DOCSIS 3.1 Downstream Profile Selection

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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 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

Note Do not use DPICs (8X10G and 2x100G) to forward IP traffic, as it may cause buffer exhaustion, leading to line card reload.

The only allowed traffic on a DPIC interface is DEPI, UEPI, and GCP traffic from the Cisco cBR-8 router to Remote PHY devices. Other traffic such as DHCP, SSH, and UTSC should flow via another router, since DPICs cannot be used for normal routing.

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. 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.

Internal PMA is enabled by default on the cBR-8. If external PMA is enabled, internal PMA is disabled and can be enabled by running the following config command on the cBR-8:

```
no cable downstream ofdm-prof-mgmt prof-upgrade-pma
```

In external PMA, the cBR-8 does not automatically upgrade a CM's profile to the recommended profile. In internal PMA, the profile can be upgraded to the recommended profile in the next OFDM Profile Test (OPT) cycle.

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 2: 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
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 3: 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 4: 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.