Cisco NCS 1010 Optical Applications Configuration Guide, IOS XR Releases 7.11.x, 24.2.x, and 24.3.x

First Published: 2023-12-08

Last Modified: 2024-10-29

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NCS 1010 Overview and Optical Applications

This chapter gives a brief overview of the optical apps on NCS 1010. See NCS 1010 Overview for the product overview.

NCS 1010 software has multiple optical applications to help bring up the link and maintain traffic on the link.

- Document Objective, on page 1
- Document Organization, on page 1

Document Objective

Cisco Network Convergence System (NCS) 1010 platform has the following configuration guides.

- The *Cisco NCS 1010 System Setup and Software Installation Guide* describes how to bring up the NCS 1010 system and perform the required software installation.

- The *Cisco NCS 1010 Datapath Configuration Guide* describes how to configure various datapaths on NCS 1010.

- The *Cisco NCS 1010 Optical Applications Configuration Guide* describes multiple optical applications on NCS 1010, that help to bring up the link and maintain traffic on the link.

Document Organization

This document is organized into the following chapters:

Chapter	Description
Internode Topology Discovery and Communication, on page 3	NCS 1010 uses OSPF for topology discovery.
Span Loss, on page 7	Span Loss application measures span loss between two nodes for a given direction and verifies if span loss is within the configured range.
Raman Tuning, on page 11	Raman Tuning application sets Raman pump powers for optimum gain and spectral gain flatness.

Chapter	Description
Gain Estimator, on page 27	Gain Estimator computes power that is transmitted from the upstream node, analyzes incoming span loss, sets the gain mode of the EDFA amplifier, and provides the initial target gain for the amplifier.
Link Tuner, on page 31	Link Tuner uses actual optical measurements like span loss to compute and configure the target PSD (power spectral density) for each span.
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Automatic Network Turn Up, on page 73	All the optical applications work together to bring up the DWDM link. This chapter describes the link bring up process and how the applications working together.
Configure OTDR , on page 77	OTDR application scans and determines loss in signal power and location on the fiber path where the loss occurs.

Internode Topology Discovery and Communication

This chapter describes how internode topology discovery and communication between NCS 1010 nodes takes place using OSPF.

Internode Topology Discovery and Communication

Optical applications on the NCS 1010 nodes must discover the OLT-OLT link topology. Span level applications must discover the adjacent nodes. Link level applications must learn the complete OLT-OLT link topology. NCS 1010 uses OSPF to discover the link topology and communicate topology information.

The networking devices running OSPF detect topological changes in the network, flood link-state updates to neighbors, and quickly converge on a new view of the topology. Each OSPF router in the network soon has the same topological view again.

Optical applications on NCS 1010 must discover the link topology, the different nodes and the node types, and the optical spectral band the nodes work on. NCS 1010 uses an enhanced version of OSPF that supports a new link-state advertisement attribute that advertises the node type and band.

Configure OSPF

The following commands are the necessary configurations for OSPF on an NCS 1010 OLT node.

configure

router ospf *process-name*

router-id *router-id*

distribute link-state

nsf

network point-to-point

redistribute connected

area *area-id*

interface Loopback1

interface GigabitEthernet0/0/0/0

The following commands are the necessary configurations for OSPF on an NCS 1010 ILA node.

configure

router ospf *process-name*

router-id *router-id*

distribute link-state

nsf

network point-to-point

redistribute connected

area *area-id*

interface Loopback1

interface GigabitEthernet0/0/0/0

interface GigabitEthernet0/0/0/2

👉

Important   You must configure router ID during OSPF configuration on NCS 1010 nodes.

See Implementing OSPF, for a description of the concepts and tasks necessary to implement OSPF on Cisco IOS XR.

Configure OSPF cost

Table 1: Feature History

Feature Name	Release Information	Description
Configure OSPF cost	Cisco IOS XR Release 7.11.1	To identify the best route, OSPF path computation uses the link cost. The system calculates the cost based on the available interface bandwidth. From this release onwards, you can set a user-defined cost value using the **cost** *variable* in the **router ospf** command. As a result, this feature enables you to set a specific route when there are two equal-cost routes to the same destination.

Cost is the metric, you can use the cost command to explicitly specify the interface (network) for OSPF path calculation.

configure

router ospf *process-name*

router-id *router-id*

area *area-id*

interface Loopback1

interface GigabitEthernet0/0/0/0

cost *cost*

See cost (OSPF) for different command modes and usage guidelines to implement **cost** OSPF on Cisco IOS XR.

Note The cost of the link is inversely proportional to the bandwidth of the link.

The following example shows a sample **cost** configuration.

```
P/0/RP0/CPU0:ios(config)#router ospf 1

RP/0/RP0/CPU0:ios(config-ospf)#area 0
RP/0/RP0/CPU0:ios(config-ospf-ar)#interface Loopback0
RP/0/RP0/CPU0:ios(config-ospf-ar-if)#interface GigabitEthernet0/0/0/0
RP/0/RP0/CPU0:ios(config-ospf-ar-if)#cost 20
RP/0/RP0/CPU0:ios(config-ospf-ar-if)#commit
```

Span Loss

This chapter describes the Span Loss optical application for Cisco NCS 1010.

Overview of Span Loss

The Span Loss calculation is an automatic calculation of span losses between NCS 1010 nodes. The span loss verification algorithm calculates span loss by comparing power measurements at line Tx/Rx port at far end and line Rx/Tx port at near end. The algorithm raises the *Span Loss Value Out Of Range* alarm if span loss is not within configured thresholds.

Figure 1: Sample two node topology
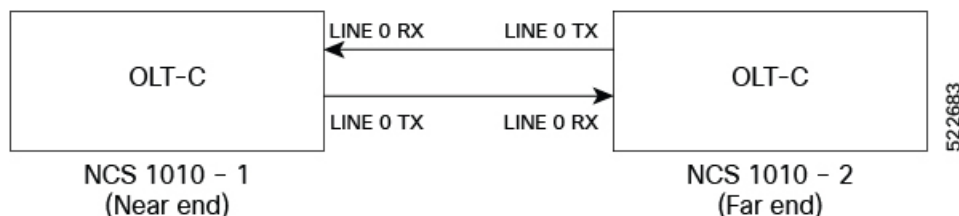
For example, in the previous figure, the **Tx Span Loss** on NCS 1010-1 is the difference in signal power between LINE 0 TX on NCS 1010-1 and LINE 0 RX on NCS 1010-2.

The span loss application reports the span loss value for a span every 90 seconds. If span loss changes, for example when a change in fiber loss occurs, the span loss application typically takes 90 seconds to update the span loss.

On a Raman span with Raman tuning enabled, span loss verification reports the following values:

- **Span loss with pumps off:** This measurement is the difference in power values between the DFB-Tx/Rx of the remote node and the DFB-Rx/Tx of the local node. This measurement also includes a timestamp. When a Raman span is up, the span loss application latches on to the difference in power between DFB-Tx and DFB-Rx before Raman tuning turns the Raman pumps on.

- **Apparent span loss:** This measurement is based on the power values of C band, L band and Optical Service Channel (OSC). For a Raman span, the span loss application uses this span loss value to raise the *Span Loss Value Out Of Range* alarm.

- **Estimated span loss:** This value is based on Raman gain that is achieved by Raman tuning application. Estimated span loss value is based on Raman gain that is achieved when safety loop was closed and tuning was performed. Raman tuning application reports the Raman gain measurement. When you disable Raman tuning, the span loss application does not compute the Estimated span loss.

  Estimated span loss = Apparent span loss + Raman gain

- **Span loss**: For non-Raman spans, the span loss algorithm calculates span loss by comparing Tx/Rx power measurement at line port at far end and Rx/Tx power measurement at line port at near end.

View Span Loss Values

Use the **show olc span-loss** command to view the Tx span loss and Rx span loss.

Note   **Rx Span Loss** values are not available on a network where one NCS 1010 node is upgraded to R25.3.1 while other nodes are on an earlier software version.

The following sample shows the output of the **show olc span-loss** command on a Raman span with Raman tuning enabled.

```
RP/0/RP0/CPU0:ios#show olc span-loss
Mon Apr 11 09:33:00.398 UTC

Controller name                          : Ots0/0/0/0
Neighbour RID                            : 10.1.1.2
Apparent Rx Span Loss                    : 7.7 dB
Rx Span Loss (with pumps off)            : 23.2 dB
Rx Span Loss (with pumps off) measured at : 2022-04-11 07:42:26
Estimated Rx Span Loss                   : 23.5 dB
Apparent Tx Span Loss                    : 17.5 dB
Tx Span Loss (with pumps off)            : 33.3 dB
Tx Span Loss (with pumps off) measured at : 2022-04-11 07:42:56
Estimated Tx Span Loss                   : 33.5 dB
```

The following sample shows the output of the **show olc span-loss** command on a Raman span with Raman tuning disabled. In this sample output, Raman tuning is disabled on both Ots0/0/0/0 and Ots0/0/0/2 on the near end node. The far end nodes have Raman tuning enabled.

```
RP/0/RP0/CPU0:ios#show olc span-loss
Mon Jun 20 06:51:58.601 UTC

Controller name                          : Ots0/0/0/0
Neighbour RID                            : 10.1.1.5
Apparent Rx Span Loss                    : 16.3 dB
Rx Span Loss (with pumps off)            : 16.4 dB
Rx Span Loss (with pumps off) measured at : 2022-06-20 05:53:52
Estimated Rx Span Loss                   : NA
Apparent Tx Span Loss                    : 5.8 dB
Tx Span Loss (with pumps off)            : 21.6 dB
Tx Span Loss (with pumps off) measured at : 2022-06-20 05:54:08
Estimated Tx Span Loss                   : 18.6 dB


Controller name                          : Ots0/0/0/2
Neighbour RID                            : 10.1.1.3
Apparent Rx Span Loss                    : 27.1 dB
Rx Span Loss (with pumps off)            : 30.3 dB
Rx Span Loss (with pumps off) measured at : 2022-06-20 06:51:22
```

```
Estimated Rx Span Loss                     : NA
Apparent Tx Span Loss                      : 6.4 dB
Tx Span Loss (with pumps off)              : 19.2 dB
Tx Span Loss (with pumps off) measured at : 2022-06-20 05:54:08
Estimated Tx Span Loss                     : 19.6 dB
```

The following sample shows the output of the **show olc span-loss** command on a non-Raman span.

```
RP/0/RP0/CPU0:ios#show olc span-loss
Mon Apr 11 09:37:31.950 UTC

Controller name                            : Ots0/0/0/0
Neighbour RID                              : 10.91.1.90
Rx Span Loss                               : 10.2 dB
Rx Span Loss (with pumps off)              : NA
Rx Span Loss (with pumps off) measured at  : NA
Estimated Rx Span Loss                     : NA
Tx Span Loss                               : 9.7 dB
Tx Span Loss (with pumps off)              : NA
Tx Span Loss (with pumps off) measured at  : NA
Estimated Tx Span Loss                     : NA
```

Configure Span Loss Thresholds

Use this task to configure span loss thresholds.

Procedure

Step 1   Select the controller on which the span loss thresholds need to be configured after entering into the optical applications configuration mode.

Example:

```
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
```

Step 2   Configure the minimum and maximum span loss threshold values.

Example:

```
RP/0/RP0/CPU0:ios(config)#span-loss min 100
RP/0/RP0/CPU0:ios(config)#span-loss max 200
```

The system raises a SPAN-LOSS-OUT-OF-RANGE alarm if span loss is greater than the maximum threshold or less than the minimum threshold.

Step 3   Commit the changes and exit all the configuration modes.

Example:

```
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc)#exit
RP/0/RP0/CPU0:ios(config)#exit
```

CHAPTER **4**

Raman Tuning

This chapter describes the Raman Tuning optical application for Cisco NCS 1010.

Overview of Raman Tuning

Raman Tuning Algorithm calculates and sets the different pump power values across five Raman pumps to obtain the target Raman Gain on a span. Raman tuning runs in both directions of the span independently at the node level. Raman tuning requires communication between peer nodes. Hence, OSC communication between the two nodes is a prerequisite for Raman Tuning.

Raman tuning algorithm uses the following parameters to calculate the pump powers necessary to achieve the target Raman gain.

- Fiber type

- Fiber length

- Loss on the fiber at each pump wavelength

- Loss on the fiber at the signal wavelength

If you configure a span length value, Raman tuning uses this value.

Raman tuning is disabled by default. Raman tuning is enabled if automatic link bring up is enabled. You can manually trigger Raman tuning if necessary. The NCS 1010 initiates the tuning process under the following circumstances:

- During the initial link bring up

- After a fiber cut

- After a power cycle event

- After a line card cold reload event

- After a DFB shut or unshut event

- After an OTS controller shut or unshut event on near end or far end node

• After modification of span length configuration

Raman tuning is traffic impacting. When Raman tuning is in progress, the amplifier on the far end of the span is turned off to block traffic. The Optical Safety Remote Interlock (OSRI) feature allows turning off the amplifier on the peer node for Raman tuning. Only the OSC is active on the link while Raman tuning is in progress.

At the LINE-TX port on the far end of the span, the dedicated Raman probe (DFB) is combined with the transmitted optical channels. The DFB laser at 191.1 THz is used to perform a link continuity check on the Raman span for optical safety. The DFB laser is used during Raman tuning.

At the LINE-RX port, five wavelengths between 1424 nm and 1495 nm are inserted in the counter propagating direction of the signal to provide amplification using the Raman effect for both C and L band optical channels.

The system triggers Raman tuning when a link goes down and comes back up. After completing Raman tuning successfully, soft reloads, RP reloads, Raman OSRI change, and Raman Force APR change do not retrigger Raman tuning.

The following table lists and describes the different Raman Tuning Status.

Raman Tuning Status	Description
WORKING – MEASUREMENT	The algorithm is measuring the span loss on the link.
WORKING – CALCULATION	The algorithm is calculating the gain target and required pump powers.
WORKING – OPTIMIZATION	The algorithm is optimizing the pump powers.
TUNED	Raman tuning is complete.
BLOCKED	The system is unable to perform Raman tuning. This status can occur because the link is down or the system detected high Raman Back Reflection.
DISABLED	Raman tuning is disabled.

Raman tuning works in the following three modes:

• Auto mode: Raman tuning defines the target gain and sets the pump powers and DFB VOA attenuation to achieve the target gain overwriting user configuration.

• Gain mode: User defines the gain target and Raman tuning sets the pump powers and DFB VOA attenuation to achieve the target gain.

• Manual mode: User disables Raman tuning and manually configures the Raman pumps and DFB VOA attenuation.

When Raman tuning is in progress, the node performing Raman tuning triggers the RAMAN-TUNE-IN-PROGRESS alarm. From Cisco IOS XR Release 7.9.1, NCS 1010 supports C+L band networks. In a C+L band configuration, the RAMAN-TUNE-IN-PROGRESS alarm is raised at the C-band OLT or ILA node performing Raman tuning as well as the far end L-band node. OSRI disables the EDFA amplifiers on both the C and L band devices in the peer node during Raman Tuning.

Note

- If Raman back reflection (BR) is high, Raman tuning turns the Raman pumps off and goes into blocked state. High BR can damage the optics. When you clear the high BR and BR is at acceptable levels, the system triggers Raman tuning and turns the Raman pumps on.

- If a Raman span has a span loss value less than 14 dB, Raman tuning goes into the BLOCKED state. The NCS 1010 performs a span loss check at system startup to verify if you can use Raman amplification effectively on the span.

View Raman Tuning Status

You can view the Raman tuning status using **show olc raman-tuning** command. The following sample is an output of the **show olc raman-tuning** command.

```
RP/0/RP0/CPU0:ios#sh olc raman-tuning
Tue Mar 21 06:11:36.944 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
```

You can view the Raman tuning status for individual controllers using **show olc raman-tuning controller ots r/s/i/p** command. The following sample is an output of the **show olc raman-tuning controller ots** *r/s/i/p* command.

```
RP/0/RP0/CPU0:ios#sh olc raman-tuning controller ots 0/0/0/0
Tue Mar 21 06:13:26.535 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
```

You can view detailed Raman tuning status using **show olc raman-tuning details** command. The following sample is an output of the **show olc raman-tuning details** command.

```
RP/0/RP0/CPU0:ios#show olc raman-tuning details
Tue Mar 21 06:27:13.302 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
Last Run Fail Reason : [ Peer node is unreachable ]
Last Run Fail Timestamp : 2023-03-19 12:20:37
Last Successful Tuning Gain : 15.7 dB
Last Successful Tuning Timestamp : 2023-03-20 07:54:00
```

You can view detailed Raman tuning status for individual controllers using **show olc raman-tuning details controller ots r/s/i/p** command. The following sample is an output of the **show olc raman-tuning details controller ots** *r/s/i/p* command.

```
RP/0/RP0/CPU0:ios#show olc raman-tuning details controller Ots 0/0/0/0
Tue Mar 21 06:27:58.213 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
Last Run Fail Reason : [ Peer node is unreachable ]
Last Run Fail Timestamp : 2023-03-19 12:20:37
Last Successful Tuning Gain : 15.7 dB
Last Successful Tuning Timestamp : 2023-03-20 07:54:00
```

To view the individual Raman pump information and other parameters, use the **show controllers ots** *r/s/i/p* **raman-info** command.

```
RP/0/RP0/CPU0:ios#show controllers ots 0/0/0/0 raman-info
Fri Apr  1 06:40:33.849 UTC

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


        Alarm Statistics:
        -----------------
        RAMAN-AUTO-POW-RED = 0
        RAMAN-1-LOW-POW = 0
        RAMAN-2-LOW-POW = 0
        RAMAN-3-LOW-POW = 0
        RAMAN-4-LOW-POW = 0
        RAMAN-5-LOW-POW = 0
        RAMAN-1-HIGH-POW = 1
        RAMAN-2-HIGH-POW = 0
        RAMAN-3-HIGH-POW = 0
        RAMAN-4-HIGH-POW = 0
        RAMAN-5-HIGH-POW = 0

        Parameter Statistics:
        ---------------------
        Raman Safety Control mode = auto
        Raman Osri = OFF
        Raman Force Apr = OFF
        Composite Raman Power = 886.60 mW

        RAMAN Pump Info:
        ---------------------
        Instance        Wavelength(nm)   Power(mW)
         1               1424.00                257.60
         2               1438.00                255.10
         3               1457.00                71.60
         4               1470.00                127.50
         5               1495.00                170.10


        Configured Parameters:
        -------------
        Raman Safety Control mode = auto
        Raman Osri = OFF
        Raman Force Apr = OFF

        RAMAN Pump Info:
```

```
--------------------
Instance        Power(mW)
 1               45.00
 2               40.00
 3               40.00
 4               40.00
 5               35.00
```

The following sample output

> **Note**   In the previous output, there are two sections for Raman Pump Info that show different values. The first Raman Pump Info section displays operational data (current pumps power values). The second Raman Pump Info section displays Raman Pump Power configuration. In this case, the default pump powers are displayed. Use the **raman-tx-power** *pump***value***value* command to configure individual Raman pump powers.

The Raman tuning application locks the OTDR scan at both fiber ends before the tuning starts, and releases the lock after the tuning completes. Therefore, when you try to start the OTDR scan when Raman tuning is running, your request gets rejected. The following example explains the OTDR start request rejection. The OTDR scan request that has been rejected already does not run automatically after the lock is released, so you have to create a new request to start the OTDR again.

Configure Raman Tuning

Table 2: Feature History

Feature Name	Release Information	Description
Four-Pump Raman Tuning Mode	Cisco IOS XR Release 7.11.1	You can now configure the Raman tuning mode to achieve the target Raman gain using only four pumps instead of all five. In **C-band only** mode, the algorithm dynamically adjusts to operate with four Raman pumps during the next Raman tuning sequence, while the fifth pump remains available without being automatically shut down. This enhancement introduces C-band-only mode specifically designed for performing Raman tuning in low-dispersion fibers such as E-LEAF fibers.

The following configurations are available for Raman Tuning:

Disable Raman Tuning

You can disable Raman tuning for a controller. Use the following commands to disable Raman tuning.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

raman-tuning disable

commit

end

The following is a sample configuration that disables Raman tuning.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#raman-tuning disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Enable Raman Tuning

You can enable Raman tuning for a controller. Use the following commands to enable Raman tuning.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

raman-tuning enable

commit

end

The following is a sample configuration that enables Raman tuning.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#raman-tuning enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Raman Tuning Mode

The existing Raman tuning algorithm uses all five Raman pumps to achieve the target Raman gain. With this enhancement, an alternative tuning mode now allows operation with only four Raman pumps.

When configured in **C-band-only** mode, the system initiates the Raman tuning process using the four-pump algorithm during the next Raman tuning sequence. To revert to the five-pump configuration, switch to **C-L-band** mode.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

raman-tuning tuning-mode C-band-only | C-L-band

commit

end

The entry highlighted in bold in the following example shows how to configure the **C-band-only** mode.

```
RP/0/RP0/CPU0:NCS1010#configure
RP/0/RP0/CPU:NCS1010 (config)#optical-line-control controller Ots 0/0/0/0
RP/0/RP0/CPU0:NCS1010(config-olc-ots)#raman-tuning tuning-mode C-band-only
RP/0/RP0/CPU0:NCS1010(config-olc-ots)#commit
```

The entry highlighted in bold in this example shows the configuration of the **C-band-only** mode.

```
IRP/0/RP0/CPU:NCS1010#show running-config optical-line-control
optical-line-control
    automatic-link-bringup
    controller Ots0/0/0/0
        raman-tuning tuning-mode C-band-only
```

Configure Raman Gain Target

You can manually set the desired Raman gain target. Use the following commands to set the Raman gain target.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

raman-tuning raman-gain-target *value*

commit

end

You can configure Target Raman Gain of 8.0 to 25.0 dB in multiples of 0.1 dB. The following is a sample configuration that configures the Raman gain target to 18 dB.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#raman-tuning raman-gain-target 180
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Raman Pump Powers

You can set the Raman pump powers manually. Use the following commands to set the pump powers.

configure

controller ots *Rack/Slot/Instance/Port*

raman-tx-power *pump***value***value*

commit

end

The following is a sample configuration that sets the pump power of the first Raman pump to 211 mW.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
```

```
RP/0/RP0/CPU0:ios(config-olc-ots)#raman-tx-power 1 value 21100
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure DFB VOA Attenuation

Raman tuning algorithm changes the DFB VOA to adjust the DFB Tx power depending on the span loss. The following table lists the DFB TX power for different span loss ranges.

Span Loss	DFB TX Power
14-25 dB	-5 dB
25-33 dB	0 dB
>33 dB	5 dB

Use the following commands to configure DFB VOA attenuation when Raman Tuning is disabled and you want to configure the DFB manually.

configure

controller dfb *Rack/Slot/Instance/Port*

tx-voa-attenuation *value*

commit

end

The following is a sample configuration that sets the DFB VOA attenuation to 10 dB.

```
RP/0/RP0/CPU0:ios#conf
Wed Jul  6 04:45:47.720 UTC
RP/0/RP0/CPU0:ios(config)#controller dfb 0/0/0/0
RP/0/RP0/CPU0:ios(config-Dfb)#tx-voa-attenuation 100
RP/0/RP0/CPU0:ios(config-Dfb)#commmit
RP/0/RP0/CPU0:ios(config-Dfb)#end
```

Initiate Raman Tuning

You can trigger Raman tuning manually. Use the following exec command to trigger Raman tuning.

olc start-raman-tuning controller ots *Rack/Slot/Instance/Port*

The following is a sample configuration that initiates Raman tuning.

```
RP/0/RP0/CPU0:ios#olc start-raman-tuning controller ots 0/0/0/0
```

Raman Tuning with OTDR Lock

Table 3: Feature History

Feature Name	Release Information	Description
Raman Tuning with OTDR Lock	Cisco IOS XR Release 7.10.1	If the OTDR scan and Raman tuning are performed on the same fiber simultaneously, the OTDR reports unexpected results.
		In this release, a check is being implemented to prevent both operations from running simultaneously. The Raman tuning application imposes an OTDR lock at both ends of the fiber before the process starts and releases the same after the tuning is completed.

The OTDR scan and Raman tuning cannot be simultaneously executed on the same fiber. To resolve this issue, Raman tuning application locks the OTDR at both ends of the fiber before the tuning process starts and releases the lock after the tuning completes.

If the OTDR scan is in progress, the lock request is rejected and the Raman tuning application retries every minute to acquire the OTDR lock. The Raman tuning starts only when OTDR scan lock is acquired at both ends of the fiber. If the Raman tuning application is running, user request to start OTDR scan is rejected. See .

The following sample shows the blocked status of the Raman Tuning due to OTDR running in remote node.

```
RP/0/RP0/CPU0:ios#show olc raman-tuning
Tue Feb 28 10:32:12.648 UTC

Controller                   : Ots0/0/0/0
Raman-Tuning Status          : BLOCKED
Blocked Reason Details       : [ Raman peer response OSRI ON/OTDR LOCK ON failure ]
Tuning Complete Timestamp    : N/A
Estimated Max Possible Gain  : N/A dB
Raman Gain Target            : N/A dB
Gain Achieved on Tuning Complete : N/A dB
```

The following sample shows the blocked status of the Raman Tuning due to OTDR running in local node.

```
P/0/RP0/CPU0:ios#sh olc raman-tuning
Tue Feb 28 10:39:18.055 UTC
Controller                   : Ots0/0/0/0
Raman-Tuning Status          : BLOCKED
Blocked Reason Details       : [ Raman local OTDR LOCK ON failure ]
Tuning Complete Timestamp    : N/A
Estimated Max Possible Gain  : N/A dB
Raman Gain Target            : N/A dB
Gain Achieved on Tuning Complete : N/A dB
```

Use OTDR for Evaluation of Raman Turn Up

Table 4: Feature History

Feature Name	Release Information	Feature Description
Fiber Health Check for Raman Turn-Up	Cisco IOS XR Release 7.11.1	This feature utilizes OTDR results to evaluate whether the optical fiber and allied components are in good condition to withstand high-power transmission by Raman pump. The automatic check is performed before Raman Turn-up to prevent possible damage to the transmission system during Raman amplification. Commands introduced: **otdr raman-turn-up [enable | disable]** **olc start-raman-turn-up** **olc force-raman-turn-up**

The Raman turn up algorithm evaluates whether the transmission fiber is in Go-condition or not before turning on the Raman pumps. When you enable OTDR for Raman turn up, OTDR can provide data on loss and reflective anomalies in the fiber along with its location. NCS 1010 software uses this OTDR results to evaluate the Go or No-Go condition of transmission fiber to launch Raman power.

The Raman turn up feature ensures safety by preventing damage to hardware or fiber due to high Raman power, during installation and after every fiber repair. The Raman turn up is triggered during the following events:

- Span fiber repair

- Line card cold reload

- Device power cycle

The Raman turn up algorithm uses the following parameters to evaluate the Go condition for fibers:

- Optical power dissipation

- Magnitude of OTDR loss event

- Critical distance at which a reliable measurement range for OTDR loss event is possible.

Note   Fiber End (FE) events are not considered for the evaluation of Raman turn up.

![Note]

Note

- If only the Raman turn up feature is enabled and the OTDR autoscan feature is disabled, the autoscan will be triggered due to Span Up event, to evaluate the transmission fiber. But it will not be triggered due to Span Down event.

- If both Raman turn up and OTDR autoscan feature are enabled OTDR autoscan will be triggered due to Span Up and Span Down events.

Configure Raman Turn Up

You can enable or disable OTDR for Raman turn up using the following commands:

configure

optical-line-control

controller ots Rack/Slot/Instance/Port

otdr raman-turn-up [enable | disable]

commit

end

The following are the sample configurations that enable and disable the Raman turn up.

```
RP/0/RP0/CPU0:ios#configure
Thu Nov  2 10:10:53.812 UTC
RP/0/RP0/CPU0:IOS(config)#optical-line-control controller Ots 0/0/0/0
RP/0/RP0/CPU0:IOS(config-olc-ots)#otdr raman-turn-up enable
RP/0/RP0/CPU0:IOS(config-olc-ots)#commit
Thu Nov  2 10:11:20.514 UTC

RP/0/RP0/CPU0:ios#configure
Fri Nov  3 11:12:34.631 UTC
RP/0/RP0/CPU0:IOS(config)#optical-line-control controller Ots 0/0/0/0
RP/0/RP0/CPU0:IOS(config-olc-ots)#otdr raman-turn-up disable
RP/0/RP0/CPU0:IOS(config-olc-ots)#commit
Fri Nov  3 11:13:23.514 UTC
```

View Raman Turn Up Results

You can view the Raman turn up status using **show olc otdr-status** command. The following sample displays the results of Raman turn up evaluation for Go condition.

```
RP/0/RP0/CPU0:iOS#show olc otdr-status
Thu Nov  2 10:35:29.338 UTC

Controller                     : Ots0/0/0/0
Auto-scan Start Time           : 2023-11-02 10:32:56
OTDR Auto-scan Status          : COMPLETED
Status Detail                  : Completed on Span Up
Raman Turn Up Fiber Check      : Success
Optical Span Status            : Up
Trigger Event                  : Span Restore

RP/0/RP0/CPU0:ios#show olc otdr-status details
Thu Nov  2 10:35:37.969 UTC
```

```
Controller                         : Ots0/0/0/0
Auto-scan Start Time               : 2023-11-02 10:32:56
OTDR Auto-scan Status              : COMPLETED
Status Detail                      : Completed on Span Up
Raman Turn Up Fiber Check          : Success
Optical Span Status                : Up
Trigger Event                      : Span Restore
Last Raman Turn Up Scan Time       : 2023-11-02 10:32:56
Last Raman Turn Up Fiber Check     : Success
Last Trigger Event                 : Span Restore


Critical Distance (m)              : 10200.00
Raman Turn Up Relaxation Factor (%) : 40
Total Events detected              : 0

NO-GO Events List

Event Type Legend: NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation

Event#      | Detected Event(s)      | Location (m)    | Accuracy (m)    | Magnitude
(dB) | Min Relaxation Factor (%)
```

The following sample displays the results of Raman turn up evaluation for No-Go condition.

```
RP/0/RP0/CPU0:ios#show olc otdr-status
Thu Nov  2 10:19:29.398 UTC

Controller                         : Ots0/0/0/0
Auto-scan Start Time               : 2023-11-02 10:19:29
OTDR Auto-scan Status              : COMPLETED
Status Detail                      : Completed on Span Up
Raman Turn Up Fiber Check          : Failed
Optical Span Status                : Up
Trigger Event                      : Span Restore

RP/0/RP0/CPU0:ios#show olc otdr-status details controller Ots 0/0/0/2
Thu Nov  2 10:20:42.173 UTC

Controller                         : Ots0/0/0/2
Auto-scan Start Time               : 2023-11-02 10:17:49
OTDR Auto-scan Status              : COMPLETED
Status Detail                      : Completed on Span Up
Raman Turn Up Fiber Check          : Failed
Optical Span Status                : Up
Trigger Event                      : Span Restore
Last Raman Turn Up Scan Time       : 2023-11-02 10:17:49
Last Raman Turn Up Fiber Check     : Failed
Last Trigger Event                 : Span Restore

Critical Distance (m)              : 19200.00
Raman Turn Up Relaxation Factor (%) : 1
Total Events detected              : 1

NO-GO Events List

Event Type Legend: NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation

Event#      | Detected Event(s)      | Location (m)    | Accuracy (m)    | Magnitude
(dB) | Min Relaxation Factor (%)
1           | R ER                   | 18217.3200      | 20.21           | -33.77
      | 9
```

```
RP/0/RP0/CPU0:ios#show controllers ots 0/0/0/2 otdr-info rx
Thu Nov  2 10:21:46.246 UTC
        Scan Direction: RX
        Scan Status: Data Ready
        Optical Return Loss: 39.0 dB
        SOR file: /harddisk:/otdr/IOS_NCS1010_OTDR_Ots0_0_0_2_RX_20231102-101952.sor
        Total Events detected: 6
        Scan Timestamp: Thu Nov  2 10:19:52 2023 UTC

Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation

Event# |  Detected Event(s) |  Location(m) |  Accuracy(m) |  Magnitude(dB) |
Attenuation/km(dB)
1      |  R ER              |  18217.3200  |  20.21       |  -33.77        |  0.19

2      |  NR                |  18217.3200  |  20.21       |  0.35          |  0.19

3      |  R ER              |  68668.7600  |  70.66       |  -32.17        |  0.20
4      |  NR                |  68668.7600  |  70.66       |  0.41          |  0.20
5      |  R FE ER           |  118869.3000 |  120.86      |  -29.21        |  0.20
6      |  NR FE             |  118869.3000 |  120.86      |  24.50         |  0.20
```

Relaxation Factor for Raman Turn Up

You can configure the Relaxation factor (a percentage value) to ignore the reflective event from the fiber evaluation done by the Raman turn-up algorithm. For example, if you configure relaxation factor to 100%, a reflective event at the faceplate (a downward slope in the OTDR traces graph) is ignored from the evaluation that is done by the Raman turn up algorithm. As the location of the reflective event moves away from the faceplate, the need of a relaxation factor reduces to avoid evaluation. After the critical distance, reflective events are ignored by the Raman turn-up algorithm.

Use the command **otdr raman-turn-up relaxation factor** *value* to configure the relaxation factor.

The following is a sample that configures relaxation factor for the Raman turn-up algorithm:

```
RP/0/RP0/CPU0:IOS#configure
Thu Nov  2 10:24:55.778 UTC
RP/0/RP0/CPU0:IOS(config)#optical-line-control controller Ots 0/0/0/0
RP/0/RP0/CPU0:IOS(config-olc-ots)#otdr raman-turn-up relaxation-factor 40
RP/0/RP0/CPU0:IOS(config-olc-ots)#commit
Thu Nov  2 10:25:06.733 UTC
RP/0/RP0/CPU0:IOS(config-olc-ots)#end
RP/0/RP0/CPU0:IOS#olc start-raman-turn-up controller Ots 0/0/0/0
Thu Nov  2 10:25:24.143 UTC
```

The following sample displays the Raman turn-up evaluation results with **No-Go** events, after configuring the relaxation factor:

```
RP/0/RP0/CPU0:IOS#show olc otdr-status details
Thu Nov  2 10:21:14.053 UTC

Controller                      : Ots0/0/0/0
Auto-scan Start Time            : 2023-11-02 10:17:50
OTDR Auto-scan Status           : COMPLETED
Status Detail                   : Completed on Span Up
Raman Turn Up Fiber Check       : Failed
Optical Span Status             : Up
Trigger Event                   : Span Restore
Last Raman Turn Up Scan Time    : 2023-11-02 10:17:50
```

```
Last Raman Turn Up Fiber Check    : Failed
Last Trigger Event                : Span Restore

Critical Distance (m)             : 17900.00
Raman Turn Up Relaxation Factor (%) : 10
Total Events detected             : 2
```

NO-GO Events List

```
Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation
```

Event#	Detected Event(s)	Location (m)	Accuracy (m)	Magnitude (dB)	Min Relaxation Factor (%)
1	R	16444.6100	18.44	-31.57	15
3	NR EA	43946.8400	45.94	2.79	33

```
RP/0/RP0/CPU0:IOS#show controllers ots 0/0/0/0 otdr-info rx
Thu Nov  2 10:21:30.227 UTC
Scan Direction: RX
Scan Status: Data Ready
Optical Return Loss: 36.0 dB
SOR file: /harddisk:/otdr/IOS_NCS1010_OTDR_Ots0_0_0_0_RX_20231102-102001.sor
Total Events detected: 5
Scan Timestamp: Thu Nov  2 10:20:01 2023 UTC
Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation
```

Event#	Detected Event(s)	Location(m)	Accuracy(m)	Magnitude(dB)	Attenuation/km(dB)
1	R	16444.6100	18.44	-31.57	0.19
2	R	43941.6100	45.94	-32.88	0.20
3	NR EA	43946.8400	45.94	2.79	0.20
4	R FE	120476.5100	122.47	-34.31	0.20
5	NR FE	120476.5100	122.47	26.00	0.20

The following sample displays the Raman turn-up evaluation results with **Go** events, after configuring the relaxation factor:

```
RP/0/RP0/CPU0:IOS#show olc otdr-status details
Thu Nov  2 10:28:47.930 UTC

Controller                        : Ots0/0/0/0
Auto-scan Start Time              : 2023-11-02 10:25:44
OTDR Auto-scan Status             : COMPLETED
Status Detail                     : Completed on Span Up
Raman Turn Up Fiber Check         : Success
Optical Span Status               : Up
Trigger Event                     : Manual
Last Raman Turn Up Scan Time      : 2023-11-02 10:25:44
Last Raman Turn Up Fiber Check    : Success
Last Trigger Event                : Manual

Critical Distance (m)             : 10200.00
Raman Turn Up Relaxation Factor (%) : 40
Total Events detected             : 0
```

NO-GO Events List

```
Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation

Event#  Detected Event(s) | Location (m) | Accuracy (m) | Magnitude (dB) | Min
Relaxation Factor (%)
RP/0/RP0/CPU0:IOS#

RP/0/RP0/CPU0:IOS#show controllers ots 0/0/0/0 otdr-info rx
Thu Nov  2 10:28:54.026 UTC
 Scan Direction: RX
 Scan Status: Data Ready
 Optical Return Loss: 36.0 dB
 SOR file: /harddisk:/otdr/IOS_NCS1010_OTDR_Ots0_0_0_0_RX_20231102-102755.sor
 Total Events detected: 5
 Scan Timestamp: Thu Nov  2 10:27:55 2023 UTC
 Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
EA:Excess-Attenuation

 Event#  | Detected Event(s) | Location(m)  | Accuracy(m) | Magnitude(dB) | Attenuation/km(dB)

  1      |  R                |  16444.6100  |  18.44      |  -31.58       |  0.19

  2      |  R                |  43941.6100  |  45.94      |  -33.36       |  0.20
  3      |  NR EA            |  43946.8400  |  45.94      |  2.77         |  0.20
  4      |  R FE             |  120618.2800 |  122.61     |  -37.87       |  0.20

  5      |  NR FE            |  120618.2800 |  122.61     |  24.74        |  0.20
```

Manually Trigger Raman Turn Up

If Raman turn up fiber check fails, RAMAN-TURNUP-FAIL alarm is raised. In this case, if you want to re-trigger Raman turn up check after the failure of previous evaluation,you can trigger using the command **olc start-raman-turn-up controller Ots R/S/I/P**. You can trigger Raman turn up fiber check without causing span up or span down event.

NCS 1010 software accepts the manual trigger of Raman turn up, in the following scenarios, and the OTDR scan will be triggered in Rx direction.

- When HIGH-RX-BR-PWR alarm is present

- When Raman pumps are configured in APR mode

The following is a sample configuration to trigger the Raman turn up.

```
RP/0/RP0/CPU0:IOS#olc start-raman-turn-up controller Ots 0/0/0/2
Thu Nov  2 10:28:41.529 UTC
```

The following sample displays the status of Raman turn up fiber check.

```
RP/0/RP0/CPU0:IOS#show olc otdr-status controller ots 0/0/0/2
Thu Nov  2 10:31:33.973 UTC

Controller                      : Ots0/0/0/2
Auto-scan Start Time            : 2023-11-02 10:29:01
OTDR Auto-scan Status           : COMPLETED
Status Detail                   : Completed on Span Up
Raman Turn Up Fiber Check       : Failed
```

```
Optical Span Status            : Up
Trigger Event                  : Manual
```

Force Raman Turn Up

If Raman Turn up fiber check fails, RAMAN-TURNUP-FAIL alarm is raised. In this case, you can forcefully turn up the Raman pumps through the command **olc force-raman-turn-up controller ots R/S/I/P**. This action will bypass only Raman turn up algorithm. It will not bypass Raman safety procedure.

NCS 1010 software accepts the forced turn up of Raman pumps, in the following scenarios, But raman pump's status will not be altered.

- When HIGH-RX-BR-PWR alarm is present

- When Raman pumps are configured in APR mode

The following is a sample configuration to forcefully configure the Raman pumps:

```
RP/0/RP0/CPU0:IOS#olc force-raman-turn-up controller ots 0/0/0/0
Thu Nov  2 10:12:26.668 UTC


RP/0/RP0/CPU0:IOS#show olc otdr-status
Thu Nov  2 10:12:34.130 UTC

Controller                     : Ots0/0/0/0
Auto-scan Start Time           : 2023-11-02 10:02:26
OTDR Auto-scan Status          : COMPLETED
Status Detail                  : Completed on Span Up
Raman Turn Up Fiber Check      : Forced
Optical Span Status            : Up
Trigger Event                  : Manual
```

Gain Estimator

This chapter describes the Gain Estimator optical application for Cisco NCS 1010.

-

Overview of Gain Estimator

Gain Estimator analyses the span loss and sets the gain mode of the EDFA amplifier and provides the initial target gain for the amplifier. EDFA amplifiers are present in both OLT and ILA variants of NCS 1010. These EDFA amplifiers are variable-gain optical amplifiers capable of working at two different gain ranges or modes. The modes are normal mode and extended mode. Extended mode provides higher gain than the normal mode. Running the Gain Estimator is a traffic-impacting operation.

Gain Estimator uses the following parameters to estimate the gain necessary on a span.

- Ingress span loss
- Span length
- Tx connector loss
- Spectrum density
- Fiber type
- Raman gain (only on Raman spans)

Gain estimator uses the estimated gain to set the gain range.

NCS 1010 automatically triggers gain estimator:

- During automatic link bring up
- After Line Card cold reload
- After device power cycle

Start Gain Estimator

Use the **olc start-gain-estimation controller ots** *Rack/Slot/Instance/Port* command to trigger the gain estimation operation.

The following output is a sample of the **olc start-gain-estimation controller ots 0/0/0/0** command.

```
RP/0/RP0/CPU0:ios#olc start-gain-estimation controller ots 0/0/0/0
```

Disable Gain Estimator

Use the following commands to disable Gain Estimator.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

gain-estimator disable

commit

end

The following output is a sample configuration that disables Gain Estimator.

```
RP/0/RP0/CPU0:ios#configure terminal
Mon Jun 13 05:35:20.510 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#gain-estimator disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

Enable Gain Estimator

Use the following set of commands to enable Gain Estimator.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

gain-estimator enable

commit

end

The following output is a sample configuration that enables Gain Estimator.

```
RP/0/RP0/CPU0:ios#configure terminal
Mon Jun 13 05:35:27.511 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#gain-estimator enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

View Gain Estimator Status

Use the **show olc gain-estimator** command to view the gain estimation details.

The following output is a sample of the **show olc gain-estimator** command.

```
RP/0/RP0/CPU0:ios#show olc gain-estimator
Thu May 12 09:30:39.987 UTC
Controller                        : Ots0/0/0/0
Egress  Gain Estimator Status     : IDLE
Egress  Estimated Gain            : 25.9 dB
Egress  Estimated Gain Mode       : Extended
```

```
Egress  Gain Estimation Timestamp   : 2022-05-07 09:16:53

Controller                          : Ots0/0/0/2
Egress  Gain Estimator Status       : IDLE
Egress  Estimated Gain              : 11.7 dB
Egress  Estimated Gain Mode         : Normal
Egress  Gain Estimation Timestamp   : 2022-05-07 10:13:53
```

Use the **show olc gain-estimator controller ots** *Rack/Slot/Instance/Port* command to view the gain estimation details for a specific controller.

The following output is a sample of the **show olc gain-estimator controller ots** *Rack/Slot/Instance/Port* command.

```
RP/0/RP0/CPU0:ios#show olc gain-estimator controller Ots 0/0/0/0
Fri Jun 10 05:47:21.119 UTC
Controller                          : Ots0/0/0/0
Ingress Gain Estimator Status       : IDLE
Ingress Estimated Gain              : 21.7 dB
Ingress Estimated Gain Mode         : Normal
Ingress Gain Estimation Timestamp   : 2022-06-10 05:46:48
```

CHAPTER 6

Link Tuner

This chapter describes the Link Tuner optical application for Cisco NCS 1010.

Overview of Link Tuner

Link tuner computes the target Power Spectral Densities (PSD) for APC by calculating the optimal PSDs for a span. Power Spectral Density represents power per 12.5 GHz of spectrum. Link tuner is enabled if automatic link bring up is enabled.. Link tuner is span-specific and computes the target PSDs for channels entering the span. Link tuner uses the following parameters to compute the target PSD:

- Fiber-type
- Span loss measurement
- Spectral density
- Connector losses
- Span length
- Raman gain (only on Raman spans)

The link tuner application finds the target PSD for the best performance for channels entering a span. You have to manually configure drop-psd. The drop-psd is the target PSD for OLT drop ports.

Link tuner monitors the span loss and total noise in the link. When link tuner detects changes in the span loss, span length, or connector loss, link tuner recomputes the target PSDs. However, it applies the new target PSDs only if it detects a change of 0.1 dB or more in the total noise value.

Link tuner computes the target PSDs and total noise whenever a link goes down and comes back up. All traffic impacting actions trigger link tuner.

Restriction   From Cisco IOS XR Release 7.9.1, NCS 1010 supports C+L band networks. In Cisco IOS XR Release 7.9.1, Link tuner support is not available for C+L band networks. In Cisco IOS XR Release 7.9.1, Link tuner is available only for C band only networks. If you are deploying a C+L band configuration for your network, you can obtain the PSD profiles (Single Band and Dual band) from Cisco Optical Network Planner.

The following table describes the different link tuner status.

Status	Description
Operational	Link tuner is active and operational.
Blocked	Link tuner is active but unable to compute ta
Disabled	Link tuner is disabled.

To view link tuner status and PSD computation information, use **show olc link-tuner** command.

The following sample is an output of **show olc link-tuner** command.

```
RP/0/RP0/CPU0:ios#show olc link-tuner
Controller          : Ots0/0/0/0
Link Tuner Status   : OPERATIONAL
Last PSD computation: 2022-05-06 10:59:51
-----------------------------------------------------------------------
Setpoint            : Computed PSD
                      (dBm/12.5 GHz)
-------------------------s-----------------------------------------------
01                    -5.7
02                    -5.6
03                    -5.6
04                    -5.5
05                    -5.5
06                    -5.4
07                    -5.4
08                    -5.3
09                    -5.3
10                    -5.2
11                    -5.2
12                    -5.1
13                    -5.1
14                    -5.0
15                    -5.0
16                    -4.9
17                    -4.9
18                    -4.8
19                    -4.8
20                    -4.7
21                    -4.7
22                    -4.6
23                    -4.6
24                    -4.5
25                    -4.4
26                    -4.4
27                    -4.3
28                    -4.3
29                    -4.2
30                    -4.2
31                    -4.1
32                    -4.1
33                    -4.0
```

> ✎
>
> **Note** When an NCS 1020 network is not fully up and the complete topology is not discovered, **show olc link tuner** shows the default psd value (-4.1dB) as link-tuner is blocked due to partial topology. APC uses Configured value to perform power correction. Link tuner performs the psd computation after the topology is fully discovered. When all nodes are up and the partial topology state changes, APC uses link tuner computed psd values. The **show olc link tuner** command shows the link tuner computed values.

To view link tuner status, PSD computation information, and computed total noise, use **show olc link-tuner detail** command.

The following sample is an output of **show olc link-tuner detail** command.

```
RP/0/RP0/CPU0:ios#show olc link-tuner detail
Controller        : Ots0/0/0/0
Link Tuner Status  : OPERATIONAL
Last PSD computation: 2022-05-06 10:59:51
Computed Total Noise: -35.4 dB
----------------------------------------------------------------------
Setpoint          : Computed PSD
                    (dBm/12.5 GHz)
----------------------------------------------------------------------
01                    -5.7
02                    -5.6
03                    -5.6
04                    -5.5
05                    -5.5
06                    -5.4
07                    -5.4
08                    -5.3
09                    -5.3
10                    -5.2
11                    -5.2
12                    -5.1
13                    -5.1
14                    -5.0
15                    -5.0
16                    -4.9
17                    -4.9
18                    -4.8
19                    -4.8
20                    -4.7
21                    -4.7
22                    -4.6
23                    -4.6
24                    -4.5
25                    -4.4
26                    -4.4
27                    -4.3
28                    -4.3
29                    -4.2
30                    -4.2
31                    -4.1
32                    -4.1
33                    -4.0
```

You can view the target PSDs configured for all setpoints using the **show olc apc-local target-psd-profile** command. The output shows the source of the PSD configuration also. The target PSD source can be Link Tuner or Configuration.

The following sample is an output of **show olc apc-local target-psd-profile** command.

```
RP/0/RP0/CPU0:ios#show olc apc-local target-psd-profile
Mon Jun 20 06:40:32.779 UTC
Controller       : Ots0/0/0/0
Target PSD source  : Link Tuner
--------------------------------------------------------------------------------
Setpoint            Frequency                    Target PSD
                    (THz)                        (dBm/12.5 GHz)
--------------------------------------------------------------------------------
01                  191.337494                   -6.3
02                  191.488495                   -6.3
03                  191.639496                   -6.2
04                  191.790497                   -6.2
05                  191.941498                   -6.2
06                  192.092499                   -6.1
07                  192.243500                   -6.1
08                  192.394501                   -6.1
09                  192.545502                   -6.0
10                  192.696503                   -6.0
11                  192.847504                   -5.9
12                  192.998505                   -5.9
13                  193.149506                   -5.8
14                  193.300507                   -5.8
15                  193.451508                   -5.8
16                  193.602493                   -5.7
17                  193.753494                   -5.7
18                  193.904495                   -5.7
19                  194.055496                   -5.6
20                  194.206497                   -5.6
21                  194.357498                   -5.5
22                  194.508499                   -5.5
23                  194.659500                   -5.5
24                  194.810501                   -5.4
25                  194.961502                   -5.4
26                  195.112503                   -5.3
27                  195.263504                   -5.3
28                  195.414505                   -5.3
29                  195.565506                   -5.2
30                  195.716507                   -5.2
31                  195.867493                   -5.1
32                  196.018494                   -5.1
33                  196.169495                   -5.1
```

Configure Link Tuner

The following configurations are available for the link tuner:

Enable Link Tuner

You can enable link tuner for a controller. Use the following commands to enable link tuner.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

link-tuner enable

commit

end

The following is a sample configuration that enables link tuner.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Disable Link Tuner

You can disable link tuner for a controller. Use the following commands to disable link tuner.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

link-tuner disable

commit

end

The following is a sample configuration that disables link tuner.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Link Parameters

Configure fiber-type, spectrum density, connector losses, and span length for accurate link tuning.

To configure fiber type, use **fiber-type** command. SMF is the default fiber-type.

You can configure the following fiber types using **fiber-type** command:

- E-LEAF
- FREE-LIGHT
- METRO-CORE
- SMF
- SMF-28E
- TERA-LIGHT
- TW-RS
- TW-Reach
- TW-minus
- TW-plus

- ULL-SMF28

To configure spectrum density, use **link-tuner spectrum-density** command. You can configure a spectrum density as a percentage value in the range of 1-100. The default spectrum density is 81.

To configure connector loss, use the **connector-loss** command. You can configure Tx and Rx connector loss in the range 0–20 dB. The default connector loss is:

- 0.25 dB for ports without Raman module

- 0.3 dB for ports with Raman module

To configure span length, use the **span-length** command. You can configure span length in the range of 0.1 to 200 km as multiples of 0.1 km. In the absence of span length configuration, link tuner computes span length using span loss.

The following example is a sample configuration that configures the link tuner parameters.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#fiber-type SMF
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner spectrum-density 80
RP/0/RP0/CPU0:ios(config-olc-ots)#connector-loss rx 1
RP/0/RP0/CPU0:ios(config-olc-ots)#connector-loss tx 1
RP/0/RP0/CPU0:ios(config-olc-ots)#span-length 100
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

CHAPTER **7**

Automatic Power Control

This chapter describes the Automatic Power Control optical application for Cisco NCS 1010.

Table 5: Feature History

Feature Name	Release Information	Feature Description
APC enhancements	Cisco IOS XR Release 7.9.1	APC (Automatic Power Control) on NCS 1010 now supports C+L band networks in addition to C band only networks. Also, APC is enhanced to perform power correction even when it doesn't have end-to-end network visibility. This ensures that the operational section of the network always has power at the target PSD profile, and when the network comes up, the traffic restoration is faster.

• Overview of Automatic Power Control, on page 37

Overview of Automatic Power Control

On a fiber, the power level may vary between channels. Over long distances and multiple amplifications, these differences in power levels can result in deterioration of the quality of some channels. Automatic Power Control (APC) corrects the power level differences and ensures that power for different channels is according to the target power profile for the spectrum. APC compensates for the degradation of the network over time. APC is enabled if automatic link bring up is enabled.

APC is a network-level feature that is distributed among different nodes. An APC domain is a set of nodes that is controlled by the same instance of APC at the network level. An APC domain identifies a portion of the network that can be independently regulated. The source OLT node acts as the APC Manager or Domain Manager for all the nodes in the path. The subsequent nodes in the path act as APC agent nodes. The manager node enables APC on agent nodes, monitors DISCREPANCY and initiates regulation if correction is required. To avoid large power fluctuations, APC adjusts power levels incrementally. APC performs power correction in steps of +/-0.8dB. This is applied to each iteration until the optimal power level is reached.

APC is direction-specific. You can enable APC for each direction at the transmitting OLT node. The source node enables and controls different parameters in all ILA nodes on the path and the far-end OLT ingress EDFA.

The following table lists the parameters that APC configures and controls in different nodes.

Node	Parameters
Transmitting OLT	EDFA Gain
	EDFA Tilt
	VOA Attenuation
	WSS Attenuation
ILA	EDFA Gain
	EDFA Tilt
	VOA Attenuation
	DGE Attenuation
Receiving OLT	EDFA Gain
	EDFA Tilt
	WSS Attenuation

When you enable APC, APC controls these parameters. APC overrides any manual configuration. When you disable APC, user configuration is applied.

APC divides the C band spectrum into 32 equal parts. APC uses 33 frequencies across the C band to divide the band. We call these 33 frequencies, **setpoints**. Each setpoint is 150 GHz apart from the adjacent setpoints. You can configure a power profile across the spectrum using these setpoints. You can configure the target PSD for each OLT and ILA node on a link.

APC applies amplification and attenuation as required at channel level and composite signal level to ensure that the channels are at the target power level. You can configure the target power spectral densities for 33 points across the band. If you enable link tuner, link tuner sets the target PSDs for APC on all nodes in the path.

APC performs the following functions:

- APC monitors the current PSD against the target PSD for each channel (ASE and user channel) and changes the amplifier parameters including VOA, WSS, and DGE to achieve the target PSD.

- APC detects optical network changes on the path and alters the amplifier parameters on the nearest nodes to compensate for the changes. APC performs these alterations in multiple steps.

- APC collects measurements from other link nodes at the transmitting OLT to precisely locate optical network changes.

From Cisco IOS XR Release 7.9.1, NCS 1010 supports C+L band networks. Before Cisco IOS XR Release 7.9.1, APC did not start regulating the power levels in a link until the full topology was discovered by OSPF. From Cisco IOS XR Release 7.9.1, APC regulation begins as soon as it discovers any part of the topology. At a transmitting OLT, it starts power correction at the OLT and subsequent ILA nodes even if the complete OLT-OLT link has not been discovered. When APC detects a partial topology, the NCS 1010 raises the PARTIAL-TOPOLOGY alarm, and after the regulation is complete APC moves to BLOCKED state.

> **Note**
> - If the input slice power of a channel is below psd-min and APC is unable to bring the channel above psd-min even after setting the WSS attenuation to 0dB, APC declares the channel as failed.
>
> - After APC regulation, all channel powers must be above psd-min (-24-dBm default) and at least one channel should be within 0.5 dB of psd-min.

View APC Status and Information

Use the **show olc apc** command to view APC status.

The following sample is an output of **show olc apc**.

```
RP/0/RP0/CPU0:OLT1#show olc apc

Controller     : Ots0/0/0/0
APC Status     : WORKING

Node RID       : 10.1.1.1
Internal State : IDLE

Node RID       : 10.99.1.2
Internal State : IDLE

Node RID       : 10.99.2.2
Internal State : IDLE

Node RID       : 10.99.4.1
Internal State : IDLE

Node RID       : 10.1.1.5
Internal State : DISCREPANCY
```

APC Status is the status of APC in the complete path. The following table lists and describes the APC Statuses.

APC Status	Description
BLOCKED	APC moves to BLOCKED state if: • there is an event in the network which resulted in topology failure • an amplifier safety event like APR or OSRI has been triggered in the network • APC is locally disabled on agent node
PAUSED	APC is paused using the **apc-pause** command.
IDLE	APC regulation has been completed successfully. All the channels in the network have achieved the target PSD provided by Link-tuner or configured by user
WORKING	APC detected a DISCREPANCY between current and target PSD. APC regulation is in progress to converge the power to target PSD.
DISABLED	APC is disabled.

| PARTIAL-TOPOLOGY NODE-BLOCKED | APC has limited visibility. APC manager does not have visibility to the full OLT-OLT topology. APC manager tries to correct the power levels on the agent nodes that are reachable and after the regulation is complete, APC moves to BLOCKED state. |

Internal State is the state of APC on each individual node. The following table lists and describes the internal states.

APC Internal State	Description
DISCREPANCY	The APC manager flags an agent node which needs correction when there is a discrepancy between target PSD and current PSD. This state is temporary and lasts until APC starts power correction and goes into CORRECTING state.
CORRECTING	APC correction is in progress on the node
OOR	APC-OUT-OF-RANGE condition is raised on an agent node when APC fails to regulate and achieve the target PSD power level because the requested gain or attenuation setpoint cannot be set due to one of the following conditions: • Amplifier gain is exhausted in the current gain range. • WSS range (0-25dB) is exhausted for a single or multiple channels. • DGE range (0-3dB) is exhausted for a single or multiple channels. • Spanloss increased and amplifier gain is insufficient to achieve target PSD
IDLE	APC regulation has been completed successfully. All the channels in the network have achieved the target PSD provided by Link-tuner or configured by user

BLOCKED	APC is unable to perform for the following reasons:
	• OSRI has shut down the amplifier: AMPLI-SHUT
	• APC is disabled locally on the node: USER-DISABLED
	• Gain Estimation is in progress: GAIN-ESTIMATION-IN-PROGRESS
	• Amplifier auto power reduction is enabled: AMPLI-APR-ENABLED
	• Amplifier is shut because of loss of input power: AMPLI-SHUT
	• An event in the network resulted in topology failure.
	• APC is BLOCKED as Band Failure Recovery sets Safe mode because of a band failure event in C+L network: BAND-FAILURE

The following sample is an output of **show olc apc** command when OSRI has shut down an amplifier in the link.

```
RP/0/RP0/CPU0:ios#sh olc apc
Thu Jul  7 13:21:05.807 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.1.1.2
Internal State  : BLOCKED
Blocked Reason  : [ AMPLI-SHUT ]

Node RID        : 10.1.1.3
Internal State  : DISCREPANCY

Node RID        : 10.1.1.4
Internal State  : DISCREPANCY

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

The following sample is an output of **show olc apc** command when APC is disabled locally on a node.

```
RP/0/RP0/CPU0:ios#sh olc apc
Thu Jul  7 13:22:44.145 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.1.1.2
```

```
Internal State  : BLOCKED
Blocked Reason  : [ USER-DISABLED ]

Node RID        : 10.1.1.3
Internal State  : DISCREPANCY

Node RID        : 10.1.1.4
Internal State  : DISCREPANCY

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

The following sample is an output of **show olc apc** command when Gain Estimation is in progress on a node.

```
RP/0/RP0/CPU0:ios#sh olc apc
Tue Jun 7 11:43:10.801 UTC

Controller : Ots0/0/0/0
APC Status : BLOCKED

Node RID : 10.1.1.1
Internal State : DISCREPANCY

Node RID : 10.1.1.2
Internal State : DISCREPANCY

Node RID : 10.1.1.3
Internal State : BLOCKED
Blocked Reason : [ GAIN-ESTIMATION-IN-PROGRESS ]
```

The following sample is an output of **show olc apc** command when amplifier auto power reduction is enabled on a node.

```
RP/0/RP0/CPU0:ios#sh olc apc
Thu Jul  7 13:21:49.530 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.1.1.2
Internal State  : BLOCKED
Blocked Reason  : [ AMPLI-APR-ENABLED ]

Node RID        : 10.1.1.3
Internal State  : DISCREPANCY

Node RID        : 10.1.1.4
Internal State  : DISCREPANCY

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

The following sample is an output of **show olc apc** command when band failure has occurred and the APC manager has visibility only to a partial topology.

```
RP/0/RP0/CPU0:ios#show olc apc
Wed Jan 18 12:21:28.195 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED
Blocked Reason  : [ PARTIAL-TOPOLOGY  NODE-BLOCKED ]
```

```
Node RID       : 10.1.1.1
Internal State : IDLE

Node RID       : 10.1.1.2
Internal State : BLOCKED
Blocked Reason : [ BAND-FAILURE ]
```

You can view the local status of APC on each node using the **show olc apc-local** command. This command shows if APC is enabled or disabled on the node.

The following sample is an output of **show olc apc-local** command.

```
RP/0/RP0/CPU0:ios#show olc apc-local
Mon Apr 11 06:59:14.679 UTC


Controller : Ots0/0/0/0

TX Status : ENABLED
RX Status : ENABLED
```

You can view the target PSDs configured for all setpoints using the **show olc apc-local target-psd-profile** command. The output shows the source of the PSD configuration also. The target PSD source can be Link Tuner or Configuration.

The following sample is an output of **show olc apc-local target-psd-profile** command on a C band node..

```
RP/0/RP0/CPU0:ios#show olc apc-local target-psd-profile
Tue Apr 26 10:19:24.910 UTC
Controller        : Ots0/0/0/0
Target PSD source : Configuration
-----------------------------------------------------------------------------
Setpoint              Frequency                    Target PSD
                       (THz)                     (dBm/12.5 GHz)
-----------------------------------------------------------------------------
01                   191.337494                      15.0
02                   191.488678                      15.0
03                   191.639847                      -4.1
04                   191.791016                      -4.1
05                   191.942184                      -4.1
06                   192.093353                      -4.1
07                   192.244537                      -4.1
08                   192.395706                      -4.1
09                   192.546875                      -4.1
10                   192.698044                      -4.1
11                   192.849213                      -4.1
12                   193.000397                      -4.1
13                   193.151566                      -4.1
14                   193.302734                      -4.1
15                   193.453903                      -4.1
16                   193.605072                      -4.1
17                   193.756256                      -4.1
18                   193.907425                      -4.1
19                   194.058594                      -4.1
20                   194.209763                      -4.1
21                   194.360931                      -4.1
22                   194.512115                      -4.1
23                   194.663284                      -4.1
24                   194.814453                      -4.1
25                   194.965622                      -4.1
26                   195.116791                      -4.1
27                   195.267975                      -4.1
28                   195.419144                      -4.1
29                   195.570312                      -4.1
```

```
30                     195.721481                              -4.1
31                     195.872650                              -4.1
32                     196.023834                              -4.1
33                     196.175003                              -4.1
```

The following sample is an output of **show olc apc-local target-psd-profile** command on an L band node.

```
RP/0/RP0/CPU0:ios#sh olc apc-local target-psd-profile
Wed Jan 18 12:12:02.236 UTC
Controller        : Ots0/0/0/0
Target PSD source  : Configuration
-------------------------------------------------------------------------
Setpoint               Frequency                     Target PSD
                        (THz)                        (dBm/12.5 GHz)
-------------------------------------------------------------------------
01                     186.050000                              -6.4
02                     186.201000                              -6.3
03                     186.352000                              -6.2
04                     186.503000                              -6.2
05                     186.654000                              -6.1
06                     186.805000                              -6.1
07                     186.956000                              -6.0
08                     187.107000                              -6.0
09                     187.258000                              -5.9
10                     187.409000                              -5.9
11                     187.560000                              -5.9
12                     187.711000                              -5.8
13                     187.862000                              -5.7
14                     188.013000                              -5.7
15                     188.164000                              -5.6
16                     188.315000                              -5.5
17                     188.466000                              -5.5
18                     188.617000                              -5.4
19                     188.768000                              -5.4
20                     188.919000                              -5.3
21                     189.070000                              -5.2
22                     189.221000                              -5.2
23                     189.372000                              -5.1
24                     189.523000                              -5.1
25                     189.674000                              -5.0
26                     189.825000                              -5.0
27                     189.976000                              -4.9
28                     190.127000                              -4.9
29                     190.278000                              -4.8
30                     190.429000                              -4.7
31                     190.580000                              -4.7
32                     190.731000                              -4.6
33                     190.882000                              -4.6
```

You can view the detailed information about APC on each node using the **show olc apc-local regulation-info** command. This command provides the following information:

- Controller

- APC Domain Manager

- Internal Status

- Minimum PSD

- Last correction timestamp

- Gain range

- Amplifier and attenuation parameters: Configured and current values and available ranges

- Detailed information on the channels

  The following details are available:

  - Center frequency of each channel

  - Channel width

  - Channel ID

  - Channel Source (ASE or user channel)

  - Slice number of the center frequency of the channel in the WSS

  - PSD of the channel at the input of the amplifier

  - Target PSD for the channel

  - Current PSD of the channel

  - Discrepancy between current and target PSD

  - The configured attenuation on the WSS (OLT) or DGE (ILA) for the channel

You can view the APC information for only the Tx or Rx direction using the **tx|rx** keyword with the **show olc apc-local regulation-info controller ots** *R/S/I/P* command.

The following sample is an output of **show olc apc-local regulation-info** command.

```
RP/0/RP0/CPU0:ios#show olc apc-local regulation-info controller ots 0/0/0/0 tx
Wed Jul  6 05:01:45.177 UTC
Controller          : Ots0/0/0/0
Domain Manager      : 10.1.1.1
Internal Status     : OOR
Direction           : TX
PSD Minumum         : -24.0 (dBm/12.5 GHz)
Gain Range          : Normal
Last Correction     : 2022-07-06 05:01:28

  Device Parameters                  Min   Max   Configuration Operational
================================================================================
  Egress Ampli Gain (dB)            :15.4  29.4 19.5          19.5
  Egress Ampli Tilt (dB)            :-5.0  3.1  -2.2          -2.2
  TX Ampli Power (dBm)              : -    22.4  -            21.4
  TX VOA Attenuation (dB)           :0.0   20.0 0.0           0.0
  Egress WSS/DGE Attenuation (dB)   :0.0   25.0  -             -


Channel Center Channel Channel Channel Spectrum   Ampli-Input     Target         Current
 Discrepancy Channel Slice
  Frequency      Width    ID    Source  Slice Num     PSD           PSD            PSD
            Attn Config
   (THz)        (GHz)                              (dBm/12.5 GHz)(dBm/12.5 GHz)(dBm/12.5 GHz)
   (dB)         (dB)
─────────────────────────────────────────────────────────────────────────────────

 191.375000    75.00     1     OCh       13          -23.2          -4.6           -4.9
     0.2         7.1
 191.449997    75.00     -     ASE       37          -23.0          -4.6           -4.7
     0.1         9.2
 191.524994    75.00     -     ASE       61          -23.1          -4.6           -4.7
```

```
                            0.1        9.3
191.600006    75.00    4     OCh   85    -23.1    -4.5    -4.7
                            0.1        8.0
191.675003    75.00    -     ASE   109   -23.0    -4.5    -4.5
                            0.0        9.1
191.750000    75.00    6     OCh   133   -23.0    -4.4    -4.6
                            0.1        8.0
191.824997    75.00    -     ASE   157   -23.1    -4.4    -4.6
                            0.1        9.3
191.899994    75.00    8     OCh   181   -23.0    -4.4    -4.4
                            0.0        8.0
191.975006    75.00    -     ASE   205   -23.0    -4.3    -4.5
                            0.1        9.1
192.050003    75.00    10    OCh   229   -23.0    -4.3    -4.5
                            0.1        8.2
192.125000    75.00    -     ASE   253   -22.9    -4.3    -4.3
                            0.0        9.0
192.199997    75.00    12    OCh   277   -22.8    -4.2    -4.3
                            0.0        8.3
192.274994    75.00    -     ASE   301   -22.9    -4.2    -4.4
                            0.1        9.0
192.350006    75.00    14    OCh   325   -22.6    -4.2    -4.2
                            0.0        8.3
192.425003    75.00    -     ASE   349   -22.8    -4.2    -4.3
                            0.1        8.7
192.500000    75.00    16    OCh   373   -22.4    -4.1    -3.9
                            -0.2       8.1
192.574997    75.00    -     ASE   397   -22.7    -4.1    -4.2
                            0.1        8.6
192.649994    75.00    18    OCh   421   -22.6    -4.1    -4.2
                            0.1        8.1
192.725006    75.00    -     ASE   445   -22.7    -4.0    -4.2
                            0.1        8.6
192.800003    75.00    20    OCh   469   -22.7    -4.0    -4.1
                            0.1        7.9
192.875000    75.00    -     ASE   493   -22.6    -4.0    -4.0
                            0.0        8.4
192.949997    75.00    22    OCh   517   -22.6    -3.9    -4.1
                            0.1        7.6
193.024994    75.00    -     ASE   541   -22.5    -3.9    -4.0
                            0.1        8.2
193.100006    75.00    24    OCh   565   -22.7    -3.8    -4.0
                            0.1        7.5
193.175003    75.00    -     ASE   589   -22.7    -3.8    -4.0
                            0.1        8.2
193.250000    75.00    26    OCh   613   -22.5    -3.8    -3.9
                            0.1        7.2
193.324997    75.00    -     ASE   637   -22.6    -3.8    -4.0
                            0.2        8.1
193.399994    75.00    28    OCh   661   -22.7    -3.7    -3.9
                            0.1        7.2
193.475006    75.00    -     ASE   685   -22.5    -3.7    -3.8
                            0.1        8.0
193.550003    75.00    30    OCh   709   -22.7    -3.7    -3.8
                            0.1        7.0
193.625000    75.00    -     ASE   733   -22.7    -3.6    -3.8
                            0.1        8.1
193.699997    75.00    32    OCh   757   -22.7    -3.6    -3.7
                            0.1        6.7
193.774994    75.00    -     ASE   781   -22.7    -3.5    -3.7
                            0.1        8.2
193.850006    75.00    34    OCh   805   -22.7    -3.5    -3.7
                            0.1        6.6
193.925003    75.00    -     ASE   829   -22.7    -3.5    -3.6
```

	0.1	8.1					
194.000000	75.00	36	OCh	853	-22.8	-3.5	-3.7
	0.2	6.6					
194.074997	75.00	–	ASE	877	-22.8	-3.4	-3.6
	0.1	8.3					
194.149994	75.00	38	OCh	901	-22.7	-3.4	-3.5
	0.1	10.9					
194.225006	75.00	–	ASE	925	-22.8	-3.3	-3.5
	0.1	8.2					
194.300003	75.00	40	OCh	949	-22.9	-3.3	-3.5
	0.1	7.1					
194.375000	75.00	–	ASE	973	-22.8	-3.3	-3.4
	0.1	8.4					
194.449997	75.00	42	OCh	997	-22.9	-3.2	-3.5
	0.2	7.3					
194.524994	75.00	–	ASE	1021	-22.9	-3.2	-3.4
	0.1	8.4					
194.600006	75.00	44	OCh	1045	-22.8	-3.2	-3.3
	0.1	7.2					
194.675003	75.00	–	ASE	1069	-22.8	-3.2	-3.3
	0.1	8.4					
194.750000	75.00	46	OCh	1093	-22.9	-3.1	-3.4
	0.2	7.3					
194.824997	75.00	–	ASE	1117	-22.8	-3.1	-3.2
	0.1	8.2					
194.899994	75.00	48	OCh	1141	-22.8	-3.0	-3.3
	0.2	6.9					
194.975006	75.00	–	ASE	1165	-22.9	-3.0	-3.2
	0.1	8.3					
195.050003	75.00	50	OCh	1189	-22.8	-3.0	-3.1
	0.1	6.6					
195.125000	75.00	–	ASE	1213	-22.9	-3.0	-3.1
	0.1	8.3					
195.199997	75.00	52	OCh	1237	-22.9	-2.9	-3.1
	0.1	6.3					
195.274994	75.00	–	ASE	1261	-23.0	-2.9	-3.0
	0.1	8.1					
195.350006	75.00	54	OCh	1285	-23.1	-2.8	-3.0
	0.1	6.4					
195.425003	75.00	–	ASE	1309	-23.2	-2.8	-3.0
	0.1	8.3					
195.500000	75.00	56	OCh	1333	-23.1	-2.8	-2.9
	0.1	6.2					
195.574997	75.00	–	ASE	1357	-23.4	-2.8	-3.0
	0.2	8.2					
195.649994	75.00	58	OCh	1381	-23.4	-2.7	-2.9
	0.1	6.4					
195.725006	75.00	–	ASE	1405	-23.4	-2.7	-2.8
	0.1	8.5					
195.800003	75.00	60	OCh	1429	-23.6	-2.7	-2.8
	0.1	6.6					
195.875000	75.00	–	ASE	1453	-23.7	-2.6	-2.9
	0.2	8.7					
195.949997	75.00	62	OCh	1477	-23.7	-2.6	-2.8
	0.2	6.9					
196.024994	75.00	–	ASE	1501	-23.6	-2.5	-2.7
	0.1	9.0					
196.100006	75.00	64	OCh	1525	-23.7	-2.5	-2.7
	0.1	7.1					

```
ASE - Noise Loaded Channel
OCh - Optical Channel
```

Note
- In the previous sample output, the channel source is ASE for channels that are empty and for channels that failed due to power level dropping below psd-min. For dropped channels, channel ID is present and the channel source is ASE. ASE or Noise loader fills noise across the spectrum with a spacing of 75 GHz for wherever optical cross connects are not present.

Configure APC

If you enable link tuner, the link tuner sets the target PSDs for APC on all nodes in the path.

You can configure the target power spectral densities for 33 points across the band. The 33 PSD values divide the entire spectrum into 150-GHz steps. APC uses the corresponding PSD value if the channel frequency corresponds to a configured point. If the central frequency is not on a configured position, APC computes the target PSD for a channel by extrapolating from the two adjacent steps.

Use the following commands to set the target PSDs for single-band for each node on a C-band network.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

psd *<1-33> value*

commit

end

The following is a sample configuration that sets the psd to 15 dBm/12.5 GHz for the setpoints 1 and 2.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#psd 1 150
RP/0/RP0/CPU0:ios(config-olc-ots)#psd 2 150
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Use the following commands to set the target PSDs for dual-band for each node on a C+L band network.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

dual-band-psd *<1-33> value*

commit

end

Example

The following is a sample configuration that sets the dual-band psd values to -50 and -49 on setpoints 1 and 2 respectively, on the 0/0/0/0 controller .

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#dual-band-psd 1 -50
RP/0/RP0/CPU0:ios(config-olc-ots)#dual-band-psd 2 -49
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Disable APC

To disable APC for a link, execute the following commands on the transmitting OLT node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc disable

commit

end

The following is a sample configuration that disables APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

☞

Important
- When you disable APC, NCS 1010 sets all setpoints to values in the configuration. If there is no configuration, NCS 1010 sets all setpoints to default values. Disabling APC is traffic impacting.

- For BFR to work, APC must be enabled on both C and L-band devices. We recommended to pause BFR before running the **apc-pause** or **apc disable** commands.

Enable APC

To enable APC for a link, execute the following commands on the transmitting OLT node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc enable

commit

end

The following is a sample configuration that enables APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Pause APC

If you want to modify the network without APC compensating for the changes, you can pause APC. Use the following commands to pause APC.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-pause

commit

end

The following is a sample configuration that pauses APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc pause
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Note	• If you run the **apc-pause** command when APC is in idle state, APC remains in the idle state until APC detects changes in the network that requires power correction. APC changes the status to paused after it detects changes, but does not perform power correction. • Running the **apc-pause** command, does not pause channel startup.

Disable APC on an ILA Node

If you want to manually disable APC on a particular node. For example, consider a scenario where the headend OLT encounters a headless event. For any power correction required at agent nodes, APC manager is unavailable to initiate regulation. Also, you cannot perform any adjustments as APC is enabled and user-configuration of target-psd does not take effect. This command gives you an option to disable APC locally on an agent node to perform the parameter adjustments manually. Use the **apc-local disable** command to disable APC on an agent node.

Use the following commands to disable APC on an ILA node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-local [RX | TX] disable

commit

end

The following is a sample configuration that disables APC locally.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-local RX disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Target Drop PSD

Link Tuner does not set the target PSD for drop ports. The default target PSD for drop ports is -8.0 dBm/12.5 GHz. The NCS 1010 applies drop PSD configuration for channels with cross connect configurations. Use the **drop-psd** command to set the desired drop-psd.

Use the following commands to set the desired drop-psd.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

drop-psd *value*

commit

end

The following is a sample configuration that sets the target PSD at drop ports to –25 dBm/12.5 GHz.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#drop-psd -250
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Minimum PSD

If the PSD of a channel with minimum attenuation at the amplifier input on an OLT is less than the minimum PSD, APC marks the channel as failed and replaces the channel using ASE source. The default minimum PSD is –24 dBm/12.5 GHz. Use the **psd-min** command to set the desired minimum PSD.

Use the following commands to set the desired minimum PSD.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

psd-min *value*

commit

end

The following is a sample configuration that sets the minimum PSD to –25 dBm/12.5 GHz.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#psd-min -250
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Path Loss

On a C+L band configuration, to launch correct power into the transmission fiber, optical applications need data about loss between the LINE-TX port of the L-band device to the LINE-TX port of the C-band device. This data, also known as path loss, is calculated from the following components:

- Patch cord loss between the LINE-TX port of the L-band device to the L-Band-RX port of the C-band device.

- Insertion loss between the L-Band-RX port of the C-band device and the LINE-TX port of the C-band device.

- Insertion loss due to the Raman modules inside the C-band device.

Use the **show olc partner-band-loss** command to view the Patchcord Loss and Path Loss values. The following output is a sample of the **show olc partner-band-loss** command executed on a C-band device.

```
RP/0/RP0/CPU0:P2B_DT_01#show olc partner-band-loss
Wed Feb 1 12:51:59.605 UTC

Controller                                 : Ots0/0/0/0
Partner IP address                         : 10.1.1.2
Partner Controller                         : Ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX           : 2.3 dB
L-LINE-TX Patchcord Loss                   : 1.0 dB
Loss Measurement Timestamp                 : 2023-02-01 12:51:54
```

The following output is a sample of the **show olc partner-band-loss** command executed on an L-band device.

```
RP/0/RP0/CPU0:P1BL_DT_10#show olc partner-band-loss
Wed Feb 1 12:51:59.605 UTC

Controller                                 : Ots0/0/0/0
Partner IP address                         : 10.1.1.3
Partner Controller                         : ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX           : 2.3 dB
L-LINE-TX Patchcord Loss                   : 1.0 dB
Loss Measurement Timestamp                 : 2023-02-01 12:51:54
```

You can view the Patchcord Loss and Path Loss values for individual controllers using the **show olc partner-band-loss controller ots r/s/i/p** command. The following output is a sample of the **show olc partner-band-loss controller ots r/s/i/p** command executed on a C-band device.

```
RP/0/RP0/CPU0:P2B_DT_01#show olc partner-band-loss controller Ots 0/0/0/0
Wed Feb 1 12:51:59.605 UTC

Controller                                 : Ots0/0/0/0
Partner IP address                         : 10.1.1.2
Partner Controller                         : Ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX           : 1.9 dB
L-LINE-TX Patchcord Loss                   : 1.2 dB
Loss Measurement Timestamp                 : 2023-02-01 12:51:54
```

The following output is a sample of the **show olc partner-band-loss controller ots r/s/i/p** command executed on an L-band device.

```
RP/0/RP0/CPU0:P1BL_DT_10#show olc partner-band-loss controller Ots 0/0/0/0
Wed Feb 1 12:51:59.605 UTC

Controller                              : Ots0/0/0/0
Partner IP address                      : 10.1.1.3
Partner Controller                      : Ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX        : 1.9 dB
L-LINE-TX Patchcord Loss                : 1.2 dB
Loss Measurement Timestamp              : 2023-02-01 12:51:54
```

Band Failure Recovery

This chapter describes the Band Failure Recovery optical application for Cisco NCS 1010.

Table 6: Feature History

Feature Name	Release Information	Description
Band Failure Recovery (BFR) Pause	Cisco IOS XR Release 7.10.1	Use the new **bfr-pause** configuration command from this release to pause the BFR function. Unlike in the previous releases, the BFR pause state is now preserved during a system reload. BFR pause stays paused indefinitely until you resume it. Command added: bfr-pause
olc bfr-pause (Command deprecated)	Cisco IOS XR Release 7.10.1	The command olc bfr-pause is deprecated starting R7.10.1. To pause and resume BFR, use the bfr-pause command. To upgrade from R7.9.1 to R7.10.1 or later with BFR pause enabled, before upgrading software, pause BFR on the OLT-C band using the **olc bfr pause** command before beginning the software upgrade. Once the upgrade is finished, pause and resume BFR using the **bfr-pause** configuration command on the OLT-C and OLT-L bands.

Feature Name	Release Information	Description
Band Failure Recovery (BFR)	Cisco IOS XR Release 7.9.1	During the C+L band network bring up, as both the bands travel through the same fiber, optical power is transferred from higher frequency to lower frequency due to SRS (Stimulated Raman Scattering). This degrades the C-band channel power and causes the existing C-band power profile to change. BFR compensates for this dynamic power change by adjusting the power profile that minimizes the impact when upgrading from C-band to the C+L band network. BFR also adjusts power during a band failure to minimize the impact on the surviving band.

Overview of Band Failure Recovery (BFR)

NCS1010 can be configured to operate in both C and L-band wavelengths to increase the capacity of optical fibers. This can be done by connecting the C-band OLT or ILA line cards to the L-band OLT or ILA line cards respectively. When C and L-band signals travel through the same fiber, there is a change in the optical power from higher frequencies to lower frequencies due to SRS. This causes a change in the existing C-band power profile. In this case, BFR compensates for the power transfer by applying dual-band PSD profile on both C and L-band devices.

The source OLT node acts as the BFR manager for all the nodes in the TX direction. All the other nodes in the path act as BFR agent nodes. The manager node collects information from the agent nodes and coordinates failure and recovery actions of the network.

On a C+L band network, if any band fails, the surviving band experiences either an increase or decrease in the optical power due to the absence of SRS. In this case, the BFR manager sends commands to the agent nodes to switch the PSD profile on the surviving band to single-band PSD profile. After the failure is resolved, the BFR manager sends a command to the agent nodes to initiate recovery on failed band nodes, one node at a time thereby ensuring no traffic impact on the surviving band. BFR also handles

Enable BFR

BFR is not enabled by default and is enabled automatically if the following configurations are present on both C and L-band cards:

- Partner band IP address configuration

- Dual-band PSD configuration

To configure partner band IP and dual-band PSD profile, use the following commands:

partner-band-port ipv4 address *ip-address* **controller** *Ots0/0/0/x*

dual-band-psd *index value*

For more information about these configurations, see partner-band-port and Configure APC.

Note Ensure that Link Tuner and Gain Estimator are disabled before BFR is automatically enabled.

View BFR Status on All Nodes

To view the status of BFR on all the nodes, use the following command:

show olc band-status

Example 1

The following example shows the status of BFR on all the nodes of a controller. When both the bands are active, the status of BFR is displayed as *Running* and BFR ensures that dual-band PSD is used on both bands.

```
RP/0/RP0/CPU0#show olc band-status
Tue Dec 13 10:45:30.594 UTC

Controller           : Ots0/0/0/0
Self-Band            : C-Band
BFR status           : Running

Node RID             : 10.1.1.1
Self IP Address   : 192.0.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.0.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.2
Self IP Address      : 192.0.2.21
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.0.2.22
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.3
Self IP Address      : 192.0.2.31
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.0.2.32
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.4
```

```
Self IP Address      : 192.0.2.41
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.0.2.42
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.5
Self IP Address      : 192.0.2.51
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.0.2.52
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band
```

For more information about these commands, see show olc band-status in the Command Reference for Cisco NCS 1010 guide.

Note If the OLC process is restarted on OLT-CR while Raman tuning is in progress, the *Partner link status* might show as DOWN in the output of the **show olc band-status** command. The *Partner link status* will change to UP after Raman tuning is completed.

Band Failure

Band failure can happen due to any of the following events:

- Optical connectivity failure between C and L-band devices.

- The amplifier or controller on the L or C band device is failed.

- The amplifier on the L or C band is shut down due to Optical Safety Remote Interlock (OSRI)

- The node shutdown due to power failure.

- L or C band line cards are in a cold reload state.

- L or C band card failure.

- Multiple fiber cuts and HA events.

- High back reflection

Note Span fiber failure is not considered as band failure as both bands are impacted due to the failure.

The following figure illustrates the BFR failure procedure in case of L-band failure. As soon as the band failure is detected, BFR sets safe mode on the failed band devices and switches the PSD profile of the surviving band devices to single-band PSD. The status of the C-band devices is ACTIVE and the PSD profile for the devices is displayed as *Single Band*.

Figure 2: Example of L-band Failure
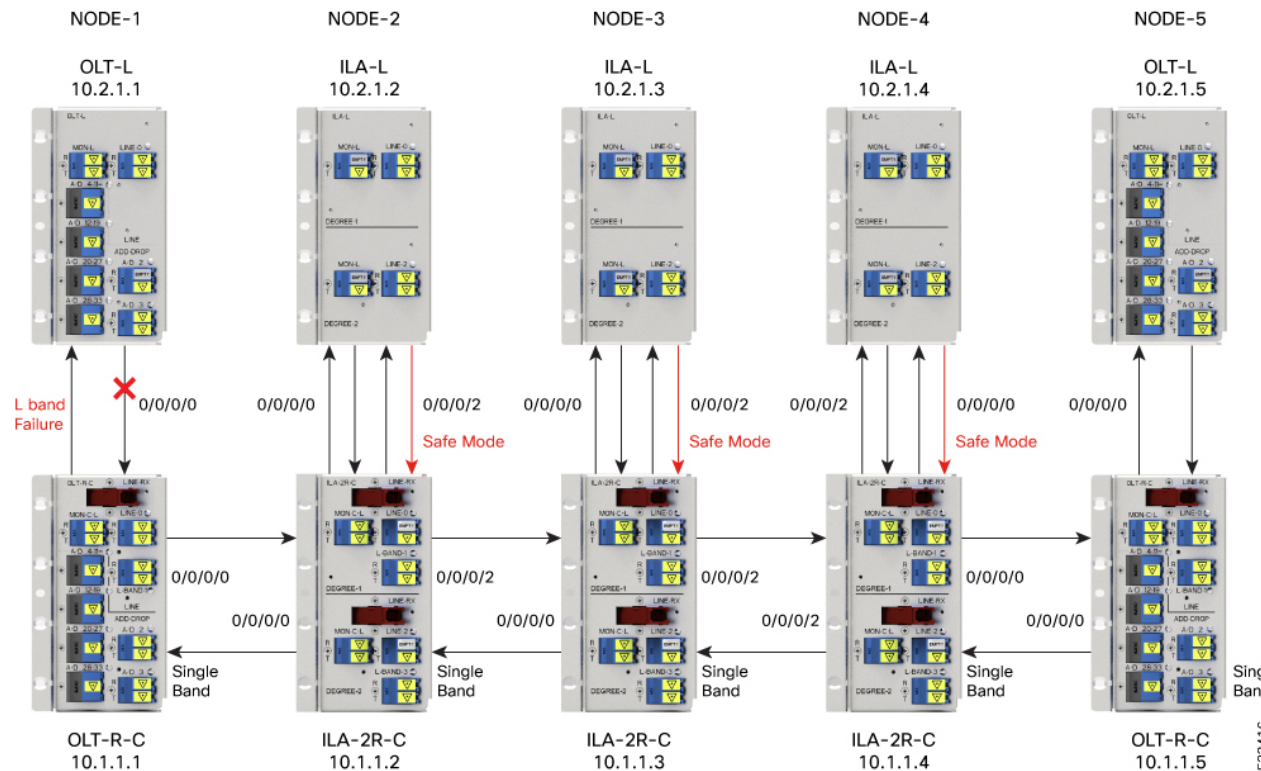
Example

The following example shows the status of BFR when L-band is in the FAILED state. In this case, all the C band nodes are switched to single-band PSD profiles and L band devices are set to safe mode.

```
RP/0/RP0/CPU0#show olc band-status

Controller               : Ots0/0/0/0
Self-Band                : C-Band
BFR status               : Running

Node RID                 : 10.2.1.1
Self IP Address          : 192.0.2.1
Self Controller          : Ots0/0/0/0
Partner IP address       : 192.0.2.2
Partner Controller       : Ots0/0/0/0
Partner link status      : UP
C-Band status            : ACTIVE
C-Band PSD               : Single Band
L-Band status            : FAILED
L-Band PSD               : NA

Node RID                 : 10.2.1.2
Self IP Address          : 192.0.2.21
Self Controller          : Ots0/0/0/0
Partner IP address       : 192.0.2.22
Partner Controller       : Ots0/0/0/2
Partner link status      : UP
```

```
C-Band status          : ACTIVE
C-Band PSD             : Single Band
L-Band status          : FAILED
L-Band PSD             : NA

Node RID               : 10.2.1.3
Self IP Address        : 192.0.2.31
Self Controller        : Ots0/0/0/0
Partner IP address     : 192.0.2.32
Partner Controller     : Ots0/0/0/2
Partner link status    : UP
C-Band status          : ACTIVE
C-Band PSD             : Single Band
L-Band status          : FAILED
L-Band PSD             : NA

Node RID               : 10.2.1.4
Self IP Address     : 192.0.2.41
Self Controller        : Ots0/0/0/0
Partner IP address     : 192.0.2.42
Partner Controller     : Ots0/0/0/0
Partner link status    : UP
C-Band status          : ACTIVE
C-Band PSD             : Single Band
L-Band status          : FAILED
L-Band PSD             : NA


Node RID               : 10.2.1.5
Self IP Address     : 192.0.2.51
Self Controller        : Ots0/0/0/0
Partner IP address     : 192.0.2.52
Partner Controller     : Ots0/0/0/0
Partner link status    : UP
C-Band status          : ACTIVE
L-Band status          : FAILED
L-Band PSD             : NA
```

Band Failure Recovery

Once the optical fiber fault is cleared, BFR starts the recovery procedure on all the failed band nodes, one node at a time and also ensures that there is no impact on the traffic. Also, the PSD profiles on the recovered and surviving band are shifted to dual-band PSD profiles.

Note
- Recovery procedure is initiated only if all nodes (both C and L bands) are active and reachable.

- The recovery procedure on the failed band and the PSD profile shifting are carried out in parallel by BFR and APC respectively. For BFR to work, APC must be enabled on both C and L-band devices. We recommend to pause BFR before running the **apc-pause** or **apc disable** commands.

The following figure illustrates the BFR recovery procedure in case of L-band failure. After the fiber fault is cleared, BFR starts recovery on all C and L-band nodes one node at a time. The recovery procedure on Node 1 is completed and the status is displayed as ACTIVE. The recovery procedure on Node 2 is in progress hence the node status is displayed as RECOVERING. After completing the recovery on Node 2, BFR will start recovery on the remaining nodes one node at a time.

Figure 3: Example of BFR Recovering Nodes
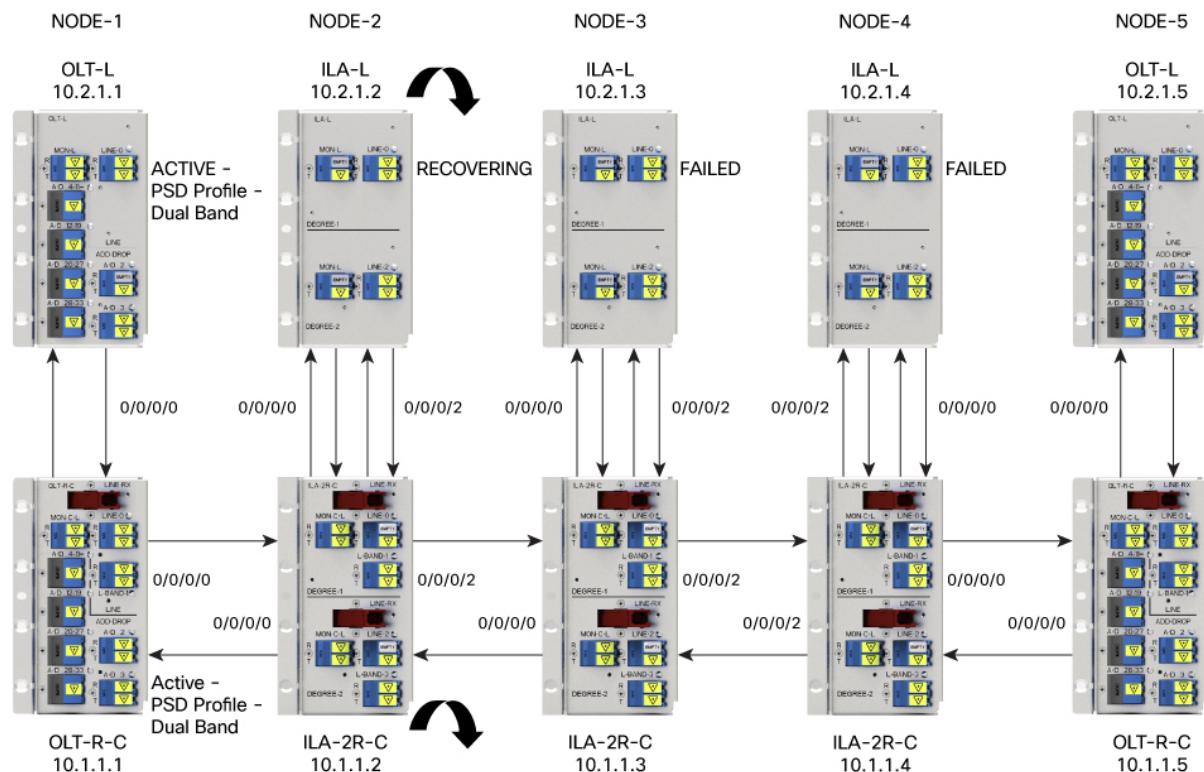
Example

The following example shows status of the C and L-band as RECOVERING on the *192.0.2.1* node:

```
RP/0/RP0/CPU0:#show olc band-status

Controller              : Ots0/0/0/0
Self-Band               : C-Band
BFR status              : Running

Node RID                : 10.1.1.1
Self IP Address    : 192.0.2.1
Self Controller         : Ots0/0/0/0
Partner IP address      : 192.0.2.2
Partner Controller      : Ots0/0/0/0
Partner link status     : UP
C-Band status           : ACTIVE
C-Band PSD              : Dual Band
L-Band status           : ACTIVE
L-Band PSD              : Dual Band

Node RID                : 10.1.1.2
Self IP Address         : 192.0.2.21
Self Controller         : Ots0/0/0/0
Partner IP address      : 192.0.2.22
Partner Controller      : Ots0/0/0/2
Partner link status     : UP
C-Band status           : RECOVERING
C-Band PSD              : NA
L-Band status           : RECOVERING
```

```
L-Band PSD              : NA

Node RID                : 10.1.1.3
Self IP Address         : 192.0.2.31
Self Controller         : Ots0/0/0/0
Partner IP address      : 192.0.2.32
Partner Controller      : Ots0/0/0/2
Partner link status     : UP
C-Band status           : ACTIVE
C-Band PSD              : Single Band
L-Band status           : FAILED
L-Band PSD              : NA

Node RID                : 10.1.1.4
Self IP Address         : 192.0.2.41
Self Controller         : Ots0/0/0/0
Partner IP address      : 192.0.2.42
Partner Controller      : Ots0/0/0/0
Partner link status     : UP
C-Band status           : ACTIVE
C-Band PSD              : Single Band
L-Band status           : FAILED
L-Band PSD              : NA

Node RID                : 10.1.1.5
Self IP Address         : 192.0.2.51
Self Controller         : Ots0/0/0/0
Partner IP address      : 192.0.2.52
Partner Controller      : Ots0/0/0/0
Partner link status     : UP
C-Band status           : ACTIVE
L-Band status           : FAILED
```

Single Band Failure Recovery on Non-Raman Network

In case of single band failure on a non-Raman network, after the optical fiber fault is cleared, BFR performs the following operations:

- Starts recovery on the failed band one node at a time.

- After the recovery is completed and both the bands are active, BFR switches the PSD profiles on both bands to dual-band PSD.

Span Failure Recovery

On a C+L band network, when both bands fail, BFR does not change the PSD profile to single-band PSD. After the failure is cleared, both the bands are recovered quickly.

When a span failure is cleared on a Raman network, in case Raman tuning is disabled, BFR starts the recovery of nodes. When Raman tuning is enabled, BFR suspends recovery and resumes it only after Raman tuning is completed.

Single Band Failure Recovery on a Raman Network

On a C+L band network without Raman amplifiers, when a band fails, Loss of Signal (LOS) is reported because the total power drops below the safe value. This shuts down the amplifiers on other nodes. On a Raman network, if a band fails on the near end node, the amplifiers on the far end nodes receive some band power because of ASE. In this case, LOS is not reported and the amplifiers on far end nodes remain active.

BFR ensures that recovery on the far end nodes is started even if the amplifiers on the nodes are active because of ASE and sets safe mode on the failed band.

Once the optical fiber fault is cleared on a Raman network, if Raman tuning is started, BFR suspends recovery and resumes it only after Raman tuning is completed. If Raman tuning is not started, BFR starts the recovery of nodes one by one.

Band Failure Recovery Due to Device in Headless Mode

In case of a band failure on a network that has an OLT device in headless mode:

- BFR will not switch the PSD profile to single-band PSD.

- BFR will not run the recovery procedure.

In case of a band failure on a network that has an ILA device in headless mode:

- BFR switches the PSD profile to single-band PSD on all the nodes that are reachable by C band OLT.

- BFR does not run the recovery procedure on all the OLT and ILA nodes.

- If one or more nodes on the network are in headless mode, BFR is not initiated which might affect traffic recovery. In this case, perform the following tasks to restore the traffic:

  1. Pause BFR

  2. Initialize BFR

  3. Resume BFR

For more information about these commands, see the Command Reference for Cisco NCS 1010 guide.

Band Failure Recovery Due to Partner Link Status is Down

On a C+L band network, if there is a connectivity failure between the C-band and L-band ILA nodes, BFR does not start the recovery procedure. If the recovery procedure is running and the *Partner link status* is DOWN, BFR suspends recovery and resumes it only after the *Partner link status* is UP.

Example

The following example shows the output of the **show olc band-status** command where the *Partner link status* status is UP.

```
RP/0/RP0/CPU0:#show olc band-status

Controller            : Ots0/0/0/0
Self-Band             : C-Band
BFR status            : Running

Node RID              : 10.1.1.1
Self IP Address       : 192.0.2.1
Self Controller       : Ots0/0/0/0
Partner IP address    : 192.0.2.2
Partner Controller    : Ots0/0/0/0
Partner link status   : UP
C-Band status         : ACTIVE
C-Band PSD            : Dual Band
L-Band status         : ACTIVE
L-Band PSD            : Dual Band
```

Pause and Resume BFR

While recovering from a span failure, if one of the bands is in failed state, BFR is not initiated and the other band is not recovered. In such cases, you can pause, initialize, and resume BFR to initiate it and to bring up the other band.

Pause BFR

Use the following commands to pause BFR:

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

bfr-pause

commit

end

Example

The following is a sample configuration to pause BFR:

```
RP/0/RP0/CPU0:#configure
RP/0/RP0/CPU0: (config)#optical-line-control
RP/0/RP0/CPU0: (config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0: (config-olc-ots)#bfr-pause
RP/0/RP0/CPU0: (config-olc-ots)#commit
```

Resume BFR

Use the following commands to resume BFR:

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

no bfr-pause

commit

end

Example

The following is a sample configuration to resume BFR:

```
RP/0/RP0/CPU0:#configure
RP/0/RP0/CPU0: (config)#optical-line-control
RP/0/RP0/CPU0: (config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0: (config-olc-ots)#no bfr-pause
RP/0/RP0/CPU0: (config-olc-ots)#commit
```

For more information about these commands, see bfr-pause in the Command Reference for Cisco NCS 1010 guide.

✎

Note   To upgrade from R7.9.1 to R7.10.1 or later with BFR pause enabled, before upgrading software, pause BFR on the OLT-C band using the olc bfr pause command before beginning the software upgrade. Once the upgrade is finished, pause and resume BFR using the bfr-pause configuration command on the OLT-C and OLT-L bands.

CHAPTER 9

Upgrade C-Band to C+L Band Without Affecting Traffic Flow

This chapter describes how to upgrade a C-band only network to C+L band network for Cisco NCS 1010 without affecting the traffic in the existing network.

Upgrade C-Band to C+L Band Without Affecting Traffic Flow

Table 7: Feature History

Feature Name	Release Information	Description
Nontraffic Affecting C+L Band Upgrade	Cisco IOS XR Release 7.10.1	Upgrading an existing C-band network to a C+L band network is now possible without impacting the traffic flow. Cisco Optical Network Planner (CONP) computes the values for relevant parameters in C+L network configuration. The upgrade benefits even those networks that were not planned for a future L-band upgrade. C+L band upgrade enables you to accommodate more bands to your network to boost network bandwidth.

Perform the following procedure to bring up the L-band node while upgrading a C-band only network to a C+L network.

Note Use the Cisco Optical Network Planner (CONP) to compute the following values for C-band and L-band devices in C+L network configuration:

1. Single band and Dual band target PSD values

2. Gain-range for amplifiers

Procedure

Step 1 Configure proper gain and gain-range on all L-band nodes.

Note

Gain-Estimator (GE) must be in DISABLED state.

The following is a sample configuration that disables Gain Estimator.

```
RP/0/RP0/CPU0:ios#configure terminal
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#gain-estimator disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

Step 2 Configure Single band PSD on all L-band nodes.

Note

Link Tuner (LT) must be in DISABLED state.

The following is a sample configuration that disables Link Tuner.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Step 3 Configure Dual band configuration (dual band PSD set points that are obtained from CONP and partner-band configuration) values on all L-band nodes. For more information on L-Band dual band PSD configuration, see Modify L-Band Amplifier Properties.

Step 4 Configure proper gain and gain-range computed by gain-estimator application manually on all C-band nodes and then disable gain-estimator.

Note

Disabling Gain estimator causes traffic impact if there is mismatch between the user-configured gain range and the gain-estimator configured gain-range.

Step 5 Configure single band PSD set points that are obtained from Link Tuner manually on all C-band nodes and disable Link Tuner.

Note

Link tuner is in *Enabled* state in the C-band network. Configure the same PSD values that are obtained from Link Tuner and then disable Link Tuner. Any mismatch between the user-configured PSD and Link-Tuner configured PSD values leads to traffic impact.

Step 6 Configure dual band configuration (dual band PSD configuration set points that are obtained from CONP and partner-band configuration) values on all C-band nodes. For more information on C-Band dual band PSD configuration, see Modify C-Band Amplifier Properties

Note

Ensure that dual band configurations are present (dual band PSD and partner-band) on all C- and L-band nodes during L-band device addition. If any one of these two configurations is not present, then BFR does not work properly, and the bands start in an uncontrolled manner which may impact traffic.

Step 7   Bring up the Interlink connectivity between C-band and L-band devices by enabling the management interfaces for partner-band communication between C-band and L-band nodes.

Step 8   Bring up the fiber connectivity between C-band and L-band devices and enable Gigabit Ethernet interfaces.

Note
Fiber connectivity is the connection between the L-band port on the C-band nodes and the Line port on the L-band nodes.

Step 9   Verify that the connectivity is fine and there are no alarms present on OSC and OTS controller.

Step 10   After the connectivity is completed till the last terminal node, verify that the topology is *UP*, and APC cleared the *PARTIAL TOPOLOGY* alarm on all OLT C-band and L-band nodes.

The following sample is an output of **show olc apc** command.

```
RP/0/RP0/CPU0:OLT1#show olc apc

Controller     : Ots0/0/0/0
APC Status     : WORKING
```

Step 11   On the L-band bfr manager, band status remains *NA* until end-to-end connectivity is up. After end-to-end terminal (OLT-OLT) is discovered, band status populates all the agent nodes. BFR initiates the BRING UP (RECOVERY) procedure and recovers one node at a time.

The following example shows the output of the **show olc band-status** command where the L-Band recovery is not initiated and *BFR status* is *NA*.

```
RP/0/RP0/CPU0:#show olc band-status

Thu Dec 15 13:54:25.703 UTC

Controller          : Ots0/0/0/0
Self-Band           : None
BFR status          : NA
```

The following example shows the output of the **show olc band-status** command where the L-Band recovery is in progress and *BFR status* is *Running*.

```
RP/0/RP0/CPU0:#show olc band-status

Thu Dec 15 13:54:25.703 UTC

Controller          : Ots0/0/0/0
Self-Band           : None
BFR status          : Running

Node RID            : 10.1.1.1
Self IP address     : 10.9.1.2
Self Controller     : Ots0/0/0/0
Partner IP address  : 10.9.1.1
Partner Controller  : Ots0/0/0/0
Partner link status : UP
C-Band status       : ACTIVE
C-Band PSD          : Dual Band
L-Band status       : ACTIVE
L-Band PSD          : Dual Band

Node RID            : 10.2.1.2
Self IP address     : 10.9.2.2
Self Controller     : Ots0/0/0/0
Partner IP address  : 10.9.2.1
Partner Controller  : Ots0/0/0/2
Partner link status : UP
```

```
C-Band status          : RECOVERING
C-Band PSD             : NA
L-Band status          : RECOVERING
L-Band PSD             : NA

Node RID               : 10.2.1.3
Self IP address        : 10.9.3.2
Self Controller        : Ots0/0/0/0
Partner IP address     : 10.9.3.1
Partner Controller     : Ots0/0/0/2
Partner link status    : UP
C-Band status          : RECOVERING
C-Band PSD             : NA
L-Band status          : RECOVERING
L-Band PSD             : NA

Node RID               : 10.2.1.4
Self IP address        : 10.9.4.2
Self Controller        : Ots0/0/0/0
Partner IP address     : 10.9.4.1
Partner Controller     : Ots0/0/0/0
Partner link status    : UP
C-Band status          : RECOVERING
C-Band PSD             : NA
L-Band status          : RECOVERING
L-Band PSD             : NA

Node RID               : 10.2.1.5
Self IP address        : 10.9.5.2
Self Controller        : Ots0/0/0/0
Partner IP address     : 10.9.5.1
Partner Controller     : Ots0/0/0/0
Partner link status    : UP
C-Band status          : RECOVERING
L-Band status          : RECOVERING
```

Step 12   Wait for the recovery to complete on all nodes. When recovery completes, check the PSD status of the C-band and partner L-band nodes, and verify that the PSD profile is *DUAL BAND PSD*.

Step 13   Verify that BFR converged on all nodes and the state on the agent nodes are *ACTIVE* with *DUAL BAND PSD*.

The following example shows the output of the **show olc band-status** command where the L-Band bring up is complete, PSD profile is *DUAL BAND PSD*, and band status of all agent nodes is *Active*.

```
RP/0/RP0/CPU0:#show olc band-status

Thu Dec 15 13:54:25.703 UTC

Controller             : Ots0/0/0/0
Self-Band              : None
BFR status             : Running

Node RID               : 10.2.1.1
Self IP address        : 10.9.1.2
Self Controller        : Ots0/0/0/0
Partner IP address     : 10.9.1.1
Partner Controller     : Ots0/0/0/0
Partner link status    : UP
C-Band status          : ACTIVE
C-Band PSD             : Dual Band
L-Band status          : ACTIVE
L-Band PSD             : Dual Band

Node RID               : 10.2.1.2
```

```
            Self IP address         : 10.9.2.2
            Self Controller         : Ots0/0/0/0
            Partner IP address      : 10.9.2.1
            Partner Controller      : Ots0/0/0/2
            Partner link status     : UP
            C-Band status           : ACTIVE
            C-Band PSD              : Dual Band
            L-Band status           : ACTIVE
            L-Band PSD              : Dual Band

            Node RID                : 10.2.1.3
            Self IP address         : 10.9.3.2
            Self Controller         : Ots0/0/0/0
            Partner IP address      : 10.9.1.1
            Partner Controller      : Ots0/0/0/2
            Partner link status     : UP
            C-Band status           : ACTIVE
            C-Band PSD              : Dual Band
            L-Band status           : ACTIVE
            L-Band PSD              : Dual Band

            Node RID                : 10.2.1.4
            Self IP address         : 10.9.4.2
            Self Controller         : Ots0/0/0/0
            Partner IP address      : 10.9.4.1
            Partner Controller      : Ots0/0/0/0
            Partner link status     : UP
            C-Band status           : ACTIVE
            C-Band PSD              : Dual Band
            L-Band status           : ACTIVE
            L-Band PSD              : Dual Band

            Node RID                : 10.2.1.5
            Self IP address         : 10.9.5.2
            Self Controller         : Ots0/0/0/0
            Partner IP address      : 10.9.5.1
            Partner Controller      : Ots0/0/0/0
            Partner link status     : UP
            C-Band status           : ACTIVE
            L-Band status           : ACTIVE
```

Step 14   Check the traffic status on C-band nodes and verify that traffic was not impacted during L-band addition.

Automatic Network Turn Up

This chapter describes the Automatic Network Turn Up workflow for Cisco NCS 1010.

Overview of Automatic Link Bring Up

You can bring up an NCS 1010 DWDM link without using any external tools. NCS 1010 measures optical parameters for all the spans at power-up. It then computes different setpoints for each of the spans to ensure optimal link performance for end-to-end traffic to pass through. The following optical applications enable Automatic Link Bring Up:

- Span loss measurement

- Gain Estimator

- Link Tuner

- Automatic Power Control

- Raman Tuning

Automatic Link Bring Up uses the following user configurations if they are available:

- Measured span loss

- Fiber type

- Spectral Density

- Span length

Automatic Link Bring Up works under the following assumptions:

- The fiber connections are proper. There are no fiber cuts or faulty connectors blocking link bring up.

- OSC link comes up without need of Raman gain. If span length is high and NCS 1010 is not able to turn up OSC without Raman Gain, you must disable Raman tuning and manually configure Raman amplification.

You need Automatic Link Bring Up after physically installing your device and connecting the fibers as necessary. Automatic Link Bring Up process starts when you turn on a device. The new device that you turn on does not have any configuration on it. First, the device must join the network and get an IP address.

The NCS 1010 device uses DHCP to get an IP address. After receiving an IP address using DHCP, the device gets ZTP configuration file from the DHCP server or a separate ZTP server. Configure the DHCP server with the desired IP address and configuration file for each NCS1010 device you want to configure. The NCS 1010 uses the configuration file and configures itself.

In optical networks with long spans, it is not always practical for all nodes to have direct connectivity to a DHCP server. In such cases, the OLT node that has server connectivity acts as a DHCP relay and provides the next node with DHCP connectivity. The ILA node that connects to the OLT then acts as a DHCP relay for the next ILA node in the link. Each subsequent node then acts as a DHCP relay and provides DHCP connectivity to the adjacent nodes down the link. See Remote Node Management in NCS 1010 for more information. As this process completes, all nodes get network connectivity and receive the ZTP configuration files. ZTP allows you to provision the network device with day 0 configurations.

The ZTP configuration file must contain the following configurations:

- Host configuration
- DHCP relay configuration (only if there are nodes further down the link)
- Interface configuration
- OSPF configuration
- SSH configuration

See Boot Using Zero Touch Provisioning for more information on configuring and using ZTP.

After ZTP configuration is complete, the NCS 1010 device uses OSPF to perform topology discovery. During topology discovery, each node finds out about its adjacent node and the entire topology. After discovering neighbor nodes, the device initiates span loss measurement. If the span is a Raman span, the device initiates Raman tuning. Simultaneously, the OLT begins ASE loading to load all the channels with noise.

After ASE loading, span loss measurement, and Raman tuning are complete, the NCS 1010 device initiates Startup Gain Estimation and Link tuner. Startup Gain Estimation sets the target gain and gain mode for the EDFA amplifier. Link tuner provides the target PSDs for the channels.

Note **Startup Gain Estimation** analyses the span loss and sets the gain mode of the EDFA amplifier and provides the initial target gain for the amplifier. EDFA amplifiers are present in both OLT and ILA variants of NCS 1010. These EDFA amplifiers are variable-gain optical amplifiers capable of working at two different gain ranges or modes. The modes are normal mode and extended mode. Extended mode provides higher gain than the normal mode. Changing the gain mode of an amplifier is traffic impacting. Therefore, Automatic Power Correction (APC) is unable to change the gain mode of an amplifier.

After Startup Gain Estimation and Link tuner operations are complete, the NCS 1010 initiates APC. APC uses the target PSDs that Link tuner sets and regulates the power output for all channels. Automatic Link Bring Up is complete and the optical link is up with all ASE loaded noise channels with the target PSDs set by link tuner. Create and configure optical cross connects to get traffic up and running on the link.

The following flowchart shows the sequence of the optical applications during automaticlink bring up.

Figure 4: Automatic Link Bring-up
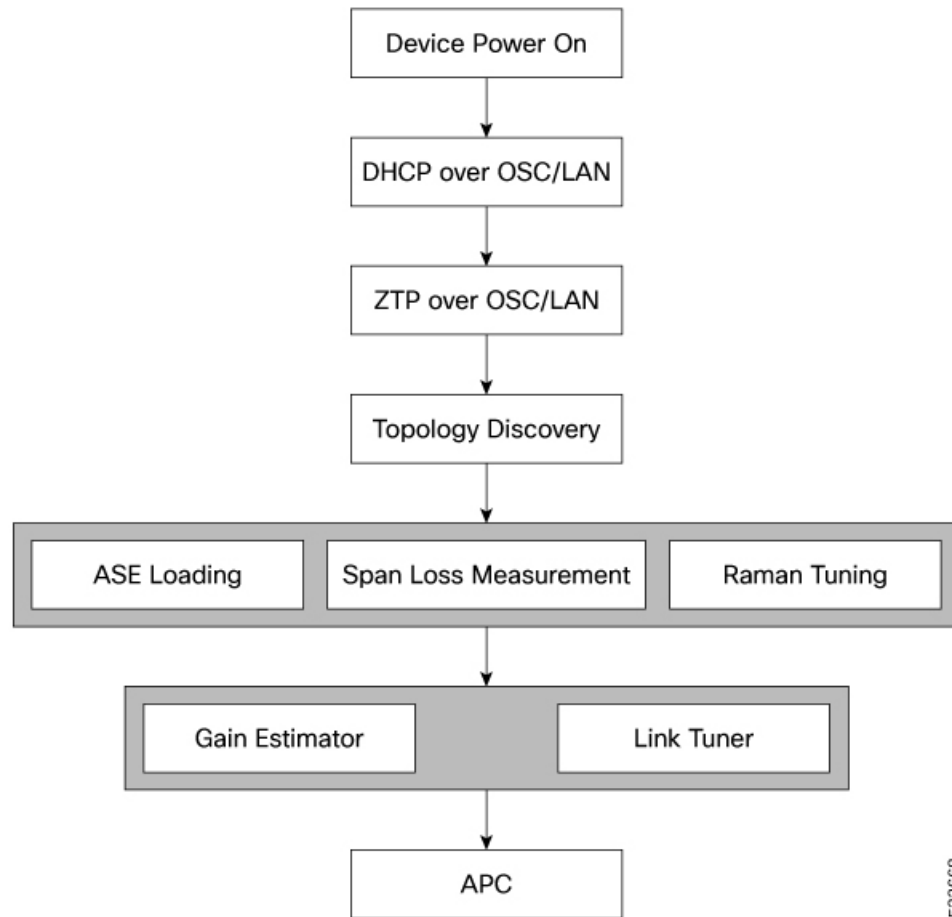
The following example shows a sample ZTP configuration file with the minimum required configuration.

```
!! IOS XR Configuration
!
hostname ios
username cisco
group root-lr
group cisco-support
secret 10
$6$7motIAh93vG/I...$iM64ZfsZ5ciicdcsdsewHdEIvLTq0YEc1G1NMpauwJUiEnkV8LwMJUDZnnTkVj9RPgf4wffWJYelPN7jqiN3q/

dhcp ipv4
profile r1 relay
  helper-address vrf default 10.33.0.51 giaddr 10.7.3.2
!
profile r2 relay
  helper-address vrf default 10.33.0.51 giaddr 10.7.2.2
!
interface GigabitEthernet0/0/0/0 relay profile r2
interface GigabitEthernet0/0/0/2 relay profile r1
!
call-home
service active
contact smart-licensing
profile CiscoTAC-1
```

```
  active
  destination transport-method email disable
  destination transport-method http
!
!
interface Loopback0
ipv4 address 10.3.3.13 255.255.255.255
!
interface GigabitEthernet0/0/0/0
ipv4 address 10.7.2.2 255.255.255.0
!
interface GigabitEthernet0/0/0/2
ipv4 address 10.7.3.2 255.255.255.0
!
router ospf 1
router-id 10.3.3.13
distribute link-state
nsf
network point-to-point
redistribute connected
area 0
  interface Loopback0
  !
  interface GigabitEthernet0/0/0/0
  !
  interface GigabitEthernet0/0/0/2
  !
!
!
ssh server v2
ssh server vrf default
ssh server netconf vrf default
!
end
```

Enable Automatic Link Bring Up

Use the following commands to enable automatic link bring up.

configure

optical-line-control

automatic-link-bringup

commit

end

Disable Automatic Link Bring Up

Use the following commands to disable automatic link bring up.

configure

optical-line-control

no automatic-link-bringup

commit

end

Configure OTDR

This chapter describes how to configure the Optical Time Domain Reflectometer (OTDR) module in NCS 1010.

OTDR

OTDR functionality in NCS 1010 OLT and ILA nodes

The NCS 1010 OLT and ILA nodes have an in-built bidirectional Optical Time Domain Reflectometer (OTDR) functionality that can capture the real-time measurements of loss and back reflection of the fiber pair linked to the TX and RX ports.

Port switching capabilities of OTDR

For the OLT device, the OTDR port can switch between LINE-TX and LINE-RX ports. For the ILA device, the OTDR port can switch among LINE-1-TX, LINE-1-RX, LINE-2-TX, and LINE-2-RX ports.

SOR file

You can view the OTDR measurement results in the Standard OTDR Record (SOR) file. The SOR file contains the fiber trace details such as the distance, reflectance, loss, and fiber attenuation measurements. You can export the SOR file from NCS 1010 using the command: **scp username@device-ip:filename_with_source_location destination-location** .

Example:

```
scp test@192.168.0.1:/harddisk:/otdr/ios_OTDR_Ots0_0_0_0_RX_20230301-101927.sor /users/test/
```

Benefits of OTDR

The OTDR offers several key benefits, including:

- **Quality of the Fiber:** Assesses the quality of the fiber during system installation, before any traffic is active.

- **Monitoring During Operation:** Monitors the fiber during system operation (live traffic) and check the fiber during cable cuts and repairs.

- **Attenuation Measurement:** Measures the attenuation (dB) of the entire fiber link and the attenuation of individual sections of fiber.

- **Distance and Magnitude of Losses:** Determine the distance and magnitude of insertion loss and reflection loss.

- **Fiber Events Detection:** Identify fiber events such as concentrated loss events, reflection events, events at the end of the fiber, and discontinuities or defects on the fiber such as fiber pinch, and fiber cut, loss events such as loss due to fiber splicing, patch panel, and coupler connections.

OTDR modes

In NCS 1010, OTDR works in two three modes:

- Auto

- Expert

Auto

The device automatically selects the optimal values for OTDR pulse width, scan duration, capture start time, and capture end time parameters. This is the default mode and does not require explicit configuration. However, you can manually configure the other scan parameters if needed.

Expert

You must manually configure all OTDR scan parameters with the valid values that are required for the OTDR measurement. Automatic adjustments are not performed in this mode.

Configure the OTDR scan parameters

Use this task to configure the various parameters for the OTDR scan. If not configured, the NCS 1010 device uses the default values for OTDR scan parameters.

Procedure

Step 1 Enter the OTS controller configuration mode for the port you want to configure the OTDR parameters.

Example:
```
RP/0/RP0/CPU0:ios#config
RP/0/RP0/CPU0:ios(config)#controller ots 0/0/0/0
```

Step 2 Enter the OTDR mode.

If you want to configure the	then run the command
Expert mode	RP/0/RP0/CPU0:ios(config-Ots)#otdr scan-mode expert
Auto mode	The Auto mode is the default mode and does not require explicit configuration.

Step 3   Set the required parameters for OTDR scan. See for the complete list of OTDR parameters.

Example:

```
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx auto reflectance-threshold -50
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx auto splice-loss-threshold 200
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx expert pulse-width 6000
RP/0/RP0/CPU0:ios(config-Ots)#commit
```

Step 4   Commit the changes and exit the configuration mode.

Example:

```
RP/0/RP0/CPU0:ios(config)#commit
RP/0/RP0/CPU0:ios(config)#exit
```

OTDR scan parameters

This table provides an overview of key OTDR parameters, including their definitions, measurement units, range of values and the default values.

Table 8: OTDR scan parameters in Auto mode

Parameter	Description	Unit	Range	Default
otdr { rx | tx} auto reflectance-threshold *<value>*	Threshold beyond which a reflective anomaly is reported as an event in the Rx or Tx direction.	dB	–50 to –10	–40
otdr { rx | tx} auto splice-loss-threshold *<value>*	Threshold beyond which a loss anomaly is reported as an event in Rx or Tx direction.	dB	0.2 to 5	0.35
otdr { rx | tx} auto excess-reflection-threshold *<value>*	Threshold beyond which a reflective event is reported as an excessive reflection event in the Rx or Tx direction.	dB	–50 to –10	–20
otdr { rx | tx} auto back-scattering *<value>*	The back scattering value in the Rx or Tx direction.	dB	–90 to –70	–81.87

Parameter	Description	Unit	Range	Default
**otdr { rx	tx} auto refractive-index** *<value>*	The refractive-index value in the Rx or Tx direction.	-	1.000 to 2.000	1.4682
**otdr { rx	tx} auto excess-orl-threshold***<value>*	Threshold below which OTDR-ABS-ORL-EXCEEDED alarm is reported in the Rx or Tx direction.	dB	10–60	60
**otdr { rx	tx} auto excess-attenuation-threshold***<value>*	Threshold beyond which a Non-Reflective event is reported as an excessive attenuation event in the Rx or Tx direction.	dB	0.5 to 5	5
**otdr { rx	tx} auto end-of-fiber-loss-threshold** *<value>*	Threshold based on which the OTDR identifies the fiber's end, distinguishing it from other components like splices or connectors.	dB	5–99	5.5

Table 9: OTDR scan parameters in Expert mode

Parameter	Description	Unit	Range	Default
**otdr {rx	tx} expert pulse-width** *<value>*	Pulse width to be used during the expert scan in the Rx or Tx direction.	ns	5–20000	20
**otdr {rx	tx} expert capture-end***<value>*	OTDR capture endpoint during the expert scan in the Rx or Tx direction.	cm	0–15000000	15000000
**otdr {rx	tx} expert capture-start** *<value>*	OTDR capture start point during expert scan in the Rx or Tx direction	cm	0–10000000	0
**otdr {rx	tx} expert scan duration***<value>*	OTDR scan duration during expert scan in the Rx or Tx direction.	Seconds	0–180	60

Verify the OTDR measurements

Use this task to view the OTDR scan measurement results.

Procedure

Use the command **show controllers ots** *R/S/I/P* **otdr-info** *direction* to view the OTDR scan measurements.

This sample displays the OTDR scan information in the Rx direction.

```
RP/0/RP0/CPU0:ios#show controllers ots 0/0/0/0 otdr-info rx
Wed Feb  9 05:55:19.791 UTC
      Scan Direction: RX
      Scan Status: Data Ready
      SOR file: /harddisk:/otdr/IOS_NCS1010_OTDR_Ots0_0_0_0_RX_20220209-055045.sor
      Total Events detected: 11
      Scan Timestamp: Wed Feb  9 05:50:45 2022 UTC
      Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection
      Event#  | Detected Event(s) | Location(km) | Accuracy(m) | Magnitude(dB)| Attenuation/km(dB)
      1       | R                 | 50.4709      | 52.47       | -39.87       | 0.18
      2       | NR                | 50.4709      | 52.47       | 1.17         | 0.18
      3       | R                 | 100.9261     | 102.92      | -37.73       | 0.21
      4       | NR                | 100.9261     | 102.92      | 1.01         | 0.21
      5       | R                 | 105.9500     | 107.94      | -38.52       | 0.24
      6       | NR                | 105.9500     | 107.94      | 0.85         | 0.24
      7       | R                 | 112.7458     | 114.74      | -40.56       | 0.00
      8       | NR                | 112.7458     | 114.74      | 1.48         | 0.00
      9       | NR                | 117.9873     | 119.98      | 0.66         | -0.02
      10      | R FE              | 120.1206     | 122.12      | -35.55       | 0.00
      11      | NR FE             | 120.1206     | 122.12      | 21.65        | 0.00
```

After upgrading the FPD of the line card, the results of previous OTDR scans may not be available using the CLI command **show controllers ots** *Rack/Slot/Instance/Port* **otdr-info** *direction*. However, you can get the results of previous OTDR scans in the form of .SOR files that are stored in the hard disk.

Excessive Reflection (ER) and Excess Attenuation (EA) events and alarms can be dynamically raised or cleared by modifying their respective threshold values. However, Fiber End (FE) and Reflectance (R) events can be raised or cleared by changing the respective thresholds and re-running the OTDR scan.

Start the OTDR scan

Use this task to start the OTDR scan manually to perform the following procedures:

1. Identify the defect after the fiber has been cut.

2. Check the fiber quality after correcting the fiber defect.

3. Initiate an OTDR scan at the time of installation.

Note   The Raman tuning application locks the OTDR scan at both fiber ends before the tuning starts, and releases the lock after the tuning completes. Therefore, when you try to start the OTDR scan when Raman tuning is running, your request gets rejected.

Procedure

Step 1   Use the **otdr-start controller ots** *R/S/I/P direction* to start the OTDR scan manually.

Example:

```
RP/0/RP0/CPU0:ios#otdr-start controller ots 0/0/0/0 rx
Wed Feb  9 05:49:39.178 UTC
OTS OTDR Scan Started at RX
RP/0/RP0/CPU0:ios#
```

The following example illustrates a rejected OTDR start request. Once an OTDR scan request has been rejected, it will not automatically run after the lock is released. You will need to create a new request to start the OTDR scan again. These examples show that OTDR scan is locked by Raman tuning:

```
RP/0/RP0/CPU0:ios#otdr-start controller ots 0/0/0/0 rx
Tue Feb 28 10:25:43.379 UTC
OTDR Scan cannot be started as it is locked by Another Entity/Application.
RP/0/RP0/CPU0:ios#
```

Step 2   If you want to request a manual OTDR scan operation without negotiating with the peer, add the `force` option.

Example:

```
RP/0/RP0/CPU0:ios#otdr-start controller ots 0/0/0/0 rx force
Wed Sep 4 08:78:34.186 UTC
OTS OTDR Scan Started at RX
RP/0/RP0/CPU0:ios#
```

The forced **otdr-start** command can fail immediately in the following scenarios:

Stop the OTDR scan

Use this task to stop the OTDR scan manually.

Procedure

Use the command **otdr-stop controller ots** *R/S/I/P direction*Stop the OTDR scan manually.

Example:

```
RP/0/RP0/CPU0:ios#otdr-stop controller ots 0/0/0/0 rx
Wed Feb  9 06:03:37.406 UTC
OTS OTDR Scan Stopped at RX
RP/0/RP0/CPU0:ios#
```

Automatic OTDR scan

Table 10: Feature History

Feature Name	Release Information	Feature Description
Automatic OTDR Scan	Cisco IOS XR Release 7.11.1	An OTDR scan is automatically triggered on Rx direction, whenever events such as span fault, span restore, device power cycle, and line card cold reload occur. The automatic scan lets you quickly identify fiber failure type and fault location. Commands added to enable and view OTDR results: **otdr auto-scan [enable | disable]** **show olc otdr-status [details]**

Automatic OTDR scan triggering events

The OTDR scan starts automatically when events like span fault, span restoration, device power cycling, and line card cold reload occur. By default, this feature is disabled, but you can enable it.

Autoscan direction and duration

In Release 7.11.1, autoscan is performed only in the Rx direction, regardless of whether the span fault is unidirectional or bidirectional.

In both span up and span down events, the bidirectional OTDR scan process terminates after both Rx and Tx scans have been completed successfully. You can stop the scan sequence by disabling the autoscan feature.

The OTDR autoscan takes less than three minutes to complete. During the autoscan, the OTDR-SCAN-IN-PROGRESS-RX alarm is raised and gets cleared once the scan is finished.

Autoscan behavior

- The autoscan locks the OTDR resource to avoid manual trigger of scan using the **otdr-start** command. However, if the manual scan is ongoing, the autoscan waits for its completion.

- The autoscan terminates any ongoing scan triggered by another applications such as Raman turn-up.

- During autoscan, if a change in Span Status is detected the ongoing scan will be terminated, and a new autoscan will be triggered.

Span fault and restoration events detection

This table explains how the span fault and span restore events are detected:

Table 11: Definition of span up and span down events

Events	Non-Raman span	Raman span	Raman span with dual safety configured
Span Down	Raise of RX-LOS-P alarm at OSC controller	Raise of RX-LOS-P alarm at DFB controller	Raise of RX-LOS-P alarm at both OSC and DFB controllers
Span Up	Clearing of RX-LOS-P alarm at OSC controller	Clearing of RX-LOS-P alarm at DFB controller	Clearing of RX-LOS-P alarm at both OSC and DFB controllers

Configure automatic OTDR scan

Use this task to enable OTDR scan to run automatically during certain events.

Procedure

Step 1 Enter the OTS controller configuration mode for the port you want to configure the automatic OTDR scan.

Example:

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control controller Ots 0/0/0/0
```

Step 2 Enable automatic OTDR scan.

Example:

```
RP/0/RP0/CPU0:ios(config-olc-ots)#otdr auto-scan enable
```

If you want to disable the automatic OTDR scan, use the **otdr auto-scan disable** command.

Step 3 Commit the changes and exit all the configuration modes.

Example:

```
RP/0/RP0/CPU0:ios(config)#commit
RP/0/RP0/CPU0:ios(config)#exit
```

Verify autoscan status

Use this task to verify the status of the autoscan.

Procedure

View the automatic OTDR scan results using the command **show olc otdr-status [details]**.

Example:

These samples display the status of autoscan triggered due to a span fault. See Examples for automatic OTDR scan results, on page 85 for more examples.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:16:16.461 UTC
Controller                              : Ots0/0/0/0
Auto-scan Start Time                    : NA
OTDR Auto-scan Status                   : RUNNING
Status Detail                           : Starting on Span Down
Optical Span Status                     : Down
Trigger Event                           : Span Fault
Last Trigger Event                      : Span Restore

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:16:33.304 UTC
Controller                              : Ots0/0/0/0
Auto-scan Start Time                    : 2023-09-18 13:16:27
OTDR Auto-scan Status                   : RUNNING
Status Detail                           : Waiting Scan Completion on Span Down
Optical Span Status                     : Down
Trigger Event                           : Span Fault
Last Trigger Event                      : Span Restore

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:18:54.154 UTC
Controller                              : Ots0/0/0/0
Auto-scan Start Time                    : 2023-09-18 13:16:27
OTDR Auto-scan Status                   : COMPLETED
Status Detail                           : Completed on Span Down
Optical Span Status                     : Down
Trigger Event                           : Span Fault
Last Trigger Event                      : Span Fault
```

Examples for automatic OTDR scan results

Here are some of the automatic OTDR scan results for different scenarios.

Non-Raman span

This sample shows the status of automatic OTDR scan in a non-Raman span before enabling it.

```
RP/0/RP0/CPU0:ios#show olc otdr-status
Mon Sep 18 13:10:57.733 UTC
Controller                              : Ots0/0/0/0
Auto-scan Start Time                    : NA
OTDR Auto-scan Status                   : DISABLED
Status Detail                           : NA
Optical Span Status                     : UP
Trigger Event                           : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:11:00.565 UTC
Controller                              : Ots0/0/0/0
Auto-scan Start Time                    : NA
OTDR Auto-scan Status                   : DISABLED
Status Detail                           : NA
Optical Span Status                     : UP
Trigger Event                           : NA
Last Trigger Event                      : NA
```

Raman span

This sample shows the status of automatic OTDR scan in a Raman span before enabling it.

```
RP/0/RP0/CPU0:ios#show olc otdr-status
Mon Sep 18 13:41:05.088 UTC
Controller                                    : Ots0/0/0/0
Auto-scan Start Time                          : NA
OTDR Auto-scan Status                         : DISABLED
Raman Turn Up Fiber Check                     : NA
Status Detail                                 : NA
Optical Span Status                           : UP
Trigger Event                                 : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:41:08.825 UTC
Controller                                    : Ots0/0/0/0
Auto-scan Start Time                          : 2023-09-20 13:58:17
OTDR Auto-scan Status                         : DISABLED
Status Detail                                 : NA
Raman Turn Up Fiber Check                     : NA
Optical Span Status                           : UP
Trigger Event                                 : NA
Last Raman Turn Up Scan Time                  : NA
Last Raman Turn Up Fiber Check                : NA
Last Trigger Event                            : NA
```

Span restore

This sample shows the status of automatic OTDR scan triggered due to span restore.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:12:40.430 UTC
Controller                                    : Ots0/0/0/0
Auto-scan Start Time                          : NA
OTDR Auto-scan Status                         : RUNNING
Status Detail                                 : Starting on Span Up
Optical Span Status                           : Up
Trigger Event                                 : Span Restore
Last Trigger Event                            : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:15:06.153 UTC
Controller                                    : Ots0/0/0/0
Auto-scan Start Time                          : 2023-09-18 13:12:42
OTDR Auto-scan Status                         : RUNNING
Status Detail                                 : Waiting Scan Completion on Span Up
Optical Span Status                           : Up
Trigger Event                                 : Span Restore
Last Trigger Event                            : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:15:06.153 UTC
Controller                                    : Ots0/0/0/0
Auto-scan Start Time                          : 2023-09-18 13:12:42
OTDR Auto-scan Status                         : COMPLETED
Status Detail                                 : Completed on Span Up
Optical Span Status                           : Up
Trigger Event                                 : Span Restore
Last Trigger Event                            : Span Restore
```

Autoscan not able to lock the OTDR resource

This sample displays the status detail of autoscan when autoscan is not able to lock OTDR resource after 30 minutes. The status detail is reported as 'Failed due to Timeout', and the autoscan will not trigger.

```
RP/0/RP0/CPU0:ios# show olc otdr-status details
Wed Sep 20 14:09:37.011 UTC
Controller                             : Ots0/0/0/0
Auto-scan Start Time                   : 2023-09-20 13:58:17
OTDR Auto-scan Status                  : COMPLETED
Status Detail                          : Failed due to Timeout
Raman Turn Up Fiber Check              : NA
Optical Span Status                    : UP
Trigger Event                          : Span Restore
Last Raman Turn Up Scan Time           : NA
Last Raman Turn Up Fiber Check         : NA
Last Trigger Event                     : NA
```

Autoscan is waiting for the OTDR resource

This sample displays the status detail where the autoscan in one port is waiting for the OTDR resource, because the autoscan is running on another port.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 15:57:43.671 UTC
Controller                             : Ots0/0/0/0
Auto-scan Start Time                   : 2023-09-18 15:57:43
OTDR Auto-scan Status                  : COMPLETED
Status Detail                          : Waiting for OTDR Resource
Raman Turn Up Fiber Check              : NA
Optical Span Status                    : UP
Trigger Event                          : Span Restore
Last Raman Turn Up Scan Time           : NA
Last Raman Turn Up Fiber Check         : NA
Last Trigger Event                     : NA
```

Autoscan is enabled and Raman turnup is disabled on a Raman span

This sample explains the status of OTDR autoscan on the Raman span where autoscan is enabled and Raman turnup is disabled. In this case:

- On the span down event, the autoscan is triggered.

- On the span up event, autoscan is not triggered and OTDR Autoscan Status will be IDLE, because Raman pumps are turned on before the start of autoscan.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Sat Sep 23 12:42:11.304 UTC
Controller                             : Ots0/0/0/0
Auto-scan Start Time                   : NA
OTDR Auto-scan Status                  : IDLE
Status Detail                          : NA
Raman Turn Up Fiber Check              : NA
Optical Span Status                    : UP
Trigger Event                          : Span Fault
Last Raman Turn Up Scan Time           : NA
Last Raman Turn Up Fiber Check         : NA
Last Trigger Event                     : Span Restore
```

Ongoing autoscan is stopped by the user

This sample explains the status detail of the autoscan where the ongoing autoscan is stopped by the user.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 15:08:27.370 UTC
Controller                              : Ots0/0/0/0
Auto-scan Start Time                    : 2023-09-18 15:08:09
OTDR Auto-scan Status                   : COMPLETED
Status Detail                           : Stopped by User
Raman Turn Up Fiber Check               : NA
Optical Span Status                     : DOWN
Trigger Event                           : Span Fault
Last Raman Turn Up Scan Time            : 2023-09-18 14:55:40
Last Raman Turn Up Fiber Check          : Success
Last Trigger Event                      : Span Restore
```

See OTDR scan status, on page 89 for a list of the different OTDR scan statuses and their definitions.

Examples for OTDR scan measurement results

Table 12: Feature History

Feature Name	Release Information	Description
Optical Return Loss Reporting	Cisco IOS XR Release 7.11.1	The Optical Return Loss (ORL) is now calculated during the OTDR scan and displayed as part of the OTDR results. You can also set the ORL threshold value.
		The ORL represents the total reflected optical power from a complete fiber link while accounting for fiber attenuation. When the ORL falls below a user-configured threshold value, the OTDR-ABS-ORL-EXCEEDED-TX or OTDR-ABS-ORL-EXCEEDED-RX alarm is raised. You can troubleshoot fiber transmission issues using the ORL value and OTDR results.
		To set the ORL threshold value, these keywords are added to the controller ots command:
		• otdr rx auto excess-orl-threshold *value*
		• otdr tx auto excess-orl-threshold *value*

Optical return loss in OTDR measurement results

From Release 7.11.1, Optical Return Loss (ORL) is measured during the OTDR scan and displayed as part of the OTDR results. The ORL represents the total reflected optical power from a complete fiber link, while considering the attenuation. This includes the natural backscattered power of the fiber and the reflected power coming from optical connectors, fiber splicing, or other discontinuities along the link. ORL is expressed with a positive number. Higher ORL values are desirable for the fiber because they indicate lower back reflection. For example, an ORL of 40 dB is better than 20 dB.

This sample displays the ORL value as part of OTDR status:

```
RP/0/RP0/CPU0:NCS1010#show controllers Ots 0/0/0/2 otdr-info rx
Mon Oct 2 11:55:48.552 UTC
Scan Direction: RX
Scan Status: Data Ready
Optical Return Loss: 39.0 dB
SOR file: /harddisk:/otdr/NCS1010_NCS1010_OTDR_Ots0_0_0_2_RX_20231001-110754.sor
Total Events detected: 8
Scan Timestamp: Sun Oct  1 11:07:54 2023 UTC
Event Type Legend:NR:Non-Reflective R:Reflective FE:Fiber-End ER:Excess-Reflection
EA:Excess-Attenuation
Event# | Detected Event(s) | Location(m) | Accuracy(m) | Magnitude(dB)| Attenuation/km(dB)
1      | NR EA             | 4.4100      | 2.00        | 0.69         | 0.00
2      | NR                | 664.3200    | 2.66        | 0.21         | 0.00
3      | R ER              | 18222.3900  | 20.22       | -33.78       | 0.19
4      | NR                | 18222.3900  | 20.22       | 0.35         | 0.19
5      | R ER              | 68674.4800  | 70.67       | -32.25       | 0.20
6      | NR                | 68674.4800  | 70.67       |  0.36        | 0.20
7      | R FE ER           | 118765.2600 | 120.76      | -28.55       | 0.23
8      | NR FE             | 118765.2600 | 120.76      | 25.86        | 0.23
```

See for a list of the different OTDR scan statuses and their definitions.

OTDR scan status

This table explains the various status of the OTDR measurements that are displayed for the **show olc controller ots R/S/I/P otdr-status** and **show controller ots R/S/I/P otdr-info** commands.

Table 13: OTDR scan status

Scan status	Description
Measuring	OTDR scan is currently in progress.
Data Processing	OTDR scan has completed and the data is ready for review
Data Ready	OTDR scan is stopped by the user, when it is in progress.
Stopped	OTDR is processing data just before populating the event table.

Scan status	Description
Error	The OTDR status may occasionally enter an Error state for various unpredictable reasons. One possible cause is a timeout event, which occurs if the scan is not completed within five minutes. In such cases, no SOR files or event table is generated. It is important to note that this is a rare occurrence. You can still initiate the OTDR scan to obtain the scan results.

This table explains the various OTDR scan statuses that are applicable for manual and autoscan.

Table 14: OTDR scan status applicable for manual and autoscan

Type of OTDR scan	Scan Status	
	show olc controller ots R/S/I/P otdr-status	**show controller ots R/S/I/P otdr-info**
Manual	NA	• Measuring • Data Processing • Data Ready • Stopped • Error
Autoscan	• Measuring • Data Processing • Data Ready • Stopped • Error	• Measuring • Data Processing • Data Ready • Stopped • Error