OFDM Channel Configuration

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

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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. OFDM Channel support includes 1 OFDM channel per port with channel bandwidth from 24 MHz to 192 MHz wide.

Each OFDM channel supports a control profile, an NCP profile, and up to 5 data profiles. Profiles support one or more modulations.

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.

Path Selection

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

How to Configure OFDM Channel

Configuring OFDM Channel Profile

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

```
enable
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
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
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 ****

<table>
<thead>
<tr>
<th>Prof Admin Controller:</th>
<th>ID</th>
<th>Assigned Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>3/0/4:158</td>
</tr>
<tr>
<td></td>
<td>101</td>
<td>3/0/0:158</td>
</tr>
</tbody>
</table>

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 ****

<table>
<thead>
<tr>
<th>Prof Cycl Roll FFT Intr Pilot Modulation (D-Default, P-Profile) Description</th>
<th>ID Prfx Off KHz Depth Scale Cntrl NCP Data Profiles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>0 System Profile 0</td>
<td>0 192 128 50 16 48 D:256 D:16 D:1024 NA NA NA NA</td>
</tr>
<tr>
<td>1 System Profile 1</td>
<td>1 192 128 50 16 48 D:256 D:16 D:1024 D:2048 D:512 NA NA</td>
</tr>
<tr>
<td>20</td>
<td>20 1024 128 50 16 48 D:1024 D:16 NA NA NA NA</td>
</tr>
<tr>
<td>30</td>
<td>30 1024 128 50 16 48 P:10 D:16 NA NA NA NA</td>
</tr>
</tbody>
</table>

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 ****

<table>
<thead>
<tr>
<th>Prof</th>
<th>FFT Width</th>
<th>Start-freq Modulations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>50</td>
<td>96000000 627000000 64</td>
<td>default</td>
</tr>
<tr>
<td></td>
<td></td>
<td>512 freq-abs 709050000 width 12000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2048 freq-abs 629000000 width 6000000</td>
<td></td>
</tr>
</tbody>
</table>

Profile Subcarrier Modulations

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>64 : 572600000[ 0] - 626950000[1087] 54400000[1088]</td>
</tr>
<tr>
<td>64 : 627000000[1088] - 628950000[1127] 2000000[ 40]</td>
</tr>
<tr>
<td>2048: 629000000[1128] - 634950000[1247] 6000000[ 120]</td>
</tr>
<tr>
<td>64 : 635000000[1248] - 709000000[2728] 74050000[1481]</td>
</tr>
<tr>
<td>64 : 723000000[3008] - 777350000[4095] 54400000[1088]</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Prof</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Prof</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>192</td>
<td>192</td>
</tr>
</tbody>
</table>
```

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

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

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

<table>
<thead>
<tr>
<th>Prof</th>
<th>FFT Width</th>
<th>Start-freq Modulations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>50</td>
<td>192000000 NA</td>
<td>2048 default</td>
</tr>
<tr>
<td></td>
<td></td>
<td>512 freq-off 480000000 width 24000000</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50</td>
<td>96000000 627000000 512</td>
<td>default 512-1k-4k</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1024 freq-abs 635000000 width 74050000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4096 freq-abs 629000000 width 6000000</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>96000000 627000000 64</td>
<td>default 709050000 width 12000000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>512 freq-abs 629000000 width 6000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2048 freq-abs 629000000 width 6000000</td>
<td></td>
</tr>
</tbody>
</table>
```
Configuring Port/Controller and Channel

To configure the port/controller and channel, follow the steps below:

```
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 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:
450000000 - 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
Channel 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
Channel 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
```
## OFDM Channel Configuration

### Verifying Port/Controller and Channel Configuration

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>License</td>
<td>granted &lt;17:02:35 EDT May 18 2016&gt;</td>
</tr>
<tr>
<td>OFDM channel license spectrum width</td>
<td>92200000</td>
</tr>
<tr>
<td>OFDM modulation license (spectrum width)</td>
<td>2K (6000000)</td>
</tr>
<tr>
<td>OFDM config state</td>
<td>Configured</td>
</tr>
<tr>
<td>OFDM channel details</td>
<td>[3/0/4:158]</td>
</tr>
<tr>
<td>OFDM channel frequency/subcarrier range</td>
<td>6270000000[1088] - 722999999[3007]</td>
</tr>
<tr>
<td>OFDM spectrum frequency/subcarrier range</td>
<td>5726000000[0] - 777399999[4095]</td>
</tr>
<tr>
<td>Active spectrum frequency/subcarrier range</td>
<td>6289000000[1126] - 721049999[2969]</td>
</tr>
<tr>
<td>OFDM channel center frequency/subcarrier</td>
<td>6750000000[2048]</td>
</tr>
<tr>
<td>PLC spectrum start frequency/subcarrier</td>
<td>6630000000[1808]</td>
</tr>
<tr>
<td>PLC frequency/subcarrier</td>
<td>6658000000[1864]</td>
</tr>
<tr>
<td>Channel width</td>
<td>9600000000</td>
</tr>
<tr>
<td>Active Channel width</td>
<td>9220000000</td>
</tr>
<tr>
<td>OFDM Spectrum width</td>
<td>2048000000</td>
</tr>
<tr>
<td>Chan prof id</td>
<td>30</td>
</tr>
<tr>
<td>Cyclic Prefix</td>
<td>1024</td>
</tr>
<tr>
<td>Roll off</td>
<td>128</td>
</tr>
<tr>
<td>Interleave depth</td>
<td>16</td>
</tr>
<tr>
<td>Spacing</td>
<td>50KHZ</td>
</tr>
<tr>
<td>Pilot Scaling</td>
<td>48</td>
</tr>
<tr>
<td>Control modulation profile</td>
<td>10</td>
</tr>
<tr>
<td>NCP modulation default</td>
<td>16</td>
</tr>
<tr>
<td>Data modulation default</td>
<td>None</td>
</tr>
<tr>
<td>Data modulation profile</td>
<td>None</td>
</tr>
<tr>
<td>Lower guardband width in freq/subcarriers</td>
<td>130000000 [38]</td>
</tr>
<tr>
<td>Upper guardband width in freq/subcarriers</td>
<td>190000000 [38]</td>
</tr>
<tr>
<td>Licensed 4K modulation spectrum width</td>
<td>0</td>
</tr>
<tr>
<td>Licensed 2K modulation spectrum width</td>
<td>600000000</td>
</tr>
<tr>
<td>PLC spectrum frequencies [subcarriers]</td>
<td>6630000000[1808] - 668999999[1927]</td>
</tr>
<tr>
<td>PLC channel frequencies [subcarriers]</td>
<td>6658000000[1864] - 666199999[1871] Size: 8 subcarriers</td>
</tr>
<tr>
<td>Count: 2252</td>
<td></td>
</tr>
<tr>
<td>Pilot frequencies [subcarriers]</td>
<td>*: PLC pilots</td>
</tr>
<tr>
<td></td>
<td>6307000000[1162] 6343000000[1234] 6379000000[1306] 6415000000[1378]</td>
</tr>
<tr>
<td></td>
<td>7087000000[2722] 7123000000[2794] 7159000000[2866] 7195000000[2938]</td>
</tr>
<tr>
<td>Count: 32</td>
<td></td>
</tr>
</tbody>
</table>

---

Cisco Converged Broadband Routers Software Configuration Guide For DOCSIS
Profiles:
Number of profiles: 2
CTRL profile (Profile A): rate: 461916 kbps, usable rate: 368000 kbps
Active frequencies [subcarriers]:
------------------------------------------------------------------
64 :659500000[1739] - 663400000[1816]
64 :665100000[1850] - 665950000[1867]
64 :666200000[1872] - 668500000[1888]
64 :668650000[1887] - 672650000[2001]
64 :672750000[2003] - 676250000[2078]
64 :679550000[2147] - 683450000[2217]
64 :687150000[2291] - 690650000[2361]
64 :694350000[2435] - 697850000[2505]
64 :701550000[2579] - 705050000[2649]
64 :708750000[2723] - 709000000[2729]
512 :712350000[2795] - 715850000[2865]
512 :719550000[2939] - 721000000[2968]
64 :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]:
------------------------------------------------------------------
16 :628900000[1126] - 628950000[1127] 16 :630650000[1161]
16 :634250000[1233] 16 :637950000[1305]
16 :641550000[1379] - 645050000[1449]
16 :651550000[1595]
16 :645150000[1595] - 652500000[1593]
16 :655500000[1737]
16 :659500000[1739] - 663400000[1816]
16 :664000000[1828]
16 :664100000[1830]
16 :665100000[1850]
16 :666200000[1872]
16 :668650000[1887]
16 :668750000[1887]
16 :672650000[2001]
16 :679550000[2147]
16 :683450000[2217]
16 :690650000[2361]
16 :694350000[2435]
16 :701550000[2579]
16 :708750000[2723]
512 :712350000[2795] - 715850000[2865]
512 :719550000[2939] - 721000000[2968]
16 :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

Cisco Converged Broadband Routers Software Configuration Guide For DOCSIS
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
RCS List:
```
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:
```
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:

```plaintext
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:

```plaintext
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:

```plaintext
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:
<table>
<thead>
<tr>
<th>Chan Idx</th>
<th>RF Chan</th>
<th>DCID</th>
<th>Freq</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In7/0/0:0</td>
<td>1</td>
<td>453000000</td>
</tr>
</tbody>
</table>

Non-Primary Receive Channel List:

OFDM Receive Channel List:
```
Example: 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 OFDM channel:

```bash
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
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
cable downstream ofdm-chan-profile 20
start-frequency 627000000 width 96000000
plc 663000000
```
Additional References

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>• DOCS-IF31-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
</tbody>
</table>

Feature Information for OFDM Channel Configuration

Use Cisco Feature Navigator to find information about 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 http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

Note

The below 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.
Table 1: Feature Information for OFDM Channel Configuration

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOCSIS 3.1 OFDM Channel Support</td>
<td>Cisco IOS-XE Release 3.18.0SP</td>
<td>This feature was introduced on the Cisco cBR Series Converged Broadband Routers.</td>
</tr>
<tr>
<td>Full Spectrum 108-1218 MHz Support</td>
<td>Cisco IOS-XE Release 3.18.0SP</td>
<td>This feature was introduced on the Cisco cBR Series Converged Broadband Routers.</td>
</tr>
<tr>
<td>DOCSIS 3.1 Path Selection</td>
<td>Cisco IOS-XE Release 3.18.0SP</td>
<td>This feature was introduced on the Cisco cBR Series Converged Broadband Routers.</td>
</tr>
</tbody>
</table>