Raman Tuning

Table 1: Feature History

Feature Name	Release Information	Description
Raman Tuning Manual Mode	Cisco IOS XR Release 7.11.1	You can now configure Raman Tuning in manual mode to not initiate tuning automatically. You can initiate tuning manually. This feature gives you the flexibility to initiate tuning and not have Raman Tuning run every time there is a span-up event in the network.

Raman tuning

Raman tuning is a process that adjusts the power and wavelength of Raman pump lasers to optimize optical signal amplification over a fiber span.

- Controls Raman pump power and wavelength.
- Targets a specific fiber span to achieve the required Raman gain.
- Optimizes end-to-end signal performance.

Purpose of Raman tuning

The primary purpose of Raman tuning is to achieve the desired Raman gain across a fiber span while maintaining optimal signal quality.

Raman tuning follows these operational principles:

- Raman tuning is performed independently in both directions of a fiber span.
- Peer nodes communicate to coordinate tuning and achieve the target gain across the span.

When Raman tuning is configured in automatic mode, the NCS 1010 system initiates the tuning process without manual intervention to maintain optimal signal amplification.

Conditions that trigger automatic Raman tuning

The NCS 1010 automatically initiates Raman tuning under these conditions:

- After the initial link bring-up.
- After a fiber cut is detected and cleared.
- After a device power cycle.
- After a line card cold reload.
- During a Distributed Feedback (DFB) shut or unshut event.
- After an OTS controller is shut or unshut on the near-end or far-end node.
- After a span length configuration change.
- After high back reflection conditions return to acceptable levels.
- During a span loss check at system startup.

Raman tuning parameters

This section describes the parameters used by the Raman tuning algorithm to optimize Raman amplifier performance.

The Raman tuning algorithm uses the following parameters to achieve the target signal amplification across an optical fiber span.

- Target Raman gain defines the required level of signal amplification.
- Raman pump power controls the strength of the Raman amplification.
- DFB VOA attenuation fine-tunes the amplified signal to meet gain requirements.

Table 2: Raman tuning parameters

Parameter	Description	Usage
Target Raman Gain (dB)	It is the desired level of amplification the Raman amplifier aims to achieve. This gain is the increase in optical signal power resulting from Raman scattering when the signal passes through the medium with co-propagating or counter-propagating pump lasers.	The desired Raman gain is typically used for compensating for signal losses in the optical fiber, ensuring signal integrity and strength over long distances.

Parameter	Description	Usage
Raman Pump Powers (mW)	It is the power levels of the Raman pump lasers used in the Raman amplification process. Higher pump power results in a higher gain but also increases the risk of fiber damage.	The power from Raman pumps is used to inject laser at specific wavelengths into the fiber, which then interacts with the signal through the Raman scattering effect to amplify it.
DFB VOA Attenuation (dB)	It is the attenuation settings of the Variable Optical Attenuator (VOA) used with Distributed Feedback (DFB) lasers. DFB lasers provide high-precision, stable-wavelength light emission, commonly used in telecommunications.	DFB VOA attenuation is used to fine-tune the signal power levels to ensure the amplified signal meets the target gain requirements. Adjusting the attenuation helps balance the pump power and signal power.

Raman tuning modes

This section describes the Raman tuning modes available on the NCS 1010 and how each mode affects tuning behavior.

Use Raman tuning modes to control when Raman tuning runs and which parameters are set automatically.

- Automatic mode starts Raman tuning based on system events and sets key parameters automatically.
- Manual and disable modes provide more operator control over when tuning starts and how parameters are set.

Table 3: Raman tuning modes

Raman tuning modes	Description
Enable (Automatic mode)	In this mode, the system automatically initiates Raman tuning when a link goes down and comes back up. Raman tuning calculates and sets the values of the following parameters automatically: • Raman target gain • Raman power • DFB VOA attenuation However, this mode also allows you to manually set the target gain, which triggers Raman tuning to adjust pump powers and DFB VOA attenuation values to achieve the target gain. For more details about the conditions that trigger Raman tuning automatically, see Raman tuning initiation conditions, on page 4.

Raman tuning modes	Description
Disable	In this mode, you must manually set the values Raman tuning parameters. After configuring these values, you must manually initiate Raman tuning. It may be necessary to manually configure these parameters to troubleshoot network issues or fine-tune the system for improved performance.
Manual	In this mode, Raman tuning must be manually initiated when a link goes down and comes back up. Once initiated, the system automatically calculates the desired gain and adjusts both pump powers and DFB VOA attenuation to achieve the specified target gain.

Raman tuning initiation conditions

This section describes the conditions under which the NCS 1010 automatically initiates Raman tuning.

When Raman tuning is configured in automatic mode, the system initiates tuning after the following events:

- An initial link bring-up.
- A fiber cut and subsequent recovery.
- A device power cycle.
- A line card cold reload.
- A Distributed Feedback (DFB) shut or unshut event.
- An OTS controller shut or unshut event on either the near-end or far-end node.
- A change in the span length configuration.
- Clearance of high back reflection conditions.
- A span loss check during system startup.

Raman tuning status

This section describes the possible Raman tuning status values and what each status indicates during the tuning process.

The Raman tuning status reflects whether the system is actively tuning, has completed tuning, or cannot perform tuning.

- Working states indicate active measurement, calculation, or optimization.
- Non-working states indicate completion, blockage, or disabled tuning.

Table 4: Raman tuning status

Raman tuning status	Description
WORKING—MEASUREMENT	Raman tuning is measuring the span loss on the link.
WORKING—CALCULATION	Raman tuning is calculating the gain target and required pump powers.
WORKING—OPTIMIZATION	Raman tuning is optimizing the pump powers.
TUNED	Raman tuning is complete.
BLOCKED	The system cannot perform Raman tuning because the link is down or there is a high Raman back reflection.
DISABLED	Raman tuning is disabled.

Configure Raman tuning

Use these tasks to configure Raman tuning based on your operational requirements.

- Configure Raman tuning mode, on page 5: Configure Raman tuning to run automatically or require manual initiation.
- Configure Raman tuning parameters manually, on page 6: Disable Raman tuning and manually configure Raman tuning parameters.

Configure Raman tuning mode

Configure the Raman tuning mode to control how and when Raman tuning runs on the optical span. Use automatic mode to:

- allow the system to trigger Raman tuning automatically.
- start Raman tuning only when you explicitly initiate it.

Raman tuning optimizes signal amplification on an optical span. You can configure the tuning process to run automatically based on system events or manually based on operational requirements.

Before you begin

- Ensure that you have access to the device CLI with configuration privileges.
- The optical controller must be available and operational.

Follow these steps to configure Raman tuning mode.

Procedure

Step 1 Enter optical line control configuration mode and select the OTS controller.

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 Enable Raman tuning in automatic or manual mode.

Use the following command to configure the tuning mode:

raman-tuning {enable | manual}

Step 3 Commit the configuration and exit configuration mode.

Example:

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

Step 4 Start Raman tuning if the controller is configured in manual mode.

Example:

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

Raman tuning is configured in the selected mode.

When automatic mode is enabled, the system triggers Raman tuning automatically. After successful tuning, events such as soft reloads, Route Processor reloads, OSRI configuration changes, or forced Automatic Power Reduction (APR) changes do not retrigger Raman tuning.

What to do next

Verify Raman tuning status to confirm successful configuration and monitor system logs or controller status for tuning completion.

Configure Raman tuning parameters manually

Manually configure Raman tuning parameters to troubleshoot network issues or fine-tune system performance.

- Disable automatic Raman tuning.
- Set Raman gain, pump power, and DFB VOA attenuation values.

When Raman tuning is disabled, the system does not automatically calculate or adjust tuning parameters. You must manually configure the required values before initiating Raman tuning.

Use this task when you need full control over Raman tuning behavior. Common use cases include troubleshooting and performance optimization.

Before you begin

The OTS controller must be available and operational.

Follow these steps to manually configure Raman tuning parameters.

Procedure

Step 1 Enter optical line control configuration mode and select the OTS controller.

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 Disable Raman tuning.

Disabling Raman tuning allows you to manually configure tuning parameters.

Example:

```
RP/0/RP0/CPU0:ios(config-olc-ots)# raman-tuning disable
```

Step 3 Configure the Raman tuning parameters.

Set the target gain, pump power, and DFB VOA attenuation values.

Example:

```
RP/0/RP0/CPU0:ios(config-olc-ots)# raman-tuning raman-gain-target 180
RP/0/RP0/CPU0:ios(config-olc-ots)# raman-tx-power 1 value 21100
RP/0/RP0/CPU0:ios(config-olc)# controller DFB 0/0/0/0
RP/0/RP0/CPU0:ios(config-Dfb)# tx-voa-attenuation 100
```

Step 4 Commit the configuration and exit configuration mode.

Example:

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

Step 5 Start Raman tuning manually.

This step is required when Raman tuning is disabled or configured in manual mode.

Example:

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

Raman tuning runs using the manually configured parameters.

What to do next

- Verify the Raman tuning status to confirm successful tuning.
- Check the controller status for a **TUNED** state.

Verify Raman tuning configuration and status

Use the following tasks to verify Raman tuning configuration, review tuning history, and inspect Raman pump values.

- Verify Raman tuning configuration, on page 8: Verify the current Raman tuning status and parameter values.
- View detailed Raman tuning status, on page 9: View detailed Raman tuning status, including failure reasons and historical timestamps.
- View Raman pump values, on page 10: View individual Raman pump values and related safety and configuration parameters.

Verify Raman tuning configuration

Use this task to verify Raman tuning configuration to confirm the current tuning state and the configured gain-related values.

- Check whether Raman tuning is measuring, calculating, optimizing, tuned, blocked, or disabled.
- View the Raman tuning parameter values reported by the controller.

Raman tuning status indicates the current state of the Raman tuning process. The output also displays key parameter values, such as target gain and achieved gain, and shows conditions that can prevent tuning.

Follow these steps to verify Raman tuning configuration.

Procedure

Verify Raman tuning status and parameter values.

The entries highlighted in bold show the Raman tuning status and Raman tuning parameter values.

Example:

```
/*Verify Raman tuning status if All Controllers*/
RP/0/RP0/CPU0:ios#show 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

/*Verify Raman tuning status on a specific controller*/
RP/0/RP0/CPU0:ios#show 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
```

For more information about Raman tuning status, see Raman tuning status, on page 4. For information about Raman tuning parameters, see Raman tuning parameters, on page 2.

The system displays the Raman tuning status and the Raman tuning parameter values for all controllers or for the specified controller.

What to do next

If tuning is blocked or disabled, correct the condition and re-run the verification command.

View detailed Raman tuning status

View detailed Raman tuning status information to understand the outcome of previous tuning attempts.

- Identify the reason and timestamp of the last Raman tuning failure.
- Review the last successful Raman tuning gain and timestamp.

In addition to the current Raman tuning state, the system maintains historical information about previous tuning attempts. This information helps troubleshoot tuning failures and verify successful tuning history.

Follow these steps to view detailed Raman tuning status.

Procedure

View the detailed Raman tuning status.

The entries highlighted in bold show the previous Raman tuning failure reason and timestamps.

Example:

```
/*View detailed Raman tuning status for all controllers*/
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


/*View detailed Raman tuning status for a specific controller*/
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:Last Successful Tuning Gain : 15.7 dB
Last Successful Tuning Timestamp : 2023-03-20 07:54:00
```

The system displays detailed Raman tuning status, including failure reasons, timestamps, and successful tuning history.

View Raman pump values

View individual Raman pump values and related parameter details to verify current pump power, configured pump values, and safety controls.

- Confirm composite Raman power and individual pump measured powers.
- Verify Raman safety control mode, OSRI status, and APR state.
- Compare configured pump values with measured values reported by the controller.

Raman pump values and parameter statistics help you assess amplifier health and safety conditions. The controller reports alarm statistics, measured pump powers, composite power, and the configured pump values. Use this task when troubleshooting Raman-related alarms, validating pump configuration, or confirming safety lock and OSRI status.

Follow these steps to view individual Raman pump values and related parameter details.

Procedure

Show Raman pump values and parameter details for the OTS controller.

The entries highlighted in bold show the Raman safety/OSRI status, composite power, and the measured pump powers. The configured pump values are shown in the Configured Parameters section.

Example:

```
/*View Raman pump values and other parameter details*/
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 command displays alarm statistics, parameter statistics (including safety and OSRI state), measured individual pump powers, and configured pump values.

Raman tuning with OTDR lock and OSRI

Raman tuning with OTDR lock and OSRI is a coordinated operating mechanism that prevents interference between Raman tuning and OTDR scanning while maintaining optical safety during tuning.

- Prevents OTDR scans and Raman tuning from running concurrently on the same fiber.

- Coordinates OTDR lock acquisition between peer nodes.
- Uses OSRI to protect personnel from high-power laser exposure.

Table 5: 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.

Concurrent operation of OTDR and Raman tuning

OTDR lock prevents OTDR scanning and Raman tuning from running concurrently on a single fiber. This avoids interference from Raman pump lasers that could introduce noise and reduce OTDR measurement accuracy.

Before Raman tuning begins, the system acquires OTDR lock at both ends of the fiber span. The lock is released after tuning completes. If Raman tuning is active, the system rejects any request to start an OTDR scan.

When an OTDR scan is already in progress:

- Raman tuning lock requests are rejected, and the system retries every minute.
- Raman tuning starts only after OTDR lock is acquired at both ends of the fiber.
- The system acquires OTDR lock at both ends of the fiber span, performs Raman tuning, and releases the lock after tuning completes.
- If an OTDR scan request occurs while Raman tuning is active, the system rejects the request to prevent interference.

For more information, see Optical Time Domain Reflectometer.

Raman tuning with OSRI

Raman tuning uses the Optical Safety Remote Interlock (OSRI) feature to safely disable the amplifier on the peer node during tuning. This reduces the risk of accidental exposure to high-power laser light.

Note While Raman tuning is in progress and traffic is blocked, only the OSC remains active.

At the transmit end of the span, the system combines a dedicated Raman probe laser—typically a Distributed Feedback (DFB) laser operating at a defined frequency such as 191.1 THz—with the outgoing optical channels. This probe laser provides a continuity check to support optical safety.

At the receive end, the system injects multiple wavelengths in the 1424 nm to 1495 nm range opposite to signal propagation. These wavelengths provide Raman amplification for both C-band and L-band channels.