Proactive Network Management

This document describes how to configure the Proactive Network Management on the Cisco cBR Series Converged Broadband Router.

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note   The hardware components that are introduced in a given Cisco IOS-XE release are supported in all subsequent releases unless otherwise specified.

Table 1: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 3.15.0S and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G[1] • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 3.15.0S and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-80G-R

[1] Effective with Cisco IOS-XE Release 3.17.0S, CBR-CCAP-SUP-60G supports 8 cable line cards. The total traffic rate is limited to 60 Gbps. The total number of downstream service flows is limited to 72268, and downstream unicast low-latency flow does not count against the limits.

Information about Proactive Network Management

Proactive Network Management (PNM) enables you to measure and report conditions in the network. The PNM detects, identifies, and quantifies undesired impacts to the network, such as cable faults and ingress noise. The DOCSIS 3.1 PHY specification defines the different types of tests and measurements that can be performed at CCAP and CM. You can leverage this information to make the necessary modifications that can improve conditions and monitor networking trends to detect when network improvements are needed.

The PNM tests and receives data output from the CMTS using the Simple Network Management Protocol (SNMP) objects. The PNM feature is supported on RPHY.

Proactive Network Management for Supervisor High Availability, Line Card High Availability and containers

PNM Supervisor High Availability support ensures that all captures are stopped and all the captures states in the Line Card and Supervisor client are cleaned up when Supervisor High Availability happens. You can create new capture configurations and initiate tests on the newly active supervisor through SNMP.

cBR supports Line Card High Availability and Line Card Process Restart for Proactive Network Management, and will support the restart of any test in progress.

Active syncing of capture data between active and standby SUP is not supported for Proactive Network Management. After switchover, all new captures must be configured by the user/client again.

Bulk Data Transfer MIBs enables configuration of the following paramters for PNM:

- TFTP server bulk data transfer IP address

- TFTP server bulk data transfer path

Proactive Network Management Using Upstream Triggered Spectrum Capture

Cisco cBR-8 supports Upstream Triggered Spectrum Capture (UTSC). The upstream triggered spectrum analysis measurement provides a wideband spectrum analyzer in the CCAP which can be triggered to examine upstream transmissions and underlying noise or interference during a quiet period.

The Cisco cBR-8 supports the following Upstream Triggered Spectrum Capture objects:

- `UsTriggeredSpectrumCaptureFile`

- `UsTriggeredSpectrumCaptureCfg`

- `UsTriggeredSpectrumCaptureCtrl`

- `UsTriggeredSpectrumCaptureStatus`

- `UsTriggeredSpectrumCaptureCapabilities`

- `CCAPBulkDataControl`

The Cisco cBR-8 router enables you to trigger a spectrum sample capture and perform spectrum-analysis using the FreeRun mode. FreeRun mode is a continuous-mode with a maximum of 10 samples per second stacked on each capture file).

The CCAP supports one client configuration per port on a line card. Create a capture configuration entry before attempting to start or stop the capture tests. The interface index key for the `UsTriggeredSpectrumCaptureCfg` object defines the one capture configuration for the FreeRun trigger mode.

The Cisco cBR-8 supports only one capture per end-user client per port simultaneously. Hence, the CCAP sets the Upstream Triggered Spectrum Capture configuration index to 1. The Cisco cBR-8 does not support a PNM MIB query for an Upstream Triggered Spectrum Capture configuration index other than 1. The Cisco cBR-8 supports a maximum of eight captures on upstream ports per line card. The Cisco cBR-8 supports a maximum of 20 captures per router for RPHY.

The Cisco cBR-8 does not support the following scenarios:

- `UsTriggeredSpectrumCaptureResult` MIB

- Simultaneous captures on adjacent ports on CLC

- RPD support captures only one us-port per RPD at a given time.

- `docsPnmCmtsUtscCfgFilename` OID

Note The UsTriggeredSpectrumCaptureConfiguration MIB is supported. The `docsPnmCmtsUtscCfgFilename` OID under this MIB is not supported only for UTSC capture mode for PNM.

The PNM IOX container is used for the TFTP transfer of capture files to a user configured destination server. The **guestshell** IOX container for TFTP transfer of PNM files is supported. The PNM executable is built into the guestshell that is packaged as part of cbr8 image. This executable must be installed on both active and standby SUP manually.

Step 1 Ensure that the guestshell container is running before the captures are started to ensure successful TFTP operation. Use the **show app-hosting list** command to check if the guestshell container is running.

Example:

```
Router# show app-hosting list
App id                          Stat
----------------------------------------------------
guestshell                      RUNNING
```

Step 2 The app-hosting CLI is used to install, deploy, start, and stop the IOX container.

Example:

```
Router# show run | begin app-hosting
app-hosting appid guestshell
app-vnic gateway0 virtualportgroup 4 guest-interface 0
guest-ipaddress 9.32.254.2 netmask 255.255.255.0
app-default-gateway 9.32.254.1 guest-interface
```

Step 3 Ensure that the python is running on the guestshell container.

Example:

```
cBR8#guestshell run python -V
Python 2.7.5
```

Step 4   Ensure that the PNM TFTP process is active and running on the guestshell container.

Example:

```
cBR8#guestshell run systemctl status pnm
 pnm.service - cbr pnm telemetry delivery system
    Loaded: loaded (/etc/systemd/system/pnm.service; disabled; vendor preset: disabled)
    Active: active (running) since Wed 2019-01-09 15:13:40 UTC; 9min ago
```

The PNM capture tests generate files to report measurements or test results. The results file includes header information that is common to all types of PNM tests and fields. The file also includes data that is specific to the type of PNM test. The abstract `PnmCaptureFile` object defines the attributes and format of the header information common to all PNM test files. File header fields are right-justified within the field and left-padded with zero values if necessary.

The following fields define the header for the `PnmCaptureFile` object for Upstream Spectrum Triggered Capture tests.

- FileType - A four-byte hexadecimal identifier specific to the type of PNM test that generated the data file.

  For Upstream Triggered Spectrum Capture, the file type is 0x504e4e6a.

- Major Version - This attribute represents the file header version. This value is incremented by one when the header format is modified by this specification.

  For Upstream Triggered Spectrum Capture, major version is 0x1.

- Minor Version - This attribute is reserved for vendor-specific and vendor-defined version information.

  For Upstream Triggered Spectrum Capture, minor version is 0x0.

- CaptureTime - This attribute represents the epoch time (also known as 'UNIX time') which is the number of seconds that have elapsed since midnight Coordinated Universal Time (UTC), Thursday, 1 January 1970.

- IfIndex - This attribute represents the ifIndex of the upstream RF port sampled.

- UniqueCcapId - A 256-byte hexadecimal field representing a unique CCAP identifier (either a loopback address (IPv4 or IPv6) or FQDN). This value is a null-terminated string.

  For Upstream Triggered Spectrum Capture, this value is the 'hostname' of the CMTS.

Proactive Network Management Interface Index

To determine which slot/subslot/port of an ifindex translates to that of RPHY, see the mapping in the running configuration.

Before you begin

The Upstream Triggered Spectrum Capture – The Cisco cBR-8 router supports multiple RPDs per line card with multiple US-ports. However, on RPDs, you can configure only one US-port and initiate the captures anytime.

For RPHY, it is not mandatory that the US port is bound to a MAC domain. If it is configured under an RPD, it can be configured for PNM.

The SNMP ifindex for MIB objects can be obtained using the show CLI:

```
Router# show snmp mib ifmib ifindex | i  0053.0013.2be0
RPD(0053.0013.2be0)-usport0: Ifindex = 435564
```

where `0053.0013.2be0` is the RPD identifier.

Step 1   Run the following show command to identify the SNMP ifindex value:

```
Router# show snmp mib ifmib ifindex | i 435564
RPD(0053.0013.2be0)-usport0: Ifindex = 435564
```

Step 2   Run the following command to identify the slot/subslot/port an ifindex that translates to RPHY:

```
Router# show run | b 0053.0013.2be0
identifier 0053.0013.2be
core-interface Te1/1/0
principal
rpd-ds 0 downstream-cable 1/0/2 profile 2
rpd-us 0 upstream-cable 1/0/2 profile 21
```

The slot/subslot/port is upstream-cable 1/0/2 profile 21.

✎

Note   Cisco IOS XE Gibraltar 16.10.1g introduces an RPHY ifIndex change. Ensure that you have gone through the following updates to enable the changes:

- The RPHY ifIndex feature removes the Cisco private ifIndex for PRHY channels (ifIndex starting from 41,000). The ifIndex are not created manually. All the ifIndex are created automatically when configuring RPD. It is applicable for ifIndex starting from 41w for US (if-type 205) and DS (if-type 128). The RPHY ifIndex feature does not work for ifIndex values that are greater than 41w.

  Before the ifIndex feature, in 16.10.1f and earlier releases:

  ```
  Router# show snmp mib ifmib ifindex | i RPD
  Upstream-Cable3/0/63:0-RPD(0053.0013.420c)-usport0: Ifindex = 421224
  ......
  RPD(0053.0013.420c)-usport0: Ifindex = 435560
  RPD(0053.0013.420c)-dsport0: Ifindex = 436584
  Downstream-Cable3/0/31:0-RPD(0053.0013.420c)-dsport0: Ifindex = 437608
  Downstream-Cable3/0/31:1-RPD(0053.0013.420c)-dsport0: Ifindex = 437609
  ```

  With the ifIndex feature, in 16.10.1g:

  ```
  Router# show snmp mib ifmib ifindex | s RPD
  RPD(0053.0013.420c)-usport0: Ifindex = 415080
  RPD(0053.0013.420c)-dsport0: Ifindex = 416104
  ```

- The RPHY ifIndex reimplement CoreToRpdMap/RpdToCoreMap tables to keep them aligned with DOCS-RPHY-MIB-2018-07-26 definition.

You do not need to create a new ifIndex for US (if-type 205) and DS (if-type 128) channels when they are configured to RPD. For versions before Cisco IOS XE Gibraltar 16.10.1g, it was required to create a new ifIndex (>41k) for US (if-type 205) and DS (if-type 128) channels when they are configured to RPD:

```
[CBR]#show snmp mib ifmib ifindex | s RPD
RPD(0053.0013.420c)-usport0: Ifindex = 415080
RPD(0053.0013.420c)-dsport0: Ifindex = 416104
```

With the Cisco cBR-8 16.10.1g RPHY ifIndex feature, you do not need to manually populate any extra item in legacy MIBs.

With the Cisco cBR-8 16.10.1g RPHY ifIndex feature, you must reimplement `docsRphyRpdIfCoreToRpdMapTable` / `docsRphyRpdIfRpdToCoreMapTable`, not mapping to ifIndex (>41k) for US (if-type 205) and DS (if-type 128). See the following:

```
/* docsRphyRpdIfCoreToRpdMapRpdRfChanType OID :1.3.6.1.4.1.4491.2.1.30.1.2.6.1.5
  Table Index: docsRphyRpdIfCoreToRpdMapRpdCoreIndex, docsRphyRpdIfCoreToRpdMapRpdUniqueId,
 docsRphyRpdIfCoreToRpdMapRpdRfPortDirection, docsRphyRpdIfCoreToRpdMapRpdRfPortIndex*/
SNMPv2-SMI::enterprises.4491.2.1.30.1.2.6.1.5.403561.0.4.159.51.0.145.2.0 = INTEGER:
usAtdma(5)
SNMPv2-SMI::enterprises.4491.2.1.30.1.2.6.1.5.322358.0.4.159.51.0.145.1.0 = INTEGER:
dsScQam(1)
IF-MIB::ifType.403561 = INTEGER: docsCableUpstream(129)
IF-MIB::ifType.322358 = INTEGER: other(1)

[CBR]#show snmp mib ifmib ifindex
Cable9/0/0-upstream1: Ifindex = 403561
Downstream-Cable9/0/4-downstream14: Ifindex = 322358
```

- If **RfChanType is usAtdma(5), ifType of docsRphyRpdIfCoreToRpdMapRpdCoreIndex is ifType docsCableUpstream(129)**

- If **RfChanType is dsScQam(1), ifType of docsRphyRpdIfCoreToRpdMapRpdCoreIndex is other(1).**

Upstream Triggered Spectrum Capture Configuration Parameters

The following configuration parameters for Upstream Triggered Spectrum Capture are supported. Examples of using the MIBs are also included.

Note   PNM capture configuration on cBR8 is supported only through SNMP user interface. Configuration examples for MIB commands for PNM are provided in the following sections with examples using both snmpr (setany/getone commands) as well as net-snmp tools (snmpset/snmpget commands).

Upstream Triggered Spectrum Capture Configuration Objects

The following Upstream Triggered Spectrum Capture configuration objects are supported:

- PNM UTSC OBJECTS OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10

- PNM UTSC CAPTURE CONFIGURATION OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.X.Y.Z

  Where X is the capture config parameter, Y is Ifindex, and Z is the PNM UTSC Config Index – Which is always 1. Currently only one capture configuration per upstream port is supported.

- The following capture configuration parameters are supported, and the corresponding MIB OID value is listed.

Table 2: Supported capture configuration parameters and the corresponding MIB OID value

Capture configuration parameters	Corresponding MIB OID value
I_docsPnmCmtsUtscCfgTriggerMode	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3
I_docsPnmCmtsUtscCfgCmMacAddr	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.6
I_docsPnmCmtsUtscCfgCenterFreq	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8
I_docsPnmCmtsUtscCfgSpan	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9
I_docsPnmCmtsUtscCfgNumBins	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10
I_docsPnmCmtsUtscCfgAveraging	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.11
I_docsPnmCmtsUtscCfgQualifyCenterFreq	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.13
I_docsPnmCmtsUtscCfgQualifyBw	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.14
I_docsPnmCmtsUtscCfgQualifyThrshld	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15
I_docsPnmCmtsUtscCfgWindow	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16
I_docsPnmCmtsUtscCfgOutputFormat	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17
I_docsPnmCmtsUtscCfgRepeatPeriod	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18
I_docsPnmCmtsUtscCfgFreeRunDuration	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19
I_docsPnmCmtsUtscCfgTriggerCount	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20

Capture configuration parameters	Corresponding MIB OID value
I_docsPnmCmtsUtscCfgStatus	1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21

Starting from Cisco IOS XE Gibraltar 16.12.1x release, PNM output format 'timeIQ' and UTSC trigger mode 'cmMac' are supported in upstream triggered spectrum capture configuration objects.

Below is an example of the SNMP command configuration with PNM output format 'timeIQ' and UTSC trigger mode 'cmMac'.

```
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0 x "0B 01 01 0C"
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0 s "path"

snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.415084.1 i 6
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.415084.1 i 4
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.2.415084.1 i ifindex
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3.415084.1 i 6
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.6.415084.1 x "CM
MAC"
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.415084.1 u 16400000
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9.415084.1 u 6400000
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10.415084.1 u 1024
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.11.415084.1 u 245
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.13.415084.1 u 10240000
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.14.415084.1 u 25600000
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15.415084.1 i -200
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.415084.1 i 3
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.415084.1 i 1
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18.415084.1 u 25000
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19.415084.1 u 5000
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20.415084.1 u 500
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.415084.1 i 1
snmpset -v2c -c private 10.74.54.13 1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.415084.1 i 1
```

Upstream Triggered Spectrum Capture Configuration MIB Objects

The following Upstream Triggered Spectrum Capture configuration MIB objects are supported for PNM:

- `CaptureCfg` – Contains the test trigger mode and its required configuration.

- `CaptureCtrl` – Controls when the test is started and stopped.

- `CaptureStatus` – Contains the current status of the test.

- `CaptureCapability` – Exposes CCAP Upstream Triggered Spectrum Capture capabilities.

The following Upstream Triggered Spectrum Capture configuration MIBs are supported. SNMP walk is supported for all the MIB objects.

- `docsPnmCmtsUtscCfgTriggerMode` - This attribute indicates which upstream triggered spectrum capture function trigger modes are supported. Only FreeRun is supported. The following are the enumerated values for trigger mode for PNM.

    - `D_docsPnmCmtsUsSpecAnTrigMode_other 1`

    - `D_docsPnmCmtsUsSpecAnTrigMode_freeRunning 2`

    - `D_docsPnmCmtsUsSpecAnTrigMode_miniSlotCount 3`

    - `D_docsPnmCmtsUsSpecAnTrigMode_sid 4`

- D_docsPnmCmtsUsSpecAnTrigMode_idleSid 5

- D_docsPnmCmtsUsSpecAnTrigMode_minislotNumber 6

- D_docsPnmCmtsUsSpecAnTrigMode_cmMac 7

- D_docsPnmCmtsUsSpecAnTrigMode_quietProbeSymbol 8

- For FreeRun mode, the CCAP initiates sampling and continues sampling until the time duration configured in the attribute FreeRunDuration has transpired. Sampling terminates when the time duration configured in FreeRunDuration has elapsed or when FFT is disabled. The interval between captures is the greater of RepeatPeriod and the minimum period that is supported by the CCAP.

- From Cisco IOS XE Gibraltar 16.12.1x release, PNM output format 'timeIQ' and UTSC trigger mode 'cmMac' are supported in upstream triggered spectrum capture configuration objects.

- Trigger mode set and get examples:

  - **snmpr** commands:

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3.<ifIndex>.1 -i 2
      clabProjDocsis.27.1.3.10.2.1.3.<ifIndex>.1 = 2
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3.<ifIndex>.1
      clabProjDocsis.<ifIndex> = 2
      ```

  - **net-snmp** commands:

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3.<ifIndex>.1 i 2
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.3.<ifIndex>.1 = INTEGER: 2
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.3.<ifIndex>.1 = INTEGER: 2
      ```

- docsPnmCmtsUtscCfgCenterFreq - This attribute specifies the center frequency of the upstream spectrum to be sampled for analysis.

  - **snmpr** commands:

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1 -g 102400000
      clabProjDocsis.27.1.3.10.2.1.8.<ifIndex> = 102400000
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.8.<ifIndex>.1 = 102400000
      ```

  - **net-snmp** commands:

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1 u 102400000
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1 = Gauge32: 102400000
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1 = Gauge32: 102400000
      ```

- `docsPnmCmtsUtscCfgSpan` - This attribute determines the frequency span of the upstream spectrum sample capture. When this attribute is read, it provides the actual span, which may be different from the requested (configured) span due to implementation effects.

  - **snmpr** commands:

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1 -g 204800000
      clabProjDocsis.27.1.3.10.2.1.9.<ifIndex>.1 = 204800000
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.9.<ifIndex>.1 = 204800000
      ```

  - **net-snmp** commands:

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1 u 204800000
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1 = Gauge32: 204800000
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1 = Gauge32: 204800000
      ```

Note The center frequency and span capture parameters are set to zero as per OSSI specifications on capture configuration entry creation. For freerun trigger mode, you must set these values in the valid range to run capture tests on the port.

- `docsPnmCmtsUtscCfgNumBins` - This attribute determines the number of frequency bins or samples per span when sampling the upstream spectrum. This attribute provides the actual number of bins, which may be different from the configured number due to implementation effects.

  - **snmpr** commands

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1 -g 4096
      clabProjDocsis.27.1.3.10.2.1.10.<ifIndex>.1 = 4096
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.10.<ifIndex>.1 = 4096
      ```

  - net-snmp commands

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1 u 4096
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1 = Gauge32: 4096
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1 = Gauge32: 4096
      ```

- `docsPnmCmtsUtscCfgAveraging` - This attribute specifies whether the CCAP should average spectral frequency domain sample power to remove spurious spectral peaks and troughs and the number of samples to use to calculate the average power. The CCAP must not calculate the average of the upstream spectrum

samples when the value of Averaging is zero. The CCAP MUST calculate the average power of upstream spectrum samples, over the number of samples that are specified, when the value of the Averaging attribute is nonzero.

- **snmpr** commands

  - ```
    server > setany -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.11.<ifIndex>.1 -g 245
    clabProjDocsis.27.1.3.10.2.1.11.<ifIndex>.1 = 245
    ```

  - ```
    server > getone -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.11.<ifIndex>.1
    clabProjDocsis.27.1.3.10.2.1.11.<ifIndex>.1 = 245
    ```

- net-snmp commands

  - ```
    server > snmpset -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.11.<ifIndex>.1 u 245
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.11.<ifIndex>.1 = Gauge32: 245
    ```

  - ```
    server > snmpget -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.11.<ifIndex>.1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.11.<ifIndex>.1 = Gauge32: 245
    ```

- `docsPnmCmtsUtscCfgCmMacAddr` - This attribute specifies the cable modem from which the CCAP captures upstream transmissions. This attribute is used only when the TriggerMode is CmMac and is ignored otherwise.

  - net-snmp commands

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.6.<ifIndex>.1
       x "CM-MAC"
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.6.<ifIndex>.1
      ```

- `docsPnmCmtsUtscCfgQualifyCenterFreq` - This attribute specifies the center frequency of a band that is used to qualify a spectrum for upload. The average of the FFT linear power values in this band is computed and compared to a threshold. If the average power in the band is below the threshold, the spectrum is discarded. If the power average is greater than or equal to the threshold, the spectrum is considered qualified.

  - **snmpr** commands

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.13.<ifIndex>.1 -g 102400000
      clabProjDocsis.27.1.3.10.2.1.13.<ifIndex>.1 = 102400000
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.13.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.13.<ifIndex>.1 = 102400000
      ```

  - **net-snmp** commands

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.13.<ifIndex>.1 u 102400000
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.13.<ifIndex>.1 = Gauge32:
      102400000
      ```

- server > snmpget -v2c -c <community_name> <cmts_ip>
  1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.13.<ifIndex>.1
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.13.<ifIndex>.1 = Gauge32:
  102400000

- docsPnmCmtsUtscCfgQualifyBw - This attribute specifies the bandwidth of a band that is used to qualify a spectrum for upload. The average of the FFT linear power values in this band is computed and compared to a threshold. If the average power in the band is below the threshold, the spectrum is discarded. If the power average is greater than or equal to the threshold, the spectrum is considered qualified.

  - **snmpr** commands:

    - server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.14.<ifIndex>.1 -g 25600000
      clabProjDocsis.27.1.3.10.2.1.14.<ifIndex>.1 = 25600000

    - server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.14.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.14.<ifIndex>.1 = 25600000

  - **net-snmp** commands:

    - server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.14.<ifIndex>.1 u 25600000
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.14.<ifIndex>.1 = Gauge32: 25600000

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.14.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.14.<ifIndex>.1 = Gauge32: 25600000

- docsPnmCmtsUtscCfgQualifyThrshld - This attribute specifies the threshold that is applied to qualify a spectrum for upload. The average of the FFT linear power values in the specified band is computed and compared to this threshold. If the average power in the band is below the threshold, the spectrum is discarded. If the power average is greater than or equal to the threshold, the spectrum is considered qualified.

  - **snmpr** commands

    - server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1 -i 200
      clabProjDocsis.27.1.3.10.2.1.15.<ifIndex> = -200

    - server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.15.<ifIndex>.1 = -200

  - **net-snmp** commands

    - server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1 i -200
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1 = INTEGER: -200

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1 = INTEGER: -200

- docsPnmCmtsUtscCfgWindow - This attribute indicates which of the upstream triggered spectrum capture function window formats are supported by the CCAP. Currently Cisco cBR-8 supports rectangular

(default), Blackmann-Harris, and Hann and Hamming formats. The following are the enumerated values for window mode for PNM.

- `D_docsPnmCmtsUtscCfgWindow_other 1`

- `D_docsPnmCmtsUtscCfgWindow_rectangular 2`

- `D_docsPnmCmtsUtscCfgWindow_hann 3`

- `D_docsPnmCmtsUtscCfgWindow_blackmanHarris 4`

- `D_docsPnmCmtsUtscCfgWindow_hamming 5`

- `D_docsPnmCmtsUtscCfgWindow_flatTop 6`

- `D_docsPnmCmtsUtscCfgWindow_gaussian 7`

- `D_docsPnmCmtsUtscCfgWindow_chebyshev 8`

- Window mode set and get examples:

  - **snmpr** commands:

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1 -i 3
      clabProjDocsis.27.1.3.10.2.1.16.<ifIndex>.1= 3
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.16.<ifIndex>.1 = 3
      ```

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1 -i 6
      Error code set in packet - COMMIT_FAILED_ERROR: 1.
      ```

  - **net-snmp** commands:

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1 i 3
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1 = INTEGER: 3
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1 = INTEGER: 3
      ```

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1 i 6
      Error in packet.
      Reason: commitFailed
      Failed object: SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.16.<ifIndex>.1
      ```

Note

- Flat-top, Gaussian, and Chebyshev window-modes are not supported.

- `docsPnmCmtsUtscCfgOutputFormat` - This attribute indicates the upstream triggered spectrum capture function data output formats that are supported by the CCAP. The CCAP is capable of reporting upstream spectrum sample FFT output data in power format. The enumeration value for power format is fftPower.

CCAP supports time-IQ and fftPower output format. The time-IQ is supported from Cisco IOS XE Gibraltar 16.12.1x. The following are the enumerated values for output format mode for PNM.

- `D_docsPnmCmtsUtscCfgOutputFormat_timeIQ 1`

- `D_docsPnmCmtsUtscCfgOutputFormat_fftPower 2`

- `D_docsPnmCmtsUtscCfgOutputFormat_rawAdc 3`

- `D_docsPnmCmtsUtscCfgOutputFormat_fftIQ 4`

- `D_docsPnmCmtsUtscCfgOutputFormat_fftAmplitude 5`

- `D_docsPnmCmtsUtscCfgOutputFormat_fftDb 6`

- Output format mode set and get examples:

  - **snmpr** commands:

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 -i 2
      clabProjDocsis.27.1.3.10.2.1.16.<ifIndex>.1 = 2
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.17.<ifIndex>.1 = 2
      ```

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 -i 4
      Error code set in packet - COMMIT_FAILED_ERROR: 1.
      ```

  - **net-snmp** commands:

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 i 2
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 = INTEGER: 2
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 = INTEGER: 2
      ```

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 i 4
      ```

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.17.<ifIndex>.1 i 1
      ```

Note Only the `fft-pwr` and `time-IQ` output formats are currently supported.

- `docsPnmCmtsUtscCfgRepeatPeriod` - This attribute specifies the length of time in milliseconds for which the CCAP continues to capture and return FFT results when in free running mode. The CCAP is permitted to trigger at larger intervals if unable to support the requested interval. Configuring a zero value indicates that the test is to run once only.

- The Repeat Period is configured in microseconds and default is 50000 usec. The CCAP MUST reject an attempt to set RepeatPeriod to a value greater than the current value of FreeRunDuration.

- Repeat Period set and get examples:

  - **snmpr** commands:

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 -g 25000
      clabProjDocsis.27.1.3.10.2.1.18.<ifIndex>.1 = 25000
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.18.<ifIndex>.1 = 25000
      ```

  - **net-snmp** commands:

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 u 25000
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 25000
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 25000
      ```

- `docsPnmCmtsUtscCfgFreeRunDuration` - This attribute specifies the length of time in milliseconds for which the CCAP continues to capture and return FFT results when in free running mode. Sample captures are expected to take a few microseconds. If FreeRunDuration is set for longer than a sample capture duration, the CCAP could potentially capture more sample data than it can store.

- The CCAP MUST reject an attempt to set FreeRunDuration to a value less than the current value of RepeatPeriod. Freerun duration is configured in millisec and the default value is 1000ms (1 second).The CCAP CLC currently captures 10 samples per second stacked in a single file. With default freerun duration configuration, there will be 11 samples.

- FreeRun Duration set and get examples:

  - **snmpr** commands

    - ```
      server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1 -g 5000
      clabProjDocsis.27.1.3.10.2.1.19.<ifIndex>.1 = 5000
      ```

    - ```
      server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1
      clabProjDocsis.27.1.3.10.2.1.19.<ifIndex>.1 = 5000
      ```

  - **net-snmp** commands

    - ```
      server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1 u 5000
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1 = Gauge32: 5000
      ```

    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1 = Gauge32: 5000
      ```

- `docsPnmCmtsUtscCfgTriggerCount` - This attribute determines the number of times to trigger upstream spectrum sample capture when Enable and InitiateTest are set to true and configured trigger conditions are met. The trigger count configuration does NOT apply and is ignored by CCAP for captures in FreeRun trigger mode.

- Trigger count set and get examples:

    - **snmpr** commands

        - ```
          server > setany -v2c <cmts_ip> <community_name>
          1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1 -g 200
          clabProjDocsis.27.1.3.10.2.1.20.<ifIndex>.1 = 200
          ```

        - ```
          server > getone -v2c <cmts_ip> <community_name>
          1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1
          clabProjDocsis.27.1.3.10.2.1.20.<ifIndex>.1 = 200
          ```

    - **net-snmp** commands

        - ```
          server > snmpset -v2c -c <community_name> <cmts_ip>
          1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1 u 200
          SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1 = Gauge32: 200
          ```

        - ```
          server > snmpget -v2c -c <community_name> <cmts_ip>
          1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1
          SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1 = Gauge32: 200
          ```

- `docsPnmCmtsUtscCfgStatus` - This attribute determines the creation, deletion, and change of status of an actual capture configuration entry on any port of the CCAP CLC. All capture entries must first be created by a client on a port before attempting to initiate any tests on the port. Thereby the client 'owns' that port and its configuration after creation. No other client can run any tests on the port till the currently active client 'destroys' the configuration entry and thereby releases ownership of that port.

- Any tests on a given port that is owned by a client can be run only when the capture configuration status is 'Active'. When a configuration is created, it is created with certain default values and marked 'Not Ready'. All capture parameters must be configured in valid range for the capture entry status to become 'Active'. If the configuration values for various capture parameters are modified by the user/client and not according to the OSSI specification, the configuration status of the entry will be marked 'NotReady'.

- A capture configuration entry cannot be modified to any state unless created first. An entry cannot be recreated without destroying the previous version first. An entry cannot be modified when capture tests are currently running on the port.

- The following are the enumerated values for configuration entry status for PNM:

    - `D_docsPnmCmtsUtscCfgStatus_active 1`

    - `D_docsPnmCmtsUtscCfgStatus_notInService 2`

    - `D_docsPnmCmtsUtscCfgStatus_notReady 3`

    - `D_docsPnmCmtsUtscCfgStatus_createAndGo 4`

    - `D_docsPnmCmtsUtscCfgStatus_createAndWait 5`

    - `D_docsPnmCmtsUtscCfgStatus_destroy 6`

- `Utsc Configuration Entry` set/get example:

    - **snmpr** commands

        - ```
          server > setany -v2c <cmts_ip> <community_name>
          1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1 -i 4
          clabProjDocsis.27.1.3.10.2.1.21.<ifIndex>.1 = 4
          ```

- server > getone -v2c <cmts_ip> <community_name>
  1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1
  clabProjDocsis.27.1.3.10.2.1.21.<ifIndex>.1 = 1

- **net-snmp** commands

  - server > snmpset -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1 i 4
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1 = INTEGER: 4

  - server > snmpget -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1 = INTEGER: 3

> **Note** A configuration can be created with certain default values and is marked 'Not Ready'. It is only changed to 'Active' when valid capture configuration parameters are configured by the user. Capture tests can only be run on configurations that are 'Active'.

- Set multiple capture config parameters at the same time.

  - Server > setany -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 -g 45000
     1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.20.<ifIndex>.1 -g 10
     1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1 -g 100000000
     1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.10.<ifIndex>.1 -g 8092
     1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.15.<ifIndex>.1 -i -100
    clabProjDocsis.27.1.3.10.2.1.18.<ifIndex>.1 = 45000
    clabProjDocsis.27.1.3.10.2.1.20.<ifIndex>.1 = 10
    clabProjDocsis.27.1.3.10.2.1.8.<ifIndex>.1 = 100000000
    clabProjDocsis.27.1.3.10.2.1.10.<ifIndex>.1 = 8092
    clabProjDocsis.27.1.3.10.2.1.15.<ifIndex>.1 = -100 10.3.1.1.<ifIndex>.1 = 0

SNMP walk is supported for all the above MIB objects.

The following is an example of SNMP walk on upstream triggered spectrum capture configuration parameter repeat period:

```
server > snmpwalk -v2c <cmts_ip> -c <community_name> 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.18

  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 45000
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 45000
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 45000
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 45000
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 45000
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 45000
  SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.18.<ifIndex>.1 = Gauge32: 50000
   <<!snip>>
```

Upstream Triggered Spectrum Capture Control Objects and MIBs

The following Upstream Triggered Spectrum Capture control objects and MIBs are supported:

- PNM UTSC OBJECTS OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10

- PNM UTSC CAPTURE CONTROL OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.Y.Z

Where Y is Ifindex, and Z is the PNM Upstream Triggered Spectrum Capture Configuration Index – Which is always 1. Currently only one capture configuration per upstream port is supported.

• The capture control entry can be used to start captures or stop any active captures. The `docsPnmCmtsUtscCtrlInitiateTest` is a boolean value which when set, initiates a capture.

• Starting a capture (You can only start a capture only if you have configured and owned the port, and if the capture configuration entry is active).

- • **snmpr** commands:

  - ```
    server > setany -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 -i 1
    clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 1
    ```

  - ```
    server > getone -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
    clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 1
    ```

- • **net-snmp** commands:

  - ```
    server > snmpset -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 i 1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 1
    ```

  - ```
    server > snmpget -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 1
    ```

• Stop a capture (You can stop an active capture only if you own that port):

- • **snmpr** commands:

  - ```
    server > setany -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 -i 0
    clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 0
    ```

  - ```
    server > getone -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
    clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 0
    ```

- • **net-snmp** commands:

  - ```
    server > snmpset -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 i 0
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 0
    ```

  - ```
    server > snmpget -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 0
    ```

Upstream Triggered Spectrum Capture Status Objects and MIBs

The following Upstream Triggered Spectrum Capture status objects and MIBs are supported:

• PNM UTSC OBJECTS OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10

• PNM UTSC CAPTURE STATUS OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10.4.1.1.Y.Z

Where Y is Ifindex, and Z is the PNM Upstream Triggered Spectrum Capture Configuration Index – Which is always 1. Currently only one capture configuration per upstream port is supported.

- The capture status MIB is a read-only MIB. It reports the status of the capture on a given port (if owned by that client).

- When the value is sampleReady, the CCAP has completed capturing and recording samples. Following are the enumerated values for capture status entry for PNM.

    - `D_docsPnmCmtsUtscStatusMeasStatus_other 1`

    - `D_docsPnmCmtsUtscStatusMeasStatus_inactive 2`

    - `D_docsPnmCmtsUtscStatusMeasStatus_busy 3`

    - `D_docsPnmCmtsUtscStatusMeasStatus_sampleReady 4`

    - `D_docsPnmCmtsUtscStatusMeasStatus_error 5`

    - `D_docsPnmCmtsUtscStatusMeasStatus_resourceUnavailable 6`

    - `D_docsPnmCmtsUtscStatusMeasStatus_sampleTruncated 7`

- The status is inactive when the capture configuration entry is created and is marked busy when the tests are actively running on the port. Any platform resource limitation to run a test to make the status 'resource unavailable' and the error encountered while running a test would mark the status as 'error'.

- Get capture status on a port (You can get the status of capture on the port only if you own that port.

    - **snmpr** commands:

    ```
    server > getone -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.4.1.1.<ifIndex>.1
    clabProjDocsis.27.1.3.10.4.1.1.<ifIndex>.1 = 4
    ```

    - **net-snmp** commands:

    ```
    server > snmpget -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.4.1.1.<ifIndex>.1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.4.1.1.<ifIndex>.1 = INTEGER: 4
    ```

Upstream Triggered Spectrum Capture Capability Objects and MIBs

The following Upstream Triggered Spectrum Capture capability objects and MIBs are supported for PNM:

- PNM UTSC OBJECTS OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10

- PNM UTSC CAPTURE CAPABILITY OID: 1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.X.Y

Where X is the capability parameter and Y is the Ifindex.

- The capture capability MIB is a read-only MIB. The Upstream Triggered Spectrum Capture Capabilities object exposes capabilities that are supported by the CCAP for Upstream Triggered Spectrum Capture trigger modes, data output formats, and windowing function used when performing the discrete Fourier transform.

- The following are the enumerated values for capture capability entry for PNM for CCAP.

    - `docsPnmCmtsUtscCapabTriggerMode 1`

- docsPnmCmtsUtscCapabOutputFormat 2

- docsPnmCmtsUtscCapabWindow 3

- docsPnmCmtsUtscCapabDescription 4

- Get capture capability on a port:

  - **snmpr** commands:

    - server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.1.<ifIndex>
      docsPnmCmtsObjects.10.1.1.1.<ifIndex> = 00 02

    - server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.2.<ifIndex>
      docsPnmCmtsObjects.10.1.1.2.<ifIndex> = 04

    - server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.3.<ifIndex>
      docsPnmCmtsObjects.10.1.1.3.<ifIndex> = 1e

    - server > getone -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.4.<ifIndex>
      docsPnmCmtsObjects.10.1.1.4.<ifIndex> = Center Frequency range and resolution

  - **net-snmp** commands:

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.1.<ifIndex>
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.1.1.1.<ifIndex> = Hex-STRING: 00 02

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.2.<ifIndex>
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.1.1.2.<ifIndex> = Hex-STRING: 04

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.3.<ifIndex>
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.1.1.3.<ifIndex> = Hex-STRING: 1

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.1.1.4.<ifIndex>
      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.1.1.4.<ifIndex> = STRING: "Center
      Frequency range and resolution"

Upstream Triggered Spectrum Capture Bulk Data Control Objects and MIBs

The following Upstream Triggered Spectrum Capture bulk data control objects and MIBs are supported for PNM:

- PNM Bulk Data Control Objects OID: 1.3.6.1.4.1.4491.2.1.27.1.1.1

- PNM BULK DATA CONTROL OID: 1.3.6.1.4.1.4491.2.1.27.1.1.1.X

  Where X is the bulk data transfer control parameter.

- The Bulk Data Transfer (BDT) control objects that are supported are the IPaddress type, BDT server IP and BDT destination path. This indicates to the CCAP the location where the capture results files should be sent through TFTP transfer. In CBR8, the TFTP transfer is done through IOX container and as such,

other BDT objects are not relevant to this design model. IP address type can be automatically set by CCAP based on the server IP value specified.

- The following are the enumerated values for BDT for PNM:

    - `docsPnmBulkDestIpAddrType 1`

    - `docsPnmBulkDestIpAddr 2`

    - `docsPnmBulkDestPath 3`

- Set the BDT IPv4 IP address type and TFTP IP address

    - **snmpr** commands:

        - ```
server > setany -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0
 -o 20:01:0d:b8
docsPnmBulkDestIpAddr.0 = 20 01 0d b8
```

        - ```
server > getone -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.1.0

docsPnmBulkDestIpAddrType.0 = ipv4(1)
```

        - ```
server > getone -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0

docsPnmBulkDestIpAddr.0 = 20 01  0d b8
```

    - **net-snmp** commands:

        - ```
server > snmpset -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0 x 20010db8
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.2.0 = Hex-STRING: 20 01 0D B8
```

        - ```
server > snmpget -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.1.0
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.1.0 = INTEGER: 1
```

        - ```
server > snmpget -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.2.0 = Hex-STRING: 20 01 0D B8
```

- Set the BDT IPv6 IP address type and TFTP IP address

    - **snmpr** commands:

        - ```
server > setany -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0
 -o 20:01:0d:b8:85:a3:00:00:00:00:8a:2e:03:70:73:11

docsPnmBulkDestIpAddr.0 = 2001 0db8 85a3 0000 0000 8a2e 0370 7311
```

        - ```
server > getone -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.1.0

docsPnmBulkDestIpAddrType.0 = ipv6(2)
```

        - ```
server > getone -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0
docsPnmBulkDestIpAddr.0 = 2001 0db8 85a3 0000 0000 8a2e 0370 7311
```

    - **net-snmp** commands:

        - ```
server > snmpset -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0 x 20010db885a3000000008a2e03707311
```

```
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.2.0 = Hex-STRING: 20 01 0D B8 85 A3
00 00 00 00 8A 2E 03 70 73 11

server > snmpget -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.1.0
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.1.0 = INTEGER: 2
```

  - ```
server > snmpget -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.2.0 = Hex-STRING: 20 01 0D B8 85 A3
00 00 00 00 8A 2E 03 70 73 11
```

- Set the BDT destination TFTP path

  - **snmpr** commands:

    - ```
server > setany -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0
 -o pnm
docsPnmBulkDestPath.0 = pnm
```

    - ```
server > getone -v2c <cmts_ip> <community_name> 1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0

docsPnmBulkDestPath.0 = pnm
```

  - **net-snmp** commands:

    - ```
server > snmpset -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0 s 'pnm/test'
SSNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.3.0 = STRING: "pnm/test"
```

    - ```
server > snmpget -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.3.0 = STRING: "pnm/test"
```

Configuring the PNM MAX-HOLD Trigger Mode

When RPHY configuration is for MAX-HOLD PNM mode, RPHY sends PNM data continuously, until the user issues stop command or the duration is complete.

To configure for MAX-HOLD trigger mode on the Supervisor, complete the following steps:

Step 1 Configure the PNM **docsPnmCmtsUsSpecAnTrigMode** to 'other' mode. Both the SNMP and CLI can set the trigger mode. See the following examples:

- For SNMP:

```
snmpset -v2c -c private 80.4.2.11 1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.3.435572.1 i 1
```

- For CLI:

```
test cable pnm uts configure trigger-mode other
```

Adding a new TrigMode to MIB might take long and cause many specification changes.

Step 2 Set the PNM bulk destination IP address.

- For SNMP:

```
snmpset -v2c -c private 80.4.2.11 1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0 x "20 01 0d b8"
```

- For CLI:

```
test cable pnm bdt config set-ip 32.1.13.184
```

Step 3   Start and stop the capture test.

- Starting the SNMP:

```
snmpset -v2c -c private 80.4.2.11 1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.435572.1 i 1
```

- Starting the CLI:

```
test cable pnm uts start client-id 1 test-id 1 0004.9f00.0591 0
```

- Stopping the SNMP:

```
snmpset -v2c -c private 80.4.2.11 1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.435572.1 i 0
```

- Stopping the CLI:

```
test cable pnm uts stop client-id 1 test-id 1 0004.9f00.0591 0
```

Step 4   Enable GCP message support. Send the TFTP server IP address and Static L2TP session ID through TLV58 message, and the TrigMode 'other' is send to RPD through TLV41 message.

Proactive Network Management MAX-HOLD trigger mode

The cBR enables MAX-HOLD trigger mode support in PNM. The non-CCAP defined MAX-HOLD mode offers significant advantages over the existing FREE-RUN mode that was used earlier. With the MAX-HOLD trigger mode, the RPD sends samples much faster - one sample every 2ms, compared to the earlier rate of one sample per 100ms. The RPD also sends the sample to the server, instead of the Line Card.

The MAX-HOLD trigger mode support functionality includes:

- cBR support for the configuration of the MAX-HOLD trigger mode

- cBR support for notify UBUNTU server IP and Static L2tp session IDs to RPD

- RPD usage of the max hold mode to capture the upstream spectrum

- RPD sending the captured BIN to UBUNTU server

Debugging the PNM feature on cBR8

cBR supports debugging on Upstream Triggered Spectrum Capture – Proactive Network Management by using the debug commands available for the UTSCOM client on supervisor.

Use the CLI to enable the debug commands:

- **debug cable pnm utscom-error**

- **debug cable pnm utscom-debug**

Use the following show command to check the state of capture on the Line Card. It lists the total number of samples per capture context in the CLC. When the capture tests are running, the packet counts on the corresponding Line Card would keep incrementing.

```
Router# show cable card 6/0 us-triggered-spectrum its-commonLAST event
UTSCOM event    STATUS
client_id       1
test_id         1
port            0
dev             8
phy_chan        0
logi_chan       0
status          4
WBFFT    Dev   trig-mode,    data-ready,    packets on WBFFT dev,    countdown :
wbfft   dev 0:     0             0                  11                    0
wbfft   dev 1:     0             0                  0                     0
wbfft   dev 2:     0             0                  0                     0
wbfft   dev 3:     0             0                  0                     0
wbfft   dev 4:     0             0                  0                     0
wbfft   dev 5:     0             0                  0                     0
wbfft   dev 6:     0             0                  0                     0
wbfft   dev 7:     0             0                  0                     0
total packets: 11
```

The **dtrack** utility can also be used for debugging the packets punted through CPP from CLC to container. To use the **dtrack** utility, complete the following steps:

1. On the supervisor, use the following CLI:

```
test platform hardware qfp active feature docsis dtrack mac 0001.aaaa.cccc
test platform hardware qfp active feature docsis dtrack packe
```

2. Start the trigger and use the following CLI to dump the packets (this can be very verbose as there are 10 samples per file per second):

```
show platform hardware qfp active feature docsis dtrack statistics verbose
```

To obtain the dumping statistics on the IOX container, use the following CLI:

- **dir harddisk:/iox/repo-lxc/lxc-data/<CAF id>/logs/**

- **more harddisk:/iox/repo-lxc/lxc-data/<CAF id>/logs/.stats**

- **more harddisk:/iox/repo-lxc/lxc-data/<CAF id>/logs/pnm.log**

To change configuration on the container console, complete the following steps:

1. Log onto the CAF console as root.

2. Run the **echo "DEBUG" > /data/logs/.loglevel** command.

```
debug level are: ERROR, WARNING, INFO, DEBUG, DEBUG1, DEBUG2, DEBUG3, DEBUG4
```

3. Run the **echo "0" > /data/logs/.resend** command.

```
value "0" disable "tftp resend" due to tftp error.
value "12" enable clc log pnm file at local.
```

Ensure that the PNM TFTP process is active and running on the `guestshell` container as listed:

```
cbr8# guestshell run systemctl status pnm
â pnm.service - cbr pnm telemetry delivery system
   Loaded: loaded (/etc/systemd/system/pnm.service; disabled; vendor preset: disabled)
   Active: active (running) since Wed 2019-01-09 15:13:40 UTC; 1min 28s ago
```

• If the PNM service is not active, attempt recovery by going through the following steps:

1. Destroy the `guestshell` instance. Run the `guestshell destroy` command.

2. Recreate the `gusetshell` by running the `guestshell enable` command.

3. Check if the `guestshell` instance is running by using the `show app-hosting list` command. Verify that the PNM service is active.

• Verify that the TFTP server IP is reachable from the guestshell container and ping is successful.

```
guestshell run ping -c5 <tftp_server_ip>
```

Quick Install Guide

You can bring up the Proactive Network Management and get the captures running using a minimal configuration. Complete the following steps to enable PNM with a minimal configuration:

1. Find the correct PNM Interface Index for the RPD. Run the `show snmp mib ifmib ifindex | include <rpd_mac>` command.

```
Router# show snmp mib ifmib ifindex | i badb.ad13.2be0
RPD(badb.ad13.2be0)-usport0: Ifindex = 435564
```

Where `badb.ad13.2be0` is the RPD identifier.

2. Ensure that the `guestshell` container is up and running on both active and standby SUP. Run the `show app-hosting list` command.

```
Router# show app-hosting list
App id                    State
-----------------------------------------------------
guestshell                RUNNING
```

3. Ensure that the pnm process is running on the `guestshell`. Run the **guestshell run systemctl status pnm** command. For more information on the command usage, go through Step 4, on page 4.

4. Configure the Bulk Data Ttransfer parameters. Go through the following steps to set the TFTP IP address and TFTP path. Alternatively, also go through Upstream Triggered Spectrum Capture Bulk Data Control Objects and MIBs, on page 20 for detailed information.

• Set the BDT IPv4 IP address type and TFTP IP address

• **snmpr** commands:

```
server > setany -v2c <cmts_ip> <community_name>
1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0 -o 20:01:0d:b8

docsPnmBulkDestIpAddr.0 = 20 01  0d b8
```

• **net-snmp** commands:

```
server > snmpset -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0 x 20010db8
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.2.0 = Hex-STRING: 20 01 0D B8
```

```
server > snmpget -v2c -c <community_name> <cmts_ip>
1.3.6.1.4.1.4491.2.1.27.1.1.1.1.0
SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.1.0 = INTEGER: 1
```

- server > snmpget -v2c -c <community_name> <cmts_ip>
  1.3.6.1.4.1.4491.2.1.27.1.1.1.2.0
  SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.2.0 = Hex-STRING: 20 01 0D B8

- Set the BDT destination TFTP path

  - **snmpr** commands:

    - server > setany -v2c <cmts_ip> <community_name>
      1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0 -o pnm
      docsPnmBulkDestPath.0 = pnm

  - **net-snmp** commands:

    - server > snmpset -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0 s 'pnm/test'
      SSNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.3.0 = STRING: "pnm/test"

    - server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.1.1.3.0
      SNMPv2-SMI::enterprises.4491.2.1.27.1.1.1.3.0 = STRING: "pnm/test"

5. Create and configure a capture config entry. Go through the Upstream Triggered Spectrum Capture Control Objects and MIBs, on page 17 for information on creating and configuring a capture config entry.

6. Set the minimum capture config paramters that are needed (center-frequency, span and duration).

   a. Set the `D_docsPnmCmtsUtscCfgStatus_createAndGo 4`.

   ```
   server > setany -v2c <cmts_ip> <community_name>
   1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1 -i 4
   clabProjDocsis.27.1.3.10.2.1.21.<ifIndex>.1 = 4
   ```

   b. Set the `docsPnmCmtsUtscCfgCenterFreq`.

   ```
   server > setany -v2c <cmts_ip> <community_name>
   1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.8.<ifIndex>.1 -g 102400000
   clabProjDocsis.27.1.3.10.2.1.8.<ifIndex>.1 = 102400000
   ```

   c. Set the `docsPnmCmtsUtscCfgSpan`.

   ```
   server > setany -v2c <cmts_ip> <community_name>
   1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.9.<ifIndex>.1 -g 204800000
   clabProjDocsis.27.1.3.10.2.1.9.<ifIndex>.1 = 204800000
   ```

   d. Set the `docsPnmCmtsUtscCfgFreeRunDuration`. Increase the duration to a large value to keep the freerun capture running.

   ```
   server > setany -v2c <cmts_ip> <community_name>
   1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.19.<ifIndex>.1 -g 5000
   clabProjDocsis.27.1.3.10.2.1.19.<ifIndex>.1 = 5000
   ```

   e. Ensure that the config entry status is active.

   ```
   server > snmpget -v2c -c <community_name> <cmts_ip>
   1.3.6.1.4.1.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1
   SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.2.1.21.<ifIndex>.1 = INTEGER: 1
   ```

✎

Note   Ensure that the capture center frequency and span are in a valid range. IOS error messages are triggered if the user attempts to start capture tests with an invalid capture configuration. The recommended configuration values are provided in the messages.

7. Start the PNM capture.

- **snmpr** commands:

  - ```
    server > setany -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 -i 1
    clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 1
    ```

  - ```
    server > getone -v2c <cmts_ip> <community_name>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
    clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 1
    ```

- **net-snmp** commands:

  - ```
    server > snmpset -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 i 1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 1
    ```

  - ```
    server > snmpget -v2c -c <community_name> <cmts_ip>
    1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
    SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 1
    ```

8. The captures are running and files should appear on the TFTP server under the BDT TFTP path configured.

Proactive Network Management using OFDMA RxMER Probes

Cisco cBR 16.12.1y supports Proactive Network Management using OFDMA RxMER Probes. This feature enables collection and reporting of the OFDMA channel Receive Modulation Error Ratio (RxMER) for every subcarrier.

The DOCSIS 3.1 CMTS and CM support OFDMA RxMER probes. The CM transmits signals over the OFDMA upstream channel to the CMTS. The signals are received at the upstream PHY, and each subcarrier in the OFDMA channel is evaluated. RxMER is defined as the ratio of the average power of the ideal QAM constellation to the average error-vector power. The error vector is the difference between the equalized received probe value and the known correct probe value. If some subcarriers (such as exclusion bands) cannot be measured by the CMTS, a value of 0xFF will be returned for that subcarrier.

PNM RxMER probes are initiated and controlled through SNMP MIB commands. The DOCS-PNM-MIB specification details the applicable commands under the **docsPnmCmtsUsOfdmaRxMerTable.** A single RxMER probe can be started for each OFDMA channel in the system by specifying the target cable modem mac-address. The RxMER probe results are sent to a remote TFTP server using the IOX Guestshell PNM service

The following command options are supported for **DocsPnmCmtsUsOfdmaRxMerTable**:

- **docsPnmCmtsUsOfdmaRxMerEntry.[ifIndex]**

  Each row of the **DocsPnmCmtsUsOfdmaRxMerTable** is uniquely identified by the OFDMA channel ifIndex. You can identify the ifIndex of a particular OFDMA channel by running the following command:

```
Router# show snmp mib ifmib ifindex | i Cable1/0/2-upstream7 Cable1/0/2-upstream7:
Ifindex = 389839
```

• **docsPnmCmtsUsOfdmaRxMerEnable**

Set to TRUE to initiate collection of the RxMER data and send to TFTP server. Setting it to FALSE restores the MIB values to defaults.

• **docsPnmCmtsUsOfdmaRxMerCmMac**

Specifies the mac-address of the CM that performs the RxMER probe.

• **docsPnmCmtsUsOfdmaRxMerPreEq**

You can either set the value to TRUE to perform RxMER probe with Pre-Equalization, or choose to set the value to FALSE to perform RxMER probe without Pre-Equalization.

Note   We recommend that probing is done with Pre-Equalization, as this will have the CM transmit on each sub-carrier using a gain that will normalize the signal arriving at the CMTS.

• **docsPnmCmtsUsOfdmaRxMerNumAvgs**

This is in the range of 1-255. Any integer greater than one will generate multiple probes and average the result before sending it to the TFTP server.

• **docsPnmCmtsUsOfdmaRxMerMeasStatus**

Indicates the status of the probe request [Inactive, Busy, SampleReady, Error]. See the MIB definition for complete details. Ensure that no modifications are made to other MIB fields for the table entry while the probe is in `Busy` state.

• **docsPnmCmtsUsOfdmaRxMerFileName**

Displays the name of the file written to the TFTP server. You can choose to leave it blank, and an autogenerated filename will be used. The filename is read back after the probe is complete and the status is read as `SampleReady`.

Note   Do note that new file names are not autogenerated for subsequent probes. Hence, ensure that your filename value is cleared or set to a new value before initiating a subsequent probe. This will avoid the problem of new probe data overwriting information on the previous probe with the same filename.

PNM RxMER Probe High Availability

• **docsPnmCmtsUsOfdmaRxMerTable**

   • SUPHA: In progress operation will need to be restarted by the operator after the switchover. Currently the IOX PNM service is not available after a SUP-HA event.

   • LCHA: In progress operation will need to be restarted by the operator after switchover

✎

Note   When restarting the RxMER probe on the Standby Line Card, care should be taken to identify the new ifIndex of the OFMDA channel. This will be different from the Primary Line Card.

> • LCPR: Operations that are in progress will be restarted by SUP after the LCPR completion. An internal operation timeout will restart the RxMER probe after one minute, for a maximum of three attempts. During this time, the RxMER status will remain as "Busy".

RxMer Probe Debugging

You can use the following command options to display the status and count of the PNM RxMER jobs.

> • To display the status of PNM RxMER jobs by ifIndex, use the **test cable pnm rxmer show** command. See the following usage example:

```
Router# test cable pnm rxmer show

Job   Client   ifIndex   CM-Mac            Status       Enable   Pre-Eq   Num-Avgs   Retry
----------------------------------------------------------------------------------------
0     SNMP     389838    0000.0000.0000    INACTIVE     N        N        1          0
0     SNMP     389839    0000.0000.0000    INACTIVE     N        N        1          0
0     SNMP     389933    0000.0000.0000    INACTIVE     N        N        1          0
0     SNMP     389981    0000.0000.0000    INACTIVE     N        N        1          0
.
.
.
0     SNMP     404239    0000.0000.0000    INACTIVE     N        N        1          0
0     SNMP     404246    0000.0000.0000    INACTIVE     N        N        1          0
0     SNMP     404247    0000.0000.0000    INACTIVE     N        N        1          0

PNM RxMER job count 33
```

> • To display the count of all the PNM RxMER jobs by ifIndex, use the **test cable pnm rxmer <ifIndex> get all** command. See the following example:

```
Router# test cable pnm rxmer 389838 get all PNM RxMER MIB for ifIndex 389838
Status: INACTIVE
CM-mac: 0000.0000.0000

Enable: False
Pre-Eq: OFF
Num-Avgs: 1
TFTP filename: <default>
```

When upstream profile management is enabled, the **show cable modem <mac> prof-mgmt upstream verbose** command can also be used to view the OFDMA RxMER probe data. The values shown should be similar to, but not exactly the same as the values reported in the TFTP upload file. This is because data was collected using probes at different times.

The RxMER probe data can also be collected and displayed directly on the CBR8 console using the **ping docsis pnm <ip-address> upstream <us-chan> ignored** command. This command will initiate a RxMER probe to the targeted cable modem upstream OFDMA channel. The **ignore** option on the command will prevent the RxMER probe results from impacting OFDMA profile management. The RxMER probe data can

then be viewed on the console using the **show cable modem <ip-address> prof-mgmt upstream ignored** command. For example:

```
Router# ping docsis pnm 9.23.4.91 upstream 6 ignore
Queueing 1 MAC-layer station maintenance intervals, timeout is 80 msec:
!
Success rate is 100 percent (1/1)

cbr8# show cable modem 9.23.4.91 prof-mgmt upstream ignored
Upstream Profile Management Data (Ignored):
MAC Address             : 4800.33ea.6e3e
Number of US Chan       : 1

Ucid                    : 7
RxMer Exempt Percent    : 0
RxMer Margin qDB        : 0
RxMer Threshold Percent : 2
Start Sc                : 148
End Sc                  : 1067
Num RxMER Measurement   : 1068
Tx Time                 : 0h:03m:49s ago
Rx Time                 : 0h:03m:49s ago
MER Poll Period   (min) : 5
Auto Profile Upgrade    : Yes
Upgrd Dly Cnt (cur/cfg) : 0/1
Upgrd Dly rcmd IUC      : none
Recommended IUC         : 13
Current IUC             : 13
Downgrade IUC           : 13
RxMER send/recv count   : 196/196
DBC                     : 31/31/0/0/0
                          (send/succeed/err/reject/timeout)
State                   : Ready
Profile Downgrade       : Disabled
0x0000  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0020  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0040  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0060  00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
0x0080  00000000 00000000 00000000 00000000 00000000 B3AEB0BB AEACA9B1 A8A9AEB8
0x00A0  ABADB6A7 AAB1B2AE B1B9B5A8 B4A7ABB0 A4B3ACAE AEB1BAB4 B2ADB3B4 B0B7B9B5
0x00C0  BAB3B5AA A5A3A7AB ABB2ACB1 B1B1B3AC B4ADAFAB 9DACA5AE AEB5ACB1 A6ADB4B2
0x00E0  A3B7ADBB B5ADAEB7 A8A7ABB2 9EAEBDB1 AAB1B6B7 B2AFAAB0 9BB0B1AF B7ACB5AD
0x0100  AFB0B0AF A9B7A8AB B1AEB5B1 B59FAEB3 A4ADB1B3 AFB0AEB1 AEABADB7 ABB6B9B6
0x0120  ACB7B5AE ADABB5A7 A4AEB0AA ADB2B8AB B1ADAEB6 A4B2B3AF AEB7A9AE BA9FABAC
0x0140  9AA5B5BB B1BAB9B7 B0A0A8B3 A4A0B3B6 B1A7B1B5 B1ADA9B0 A6B2B1BB AFB9ACAF
0x0160  B4A4B4A7 A2A7B6B3 B1B9ADB7 B5A1B7AD A6ADBCA8 AEB3B4AD AEB0B0B3 ADAEB3B1
0x0180  A8AEACAF B0ADB4A4 A5ACB0AF B1B7B2B0 B2A5B8AC 9FABAFB7 B7A9AFB0 B6B3B1B3
0x01A0  B7AAB1B2 ACBBADC1 A8B3AAB2 B7B1B5B5 BEB1AEB6 ADB3B1AD ACB0B1B2 B7BBAFB8
0x01C0  AFAEACB5 ACB5B1B0 AEA8ACAE B4B5B0AC B4B9ADB5 B4ADB5B6 B2B3AAAB A8AEB4AC
0x01E0  AEAFADB5 AAAFB0B6 ADADAAB4 ABACABB6 B3A5ABB1 ADB4B7B9 AEB6BFAF B1B5B3B0
0x0200  ACAFBAB2 B4B5B3AF B2B4B1BB B5AFADB7 B5B1B3B2 B4B0B0B3 B7B0ACB5 B1B1B0B7
0x0220  AEAAACB9 B8AFACAF B7B1AFAD ADB1B3AE A9B9B0B0 B0AFB2AB ACADACB2 ACB4B2AE
0x0240  A8ABB1AF ADBBA8AC B4B1B3B4 B4AFADB8 B1AEA6AD B0AFAEAD BBB1B4B7 AEA7ADA7
0x0260  AEB2AEB5 B0AAB5B1 B3ACAFB6 B1ACB2A3 A8B7BCAA B5A9ABA9 B6B7AAA8 ACB1A9B3
0x0280  B0B1AFAA B4AEB1A9 ABACB4AF B3B4AFAC B1B0B2B1 B0B0B0B0 B5B7AEB0 B7B2B9A1
0x02A0  B1B0AFB1 AEAEB4A7 ABB4B8B0 ADB0ABAE B1A9B9AD B2B1BBAF B1B4AAAF A8ADB3A9
0x02C0  BDA9B9B0 B2ADB0B2 AEAFB3B4 B0AEAAAF AEAFB4A9 B4A9ADB0 B6A9B1AB B0AFAEAB
0x02E0  B1ADA9B2 A8A9A9AC ACACB2AF A8AAB1B4 ABB0ADAD B8ADB1B6 ADB4AEAE AEB0ABB1
0x0300  B2ADACAF ABADABB7 ACA8ACAD A9AFAAB5 A9B0B1BA B1ADB4B3 ABB0AFB0 AEB0ADB2
0x0320  AFABADB7 B0AEABA8 ABAFAFB1 A8A7ADAB B3AFAAB2 A9B1B6AE B1B0B1AE ACADB4B7
0x0340  ADB2B0AF B4B1ACA9 B7AFADB5 A9ACB1AD A6ADA6B1 AAA3A3A4 B7A5AFAA A7B2ABB4
0x0360  A8AFA7A7 A6A8ACAF ADA3B4AB A8AAB8AB A5A5ABA4 A7A8BBB1 ABA6A8A4 A79FA9A1
0x0380  AEA3AFAC B1AEABAD ACA8A7A6 B4A2A9A8 A8B2A2AB ABA2A6AE A99B9EA6 A9A59EA4
```
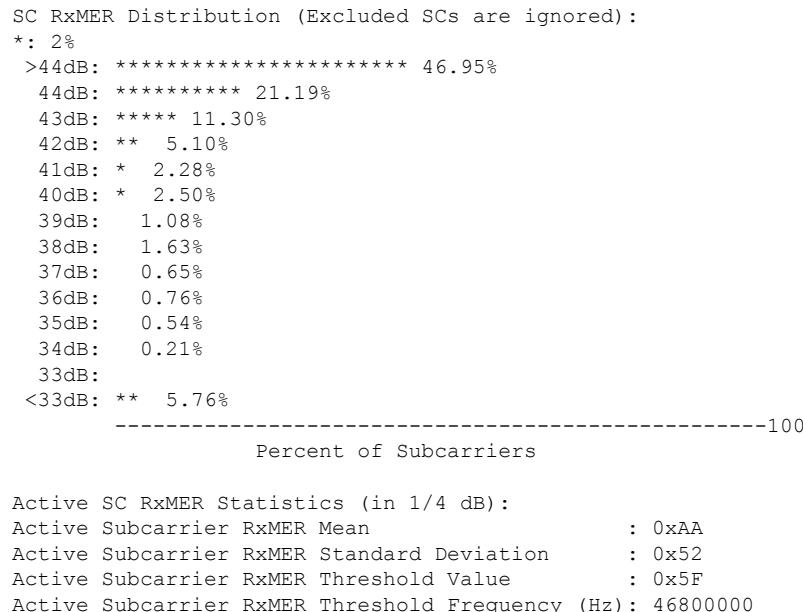
```
0x03A0  9FAD99A5 9FA39FA4 ABACA3A5 AA9FA9A1 9EA59AA2 9F9EAA9D A4A5A6A2 A59FA7A1
0x03C0  A09E98A0 9DA0A39F 9C9CA09F 9C999899 9695969A 9597939D 97979B9B 9C909291
0x03E0  938D9790 8B929492 998B8D95 8C85898A 8D878D87 7F7F7E83 817B847F 7E888071
0x0400  75787C76 7A707375 6C6A6D69 6C5B6565 615D5B68 55575458 554C5046 3641452B
0x0420  39402E32 16191D1A 1C223434


SC RxMER Distribution (Excluded SCs are ignored):
*: 2%
 >44dB: ********************** 46.95%
  44dB: ********** 21.19%
  43dB: ***** 11.30%
  42dB: **  5.10%
  41dB: *  2.28%
  40dB: *  2.50%
  39dB:   1.08%
  38dB:   1.63%
  37dB:   0.65%
  36dB:   0.76%
  35dB:   0.54%
  34dB:   0.21%
  33dB:
 <33dB: **  5.76%
        -------------------------------------------------100
                 Percent of Subcarriers

Active SC RxMER Statistics (in 1/4 dB):
Active Subcarrier RxMER Mean                  : 0xAA
Active Subcarrier RxMER Standard Deviation    : 0x52
Active Subcarrier RxMER Threshold Value       : 0x5F
Active Subcarrier RxMER Threshold Frequency (Hz): 46800000
```

Troubleshooting Proactive Network Management Issues

The Upstream Triggered Spectrum Capture issues, their possible causes, and resolution are listed.

- Capture configuration failure:

  - Ensure that the ifindex that is used is correct and the port is configured correctly under RPD for RPHY.

  - Ensure that the capture configuration entry was created properly and the client/snmp owns the capture port using MIB commands.

  - Ensure that the parameters being configured are supported and within the valid range.

  - Enable **debug cable pnm utscom-error** to check for any errors.

- Capture control or initiate test failure:

  - Ensure that the capture configuration is created and configured correctly by the client using MIB commands.

  - Verify that the capture configuration entry status is active using MIB commands.

  - The total number of captures is below the enforced limit.

  - Ensure that no other tests are already running on the port using MIB commands.

  - Ensure that only one port per RPD is running the test.

- TFTP file transfer failure:

  - Ensure that the BDT TFTP information is configured correctly on the CMTS.

  - Ensure that the TFTP server is reachable and the destination location is writable.

  - Ensure that the container is in running state using show commands.

  - Ensure that the PNM TFTP process is active and running on the `guestshell` container and the TFTP server IP is reachable from the `guestshell` container.

  - Ensure that the capture tests are running correctly and with the CLC show, CLI show, files are being generated.

  - Check dtrack to ensure that the punt path is working and packets are being sent to the container.

  - Use the PNM debug and the container statistics/log file to check for any errors.

- PNM packets are not reaching guestshell:

  - Check dtrack. All PNM packets should be punted with punt-cause Service-Engine.

  - Run bash in guestshell, and check **RX packets** in ifconfig.

  - Run bash in guestshell, and use tcpdump to check if the PNM packets are arriving.

  - PNM packets from CLC use the Global Routing Table, and there is no mechanism to allow these packets to use anything other than GRT. If the guestshell and VirtualPortGroup are in the VRF, you can add a static route which directs the PNM packets into VRF. For example:

    The current configuration is:

    ```
    !
    ip vrf vrf_pnm
     rd yyy:zzz
     route-target export yyy:w
     route-target import yyy:w
    !
    interface VirtualPortGroup0
     ip vrf forwarding vrf_pnm
     ip address P.Q.R.253 255.255.255.252
     no mop enabled
     no mop sysid
    !
    app-hosting appid guestshell
     app-vnic gateway0 virtualportgroup 0 guest-interface 0
      guest-ipaddress P.Q.R.254 netmask 255.255.255.252
     app-default-gateway P.Q.R.253 guest-interface 0
    !
    ```

    Add a static route:

    ```
    (config)# ip route P.Q.R.254 255.255.255.255 VirtualPortGroup0
    ```

Feature Information for Proactive Network Management

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 3: Feature Information for Upstream Triggered Spectrum Capture - Proactive Network Management

Feature Name	Releases	Feature Information
DOCSIS 3.1 Upstream Triggered Spectrum Capture	Cisco IOS XE Gibraltar 16.10.1	This feature was integrated into Cisco IOS XE Gibraltar 16.10.1 on the Cisco cBR Series Converged Broadband Routers.
MAX-HOLD trigger mode	Cisco IOS XE Gibraltar 16.10.1d	This feature was integrated into Cisco IOS XE Gibraltar 16.10.1d on the Cisco cBR Series Converged Broadband Routers.
Support PNM output format 'timeIQ' and UTSC trigger mode 'cmMac'	Cisco IOS XE Gibraltar 16.12.1x	This feature was integrated into Cisco IOS XE Gibraltar 16.12.1x on the Cisco cBR Series Converged Broadband Routers.
Proactive Network Management using OFDMA RxMER Probes	Cisco IOS XE Gibraltar 16.12.1y	This feature was integrated into Cisco IOS XE Gibraltar 16.12.1y on the Cisco cBR Series Converged Broadband Routers.