



# DOCSIS 3.1 OFDMA Channel Configuration

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This document describes how to configure the OFDMA channel on the Cisco cBR Series Converged Broadband Router.

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## Hardware Compatibility Matrix for the Cisco cBR Series Routers



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

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

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	<p><b>Cisco IOS-XE Release 16.5.1 and Later Releases</b></p> <p>Cisco cBR-8 Supervisor:</p> <ul style="list-style-type: none"> <li>• PID—CBR-SUP-250G</li> <li>• PID—CBR-CCAP-SUP-160G</li> </ul>	<p><b>Cisco IOS-XE Release 16.5.1 and Later Releases</b></p> <p>Cisco cBR-8 CCAP Line Cards:</p> <ul style="list-style-type: none"> <li>• PID—CBR-LC-8D30-16U30</li> <li>• PID—CBR-LC-8D31-16U30</li> <li>• PID—CBR-RF-PIC</li> <li>• PID—CBR-RF-PROT-PIC</li> <li>• PID—CBR-CCAP-LC-40G</li> <li>• PID—CBR-CCAP-LC-40G-R</li> <li>• PID—CBR-CCAP-LC-G2-R</li> <li>• PID—CBR-SUP-8X10G-PIC</li> <li>• PID—CBR-2X100G-PIC</li> </ul> <p>Digital PICs:</p> <ul style="list-style-type: none"> <li>• PID—CBR-DPIC-8X10G</li> <li>• PID—CBR-DPIC-2X100G</li> </ul> <p>Cisco cBR-8 Downstream PHY Module:</p> <ul style="list-style-type: none"> <li>• PID—CBR-D31-DS-MOD</li> </ul> <p>Cisco cBR-8 Upstream PHY Modules:</p> <ul style="list-style-type: none"> <li>• PID—CBR-D31-US-MOD</li> </ul>

## 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 80 MHz
- Upstream spectrum 5 – 85 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

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

```



#### 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.
- 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.

## 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

Override 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
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)      (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
```

## 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://cfngn.cisco.com/> link. An account on the Cisco.com page is not required.




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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.

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**Table 2: Feature Information for DOCSIS 3.1 OFDMA Channel Configuration**

<b>Feature Name</b>	<b>Releases</b>	<b>Feature Information</b>
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.

