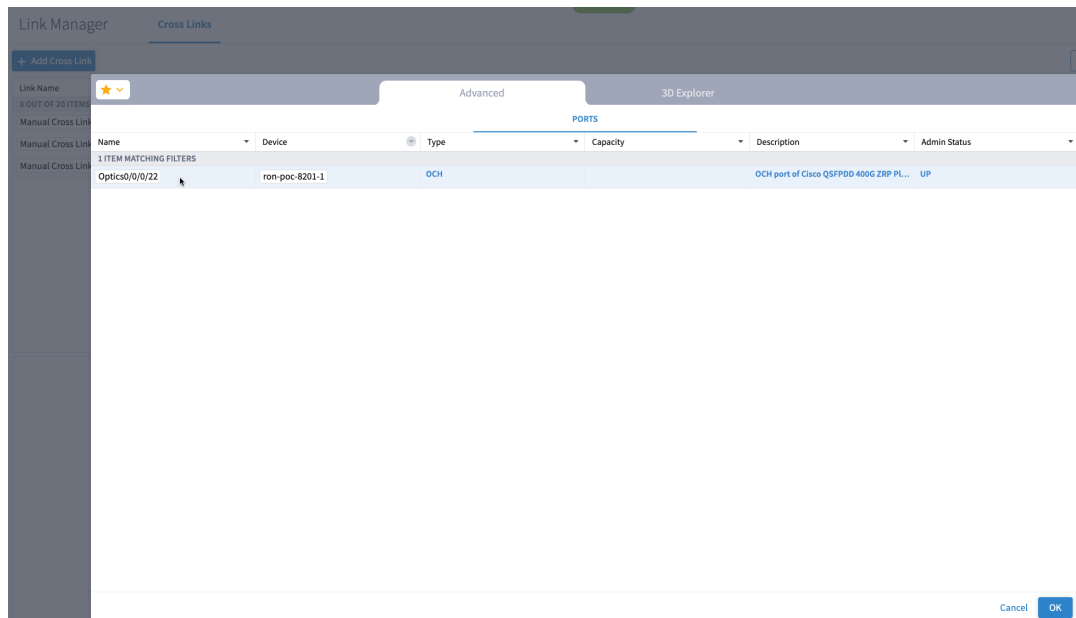
c. Select the NMC cross link type. Cross Link Manager supports ETH and NMC cross links.



- d. The Link Manager application allows you to select either router DCO port or optical add/drop first. In the following image we filter the ports by the router device that we use for our NMC cross link.

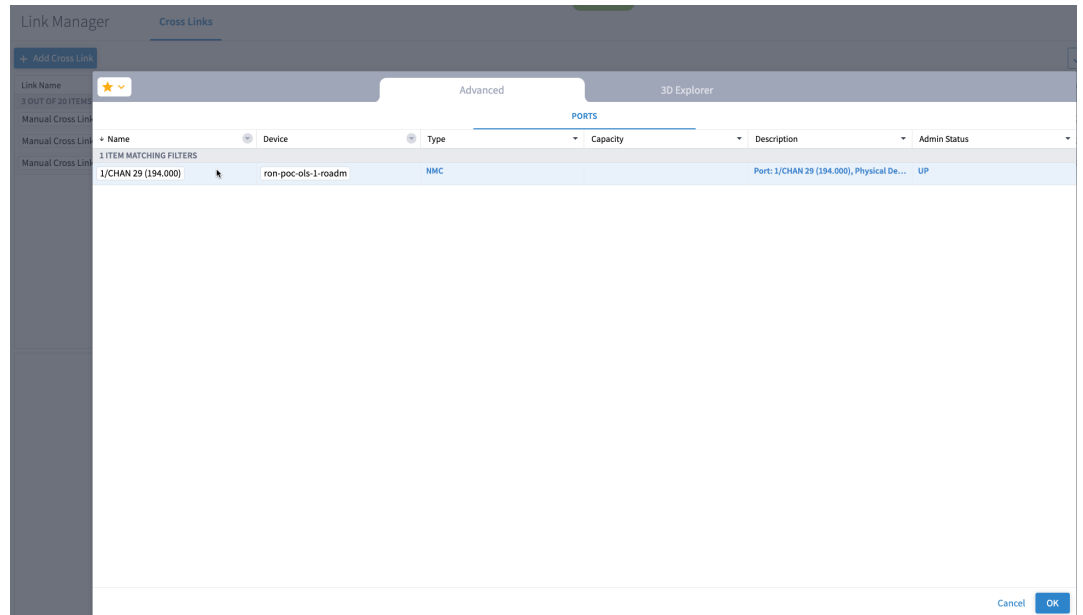


- e. The following image shows the filtered list. Our router, ron-poc-8201-1 has a single ZR+ optics port, select the port and click OK

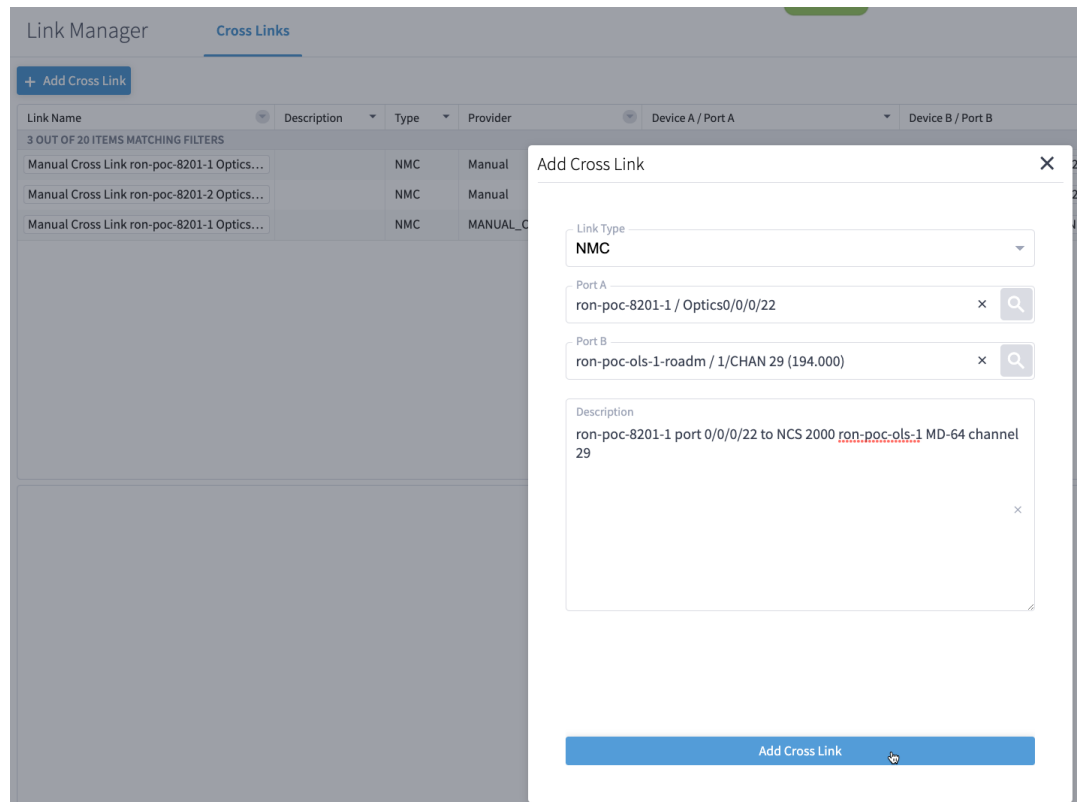


- f. Like in the previous step, select the second port which is the optical add/drop port. Filter by device as *ron-poc-ols-1* and the Name as *194.000* to filter to the add/drop port





- g. Select the two ports (Ethernet and OCH) in your NMC Cross Link. Click **Add Cross Link**. (Optional) Add a description



- h. Click the added cross link to see its attributes.

The screenshot shows the Link Manager interface with the 'Cross Links' tab selected. A table lists one cross-link with the following details:

Link Name	Description	Type	Provider	Device A / Port A	Device B / Port B	Status	Method	Last Change
Optics0/0/0/22 / 1/CHAN 29 (194.000)	ron-poc-8201-1...	NMC	Manual	ron-poc-8201-1 / Optics0/0/0/22	ron-poc-ols-1-roadm / 1/CHAN 29 (194.000)	Unknown	N/A	2023-04-24 10:23:34 EDT

Below the table, a summary card for the selected link shows:

- LINK NAME:** Optics0/0/0/22 / 1/CHAN 29 (194.000)
- DEVICE A / PORT A:** ron-poc-8201-1 / Optics0/0/0/22
- DEVICE B / PORT B:** ron-poc-ols-1-roadm / 1/CHAN 29 (194.000)
- TIME ADDED:** N/A
- SOURCE:** Manual
- STATUS:** Unknown
- METHOD:** N/A
- LAST CHANGE:** N/A
- DESCRIPTION:** ron-poc-8201-1 port 0/0/0/22 to NCS 2000 ron-poc-ols-1 MD-64 channel 29

- i. View the added crosslink in the explorer app by clicking on the link.
- j. Similar to the previous steps, create the second NMC cross link.

The screenshot shows the Link Manager interface with two cross-links listed in the table:

Link Name	Description	Type	Provider	Device A / Port A	Device B / Port B	Status	Method	Last Change
Manual Cross Link ron-poc-8201-1 Optics0/0/0/22	ron-poc-8201-1...	NMC	Manual	ron-poc-8201-1 / Optics0/0/0/22	ron-poc-ols-1-roadm / 1/CHAN 29 (194.000)	Unknown	N/A	2023-04-24 10:23:34 EDT
Manual Cross Link ron-poc-57b1-1 Optics0/0/0/24	NCS-57B1 0/0/0/...	NMC	Manual	ron-poc-57b1-1 / Optics0/0/0/24	ron-poc-ols-2-roadm / 1/CHAN 29 (194.000)	Unknown	N/A	2023-04-24 10:29:55 EDT

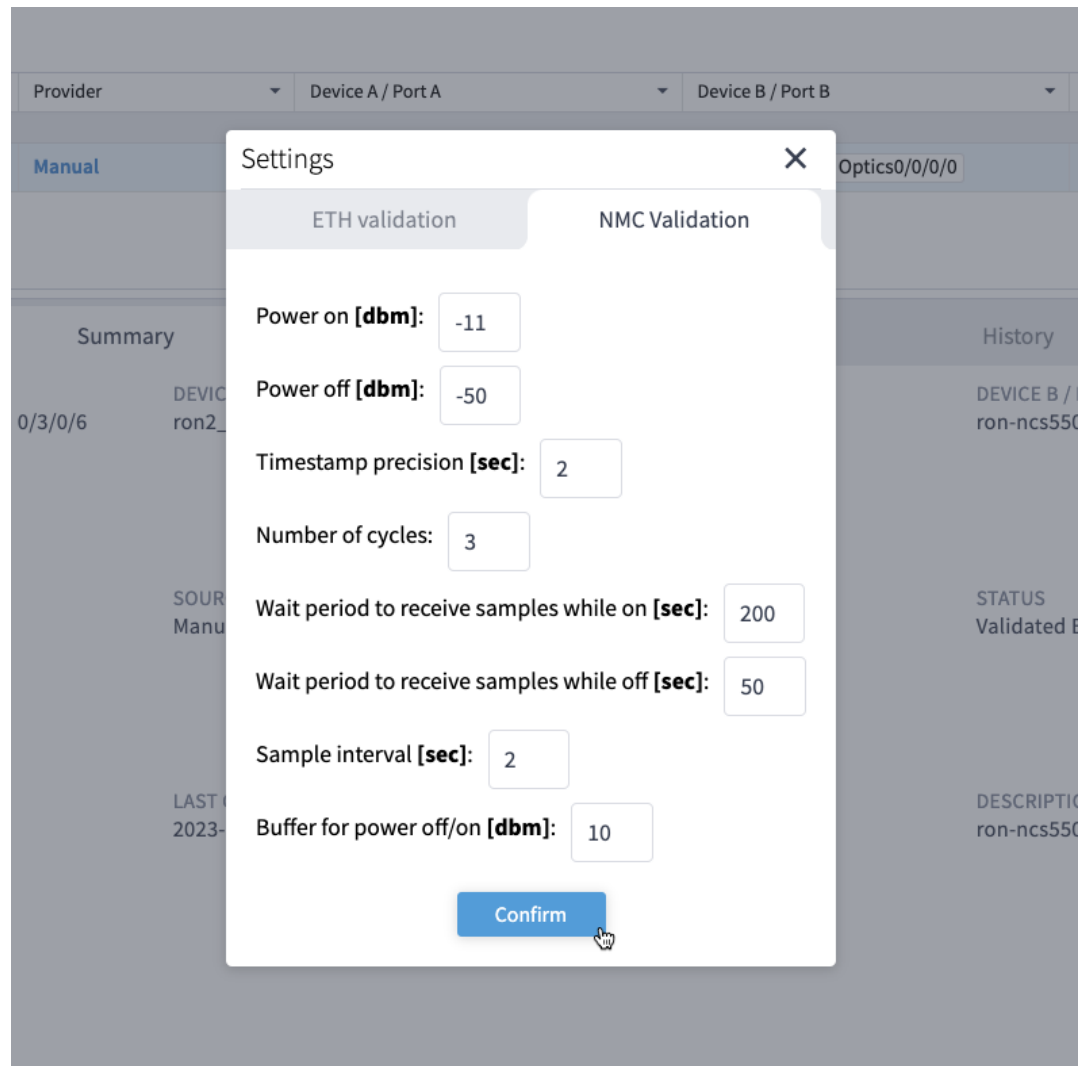
The summary card for the second link shows:

- LINK NAME:** Manual Cross Link ron-poc-57b1-1 Optics0/0/0/24 to ron-poc-ols-2-roadm 1/CHAN 29 (194.000)
- DEVICE A / PORT A:** ron-poc-57b1-1 / Optics0/0/0/24
- DEVICE B / PORT B:** ron-poc-ols-2-roadm / 1/CHAN 29 (194.000)
- TIME ADDED:** N/A
- SOURCE:** Manual
- STATUS:** Unknown
- METHOD:** N/A
- LAST CHANGE:** N/A
- DESCRIPTION:** NCS-57B1 0/0/0/24 to NCS 2000 MD-64 channel 29

- k. View the end-to-end network with both crosslinks in the Explorer app.

## 2. (Optional) Cross-Link Connectivity Verification

- Cross-Link Connectivity Verification is supported on all router platforms and NCS 1010 with MD-32 and BRK-24 modules.
  - Connectivity Verification uses NSO CLI NED to modify router port state and TX power, is service affecting.
  - When validation starts, Hierarchical Controller continuously checks the RX power on the optical add/drop port. Connectivity Verification is performed in the background.
- a. Configure NMC Validation Settings. Settings are used to control validation, **Wait period to receive samples while on** must be set to 180 seconds, **Wait period to receive samples while off** must be set to 50.



- b. Select a link and click **Validate Link**. Alternatively, you can click **Validate All Manual Links** to perform connectivity verification for all links.

Link Manager Cross Links

+ Add Cross Link Validate All Manual Links

Link Name	Description	Type	Provider	Device A / Port A	Device B / Port B	Status	Method	Last Change
Manual Cross Link ron-ncs5504-1 Optic...	ron-ncs5504-...	NMC	Manual	ron2_olt2-roadm / 0/3/0/6	ron-ncs5504-1 / Optics0/0/0/0	Validated By Shut No Shut	Shut no shut	2023-03-30 04:39:03 EDT

1 OUT OF 24 ITEMS MATCHING FILTERS

Summary Evidence History

LINK NAME  
Manual Cross Link ron-ncs5504-1 Optics0/0/0/0 to ron2\_olt2-roadm 0/3/0/6

DEVICE A / PORT A  
ron2\_olt2-roadm/0/3/0/6

DEVICE B / PORT B  
ron-ncs5504-1/Optics0/0/0/0

TIME ADDED  
2023-03-30 03:16:34 EDT

SOURCE  
Manual

STATUS  
Validated By Shut No Shut

METHOD  
Shut no shut

LAST CHANGE  
2023-03-30 04:39:03 EDT

DESCRIPTION  
ron-ncs5504-1 to ron2\_olt2-roadm

Validate Link Delete Link

- c. After validation completes, inspect the evidence of either successful or unsuccessful verification. The following image shows a successful verification. Status changes from **Unknown** to **Validated By Shut No Shut**. The time it takes for the ZR/ZR+ to start transmitting after no shut is set is typically 60–80 seconds.

Link Manager Cross Links

+ Add Cross Link Validate All Manual Links

Link Name	Description	Type	Provider	Device A / Port A	Device B / Port B	Status	Method	Last Change
Manual Cross Link ron-ncs5504-1 Optic...	ron-ncs5504-...	NMC	Manual	ron2_olt2-roadm / 0/3/0/6	ron-ncs5504-1 / Optics0/0/0/0	Validated By Shut No Shut	Shut no shut	2023-03-30 04:39:03 EDT

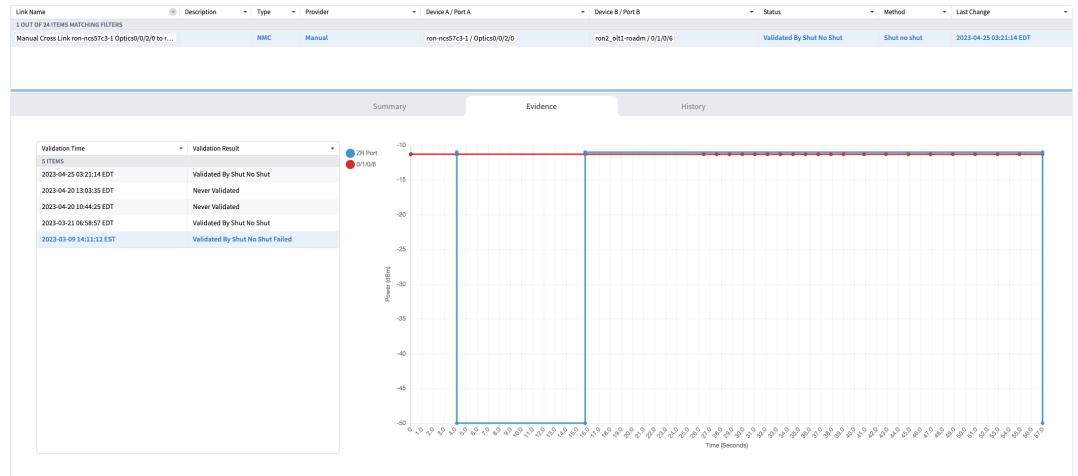
1 OUT OF 24 ITEMS MATCHING FILTERS

Summary Evidence History

Validation Time	Validation Result
2023-03-30 04:39:03 EDT	Validated By Shut No Shut
2023-03-21 03:25:50 EDT	Validated By Shut No Shut
2023-03-09 14:08:00 EST	Validated By Shut No Shut Failed

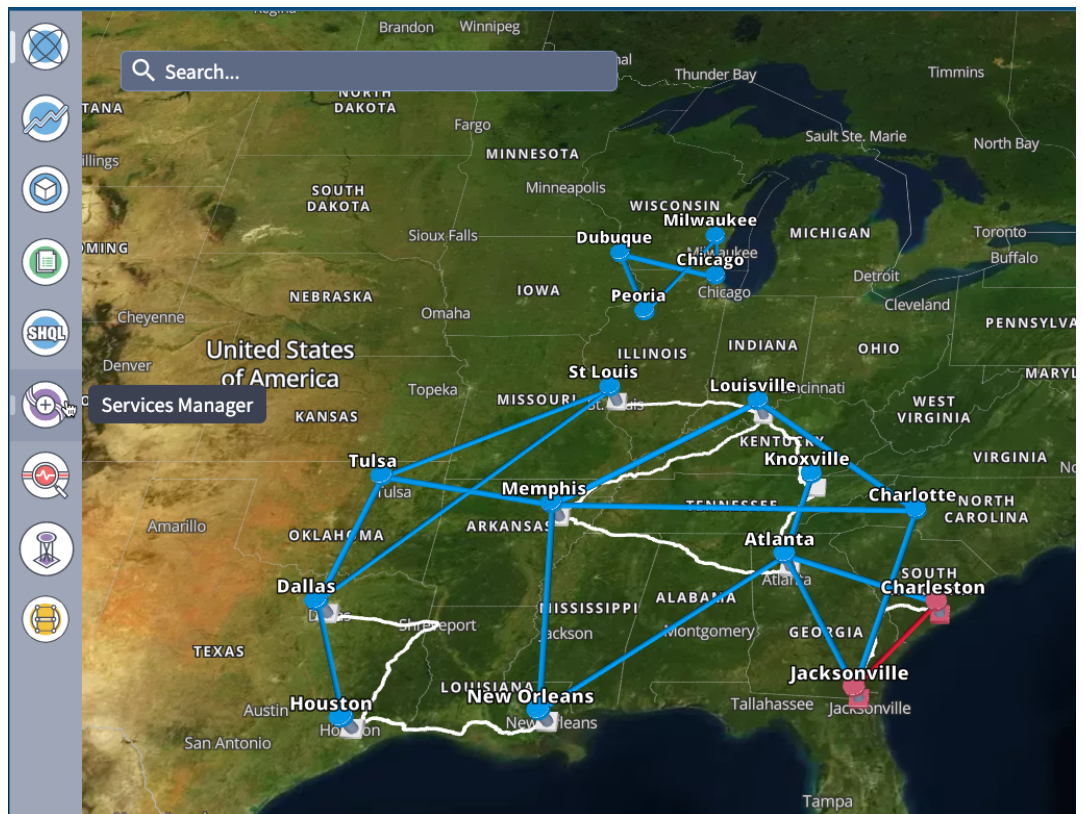
Legend: ● ZR Port (Blue), ● 0/3/0/6 (Red)

The following image shows a failed verification. There is no change in the optical device port power levels after the **no shut** operation



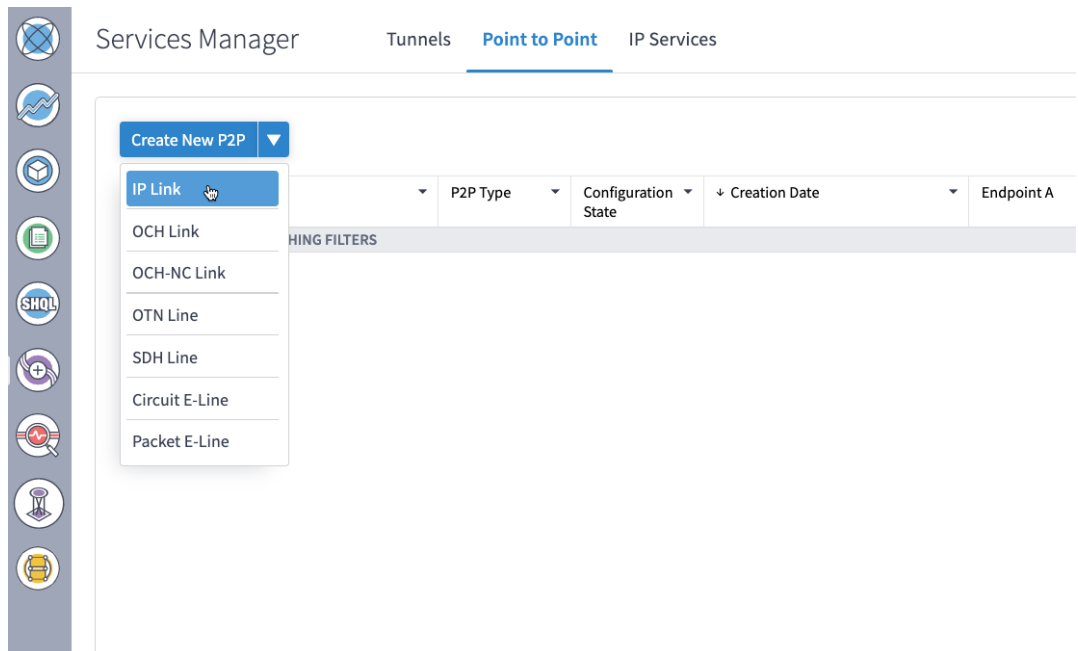
3. To provision the Routed Optical Networking IP link, perform these steps:

a. In the applications bar in the Crosswork Hierarchical Controller, click the **Services Manager** icon.



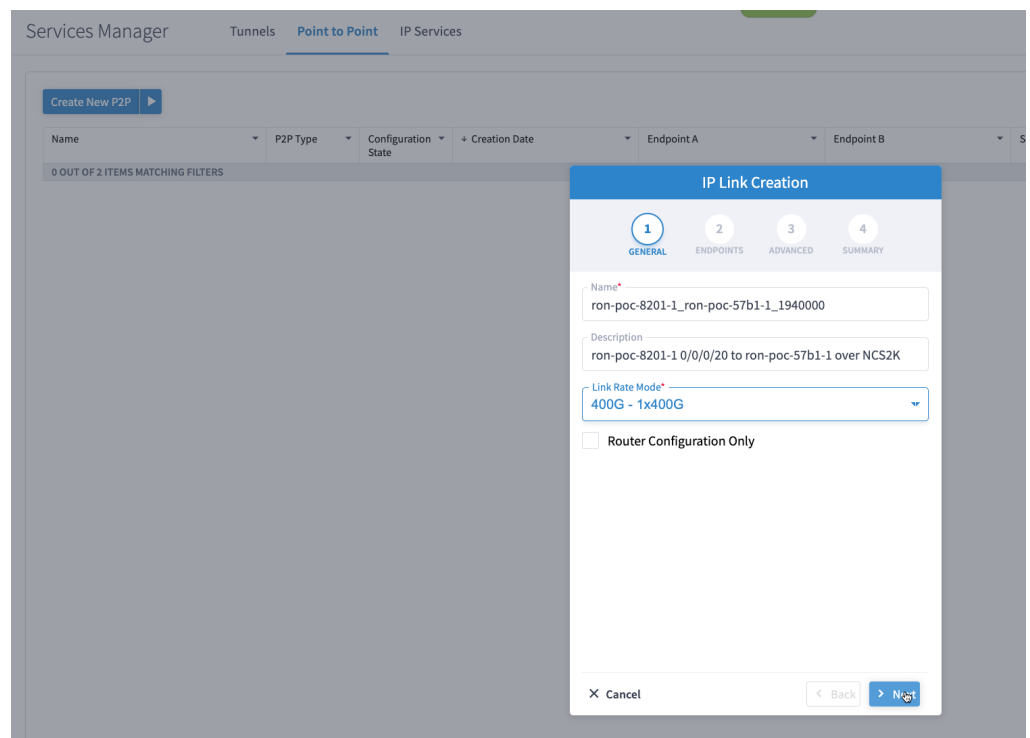
The Service Manager Application shows you a list of services.

b. Select the **Point to Point** tab and click **IP Link** from the **Create New P2P** drop-down list to create end to end service between router DCO ports.



The **IP Link Creation** wizard appears.

- c. Enter the Cisco Crosswork Hierarchical Controller service name, description of the router optical controller, and the Link Rate Mode in the **General** tab.
  - Here, we are creating a 1x400G link. In 2x100G, 3x100G, and 4x100G modes, you can choose to create separate IP links or create a Bundle with each channel link added as a member.



*Alternatively*

- To create a 200G 16-QAM link, Select the 200G – 2x100G link rate mode.

200G 16-QAM allows the use of 200G signals on 50Ghz optical line systems. Default for 200G is QPSK at 60.1Ghz.

## IP Link Creation

**1**  
GENERAL

**2**  
ENDPOINTS

**3**  
ADVANCED

**4**  
SUMMARY

Name\*  
200G legacy mode support

Description  
Configure link as 200G 16QAM @ 30.1Ghz

Link Rate Mode\*  
200G - 2x100G

Router Configuration Only

✕ Cancel < Back Next >

*Alternatively*

- To create a Bundle interface, Select a bundle option from the link rate mode drop down list.



You can create a 400G bundle interface (400G Member). Alternatively, 300G-bundle (3X100G Members) and 200G-Bundle (2x100G Members) can be created

## IP Link Creation

**1**  
GENERAL

2  
ENDPOINTS

3  
ADVANCED

4  
SUMMARY

Name\*  
400G-Bundle-Cisco8000-ASR9903

Description

Link Rate Mode\*  
400G - Bundle

Router Configuration Only

---

✕ Cancel < Back > Next

(Optional) Check the **Router Configuration Only** check box to configure only the router optical controller and IP information and not the optical line system. This configuration is used when the OCHNC is created outside Cisco Crosswork Hierarchical Controller.

- d. Select the two router ports in the service. This is done by selecting the Site and Port. The transmit power for each endpoint is an optional parameter. The default TX power is used if no value is provided.

The screenshot shows the 'IP Link Creation' dialog box in the Services Manager. The dialog is currently on the 'ENDPOINTS' tab. It features two sections for configuring endpoints: 'ENDPOINT A' and 'ENDPOINT B'. Each section includes a 'Site' field, a 'Port' field with a magnifying glass icon for selection, and a 'Transmit Power [dBm]' field. The background shows a table with columns for Name, P2P Type, Configuration State, Creation Date, Endpoint A, Endpoint B, and Speed. The table currently shows 0 items matching filters.

- e. Click the magnifying glass icon to select the first router port.

The ports are displayed based on the following criteria:

- Is a ZR/ZR+ interface
- Has no existing optics configuration
- Has a proper NMC cross-connect configured

This page lists all available ZR/ZR+ ports currently unused on all devices. Select the *ron-poc-8201-1 Optics0/0/0/22* port.

Name	Device	Type	Capacity	Description	Admin Status
17 ITEMS					
Optics0/0/0/24	ron-poc-57b1-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP
Optics0/0/0/24	ron-ncs57b1-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP
Optics0/0/0/14	ron-8201-32FH-3	OCH		OCH port of Cisco QDD 400G BRT ZRP Plug...	UP
Optics0/0/0/16	ron-8201-32FH-3	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP
Optics0/0/0/0	ron-ncs540-2dd-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP
Optics0/0/0/18	ron-8201-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	DOWN
Optics0/0/0/8	ron-8201-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	DOWN
Optics0/0/0/20	ron-8201-1	OCH		OCH port of Cisco QSPDD 400G ZR Plugg...	UP
Optics0/0/0/22	ron-8201-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP
Optics0/0/1/4	ron-asr9903-1	OCH		OCH port of 400G ZRP-S QSPDD Module	UP
Optics0/0/1/8	ron-asr9903-1	OCH		OCH port of 400G ZR-S QSPDD Module	UP
Optics0/0/0/10	ron-8201-2	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP
Optics0/0/0/20	ron-8201-2	OCH		OCH port of Cisco QSPDD 400G ZR Plugg...	UP
Optics0/0/0/22	ron-poc-8201-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plu...	UP
Optics0/0/0/20	ron-8201-4	OCH		OCH port of Cisco QSPDD 400G ZR Plugg...	UP
Optics0/0/3/0	ron-ncs57c3-1	OCH		OCH port of Cisco QDD 400G BRT ZRP Plug...	UP
Optics0/0/2/2	ron-ncs57c3-1	OCH		OCH port of Cisco QSPDD 400G ZRP Plug...	UP

- f. Similar to the previous step, choose *ron-poc-57b1-1 Optics 0/0/0/24* as the second router port.
- g. (Optional) Set the transmit power in dBm on each port. If OLS provisioning is being performed, the OLS controller returns the optical power. If the OLS controller does not return the optical power or **router only** provisioning is being used, the router default power is used.
- h. (Optional) Enter the IP address information for interfaces. If IP addresses are not entered, ZR/ZR+ router optical configuration happens; however, IP addresses are not configured.
- i. Click **Next** to move to **Advanced** configuration.

### IP Link Creation

1  
GENERAL

2

3  
ADVANCED

4  
SUMMARY

Transmit Power [dBm]

#### ENDPOINT B

Site B  🔍

Port B\*  ✕ 🔍

Transmit Power [dBm]

#### LINK #1 IP ADDRESSES

IP Address A (CIDR)

IP Address B (CIDR)

✕ Cancel< Back> Next

- j. (Optional) Set the Frequency. If optical provisioning is being performed, the OLS controller can return the frequency to be used, and it may be omitted. If **router only** provisioning is being performed, the Frequency must be specified.
- k. (Optional) Set the DAC rate. A DAC rate setting can be used to enable OpenZR+ compatibility mode, disabling TX shaping and enhanced modem mode. See [OpenZR+ Compatibility Mode](#) for more information on mode support.

## IP Link Creation

1 GENERAL 2 ENDPOINTS 3 **ADVANCED** 4 SUMMARY

Add to existing LAG

**FREQUENCY**

L Band

C Band

Frequency THz

Digital-to-Analog Converter (DAC) rate

1 X 1

1 X 1.25

**Set Path Preferences**

Min Path Criteria

▼ **Include Nodes or Links**

Select Node or Link

✕ Cancel

- (Optional) Set links or nodes to include/exclude in the optical path. This setting is not available in **router only** provisioning.

- m. (Optional) To add the new link or set of links to an existing Bundle LAG interface configured on the routers, choose the bundle from the **Add to existing LAG** drop-down.

**IP Link Creation**

1 GENERAL 2 ENDPOINTS 3 **ADVANCED** 4 SUMMARY

Add to existing LAG

✓ Bundle-Ether1 to Bundle-Ether1

L Band

C Band

Frequency THz\* 195.200

Digital-to-Analog Converter (DAC) rate

Modulation

Set Path Preferences

Min Path Criteria Latency

▼ Include Nodes or Links

Select Node or Link

✕ Cancel < Back > Next



- n. (Optional) If you are configuring a 200G 16-QAM link, set the DAC rate to 1x1.25.  
200G link rate mode enables the **Modulation** selection drop-down. Modulation selection is not available in any other mode. Select the 16 QAM (30Ghz) modulation.

## IP Link Creation

1  
GENERAL

2  
ENDPOINTS

3  
ADVANCED

4  
SUMMARY

Add to existing LAG ▼

---

**FREQUENCY**

L Band

C Band

Frequency THz

Digital-to-Analog Converter (DAC) rate  ▼

**Modulation**

✓ 8 QAM

16 QAM

QPSK

▼ Include Nodes or Links

Select Node or Link
🔍

---

✕ Cancel

< Back
> Next

- o. Click **Next** to review the final configuration. Verify the router endpoint and optical line system parameters. Click **Finish** to start provisioning, or click **Save** to save for later provisioning.

## IP Link Creation

1  
GENERAL2  
ENDPOINTS3  
ADVANCED4  
SUMMARY

**Name:** ron-poc-8201-1\_ron-poc-57b1-1\_1940000  
**Description:** ron-poc-8201-1 0/0/0/20 to ron-poc-57b1-1 over NCS2K

▼ **Endpoint A**  
**Port:** ron-poc-8201-1 - Optics0/0/0/22  
**Transmit Power:** -10.0 dBm

▼ **Endpoint B**  
**Port:** ron-poc-57b1-1 - Optics0/0/0/24  
**Transmit Power:** -10.0 dBm

**Link Rate Mode:** 400G - 1x400G  
**Frequency:** 194.0 THz  
**DAC rate:** -  
**Modulation:** -

**Path Criteria:** Latency  
**Optical Excluded List:** -  
**Included List:** -  
**Disjoint From Links:** -

✕ Cancel< Back> FinishSave

The following image shows a sample summary for a 200G 16-QAM link.

**IP Link Creation**

1  
GENERAL

2  
ENDPOINTS

3  
ADVANCED

4  
SUMMARY

**Name:** 200G legacy mode support  
**Description:** Configure link as 200G 16QAM @ 30.1Ghz

▼ **Endpoint A**  
**Port:** ron-ncs540-2dd-1 - Optics0/0/0/0  
**Transmit Power:** -

▼ **Endpoint B**  
**Port:** ron-ncs57b1-1 - Optics0/0/0/24  
**Transmit Power:** -

**Link Rate Mode:** 200G - 2x100G  
**Frequency:** 195.2 THz  
**DAC rate:** 1 X 1.25  
**Modulation:** MT\_16QAM

**Path Criteria:** Latency  
**Optical Excluded List:** -  
**Included List:** -  
**Disjoint From Links:** -

✕ Cancel
< Back
> Finish
Save

- p. Go to Services Manager to view provisioning progress.

Click the **Operations > Logs** tab to view the provisioning API calls used and responses. The logs show API calls and responses for both optical line system provisioning via Cisco Optical Network Controller and router provisioning via Crosswork Network Controller.

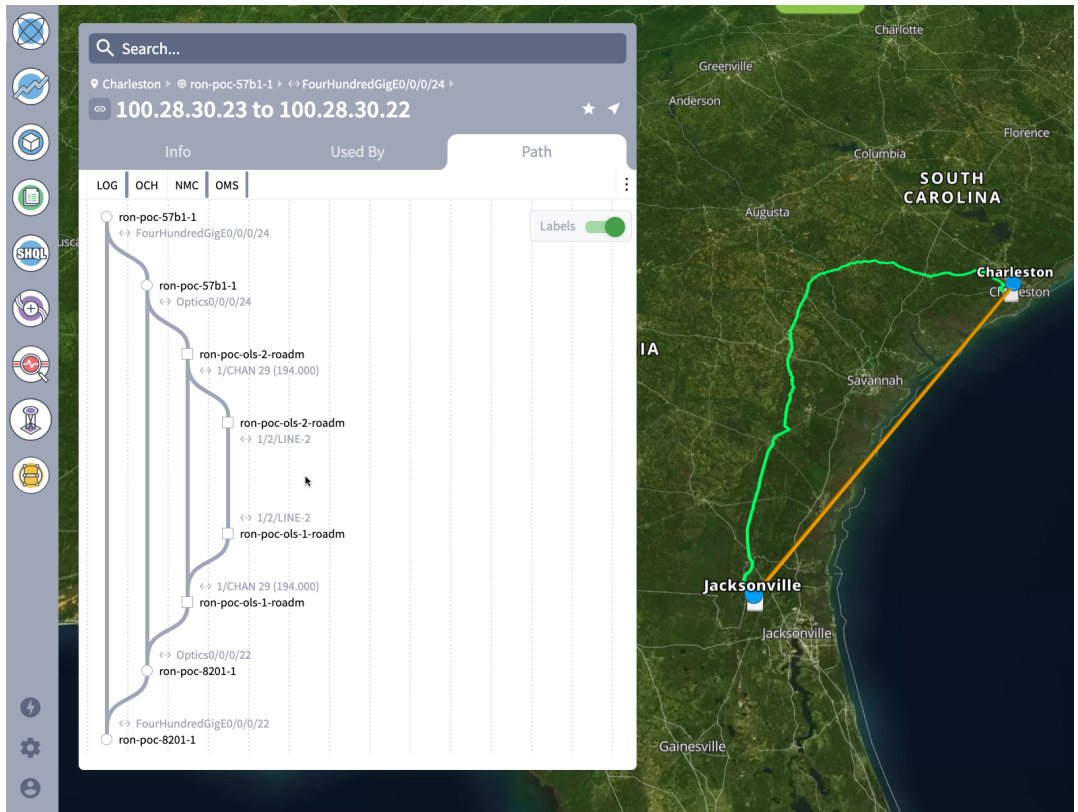
The screenshot shows the Services Manager interface with the 'Point to Point' tunnel selected. A table lists service links, with one link in 'IN PROGRESS' state. Below the table, the 'Operations' tab is active, showing a 'Discovery' action. The 'Logs' sub-tab is selected, displaying a 'Normal Flow' log entry with a green checkmark.

If the provisioning is successful, the **Configuration State** field changes to INSTALLED state and the **Operational State** field changes to UP state.

The screenshot shows the Services Manager interface with the 'Point to Point' tunnel selected. A table lists service links, with one link in 'INSTALLED' state and 'Up' operational state. Below the table, the 'Summary' tab is active, displaying details such as GUID, Name, Creation Time, Last Changed, Template Name, Service Links, IP Address Assignment Policy, Is Bundled, Channel Config, and Path Criteria.

The **Summary** tab displays the new service link.

- q. Verify the end to end link across both IP and optical layers in the Explorer view.



- Use the Link Assurance application to verify the end to end path and relevant PM data. Select a link or port to see data on the ZRM, OCH, and OTS layers.



## Operate Phase

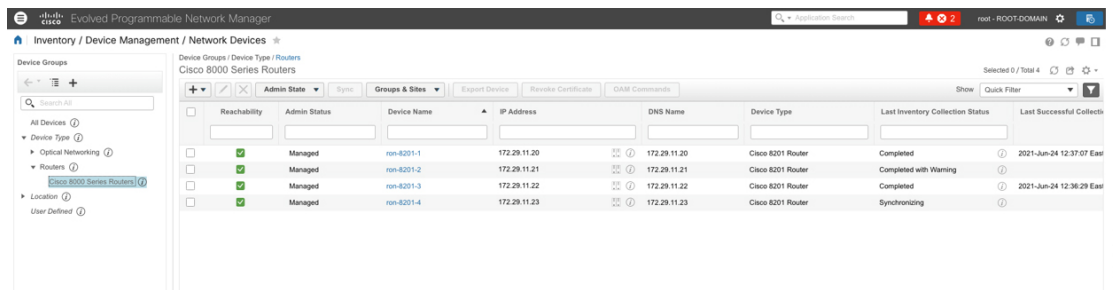
To monitor the ZR/Z+ optics:

1. Use either CLI commands or EPNM to monitor router ZR/ZR+ optics for proper operation. See [Monitor ZR or ZR+ Optics Using EPNM](#), on page 59.
2. (Optional) Setup router ZR/ZR+ optics data collection in CW Health Insights. See [Monitor Performance of ZR/ZR+ Optics Using KPIs](#), on page 68.

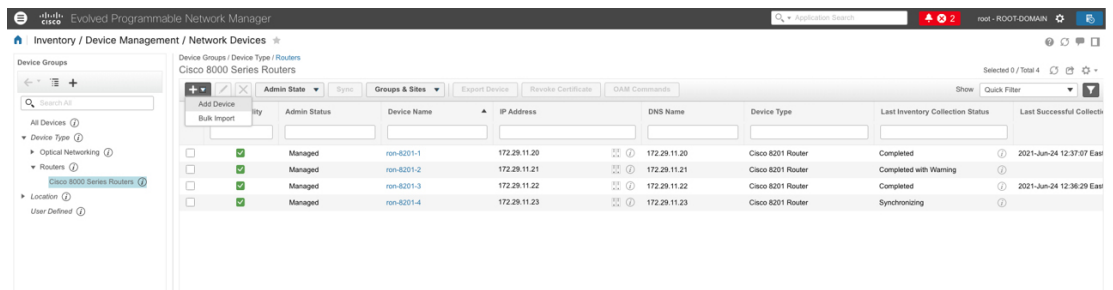
### Monitor ZR or ZR+ Optics Using EPNM

This section adds the 8201 router to EPNM for monitoring the PM parameters on the ZR or ZR+ optics.

1. To add a new device to EPNM choose **Inventory > Device Management > Network Devices**. Click **Routers** or a subgroup if it is already defined in the left panel.



2. Click the **+** icon above the Network Devices table, then choose **Add Device**.



3. Configure the General, SNMP, and SSH parameters as seen in that following figures. Click **Verify Credentials** to validate that Cisco EPN Manager can reach the device. Click **Add** to add the device to EPNM.

### Add Device



- \* General ✔
- \* SNMP  
(Optional if TL1 is configured)
- Telnet/SSH
- HTTP/HTTPS
- TL1
- Civic Location

\* General Parameters

IP Address

DNS Name

License Level  ?

Device Role  ?

Add to Group  ?

Credential Profile  ?

Add
Verify Credentials
Cancel

521945

### Add Device



- \* General ✔
- \* SNMP  
(Optional if TL1 is configured) ✔
- \* Telnet/SSH ✔
- HTTP/HTTPS
- TL1
- Civic Location

Telnet/SSH Parameters

Protocol

\* Port

\* Timeout  (secs)

Username

Password

Confirm Password

Enable Password  ?

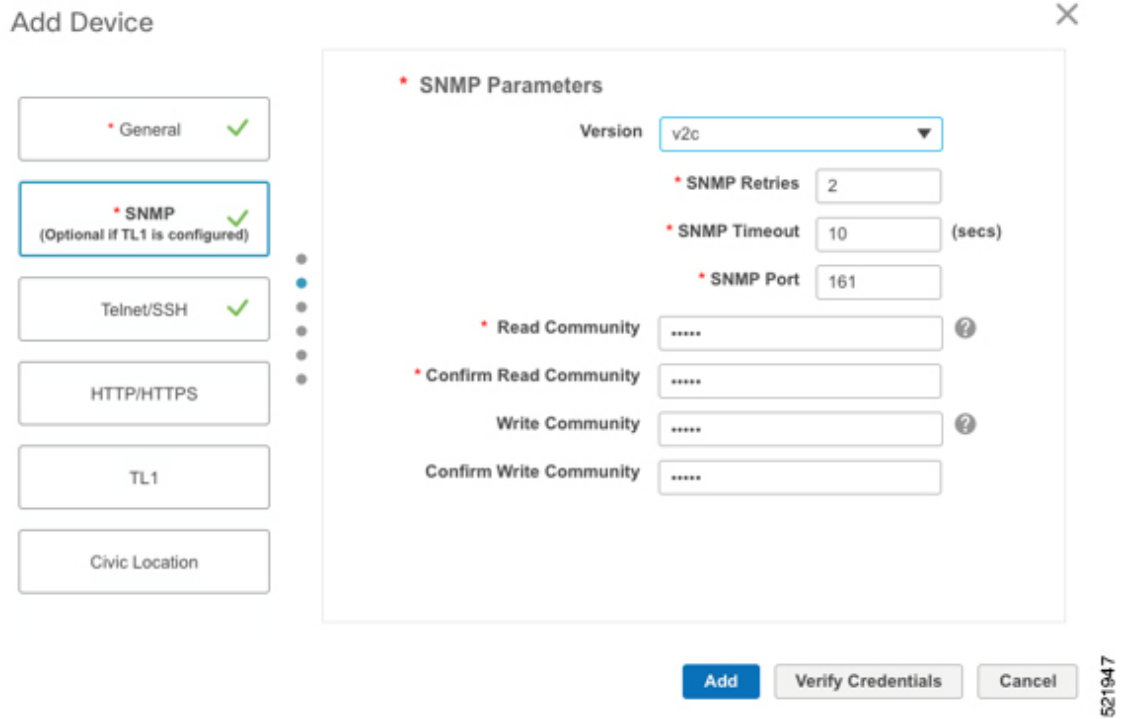
Confirm Enable Password

\* Note: Not providing Telnet/SSH credentials may result in partial collection of inventory data.

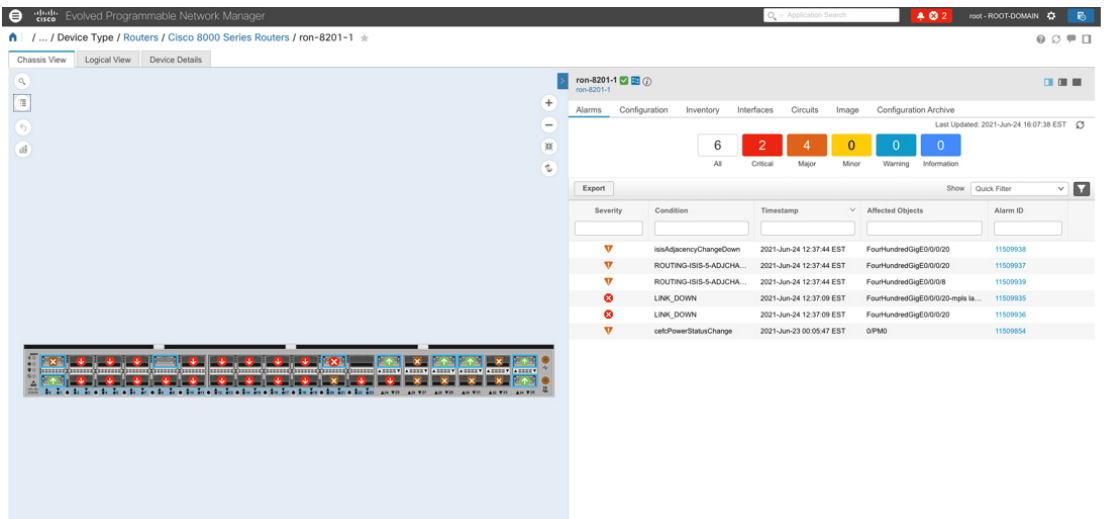
Add
Verify Credentials
Cancel

521946

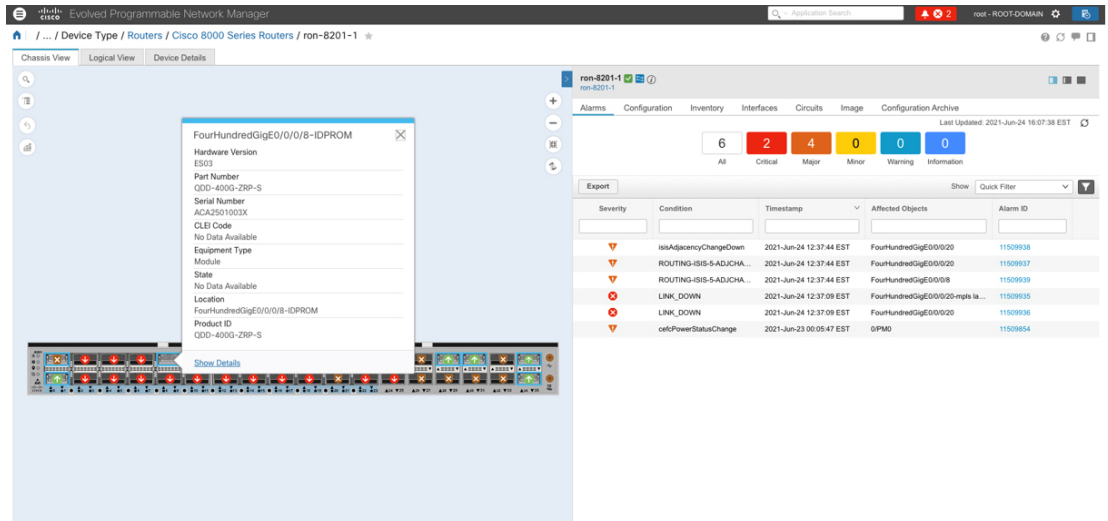




4. To open the chassis view from the Network devices table, click the device name link. The following figure displays the chassis view of the 8201 router.

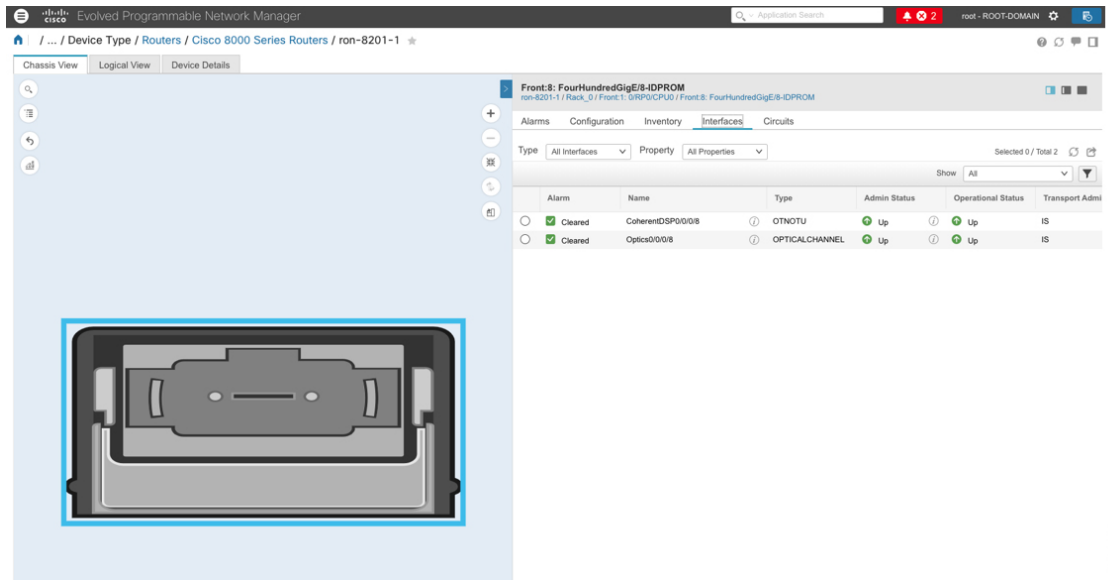


5. Click the QSFP-DD ZR+ port to see specific data about that port.



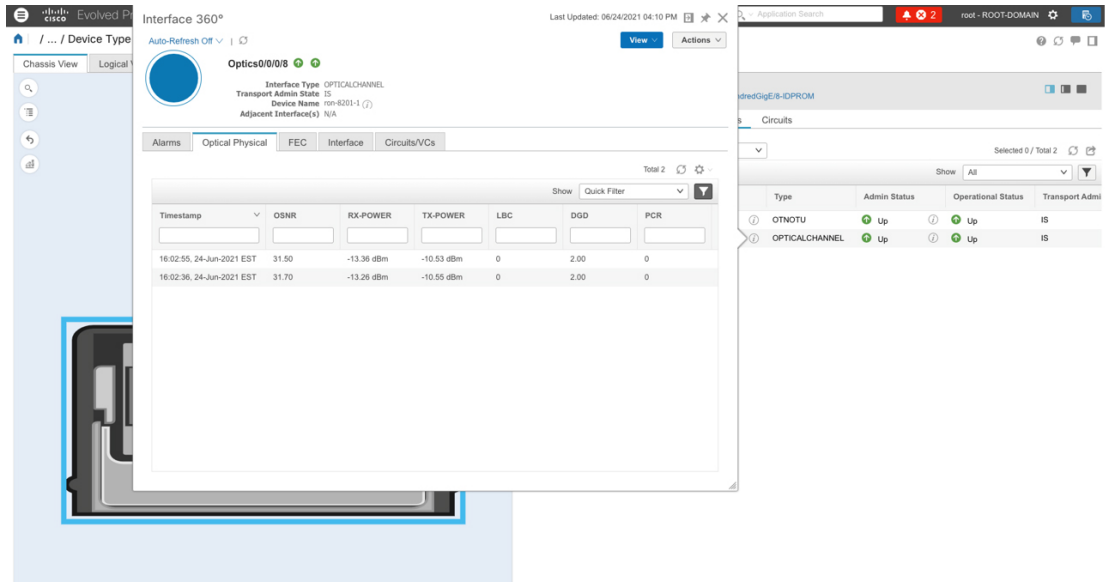
521949

Here you can view the port and specific optical channel and CoherentDSP entities.



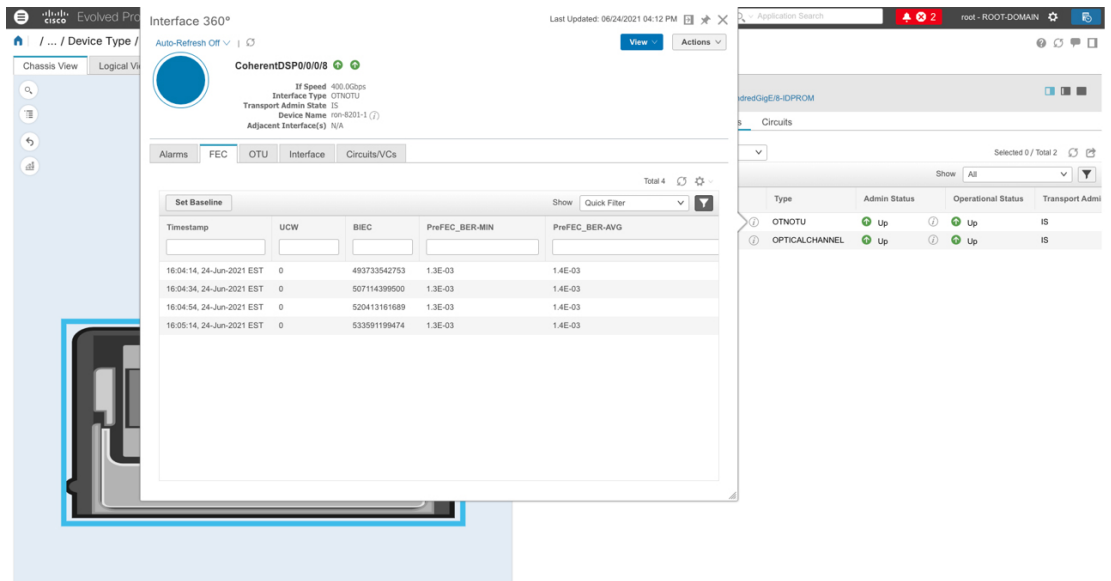
521950

- Clicking the additional information icon for the optical channel and then the **Optical Physical** measurement tab displays the relevant optical PM values such as **RX/TX signal power** and **OSNR** values.



521951

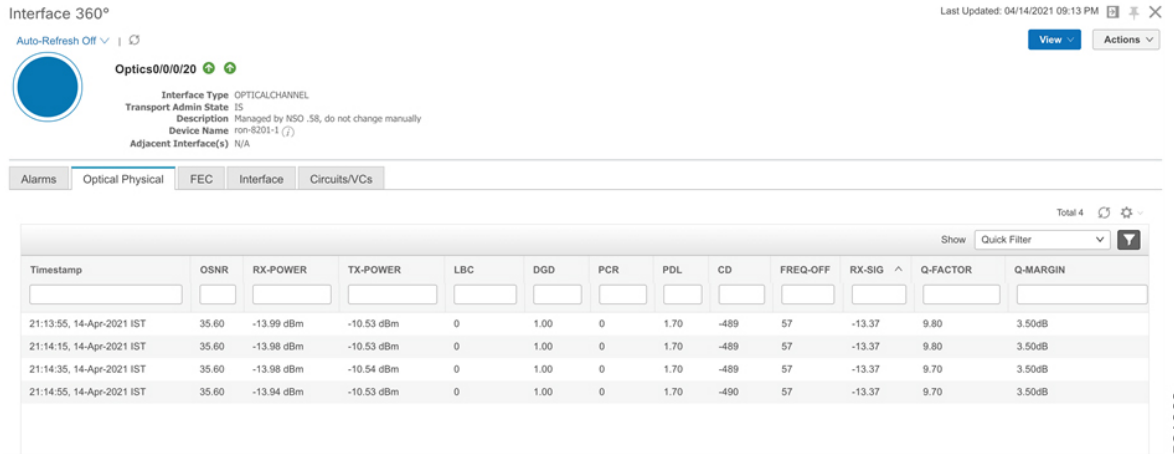
- Clicking the additional information icon for the coherent DSP and then the **FEC** measurement tab displays the relevant coherent DSP FEC statistics such as **PreFEC Bit Error Rate**, **Bit Error Rate Count (BIEC)**, and **Uncorrected Words (UCW)**. The UCW value must remain 0.



521952

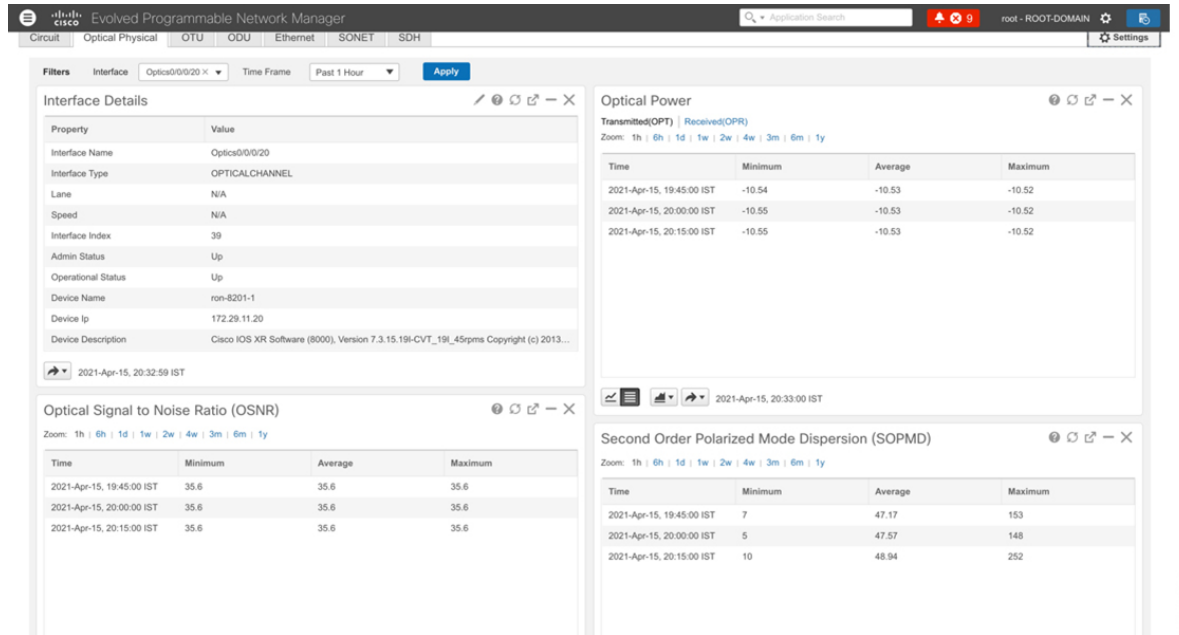
The following figures display the current and historical performance monitoring data in EPNM that is specific to the ZR or ZR+ optics.

Figure 17: Optical Physical Parameters



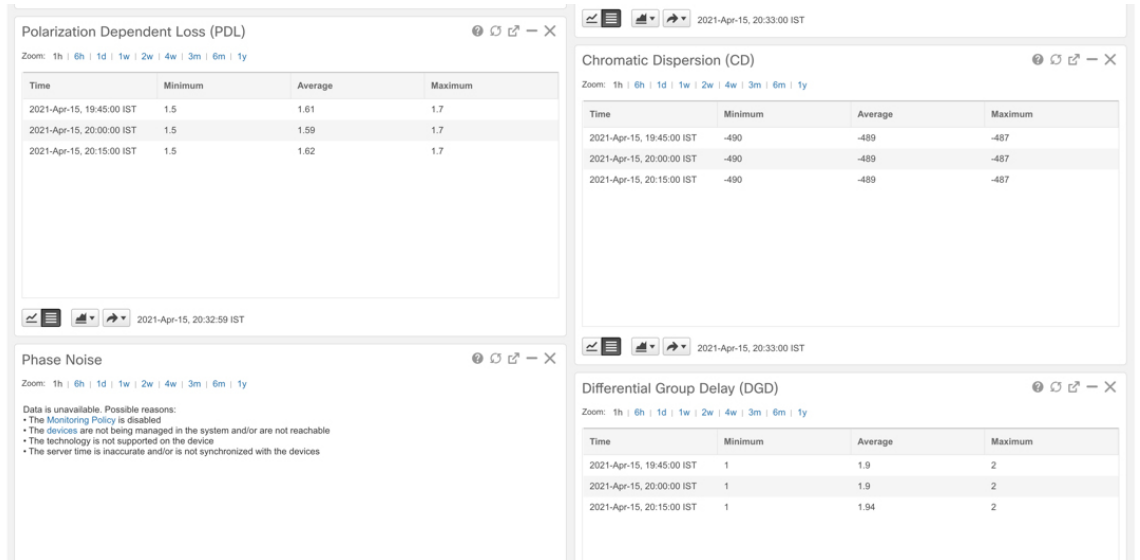
521883

Figure 18: Historical Optical Physical Parameters



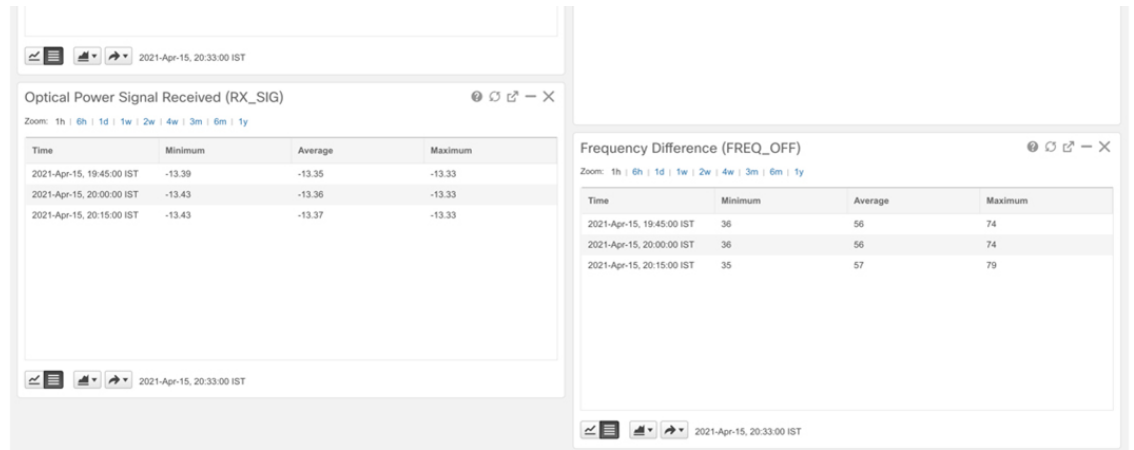
521884

Figure 19: Historical Optical Physical Parameters



521885

Figure 20: Historical Optical Physical Parameters



521888

Figure 21: FEC Parameters

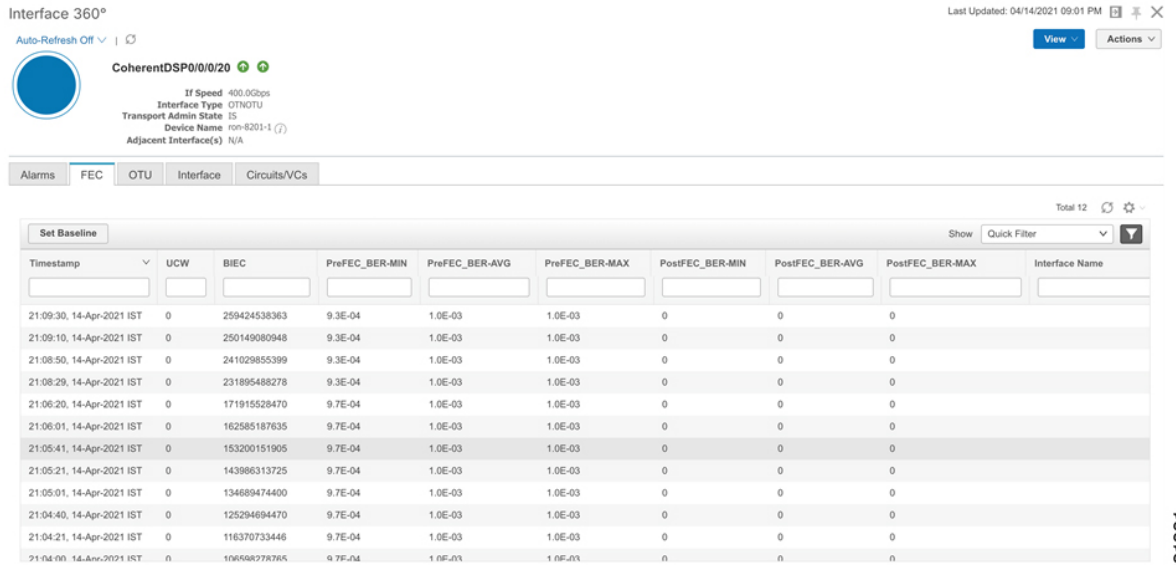


Figure 22: Historical FEC Parameters



521881

521889

Figure 23: Historical FEC Parameters

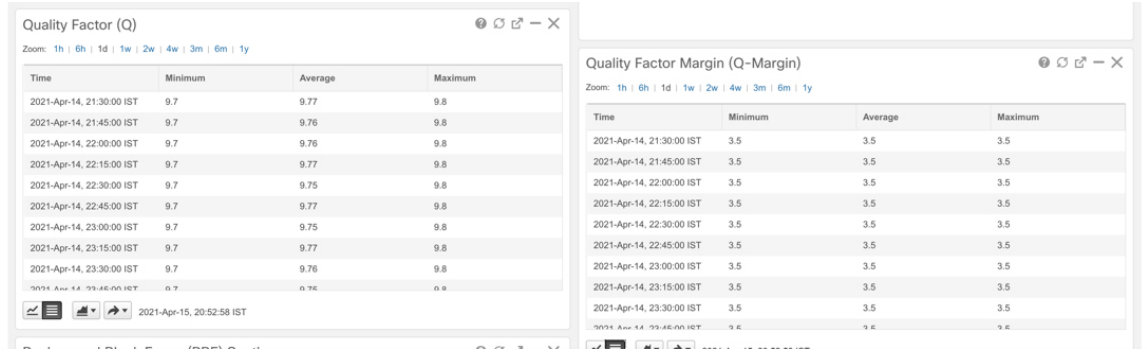
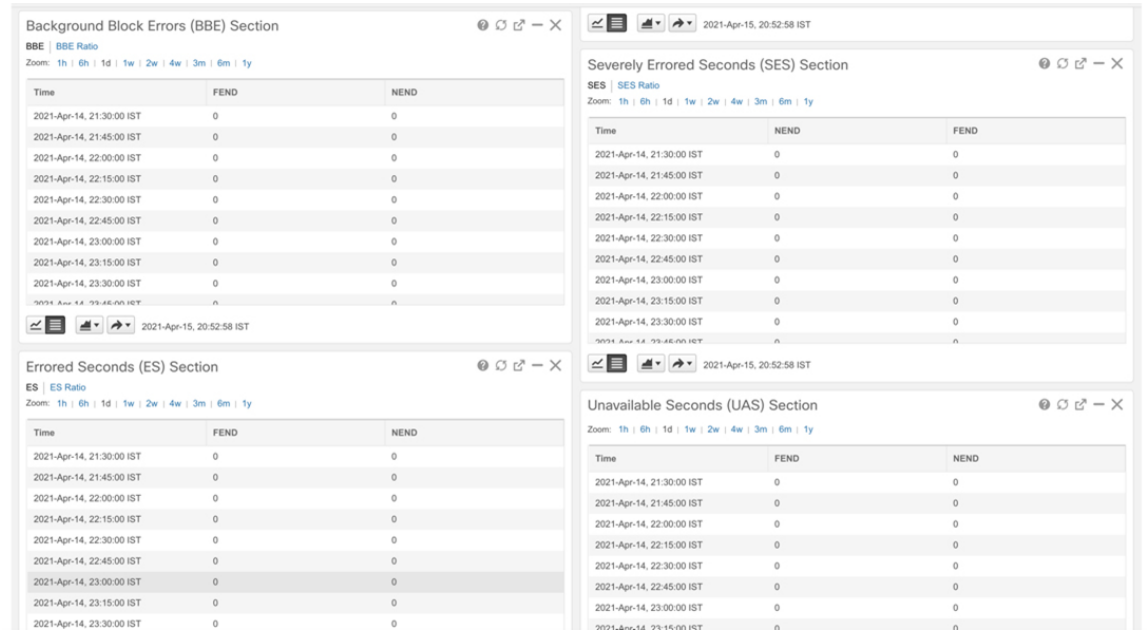


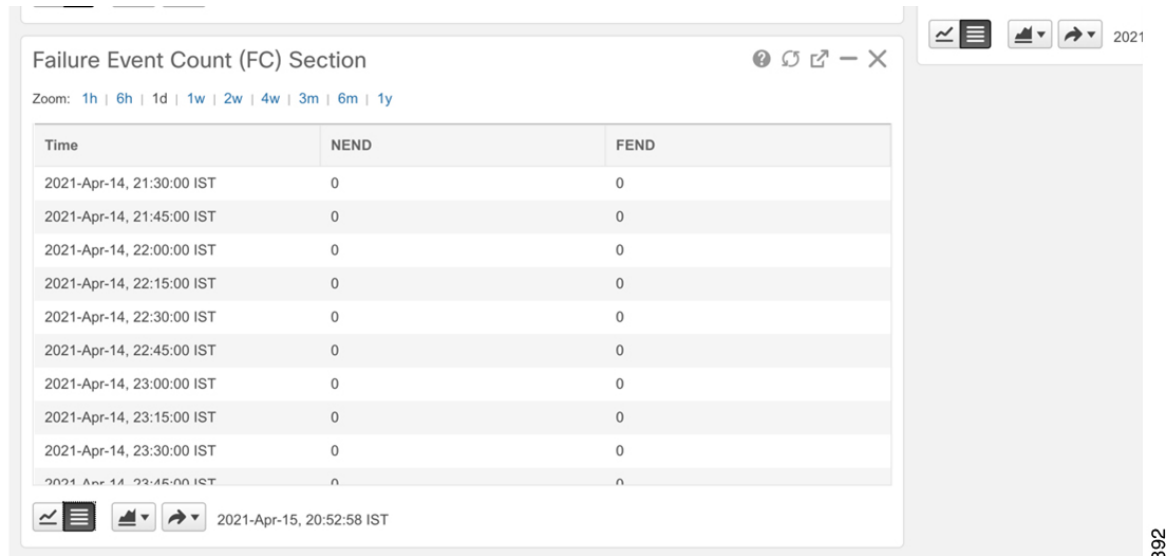
Figure 24: Historical OTN Parameters



521890

521891

Figure 25: Historical OTN Parameters



521892

## Monitor Performance of ZR/ZR+ Optics Using KPIs

Perform the following steps to create KPI Profiles in Health Insights and enable them on the devices to monitor network health.



**Note** Plan which Cisco-supplied KPIs you want to begin using, based on each device's function and the device performance characteristics you want to monitor. Review the Cisco-supplied KPIs documented in [List of Health Insights KPIs](#). In the following image, you see the available default L1 optics KPIs.

KPI Name	Category	Description	Linked Playbook
<input type="checkbox"/> Layer 1 optical alarms	Layer1-Optics	Monitors per-port optical alarms	
<input type="checkbox"/> Layer 1 optical errors	Layer1-Optics	Monitors per-port Layer 1 errors; generates ale...	
<input type="checkbox"/> Layer 1 optical FEC errors	Layer1-Optics	Monitors per-port optical FEC errors; generate...	
<input type="checkbox"/> Layer 1 optical power	Layer1-Optics	Monitors per-port optical power; generates ale...	
<input type="checkbox"/> Layer 1 optical temperature	Layer1-Optics	Monitors per-port optical temperature; generat...	
<input type="checkbox"/> Layer 1 optical voltage	Layer1-Optics	Monitors per-port optical voltage; generates al...	

521913

1. Group the relevant KPIs to form a KPI Profile. A KPI profile can have many different KPIs assigned. In this case, the focus is only on some specific optics KPIs to add to the **optics\_profile** KPI profile.



Performance Alerts / KPI Profiles / Create Profile

Create New Profile

Profile Name  Description

External Destination Details

Server Type  Name

Add KPIs to Profile

All KPIs  Recommended KPIs

Category	KPI	Summary
<input type="checkbox"/> optics		
<input type="checkbox"/> Layer1-Optics	Layer 1 optical alarms	Monitors per-port optical alarms
<input type="checkbox"/> Layer1-Optics	Layer 1 optical errors	Monitors per-port Layer 1 errors; generates alert when error rates exceeds the configured threshold
<input type="checkbox"/> Layer1-Optics	Layer 1 optical FEC errors	Monitors per-port optical FEC errors; generates an alert when FEC errors exceeds the configured th...
<input checked="" type="checkbox"/> Layer1-Optics	Layer 1 optical power	Monitors per-port optical power; generates alert when power levels exceeds the configured threshold
<input checked="" type="checkbox"/> Layer1-Optics	Layer 1 optical temperature	Monitors per-port optical temperature; generates alert when temperature exceeds the configured th...
<input checked="" type="checkbox"/> Layer1-Optics	Layer 1 optical voltage	Monitors per-port optical voltage; generates alert when voltages exceeds the configured threshold

521914

See [Create a New KPI Profile](#).

2. Enable the appropriate KPI Profiles on the devices you want to monitor. From the main menu, choose **Performance Alerts > Enable/Disable KPI Profiles**. Check the checkboxes of all the nodes to which the profile must be applied to, and click **Enable KPI Profiles**.

Multiple nodes may be selected. In the following figure, we are applying the KPI profile to a single node.

Performance Alerts / Enable/Disable KPI Profiles

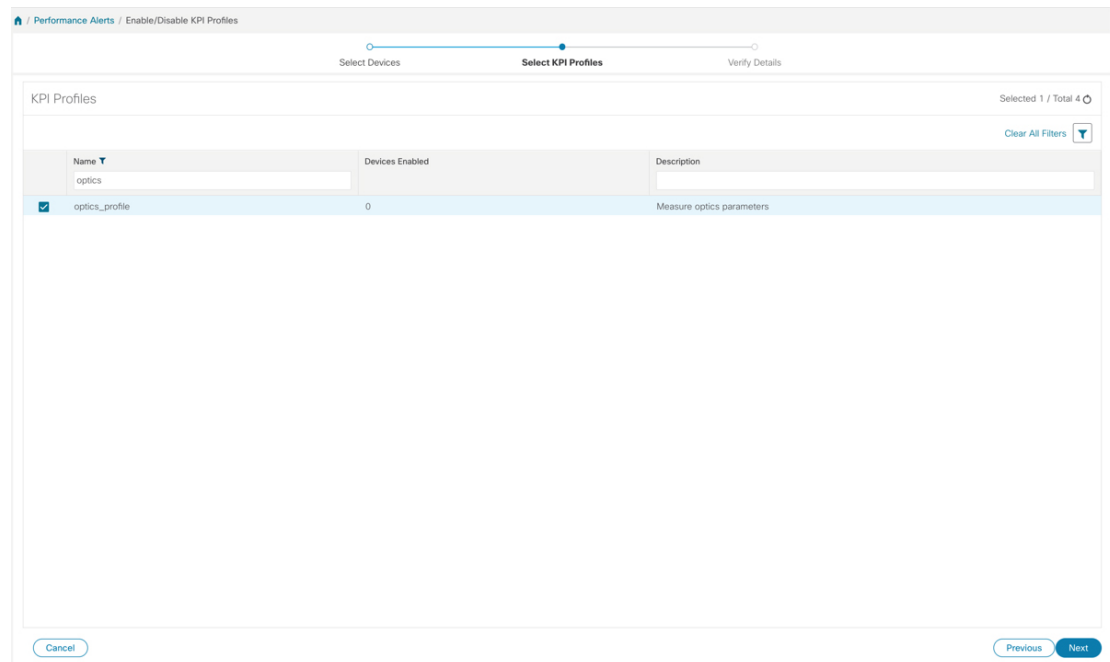
Select By  Device  Device Tags

Devices Selected 1 / Total 13

Reachability	Name	Device Type	Operational State	Enabled Profiles
<input checked="" type="checkbox"/> <span style="color: green;">✔</span> Reachable	ron-8201-1	ROUTER	<span style="color: green;">✔</span> OK	3

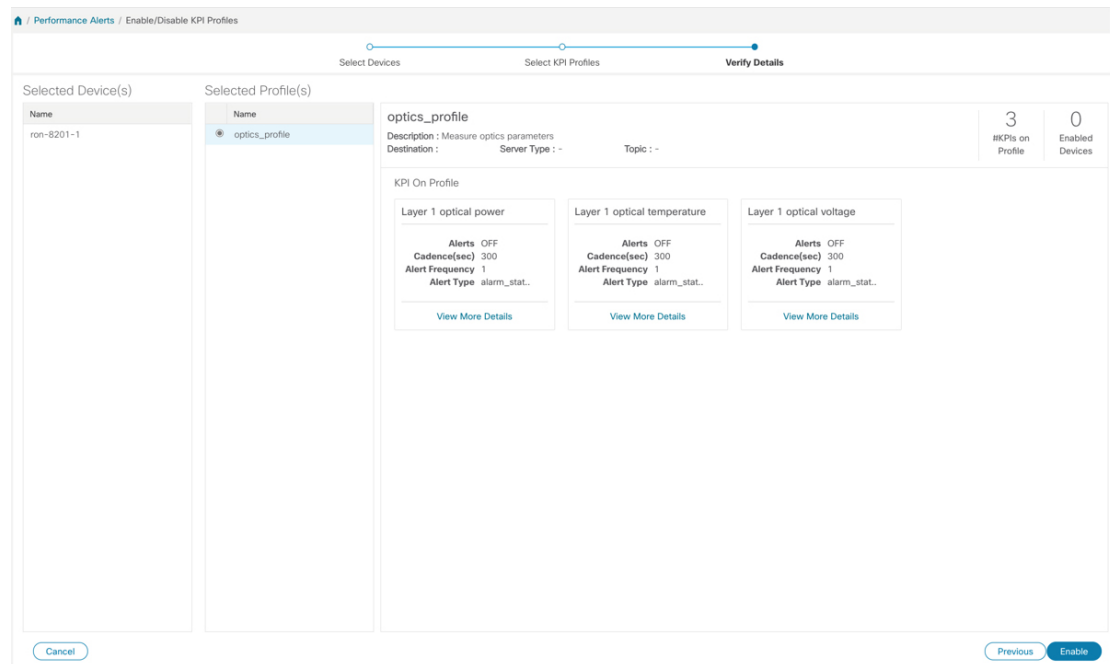
521915

3. Select the optics\_profile KPI profile that was created in the previous step and click next to finalize enabling the KPI for the selected device.



521916

4. The following image displays the final page before enabling the KPI profile for the router. After you click **Enable**, the appropriate configuration is applied to the router to begin streaming the telemetry sensors data for the selected optical KPIs.



521917

See [Enable KPI Profiles on Devices](#).

5. To view alerts from network devices, see [View Alerts for Network Devices](#).

The following figure displays the RX and TX power of the QDD-400G-ZR-S transceiver.



521918

## Optimization Phase

The optimization phase involves:

1. Return to planning stage.
2. Continue to add or change circuits on the network to match packet demands.

