



## Upstream Channel Bonding

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The Upstream Channel Bonding (USCB) feature helps cable operators offer higher upstream (US) bandwidth per cable modem (CM) user by combining multiple radio frequency (RF) channels to form a larger bonding group at the MAC layer.

### Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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.

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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 Channel Bonding

- Enable downstream channel bonding before configuring the Upstream Channel Bonding feature on a Cisco cable modem termination system (CMTS) router.
- Ensure that the CM is registered in Multiple Receive Channel (MRC) mode before configuring upstream channel bonding on a Cisco CMTS router.
- Ensure that the CM is DOCSIS 3.0 certified.

## Restrictions for Upstream Channel Bonding

The following are the general restrictions for the Upstream Channel Bonding feature:

- Only the static bonding groups are supported.
- Only the upstream channels belonging to the same MAC domain can be added to an upstream bonding group.



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**Note** Starting from Cisco IOS-XE 3.18.0S release, maximum of 16 upstream channels can be configured for each MAC Domain, which are divided into two groups:

- Group 1: upstream channel 0-7
- Group 2: upstream channel 8-15

The **upstream bonding-group** should include all the upstream channels either from Group 1 or Group 2 only.

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- Committed information rate (CIR) oversubscription is not supported on USCB groups.

Cisco CMTS allows oversubscription of the available bandwidth for individual upstream channels. However, oversubscription of bandwidth is not supported for USCB groups.

An individual upstream may get oversubscribed due to static CIR service flows created for voice traffic. This may cause the DOCSIS 3.0 CMs with USCB to come online on single channel US bonding group (also known as default bonding group).

This problem is mainly encountered in the voice deployments using static service flows. It is, therefore, recommended to choose from the following voice deployments such that the CIR is allocated (or released) when a voice call is attempted (or dropped):

1. Dynamic Quality of Service (DQoS) Lite
2. Packet Cable (PC) DQoS
3. Packet Cable Multimedia (PCMM)

These deployments avoid the individual upstream oversubscription and CMs come online on expected bonding groups.

## Information About Upstream Channel Bonding

DOCSIS 3.0-based upstream channel bonding is a method for increasing upstream bandwidth up to a maximum of 120 Mbps raw throughput per CM user in a cable communications system that includes a Cisco CMTS router and multiple CMs. The upstream channel bonding method enables a CM to transmit data to a Cisco CMTS router on multiple upstream channels simultaneously.

Channel bonding is a method by which smaller bandwidth upstream channels are bonded together to create a larger upstream bonding group in the MAC domain. A MAC domain is a logical sub-component of a Cisco CMTS router and is responsible for implementing all DOCSIS functions on a set of downstream and upstream channels.

The Upstream Channel Bonding feature supports upstream traffic in Multiple Transmit Channel (MTC) mode for data and video services as these services require more bandwidth than voice-based services. Voice-based services either use the traditional single upstream channel or a single upstream channel bonding group configuration. Any traffic contract that exceeds 30 Mbps requires upstream channel bonding as the physical capacity of a single RF channel in DOCSIS cannot exceed 30 Mbps.

The Upstream Channel Bonding feature is supported on the Cisco cBR-8 router. Upstream data from the subscriber comes through the upstream ports (US0-US19) that are automatically configured on the cable

interface line card. The cable interface line card processes the data and sends it across the backplane to the WAN card and out to the Internet.

The table below lists the downstream and upstream frequency supported on the cable interface line card.

*Table 2: Downstream and Upstream Frequency*

Line Card	Downstream Frequency	Upstream Frequency
Cisco cBR-8 CCAP	55-999 MHz <sup>2</sup>	The upstream frequency range for the Cisco cBR-8 CCAP line card is from 5 to 85 MHz irrespective of the region and Annexure configuration.

<sup>2</sup> This frequency range is subjected to the frequency restriction of the attached EQAM device.

## Multiple Transmit Channel Mode

Multiple Transmit Channel mode is a CM capability that enables CMs to send upstream traffic on multiple upstream channels. You can enable the MTC mode on a cable interface line card:

- MTC mode for all CMs in a MAC domain—The MTC mode for all CMs in a MAC domain is enabled by default on an upstream bonding capable cable interface line card.

## Multiple Receive Channel Mode

MRC mode is a CM capability that enables CMs to receive downstream traffic on multiple downstream channels. The MRC mode is enabled by default on an upstream bonding capable cable interface line card. You can enable or disable the MRC mode in the MAC domain during or after the CM registration using the **cable mrc-mode** command.

## Dynamic Range Window and Transmit Power Levels for Upstream Channel Bonding

The dynamic range window functionality is based on the CableLabs DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification and DOCSIS 3.0 Specification. This requires a DOCSIS 3.0 CM to have upstream transmit channel power level within a 12 dB range for all channels in its transmit channel set (TCS).

DOCSIS 1.x or 2.0 CMs operating with a single upstream channel, in non-MTC mode, have a higher maximum transmit power level than DOCSIS 3.0 CMs operating in the MTC mode with two or more upstream channels. That is, the maximum transmit power level per channel is reduced in the MTC mode.

When the upstream attenuation exceeds the maximum transmit power level, a DOCSIS 3.0 CM attempting to register in the MTC mode may fail to come online, or register in partial mode. The CM fails to register when the transmit power level of all upstream channels in its TCS exceeds the maximum transmit power level. If the CM has some upstream channels that are within the maximum transmit power level, the CM may come online in partial mode. However, the upstream channels that exceed the maximum transmit power level are marked as down and cannot be used for upstream traffic.

To verify the transmit power levels on a CM, use the **show cable modem** command with the verbose keyword. This command displays the following transmit power values for each assigned upstream channel:

- **Reported Transmit Power**—This is the reported transmit power level by the CM for each upstream channel.
- **Minimum Transmit Power**—This is the minimum transmit power level that the CM in the MTC mode could transmit at for the upstream channel.
- **Peak Transmit Power**—This is the maximum transmit power level that the CM in the MTC mode could transmit at for the upstream channel.

To support upstream channel bonding, the minimum transmit power must be less than or equal to the reported transmit power, and the reported transmit power must be less than or equal to the peak transmit power. The peak transmit power and minimum transmit power levels are derived from the CM TCS assignment and each individual upstream channel configuration.

If the minimum transmit power is higher than the reported transmit power, or the reported transmit power is higher than the peak transmit power, the CM may not come online or may register in partial mode.

You can troubleshoot this transmit power problem in the following two ways:

- Insert an additional amplifier to reduce the upstream attenuation so that the upstream transmit power falls within the allowed transmit power range (12 dB).
- Disable the MTC mode. To switch the CM from the MTC mode to non-MTC mode, disable the bonded-bit (bit-0) in type, length, value (TLV) 43.9.3 using the CM configuration file.

## Extended Transmit Power

During the early deployment of DOCSIS 3.0 CMs, additional power is required from the CMs in order to compensate for the attenuation in the upstream path. CMs should transmit at extended power level than that defined in DOCSIS. This scenario is generally observed when USCB is enabled at the Cisco CMTS and the DOCSIS 3.0 CMs are operating in MTC mode.

Additional upstream power provides the operator with a power margin that helps overcome the upstream signal loss, reduces the cable plant operational cost, and enables rapid deployment of DOCSIS 3.0 CMs.

The Cisco CMTS supports the following features with which the CMs can transmit data at an extended power:

- Cisco Extended Transmit Power Feature
- DOCSIS Extended Transmit Power Feature

### Cisco Extended Transmit Power Feature

The Cisco Extended Transmit Power feature supports DOCSIS 3.0 CMs operating in MTC mode to transmit at a higher power level than the power level specified in the *DOCSIS 3.0 Specification*. This feature is supported only with Cisco DPC3000 CMs.

The Cisco Extended Transmit Power feature enables cable operators to have better control on the cable modems that register in 4-channel or 2-channel MTC mode or in non-MTC mode to transmit at a higher power level than the DOCSIS-defined maximum power level. The cable operator can configure extended transmit power using the **cable tx-power-headroom** command in global configuration mode.

### DOCSIS Extended Transmit Power Feature

The DOCSIS Extended Transmit Power feature supports extended upstream transmit power capability as defined in the DOCSIS3.0 Specification. This feature allows the CMs to transmit at a high extended power level to counter the attenuation in the US channel.

The table below lists the new TLVs supported by the DOCSIS Extended Transmit Power feature.

Table 3: TLVs for DOCSIS Extended Power Feature

TLV Name	Type	Length	Value
Extended Upstream Transmit Power Support	16	1	0—Extended Upstream Transmit Power Support Off 1—Extended Upstream Transmit Power Support On 2-255—Reserved
Extended Upstream Transmit Power CM Capability	5.40	1	0, 205-244 (units of one-quarter dB)

The Cisco CMTS sends TLV16 to inform the CM if the DOCSIS Extended Transmit Power feature is enabled. The CM in turn, sends TLV5.40 to the Cisco CMTS to communicate its extended power capability. After the negotiations are complete, the CM can transmit at an extended power.

DOCSIS Extended Transmit Power feature is enabled by default. Use the cable upstream ext-power command to enable or disable this feature. For more information on how to enable or disable DOCSIS Extended Power feature, see [Configuring DOCSIS Extended Transmit Power Feature, on page 27](#).



**Note** DOCSIS Extended Transmit Power feature takes precedence, if both Cisco Extended Transmit Power feature and DOCSIS Extended Transmit Power feature are configured.

## Reduced Transmit Channel Set

The Reduced Transmit Channel Set feature enables the Cisco CMTS router to reduce upstream channel set assignment based on the total power budget of the CM. For example, a reduction from four to two upstream channels gains 3 dB headroom. Further reduction from two channels to a single channel gains another 3 dB headroom, and the CM starts operating in non-MTC mode.

In order to take advantage of the reduced upstream channel set, the corresponding static bonding groups must be configured. For example, a MAC domain is configured with a bonding group having four channels. A CM with the reduced channel set of two is unable to match to the 4-channel bonding group, and can only be matched to a bonding group with two channels or less.

The Reduced Transmit Channel Set feature is helpful when a DOCSIS 3.0 CM is required to increase its total transmit power by 3 dB. For example, a DOCSIS 1.0 or 2.0 CM supports a maximum transmit power of 58 dBmV for Quadrature Phase Shift Keying (QPSK) modulation, while a DOCSIS 3.0 CM supports a maximum transmit power of 61 dBmV. In this case, the DOCSIS 3.0 CM operating in 4-channel MTC mode has a reduction in the maximum transmit power per upstream channel. This feature enables the Cisco CMTS router to support reduced input power level by 6 dB to prevent upstream path attenuation.

## T4 Multiplier

T4 multiplier is the T4 timeout multiplier value of the default T4 timeout values as defined in for cable modems that are in the MTC mode. The default value is derived from the number of channels in the modem transmit channel set. You can change the default T4 multiplier value using the cable upstream ranging-poll command in cable interface configuration mode.

The T4 timeout multiplier values range is from 1 to 10. If the T4 multiplier value is equal to 1, the cable modem will T4 time out in 30 seconds (that is,  $1 \times 30 = 30$ ). If you change the T4 multiplier to 4, then the new T4 timeout value will be 120 seconds (that is,  $4 \times 30 = 120$ ).



**Note** If the T4 timeout multiplier is not configured from the range (1 - 10), then the CMTS uses the T4 timeout value of modem as T4 timeout value. For example, if the T4 timeout of the modem is 90 seconds, then the CMTS applies 3 as the T4 multiplier.

In the MTC mode, you can increase the T4 timeout value in order to reduce the router overhead associated with processing of ranging request (RNG-REQ) slots and ranging response messages. If an RNG-RSP message does not contain a T4 timeout multiplier value, then the CM uses the default T4 timeout value.

## Fiber Node Configuration for Upstream Channel Bonding

The fiber node configuration on a Cisco CMTS router is used to define MAC domain downstream service groups (MD-DS-SGs) and MAC domain upstream service groups (MD-US-SGs) as defined in DOCSIS 3.0. Only the DOCSIS 3.0 certified modems use this information.

In hybrid fiber coaxial (HFC) networks, all CMs connected to the same coaxial segment of a fiber node reach the same set of downstream and upstream channels on one or more Cisco CMTS routers located at the headend.

A CM is physically connected to only one fiber node. The fiber node must include at least one primary-capable controller for the CM connected to the fiber node to be operational.

## New TLVs for Upstream Channel Bonding

The table below lists the new CableLabs defined type, length, values (TLVs) for the Upstream Channel Bonding feature.

*Table 4: New TLVs for Upstream Channel Bonding*

TLV Name	Type	Length	Value
CM vendor ID	43.8	3	Per vendor definition
Cable modem attribute mask	43.9	n	Cable modem attribute mask subtype encodings

A Cisco CMTS can have multiple upstream channel bonding groups (USBG) configured. Each of these bonding groups can include upstream channels with different upstream frequencies. Some bonding groups can include channels with frequencies within the extended frequency range (see [Table 2: Downstream and Upstream Frequency, on page 4](#)). An HFC network consists of several types of CMs, each supporting standard or extended upstream frequencies.

When you register a CM, the Cisco CMTS does not assign bonding groups based on the upstream frequency range supported by that CM. The assignment of the bonding groups is done to balance the CM count on each of the bonding groups. This may lead to assignment of a bonding group, in the extended frequency range, to a CM that lacks the extended frequency support. As a result, the CM will not be able to register. This scenario is generally observed in the Cisco cBR-8 CCAP line card deployment (containing a mix of CMs), which supports frequency as high as 85MHz (see [Table 2: Downstream and Upstream Frequency, on page 4](#)).

If the Cisco CMTS assigns a USBG with a channel within the extended frequency range to a CM limited to the standard frequency range, that CM may not be able to register on that upstream bonding group. Use the TLV 43.9.3 (CM US Required Attribute Mask) or TLV 43.9.4 (CM US Forbidden Attribute Mask) as a workaround. These TLVs enable the Cisco CMTS to assign CM to a USBG, which is in the upstream frequency range supported by that CM.

The default attributes (in hexadecimal) on a CM Attribute Mask (TLV 43.9) are "80 00 00 00", which means by default the mask is all zeroes with the bonding bit enabled. The first four bytes are pre-defined while the last four bytes are user defined. In order to enable Cisco CMTS to assign bonding groups based on the frequency range supported by CMs, complete these steps:

1. Configure a mask, using TLV 43.9.3 or TLV 43.9.4, by modifying the last four bytes. The mask should be configured such that a unique attribute is assigned to each of the bonding groups.
2. Apply this mask to the CM configuration file. CMs supporting extended frequency, can register with any USBGs, irrespective of the configured frequency range of the USBG. CMs supporting standard frequency, can only register with USBGs that are configured with standard frequency range.

Apply the mask you have configured above, to the CMs that support standard or extended frequency ranges. However, the ONLY CMs that need to employ the attribute mask are the ones with the standard frequency range, since they will not be able to register with the USBG configured with extended upstream frequency range. No attribute mask on the extended frequency supporting CMs means that these modems will be assigned any USBG.

The Cisco CMTS uses this mask, received in the CM configuration file during registration, to decide which USBG should be assigned to the CM.

## Upstream Weighted Fair Queuing

The upstream weighted fair queuing (WFQ) is a quality of service (QoS) feature that enables the Cisco CMTS router to allocate optimum bandwidth to upstream service flows based on the WFQ parameter configurations. To enable upstream WFQ, you must configure either the class-based or activity-based WFQ on a cable interface.

The following WFQ parameter configurations are supported:

### Class-Based Weighted Fair Queuing

In the class-based weighted fair queuing configuration, allocation of available bandwidth is dependent on the service flows that are active in a service class. A service class is a group of queuing attributes configured on the Cisco CMTS router. The class must have at least one active service flow. The class receives its portion of the available bandwidth based on the weight of the class. By default, each class (0 to 7) has a weight of "class + 1." For example, the class 0 has a weight of 1, and class 1 has a weight of 2.

### Activity-Based Weighted Fair Queuing

In the activity-based weighted fair queuing configuration, allocation of available bandwidth is based on the service class and the total number of service flows that are active in a map for the service class. A service class with higher number of service flows receives the larger percentage of bandwidth.

### Custom Weight for Service Flow Priorities

The weighted fair queuing functionality helps the Cisco CMTS router share the available bandwidth based on the weight of the service flow priorities specified for outstanding requests from an upstream service flow. Priority refers to the service flow priority specified in the CM configuration file, or the Cisco CMTS service

class configuration. By default, the weight of a priority is equal to “priority+1.” For example, priority 0 has a weight of 1, and priority 1 has a weight of 2. A higher priority provides more weight to the outstanding request. The custom weight can be specified for a total of eight priorities (0 to 7) in a service class.

The priority parameter refers to the priority of traffic in a service flow ranging from 0 (the lowest) to 7 (the highest). In the upstream traffic, all of the pending high priority service flows are scheduled for transmission before low priority service flows. You can configure the weight for priorities based on how much weight is appropriate per priority.

The table below lists the default weight for each service flow priority.

**Table 5: Default Weight of Service Flow Priorities**

Service Flow Priority	Default Weight
0	1
1	2
2	3
3	4
4	5
5	6
6	7
7	8

## Upstream Scheduler and Service Flows

A DOCSIS-qualified Cisco CMTS router can provide varied upstream scheduling modes for different packet streams or applications using upstream service flows. A service flow represents either an upstream or a downstream flow of data. A unique service flow ID (SFID) identifies each service flow. Each service flow can have its own quality of service (QoS) parameters, such as maximum throughput, minimum guaranteed throughput, and priority. In the case of upstream service flows, you can also specify a scheduling mode.

Scheduling is a process that enables the Cisco CMTS router to receive bandwidth requests and grant timeslots to CMs for the upstream traffic. The Cisco CMTS router periodically creates a grant map for each enabled upstream channel. The map grants individual timeslots to enable CMs to place packets on the upstream channels.

DOCSIS 3.0 describes a method by which a CM creates an upstream service flow. The following scheduling types enable the Cisco CMTS router to allocate bandwidth for upstream service flows:

- Unsolicited grant service (UGS)
- Solicited grant service

The unsolicited grant service is primarily used for voice. In the case of UGS, the CM does not have to explicitly request grants from the Cisco CMTS router whereas in the solicited grant service the CM has to explicitly request grants from the Cisco CMTS router. The solicited grant service is primarily used for best effort (BE) services.

Unlike DOCSIS 2.0, DOCSIS 3.0 allows multiple outstanding requests per service flow. For more information about the upstream scheduler, see the *Upstream Scheduler Mode for the Cisco CMTS Routers* feature guide at the following URL:

[http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts\\_upstm\\_sch\\_md\\_ps2209\\_TSD\\_Products\\_Configuration\\_Guide\\_Chapter.html](http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_upstm_sch_md_ps2209_TSD_Products_Configuration_Guide_Chapter.html)

## Upstream Service Flow Fairness

The service flows in the same class receive approximately the same amount of bandwidth. Fairness resolves the bandwidth distribution disparity among various service flows including:

- non-bonded service flow vs bonded service flows
- Service flows on modems of different vendors, i.e Intel/TI vs Broadcom
- Service flows associated with different sized bonding groups, i.e. 1,2 4 channels

The upstream scheduler supports flow based queuing. When Upstream Service Flow Fairness is configured, the upstream scheduler determines the order and amount of BW a service flow should receive based on it's current consumption relative to other flows in the flows in the same class.

Use the **cable upstream qos fairness** command to configure the Upstream Service Flow Fairness feature. Use this command in interface configuration mode (or MAC Domain configuration mode).

## Distribution of Traffic across all Channels in a USBG

When upstream channel bonding (USCB) is enabled, the Distribution of Traffic across all Channels in a USBG feature can be used to balance the bandwidth utilization across upstream channels on one upstream bonding group.

This feature balances the utilization only if there is one upstream channel bonding group configured per MAC domain.

### Restrictions:

- This feature is supported only on one upstream bonding group under a MAC domain. When multiple upstream bonding groups are configured under a MAC domain, the utilization is unfair.
- All the channels must be configured in one upstream bonding group under the same MAC domain.
- This feature is used only for UB-online cable modems.

The USCB Balancing Scheduler may be enabled or disabled using the **cable upstream balance-scheduler** command in the interface (config-if) configuration mode.

## DOCSIS 3.0 Load Balancing with USBG Smaller than Cable Modem Capabilities

When using USCB in a service group with USBGs containing fewer upstream channels than the total upstream channel set with DOCSIS 3.0 load balancing enabled, the CMTS can assign a Transmit Channel Set (TCS) to DOCSIS 3.0 cable modems for potential use which falls outside of the configured USBG. The CMTS will try to bind smaller UBGs and default single channel bonding groups into a bigger channel set in order to increase the cable modem services. For example, a DOCSIS 3.0 cable modem receiving the larger TCS can use these additional channels for dynamic service flow addition. The DOCSIS 3.0 Load Balancing feature can also move cable modems to upstream channels that are not explicitly configured with USBGs as a result of the larger TCS.

If you activate DOCSIS 3.0 Load Balancing while using upstream bonding, ensure that the upstream bonding group configuration is embedded and aligned by performing the following:

- Configure USBGs, which is matched to cable modem capabilities within the service group, such as a 4 channel USBG, 2 channel USBG, and 3 channel USBG as applicable.
- Ensure that configured USBGs are optimal for the upstream channel set based on modem capabilities within the service group. For example, if four upstream channels are available, channels 0+1 and 2+3 should each be an USBG to avoid dynamic TCS creating sub optimal bonding scenarios.
- Alternatively, you can choose to shut down any upstream channels that is not configured in USBGs which is not be used for bonding.

## Cisco cBR-8 CCAP Line Card Rate Limiting

The rate limiting functionality enables you control the aggregated rate and CPU consumption of upstream traffic for DOCSIS 3.0 bonded service flows on the Cisco cBR-8 CCAP line card. The rate limiting functionality is configured by default on the Cisco cBR-8 CCAP line card. However, the default configuration can be modified using the **cable upstream rate-limit-ccf** command.

The rate limiting functionality uses the following two rate limiting methods:

- Aggregated rate limiting—This is based on Peripheral Component Interconnect (PCI) bus aggregated throughput. The throughput is per line card for all bonded service flows. You can modify the default throughput and burst rate configuration. The maximum allowed throughput is 115 Mbps.
- CPU-based rate limiting—This method controls the CPU consumed by Continuous Concatenation and Fragmentation (CCF) and ensures that the line card functions properly when traffic is overloaded with bonded service flows. The default configuration allocates 50 per cent of CPU to CCF. You can modify the default CPU threshold value and burst rate as required.

## SID Tracking

The service ID (SID) tracking functionality enables you to track events related to upstream bandwidth requests and processing of grants. The SID tracker module can track events for a maximum of two service flows per MAC domain. The SID tracker module tracks up to 40,000 events per service flow on a cable interface line card.

You can enable SID tracking for the following types of events:

- DOCSIS 2.0 bandwidth request
- DOCSIS 3.0 bandwidth request
- Grant
- Pending grant (due to traffic congestion)
- Pending grant (due to shaping)

You can enable SID tracking using the **track keyword** along with the **debug cable interface sid** command. To verify SID tracking, use the **show interface cable upstream debug** command in privileged EXEC mode.

## Service ID Clusters

A Cisco CMTS router can assign one or more service ID clusters to the upstream bonded service flows (upstream service flows assigned to an upstream bonding group) at the time of service flow creation. A SID

cluster contains one SID per upstream in a bonding group. A CM uses one of the SIDs defined in the SID cluster for the upstream interface when the CM sends a bandwidth request. The CM chooses a SID or a SID cluster based on the SID cluster switching criteria.

For example, assume that a CM has ranged on upstream channels from 1 to 4. The Cisco CMTS router creates a bonded service flow and assigns a single SID cluster to each upstream channel. That is SID1 for UP1, SID2 for UP2, SID3 for UP3, and SID4 for UP4. Now, the CM can send a bandwidth request using any of the four upstream channels. That is, the CM can request bandwidth on any of the upstream interfaces in the SID cluster using the SID defined for the particular upstream. The Cisco CMTS router grants bandwidth to the CM using any combination of upstream channels.

## How to Configure Upstream Channel Bonding



**Note** Before configuring the Upstream Channel Bonding feature, ensure that the fiber node is configured. The fiber node must be configured in accordance with the physical plant topology.

The following tasks describe how to configure Upstream Channel Bonding on the Cisco cBR-8 router:

### Enabling MTC Mode on a Cisco CMTS Router

This section explains how to enable the MTC mode on a Cisco CMTS router.

#### Default MTC Mode Configuration on a Cisco CMTS Router

By default, the MTC mode is configured on a cable interface line card. With this default configuration, the Cisco CMTS router enables the MTC mode on a per MAC domain basis depending on the configuration file of each CM. When the CM configuration file has the bonded-bit (bit-0) enabled in TLV 43.9.3 (cable modem upstream required attribute mask), the Cisco CMTS router enables the CM to come online in the MTC mode. If the CM configuration file does not have the bonded-bit on, the CM comes online in non-MTC mode.

For more information on how to add the required attribute in the CM configuration file, see [Example: Enabling MTC Mode for a Single CM Using the CM Configuration File, on page 29](#).

### Enabling MTC Mode for All CMs



**Note** This MTC mode configuration supersedes the default MTC mode configuration (per CM basis) with the required attribute. To disable the MTC mode for all CMs in a MAC domain, use the **no** form of the **cable mtc-mode** command. If the MTC mode is enabled and the forbidden mask of the upstream bonding in TLV 43.9.4 is disabled, the CM does not support the Upstream Channel Bonding feature.

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b>	Enables privileged EXEC mode.

	Command or Action	Purpose
	<b>Example:</b> Router> <b>enable</b>	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> {slot/subslot/port   slot/subslot/cable-interface-index   slot/port   slot/cable-interface-index} <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable mtc-mode</b> <b>Example:</b> Router(config-if)# <b>cable mtc-mode</b>	Enables MTC mode at the MAC interface for all CMs.
<b>Step 5</b>	<b>end</b> <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring UCSB Required Attribute

If the CM configuration file has TLV 43.9.3 (CM upstream required attribute mask) configured and bonded bit is set to 1, then the modem comes UB-online on a MAC domain basis. If the CM configuration file has no TLV 43.9.3 or the bonded bit is not set to 1, then the modem comes online with a single upstream channel on a MAC domain basis.



**Note** Without this configuration, the modem comes UB-online on the MAC domain regardless of whether the TLV 43.9.3 is configured in the modem configuration file.

### Procedure

	Command or Action	Purpose
<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.

	Command or Action	Purpose
<b>Step 3</b>	<b>interface cable</b> { <i>slot/subslot/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> }  <b>Example:</b> Router(config)# <b>interface cable</b> 7/0/0	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable mtc-mode required-attribute</b>  <b>Example:</b> Router(config-if)# <b>cable mtc-mode required-attribute</b>	Enable enforcement of required CM attribute on UCSB.
<b>Step 5</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Creating a Bonding Group

An upstream bonding group is created by combining multiple upstream channels together on a cable interface line card.

### Procedure

	Command or Action	Purpose
<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/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> }  <b>Example:</b> Router(config)# <b>interface cable</b> 7/0/0	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream bonding-group id</b>  <b>Example:</b> Router(config-if)# <b>cable upstream bonding-group</b> 200	Creates the bonding group on the specified cable interface.
<b>Step 5</b>	<b>end</b>  <b>Example:</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

	Command or Action	Purpose
	<code>Router(config-if)# end</code>	

### What to do next

After creating an upstream bonding group, you must add upstream channels to the bonding group.

## Adding Upstream Channels to a Bonding Group



### Restriction

DOCSIS 3.0-certified CMs support only four upstream channels on an upstream bonding group. These CMs do not accept additional upstream channels that are added to a bonding group.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> <code>Router&gt; enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> <code>Router# configure terminal</code>	Enters global configuration mode.
<b>Step 3</b>	<b>interface cable</b> { <i>slot/subslot/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> } <b>Example:</b> <code>Router(config)# interface cable 7/0/0</code>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream bonding-group</b> <i>id</i> <b>Example:</b> <code>Router(config-if)# cable upstream bonding-group 200</code>	Creates the bonding group on the specified interface.
<b>Step 5</b>	<b>upstream</b> <i>number</i> <b>Example:</b> <code>Router(config-upstream-bonding)# upstream 1</code>	Enters upstream bonding configuration submode and adds an upstream channel to the upstream bonding group. <b>Note</b> Upstream channel needs to be bonded to mac-domain first before adding it to the bounding group. For detailed configuration steps of the upstream channel bonding, please refer to <a href="#">Configuration Example for Upstream Channel Bonding</a>

	Command or Action	Purpose
		Starting from Cisco IOS-XE 3.18.0S release, maximum of 16 upstream channels can be configured for each MAC Domain, which are divided into two groups: <ul style="list-style-type: none"> <li>• Group 1: upstream channel 0-7</li> <li>• Group 2: upstream channel 8-15</li> </ul> The <b>upstream bonding-group</b> should include all the upstream channels either from Group 1 or Group 2 only.
<b>Step 6</b>	<b>end</b> <b>Example:</b> Router (config-upstream-bonding) # <b>end</b>	Exits upstream bonding configuration submode and returns to privileged EXEC mode.

## Adding Upstream Channel Ports to a Fiber Node

You must add upstream channel controllers to a fiber node in order to complete the basic upstream channel bonding configuration on a cable interface line card. The fiber node must contain all upstream and downstream controllers reached by the CMs.



### Restriction

- Configuration of a fiber node is valid only if all upstream channels inside the fiber node have different upstream frequencies.
- For any two upstream channels mapped to the upstream cable controllers in the same fiber node where a spectrum group is assigned to one upstream channel, and a frequency is assigned to the other upstream channel, any overlap between any bands associated with the spectrum group of the upstream channel and the frequency of the upstream channel will result in an invalid fiber node configuration. That is a fixed frequency cannot overlap with another upstream channel's available spectrum group bands.



### Note

The fiber node configuration must be done in accordance with the physical plant topology.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.

	Command or Action	Purpose
<b>Step 3</b>	<b>cable fiber-node</b> <i>fiber-node-id</i> <b>Example:</b> Router(config)# <b>cable fiber-node 2</b>	Enters fiber node configuration mode.
<b>Step 4</b>	<b>upstream Upstream-Cable</b> <i>slot/subslot/port</i> <b>Example:</b> Router(config-fiber-node)# <b>upstream Upstream-Cable 7/0/1</b>	Specifies the upstream channel ports for a fiber node.
<b>Step 5</b>	<b>end</b> <b>Example:</b> Router(config-fiber-node)# <b>end</b>	Exits fiber node configuration mode and returns to privileged EXEC mode.

## Configuring the Class-Based Weighted Fair Queuing

In the case of a class-based configuration, allocation of available bandwidth is dependent on the service flows that are active in a service class.

### Procedure

	Command or Action	Purpose
<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/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> } <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream qos wfq class</b> <b>Example:</b> Router(config-if)# <b>cable upstream qos wfq class</b>	Enables class-based weighted fair queuing.
<b>Step 5</b>	<b>end</b> <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring the Activity-Based Weighted Fair Queuing

In the activity-based configuration, allocation of available bandwidth is based on the service class and the total number of service flows that are active in a map for the service class.

### Procedure

	Command or Action	Purpose
<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/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> } <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream qos wfq activity</b> <b>Example:</b> Router(config-if)# <b>cable upstream qos wfq activity</b>	Enables activity-based weighted fair queuing.
<b>Step 5</b>	<b>end</b> <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring Custom Weights for Service Flow Priorities

The WFQ functionality helps the Cisco CMTS router share the available bandwidth based on the weight of the service flow priorities specified for outstanding requests from an upstream service flow.

### Procedure

	Command or Action	Purpose
<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>	Enters global configuration mode.

	Command or Action	Purpose
	Router# <b>configure terminal</b>	
<b>Step 3</b>	<b>interface cable</b> {slot/subslot/port   slot/subslot/cable-interface-index   slot/port   slot/cable-interface-index}  <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream qos wfq weights</b> priority0-priority7  <b>Example:</b> Router(config-if)# <b>cable upstream qos wfq weights 10 20 30 40 50 60 70 80.</b>	Enables custom weight configuration for all the service flow priorities in a service class.  <b>Note</b> You must specify custom weight values for all the eight service flow priorities (0 to 7) when you modify the default weights of priorities. The valid range is from 1 to 255.
<b>Step 5</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring the SID Cluster

This section explains how to configure and assign a SID cluster to an upstream bonded service flow.



**Note** Configure the **cable sid-cluster-group num-of-cluster 2** command to achieve desired upstream bonded speeds. Alternatively, use a large upstream Max Traffic burst value in the cable modem file (such as 30 kB). The Max Concat burst value in the cable modem file need not be changed because DOCSIS 3.0 uses continuous concatenations and fragmentation (CCF) and can therefore use the default value of 3044 in the Max Concat field.



**Note** If the **cable sid-cluster-group** command is not used, the router accepts the default SID cluster configuration. By default, only one SID cluster is configured. Similarly, if the **cable sid-cluster-switching** command is not used, the router accepts the default SID cluster switchover criterion. That is, only one request can be made using the SID cluster.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  Enter your password if prompted.

	Command or Action	Purpose
<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/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> } <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable sid-cluster-group</b> [dynamic   req-multiplier <i>value</i>   num-of-cluster <i>number</i> ] <b>Example:</b> Router(config-if)# <b>cable sid-cluster-group dynamic</b> Router(config-if)# <b>cable sid-cluster-group req-multiplier 12</b> Router(config-if)# <b>cable sid-cluster-group num-of-cluster 2</b>	Creates a SID cluster group.
<b>Step 5</b>	<b>cable sid-cluster-switching</b> [max-outstanding-byte <i>value</i>   max-request <i>value</i>   max-time <i>seconds</i>   max-total-byte <i>value</i> ] <b>Example:</b> Router(config-if)# <b>cable sid-cluster-switching max-outstanding-byte 4444</b> Router(config-if)# <b>cable sid-cluster-switching max-request 222</b> Router(config-if)# <b>cable sid-cluster-switching max-time 444</b> Router(config-if)# <b>cable sid-cluster-switching max-total-byte 67890</b>	Specifies SID cluster switchover criteria.
<b>Step 6</b>	<b>end</b> <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

### What to do next

Use the **show running-config all** command to verify the SID cluster configuration. Following is a sample output of the command:

```
Router# show running-config all
.
.
.
cable sid-cluster-group num-of-cluster 1
cable sid-cluster-group dynamic
cable sid-cluster-group req-multiplier 4
```

## Configuring the Channel Timeout for a Cable Modem

The channel timeout configuration allows you to specify the maximum time that a CM can spend performing initial ranging on the upstream channels described in the Registration Response (REG-RSP) and REG-RSP-MP messages. The default channel timeout value (60 seconds) is automatically configured.

### Procedure

	Command or Action	Purpose
<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> {slot/subslot/port   slot/subslot/cable-interface-index   slot/port   slot/cable-interface-index} <b>Example:</b> Router(config)# <b>interface cable</b> 7/0/0	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable init-channel-timeout</b> value <b>Example:</b> Router(config-if)# <b>cable</b> <b>init-channel-timeout</b> 160	Specifies the maximum time that a CM can spend performing initial ranging on the upstream channels.
<b>Step 5</b>	<b>end</b> <b>Example:</b> Router(config-if)# <b>end</b>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring Cable Upstream Resiliency

The cable upstream resiliency module ensures that a CM remains operational if one or more non-primary upstream service flows of the CM enter temporary or persistent error states. This module enables a Cisco CMTS router to handle various events and maintain the transmit channel set of each CM.

In the event of the primary upstream service flow failure, the upstream resiliency module forces the CM to go offline.

For a Multiple Transmit Channel (MTC) modem, the (NRTPS), Real-time Polling Service (RTPS), (UGS), and (UGS-AD) upstream service flows on an impaired upstream channel is moved to another good upstream channel in the cable modem without resetting the cable modem.

### Procedure

	Command or Action	Purpose
<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>cable upstream resiliency data-burst polling-interval <i>number</i></b> <b>Example:</b> Router(config)# <b>cable upstream resiliency data-burst polling-interval 60</b>	Configures the polling interval for data-burst resiliency in seconds. The range is from 5 to 3600. The default configuration for polling-interval is 60.
<b>Step 4</b>	<b>interface cable {<i>slot/subslot/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i>}</b> <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 5</b>	<b>cable upstream resiliency {<i>channel-down-detect number</i>   <i>data-burst snr number ufec number cfec number hysteresis number</i>   <i>modem-offline-detect number</i>   <i>on-failure {disable-channel   extended-ranging   reset-modem}</i>   <i>sf-move {NRTPS   RTPS   UGS   UGS-AD}</i> }</b> <b>Example:</b> Router(config-if)# <b>cable upstream resiliency channel-down-detect 68</b> Router(config-if)# <b>cable upstream resiliency modem-offline-detect 16</b> Router(config-if)# <b>cable upstream resiliency on-failure disable-channel</b> Router(config-if)# <b>cable upstream resiliency sf-move NRTPS</b> Router(config-if)# <b>cable upstream resiliency sf-move RTPS</b>	Configures upstream resiliency for bonded upstream service flows.

	Command or Action	Purpose
	<pre>Router(config-if)# cable upstream resiliency sf-move UGS  Router(config-if)# cable upstream resiliency sf-move UGS-AD  Router(config-if)# cable upstream resiliency data-burst snr 24 ufec 1 cfec 0 hysteresis 3</pre>	
<b>Step 6</b>	<p><b>end</b></p> <p><b>Example:</b></p> <pre>Router(config-if)# end</pre>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring Rate Limiting on the Cisco cBR-8 CCAP Line Card

The rate limiting functionality is configured by default on the Cisco cBR-8 CCAP line card. However, the default configuration can be modified using the cable upstream rate-limit-ccf command.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<p><b>enable</b></p> <p><b>Example:</b></p> <pre>Router&gt; enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
<b>Step 2</b>	<p><b>configure terminal</b></p> <p><b>Example:</b></p> <pre>Router# configure terminal</pre>	Enters global configuration mode.
<b>Step 3</b>	<p><b>cable upstream rate-limit-ccf</b>  <b>[aggregated-burst value  </b>  <b>aggregated-throughput value   cpu-burst</b>  <b>value   cpu-threshold value]</b></p> <p><b>Example:</b></p> <pre>Router(config)# cable upstream rate-limit-ccf aggregated-burst 25000  Router(config)# cable upstream rate-limit-ccf aggregated-throughput 540000  Router(config)# cable upstream rate-limit-ccf cpu-burst 30  Router(config)# cable upstream rate-limit-ccf cpu-threshold 60</pre>	Configures rate limiting parameters for upstream bonded service flows on a cable interface line card.

	Command or Action	Purpose
<b>Step 4</b>	<b>end</b> <b>Example:</b> Router(config)# <b>end</b>	Exits global configuration mode and returns to privileged EXEC mode.

## Enabling Upstream Related Events for CM Status Reports

You can enable upstream related CM status events only on a cable interface line card. You can enable the following upstream related CM status events per interface using the `cable cm-status enable` command:

- T4 time-out
- T3 re-tries exceeded
- Successful ranging after T3 re-tries exceeded

For details on how to enable upstream and downstream related CM status events, see the Wideband Modem Resiliency feature guide at the following URL:

[http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr\\_wm\\_resiliency.html](http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_wm_resiliency.html)

## Modifying the Bonding Group Attributes

Bonding group attributes are automatically configured for each upstream bonding group. You can modify them using the `attributes` command in upstream bonding configuration mode.

### Procedure

	Command or Action	Purpose
<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/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> } <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream bonding-group</b> <i>id</i> <b>Example:</b> Router(config-if)# <b>cable upstream bonding-group 200</b>	Creates the bonding group on the specified cable interface and enters the upstream bonding configuration mode.

	Command or Action	Purpose
<b>Step 5</b>	<b>attributes</b> <i>value</i> <b>Example:</b> Router(config-upstream-bonding)# <b>attributes eeeeeeee</b>	Modifies the attribute value for the specified bonding group.
<b>Step 6</b>	<b>end</b> <b>Example:</b> Router(config-upstream-bonding)# <b>end</b>	Exits upstream bonding configuration mode and returns to privileged EXEC mode.

## Modifying the Ranging Poll Interval on Upstream Channels

You can change the default ranging poll interval (20 seconds) on upstream channels using the cable upstream ranging-poll command in cable interface configuration mode. You can also specify the T4 timeout multiplier value using this command.

For information on T4 Multiplier, see [T4 Multiplier, on page 6](#).



**Note** We recommend that you do not modify the default ranging poll interval unless required. With the default configuration, a DOCSIS 2.0 CM in non-MTC mode performs ranging on one upstream channel every 20 seconds.

### Procedure

	Command or Action	Purpose
<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/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i> } <b>Example:</b> Router(config)# <b>interface cable</b> 7/0/0	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream ranging-poll</b> [ <i>interval value</i>   <i>t4-multiplier timeout_value</i> ] <b>Example:</b>	Specifies the ranging poll interval for upstream channels.

	Command or Action	Purpose
	<pre>Router(config-if)# cable upstream ranging-poll interval 24000 t4-multiplier 4</pre>	<p><b>Note</b> If <b>t4-multiplier</b> <i>timeout_value</i> is not configured, then the CMTS uses the the T4 timeout of the modem. For example, if the T4 timeout of the modem is 90 seconds, then the CMTS will apply 3 as T4 multiplier for the modem.</p>
<b>Step 5</b>	<p><b>end</b></p> <p><b>Example:</b></p> <pre>Router(config-if)# end</pre>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring the Reduced Channel Set Assignment

You need to configure the transmit power offset budget to enable the Cisco CMTS router to reduce upstream channel set assignment based on the total power budget of the CM.



### Note

The threshold value specified for the power budget offset (**max-channel-power-offset**) must be less than the power threshold value (**power-adjust continue**) that determines the value of the Ranging Status field in the Ranging Response (RNG-RSP) messages that the Cisco CMTS router sends to the CM. You can specify the power threshold value using the **cable upstream power-adjust** command.

### Before you begin

- Configure extended transmit power using the **cable tx-power-headroom** command in global configuration mode.
- Ensure that corresponding static bonding groups are configured.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<p><b>enable</b></p> <p><b>Example:</b></p> <pre>Router&gt; enable</pre>	<p>Enables privileged EXEC mode.</p> <p>Enter your password if prompted.</p>
<b>Step 2</b>	<p><b>configure terminal</b></p> <p><b>Example:</b></p> <pre>Router# configure terminal</pre>	Enters global configuration mode.
<b>Step 3</b>	<p><b>interface cable</b> {<i>slot/subslot/port</i>   <i>slot/subslot/cable-interface-index</i>   <i>slot/port</i>   <i>slot/cable-interface-index</i>}</p> <p><b>Example:</b></p>	Specifies the cable interface line card on a Cisco CMTS router.

	Command or Action	Purpose
	<code>Router(config)# interface cable 7/0/0</code>	
<b>Step 4</b>	<b>cable upstream max-channel-power-offset</b> <i>dB-value</i> <b>Example:</b> <code>Router(config-if)# cable upstream max-channel-power-offset 2</code>	Specifies the power offset value for upstream channels.
<b>Step 5</b>	<b>end</b> <b>Example:</b> <code>Router(config-if)# end</code>	Exits cable interface configuration mode and returns to privileged EXEC mode.

## Configuring DOCSIS Extended Transmit Power Feature

The DOCSIS Extended Transmit Power feature is enabled by default on the Cisco CMTS. However, the default configuration can be modified using the cable upstream ext-power command.

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> <code>Router&gt; enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> <code>Router# configure terminal</code>	Enters global configuration mode.
<b>Step 3</b>	<b>interface cable</b> {slot/subslot/port   slot/subslot/cable-interface-index   slot/port   slot/cable-interface-index} <b>Example:</b> <code>Router(config)# interface cable 7/0/0</code>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream ext-power</b> <b>Example:</b> <code>Router(config-if)# cable upstream ext-power</code>	Enables the DOCSIS Extended Transmit Power feature on the Cisco CMTS. Using the <b>no</b> form of this command disables the DOCSIS Extended Transmit Power feature.
<b>Step 5</b>	<b>end</b> <b>Example:</b> <code>Router(config-if)# end</code>	Exits interface configuration mode and returns to privileged EXEC mode.

## Troubleshooting Tips

The following debug commands help you troubleshoot an improper upstream channel bonding configuration and its related features:

- **debug cable cm-status**—Provide debugging information about CM status messages on the Cisco CMTS routers.
- **debug cable mdd**—Provides debugging information about MAC domain descriptor (MDD).
- **debug cable md-sg**—Provides information about service group debugging messages.
- **debug cable ubg**—Provides debugging information about upstream bonding groups.

## Configuration Example for Upstream Channel Bonding

The following example shows how to configure the basic upstream channel bonding on the Cisco cBR-8 CCAP line card interface 7/0/0 on the Cisco cBR-8 router:

```

controller Upstream-Cable 7/0/0
us-channel 0 frequency 10000000
us-channel 0 channel-width 3200000 3200000
us-channel 0 ingress-noise-cancellation 50
us-channel 0 docsis-mode atdma
us-channel 0 minislots-size 2
us-channel 0 modulation-profile 221
us-channel 0 equalization-coefficient
no us-channel 0 shutdown
us-channel 1 frequency 16400000
us-channel 1 channel-width 6400000 6400000
us-channel 1 ingress-noise-cancellation 50
us-channel 1 docsis-mode atdma
us-channel 1 minislots-size 1
us-channel 1 modulation-profile 221
us-channel 1 equalization-coefficient
no us-channel 1 shutdown
us-channel 2 frequency 22800000
us-channel 2 channel-width 6400000 6400000
us-channel 2 docsis-mode atdma
us-channel 2 minislots-size 1
us-channel 2 modulation-profile 221
us-channel 2 equalization-coefficient
no us-channel 2 shutdown
us-channel 3 frequency 29200000
us-channel 3 channel-width 6400000 6400000
us-channel 3 docsis-mode atdma
us-channel 3 minislots-size 1
us-channel 3 modulation-profile 221
us-channel 3 equalization-coefficient
no us-channel 3 shutdown
us-channel 4 channel-width 1600000 1600000
us-channel 4 docsis-mode tdma
us-channel 4 minislots-size 4
us-channel 4 modulation-profile 21
us-channel 4 shutdown
us-channel 5 channel-width 1600000 1600000
us-channel 5 docsis-mode atdma
us-channel 5 minislots-size 4
us-channel 5 modulation-profile 221
us-channel 5 shutdown
!
```

```

interface Cable7/0/0
load-interval 30
downstream Integrated-Cable 7/0/0 rf-channel 0
downstream Integrated-Cable 7/0/0 rf-channel 8
downstream Integrated-Cable 7/0/0 rf-channel 16
upstream 0 Upstream-Cable 7/0/0 us-channel 0
upstream 1 Upstream-Cable 7/0/0 us-channel 1
upstream 2 Upstream-Cable 7/0/0 us-channel 2
upstream 3 Upstream-Cable 7/0/0 us-channel 3
no cable upstream 0 equalization-error-recovery
no cable upstream 1 equalization-error-recovery
no cable upstream 2 equalization-error-recovery
no cable upstream 3 equalization-error-recovery
cable upstream 7 attribute-mask 1FF
cable upstream bonding-group 1
upstream 0
upstream 1
upstream 2
attributes 80000000
cable bundle 1
cable map-advance static 2000
cable sync-interval 121
cable reduction-mode mta-battery enable
cable privacy accept-self-signed-certificate
end

cable fiber-node 1
description Feed Mac Domain: Cable7/0/0
downstream Integrated-Cable 7/0/0
upstream Upstream-Cable 7/0/0

```




---

**Note** Bonded channels are typically from the same connector; however, channels from different connectors in the same MAC domain can also be bonded together. A single MAC domain can support multiple channel bonding groups.

---




---

**Note** Up to 8 frequencies can be stacked to one upstream-cable controller. Once the upstream-cable controller has 8 frequencies stacked, no more frequency left for the adjacent upstream-cable controller.

---

## Example: Enabling MTC Mode for a Single CM Using the CM Configuration File

The following example shows how to enable the MTC required attribute using the CM configuration file:

```

03 (Net Access Control) = 1
Unknown Type 005 = 01 01 01
18 (Maximum Number of CPE) = 4
24 (Upstream Service Flow Encodings)
  S01 (Service Flow Reference) = 1
  S06 (QoS Parameter Set Type) = 7
  S10 (Min Reserved Traffic Rate)= 500000
25 (Downstream Service Flow Encodings)
  S01 (Service Flow Reference) = 2

```

```

S06 (QoS Parameter Set Type) = 7
S10 (Min Reserved Traffic Rate) = 1000000
29 (Privacy Enable) = 0
43 (Vendor Specific Options)
  S08 (Vendor ID) = ff ff ff
  S009 (Unknown sub-type) = 03 04 80 00 00 00

```

## Verifying the Upstream Channel Bonding Configuration

Use the following **show** commands to verify the upstream channel bonding configuration:

- **show cable mac-domain upstream-service-group**
- **show cable fiber-node**
- **show interface cable upstream**
- **show interface cable service-flow**
- **show cable modem**

To verify the runtime statistics of the upstream service group on a cable interface line card, use the **show cable mac-domain upstream-service-group** command.

To verify the configuration of a fiber node, use the **show cable fiber-node** command.

To verify the bonding groups configured on a cable interface line card, use the **show interface cable upstream** command.

To verify upstream bonding information on a cable interface line card, use the **show interface cable service-flow** command.

To verify the transmit power levels on a CM, use the **show cable modem** command.

## Verifying Weighted Fair Queuing for Upstream Service Flows

To verify WFQ parameters configured for upstream service flows on a cable interface line card, use the **show interface cable mac-scheduler** command.

## Verifying Rate Limiting for Upstream Bonded Service Flows

To verify the rate limiting criteria configured on the Cisco cBR8 CCAP line card for upstream bonded service flows, use the **show cable rate-limit-ccf** command.



### Note

The **show cable rate-limit-ccf** command is applicable only to the Cisco cBR8 CCAP cable interface line card.

## Verifying Extended Power Transmission

To verify that a CM is transmitting at a higher power level, use the **show cable modem** command.

To list all the CMs that are transmitting at higher power level, use the **show cable modem extended-power** command.

## Additional References

The following sections provide references related to the Upstream Channel Bonding feature.

### 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/techsupport">http://www.cisco.com/techsupport</a>

## Feature Information for Upstream Channel Bonding

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 6: Feature Information for Upstream Channel Bonding**

Feature Name	Releases	Feature Information
Upstream Channel Bonding	Cisco IOS-XE Release 3.15.0S	This feature was introduced on the Cisco cBR Series Converged Broadband Router.

