

Optical Time Domain Reflectometer

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Fiber link monitoring and diagnostics using OTDR

An Optical Time Domain Reflectometer (OTDR) is a fiber optic measurement device that

- captures real-time data on loss and back reflection across fiber links,
- performs bidirectional analysis by connecting to both transmitter (TX) and receiver (RX) ports, and
- enables assessment and ongoing monitoring of fiber quality and performance.

The NCS 1010 OLT and ILA nodes feature in-built bidirectional OTDR functionality, allowing them to measure loss and back reflection in real time for fiber pairs linked to the TX and RX ports. 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 OTDR measurement results in a Standard OTDR Record (SOR) file. The SOR file includes fiber trace details such as 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

The OTDR offers several key benefits, including:

- Assess the quality of the fiber during system installation, before any live traffic run.
- Monitor the fiber link during operation, including live traffic. You can also monitor the fiber link during troubleshooting after cable cuts or repairs.
- Measure attenuation over the entire fiber link and across individual fiber sections.

- Determine the distance and magnitude of insertion loss and reflection loss.
- Detect fiber events, including concentrated loss events, reflection events, end-of-fiber events, and discontinuities or defects such as pinches or cuts. The OTDR pluggable can also detect loss events from splicing, patch panel connections, and couplers.

OTDR modes

OTDR modes are operational configurations that

- determine how scan parameters (like pulse width and scan duration) are selected and applied,
- optimize measurements for different user needs or fiber types, and
- support both automated and manual control for various operational scenarios.

An OTDR can operate in several modes to suit different network testing requirements. Selecting the appropriate mode helps ensure efficient, accurate fiber characterization by adapting OTDR performance to the specific task or fiber segment.

These modes are designed to address different testing needs and operational preferences:

1. 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.
2. 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 procedure to configure the parameters for the OTDR scan. If you do not configure the parameters, the NCS 1010 device uses the default values.

Procedure

Step 1 Enter the OTS controller configuration mode for the port where 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 this command
Expert mode	`RP/0/RP0/CPU0:ios(config-Ots)#otdr scan-mode expert`
Auto mode	Auto mode is the default and you do not need to configure it

Step 3 Set the required parameters for the OTDR scan. For a complete list of OTDR parameters, refer to OTDR scan parameters, on page 3.

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
```

What to do next

Start the OTDR scan manually, on page 4.

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 1: 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 2: 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 the expert scan in the Rx or Tx direction	cm	0–10000000	0
otdr {rx | tx} expert scan duration<*value*>	OTDR scan duration during the expert scan in the Rx or Tx direction.	Seconds	30–180	60

Start the OTDR scan manually

Manually initiate the OTDR scan to diagnose fiber defects, check fiber quality, or verify proper 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

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#
```

This 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#
```

The OTDR scan initiates and begins analyzing the fiber. If the scan cannot start, an error message states the reason.

What to do next

Review scan results to identify defects and assess fiber quality.

View the OTDR measurements

Use this procedure to view the OTDR scan measurement results.

Table 3: 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*

From Release 7.11.1, Optical Return Loss (ORL) is measured during the OTDR scan and displayed as part of the OTDR results. ORL represents the total reflected optical power from a complete fiber link, while considering the attenuation.

This measurement 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.



Note 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.

Procedure

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

Example:

```
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 you upgrade the FPD of the line card, you may not be able to view the previous OTDR scan results using the **show controllers ots** *Rack/Slot/Instance/Port* otdr-info *direction*. To access results from earlier OTDR scans, locate the .SOR files on the hard disk.

You can dynamically raise or clear Excessive Reflection (ER) and Excess Attenuation (EA) events and alarms by modifying their respective threshold values. In contrast, to raise or clear Fiber End (FE) and Reflectance (R) events, change the relevant thresholds and rerun the OTDR scan.

See OTDR scan measurement results, on page 7 for various examples.

OTDR scan measurement results

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

```
RP/0/RP0/CPU0:ios#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/ios_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
```

Stop the OTDR scan manually

Use this procedure to stop the OTDR scan manually.

Procedure

Enter the command **otdr-stop controller ots** *R/S/I/P direction* to stop the OTDR scan.

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 scans

An automatic OTDR scan is a fiber diagnostics feature that

- automatically triggers OTDR tests in response to specific events such as span fault, span restoration, device power cycling, and line card cold reload that affect the optical span,
- enables RX directionscanning for comprehensive fault detection and prevents scan collisions, and
- provides rapid fault localization by monitoring and raising relevant alarms during scan execution.

Table 4: 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]`

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

Autoscan manages OTDR scanning by coordinating access to scanning resources and responding to interactions with manual and application-triggered scans:

Autoscan manages OTDR scanning operations in these ways:

- Autoscan locks the OTDR resource to prevent manual scan triggers using the **otdr-start** command. However, if a manual scan is already in progress, autoscan waits for its completion before proceeding.
- Autoscan terminates any ongoing scan that was triggered by other applications, such as Raman turn-up.
- During autoscan, if a change in Span Status is detected, it terminates the ongoing scan and automatically initiates a new autoscan.

Criteria for span fault and restoration events

This table lists the detection criteria for span fault and restoration events.

Table 5: 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 OTS controller configuration mode for the port on which you want to enable 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
RP/0/RP0/CPU0:ios(config)#commit
RP/0/RP0/CPU0:ios(config)#exit
```

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

Automatic OTDR scans are enabled for the selected port. The system will now run OTDR scans automatically during applicable events, allowing you to proactively monitor fiber links and detect faults without manual intervention.

Verify autoscan status

Use this procedure to verify the status of the autoscan.

Procedure

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

Example:

This sample display the status of autoscan triggered due to a span fault. See Automatic OTDR scan results, on page 11 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
```

What to do next

If events indicate potential fiber issues, review the SOR file or perform additional analysis as needed.

Automatic OTDR scan results

This table presents automatic OTDR scan results observed across different network scenarios.

Table 6: Automatic scan results

Network scenarios	Sample OTDR scan results
Non-Raman span	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	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

Network scenarios	Sample OTDR scan results
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 is unable to lock the OTDR resource	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

Network scenarios	Sample OTDR scan results
Autoscan on 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 In this case • On the span down event, the autoscan is triggered. • On the span up event, autoscan is triggered and *OTDR Autoscan Status* is displayed as RUNNING.	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	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 13 for a list of the different OTDR scan statuses and their definitions.

OTDR scan status

This section describes and explains the various OTDR statuses that appear when using the **show olc controller ots R/S/I/P otdr-status** and **show controller ots R/S/I/P otdr-info** commands.

Table 7: 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.
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 8: 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