Cisco cBR Converged Broadband Routers Layer 2 and DOCSIS 3.1 Configuration Guide for Cisco IOS XE Bengaluru 17.6.x

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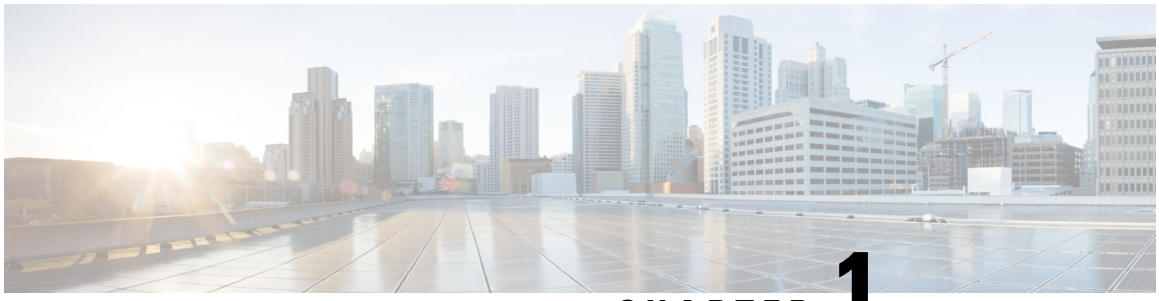


CHAPTER 1

DOCSIS 3.1 OFDM Channel Configuration

This document describes how to configure the OFDM channel 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about OFDM Channel Configuration

OFDM Channels

DOCSIS 3.1 introduces modes for higher throughput and higher spectral efficiency while still allowing backward compatibility to DOCSIS 3.0. The OFDM Channel support includes two OFDM channel per port with channel bandwidth from 24 MHz to 192 MHz wide.

From the Cisco IOS XE Gibraltar 16.10.1d release, the Cisco cBR router supports two OFDM channels per service group for an RPD downstream port. You can configure the channels using the **cable downstream controller-profile** configuration.

Cisco cBR-8 supports 158 SC-QAMs for a single OFDM channel and 128 SC-QAMs for multiple OFDM channels. The max-carrier attribute is automatically set to 158 by default. However, you should set the max-carrier to a value of 128 or below to configure multiple OFDM channels. The Cisco cBR router does not support any value above 128 if you are configuring multiple OFDM channels.

Each OFDM channel supports a control profile, an NCP profile, and up to five data profiles. Profiles support one or more modulations.

You can configure the guard band of an OFDM channel to potentially trade off some performance margin using command **guardband-override**. By default, Cisco cBR-8 router use the default guard band, which is based on the roll off and spacing in OFDM channel profile.

DOCSIS 3.1 OFDM support also allows the user to configure the RF-channels 158 to 162 under the mac-domain as primary channel.

Channel Profile

A globally configured OFDM channel profile contains channel parameters, and the modulation or modulation profile associated with the control, NCP, and data profiles.

Each OFDM channel must specify an OFDM channel profile in its configuration.

Modulation Profile

A globally configured OFDM modulation profile assigns different modulations to ranges of sub-carriers, or lists of individual sub-carriers.

A modulation profile may be assigned to a control, NCP, or data profile in a channel profile.

OFDM Channel Exclusion Band

Ranges of frequencies can be excluded from all OFDM channels on a port using the **ofdm-freq-excl-band** command.

How to Configure OFDM Channel

Configuring OFDM Modulation Profile

To configure the OFDM modulation profile, follow the steps below:

```
enable
configure terminal
cable downstream ofdm-modulation-profile id
description text
subcarrier-spacing value
width value
start-frequency value
assign {modulation-default mod_prof_id | modulation mod_prof_id {list-subcarriers
 {freq-abs | freq-offset} value | range-subcarriers {freq-abs | freq-offset}
 value width value}}
```

Note Subcarrier spacing must match the subcarrier spacing of each channel profile in which it is configured.

Verifying OFDM Modulation Profile Configuration

To display the OFDM modulation profile details, use the **show cable ofdm-modulation-profiles** command as shown in the example below:

```
Router# show cable ofdm-modulation-profile 10

**** OFDM Modulation Profile Configuration ****

Prof  FFT  Width     Start-freq Modulations
ID    KHz  Hz        Hz
10    50   96000000  627000000  64   default
                                512  freq-abs  709050000 width   12000000
                                2048 freq-abs  629000000 width    6000000

Profile Subcarrier Modulations
  Modulation: Start-freq-abs[start-sc] - End-freq-abs[end-sc] Width-freq[num-sc]
  64  : 572600000[   0] -  626950000[1087]    54400000[1088]
  64  : 627000000[1088] -  628950000[1127]     2000000[  40]
  2048: 629000000[1128] -  634950000[1247]     6000000[ 120]
  64  : 635000000[1248] -  709000000[2728]    74050000[1481]
  512 : 709050000[2729] -  721000000[2968]    12000000[ 240]
  64  : 721050000[2969] -  722950000[3007]     1950000[  39]
  64  : 723000000[3008] -  777350000[4095]    54400000[1088]

**** OFDM Modulation Profile Assigned Channel Profiles ****

Prof  Channel
ID    Profiles
10    30
```

To display the associations between OFDM modulation profiles and OFDM channel profiles, use the **show cable ofdm-modulation-profile** command with **channel-profiles** option as shown in the example below:

```
Router# show cable ofdm-modulation-profile channel-profiles

**** OFDM Modulation Profile Assigned Channel Profiles ****

Prof  Channel
ID    Profiles
8     None
9     28
10    30
192   192
```

To display the OFDM modulation profile configurations, use the **show cable ofdm-modulation-profile** command with **configuration** option as shown in the example below:

```
Router# show cable ofdm-modulation-profile configuration

**** OFDM Modulation Profile Configuration ****

Prof  FFT  Width     Start-freq Modulations             Description
ID    KHz  Hz        Hz                                (Limited to 20)
8     50   192000000 NA         2048 default
```

```
                                    512  freq-off   48000000
                                         width      24000000
9      50   96000000  627000000     512  default             512-1k-4k
                                    1024 freq-abs  635000000
                                         width      74050000
                                    4096 freq-abs  629000000
                                         width       6000000
10     50   96000000  627000000     64   default
                                    512  freq-abs  709050000
                                         width      12000000
                                    2048 freq-abs  629000000
                                         width       6000000
```

Configuring OFDM Channel Profile

To configure the OFDM channel profile, follow the steps below:

```
enable
configure terminal
cable downstream ofdm-chan-profile id
description text
cyclic-prefix value
interleaver-depth value
pilot-scaling value
roll-off value
subcarrier-spacing value
profile-ncp modulation-default mod_prof_id
profile-control {modulation-default mod_prof_id | modulation-profile mod_prof_id}
profile-data channel_data_prof_id {modulation-default mod_prof_id |
modulation-profile mod_prof_id}
```

Verifying OFDM Channel Profile Configuration

To display the OFDM channel profile details, use the **show cable ofdm-chan-profiles** command as shown in the example below:

```
Router# show cable ofdm-chan-profile 20

**** OFDM Channel Profile Configuration ****

Prof  Cycl  Roll  FFT  Intr   Pilot  Modulation (D-Default, P-Profile)
ID    Prfx  Off   KHz  Depth  Scale  Cntrl   NCP     Data Profiles

                                                     1       2       3       4       5

20    1024  128   50   16     48     D:1024  D:16    NA      NA      NA      NA      NA
**** OFDM Channel Profile Assigned Channels ****

Prof  Admin  Controller:channels
ID
20    Up     3/0/1:158             3/0/2:158             3/0/3:158             3/0/5:158

             3/0/6:158             3/0/7:158
```

To display the associations between OFDM channel profiles and OFDM channels, use the **show cable ofdm-chan-profiles** command with **channels** option as shown in the example below:

```
Router# show cable ofdm-chan-profile channels

**** OFDM Channel Profile Assigned Channels ****

Prof  Admin  Controller:channels
ID
20    Up     3/0/1:158             3/0/2:158             3/0/3:158             3/0/5:158

             3/0/6:158             3/0/7:158
30    Up     3/0/4:158
101   Up     3/0/0:158
```

To display the OFDM channel profile configurations, use the **show cable ofdm-chan-profiles** command with **configuration** option as shown in the example below:

```
Router# show cable ofdm-chan-profile configuration

**** OFDM Channel Profile Configuration ****

Prof  Cycl  Roll  FFT  Intr   Pilot  Modulation (D-Default, P-Profile)
  Description
ID    Prfx  Off   KHz  Depth  Scale  Cntrl   NCP     Data Profiles
  (Limited to 20)
                                                     1       2       3       4       5

0     192   128   50   16     48     D:256   D:16    D:1024  NA      NA      NA      NA
  System Profile 0
1     192   128   50   16     48     D:256   D:16    D:1024  D:2048  D:512   NA      NA
  System Profile 1
20    1024  128   50   16     48     D:1024  D:16    NA      NA      NA      NA     NA
30    1024  128   50   16     48     P:10    D:16    NA      NA      NA      NA      NA
```

Configuring OFDM Channel as Primary Channel

To configure an RF-channel in the mac-domain as an OFDM primary channel, use the following commands.

```
enable
configure terminal
interface cable <slot/subslot/port> downstream Integrated-Cable <slot/subslot/port>
rf-channel <ofdm-channel-number: 158-162>
end
```

Verifying OFDM Primary Channel Configuration

To display the OFDM channel configuration details, where the OFDM channel is the primary channel, use the command as shown in the following example:

```
Router#sh run int c3/0/3
Building configuration...

Current configuration : 539 bytes
!
interface Cable3/0/3
 load-interval 30
 downstream Integrated-Cable 3/0/3 rf-channel 0
 downstream Integrated-Cable 3/0/3 rf-channel 158
 upstream 0 Upstream-Cable 3/0/6 us-channel 0
 upstream 1 Upstream-Cable 3/0/6 us-channel 1
 upstream 2 Upstream-Cable 3/0/6 us-channel 2
```

```
 upstream 3 Upstream-Cable 3/0/6 us-channel 3
 cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes 80000000
 cable bundle 1
 cable cm-status enable 3 6-11 16-18 20-27
 cable privacy accept-self-signed-certificate
end
```

You can also use the following command to display the OFDM primary channel configuration details as shown in this example.

```
Router#sh cable mac-domain c3/0/3 cgd-associations
CGD Host  Resource  DS Channels            Upstreams    (ALLUS)   Active DS
Ca3/0/3   3/0/3     0                      0-3          Yes        0
                    158                    0-3          Yes        158
```

The **show cable mac-domain Cable <slot>/<subslot>/<port> mdd** command also displays the OFDM primary channel configuration details as shown in the example.

```
...
Downstream Active Channel List
        Channel ID:             159
        Frequency:              836000000Hz
        Primary Capable:        Primary-Capable
        CM-STATUS Event Bitmask:0x36
                                MDD Timeout
                                QAM FEC failure
                                MDD Recovery
                                QAM FEC recovery
        MAP/UCD Transport Indicator:  Can carry MAPs and UCDs
        OFDM PLC Params Bitmask:
               Tukey raised cosine window: 0.625
               Cyclic Prefix: 5.0
               Sub carrier spacing: 50
```

RF channels use a zero-based numbering scheme, whereas the downstream channel IDs are numbered starting from one. Thus RF channel 158 is equivalent to channel ID 159. The Channel ID in this example is 159. The `MAP/UCD Transport Indicator` shows that MAPs and UCDs are sent only on Primary Channels.

Configuring Port or Controller and Channel

To configure the port/controller and channel, use the following commands:

```
enable
configure terminal
controller integrated-cable slot/subslot/port
max-ofdm-spectrum value
ofdm-freq-excl-band start-frequency value width value
rf-chan start_id [end_id]
ofdm channel-profile id start-frequency value width value [plc value]
```

Note The range of *start_id* is 158 to 162 in the OFDM channel configuration.

The maximum OFDM spectrum is assigned to OFDM channels, which is used by the the CMTS to calculate default port base power.

Ranges of frequencies can be excluded from all OFDM channels using the **ofdm-freq-excl-band** command.

Verifying Port/Controller and Channel Configuration

To display the RF port details, use the **show controller integrated-cable** command with **rf-port** option as shown in the example below:

```
Router# show controller integrated-cable 3/0/0 rf-port

Admin:  UP  MaxCarrier: 128  BasePower: 33 dBmV  Mode: normal
  Rf Module 0: UP
  Free freq block list has 3 blocks:
    45000000  - 107999999
    624000000 - 644999999
    837000000 - 1217999999
  Rf Port Status: UP
  MaxOfdmSpectrum:  192000000   Equivalent 6MHz channels: 32
  UsedOfdmSpectrum: 192000000   AvailOfdmSpectrum:        0
  DefaultBasePower: 33 dBmV     Equivalent 6MHz channels: 160
  OFDM frequency exclusion bands: None
```

To display the summary information on OFDM channel, use the **show controller integrated-cable** command with **rf-channel** option as shown in the example below:

```
Router# show controller integrated-cable 3/0/0 rf-channel 158

Chan State Admin Mod-Type  Start       Width     PLC        Profile-ID    dcid  power
output
                           Frequency
 158   UP   UP   OFDM      627000000   96000000  663000000       20       159   34
NORMAL
```

To display detailed information on OFDM channel, use the **show controller integrated-cable** command with **rf-channel** and **verbose** options as shown in the example below:

```
Router# show controller integrated-cable 3/0/0 rf-channel 158 verbose

Chan State Admin Mod-Type  Start       Width     PLC        Profile-ID    dcid  power
output
                           Frequency
 158   UP   UP   OFDM      627000000   96000000  663000000       30       159   32
NORMAL
 Resource status:   OK
 License: granted <17:02:35 EDT May 18 2016>
 OFDM channel license spectrum width: 92200000
 OFDM modulation license (spectrum width): 2K (6000000)
 OFDM config state: Configured

 OFDM channel details: [3/0/4:158]
-----------------------------------------
 OFDM channel frequency/subcarrier range     : 627000000[1088] - 722999999[3007]
 OFDM spectrum frequency/subcarrier range    : 572600000[   0] - 777399999[4095]
```

```
Active spectrum frequency/subcarrier range  : 628900000[1126] - 721049999[2969]
OFDM channel center frequency/subcarrier    : 675000000[2048]
PLC spectrum start frequency/subcarrier     : 663000000[1808]
PLC frequency/subcarrier                    : 665800000[1864]
Channel width                               : 96000000
Active Channel width                        : 92200000
OFDM Spectrum width                         : 204800000
Chan prof id                                : 30
Cyclic Prefix                               : 1024
Roll off                                    : 128
Interleave depth                            : 16
Spacing                                     : 50KHZ
Pilot Scaling                               : 48
Control modulation profile                  : 10
NCP modulation default                      : 16
Data modulation default                     : None
Data modulation profile                     : None
Lower guardband width in freq/subcarriers   : 1900000[38]
Upper guardband width in freq/subcarriers   : 1900000[38]
Licensed 4K modulation spectrum width       : 0
Licensed 2K modulation spectrum width       : 6000000

PLC spectrum frequencies [subcarriers]             :
 663000000[1808] - 668999999[1927]

PLC channel frequencies [subcarriers]                :
 665800000[1864] - 666199999[1871]   Size: 8 subcarriers

Excluded frequencies [subcarriers]                :
 572600000[   0] - 628899999[1125]     721100000[2970] - 777399999[4095]
 Count: 2252

Pilot frequencies [subcarriers]                   :
 *:PLC pilots
 630700000[1162]   634300000[1234]   637900000[1306]   641500000[1378]
 645100000[1450]   648700000[1522]   652300000[1594]   655900000[1666]
 659500000[1738]   663450000[1817]*  664050000[1829]*  664600000[1840]*
 665050000[1849]*  666900000[1886]*  667350000[1895]*  667900000[1906]*
 668500000[1918]*  669100000[1930]   672700000[2002]   676300000[2074]
 679900000[2146]   683500000[2218]   687100000[2290]   690700000[2362]
 694300000[2434]   697900000[2506]   701500000[2578]   705100000[2650]
 708700000[2722]   712300000[2794]   715900000[2866]   719500000[2938]
 Count: 32

Active frequencies [subcarriers]                  :
 628900000[1126] - 721099999[2969]
 Count: 1844

Data frequencies [subcarriers]                    :
 628900000[1126] - 630699999[1161]     630750000[1163] - 634299999[1233]
 634350000[1235] - 637899999[1305]     637950000[1307] - 641499999[1377]
 641550000[1379] - 645099999[1449]     645150000[1451] - 648699999[1521]
 648750000[1523] - 652299999[1593]     652350000[1595] - 655899999[1665]
 655950000[1667] - 659499999[1737]     659550000[1739] - 663449999[1816]
 663500000[1818] - 664049999[1828]     664100000[1830] - 664599999[1839]
 664650000[1841] - 665049999[1848]     665100000[1850] - 665799999[1863]
 666200000[1872] - 666899999[1885]     666950000[1887] - 667349999[1894]
 667400000[1896] - 667899999[1905]     667950000[1907] - 668499999[1917]
 668550000[1919] - 669099999[1929]     669150000[1931] - 672699999[2001]
 672750000[2003] - 676299999[2073]     676350000[2075] - 679899999[2145]
 679950000[2147] - 683499999[2217]     683550000[2219] - 687099999[2289]
 687150000[2291] - 690699999[2361]     690750000[2363] - 694299999[2433]
 694350000[2435] - 697899999[2505]     697950000[2507] - 701499999[2577]
 701550000[2579] - 705099999[2649]     705150000[2651] - 708699999[2721]
```

```
 708750000[2723] - 712299999[2793]     712350000[2795] - 715899999[2865]
 715950000[2867] - 719499999[2937]     719550000[2939] - 721099999[2969]
 Count: 1804

Profiles:
 Number of profiles: 2
 CTRL profile (Profile A): rate: 461916 kbps, usable rate: 368000 kbps
 Active frequencies [subcarriers]:
 Modulation:Start-freq[start-subcarrier] - End-freq[end-subcarrier]
 ------------------------------------------------------------------
 64   :628900000[1126] - 628950000[1127]     2048 :629000000[1128] - 630650000[1161]
 2048 :630750000[1163] - 634250000[1233]     2048 :634350000[1235] - 634950000[1247]
 64   :635000000[1248] - 637850000[1305]     64   :637950000[1307] - 641450000[1377]
 64   :641550000[1379] - 645050000[1449]     64   :645150000[1451] - 648650000[1521]
 64   :648750000[1523] - 652250000[1593]     64   :652350000[1595] - 655850000[1665]
 64   :655950000[1667] - 659450000[1737]     64   :659550000[1739] - 663400000[1816]
 64   :663500000[1818] - 664000000[1828]     64   :664100000[1830] - 664550000[1839]
 64   :664650000[1841] - 665000000[1848]     64   :665100000[1850] - 665750000[1863]
 64   :666200000[1872] - 666850000[1885]     64   :666950000[1887] - 667300000[1894]
 64   :667400000[1896] - 667850000[1905]     64   :667950000[1907] - 668450000[1917]
 64   :668550000[1919] - 669050000[1929]     64   :669150000[1931] - 672650000[2001]
 64   :672750000[2003] - 676250000[2073]     64   :676350000[2075] - 679850000[2145]
 64   :679950000[2147] - 683450000[2217]     64   :683550000[2219] - 687050000[2289]
 64   :687150000[2291] - 690650000[2361]     64   :690750000[2363] - 694250000[2433]
 64   :694350000[2435] - 697850000[2505]     64   :697950000[2507] - 701450000[2577]
 64   :701550000[2579] - 705050000[2649]     64   :705150000[2651] - 708650000[2721]
 64   :708750000[2723] - 709000000[2728]     512  :709050000[2729] - 712250000[2793]
 512  :712350000[2795] - 715850000[2865]     512  :715950000[2867] - 719450000[2937]
 512  :719550000[2939] - 721000000[2968]     64   :721050000[2969] - 721050000[2969]
 Active subcarrier count: 1804, ZBL count: 0
 Discontinuity time [days:hours:mins:secs]: 00:00:54:32 [16:15:02 EDT May 18 2016]

 NCP profile:
 Active frequencies [subcarriers]:
 Modulation:Start-freq[start-subcarrier] - End-freq[end-subcarrier]
 ------------------------------------------------------------------
 16   :628900000[1126] - 630650000[1161]     16   :630750000[1163] - 634250000[1233]
 16   :634350000[1235] - 637850000[1305]     16   :637950000[1307] - 641450000[1377]
 16   :641550000[1379] - 645050000[1449]     16   :645150000[1451] - 648650000[1521]
 16   :648750000[1523] - 652250000[1593]     16   :652350000[1595] - 655850000[1665]
 16   :655950000[1667] - 659450000[1737]     16   :659550000[1739] - 663400000[1816]
 16   :663500000[1818] - 664000000[1828]     16   :664100000[1830] - 664550000[1839]
 16   :664650000[1841] - 665000000[1848]     16   :665100000[1850] - 665750000[1863]
 16   :666200000[1872] - 666850000[1885]     16   :666950000[1887] - 667300000[1894]
 16   :667400000[1896] - 667850000[1905]     16   :667950000[1907] - 668450000[1917]
 16   :668550000[1919] - 669050000[1929]     16   :669150000[1931] - 672650000[2001]
 16   :672750000[2003] - 676250000[2073]     16   :676350000[2075] - 679850000[2145]
 16   :679950000[2147] - 683450000[2217]     16   :683550000[2219] - 687050000[2289]
 16   :687150000[2291] - 690650000[2361]     16   :690750000[2363] - 694250000[2433]
 16   :694350000[2435] - 697850000[2505]     16   :697950000[2507] - 701450000[2577]
 16   :701550000[2579] - 705050000[2649]     16   :705150000[2651] - 708650000[2721]
 16   :708750000[2723] - 712250000[2793]     16   :712350000[2795] - 715850000[2865]
 16   :715950000[2867] - 719450000[2937]     16   :719550000[2939] - 721050000[2969]
 Active subcarrier count: 1804, ZBL count: 0

CCCs:
  OCD CCC: 2
  DPD CCCs:
    Control profile  (Profile A) CCC: 2
        NCP profile  CCC: 2
Resource config time taken: 2286 msecs


JIB channel number: 776
```

```
Chan Pr EnqQ  Pipe  RAF   SyncTmr DqQ ChEn   RAF Pipe Phy0 Phy1 Tun# SessId 0[TkbRt MaxP]
    1[TkbRt MaxP]
 776  0   384     1   725       0 384 0100 13032    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  1   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  2   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  3   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  4   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  5   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  6   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  7   384     1     0       0 384 0100     0    1    0    1    2      0 479610000 4485120
 383688000 4485120

Chan   Qos-Hi   Qos-Lo    Med-Hi   Med-Lo    Low-Hi   Low-Lo
 776   368640   245760    368640   245760    614400   368640
Chan  Med Low TB-neg Qos_Exc  Med_Xof  Low_Xof  Qdrops(H-M-L)  Pos    Qlen(Hi-Med-lo) Fl
Tgl_cnt Rdy_sts
  776   0   0      0       0        0        0    0    0    0  Y      0      0      0  0
     0 ff
Chan       Rate   Neg   Pos    LastTS  CurrCr  Pos  [PLC Rate Neg Pos]
 776   10485750 65535 65535 116199669 268431360   Y [MM 86 128 1114][EM 87 128 6204][TR 2
9 3102]
DSPHY Info:
 Local rf port 0 , rf chan 158 pic loss 123
 non short CWs: = 235681130, shorts = 0, stuff bytes = 235639172 bch 235681130
 NCP msgs: = 453809753, PLC encodings = 16902476
 flow0 rcv 70203 flow1 rcv 3 flow0 drops 0 flow1 drops 0
```

Configuration Examples

This section provides examples for configuring the OFDM channel.

Example1: Configuring OFDM Channel

Note The OFDM modulation profile must be configured before the OFDM channel profile which references it.

The following example shows how to configure the OFDM channel:

```
enable
configure terminal
cable downstream ofdm-modulation-profile 9
description 512-1k-4k
subcarrier-spacing 50KHz
width 96000000
start-frequency 627000000
assign modulation-default 512-QAM
assign modulation 1024-QAM range-subcarriers freq-abs 635000000 width 74050000
assign modulation 4096-QAM range-subcarriers freq-abs 629000000 width 6000000
```

```
exit
configure terminal
cable downstream ofdm-chan-profile 20
description Data profiles: 2 single mod, 1 mixed mod
cyclic-prefix 192
interleaver-depth 16
pilot-scaling 48
roll-off 128
subcarrier-spacing 50KHz
profile-ncp modulation-default 16-QAM
profile-control modulation-default 256-QAM
profile-data 1 modulation-default 1024-QAM
profile-data 2 modulation-default 2048-QAM
profile-data 3 modulation-profile 9
exit
configure terminal
controller integrated-cable 3/0/0
max-ofdm-spectrum 96000000
ofdm-freq-excl-band start-frequency 683000000 width 10000000
rf-chan 158
power-adjust 0
docsis-channel-id 159
ofdm channel-profile 20 start-frequency 627000000 width 96000000 plc 663000000
```

Example 2: Configuring OFDM Primary Channel in the MAC Domain

```
enable
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
interface cable 3/0/0
downstream Integrated-Cable 3/0/3 rf-channel 158
end
```

Additional References

Related Document

Document Title	Link
Cisco cBR Converged Broadband Routers Layer 2 and DOCSIS 3.0 Configuration Guide	http://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_cbr_layer2_docsis30.html

MIBs

MIBs	MIBs Link
DOCS-IF31-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

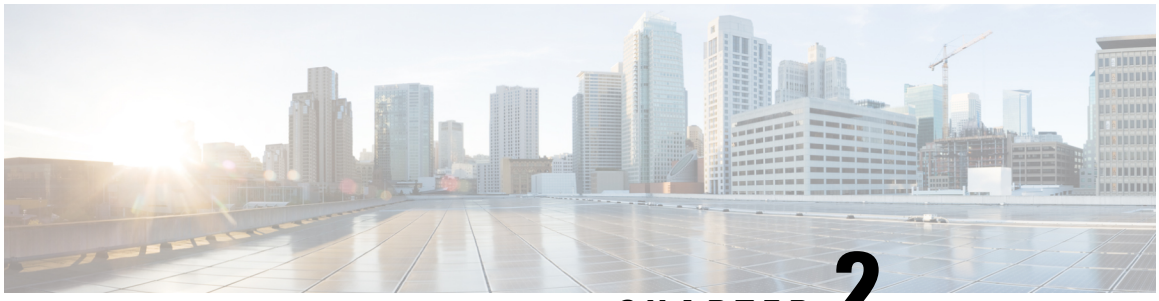
Feature Information for DOCSIS 3.1 OFDM Channel Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 2: Feature Information for DOCSIS 3.1 OFDM Channel Configuration

Feature Name	Releases	Feature Information
DOCSIS 3.1 OFDM Channel Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Full Spectrum 108-1218 MHz Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
DOCSIS 3.1 OFDM Primary Channel Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Enhanced support for subcarrier spacing, exclusion band, and LCPR	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Hitless OFDM Profile Changes	Cisco IOS XE Everest 16.12.1x	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Ephemeral Profile to Cable Modem Assignment	Cisco IOS XE Everest 16.12.1x	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Profile Management Application Scaling	Cisco IOS XE Everest 16.12.1z	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 2

OFDM Channel Power Profile

The OFDM Channel Power Profile feature helps in adjusting the power-level of 6 MHz bands in a DOCSIS 3.1 downstream OFDM channel.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

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 3: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information About OFDM Channel Power Profile

The OFDM power profile provides a better, consistent power-level output at the cable modem, compensating the power levels at a finer granularity. It reduces the differing amounts of cable-loss over the bandwidth of OFDM channel.

This feature enables the Cisco cBR Series Converged Broadband Router to correct the transmission loss due to the cable in the plant.

The OFDM power profile (ofdm-power-profile) adjusts the transmission power level of each 6 MHz in an OFDM channel. The OFDM channel width can range from 24 MHz to 192 MHz, resulting in band-counts between 4 and 32 for the profile.

Each 6 MHz band is referenced by a band index (band-index) that is zero-based, with a maximum band range of 192 MHz OFDM channel being 0 to 31. Each band within the OFDM channel can have a unique power level setting. The OFDM power profile allows a total band adjustment range of 8 dB. Under some specific conditions, if the OFDM channel's downstream controller's base channel power is set to exceed the maximum DRFI specification power level, the OFDM power profile adjustment range can become as high as 9 dB.

In a power profile, you can set the power level (power-adjust-default) to a default value. This default value is applied to any band that is not configured through any other means.

You can configure band power levels in two methods: through the power tilt config (power-tilt-linear) or by configuring the power level for a band or range of bands (band-index). You can use both methods for configuring the band power levels simultaneously within an OFDM power profile.

The power tilt configuration applies a linear power-adjust value between the `power-adjust-default` value applied to the band index 0, and the power-tilt-linear adjust value applied to the highest band index of the profile. For example, an OFDM Power Profile of 96 MHz, with a power-tilt-linear of 4 dB, and power-adjust-default of 0 dB, has16 bands numbered 0 to 15, band index 0 is +0 dB, band index 15 is +4 dB, and bands 1 to 14 contain the linear power level setting based on the slope of the line between the band 0 and band 15 to the nearest 1/10th dB.

The band-index configuration applies a specified value to the indicated bands. The band-index configuration can specify a single band or a range of bands. A power-adjust configuration is used to specify the power level for the bands to the nearest 1/10th dB.

You can simultaneously use both power tilt and band index, where band-index is applied last. When you use both, the power-tilt-linear values can be overridden using the band-index power-adjust values.

A maximum of 64 OFDM power profiles can be configured on the Cisco cBR routers, numbered from 1 to 64. You can apply a single OFDM power profile to multiple controller OFDM channels, across line cards, as long as all validity checks pass during configuration. The router console displays an error message explaining any configuration errors or warnings.

Restrictions for Configuring OFDM Power Profile

The following restrictions are applicable for configuring an OFDM power profile:

- OFDM power profile can be configured only on DOCSIS 3.1 system
- The power profile can be applied only to downstream controller OFDM channels (RF-channels 158 to 162)

How to Configure the OFDM Channel Power Profile

Configuring OFDM Power Profile Using Band-index

Use the following commands along with the band-index configuration to configure OFDM Power Profile, where the band-index values act as an override.

```
enable
configure terminal
cable downstream ofdm-power-profile <profile_id>
  power-adjust-default -2.1
  band-index 0 7
```

```
    power-adjust -1.0
  band-index 8 15
    power-adjust -0.5
  band-index 16 23
    power-adjust 0.5
  band-index 24 31
    power-adjust 1.5

controller Integrated-Cable {slot}/{subslot}/{port}
rf-channel {158 - 162 }
power-profile {ofdm-power-profile-id}
```

Verifying the Power Profile Configuration

To display the power profile configuration details, use the **show cable ofdm-power-profile** command as given in the following example. This command also displays the actual power-band power levels as set by the profile.

```
Router> show cable ofdm-power-profile 3
OFDM Power Profile 3

Power-Adjust-Default(*): -2.1

Power-Band:
[00-07]   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0
[08-15]   -0.5   -0.5   -0.5   -0.5   -0.5   -0.5   -0.5   -0.5
[16-23]    0.5    0.5    0.5    0.5    0.5    0.5    0.5    0.5
[24-31]    1.5    1.5    1.5    1.5    1.5    1.5    1.5    1.5

  +4 .0 |
        |
  +3 .0 |
        |
  +2 .0 |                                                 * * * * * * * *
        |
  +1 .0 |                                   * * * * * * * *
        |
  +0 .0 | ------------------------------------------------------------------
        |                 * * * * * * * *
  -1 .0 | * * * * * * * * *
        |
  -2 .0 |
        |
  -3 .0 |
        |
  (dB)    0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 3 3
          0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
                              band-index
```

Configuring OFDM Power Profile with Linear Power-tilt

Use the following commands to configure the OFDM power profile with a linear power-tilt and the band-index override.

```
enable
configure terminal
cable downstream ofdm-power-profile <profile_id>
  power-adjust-default 0.0
  power-tilt-linear 3.5
  band-index 0
  power-adjust 4.0
```

Verifying the Power Profile Using show controller Command

Use the **show controller** command to display the absolute power-band levels as set by the power profile. When the power-profile is applied to the controller, the power level displayed is the actual transmit power level in dBmV.

```
Router>show controller Integrated-Cable 3/0/0 rf-channel 158 verbose
Chan State Admin Mod-Type  Start  Width     PLC        Profile-ID    dcid  power  output
                           Frequency
 158   UP   UP   OFDM      849000000   96000000  856000000       20       159   33.0
NORMAL
 Resource status:   OK
 License: granted <09:23:14 EDT Aug 1 2016>
 OFDM channel license spectrum width: 92200000
 OFDM config state: Configured

 OFDM Power Profile: 3
Power-Band:
[00-07]   32.0   32.0   32.0   32.0   32.0   32.0   32.0   32.0
[08-15]   32.5   32.5   32.5   32.5   32.5   32.5   32.5   32.5
[16-23]   33.5   33.5   33.5   33.5   33.5   33.5   33.5   33.5
[24-31]   34.5   34.5   34.5   34.5   34.5   34.5   34.5   34.5

OFDM channel details: [3/0/0:158]
-----------------------------------------
```

Configuration Example for OFDM Power Profile

This section provides example for the OFDM Power Profile configuration.

Example: OFDM Power Profile with Linear Power-tilt Configuration

```
enable
configure terminal
cable downstream ofdm-power-profile 3
  power-adjust-default 0.0
  power-tilt-linear 3.5
  band-index 0
  power-adjust 4.0
```

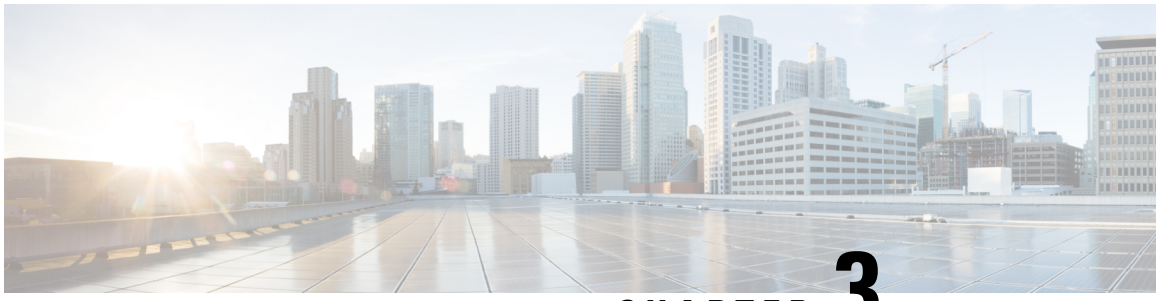
Feature Information for OFDM Channel Power Profile

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 4: Feature Information for OFDM Channel Power Profile

Feature Name	Releases	Feature Information
OFDM Channel Power Profile	Cisco IOS XE Fuji 16.7.1	This feature was integrated into the Cisco cBR Series Converged Broadband Routers.



CHAPTER 3

DOCSIS 3.1 Path Selection

This document describes how to configure the path selecion on the Cisco cBR Series Converged Broadband Router.

Information about Path Selection

DOCSIS 3.1 Path Selection feature is enhanced to support OFDM downstream channels and OFDMA upstream channels. The RCC selection process is enhanced to include OFDM channels. The TCC selection process is enhanced to include OFDMA channels.

How to Configure Path Selection

Configuring Downstream Bonding Group with OFDM Channel

To configure the downstream bonding group with OFDM channel, follow the steps below:

```
enable
configure terminal
interface wideband-cable slot/subslot/bay:wideband-channel
description text
cable bundle id
cable rf-channels channel-list grouplist bandwidth-percent percentage-bandwidth
```

Note Channel 158 to 162 are specified as OFDM channel.

Verifying Downstream Bonding Group with OFDM Channel Configuration

To display the details of the downstream bonding group with OFDM channel, use the **show running-config interface** command as shown in the example below:

```
Router# show running-config interface wideband-cable 3/0/0:13

Building configuration...

Current configuration : 212 bytes
!
interface Wideband-Cable3/0/0:13
 description D31-DSBG: 1 SC-QAM plus 1 OFDM
 cable bundle 1
 cable rf-channels channel-list 8 bandwidth-percent 30
 cable rf-channels channel-list 158 bandwidth-percent 25
end
```

Configuring Upstream Bonding Group with OFDMA Channel

To configure the upstream bonding group with OFDMA channel, follow the steps below:

```
enable
configure terminal
interface cable slot/subslot/bay
cable upstream bonding-group id
upstream id
```

Verifying Upstream Bonding Group with OFDMA Channel Configuration

To display the details of the upstream bonding group with OFDMA channel, use the **show running-config interface** command as shown in the example below:

```
Router# show running-config interface cable 6/0/3
Building configuration...

Current configuration : 212 bytes
!
interface Cable6/0/3
 load-interval 30
 downstream Integrated-Cable 6/0/1 rf-channel 158
 upstream 0 Upstream-Cable 1/0/0 us-channel 0
 upstream 1 Upstream-Cable 1/0/0 us-channel 1
 upstream 2 Upstream-Cable 1/0/0 us-channel 2
 upstream 3 Upstream-Cable 1/0/0 us-channel 3
 upstream 6 Upstream-Cable 1/0/0 us-channel 12
 cable upstream balance-scheduling
 cable upstream bonding-group 2
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  upstream 6
  attributes 80000000
 cable bundle 1
 cable privacy accept-self-signed-certificate
!
```

Verifying the Path Selection Status

To display the path selection status of a cable modem, use the **show cable modem path-sel** command as shown in the example below:

```
router#show cable modem 38c8.5cfe.efa6 path-sel

CM 38c8.5cfe.efa6 Path-Sel Info: 07:20

RCS Filter Result: Succeed
Candidate RCS List: 2
  RCC-Id   Owner-Id   Preliminary  RCP      TLV-56   LBG      SF-Attr   CM-Attr
  1        1 :12289   Pass         Pass      --      Pass     Pass      Pass
  2        1 :12290   Pass         Pass      --      Pass     Pass      Pass

TCS Filter Result: Succeed
TCS Info:
  TCS in CGD            : 0x7         UCID: 1 2 3
  TCS in Freq Range     : 0x7         UCID: 1 2 3
  TCS Impaired          : 0x0
TCS Passed filters:
  Preliminary           : 0x7         UCID: 1 2 3
  LB Group              : 0x7         UCID: 1 2 3
  SF Attr Mask          : 0x7         UCID: 1 2 3
  CM Attr Mask          : 0x7         UCID: 1 2 3

Candidate US-BG List: 4
  UBG-Id   Chan-Mask    Preliminary  TLV-56   LBG      SF-Attr   CM-Attr
  1        0x7          Pass          --      Pass     Pass      Pass
  65537    0x2          Pass          --      Pass     Pass      Pass
  65538    0x4          Pass          --      Pass     Pass      Pass
  65536    0x1          Pass          --      Pass     Pass      Pass

Primary DS Chan Result: Skipped
Candidate Primary DS Chan List: 0

Primary US Chan Result: Skipped
Candidate Primary US Chan List: 0
```

Clearing the Path Selection Status

To clear the path selection status for all CMs, use the **clear cable modem all path-sel** command as shown in the example below:

```
Router# clear cable modem all path-sel

Router# show cable modem c8fb.26a6.c46a path-sel

CM c8fb.26a6.c46a Path-Sel Info: N/A
Path-Sel status has been cleared after register online.
```

Verifying the RCC Configuration

To verify the runtime RCCs on a cable interface, use the **show cable mac-domain rcc** command as shown in the example below:

```
Router# show cable mac-domain cable 7/0/0 rcc
```

```
RCC-ID   RCP               RCs MD-DS-SG CMs   WB/RCC-TMPL      D3.0 D3.1
4        00 00 00 00 00    16  0        1     WB (Wi7/0/0:0)   Y    Y
5        00 00 00 00 00    25  0        2     WB (Wi7/0/0:1)   N    Y
6        00 10 00 00 08    8   0        0     RCC-TMPL(3:1)    Y    N
7        00 00 00 00 00    4   0        0     WB (Wi7/0/0:4)   Y    Y
```

To display the detailed information for only DOCSIS 3.1 capable RCC, use the **show cable mac-domain rcc simplified** command as shown in the example below:

```
router#show cable mac-domain cable 7/0/0 rcc 5 simplified

RCC ID                 : 5
Created Via            : Wideband - Wi7/0/0:1
CM attribute mask      : 0x80000000

Primary Receive Channel List:
  Chan Idx   RF Chan         DCID  Freq
  1          In7/0/0:0       1     453000000

Non-Primary Receive Channel List:
  Chan Idx   RF Chan         DCID  Freq
  2          In7/0/0:1       2     459000000
  3          In7/0/0:2       3     465000000
  4          In7/0/0:3       4     471000000
  5          In7/0/0:4       5     477000000
  6          In7/0/0:5       6     483000000
  7          In7/0/0:6       7     489000000
  8          In7/0/0:7       8     495000000
  9          In7/0/0:8       9     501000000
  10         In7/0/0:9       10    507000000
  11         In7/0/0:10      11    513000000
  12         In7/0/0:11      12    519000000
  13         In7/0/0:12      13    525000000
  14         In7/0/0:13      14    531000000
  15         In7/0/0:14      15    537000000
  16         In7/0/0:15      16    543000000
  17         In7/0/0:16      17    549000000
  18         In7/0/0:17      18    555000000
  19         In7/0/0:18      19    561000000
  20         In7/0/0:19      20    567000000
  21         In7/0/0:20      21    573000000
  22         In7/0/0:21      22    579000000
  23         In7/0/0:22      23    585000000
  24         In7/0/0:23      24    591000000
  25         In7/0/0:158     159   663000000

OFDM Receive Channel List:
  Chan Idx   RF Chan         DCID  PLC-Freq        Profiles
  25         In7/0/0:158     159   663000000       0 1 2
```

Additional References

Related Document

Document Title	Link
Cisco cBR Converged Broadband Routers Layer 2 and DOCSIS 3.0 Configuration Guide	http://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_cbr_layer2_docsis30.html

MIBs

MIBs	MIBs Link
• DOCS-IF31-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

Feature Information for DOCSIS 3.1 Path Selection

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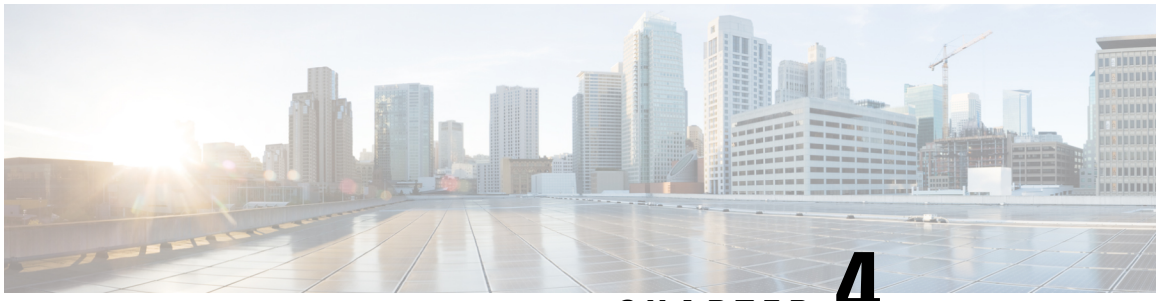
Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 5: Feature Information for DOCSIS 3.1 Path Selection

Feature Name	Releases	Feature Information
DOCSIS 3.1 Path Selection	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
DOCSIS 3.1 Upstream Path Selection	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 4

DOCSIS 3.1 Downstream Profile Selection

First Published: July 13, 2016

DOCSIS 3.1 introduces the concept of downstream profiles for OFDM channels.

Contents

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 6: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about Downstream Profiles

A profile is a list of modulation orders that are defined for each of the subcarriers within an OFDM channel. The CMTS can define multiple profiles for use in an OFDM channel, where the profiles differ in the modulation orders assigned to each subcarrier. The CMTS can assign different profiles for different groups of CMs.

Default Data Profile

The first time a CM registers, it is assigned a default data profile. The default data profile is "profile-data 1". If "profile-data 1" is not configured, "profile-control" is assigned to the CM.

Note Profile A, with profile ID 0, is also referred to as the control profile.

Recommended Profile

Based on the Receive Modulation Error Ratio (RxMER) values collected from a modem, the CMTS finds among the existing profiles the one that may provide the highest speed, and yet at the same time may have sufficient Signal to Noise Ratio (SNR) margin for the modem to receive code words with acceptable error. This profile is called the recommended profile for that CM. The **show cable modem phy ofdm-profile** command displays the recommended profile for each CM. The CMTS does not automatically upgrade a CM's profile to the recommended profile. Recommended Profile will take effect when the CM is reset by the operator. When the CM comes back online, recommended profile is assigned to it.

A user configurable age is associated with each recommended profile, which can be configured as follows:

```
Router (config)#cable downstream ofdm-prof-mgmt recommend-profile-age age-in-minutes
```

If the recommended profile exceeds this age, it is no longer valid for that CM.

Unfit Profile

When the CMTS receives CM-STATUS Event 16 (DS OFDM Profile Failure), the profile indicated in the CM-STATUS message is marked as 'unfit profile' for this modem.

A user configurable maximum age is associated with each unfit profile, which can be configured as follows:

```
Router (config)#cable downstream ofdm-prof-mgmt unfit-profile-age age-in-minutes
```

If the unfit profile for a modem exceeds this age, it is no longer valid.

How to Configure Profiles

Configuring Profile Downgrade

A CM sends a CM-STATUS Event 16 message to indicate a DS OFDM profile failure. When this indication is received by the CMTS, it takes immediate action to downgrade the modem to a lower profile, as per the profile ordering displayed by the following command:

```
Router# show controllers integrated-Cable 2/0/3 rf-channel 158 prof-order
```

The following table, extracted from [DOCSIS 3.1 MULPI], lists the CM-Status events that will trigger a profile downgrade:

Table 7: Table: CM-Status Events for Profile Downgrade

Event Type	Event Condition	Status Report Events		Parameters reported by CM	
		Trigger event to "on"	Trigger event to "off"	DCID	Profile ID

Event Type	Event Condition	Status Report Events		Parameters reported by CM	
16	DS OFDM profile failure	Loss of FEC lock on one of the assigned downstream OFDM profiles of a channel	Re-establishment of FEC lock for that OFDM profile; OR Removal of the channel from the active channel list in the primary channel MDD; OR Removal of the channel from the CM's Receive Channel set via DBC-REQ	Yes	Yes

To disable the automatic profile downgrade, use the following command in global configuration mode:

```
Router (config)#no cable downstream ofdm-prof-mgmt prof-dwngrd-auto
```

Configuring RxMER to Bit Loading Mapping

There are many ways to map the RxMER values to bit loading values. We use the following mapping recommended in [DOCSIS 3.1 OSSI], as our baseline mapping:

RxMER (in ¼ DB)	QAM	Bit Loading
60	16	4
84	64	6
96	128	7
108	256	8
122	512	9
136	1024	10
148	2048	11
164	4096	12
184	8192	13
208	16384	14

- To configure a margin to adjust the RxMER to bit loading mapping, use the following command:

```
Router(config)# cable downstream ofdm-prof-mgmt mer-margin-qdb quarter-DB
```

This configured value (*quarter-DB*) is added to the RxMER values collected by CMTS before using the above mapping table, thus giving a user more control in selecting the recommended profiles.

- To specify the percentage of subcarriers that can be ignored in the recommended profile calculation, use the following command:

```
Router(config)# cable downstream ofdm-prof-mgmt exempt-sc-pct percent
```

This provides a way to specify the extent that the outliers can be ignored.

Hitless OFDM Profile Changes

Cisco cBR supports Hitless OFDM Profile from Cisco IOS XE Everest 16.12.1x, as a Profile Management Application (PMA) tool.

The operation is as follows:

1. PMA determines if the modulation order of a data profile in an OFDM channel can be upgraded or downgraded. This decision is based on the MER data that is received from cable modems that uses the profile.
2. Poll cBR for all modems with active profiles to identify inactive ones.
3. Move modems to a temporary data profile if all are in use. Note that this is not control profile.
4. Delete any unused OFDM profile. The PMA repeats step 2 and step 3 to avoid race conditions.
5. Add (or Delete) a new OFDM profile with the desired modulation order to the OFDM channel.
6. Define the new profile list for the modems (DBC sent to modems by cBR).
7. Move modems to the new profile.

Ephemeral Profile to Cable Modem Assignment

Cisco cBR supports Ephemeral Profile to Cable Modem Assignment from Cisco IOS XE Everest 16.12.1x, as a Profile Management Application (PMA) tool.

If the modem is not listening to the desired profile, you can submit up to 4 data profiles. The PMA wants to be active for that cable modem before issuing the profile assignment command. The control profile zero (0) is always included by default.

The following commands are supported:

- **cable modem <mac> ofdm-set-profiles chan <n> profiles <profile list>**

  This command initiates a DBC to the cable modem with the specified profile list. The profile list order defines the downgrade profile in case the CM-STATUS is 16.

- **cable downstream ofdm-flow-to-profile interface <integrated-Cable x/y/z:n> profile-data <n> mac-address <mac>**

  This command enables the CMTS to start forwarding all traffic to the cable modem using the specified profile. Ensure that you use the accompanying **cable modem mac-address mac opt0** command for the changes to take effect immediately.

Move the cable modems traffic to one of the profiles that it is listening to. DBC is not necessary. If the profile is not active on the cable modem, then the CLI reports error. If the CMTS receives a CM-STATUS 16 for that profile, the CMTS downgrades the profile automatically.

The CM-STATUS does not reset when moving to another profile.

Display the Cable Modem Count per Profile

Feature History

Table 8: Feature History

Feature Name	Release Information	Feature Description
Display CM counts per US IUC and DS profile	Cisco IOS XE Bengaluru 17.6.1x	This feature introduces new commands **show cable modem phy ofdm downstream prof-count** and **show cable modem phy ofdm upstream iuc-count**, it helps tracking and reporting number of Cable Modems being in use per Upstream IUC and Downstream Profile on each controller separately. These counters are indicative of health of the RF plant.

To display the CM count per downstream channel and profile, use the **show cable modem phy ofdm downstream prof-count** command as shown in the examples below:

```
Router#show cable modem phy ofdm downstream prof-count
                      |<---------------------------- CM Count per profile
-------------------------->|
Channel       IF-INDX  P-0  P-1  P-2  P-3  P-4  P-5  P-6  P-7  P-8  P-9 P-10 P-11 P-12 P-13
 P-14 P-15
------------- ------- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ----
 ---- ----
In0/0/0:158   264134     0    0    0    3    0    0    -    -    -    0    -    -    -
-    -    -
In0/0/0:159   264135     0    0    0    3    0    0    -    -    -    0    -    -    -
-    -    -
Do9/0/0:158   321478     1    0    0    0    4    0    -    -    -    0    -    -    -
-    -    -
```

Or use the command in the example below:

```
Router#show controllers downstream-cable 9/0/0 rf-channel 158 prof-status

Profile status:
------------------------------------------------------
Control profile: Oper state: UP, Modem count: 1
    Modem list: 4800.33ef.3aea
Data profile  1: Oper state: UP, Modem count: 0
Data profile  2: Oper state: UP, Modem count: 0
Data profile  3: Oper state: UP, Modem count: 0
Data profile  4: Oper state: UP, Modem count: 4
    Modem list: 4800.33ef.06ca 4800.33ef.0d1a 4800.33ea.716a 4800.33ef.3c52

Data profile  5: Oper state: UP, Modem count: 0
```

Additional References

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

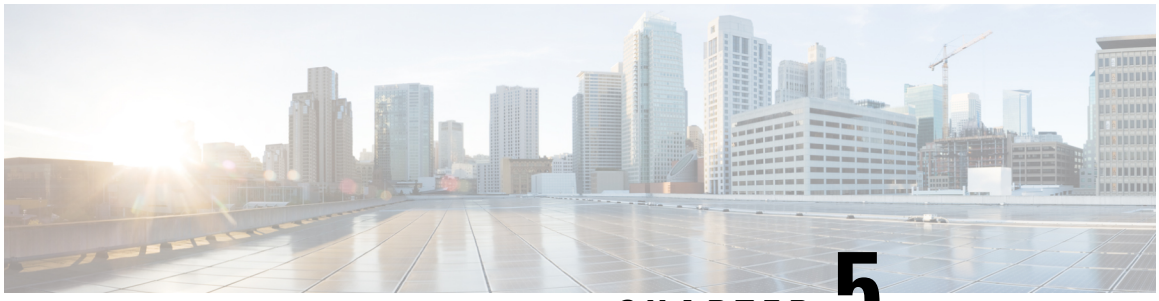
Feature Information for Downstream Profile Selection

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 9: Feature Information for Downstream Profile Selection

Feature Name	Releases	Feature Information
Downstream Profile Selection	Cisco IOS XE Everest 16.6.1	This feature was integrated into Cisco IOS XE Everest 16.6.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 5

DOCSIS 3.1 Commanded Power for Upstream SC-QAMs

This guide describes commanded power for upstream SC-QAMs on the Cisco cBR 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 10: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information About Commanded Power Feature for Upstream SC-QAMs

To view the new commanded power levels pr upstream, use the following command:

```
Router# show cable modem [ ip-address | mac-address | cable {slot /subslot
/cable-interface-index}] verbose
```

Note DOCSIS 3.1 Commanded Power feature is enabled by default.

Feature TLVs

TLVs Affected by Commanded Power for US SC-QAMs

The following table lists the TLVs affected by the DOCSIS 3.1 Ranging Response (RNG-RSP) Commanded Power for upstream SC-QAMs:

Name	Type	DOCSIS 3.1 Value
Power Level Adjust	2	TX Power offset adjustment (signed 8-bit, 1/4-dB units)
Power Offset	12.4.4	TX Power offset adjustment (signed 8-bit, 1/4-dB units)
Dynamic Range Window Upper Edge	14	The upper edge of the Dynamic Range Window expressed in units 1/4 dB below the max allowable setting (Phi) [DOCSIS PHYv3.0].
Commanded Power	17	This TLV contains the Dynamic Range Window value, P1.6load_min_set as well as the Transmit Power Level for each of the channels in the CM's Transmit Channel Set, expressed in units of quarter dBmV.

Commanded Power Sub-TLVs

The following table lists the sub-TLVs for DOCSIS 3.1 Commanded Power:

Name	Type (1 byte)	Length (1 byte)	Value (Variable Length)
Commanded Power	17	5 + 3*N	
Dynamic Range Window	17.1	1	The range, in decibels, of the maximum difference in power per 1.6 MHz between multiple transmitters in a cable modem’s Transmit Channel Set.

Name	Type (1 byte)	Length (1 byte)	Value (Variable Length)
List of Upstream Channel IDs and Corresponding Transmit Power Levels	17.2	3*N	Values for each channel in the TCS: • Bits 23 to 16: UCID • Bits 15 to 0: Transmit Power Level (quarter dBmV)

Additional References

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

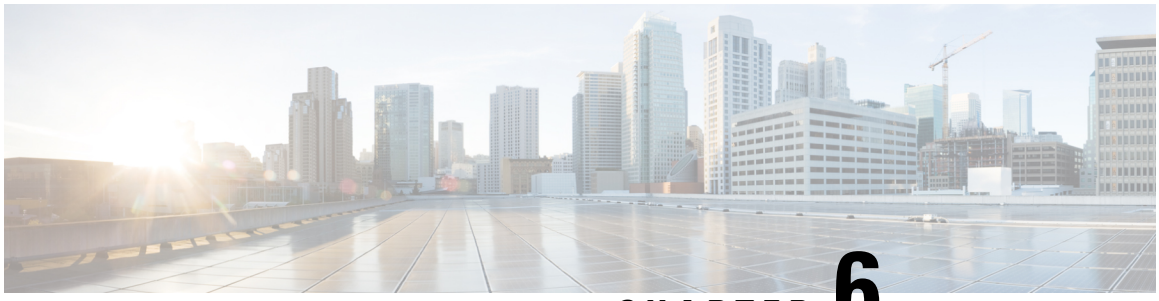
Feature Information for Commanded Power for US SC-QAMs

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 11: Feature Information for Commanded Power Feature

Feature Name	Releases	Feature Information
DOCSIS 3.1 Commanded Power for US SC-QAMs	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 6

DOCSIS3.1 Downstream Resiliency for OFDM channel

This document describes how to configure the DOCSIS3.1 Downstream Resiliency for OFDM channel on the Cisco cBR Series Converged Broadband Router.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

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 12: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about DOCSIS3.1 Downstream Resiliency for OFDM Channel

When DOCSIS3.1 CM reports non-primary RF channel failure for SCQAM or OFDM channel, actions performed by downstream resiliency is the same as DOCSIS3.0 CM. In other words, if RF channel impairment is below the resiliency threshold, CMs service flows are moved to Resiliency Bonding Group (RBG) or Narrow Band (NB) interface. If RF channel impairment is above the resiliency threshold, the impaired RF channel is temporarily removed from the bonding group.

The following table summarizes the CM-STATUS events for OFDM channel, and the action to be taken by the downstream resiliency module:

Table 13: CM-STATUS events for OFDM channel

Event Type Code	Event Description	DS Resiliency Action
1	MDD timeout	Move CM's service flows to RBG/NB or suspend RF from BG.
2	FEC lock failure	Move CM's service flows to RBG/NB or suspend RF from BG.
4	MDD recovery	Move CM's service flows back to original BG.
5	FEC lock recovery	Move CM's service flows back to original BG.
16	DS OFDM profile failure. A loss of FEC lock on one of the assigned downstream OFDM profiles of a channel.	DS OFDM Profile Manager will handle this event and take action.
20	NCP profile failure. Loss of FEC lock on NCP.	Move CM's service flows to RBG/NB or suspend RF from BG.
21	Loss of FEC lock on the PLC.	Move CM's service flows to RBG/NB or suspend RF from BG.
22	NCP profile recovery.	Move CM's service flows back to original BG.
23	FEC recovery on PLC channel.	Move CM's service flows back to original BG.
24	FEC recovery on OFDM profile.	Recovery of impairment reported by event 16. DS OFDM Profile Manager will handle this event and take action.

How to Configure DOCSIS3.1 Downstream Resiliency for OFDM Channel

Configuring DOCSIS3.1 Downstream Resiliency for OFDM Channel

User must configure the command **cable rf-change-trigger percent** *value* **count** *number* to enable the downstream resiliency functionality.

To configure the trigger thresholds specific to OFDM RF impairment, follow the steps below:

```
enable
configure terminal
cable ofdm-rf-change-trigger percent value counter number [no-ncp-plc]
```

Starting from Cisco IOS XE Fuji 16.10.1d release, you can exclude NCP and PLC reports separately by following these steps:

```
enable
configure terminal
cable ofdm-rf-change-trigger percent value counter number [no-ncp] [no-plc]
```

Trigger thresholds *value* and *number* apply globally to the non-primary OFDM RF channels. If this command is not configured, the trigger thresholds configured by the command **cable rf-change-trigger percent** *value* **count** *number* will be used for the non-primary OFDM channels.

With **no-ncp-plc** configured in the command, this feature will not take any action when CM reports CM-STATUS-EVENT 20 or 21.

Note The **cable rf-change-trigger percent** *value* **count** *number* command is optional and the configured trigger thresholds apply to non-primary OFDM channels only.

Displaying OFDM Specific CM-STATUS Events

To display the statistics of the OFDM specific CM-STATUS events, use the **show cable modem wideband rcs-status** command as shown in the example below:

```
router#show cable modem 4800.33ea.7072 wideband rcs-status verbose
CM  : 4800.33ea.7072
RF  : 3/0/0 0
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  Flaps                   : 0
  Flap Duration           : 00:00
RF  : 3/0/0 1
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  Flaps                   : 0
  Flap Duration           : 00:00
RF  : 3/0/0 159
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
```

```
FEC/QAM Recovery          : 0
Dup FEC/QAM Recovery      : 0
MDD Failure               : 0
Dup MDD Failure           : 0
MDD Recovery              : 0
Dup MDD Recovery          : 0
NCP PROF Failure          : 2          May 8  15:14:24
Dup NCP PROF Failure      : 0
NCP PROF Recovery         : 1          May 8  15:15:18
Dup NCP PROF Recovery     : 0
PLC Lock Failure          : 1          May 8  15:14:47
Dup PLC Lock Failure      : 0
PLC Lock Recovery         : 1          May 8  15:15:46
Dup PLC Lock Recovery     : 0
Flaps                     : 0
Flap Duration             : 00:00
OFDM Profile Id : 2
Status                    : UP
Profile Failure           : 1          May 8  15:16:18
DUP Profile Failure       : 0
Profile Recovery          : 1          May 8  15:16:44
DUP Profile Recovery      : 0
```

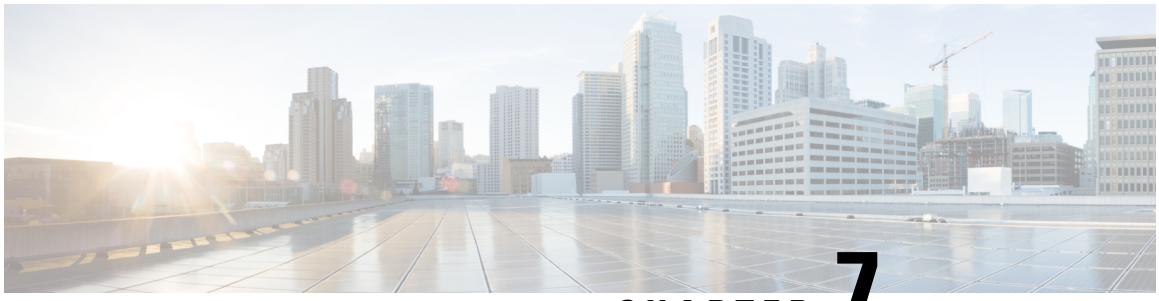
Feature Information for DOCSIS3.1 Downstream Resiliency for OFDM Channel

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 14: Feature Information for DOCSIS3.1 Downstream Resiliency for OFDM Channel

Feature Name	Releases	Feature Information
DOCSIS3.1 Downstream Resiliency for OFDM Channel	Cisco IOS XE Everest 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 7

DOCSIS 3.1 OFDMA Channel Configuration

This document describes how to configure the OFDMA channel 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 15: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about OFDMA Channel Configuration

OFDMA Channels

DOCSIS 3.1 introduces modes for higher throughput and higher spectral efficiency while still allowing backward compatibility to DOCSIS 3.0. Orthogonal Frequency Division Multiple Access (OFDMA) channel has following features:

- Frequency-range up to 96 MHz
- Upstream spectrum 5 – 204 MHz

- 25 kHz subcarrier spacing
- OFDMA Channel-width up to 80 MHz - The Cisco IOS XE Fuji 16.7.x release supports configuration of a single 80 MHz OFDMA channel on every port of a line card.
- OFDMA Channel-width up to 96 MHz - The Cisco IOS XE 16.8.x release supports configuration of a single 96 MHz OFDMA channel on every port of a line card.
- OFDMA Upstream spectrum 5 – 85 MHz - The Cisco IOS XE Fuji 16.7.x supports a maximum frequency value of 85 Mhz for an OFDMA channel.
- OFDMA Upstream spectrum 5 – 204 MHz - The Cisco IOS XE 16.8.x extends the supported maximum frequency value of an OFDMA channel from 85 Mhz to 204 Mhz.

For a specific subcarrier spacing, the number of subcarriers on an OFDMA channel depends on the channel width.

Channel Width	50 kHz	25 kHz
48 MHz	960	1920
96 MHz	1920	3840

Note When the OFDMA is configured with SC-QAMs on the same port pair, it is recommended to configure no more than 45 MHz OFDMA per port, or 90 MHz per port pair in Cisco IOS XE Everest Release 16.6.1.

Modulation Profile

A globally configured OFDMA modulation profile defines modulation orders and pilot patterns for different interval usage codes (IUC). You can also use it to assign parameters for initial ranging and fine ranging.

The following table gives information on the supported modulation orders.

Modulation Order	Support
BPSK	Yes
QPSK	Yes
8-QAM	Yes
16-QAM	Yes
32-QAM	Yes
64-QAM	Yes
128-QAM	Yes
256-QAM	Yes
512-QAM	Yes

Modulation Order	Support
1024-QAM	Yes
2048-QAM	Yes
4096-QAM	No

OFDMA Channel Exclusion Band

Ranges of frequencies can be excluded from all OFDMA channels on a port using the **ofdma-frequency-exclusion-band** command.

Exclusion and unused bands apply to OFDMA channels only. OFDMA channel never use frequencies in exclusion band. So the legacy SC-QAM channel can be placed in this band. OFDMA channel does not use frequencies in unused band set by **ofdma-frequency-unused-band** command for data traffic, but can send probes in them.

Configure OFDMA Channel

Configuring OFDMA Controller Profile

To configure upstream controller profile, follow the steps below:

```
enable
configure terminal
cable mod-profile-ofdma id
subcarrier-spacing value
initial-rng-subcarrier value
fine-rng-subcarrier value
data-iuc id modulation  value pilot-pattern  value
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)#cable mod-profile-ofdma 425
Router(config)#subcarrier-spacing 25KHz
Router(config)#initial-rng-subcarrier 64
Router(config)#fine-rng-subcarrier 192
Router(config)#data-iuc 5 modulation 2048-QAM pilot-pattern 11
Router(config)#data-iuc 6 modulation 1024-QAM pilot-pattern 11
Router(config)#data-iuc 9 modulation 256-QAM pilot-pattern 11
Router(config)#data-iuc 10 modulation 128-QAM pilot-pattern 11
Router(config)#data-iuc 11 modulation 64-QAM pilot-pattern 11
Router(config)#data-iuc 12 modulation 32-QAM pilot-pattern 11
Router(config)#data-iuc 13 modulation 16-QAM pilot-pattern 11
Router(config)# cable mod-profile-ofdma 466
Router(config-ofdma-mod-profile)# subcarrier-spacing 50KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 128
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 1024-QAM pilot-pattern 2
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 1024-QAM pilot-pattern 2
```

```
Router(config-ofdma-mod-profile)# exit
Router(config)# cable mod-profile-ofdma 423
Router(config-ofdma-mod-profile)# subcarrier-spacing 25KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 128
Router(config-ofdma-mod-profile)# data-iuc 6 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 9 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 10 modulation 512-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 11 modulation 256-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 12 modulation 128-QAM pilot-pattern 9
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 64-QAM pilot-pattern 9
```

Note Subcarrier spacing must match the subcarrier spacing of each channel profile in which it is configured.

Verifying OFDMA Modulation Profile Configuration

To display the OFDMA modulation profile details, use the **show cable modulation-profile ofdma** command as shown in the example below:

```
Router# show cable modulation-profile ofdma
Mod  Subc     IUC type   Act  Preamble  Bit       Pilot
     Spacing             subc Symbols   Loading   Pattern
421  25KHz    3  (IR)    64      4
              4  (FR)    192     1
              13 (data)                16-QAM    8

423  25KHz    3  (IR)    64      4
              4  (FR)    128     1
              6  (data)                1024-QAM  8
              10 (data)                512-QAM   8
              11 (data)                256-QAM   8
              12 (data)                128-QAM   9
              13 (data)                64-QAM    9

461  50KHz    3  (IR)    32      4
              4  (FR)    192     1
              13 (data)                16-QAM    1

466  50KHz    3  (IR)    64      4
              4  (FR)    128     1
              13 (data)                1024-QAM  2
```

Configuring OFDMA Channel

Feature History

Table 16: Feature History

Feature Name	Release Information	Feature Description
Remote PHY 2 OFDMA channels per controller support	Cisco IOS XE Bengaluru 17.6.1x	This feature allows you to configure two OFDMA channels on the same Upstream-Cable controller in a Remote PHY deployment.

To configure the OFDMA channel, follow these steps:

```
enable
configure terminal
controller Upstream-Cable slot/subslot/port
us-channel id docsis-mode ofdma
us-channel id subcarrier-spacing value
us-channel id frequency-range start-value end-value
us-channel id modulation-profile id
us-channel id cyclic-prefix value roll-off-period value
us-channel id symbols-per-frame value
us-channel id data-iuc id band start-value end-value modulation value pilot-pattern
 value
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# controller Upstream-Cable 1/0/4
Router(config-controller)# us-channel 12 docsis-mode ofdma
Router(config-controller)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller)# us-channel 12 frequency-range 40000000 85000000
Router(config-controller)# us-channel 12 modulation-profile 423
Router(config-controller)# us-channel 12 cyclic-prefix 640 roll-off-period 224
Router(config-controller)# us-channel 12 symbols-per-frame 9
Router(config-controller)# us-channel 12 data-iuc 9 band 50000000 60000000 modulation 512-QAM
 pilot-pattern 8
Router(config-controller)# no us-channel 12 shutdown
```

This is a configuration example for two OFDMA channels in Remote PHY deployment:

```
Router# enable
Router# configure terminal
Router(config)# cable upstream controller profile 1
Router(config-controller-profile)# us-channel 12 docsis-mode ofdma
Router(config-controller-profile)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 12 modulation-profile 423
Router(config-controller-profile)# us-channel 12 frequency-range 40000000 85000000
Router(config-controller-profile)# us-channel 12 initial-rng-frequency-start 50000000
Router(config-controller-profile)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller-profile)# us-channel 12 symbols-per-frame 12
Router(config-controller-profile)# no us-channel 12 shutdown
Router(config-controller-profile)# us-channel 13 docsis-mode ofdma
Router(config-controller-profile)# us-channel 13 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 13 modulation-profile 423
```

```
Router(config-controller-profile)# us-channel 13 frequency-range 108000000 204000000
Router(config-controller-profile)# us-channel 13 initial-rng-frequency-start 118000000
Router(config-controller-profile)# us-channel 13 cyclic-prefix 96 roll-off-period 64
Router(config-controller-profile)# us-channel 13 symbols-per-frame 12
Router(config-controller-profile)# no us-channel 13 shutdown

Router# configure terminal
Router(config)# cable rpd rpd-20
Router(config-rpd)# description RPD20
Router(config-rpd)# identifier badb.1111.1111
Router(config-rpd)# core-interface Te7/1/3
Router(config-rpd-core)# principal
Router(config-rpd-core)# rpd-ds 0 downstream-cable 7/0/31 profile 2
Router(config-rpd-core)# rpd-us 0 upstream-cable 7/0/63 profile 1
```

Note

- OFDMA uses us-channel range 12–15.
- Change docsis-mode to **ofdma** to enable OFDMA configuration options. These options are enabled by default on us-channel 12–15.
- The default us-channel is 12 docsis-mode (does not return configuration to default).
- In Cisco IOS XE Fuji 16.7.x and earlier releases, we recommend that you configure no more than four active SC-QAMs on the same controller while an OFDMA channel is present.
- You can configure a maximum of one OFDMA channel per controller. Starting from Cisco IOS XE Gibraltar 16.10.x release, two OFDMA channels—us-channel 12 and us-channel 13 can be configured per controller. Starting from Cisco IOS XE Bengaluru 17.6.1x release, you can configure two OFDMA channels in Remote PHY deployment.
- In Cisco IOS XE Everest 16.6.x release, place the OFDMA channel in the range from 40 through 85 MHz.
- In Cisco IOS XE Fuji 16.7.x and following releases, place OFDMA channels in the range from 5 through 85 MHz.
- Values of the options are often interdependent, changing one value may change other values or make them invalid.
- We recommend setting the subcarrier spacing and frequency range first. Frequency range must be increments of 50 kHz.
- Each fiber node supports two OFDMA channels.
- Each bonding group supports two OFDMA channels.
- Each controller pair supports a maximum of 192-Mhz OFDMA spectrum in iCCAP deployment.
- Each CBR-CCAP-LC-G2-R card supports a maximum of 32 OFDMA channels.

Verifying OFDMA Channel Configuration

To display the OFDMA channel configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/4 us-channel 12
USPHY OFDMA support: FULL


Controller 1/0/4 upstream 12  AdminState:UP OpState: UP
  ofdma mode enabled
  Channel Freq Range 35.500 MHz to 79.500 MHz
  Channel Subcarrier Index Range Cfg: 74, 953 Op: 74, 953
  Channel SC0 Freq Cfg: 31.800 MHz Op: 31.800 MHz
  #Excl bands: 2
  (   0,   73), ( 954, 2047),
  #Unused bands: 0
  Cyclic Prefix Size 96,  Rolloff Period Size 64
  Subcarrier Spacing 50KHz,  Symbols Per Frame 18 Subcarrier Per Minislot: 8

  Modulation Profile (ID 466, Subcarrier Spacing 50KHz)
    IUC type   Cfg   Act  Preamble Bit       Pilot
               subc  subc Symbols  Loading   Pattern
    3  (IR)    64    64      4       -         -
    4  (FR)    128   128     1       -         -
    13 (data)  -     -       -     1024-QAM    2
  Calculated Data burst profile:
  IUC  Group   Bit       Pilot   Start  Consec
               Loading   Pattern Mslot  Mslot
  13   0       1024-QAM  2       0       109

  #Total mslots:110 #Fine Rng capable:95 #Initial Rng capable:103
   Initial Rng - Freq 50.000MHz mslotOffset:36 #mslot in frame:8
  Minislot mapping:  mslot#(start_sc start_freq(Mhz) end_sc end_freq(Mhz)
   mslot type(E-Edge; B-Body; S-Share with SCQAM;
   I-Initial rng capable; F-Fine rng capable)
   (next Fine Rng capable minislot if current is not capable))
  0  (  74, 35.500,   81, 35.850, EIF ( - )), 1  (  82, 35.900,   89, 36.250, BIF ( - )),
  2  (  90, 36.300,   97, 36.650, BIF ( - )), 3  (  98, 36.700,  105, 37.050, BIF ( - )),
  4  ( 106, 37.100,  113, 37.450, BIF ( - )), 5  ( 114, 37.500,  121, 37.850, BIF ( - )),
  6  ( 122, 37.900,  129, 38.250, BIF ( - )), 7  ( 130, 38.300,  137, 38.650, BIF ( - )),
  8  ( 138, 38.700,  145, 39.050, BIF ( - )), 9  ( 146, 39.100,  153, 39.450, BIF ( - )),
  10 ( 154, 39.500,  161, 39.850, BIF ( - )), 11 ( 162, 39.900,  169, 40.250, BIF ( - )),
  12 ( 170, 40.300,  177, 40.650, BIF ( - )), 13 ( 178, 40.700,  185, 41.050, BIF ( - )),
  14 ( 186, 41.100,  193, 41.450, BIF ( - )), 15 ( 194, 41.500,  201, 41.850, BIF ( - )),
  16 ( 202, 41.900,  209, 42.250, BIF ( - )), 17 ( 210, 42.300,  217, 42.650, BIF ( - )),
  18 ( 218, 42.700,  225, 43.050, BIF ( - )), 19 ( 226, 43.100,  233, 43.450, BIF ( - )),
  20 ( 234, 43.500,  241, 43.850, BIF ( - )), 21 ( 242, 43.900,  249, 44.250, BIF ( - )),
  22 ( 250, 44.300,  257, 44.650, BIF ( - )), 23 ( 258, 44.700,  265, 45.050, BIF ( - )),
  24 ( 266, 45.100,  273, 45.450, BIF ( - )), 25 ( 274, 45.500,  281, 45.850, BIF ( - )),

  26 ( 282, 45.900,  289, 46.250, BIF ( - )), 27 ( 290, 46.300,  297, 46.650, BIF ( - )),
  28 ( 298, 46.700,  305, 47.050, BIF ( - )), 29 ( 306, 47.100,  313, 47.450, BIF ( - )),
  30 ( 314, 47.500,  321, 47.850, BIF ( - )), 31 ( 322, 47.900,  329, 48.250, BIF ( - )),
  32 ( 330, 48.300,  337, 48.650, BIF ( - )), 33 ( 338, 48.700,  345, 49.050, BIF ( - )),
  34 ( 346, 49.100,  353, 49.450, BIF ( - )), 35 ( 354, 49.500,  361, 49.850, BIF ( - )),
  36 ( 362, 49.900,  369, 50.250, BIF ( - )), 37 ( 370, 50.300,  377, 50.650, BIF ( - )),
  38 ( 378, 50.700,  385, 51.050, BIF ( - )), 39 ( 386, 51.100,  393, 51.450, BIF ( - )),
  40 ( 394, 51.500,  401, 51.850, BIF ( - )), 41 ( 402, 51.900,  409, 52.250, BIF ( - )),
  42 ( 410, 52.300,  417, 52.650, BIF ( - )), 43 ( 418, 52.700,  425, 53.050, BIF ( - )),
  44 ( 426, 53.100,  433, 53.450, BIF ( - )), 45 ( 434, 53.500,  441, 53.850, BIF ( - )),
  46 ( 442, 53.900,  449, 54.250, BIF ( - )), 47 ( 450, 54.300,  457, 54.650, BIF ( - )),
  48 ( 458, 54.700,  465, 55.050, BIF ( - )), 49 ( 466, 55.100,  473, 55.450, BIF ( - )),
  50 ( 474, 55.500,  481, 55.850, BIF ( - )), 51 ( 482, 55.900,  489, 56.250, BIF ( - )),
  52 ( 490, 56.300,  497, 56.650, BIF ( - )), 53 ( 498, 56.700,  505, 57.050, BIF ( - )),
  54 ( 506, 57.100,  513, 57.450, BIF ( - )), 55 ( 514, 57.500,  521, 57.850, BIF ( - )),
  56 ( 522, 57.900,  529, 58.250, BIF ( - )), 57 ( 530, 58.300,  537, 58.650, BIF ( - )),
  58 ( 538, 58.700,  545, 59.050, BIF ( - )), 59 ( 546, 59.100,  553, 59.450, BIF ( - )),
  60 ( 554, 59.500,  561, 59.850, BIF ( - )), 61 ( 562, 59.900,  569, 60.250, BIF ( - )),
```

```
62 ( 570, 60.300,  577, 60.650, BIF ( - )), 63 ( 578, 60.700,  585, 61.050, BIF ( - )),
64 ( 586, 61.100,  593, 61.450, BIF ( - )), 65 ( 594, 61.500,  601, 61.850, BIF ( - )),
66 ( 602, 61.900,  609, 62.250, BIF ( - )), 67 ( 610, 62.300,  617, 62.650, BIF ( - )),
68 ( 618, 62.700,  625, 63.050, BIF ( - )), 69 ( 626, 63.100,  633, 63.450, BIF ( - )),
70 ( 634, 63.500,  641, 63.850, BIF ( - )), 71 ( 642, 63.900,  649, 64.250, BIF ( - )),
72 ( 650, 64.300,  657, 64.650, BIF ( - )), 73 ( 658, 64.700,  665, 65.050, BIF ( - )),
74 ( 666, 65.100,  673, 65.450, BIF ( - )), 75 ( 674, 65.500,  681, 65.850, BIF ( - )),
76 ( 682, 65.900,  689, 66.250, BIF ( - )), 77 ( 690, 66.300,  697, 66.650, BIF ( - )),
78 ( 698, 66.700,  705, 67.050, BIF ( - )), 79 ( 706, 67.100,  713, 67.450, BIF ( - )),
80 ( 714, 67.500,  721, 67.850, BIF ( - )), 81 ( 722, 67.900,  729, 68.250, BIF ( - )),
82 ( 730, 68.300,  737, 68.650, BIF ( - )), 83 ( 738, 68.700,  745, 69.050, BIF ( - )),
84 ( 746, 69.100,  753, 69.450, BIF ( - )), 85 ( 754, 69.500,  761, 69.850, BIF ( - )),
86 ( 762, 69.900,  769, 70.250, BIF ( - )), 87 ( 770, 70.300,  777, 70.650, BIF ( - )),
88 ( 778, 70.700,  785, 71.050, BIF ( - )), 89 ( 786, 71.100,  793, 71.450, BIF ( - )),
90 ( 794, 71.500,  801, 71.850, BIF ( - )), 91 ( 802, 71.900,  809, 72.250, BIF ( - )),
92 ( 810, 72.300,  817, 72.650, BIF ( - )), 93 ( 818, 72.700,  825, 73.050, BIF ( - )),
94 ( 826, 73.100,  833, 73.450, BIF ( - )), 95 ( 834, 73.500,  841, 73.850, BI  (0  )),
96 ( 842, 73.900,  849, 74.250, BI  (0  )), 97 ( 850, 74.300,  857, 74.650, BI  (0  )),
98 ( 858, 74.700,  865, 75.050, BI  (0  )), 99 ( 866, 75.100,  873, 75.450, BI  (0  )),
100( 874, 75.500,  881, 75.850, BI  (0  )), 101( 882, 75.900,  889, 76.250, BI  (0  )),
102( 890, 76.300,  897, 76.650, BI  (0  )), 103( 898, 76.700,  905, 77.050, B   (0  )),
104( 906, 77.100,  913, 77.450, B   (0  )), 105( 914, 77.500,  921, 77.850, B   (0  )),
106( 922, 77.900,  929, 78.250, B   (0  )), 107( 930, 78.300,  937, 78.650, B   (0  )),
108( 938, 78.700,  945, 79.050, B   (0  )), 109( 946, 79.100,  953, 79.450, B   (0  )),

Mapped to connector 4 and receiver 108

Bind to Cable1/0/4 US4
MER(SNR) - Unknown - no modems online.
Spectrum Group is unassigned
Nominal Input Power Level 0 dBmV

UCD procedures on lch 0
UCD ucd-proxy-timeout   (0   ) ucd-proxy-wrong-ack (0   )
```

Configure Exclusion / Unused Bands

An OFDMA channel never use frequencies located in exclusion bands. OFDMA probes will be sent on frequencies located in the unused bands. Therefore exclusion bands must be used to prevent interference with SC-QAM channels. To configure the Exclusion / Unused Bands, follow the steps below:

enable
configure terminal
controller Upstream-Cable *slot/subslot/port*
cable ofdma-frequency-exclusion-band *start-value end-value*
cable ofdma-frequency-unused-band *start-value end-value*

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# controller Upstream-Cable 1/0/2
Router(config-controller)# cable ofdma-frequency-exclusion-band 48000000 54200000
Router(config-controller)# cable ofdma-frequency-unused-band 50000000 52000000
Router(config-controller)# us-channel 12 docsis-mode ofdma
Router(config-controller)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller)# us-channel 12 modulation-profile 423
Router(config-controller)# us-channel 12 frequency-range 45000000 70000000
Router(config-controller)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller)# us-channel 12 symbols-per-frame 18
```

Verifying Exclusion / Unused Bands

To display the Exclusion / Unused Band configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/2 us-channel 12
USPHY OFDMA support: FULL

Controller Exclusion Freq List:
( 40.000 MHz, 44.200 MHz),
Controller Unused Freq List:
( 50.000 MHz, 52.000 MHz),

Controller 1/0/9 upstream 12 AdminState:UP OpState: UP
ofdma mode enabled
Channel Freq Range 28.500 MHz to 69.500 MHz
Channel Subcarrier Index Range Cfg: 148, 1787 Op: 148, 1787
Channel SC0 Freq Cfg: 24.800 MHz Op: 24.800 MHz
#Excl bands: 3
( 0, 147), ( 608, 776), (1788, 4095),
#Unused bands: 3
( 596, 607), (1001, 1088), (1777, 1787),
```

Override OFDMA Profile Per Channel

It is possible to override the modulation and pilot pattern used by a particular IUC on a given OFDMA channel as shown with the command below.

enable
configure terminal
controller Upstream-Cable *slot/subslot/port*
us-channel *id* **data-iuc** *id* **band** *start-value end-value* **modulation** *value* **pilot-pattern** *value*

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# controller Upstream-Cable 1/0/2
Router(config-controller)# us-channel 12 docsis-mode ofdma
Router(config-controller)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller)# us-channel 12 modulation-profile 423
Router(config-controller)# us-channel 12 frequency-range 28000000 70000000
Router(config-controller)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller)# us-channel 12 symbols-per-frame 18
Router(config-controller)# us-channel 12 data-iuc 6 band 60000000 65000000 modulation 128-QAM
 pilot-pattern 9
Router(config-controller)# no us-channel 12 shutdown
```

Note Override values will be removed from US channel when changing modulation profile, including when profile changes due to changes in subcarrier spacing.

From Cisco cBR Series Converged Broadband Router 16.12.1w and later, the limitation of one IUC override per IUC configuration no longer applies for cBR-8 I-CMTS controller implementations on the CBR-LC-8D31-16U31 line card and R-PHY implementations on CBR-LC-8D31-16U31,

CBR-CCAP-LC-40G-R, and CBR-CCAP-LC-G2-R line cards. The OFDMA - 4 override zones per IUC feature increases the number of overrides that can be defined to four per IUC.

A maximum channel configuration would appear as below:

```
controller Upstream-Cable 1/0/0
us-channel 12 data-iuc 5 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 5 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 5 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 5 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
us-channel 12 data-iuc 6 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 6 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 6 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 6 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
us-channel 12 data-iuc 9 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 9 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 9 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 9 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
us-channel 12 data-iuc 10 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 10 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 10 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 10 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
us-channel 12 data-iuc 11 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 11 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 11 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 11 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
us-channel 12 data-iuc 12 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 12 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 12 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 12 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
us-channel 12 data-iuc 13 band 40500000 41500000 modulation 64-QAM pilot-pattern 8
us-channel 12 data-iuc 13 band 42000000 43500000 modulation 128-QAM pilot-pattern 8
us-channel 12 data-iuc 13 band 44000000 45500000 modulation 256-QAM pilot-pattern 8
us-channel 12 data-iuc 13 band 46000000 47500000 modulation 512-QAM pilot-pattern 8
```

This allows nine modulation zones per profile across the channel. So, for example, for a modem using IUC 5, the channel modulation would be as follows:

```
router# show controller Upstream-Cable 1/0/0 us-channel 12 cdm-ump | beg Rang
Ranging profile:
IUC 3, preamble_len 256, sc mode 25KHz active_sc 64 guard_sc 0
IUC 4, preamble_len 192, sc mode 25KHz active_sc 192 guard_sc 0
Calculated Data burst profile:
  IUC  Group   Bit       Pilot   Start  Consec
               Loading   Pattern Mslot  Mslot
   5     0    1024-QAM     8       0      24
   5     1      64-QAM     8      25       1
   5     2    1024-QAM     8      27       1
   5     3     128-QAM     8      29       2
   5     4    1024-QAM     8      32       1
   5     5     256-QAM     8      34       2
   5     6    1024-QAM     8      37       1
   5     7     512-QAM     8      39       2
   5     8    1024-QAM     8      42      42
 ...
```

Note

- All subcarriers within a single OFDMA minislot must be assigned the same modulation order. Different modulation orders cannot be assigned to different subcarriers within the same minislot.
- If a modulation override configuration is applied that places the frequency start and/or end within the middle of a minislot, the entire minislot will receive the override configuration.
- If two adjacent modulation overrides overlap the same minislot, the minislot receives the modulation configuration of the last override configuration. In most cases this will be the higher frequency override modulation.
- For the RPHY cards, the OFDMA - 4 override zones per IUC enhancement is supported with all RPD types that support OFDMA.

Verifying Override Configuration

To display the override configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/2 us-channel 12
 .....
   Modulation Profile (ID 423, Subcarrier Spacing 25KHz)
    IUC type   Cfg   Act  Preamble Bit       Pilot
               subc  subc Symbols  Loading   Pattern
    3  (IR)    64    64     4       -         -
    4  (FR)    128   128    1       -         -
    6  (data)  -     -      -       1024-QAM  8
    10 (data)  -     -      -       512-QAM   8
    11 (data)  -     -      -       256-QAM   8
    12 (data)  -     -      -       128-QAM   9
    13 (data)  -     -      -       64-QAM    9
  Overwrite Data Profile:
  IUC  Start      End        Start   End    Bit       Pilot
       Freq(MHz)  Freq(MHz)  Subc    Subc   Loading   Pattern
  6      60.0      65.0      1408    1608   128-QAM   9

  Calculated Data burst profile:
  IUC  Group   Bit       Pilot   Start  Consec
               Loading   Pattern Mslot  Mslot
  6    0       1024-QAM  8       0      61
  6    1       128-QAM   9       62     11
  6    2       1024-QAM  8       74     10
  10   0       512-QAM   8       0      84
  11   0       256-QAM   8       0      84
  12   0       128-QAM   9       0      84
  13   0       64-QAM    9       0      84
 ......
```

Apply OFDMA Upstream To Cable Interface

To associate upstream channels with a MAC domain and configure upstream bonding, follow the steps below:

```
enable
configure terminal
```

```
interface Cable slot/subslot/interface
cable upstream bonding-group id
upstream id
attributes value
cable bundle id
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# interface Cable 1/0/4
Router(config-if)# downstream Integrated-Cable 1/0/4 rf-channel 0
Router(config-if)# downstream Integrated-Cable 1/0/4 rf-channel 16
Router(config-if)# upstream 0 Upstream-Cable 1/0/0 us-channel 0
Router(config-if)# upstream 1 Upstream-Cable 1/0/0 us-channel 1
Router(config-if)# upstream 2 Upstream-Cable 1/0/0 us-channel 2
Router(config-if)# upstream 3 Upstream-Cable 1/0/0 us-channel 3
Router(config-if)# upstream 6 Upstream-Cable 1/0/0 us-channel 12
Router(config-if)# cable upstream bonding-group 1
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# attributes 80000000
Router(config-upstream-bonding)# exit
Router(config-if)# cable upstream bonding-group 2
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# upstream 6
Router(config-upstream-bonding)# attributes 80000000
Router(config-upstream-bonding)# exit
Router(config-if)# cable bundle 1
```

Determine DOCSIS 3.1 Cable Modems and the Cable Modems Using OFDMA Upstreams

To display the DOCSIS 3.1 cable modem, use the **show cable modem docsis version d31-capable** command as shown in the example below:

```
Router# show cable modem docsis version d31-capable
MAC Address    I/F            MAC              Reg Oper DSxUS DS   RCC   US
                              State            Ver Ver        OFDM ID    OFDMA
4800.33ea.7012 C1/0/0/UB      w-online(pt)     3.1 3.1  33x4  1    5     1
203d.66ae.4169 C1/0/0/UB      w-online(pt)     3.1 3.1  33x4  1    5     1
```

To display DOCSIS PHY layer information for the cable modem, use the **show cable modem phy** command as shown in the example below:

```
Router# show cable modem 5039.5584.5bbe phy
MAC Address    I/F        Sid   USPwr  USMER Timing DSPwr  DSMER  Mode   DOCSIS
                             (dBmV) (SNR) Offset (dBmV) (SNR)         Prov
                                    (dB)                (dB)
5039.5584.5bbe C1/0/0/U0  15    38.75  ----- 2282   0.00   -----  ofdma  1.1
```

To display the cable modem using OFDMA upstream, use the **show cable modem phy** command as shown in the example below:

```
Router# show cable modem phy | include ofdma
5039.5584.5bbe C1/0/0/U0     15    38.75  ----- 2282    0.00  -----  ofdma  1.1
0895.2a9b.26f1 C1/0/0/U0     16    28.00  ----- 2146    0.00  -----  ofdma  1.1
```

To display the OFDMA channel capacity and utilization, use the **show interface cable mac-scheduler** command as shown in the example below:

```
Router# show interfaces cable 1/0/2 mac-scheduler 6
     DOCSIS 1.1 MAC scheduler for Cable1/0/2/U6 : rate 279807192
     Max potential performance for each configured IUC type
     IUC: 6     rate: 279807192
     IUC: 10    rate: 263104848
     IUC: 11    rate: 233779840
     IUC: 12    rate: 203019328
     IUC: 13    rate: 173899376
     wfq:None
     us_balance:OFF
     dpon_mode:OFF
     fairness:OFF
     Queue[Rng Polls] flows 0
     Queue[CIR Grants] flows 0
     Queue[BE(07) Grants] flows 0
     Queue[BE(06) Grants] flows 0
     Queue[BE(05) Grants] flows 0
     Queue[BE(04) Grants] flows 0
     Queue[BE(03) Grants] flows 0
     Queue[BE(02) Grants] flows 0
     Queue[BE(01) Grants] flows 0
     Queue[BE(00) Grants] flows 0
     Req Slots 38510548
     Req/Data Slots 1275
     Init Mtn Slots 47832
     Stn Mtn Slots 0
     IUC 5 Slots 0
     IUC 6 Slots 6378
     IUC 9 Slots 0
     IUC 10 Slots 254923830
     IUC 11 Slots 220
     IUC 12 Slots 4006
     IUC 13 Slots 251213508
     Avg upstream channel utilization : 0%
     Avg upstream channel utilization in 30 sec : 0%
     Avg percent contention slots : 96%
     Avg percent initial ranging slots : 0%
     Avg percent minislots lost on late MAPs : 0%

     MAP TSS: lch_state 10, init_retries 0
              late_initial_maps 0, late_ucd_maps 0
              mac-phy tss errors 0, missed ccc 0
```

Verifying DOCSIS 3.1 Upstream OFDMA channel bonding across DOCSIS 3.0 ATDMA channels

Starting from Cisco IOS XE Everest 16.6.1 release, DOCSIS 3.1 Upstream OFDMA channel can be bonded with DOCSIS 3.0 ATDMA channel. If the user wants to utilize non-best effort flows, it is recommended to bond the OFDMA channel with one or more ATDMA channels. But be aware that in Cisco IOS XE Everest 16.6.1 release, a maximum of 1 OFDMA channel and 4 ATDMA channels can be bonded together.

Below is an output example showing the bonding group 8 has both OFDMA (channel 12) and ATDMA channels (channel 0, 1, 2, 3).

```
interface Cable6/0/0
downstream Integrated-Cable 6/0/0 rf-channel 1
downstream Integrated-Cable 6/0/0 rf-channel 158
upstream 0 Upstream-Cable 6/0/0 us-channel 0
upstream 1 Upstream-Cable 6/0/0 us-channel 1
upstream 2 Upstream-Cable 6/0/0 us-channel 2
upstream 3 Upstream-Cable 6/0/0 us-channel 3
upstream 6 Upstream-Cable 6/0/0 us-channel 12
cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes 80000000
cable upstream bonding-group 8
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  upstream 6
  attributes 80000000
cable bundle 1
cable privacy accept-self-signed-certificate
end
```

Display the OFDMA Performance Statistics

Feature History

Table 17: Feature History

Feature Name	Release Information	Feature Description
RPHY support for show cable upstream ofdma mer-fec command	Cisco IOS XE Bengaluru 17.6.1x	This feature introduces the command **show cable upstream ofdma mer-fec** in Remote PHY deployment to get the channel performance statistics for the upstream OFDMA channel.
RPHY support for show cable upstream ofdma mer-fec command	Cisco IOS XE Bengaluru 17.6.1x	This feature introduces the command **show cable upstream ofdma mer-fec** in Remote PHY deployment to get the channel performance statistics for the upstream OFDMA channel.

To display the OFDMA channel performance statistics at chassis level, use the **show cable upstream ofdma mer-fec** command as shown in the example below:

```
Router#show cable upstream ofdma mer-fec
Upstream:IUC           MER(dB)      TotalFecCW            CorrectedFecCW
UncorrFecCW          UncorrCW% MD:upstream
UC1/0/0:U12:IR           0.00      0                     0                     0
                     0.0     Ca1/0/0:u6
UC1/0/0:U12:FR           0.00      0                     0                     0
                     0.0     Ca1/0/0:u6
UC1/0/0:U12:IUC5        43.50      551758                161625                199
```

```
                  0.188   Ca1/0/0:u6
UC1/0/0:U12:IUC6        0.00      0                    0                    0
                  0.0     Ca1/0/0:u6
UC1/0/0:U12:IUC9       35.50      222                  193                  0
                  0.0     Ca1/0/0:u6
UC1/0/0:U12:IUC10       0.00      0                    0                    0
                  0.0     Ca1/0/0:u6
UC1/0/0:U12:IUC11       0.00      0                    0                    0
                  0.0     Ca1/0/0:u6
UC1/0/0:U12:IUC12       0.00      0                    0                    0
                  0.0     Ca1/0/0:u6
UC1/0/0:U12:IUC13      43.50      107                  0                    0
                  0.0     Ca1/0/0:u6
UC1/0/0:U13:IR          0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:FR          0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:IUC5       45.70      545911               14257                1153
                  0.100   Ca1/0/0:u7
UC1/0/0:U13:IUC6        0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:IUC9        0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:IUC10       0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:IUC11       0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:IUC12       0.00      0                    0                    0
                  0.0     Ca1/0/0:u7
UC1/0/0:U13:IUC13      45.70      85                   0                    0
                  0.0     Ca1/0/0:u7
UC9/0/0:U12:IR          0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:FR          0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC5       46.50      552047               1779                 0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC6        0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC9        0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC10       0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC11       0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC12       0.00      0                    0                    0
                  0.0     Ca9/0/0:u6
UC9/0/0:U12:IUC13      47.70      155                  0                    0
                  0.0     Ca9/0/0:u6
UC9/0/1:U12:IR          0.00      0                    0                    0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:FR          0.00      0                    0                    0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC5       46.00      552906               6353                 0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC6        0.00      0                    0                    0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC9        0.00      0                    0                    0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC10       0.00      0                    0                    0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC11       0.00      0                    0                    0
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC12       0.00      0                    0                    0
```

```
                  0.0     Ca9/0/1:u6
UC9/0/1:U12:IUC13       43.70      58                    0                     0
                  0.0     Ca9/0/1:u6
UC9/0/2:U12:IR           0.00      0                     0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:FR           0.00      0                     0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:IUC5        42.20      552542                194533                264
                  0.32    Ca9/0/2:u12
UC9/0/2:U12:IUC6        41.70      55                    0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:IUC9         0.00      0                     0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:IUC10        0.00      0                     0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:IUC11        0.00      0                     0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:IUC12        0.00      0                     0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U12:IUC13       42.00      105                   0                     0
                  0.0     Ca9/0/2:u12
UC9/0/2:U13:IR           0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:FR           0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:IUC5         0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:IUC6        40.20      526632                40107                 3
                  0.44    Ca9/0/2:u13
UC9/0/2:U13:IUC9         0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:IUC10        0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:IUC11        0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:IUC12        0.00      0                     0                     0
                  0.0     Ca9/0/2:u13
UC9/0/2:U13:IUC13       43.00      18                    0                     0
                  0.0     Ca9/0/2:u13
```

To display the channel specific OFDMA performance statistics, use the **show controllers upstream-cable** command as shown in the example below:

```
Router#show controllers upstream-Cable 9/0/0 us-channel 12
Controller RPD US Port List:

DevID  RPD ID          US Port  I/F       Name
------ --------------- -------- --------- ------------
  0    70b3.1791.4278     0     Te9/1/0   LC9_RPD1_3x6_RACK4

rpd_id           upstream-Port  mac_idx  mac_chidx discontinuityTime         pollCnt
------           -------------  -------  --------- -----------------         -------
70b3.1791.4278   0              336      7         Mon Jan 17 22:38:54 2022  2327

IUC IUC    FEC                FEC Post            FEC Post            RxMer Scheduled
       NoEnergy            NoPreamble          Error
    Type   Tot. CWs            Pass CWs            Fail CWs            Avg   Grants
       Bursts              Bursts              Bursts
3   IR     0                   0                   0                   00.00 -
       -                   -                   -
4   FR     0                   0                   0                   00.00 -
       -                   -                   -
5   (data) 552083              1779                0                   46.50 299078
       0                   -1                  -1
```

```
6   (data) 0                    0                    0                    00.00 0
       0                    -1                   -1
9   (data) 0                    0                    0                    00.00 0
       0                    -1                   -1
10  (data) 0                    0                    0                    00.00 0
       0                    -1                   -1
11  (data) 0                    0                    0                    00.00 0
       0                    -1                   -1
12  (data) 0                    0                    0                    00.00 0
       0                    -1                   -1
13  (data) 155                  0                    0                    47.70 132
       0                    -1                   -1


USPHY OFDMA support: FULL


Controller 9/0/0 upstream 12  AdminState:UP OpState: UP
  ofdma mode enabled
  Channel Freq Range 60.500 MHz to 79.500 MHz
  Channel Subcarrier Index Range Cfg: 148, 907 Op: 148, 907
  Channel SC0 Freq Cfg: 56.800 MHz Op: 56.800 MHz
  #Excl bands: 2
  (   0,  147), ( 908, 4095),
  #Unused bands: 1
  ( 900,  907),
  Cyclic Prefix Size 96,  Rolloff Period Size 0
  Subcarrier Spacing 25KHz,  Symbols Per Frame 9 Subcarrier Per Minislot: 16

  Modulation Profile (ID 450, Subcarrier Spacing 25KHz)
    IUC type   Cfg   Act  Preamble Bit       Pilot
               subc  subc Symbols  Loading   Pattern
    3  (IR)    64    64      4       -         -
    4  (FR)    256   256     1       -         -
    5  (data)  -     -       -     4096-QAM    14
    6  (data)  -     -       -     2048-QAM    12
    9  (data)  -     -       -     1024-QAM    12
    10 (data)  -     -       -     512-QAM     12
    11 (data)  -     -       -     256-QAM     12
    12 (data)  -     -       -     128-QAM     12
    13 (data)  -     -       -     64-QAM      12
  Calculated Data burst profile:
  IUC  Group   Bit       Pilot   Start  Consec
               Loading   Pattern Mslot  Mslot
  5    0       4096-QAM  14      0       46
  6    0       2048-QAM  12      0       46
  9    0       1024-QAM  12      0       46
  10   0       512-QAM   12      0       46
  11   0       256-QAM   12      0       46
  12   0       128-QAM   12      0       46
  13   0       64-QAM    12      0       46

  #Total mslots:47 #Fine Rng capable:32 #Initial Rng capable:44
   Initial Rng - Freq 0.000MHz mslotOffset:15 #mslot in frame:4
  Minislot mapping:  mslot#(start_sc start_freq(Mhz) end_sc end_freq(Mhz) peer_scqam
   mslot type(E-Edge; B-Body; S-Share with SCQAM;
   I-Initial rng capable; F-Fine rng capable)
   (next Fine Rng capable minislot if current is not capable))
  0  ( 148, 60.500,  163, 60.875,      EIF ( - )), 1  ( 164, 60.900,  179, 61.275,      BIF
 ( - )),
  2  ( 180, 61.300,  195, 61.675,      BIF ( - )), 3  ( 196, 61.700,  211, 62.075,      BIF
 ( - )),
  4  ( 212, 62.100,  227, 62.475,      BIF ( - )), 5  ( 228, 62.500,  243, 62.875,      BIF
 ( - )),
```

```
 6  ( 244, 62.900,  259, 63.275,      BIF ( - )), 7  ( 260, 63.300,  275, 63.675,      BIF
( - )),
 8  ( 276, 63.700,  291, 64.075,      BIF ( - )), 9  ( 292, 64.100,  307, 64.475,      BIF
( - )),
 10 ( 308, 64.500,  323, 64.875,      BIF ( - )), 11 ( 324, 64.900,  339, 65.275,      BIF
( - )),
 12 ( 340, 65.300,  355, 65.675,      BIF ( - )), 13 ( 356, 65.700,  371, 66.075,      BIF
( - )),
 14 ( 372, 66.100,  387, 66.475,      BIF ( - )), 15 ( 388, 66.500,  403, 66.875,      BIF
( - )),
 16 ( 404, 66.900,  419, 67.275,      BIF ( - )), 17 ( 420, 67.300,  435, 67.675,      BIF
( - )),
 18 ( 436, 67.700,  451, 68.075,      BIF ( - )), 19 ( 452, 68.100,  467, 68.475,      BIF
( - )),
 20 ( 468, 68.500,  483, 68.875,      BIF ( - )), 21 ( 484, 68.900,  499, 69.275,      BIF
( - )),
 22 ( 500, 69.300,  515, 69.675,      BIF ( - )), 23 ( 516, 69.700,  531, 70.075,      BIF
( - )),
 24 ( 532, 70.100,  547, 70.475,      BIF ( - )), 25 ( 548, 70.500,  563, 70.875,      BIF
( - )),
 26 ( 564, 70.900,  579, 71.275,      BIF ( - )), 27 ( 580, 71.300,  595, 71.675,      BIF
( - )),
 28 ( 596, 71.700,  611, 72.075,      BIF ( - )), 29 ( 612, 72.100,  627, 72.475,      BIF
( - )),
 30 ( 628, 72.500,  643, 72.875,      BIF ( - )), 31 ( 644, 72.900,  659, 73.275,      BIF
( - )),
 32 ( 660, 73.300,  675, 73.675,      BI  (0  )), 33 ( 676, 73.700,  691, 74.075,      BI
 (0  )),
 34 ( 692, 74.100,  707, 74.475,      BI  (0  )), 35 ( 708, 74.500,  723, 74.875,      BI
 (0  )),
 36 ( 724, 74.900,  739, 75.275,      BI  (0  )), 37 ( 740, 75.300,  755, 75.675,      BI
 (0  )),
 38 ( 756, 75.700,  771, 76.075,      BI  (0  )), 39 ( 772, 76.100,  787, 76.475,      BI
 (0  )),
 40 ( 788, 76.500,  803, 76.875,      BI  (0  )), 41 ( 804, 76.900,  819, 77.275,      BI
 (0  )),
 42 ( 820, 77.300,  835, 77.675,      BI  (0  )), 43 ( 836, 77.700,  851, 78.075,      BI
 (0  )),
 44 ( 852, 78.100,  867, 78.475,      B   (0  )), 45 ( 868, 78.500,  883, 78.875,      B
 (0  )),
 46 ( 884, 78.900,  899, 79.275,      B   (0  )),

 Mapped to connector 0 and receiver 256
 Bind to Cable9/0/0 US6
 US phy MER(SNR)_estimate - Unknown
 Spectrum Group is unassigned
 Nominal Input Power Level 10 dBmV

 UCD procedures on lch 0  ucd-proxy-timeout   (0   )
 UCD ucd-proxy-wrong-ack (1   )
```

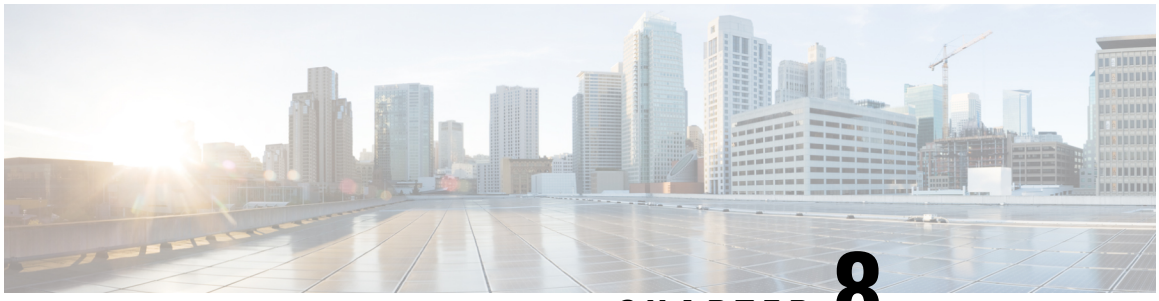
Feature Information for DOCSIS 3.1 OFDMA Channel Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 18: Feature Information for DOCSIS 3.1 OFDMA Channel Configuration

Feature Name	Releases	Feature Information
DOCSIS 3.1 US 16 OFDMA channel support per line card	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
DOCSIS 3.1 US OFDMA channel bonding across DOCSIS 3.0 ATDMA channels	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
TaFDM OFDMA Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
204 Mhz Maximum Frequency OFDMA Support	Cisco IOS XE Fuji 16.8.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Remote PHY DOCSIS 3.1 OFDMA Channel Configuration	Cisco IOS XE Fuji 16.9.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
iCCAP 2 OFDMA Channels per port	Cisco IOS XE Gibraltar 16.10.1c	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Remote PHY DOCSIS 3.1 OFDMA LCHA & LCPR	Cisco IOS XE Gibraltar 16.10.1c	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
OFDMA - 4 override zones per IUC	Cisco IOS XE Gibraltar 16.12.1w	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 8

Time and Frequency Division Multiplexing Configuration

This document provides information on the Cisco cBR-8 series routers support for Time and Frequency Division Multiplexing (TaFDM) feature in DOCSIS 3.1 upstream channels.

Information About TaFDM Support

Using the Time and Frequency Division Multiplexing (TaFDM) method, the OFDMA and SCQAM channels, which are allowed to overlap in DOCSIS 3.1, are also allowed to use the upstream at different times. With the implementation of TaFDM, both OFDMA and SC-QAM can simultaneously operate on separate frequencies. They can also operate on the same frequencies, but in different times.

TaFDM enables the OFDMA capability across the entire spectrum, while retaining the backward compatibility with legacy DOCSIS SC-QAM channels.

TaFDM is typically configured at the controller level. However, it is implemented at the Mac Domain level. Overlapping channels cannot be bound to different Mac Domains.

Overlapping SC-QAM and OFDMA channels using TaFDM may be bonded. However, we recommend this bonding only if the modems are provisioned with UGS flows and another non-overlapping SC-QAM is not available.

For a better performance of UGS flows on overlapped SC-QAM channel, configure OFDMA channel with 50kHz subcarrier spacing, lower symbols per frame, and lower cyclic prefix.

To achieve a higher OFDMA channel traffic throughput, configure OFDMA channel with 25kHz subcarrier spacing, and higher pilot pattern.

Prerequisites for Configuring TaFDM Support

The following prerequisite is applicable to configuring TaFDM configuration:

- All overlapped SC-QAM channels and OFDMA channels on the same port must be bound to the same Mac Domain
- Reserve a minimum 0.8–3.2 MHz OFDMA exclusive spectrum with good signal quality to be used for OFDMA channel IM zone

How to Configure cBR for TaFDM Support

Configuring TaFDM Modulation Profile

The TaFDM modulation profile is used to configure initial ranging, fine ranging and data IUC parameters. To define the TaFDM modulation profile, run the configuration commands, as given in the following example:

```
cable mod-profile-ofdma 450
  subcarrier-spacing 25KHz
  initial-rng-subcarrier 64
  fine-rng-subcarrier 192
  data-iuc 9 modulation 1024-QAM pilot-pattern 11
  data-iuc 10 modulation 512-QAM pilot-pattern 11
  data-iuc 11 modulation 256-QAM pilot-pattern 8
  data-iuc 12 modulation 128-QAM pilot-pattern 8
  data-iuc 13 modulation 64-QAM pilot-pattern 8

cable mod-profile-ofdma 470
  subcarrier-spacing 50KHz
  initial-rng-subcarrier 64
  fine-rng-subcarrier 192
  data-iuc 9 modulation 1024-QAM pilot-pattern 1
  data-iuc 10 modulation 512-QAM pilot-pattern 1
  data-iuc 11 modulation 256-QAM pilot-pattern 1
  data-iuc 12 modulation 128-QAM pilot-pattern 1
  data-iuc 13 modulation 64-QAM pilot-pattern 1
```

Configuring I/O Controller for TaFDM

The following sample configuration defines a shared region in the areas of the SC-QAM upstream channels.

```
controller Upstream-Cable slot/subslot/port
  us-channel 0 frequency 35800000
  us-channel 0 channel-width 6400000 6400000
  us-channel 0 docsis-mode atdma
  us-channel 0 minislot-size 2
  us-channel 0 modulation-profile 221
  us-channel 0 equalization-coefficient
  no us-channel 0 shutdown
  us-channel 1 frequency 29400000
  us-channel 1 channel-width 6400000 6400000
  us-channel 1 docsis-mode atdma
  us-channel 1 minislot-size 2
  us-channel 1 modulation-profile 221
  us-channel 1 equalization-coefficient
  no us-channel 1 shutdown
  us-channel 2 frequency 23000000
  us-channel 2 channel-width 6400000 6400000
  us-channel 2 docsis-mode atdma
  us-channel 2 minislot-size 2
```

```
  us-channel 2 modulation-profile 221
  us-channel 2 equalization-coefficient
  no us-channel 2 shutdown
  us-channel 3 frequency 16600000
  us-channel 3 channel-width 6400000 6400000
  us-channel 3 docsis-mode atdma
  us-channel 3 minislot-size 2
  us-channel 3 modulation-profile 221
  us-channel 3 equalization-coefficient
  no us-channel 3 shutdown
```

Enhancing OFDMA Channel Throughput

The following example shows how to enhance the OFDMA channel throughput:

```
controller Upstream-Cable 1/0/0
  …
  us-channel 12 docsis-mode ofdma
  us-channel 12 subcarrier-spacing 25KHz
  us-channel 12 modulation-profile 450
  us-channel 12 frequency-range 10000000 85000000    #Overlap with SC-QAM channels
  us-channel 12 initial-rng-frequency-start 50000000    # Specify the preferred start
frequency for IM zone
  us-channel 12 cyclic-prefix 96 roll-off-period 64
  us-channel 12 symbols-per-frame 9
  no us-channel 12 shutdown
```

Enhancing SC-QAM Channel UGS Flow Performance

The following example shows how to enhance the UGS flow performance of the SC-QAM channel:

```
controller Upstream-Cable 1/0/0
  …
  us-channel 12 docsis-mode ofdma
  us-channel 12 subcarrier-spacing 50KHz
  us-channel 12 modulation-profile 470
  us-channel 12 frequency-range 10000000 85000000    #Overlap with SC-QAM channels
  us-channel 12 initial-rng-frequency-start 50000000   #Specify the preferred frequency for
 IM zone
  us-channel 12 cyclic-prefix 96 roll-off-period 64
  us-channel 12 symbols-per-frame 8
  no us-channel 12 shutdown
```

Configuring Cable Interface-MAC Domain

The following example shows how to configure a cable interface for MAC Domain:

```
interface Cable1/0/0
  load-interval 30

  upstream 0 Upstream-Cable 1/0/0 us-channel 0
  upstream 1 Upstream-Cable 1/0/0 us-channel 1
  upstream 2 Upstream-Cable 1/0/0 us-channel 2
  upstream 3 Upstream-Cable 1/0/0 us-channel 3
  upstream 6 Upstream-Cable 1/0/0 us-channel 12
  cable upstream bonding-group 1
    upstream 0
    upstream 1
```

```
    upstream 2
    upstream 3
    attributes 80000000
  cable upstream bonding-group 2
    upstream 0
    upstream 1
    upstream 2
    upstream 3
    upstream 6
    attributes 80000000
  cable bundle 1
  cable sid-cluster-group num-of-cluster 2     #Maximize single modem throughput
  cable sid-cluster-switching max-request 4
  cable cm-status enable 3 6-11 16-18 20-27
  cable privacy accept-self-signed-certificate
```

Configuring Service Class

The following example shows how to configure service classes:

```
cable service class 198 name mega_up
cable service class 198 upstream
cable service class 198 max-concat-burst 16384
cable service class 198 max-rate 1000000000    # Maximize single modem throughput
cable service class 198 max-burst 250000
cable service class 198 priority 0
cable service class 198 peak-rate 0
```

Excluding a Frequency Band from TaFDM

If you want the SC-QAM to exclusively use a specific frequency range, configure Cisco cBR to exclude the band using the following sample commands.

```
controller Upstream-Cable slot/subslot/port
 cable frequency-exclusion-band 18700000 22100000
```

Verifying TaFDM Configuration

The following example shows how to verify the TaFDM configuration:

```
# show controllers upstream-Cable slot/subslot/port us-channel uschan-number-in-controller

#show controllers upstream-Cable slot/subslot/port us-channel uschan-number-in-controller
cdm-ump

# show interfaces cable slot/subslot/port mac-scheduler uschan-number-in-mac-domain
```

Configuration Example

TaFDM Configuration

```
controller Upstream-Cable 1/0/0
  us-channel 0 frequency 15000000
```

```
us-channel 0 channel-width 3200000 3200000
us-channel 1 frequency 22000000
us-channel 1 channel-width 6400000 6400000
us-channel 2 frequency 29000000
us-channel 2 channel-width 6400000 6400000
us-channel 3 frequency 36000000
us-channel 3 channel-width 6400000 6400000
us-channel 4 frequency 11000000
us-channel 4 channel-width 1600000 1600000
us-channel 12 frequency-range 14000000 85000000
```

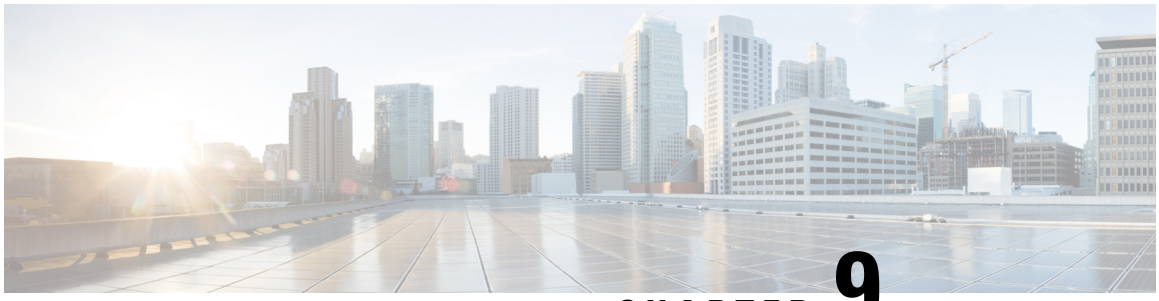
Feature Information for TaFDM Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 19: Feature Information for for TaFDM Configuration

Feature Name	Releases	Feature Information
TaFDM Configuration	Cisco IOS XE Fuji 16.7.1	This feature was introduced on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 9

DOCSIS 3.1 Upstream Profile Selection

DOCSIS 3.1 introduces the concept of upstream profiles for OFDMA channels. This document describes how to configure the DOCSIS 3.1 Upstream Profile Selection on the Cisco cBR Series Converged Broadband Router.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

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 20: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about Upstream Profiles

A modulation profile is a list of interval usage codes (IUCs) that are defined for an OFDMA channel. Each IUC will have a modulation order and pilot pattern. Multiple IUCs within a modulation profile allow for different modulation orders on the same OFDMA channel. The CMTS can define multiple profiles for use in an OFDMA channel, where the profiles differ in the modulation orders assigned to each minislot.

You can use the following commands to view the profiles:

- To display the profiles associated with the cable modems (CMs), use the **show cable modem** *[ip-address| mac-address| cable| {slot | subslot | cable-interface-index}]* **phy ofdm-profile upstream** command.

- To display detailed profile management data associated with specific cable modem, use the **show cable modem** *[ip-address| mac-address]* **prof-mgmt upstream verbose** command.

The CMTS can assign different data IUCs for different groups of CMs.

A DOCSIS 3.1 CM can only have two active OFDMA Upstream Data Profile IUCs on a given channel.

Default Data IUC

Data IUC 13 is intended to be the most robust IUC and able to be used by all cable modems.

Recommended Interval Usage Code (IUC)

Based on the receive modulation error ratio (RxMER) values collected periodically during upstream probing, the CMTS finds among the existing IUCs up to two that provide the highest speed while having sufficient signal to noise ratio (SNR) margin for the CMTS to receive code words with acceptable error rates. The **show cable modem phy ofdm-profile upstream** command displays the one or two recommended IUCs for each CM.

In Cisco IOS XE Everest 16.6.1 release, data IUC 13 will be one of the IUCs assigned to the CM.

To disable the automatic profile downgrade, use **no cable upstream ofdma-prof-mgmt prof-upgrade-auto** command in global configuration mode.

How to Configure Upstream Profiles

Configuring RxMER to Bit Loading Mapping

There are many ways to map the Receive Modulation Error Ratio (RxMER) values to bit loading values. We use the following mapping recommended in DOCSIS 3.1 OSSI, as our baseline mapping:

RxMER (in ¼ DB)	QAM	Bit Loading
60	16	4
84	64	6
96	128	7
108	256	8
122	512	9
136	1024	10
148	2048	11
164	4096	12
184	8192	13

RxMER (in ¼ DB)	QAM	Bit Loading
208	16384	14

- To configure a margin to adjust the RxMER to bit loading mapping, use the following command:

  ```
  Router(config)# cable upstream ofdma-prof-mgmt mer-margin-qdb interval-in-minutes
  ```

  This configured value (*quarter-DB*) is added to the RxMER values collected by CMTS before using the above mapping table, thus giving a user more control in selecting the recommended profiles.

- To specify the percentage of minislot average RxMER that can be ignored in the recommended profile calculation, use the following command:

  ```
  Router(config)# cable upstream ofdma-prof-mgmt exempt-mslot-pct percent
  ```

  This provides a way to specify the extent that the outliers can be ignored.

- To configure the RxMER poll interval, use the following command:

  ```
  Router(config)# cable upstream ofdma-prof-mgmt rxmer-poll-interval interval-in-minutes
  ```

  The CMTS uses upstream probing to collect RxMER data per CM. This occurs during registration and periodically thereafter. The collected RxMER data is averaged per minislot and used to compute the recommended IUCs for each CM.

  The **no cable upstream ofdma-prof-mgmt rxmer-poll-interval** command sets the rxmer-poll-interval to 1440, which is the value to disable the feature. The rxmer data is also not displayed after disabling the feature.

Configuring Codeword Error Threshold

Starting from Cisco IOS XE Gibraltar 16.12.1x release, user can configure a codeword error threshold above which the profile will be downgraded, that is, switch to a lower order QAM.

Compared with the existing profile management scheme, in which the RxMER is read at configured interval, and data IUC is upgraded or downgraded based on RxMER data and configurable criteria, using customized codeword error threshold has several benefits, including:

- React to noise within minimal time window to maintain service quality
- If IUC selected by RxMER causes errors, it can be downgraded quickly
- Downgrade interval is much shorter than RxMER interval

To configure the codeword error threshold, enable this feature first:

```
Router(config)# cable upstream ofdma-prof-mgmt downgrade enable
```

Then configure the minimum number of codewords required within downgrade interval to consider for downgrade:

```
Router(config)# cable upstream ofdma-prof-mgmt downgrade min-cws value
```

Use **show cable modem prof-mgmt upstream** to check whether this feature is enabled:

```
Router#show cable modem 4800.33ef.3dd2 prof-mgmt upstream
Upstream Profile Management Data:
MAC Address            : 4800.33ef.3dd2
Number of US Chan      : 1
```

```
Ucid                     : 6
RxMer Exempt Percent     : 0
RxMer Margin qDB         : 0
RxMer Threshold Percent  : 2
Start Sc                 : 148
End Sc                   : 1907
Num RxMER Measurement    : 1908
Tx Time                  : 0h:04m:50s ago
Rx Time                  : 0h:04m:50s ago
MER Poll Period   (min)  : 5
Auto Profile Upgrade     : Yes
Upgrd Dly Cnt (cur/cfg)  : 0/1
Upgrd Dly rcmd IUC       : none
Recommended IUC          : 5
Current IUC              : 5
Downgrade IUC            : 6
RxMER send/recv count    : 1/1
DBC                      : 1/1/0/0/0
                          (send/succeed/err/reject/timeout)
State                    : Ready
Profile Downgrade        : Enabled
Profile Downgrade count  : 0
Interval good/cor/uncor  : 294/93/0
Downgrade Check Time     : 0h:00m:14s ago
```

After a downgrade, Profile Downgrade count is updated in the command output:

```
Router#show cable modem 4800.33ef.3dd2 prof-mgmt upstream
Upstream Profile Management Data:
MAC Address             : 4800.33ef.3dd2
Number of US Chan       : 1

Ucid                     : 6
RxMer Exempt Percent     : 0
RxMer Margin qDB         : 0
RxMer Threshold Percent  : 2
Start Sc                 : 148
End Sc                   : 1907
Num RxMER Measurement    : 1908
Tx Time                  : 0h:00m:01s ago
Rx Time                  : 0h:00m:01s ago
MER Poll Period   (min)  : 5
Auto Profile Upgrade     : Yes
Upgrd Dly Cnt (cur/cfg)  : 0/1
Upgrd Dly rcmd IUC       : none
Recommended IUC          : 6
Current IUC              : 6
Downgrade IUC            : 9
RxMER send/recv count    : 3/3
DBC                      : 2/1/0/0/0
                          (send/succeed/err/reject/timeout)
State                    : MER Received
Profile Downgrade        : Enabled
Profile Downgrade count  : 1
Interval good/cor/uncor  : 222/0/119
Downgrade Check Time     : 0h:00m:03s ago
Holddown Time            : 0h:00m:03s ago
```

The **Holddown Time** will not be displayed in the command output anymore after the configured holddown time is expired. In the following example, after two downgrades, the holddown time was expired, an RxMER was read and checked, and the profile was upgraded back to 5.

```
Router#show cable modem 4800.33ef.3dd2 prof-mgmt upstream
Upstream Profile Management Data:
MAC Address            : 4800.33ef.3dd2
Number of US Chan      : 1

Ucid                    : 6
RxMer Exempt Percent    : 0
RxMer Margin qDB        : 0
RxMer Threshold Percent : 2
Start Sc                : 148
End Sc                  : 1907
Num RxMER Measurement   : 1908
Tx Time                 : 0h:03m:07s ago
Rx Time                 : 0h:03m:07s ago
MER Poll Period   (min) : 5
Auto Profile Upgrade    : Yes
Upgrd Dly Cnt (cur/cfg) : 0/1
Upgrd Dly rcmd IUC      : none
Recommended IUC         : 5
Current IUC             : 5
Downgrade IUC           : 6
RxMER send/recv count   : 6/6
DBC                     : 4/4/0/0/0
                          (send/succeed/err/reject/timeout)
State                   : Ready
Profile Downgrade       : Enabled
Profile Downgrade count : 2
Interval good/cor/uncor : 269/72/0
Downgrade Check Time    : 0h:00m:03s ago
```

Downgrading to Partial Mode

Starting from Cisco IOS XE Gibraltar 16.12.1y release, user can configure a codeword error threshold above which the profile will be downgraded to partial mode, that is disable some of the OFDMA channels when the CM is currently using IUC13 due to MER or downgrade.

To configure the codeword error threshold, enable this feature first:

```
Router(config)# cable upstream ofdma-prof-mgmt downgrade enable
```

Then configure the threshold to consider for downgrading to partial mode:

```
Router(config)# cable upstream ofdma-prof-mgmt downgrade partial-threshold value
```

Use **show cable modem partial-mode** to check the reason for downgrading to partial mode:

```
Router#show cable modem 4800.33ef.3dd2 partial-mode
MAC Address    IP Address  I/F       MAC      Prim  RCC  UP-reason/
                                     State    Sid   ID   Failed-tcsf
81d.0f01.1e10  9.2.0.46    C1/0/0/p  w-online 1     1    0x10 / 0x20

Note: 0x01 = Ranging
      0x10 = CWErr Partial Mode
      0x11 = Both
```

Configuring RxMER Downgrade

Comparing to the existing upstream profile managements mechanism, RxMER downgrade has the following benefits:

- Ability to downgrade to partial mode based only on RxMER data
- Configurable desired lowest acceptable IUC
- This allows IUC 13 modulation to be robust for registration and DBC
- Allow certain percentage of subcarriers under threshold
- Re-evaluate RxMER data at next poll interval
- Channel leaves partial-mode and uses recommended IUC when RxMER data is above threshold
- Works independently with codeword error downgrade

By default, RxMER downgrade is disabled, use the following command to enablethis feature:

```
Router(config)# cable upstream ofdma-prof-mgmt downgrade rxmer-enable
```

Then configure the data IUC below which the OFDMA channel will be downgraded to partial mode, the default number is 13:

```
Router(config-ofdma-mod-profile)# ofdma-prof-mgmt downgrade rxmer min-iuc value
```

You can also configure the number of minislots that can be below minimum IUC and not trigger downgrade, the default number is 0:

```
Router(config)# cable upstream ofdma-prof-mgmt downgrade
rxmer-exempt-mslot-pct value
```

The following example shows how to configure RxMER downgrade in cBR-8:

```
Router(config)# cable upstream ofdma-prof-mgmt rxmer-poll-interval 5
Router(config)# cable upstream ofdma-prof-mgmt prof-upgrade-auto
Router(config)# cable upstream ofdma-prof-mgmt downgrade rxmer-enable
Router(config)# cable mod-profile-ofdma 466
Router(config-ofdma-mod-profile)# subcarrier-spacing 25KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 256
Router(config-ofdma-mod-profile)# data-iuc 5 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 9 modulation 512-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 10 modulation 256-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 11 modulation 128-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 12 modulation 64-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 16-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# ofdma-prof-mgmt downgrade rxmer min-iuc 12
```

To display the count of profile partial downgrade, use the command as shown in the following example:

```
Router# show cable modem 4800.33ef.3dd2 prof-mgmt upstream
Upstream Profile Management Data :
MAC Address             : 4800.33ef.3dd2
Ucid                    : 6
Num RxMER Measurement   : 1908
Tx Time                 : 0h:00m:15s ago
Rx Time                 : 0h:00m:15s ago
MER Poll Period   (min) : 5
Auto Profile Upgrade    : Yes
Recommended IUC         : 13
Current IUC             : 13
Downgrade IUC           : 13
RxMER send/recv count   : 10/10
DBC                   : 0/0/0/0/0                        (send/succeed/err/reject/timeout)
State                   : MER Received
```

```
Profile Downgrade Partial count : 1
mslot RxMER(in 1/4 dB):
# msMer    0   : B3B7B4B0 B5ADB1B1 A6A9A5A3 89867A66 3A2C4152 53525D59 595F5C5F 5F636366
# msMer    32 : 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
# msMer    64 : 00000000 00000000
SC RxMER Distribution (Excluded SCs are ignored):*: 2%
>44dB: ***** 10.00%
>42dB: **  4.31%
>39dB:   0.86%
>36dB:   1.55%
>33dB: *  2.41%
>30dB:   1.29%
>27dB: **  5.17%
>24dB: ****  8.27%
>21dB: *  3.96%
>18dB:   1.63%
>15dB:   1.20%
<15dB: ***************************** 59.31%
        ---------------------------------------------------100
                          Percent of Subcarriers
```

Display the Cable Modem Count per Profile

Feature History

Table 21: Feature History

Feature Name	Release Information	Feature Description
Display CM counts per US IUC and DS profile	Cisco IOS XE Bengaluru 17.6.1x	This feature introduces new commands **show cable modem phy ofdm downstream prof-count** and **show cable modem phy ofdm upstream iuc-count**, it helps tracking and reporting number of Cable Modems being in use per Upstream IUC and Downstream Profile on each controller separately. These counters are indicative of health of the RF plant.

To display the CM count per upstream port and IUC, use the **show cable modem phy ofdm upstream iuc-count** command as shown in the example below:

```
Router#show cable modem phy ofdm upstream iuc-count
                      |<----------- CM Count per profile ----------->|
I/F           IF-INDX  IUC-5  IUC-6  IUC-9 IUC-10 IUC-11 IUC-12 IUC-13
-----------   ------- ------ ------ ------ ------ ------ ------ ------
C1/0/0/U6     488046       3      0      0      0      0      0      3
C1/0/0/U7     488047       3      0      0      0      0      0      3
C9/0/0/U6     501870       1      0      0      0      0      0      1
C9/0/0/U7     501871       1      0      0      0      0      0      1
C9/0/1/U6     501918       1      0      0      0      0      0      2
C9/0/1/U7     501919       1      0      0      0      0      0      2
```

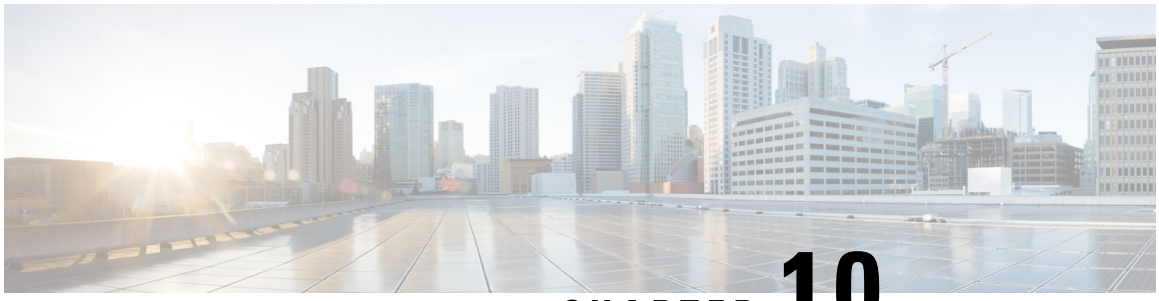
Feature Information for Upstream Profile Selection

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 22: Feature Information for Upstream Profile Selection

Feature Name	Releases	Feature Information
DOCSIS3.1 US Profile Selection	Cisco IOS XE Fuji 16.7.1	This feature was integrated into Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.
Codeword Errors Monitoring	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.
Downgrading to Partial Mode	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.
RxMER Downgrade	Cisco IOS XE Gibraltar 16.12.1z	This feature was integrated into Cisco IOS XE Gibraltar 16.12.1z on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 10

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 23: 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 24: 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 2

      clabProjDocsis.27.1.3.10.3.1.1.<ifIndex>.1 = 2
      ```
    - ```
      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 = 2
      ```

    Note Ensure that you pass a value '2', for the **setany** command to stop the capture.
  - **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 2

      SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 2
      ```
    - ```
      server > snmpget -v2c -c <community_name> <cmts_ip>
      1.3.6.1.4.1.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1
      ```

```
SNMPv2-SMI::enterprises.4491.2.1.27.1.3.10.3.1.1.<ifIndex>.1 = INTEGER: 2
```

Note Ensure that you pass a value '2', for the **snmpset** command to stop the capture.

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 84.
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 101 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 97 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
```

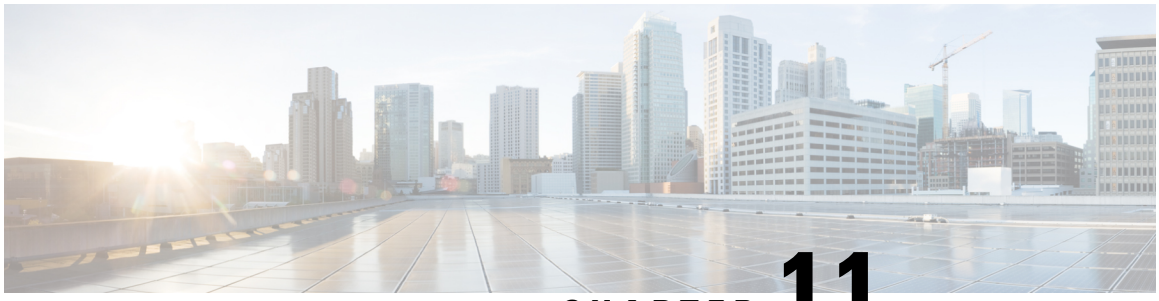
Feature Information for Proactive Network Management

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 25: 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.



CHAPTER 11

Downstream Power Tilt

The Downstream Power tilt feature is used to correct cable loss in the head-end to produce a flat power spectrum for all channels in the controller port.

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 26: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about Downstream Power Tilt

The downstream power tilt feature is used to correct cable loss in the head-end to produce a flat power spectrum for all channels on the controller port.

Note There may be noise floor degradation on the failover path (following linecard switchover) with this feature enabled.

Restrictions for Configuring Downstream Power Profile

The downstream power tilt feature and OFDM power profile feature are mutually exclusive. They cannot be configured at the same time.

How to Configure the Downstream Power Tilt

Configuring Downstream Power Tilt

Downstream power tilt applies to all the SCQAM or OFDM channels on the downstream. To configure downstream power tilt for a controller port, use the power-tilt configuration command under the downstream controller port.

```
enable
configure terminal
controller Integrated-Cable slot/subslot/port
max-ofdm-spectrum value
max-carrier value
base-channel-power value
power-tilt mode loss max-frequency freq-max
rf-chan start_id [end_id]
type value
rf-output value
power-adjust value
qam-profileid
docsis-channel-idid
ofdm channel-profile id start-frequency value width value [plc value]
```

Below is an example:

```
controller Integrated-Cable 3/0/0
  max-ofdm-spectrum 192000000
  max-carrier 32
  base-channel-power 34
  power-tilt linear 4.0 max-frequency 696000000
  rf-chan 0 31
    type DOCSIS
    frequency 261000000
    rf-output NORMAL
    power-adjust -2.0
    qam-profile 1
    docsis-channel-id 1
  rf-chan 158
    power-adjust 0
    docsis-channel-id 159
    ofdm channel-profile 20 start-frequency 600000000 width 96000000 plc 645000000
```

In the above configuration steps, there is a command **power-tilt** *mode loss* **max-frequency** *freq-max*, where the *mode* represent a formula that calculates the loss of a coax cable at a frequency F, given the loss at *freq-max* is known. It provides two options to select:

- linear: $loss_F = loss_{freq\text{-}max} * (F / freq\text{-}max)$
- cable-loss-approx: $loss_F = loss_{freq\text{-}max} * SQRT((freq\text{-}max - F) / freq\text{-}max)$

loss is the measured cable loss at *freq-max*, specified in 1/10 dB.

Verifying Downstream Power Tilt Configuration

To display the downstream power tilt details, use the **show cable controller integrated-cable** command as given in the following example. This command will display the actual SCQAM and OFDM channel power levels as set by the DS Power Tilt command. For OFDM channels, the power level displayed represents the center frequency 6-MHz band power level.

```
Router# show controller Integrated-Cable 1/0/1 rf-chan 0-162
Chan State Admin Frequency Type   Annex Mod srate Interleaver dcid power output
0    UP    UP    261000000 DOCSIS B     256 5361  I32-J4      1    29.9  NORMAL
1    UP    UP    267000000 DOCSIS B     256 5361  I32-J4      2    30.0  NORMAL
2    UP    UP    273000000 DOCSIS B     256 5361  I32-J4      3    30.0  NORMAL
3    UP    UP    279000000 DOCSIS B     256 5361  I32-J4      4    30.0  NORMAL
4    UP    UP    285000000 DOCSIS B     256 5361  I32-J4      5    30.1  NORMAL
5    UP    UP    291000000 DOCSIS B     256 5361  I32-J4      6    30.1  NORMAL
6    UP    UP    297000000 DOCSIS B     256 5361  I32-J4      7    30.2  NORMAL
7    UP    UP    303000000 DOCSIS B     256 5361  I32-J4      8    30.2  NORMAL
8    UP    UP    309000000 DOCSIS B     256 5361  I32-J4      9    30.2  NORMAL
9    UP    UP    315000000 DOCSIS B     256 5361  I32-J4      10   30.3  NORMAL
10   UP    UP    321000000 DOCSIS B     256 5361  I32-J4      11   30.3  NORMAL
11   UP    UP    327000000 DOCSIS B     256 5361  I32-J4      12   30.3  NORMAL
12   UP    UP    333000000 DOCSIS B     256 5361  I32-J4      13   30.4  NORMAL
13   UP    UP    339000000 DOCSIS B     256 5361  I32-J4      14   30.4  NORMAL
14   UP    UP    345000000 DOCSIS B     256 5361  I32-J4      15   30.4  NORMAL
15   UP    UP    351000000 DOCSIS B     256 5361  I32-J4      16   30.5  NORMAL
16   UP    UP    357000000 DOCSIS B     256 5361  I32-J4      17   30.5  NORMAL
17   UP    UP    363000000 DOCSIS B     256 5361  I32-J4      18   30.5  NORMAL
18   UP    UP    369000000 DOCSIS B     256 5361  I32-J4      19   30.6  NORMAL
19   UP    UP    375000000 DOCSIS B     256 5361  I32-J4      20   30.6  NORMAL
20   UP    UP    381000000 DOCSIS B     256 5361  I32-J4      21   30.6  NORMAL
21   UP    UP    387000000 DOCSIS B     256 5361  I32-J4      22   30.7  NORMAL
22   UP    UP    393000000 DOCSIS B     256 5361  I32-J4      23   30.7  NORMAL
23   UP    UP    399000000 DOCSIS B     256 5361  I32-J4      24   30.7  NORMAL
24   UP    UP    405000000 DOCSIS B     256 5361  I32-J4      25   30.8  NORMAL
25   UP    UP    411000000 DOCSIS B     256 5361  I32-J4      26   30.8  NORMAL
26   UP    UP    417000000 DOCSIS B     256 5361  I32-J4      27   30.8  NORMAL
27   UP    UP    423000000 DOCSIS B     256 5361  I32-J4      28   30.9  NORMAL
28   UP    UP    429000000 DOCSIS B     256 5361  I32-J4      29   30.9  NORMAL
29   UP    UP    435000000 DOCSIS B     256 5361  I32-J4      30   30.9  NORMAL
30   UP    UP    441000000 DOCSIS B     256 5361  I32-J4      31   30.9  NORMAL
31   UP    UP    447000000 DOCSIS B     256 5361  I32-J4      32   31.0  NORMAL

Chan State Admin Mod-Type Start     Width    PLC       Profile-ID dcid power output Frequency

158  UP    UP    OFDM     600000000 96000000 645000000 22         159  33.9         NORMAL
```

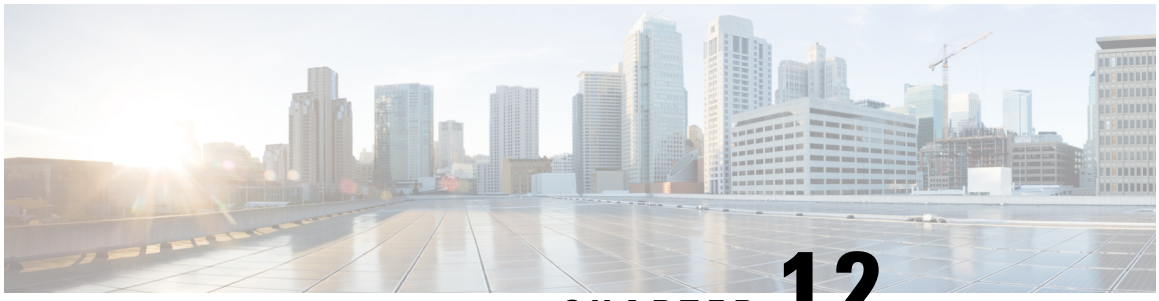
Feature Information for Downstream Power Tilt

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 27: Feature Information for Downstream Power Tilt

Feature Name	Releases	Feature Information
Downstream Power Tilt	Cisco IOS XE Fuji 16.7.1	This feature was introduced on Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 12

Controller Profile Configuration

This document describes how to configure the controller profile 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 28: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about Controller Profile Configuration

As density increases with the merging of CMTS and UEQAM functions in the same device, the current controller configuration method becomes too complex and difficult. There are too many identical lines of configuration.

To simplify the controller configuration, a new concept called controller profile is introduced. A controller profile is a group of configuration parameters that apply to downstream and upstream controller, the benefits include:

- Speed up deployment
- Simplify cBR-8 deployment, configuration and troubleshooting

- Common configurations across nodes/regions
- Consistency across Cisco products for common functions

How to Configure the Controller Profile

User configures I-CMTS controllers using legacy controller configuration commands by default. If user wants to use I-CMTS controller profile, needs to enable it first with **cable controller-profile I-CMTS enable** command.

Note

- If user wants to configure controller using profile, it is recommended to start configuration on a "clean" CMTS without any legacy command configured in Integrated-Cable and Upstream-Cable controllers. Do not switch over between legacy configuration and profile.
- When modifying controller profile, all related controllers will be changed. So if user wants to configure a specific controller, for example, modify the base-channel power of a controller, user should not bind this controller to a profile together with other controllers.
- Legacy controller configuration commands are not supported if I-CMTS controller-profile is enabled.
- Legacy controller configuration cannot be shown in running-config if I-CMTS controller-profile is enabled.

Configuring Downstream Controller Profile

To configure downstream controller profile, use the steps below:

```
enable
configure terminal
cable downstream controller-profile id [RPHY|I-CMTS]
base-channel-power value
max-carrier value
freq-profile id
max-ofdm-spectrum value
ofdm-freq-excl-band start-frequency value widthvalue
rf-chan start_id [end_id]
type value
rf-output value
power-adjust value
qam-profileid
docsis-channel-idid
power-profile id
ofdm channel-profile id start-frequency value width value [plc value]

enable
configure terminal
controller integrated-cable slot/subslot/port
profile id
```

Below is an example:

```
cable downstream controller-profile 0 I-CMTS
 max-carrier 32
 base-channel-power 34
 rf-chan 0 3
  type DOCSIS
  frequency 111000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1

controller integrated-cable 2/0/0
 profile 0
```

Note

- When configure a new I-CMTS controller profile, keyword I-CMTS is needed. If input RPHY or do not input any keyword, the system will consider it as a RPHY controller profile. Once a profile type (RPHY/I-CMTS) is set, it cannot be modified.
- Updating a profile will affect all the controllers bond with it. To delete a profile that bond with controller, user must unbind all the controllers first. All rf-channel configuration in controller will be deleted after unbind.
- At least 8 QAM channels should be configured to get the right power. Single continuous wave (CW) mode is not supported.

Verifying Downstream Controller Profile Configuration

Use the **show cable downstream controller-profile** command to verify the configuration of the downstream controller profile.

```
Router# show cable downstream controller-profile 0
Downstream controller-profile 0, type I-CMTS
Description:
Downstream controller-profile 0 is being used by controller Integrated-Cable:
  2/0/0,
  Admin:  UP
  MaxOfdmSpectrum: 192000000
  MaxCarrier: 128
  BasePower: 33.0 dBmV
  Mode: normal
  Frequency profile: unconfigured
  DS Splitting: No
  OFDM frequency exclusion bands: None

Configured RF Channels:
Chan Admin Frequency  Type        Annex Mod  srate Qam-profile  dcid  power output
 0    UP   213000000  DOCSIS       B    256   5361  1           1     33.0  NORMAL
 1    UP   219000000  DOCSIS       B    256   5361  1           2     33.0  NORMAL
 2    UP   225000000  DOCSIS       B    256   5361  1           3     33.0  NORMAL
 3    UP   231000000  DOCSIS       B    256   5361  1           4     33.0  NORMAL
 4    UP   237000000  DOCSIS       B    256   5361  1           5     33.0  NORMAL
 5    UP   243000000  DOCSIS       B    256   5361  1           6     33.0  NORMAL
```

In the above output, integrated-cable 2/0/0 is bond to profile 0. So the output of the **show controllers integrated-Cable 2/0/0 rf-channel 0 5** should match the above output. See the example below:

```
Router# show controllers integrated-cable 2/0/0 rf-channel 0-5
...
Chan Admin Frequency  Type        Annex Mod  srate Qam-profile  dcid  power output
 0    UP   213000000  DOCSIS       B    256   5361  1           1     33.0  NORMAL
 1    UP   219000000  DOCSIS       B    256   5361  1           2     33.0  NORMAL
 2    UP   225000000  DOCSIS       B    256   5361  1           3     33.0  NORMAL
 3    UP   231000000  DOCSIS       B    256   5361  1           4     33.0  NORMAL
 4    UP   237000000  DOCSIS       B    256   5361  1           5     33.0  NORMAL
 5    UP   243000000  DOCSIS       B    256   5361  1           6     33.0  NORMAL
```

To check if the parameters in a profile match with the ones configured, use the **show running-config [all] | section cable downstream controller-profile** command as shown in the example below:

```
Router# show running-config | section downstream controller-profile
cable downstream controller-profile 0 I-CMTS
 max-carrier 32
 base-channel-power 34
 rf-chan 0 3
  type DOCSIS
  frequency 111000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1
```

Configuring Upstream Controller Profile

To configure upstream controller profile, use the steps below:

enable
configure terminal
cable upstream controller-profile *id* **[RPHY|I-CMTS]**
us-channel *id* {**chan-class-id** *id*|**channel-width** {*first-choice-width* [*last-choice-width*]}|**docsis-mode**{**atdma| tdma| tdma-atdma**}|**equalization-coefficient**|**frequency***value*|**hop-priority**{**frequency modulation channel-width| modulation frequency channel-width| frequency channel-width modulation**}|**ingress-nosie-cancellation** *interval*|**maintain-psd**|**max-logical-chans** *id*|**minislot-size** *value*|**modulation-profile** *primary-profile-number*[*secondary-profile-number*][*tertiary-profile-number*]|**power-level** *value*|**rng-holdoff** *priority*|**specsvl error-adaptive-profile** *id*|**spectrum-group** *id*|**threshold** {**cnr-profiles** *value* [*value*]|**corr-fec** *value*|**hysteresis** *value*|**snr-profiles** *value* [*value*]|**corr-fec** *value*}

enable
configure terminal
controller upstream-cable *slot/subslot/port*
profile *id*

Note

- When configure a new I-CMTS controller profile, keyword I-CMTS is needed. If input RPHY or do not input any keyword, the system will consider it as a RPHY controller profile. Once a profile type (RPHY/I-CMTS) is set, it cannot be modified.
- Updating a profile will affect all the controllers bond with it. To delete a profile that bond with controller, user must unbind all the controllers first.
- OFDMA does not support the use of profile in this release.

Verifying Upstream Controller Profile Configuration

Use the **show cable upstream controller-profile** command to verify the configuration of the upstream controller profile.

```
Router# show cable upstream controller-profile 0
Upstream controller-profile 0, type I-CMTS
Description:
Upstream controller-profile 0 is being used by controller Upstream-Cable:
9/0/0

Controller Upstream-Cable
    ...
  Upstream-channel 0
    chan-class-id                  : 0x0
    channel-width                  : 1600000 1600000
    docsis-mode                    : atdma
    equalization-coefficient       : TRUE
    frequency                      : 5000000
    ...
    modulation-profile             : 221
    ...
    shutdown                       : FALSE
    ...
```

In the above output, upstream-cable 9/0/0 is bond to profile 0. So the output of the **show controllers upstream-Cable 9/0/0 us-channel 0** should match the above output. See the example below:

```
Router# show controllers upstream-Cable 9/0/0 us-channel 0
...
Controller 9/0/0 upstream 0  AdminState:UP OpState: UP
  atdma mode enabled
  Frequency 5.000 MHz, Channel Width 1.600 MHz, Symbol Rate 1.280 Msps
  Modulation Profile Group 221
```

To check if the parameters in a profile match with the ones configured, use the **show running-config [all] | section cable upstream controller-profile** command as shown in the example below:

```
Router# show running-config | s cable upstream controller-profile 0
cable upstream controller-profile 0 I-CMTS
 us-channel 0 channel-width 1600000 1600000
 us-channel 0 docsis-mode atdma
 us-channel 0 minislot-size 4
 us-channel 0 modulation-profile 221
 us-channel 0 shutdown
 ...
```

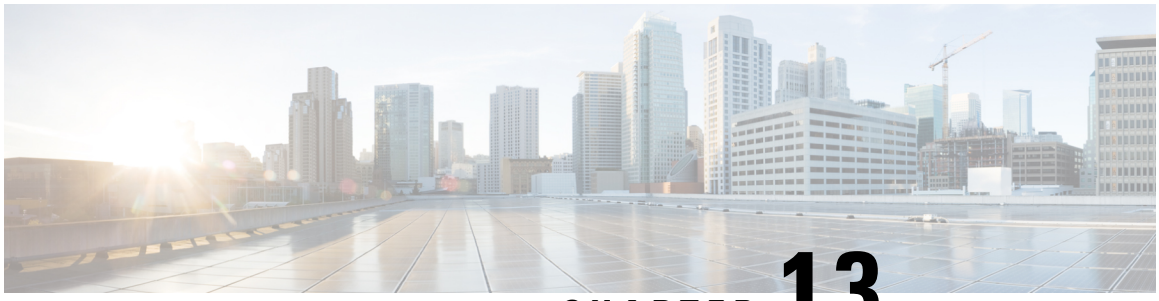
Feature Information for Controller Profile Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 29: Feature Information for Controller Profile Configuration

Feature Name	Releases	Feature Information
SG Based Config (OpSimp) Phase 2	Cisco IOS XE Fuji 16.7.1	This feature was introduced on Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 13

Voltage Thresholds for AC Power Supply Module Mode Control

This document describes how to configure the voltage thresholds for switching modes in AC Power SupplyModule (PSM).

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

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 30: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about Voltage Thresholds for AC PSM Mode Control

Configuring voltage thresholds help switch between different modes when power budget provided by AC PSMs is not sufficient to power Field Replaceable Units (FRUs).

Overview of Voltage Thresholds for AC PSM Mode Control

The AC PSM can operate in either 120V or 220V mode.

When the input voltage is between 70V and 197V, the PSM operates in the 120V mode with 1300W power capacity. When input voltage drops below 85V, the PSM powers down completely and its power capacity becomes 0W.

When the input voltage is greater than 197V, the PSM operates in the 220V mode with 3000W power capacity. When input voltage drops below 190V, the PSM switches to the 120V mode and its power capacity decreases to 1300W.

To allow users configure mode switching, two new hystersis thresholds Voff_3000W and Von_3000W have been provided. The hystersis thresholds define when the PSM should switch modes and can be configured using CLI commands.

For example, if *Voff_3000W* is configured as 180V, the PSM switches to the 120V mode with 1300W capacity when input voltage drops below 180V. If *Von_3000W* is configured as 200V, the PSM switches to the 220V mode when input voltage increases to more than 200V.

Table 31: Voltage Thresholds for Mode Control

Threshold	Default Value	Configurable Range
Voff_3000W	190V	The value of Voff_3000W can be 170V or greater. The value of Von_3000W can be 200V or lesser. The value of Voff_3000W must be less than the value of Von_3000W.
Von_3000W	197V	

How to Configure Voltage Thresholds for AC PSM Mode Control

Configuring Voltage Thresholds for AC PSM Mode Control

To configure voltage thresholds, run the **platform power protection ac220v voff von** command as shown below:

```
Router# configure terminal
platform power protection ac220v voff von
```

To use the default voltage thresholds, run the **no platform power protection ac220v** command as shown below:

```
Router# configure terminal
no platform power protection ac220v
```

Note By default, power protection action is disabled to avoid service outage. If protection action is disabled, any online FRU is not powered down in the event of insufficient power budget, but any newly installed line card is not powered up.

To enable the power protection action, run the **platform power protection action shutdown linecard** command:

```
Router# configure terminal
platform power protection action shutdown linecard
```

Verifying Voltage Thresholds for AC PSM Mode Control

To verify the voltage thresholds configuration, use the **sh run** command as shown in the example below:

```
Router# configure terminal
Router (config)# sh run | i protection
platform power protection ac220v 180 200
```

Configuration Examples

This section provides configuration examples for the voltage threshold feature.

Example: Configuring Voltage Thresholds for AC PSM Mode Control

The following example shows how to configure voltage thresholds:

```
Router# configure terminal
platform power protection ac220v 180 200
```

The following example shows how to disable DPS:

```
Router# configure terminal
no platform power protection ac220v
```

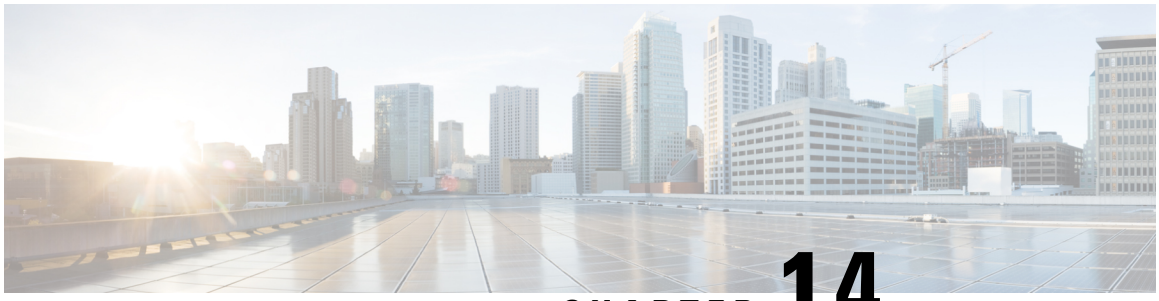
Feature Information for Voltage Thresholds for AC PSM Mode Control

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 32: Feature Information for Voltage Thresholds for AC PSM Mode Control

Feature Name	Releases	Feature Information
Voltage Thresholds for AC PSM Mode Control	Cisco IOS XE Fuji 16.7.1	This feature was introduced in Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 14

DOCSIS3.1 Downstream Zero Bit Loading

This document describes how to configure DOCSIS3.1 Downstream Zero Bit Loading 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 33: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information about DOCSIS3.1 Downstream Zero Bit Loading

Zero Bit Loading (ZBL) is a subcarrier in an OFDM channel, it has power but does not carry any user data. ZBL can be used if the user wants to bypass one or more subcarrier because, for example, cable modem reports that Modulation Error Ratio (MER) is too low on these subcarriers.

Unlike the excluded subcarrier which is defined per RF port and applied to all modulation profiles used on that port's OFDM channels, ZBL is defined per profile and applied to individual OFDM channel.

ZBL is modulated using PRBS (Pseudo Randomness Binary Sequence), it can not be used for other purpose. Excluded subcarrier is not modulated, and does not have power, so it can be used for other purposes, such as video.

For more information about the OFDM, see DOCSIS 3.1 OFDM Channel Configuration, on page 1.

How to Configure DOCSIS3.1 Downstream Zero Bit Loading

Configuring Downstream Zero Bit Loading

To configure downstream ZBL, follow these steps:

1. Configure ZBL for the data/control profile and the NCP profile.
2. Apply the modulation profiles to a channel profile.
3. Apply the channel profile to an OFDM channel.

Run the following commands as an example to configure ZBL:

```
Router# configure terminal
Router(config)# cable downstream ofdm-modulation-profile 159
Router(config-ofdm-mod-prof)# description an example of ZBL starting at 10MHZ for 1MHZ
Router(config-ofdm-mod-prof)# subcarrier-spacing 50KHZ
Router(config-ofdm-mod-prof)# width 96000000
Router(config-ofdm-mod-prof)# assign modulation-default 1024-QAM
Router(config-ofdm-mod-prof)# assign modulation zero-bit-load range-subcarriers freq-offset
 10000000 width 1000000
```

```
Router# configure terminal
Router(config)# cable downstream ofdm-modulation-profile 160
Router(config-ofdm-mod-prof)# description an example for ZBL on NCP profile for one SC
starting 14MHZ
Router(config-ofdm-mod-prof)# subcarrier-spacing 50KHZ
Router(config-ofdm-mod-prof)# width 96000000
Router(config-ofdm-mod-prof)# assign modulation-default 16-QAM
Router(config-ofdm-mod-prof)# assign modulation zero-bit-load list-subcarriers freq-offset
 14000000
```

```
Router# configure terminal
Router(config)# cable downstream ofdm-chan-profile 159
Router(config-ofdm-chan-prof)# cyclic-prefix 1024
Router(config-ofdm-chan-prof)# interleaver-depth 16
Router(config-ofdm-chan-prof)# pilot-scaling 48
Router(config-ofdm-chan-prof)# roll-off 128
Router(config-ofdm-chan-prof)# subcarrier-spacing 50KHZ
Router(config-ofdm-chan-prof)# profile-control modulation-profile 159
Router(config-ofdm-chan-prof)# profile-ncp modulation-profile 160
```

```
Router# configure terminal
Router(config)# controller Integrated-Cable 1/0/0
Router(config-controller)# max-ofdm-spectrum 192000000
Router(config-controller)# max-carrier 32
Router(config-controller)# base-channel-power 37
Router(config-controller)# rf-chan 0 3
Router(config-rf-chan)# type DOCSIS
Router(config-rf-chan)# frequency 261000000
Router(config-rf-chan)# rf-output NORMAL
Router(config-rf-chan)# power-adjust 0.0
Router(config-rf-chan)# qam-profile 1
```

```
Router(config-rf-chan)# docsis-channel-id 1
Router(config-rf-chan)# exit
Router(config-controller)# rf-chan 158
Router(config-rf-chan)# power-adjust 0.0
Router(config-rf-chan)# docsis-channel-id 159
Router(config-rf-chan)# ofdm channel-profile 159 start-frequency 627000000 width 96000000
plc 648000000
```

Verifying Downstream Zero Bit Loading

To check if the ZBL is taking effect, use **show controllers verbose** command as shown in the example below:

```
router# show controllers integrated-Cable 1/0/0 rf-channel 158 verbose | in ZBL
1024 :634350000[1235] - 636950000[1287]     ZBL  :637000000[1288] - 637850000[1305]
  ZBL  :637950000[1307] - 637950000[1307]     1024 :638000000[1308] - 641450000[1377]
  Active subcarrier count: 1804, ZBL count: 19
  ZBL  :641000000[1368] - 641000000[1368]     16   :641050000[1369] - 641450000[1377]
  Active subcarrier count: 1804, ZBL count: 1
```

User can also check DPD messages as shown in the example below:

```
router# show cable mac-domain c1/0/0 dpd integrated-Cable 1/0/0 158
DPD Message
  MAC Header
    Frame Control                   : 0xC2   (MAC specific, MAC msg, EHDR Off)
    MAC Parameters                  : 0x0
    Length                          : 41
    Header Check Sequence           : 0xB242 (45634)
  MAC Management Header
    Destination MAC ADDR            : 01e0.2f00.0001
    Source MAC ADDR                 : d42c.447c.2ce9
    Length                          : 23
    Destination SAP                 : 0
    Source SAP                      : 0
    Control                         : 3
    Version                         : 5
    Type                            : 50
    Multipart                       : 0    (Sequence number 0, Fragments 0)
  DPD fields
    DCID                            : 159
    Profile ID                      : 0
    CCC                             : 4
    TLV 5 Subcarrier Range/List     : Range (continuous)
      Modulation                    : 1024 (default value)
                                    : 0000 - 4095
    TLV 5 Subcarrier Range/List     : Range (continuous)
      Modulation                    : Zero
                                    : 1288 - 1307
DPD Message
  MAC Header
    Frame Control                   : 0xC2   (MAC specific, MAC msg, EHDR Off)
    MAC Parameters                  : 0x0
    Length                          : 39
    Header Check Sequence           : 0xCCAB (52395)
  MAC Management Header
    Destination MAC ADDR            : 01e0.2f00.0001
    Source MAC ADDR                 : d42c.447c.2ce9
    Length                          : 21
    Destination SAP                 : 0
    Source SAP                      : 0
    Control                         : 3
    Version                         : 5
    Type                            : 50
```

```
  Multipart                       : 0    (Sequence number 0, Fragments 0)
DPD fields
  DCID                            : 159
  Profile ID                      : 255
  CCC                             : 4
  TLV 5 Subcarrier Range/List     : Range (continuous)
    Modulation                    : 16 (default value)
                                  : 0000 - 4095
  TLV 5 Subcarrier Range/List     : List
    Modulation                    : Zero
                                  : 1368
```

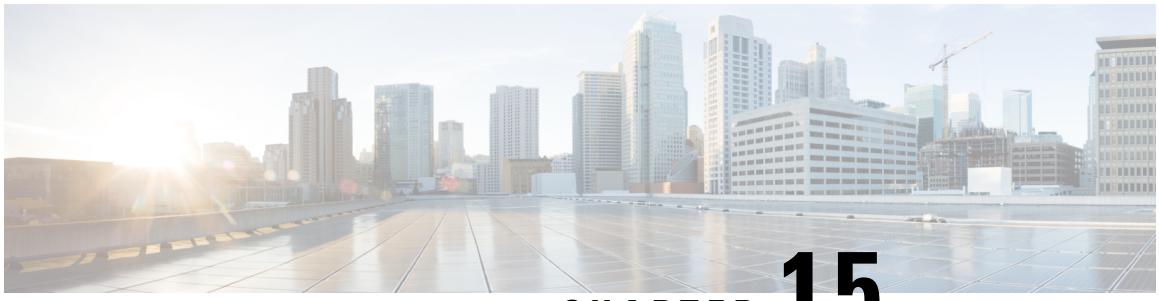
Feature Information for DOCSIS3.1 Downstream Zero Bit Loading

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 34: Feature Information for DOCSIS3.1 Downstream Zero Bit Loading

Feature Name	Releases	Feature Information
DOCSIS3.1 Downstream Zero Bit Loading	Cisco IOS XE Fuji 16.8.1	This feature was introduced into the Cisco cBR Series Converged Broadband Routers.



CHAPTER 15

Reducing Power Consumption

This document describes how to reduce power consumption on the Cisco cBR Series Converged Broadband Router.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

Finding Feature Information

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

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 35: 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 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information About Reducing Power Consumption

A Cisco cBR-8 CCAP line card has two downstream PHY modules. The first downstream PHY module has port number 0 through port number 3. The second downstream PHY module has port number 4 through port number 7. Each downstream PHY module consumes approximately 70W of power even if no RF channels are used. By default, both downstream PHY modules are powered up.

To reduce power consumption in the Cisco cBR-8, you can power down the second downstream PHY module.

The power-saving configuration is retained for supervisor card reload, supervisor high availability, LCHA, and LCPR configurations.

Restrictions for Setting Up Power-Saving Configuration

The following restrictions are applicable for setting up power-saving configuration:

- Before powering down the second downstream PHY module, you must shut down the downstream controllers.
- You cannot power down the downstream PHY module on a redundant line card.
- The redundant line card must be in the hot standby mode.

Configure Reduction of Power Consumption

Before powering down the second downstream PHY module, you must shut down the downstream controllers.

To shut down downstream controllers 4 to 7, run the following commands:

```
Router# enable
Router# configure terminal
Router(config)# controller integrated-Cable slot/subslot/port
Router (config-controller)# shutdown
```

The following example shows how to shut down downstream controllers 4 to 7.

```
Router# enable
Router# configure terminal
Router(config)# controller integrated-Cable 1/0/4
Router (config-controller)# shutdown
```

To power down the second downstream PHY module, run the following commands:

```
Router# enable
Router# configure terminal
Router(config)# cable downstream power-down-2nd-module slot
```

The following example shows how to power down the PHY module in slot 1.

```
Router# enable
Router# configure terminal
Router(config)# cable downstream power-down-2nd-module slot 1
```

Verifying the Power-Saving Configuration

After powering down the second downstream PHY module, the power consumption in downstream controllers 4 to 7 changes to 0.

To check power consumption in downstream controllers 4 to 7, run the following command:

```
Router# show cable card 1/0 ds-phy display | include Watts

Port0-3 Power Consumption 82781 (mWatts), Port4-7 Power Consumption 53443 (mWatts)
```

To check power consumption in downstream controllers 4 to 7 after powering down the downstream PHY module, run the following command.

```
Router#show cable card 1/0 ds-phy display | include Watts
Port0-3 Power Consumption 82781 (mWatts), Port4-7 Power Consumption 0 (mWatts)
```

The second downstream PHY module information shows *Powered down to save energy* when the **show cable card slot/sub-slot ds-phy display | include detected** command is run.

Feature Information for Reducing Power Consumption

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 36: Feature Information for Reducing Power Consumption

Feature Name	Releases	Feature Information
Reducing Power Consumption	Cisco IOS XE Fuji 16.9.1a	This feature was introduced in Cisco IOS XE Fuji 16.9.1 on the Cisco cBR Series Converged Broadband Routers.