



## Upstream Bonding Support for D-PON

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The DOCSIS Passive Optical Network (D-PON) architecture, also known as RF over Glass (RFoG), helps the cable operators enter fiber-to-home market space and utilize the DOCSIS infrastructure effectively.

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## Hardware Compatibility Matrix for Cisco cBR Series Routers



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**Note** The hardware components 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 3.15.0S and Later Releases</b></p> <p>Cisco cBR-8 Supervisor :</p> <ul style="list-style-type: none"> <li>• PID—CBR-CCAP-SUP-160G</li> <li>• PID—CBR-CCAP-SUP-60G<sup>1</sup></li> <li>• PID—CBR-SUP-8X10G-PIC</li> </ul>	<p><b>Cisco IOS-XE Release 3.15.0S 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> </ul> <p>Cisco cBR-8 Downstream PHY Modules:</p> <ul style="list-style-type: none"> <li>• PID—CBR-D30-DS-MOD</li> <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-D30-US-MOD</li> </ul>

<sup>1</sup> 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 60Gbps, the total number of downstream service flow is limited to 72268, and downstream unicast low-latency flow does not count against the limits.

## Prerequisites for Upstream Bonding Support for D-PON

- DOCSIS 3.0 cable modems (CMs)
- DOCSIS 2.0 capable set-top boxes (STBs)
- You should configure the **cable upstream ranging-init-technique 2** command to prevent the use of additional broadcast initial ranging opportunities for the non D-PON reference upstream channels.

## Restrictions for Upstream Bonding Support for D-PON

- Multiple CMs cannot work at the same time. Each CM must get a separate time slot for upstream data transmission. Configuring D-PON ensures that the upstream scheduler allows only a single CM to transmit at a particular time.
- cBR8 does not support Upstream Bonding for D-PON on Remote-PHY.
- It is possible to enable or disable D-PON for individual Mac domain.
- When D-PON is enabled in a MAC domain, you must manually shut down and enable the MAC domain using **shutdown** and **no shutdown** command.

- All frequencies in a MAC domain must have the same configuration for:
  - minislot size
  - channel-width
  - modulation profile
- Supports only ATDMA DOCSIS mode.
- The following features are not supported in MAC domains configured for D-PON:
  - Load balancing
  - Spectrum management
  - Upstream configuration (to change upstream configuration, you should shut down the MAC domain)
  - S-CDMA logical channels
  - Lower modulations profiles (D-PON uses only 16 QAM and 64 QAM modulation profiles)
  - Channel-width other than 3.2 MHz and 6.4 MHz
  - In-service Software Upgrade (ISSU)
  - Mixing of D-PON and HFC on the same MAC domain
  - Software licensing

## Information About Upstream Bonding Support for D-PON

D-PON is a type of networking that allows the CMTS to transmit RF signals over the optical network. This technology enables the cable operators to use the RF technologies in a Hybrid Fiber-Coaxial (HFC) network.

The downstream data from the CMTS is combined with other RF signals at the hub and is sent to the transmitter. The signal from the transmitter is intended for multiple PONs. Each PON serves 32 homes from a single fiber.

The upstream data from the Optical Network Terminal (ONT) is combined at the splitter and sent to the hub, which is then routed to the optical receiver (RX). Upstream data from multiple optical receivers are combined and sent to the CMTS.

The upstream data to the CMTS contains signals from multiple PONs. Each upstream optical receiver is dedicated to a PON that can have multiple DOCSIS upstream sources (multiple modems and DSG terminals).

A PON can be configured in different ways, depending on the coaxial network. These configurations broadly fall under the following categories:

- **Internal Control Configuration**—In this configuration, the internal CM of the ONT controls the laser. Upstream signals go to the Ethernet interface of the CM allowing the ONT to control upstream timing. The device that uses this type of configuration is the Digital Audio Visual Council (DAVIC) set top terminal (STT).
- **External Control Configuration**—In this configuration, the presence of the RF at the ONT upstream input activates the laser. The device that uses this type of configuration is the DOCSIS Set-top Gateway (DSG) device.

- **Dual Control Configuration**—In this configuration, the home that contains an ONT with an internal CM and other DOCSIS upstream sources, like DSG devices. The RF presence detector or the internal CM control line detects the upstream signal and activates the upstream laser.

## D-PON on Upstream Scheduling

In D-PON implementation, the native upstream scheduling software of the CMTS controls the timing of the upstream data transmission. Only one PON Receiver Domain (PRD) is allowed to transmit upstream data at any given point of time, irrespective of the upstream frequency allocation. The reason for this is that two lasers from the ONT of a PRD cannot work simultaneously as it leads to an Optical Beat Interference (OBI). Moreover, the use of a frequency modulation (FM) for an upstream signal transmission results in PHY errors when multiple ONTs within a PON transmit simultaneously.

Initial maintenance regions are scheduled on all upstream channels to prevent the DOCSIS 3.0 CMs in a D-PON environment from failing initial ranging on any upstream channel. When a ranging request is received within a MAC domain configured for D-PON, the CM receives an upstream channel override to the D-PON reference channel (US0).

In this implementation of D-PON, a DOCSIS device within a PRD is given a timeslot to transmit the upstream data, irrespective of the upstream frequency. Therefore, there is no benefit in having more than one upstream in a MAC domain without using the upstream channel bonding feature.

The D-PON feature supports the following service types:

- Best effort (BE) 3.0 using up to four frequencies concurrently
- BE 2.0 using only a single frequency
- Unsolicited grant service (UGS) using only a single frequency
- Real-time polling service (RTPS) using only a single frequency
- Non-real-time polling service (nRTPS) using only a single frequency

## How to Configure Upstream Bonding Support for D-PON

This section describes how to enable D-PON for a MAC domain on the Cisco cBR router. The bonding group must include a reference channel which is default to the upstream channel 0.



**Note** The USCB can support a maximum of 4 US channels in a RFOG MAC domain in the following combination:

- US0
- US0, US1
- US0, US1, US2
- US0, US1, US2, US3

All US channels must be configured to have the same number of minislots, channel width (only 3.2 and 6.4 MHz supported), DOCSIS mode (only ATDMA supported) and modulation profile.

**Procedure**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<b>enable</b> <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
<b>Step 3</b>	<b>interface cable</b> <i>slot/subslot/cable-interface-index</i> <b>Example:</b> Router(config)# <b>interface cable 8/0/0</b>	Enters interface configuration mode for the specified cable interface.
<b>Step 4</b>	<b>cable upstream dpon</b> <b>Example:</b> Router(config-if)# <b>cable upstream dpon</b>	Enables D-PON for a MAC domain.
<b>Step 5</b>	<b>shutdown</b> <b>Example:</b> Router(config-if)# <b>shutdown</b>	Shuts down the interface.
<b>Step 6</b>	<b>no shutdown</b> <b>Example:</b> Router(config-if)# <b>no shutdown</b>	Enables the interface.
<b>Step 7</b>	<b>end</b> <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to the privileged EXEC mode.

## DOCSIS 3.0 Cable Modems Upstream Bonding Enters Partial Bonding

Sometimes, upstream bonding enters partial bonding while reverting to the original CLC after switchover.

In the following example, the switchover is performed between CLC in slot 1 and 0. After reverting to CLC in slot 1, C1/0/3/UB turns to C1/0/3/p. The following output highlights the change:

```
Router# show cable modem
```

```
Load for five secs: 1%/0%; one minute: 2%; five minutes: 2% Time source is NTP, 13:00:25.570
UTC Thu Feb 18 2016
```

MAC Address	IP Address	I/F	MAC State	Prim Sid	RxPwr (dBmv)	Timing Offset	Num CPE	D I P
4844.8789.e0fc	10.78.100.6	C1/0/0/UB	w-online	6	-0.50	1787	0	N
c8fb.2639.33d0	10.78.100.7	C1/0/1/UB	w-online	1	-1.00	1793	0	N
4844.8789.e10e	10.78.100.10	C1/0/2/UB	w-online	1	-0.50	1784	0	N
602a.d0a2.9b3e	10.78.100.11	<b>C1/0/3/p</b>	w-online	4	1.50	1789	0	N
0025.2ecf.f922	10.78.100.8	C1/0/4/UB	w-online	1	-1.00	1788	0	N

This partial bonding can be recovered using the **shutdown** and **no shutdown** commands on the related upstream port under the controller. The following is a sample configuration:

```
Router(config)# controller Upstream-Cable 1/0/3
Router(config-controller)# us-channel 0 shutdown
Router(config-controller)# no us-channel 0 shutdown
```

## Verifying the Upstream Bonding Support for D-PON

To verify the upstream scheduler output for a MAC domain configured with D-PON, use the **show interface cable mac-scheduler** command.



### Note

The D-PON reference channel (US-1) MAP serves as a template for producing other MAPs within the MAC domain. Therefore, some of the statistics related to upstream scheduling is not relevant for other channels, except for the D-PON reference channel.

```
Router# show interface cable 8/0/0 mac-scheduler 1
DOCSIS 1.1 MAC scheduler for Cable8/0/0/U1 : rate 30720000
wfq:None
us_balance:OFF
dpon_mode:ON
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 1824595508, Req/Data Slots 10640906
Init Mtn Slots 89924653, Stn Mtn Slots 989543
Short Grant Slots 0, Long Grant Slots 0
Adv Phy Short Grant Slots 538, Adv Phy Long Grant Slots 219831
Adv Phy UGS Grant Slots 0
Avg upstream channel utilization : 0%
Avg percent contention slots : 98%
Avg percent initial ranging slots : 1%
Avg percent minislots lost on late MAPs : 0%
MAP TSS: lch_state 9, init_retries 0
late_initial_maps 0, late_ucd_maps 0
mac-phy tss errors 0, missed ccc 0
```

## Additional References

The following sections provide references related to the Upstream Bonding Support for D-PON feature.

**Related Documents**

Related Topic	Document Title
Prisma D-PON	<a href="#">Cisco Prisma D-PON</a>

**Technical Assistance**

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>

## Feature Information for Upstream Bonding Support for D-PON

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 2: Feature Information for Upstream Bonding Support for D-PON**

Feature Name	Releases	Feature Information
Upstream Bonding Support for D-PON	Cisco IOS-XE Release 3.17.0S	This feature was introduced on the Cisco cBR Series Converged Broadband Routers.

