



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.

Contents

- [Prerequisites for Upstream Channel Bonding](#) , page 2
- [Restrictions for Upstream Channel Bonding](#) , page 2
- [Information About Upstream Channel Bonding](#), page 3
- [How to Configure Upstream Channel Bonding](#) , page 13
- [Configuration Example for Upstream Channel Bonding](#) , page 28
- [Verifying the Upstream Channel Bonding Configuration](#), page 30
- [Additional References](#), page 35
- [Feature Information for Upstream Channel Bonding](#) , page 37

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.

The table below shows the hardware compatibility prerequisites for the Upstream Channel Bonding feature.

Table 1: Cable Hardware Compatibility Matrix for Upstream Channel Bonding

Cisco CMTS Platform	Processor Engine	Cable Interface Line Cards
Cisco uBR10012 router	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> • PRE2 • PRE4 	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> • Cisco uBR10-MC5X20H • Cisco uBR-MC20X20V
	Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> • PRE5 	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> • Cisco uBR-MC3GX60V¹
Cisco uBR7246VXR router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> • NPE-G2 	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> • Cisco uBR-MC88V
Cisco uBR7225VXR router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> • NPE-G2 	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> • Cisco uBR-MC88V

¹ Cisco uBR-MC3GX60V cable interface line card is not compatible with PRE2.

Restrictions for Upstream Channel Bonding

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

- Only the static bonding groups are supported in Cisco IOS Release 12.2(33)SCC and later.
- Only the upstream channels belonging to the same MAC domain can be added to an upstream bonding group.

**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.

- 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 uBR10012 router in Cisco IOS Release 12.2(33)SCC and later. 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 frequencies supported on the various cable interface line cards.

Table 2: Downstream and Upstream Frequencies

Line Card	Downstream Frequency	Upstream Frequency
Cisco uBR10-MC5X20H	55-858 MHz	The upstream frequency range changes according the region and Annex A or Annex B configuration. <ul style="list-style-type: none"> • Annex A (EuroDOCSIS)—5 to 65 MHz • Annex B (DOCSIS, North American)—5 to 42 MHz • Annex B (J-DOCSIS)—5 to 55 MHz
Cisco uBR10-MC20X20V	55-999 MHz	
Cisco uBR-MC88V	69-999 MHz	
Cisco uBR-MC3GX60V	55-999 MHz ²	The upstream frequency range for the Cisco uBR-MC3GX60V line card is from 5 to 85 MHz irrespective of the region and Annexure configuration.

² 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 in two ways:

- MTC mode on a per-CM basis—By default, the MTC mode is enabled with the required attribute. With this default configuration, the Cisco CMTS router enables the MTC mode on a per-CM basis depending on the CM configuration file. For more information about the default MTC mode configuration, see [Default MTC Mode Configuration on a Cisco CMTS Router](#), on page 13.
- MTC mode for all CMs in a MAC domain—The MTC mode for all CMs in a MAC domain is disabled by default on an upstream bonding capable cable interface line card. You can enable MTC mode for all CMs in a MAC domain using the **cable mtc-mode** command in cable interface configuration mode.

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, introduced in Cisco IOS Release 12.2(33)SCE3, 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, introduced in Cisco IOS Release 12.2(33)SCF2, 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, introduced in Cisco IOS Release 12.2(33)SCE3, 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 channel for the CM connected to the fiber node to be operational. The fiber node can include one or more primary-capable channels either from the cable interface line card, or from the primary-capable Shared Port Adaptor (SPA) downstream channels, or both.

**Note**

When upgrading from Cisco IOS Releases 12.3(23)BC, 12.2(33)SCA, and 12.2(33)SCB to Cisco IOS Release 12.2(33)SCC and later, ensure that you add downstream and upstream connectors to the fiber node configuration. The fiber node configuration must be done in accordance with the physical plant topology. For details about the fiber node configuration, see the *Cable Fiber Node Best Practices for the Cisco uBR10012 Router* document at the following URL: http://www.cisco.com/en/US/tech/tk86/tk804/technologies_tech_note09186a00807f32fd.shtml

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 Frequencies, 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 uBR-MC3GX60V line card deployment (containing a mix of CMs), which supports frequency as high as 85MHz (see [Table 2: Downstream and Upstream Frequencies, 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 in Cisco IOS Release 12.2(33)SCD2 and later:

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

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.

Effective from Cisco IOS Release 12.2(33)SCH2, 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 USBGs 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 uBR10-MC5X20H 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 uBR10-MC5X20H line card. In Cisco IOS Release 12.2(33)SCC, this functionality is supported only on the Cisco uBR10-MC5X20H line card. The rate limiting functionality is configured by default on the Cisco uBR10-MC5X20H 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. For details about the fiber node configuration, see the *Cable Fiber Node Best Practices for the Cisco uBR10012 Router* document at the following URL: http://www.cisco.com/en/US/tech/tk86/tk804/technologies_tech_note09186a00807f32fd.shtm

The following tasks describe how to configure Upstream Channel Bonding on the Cisco uBR10012 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 required attribute is configured on a cable interface line card. With this default configuration, the Cisco CMTS router enables the MTC mode on a per CM 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 30.

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.

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	configure terminal Example: Router# <code>configure terminal</code>	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# <code>interface cable 7/1/0</code>	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable mtc-mode Example: Router(config-if)# <code>cable mtc-mode</code>	Enables MTC mode at the MAC interface for all CMs.
Step 5	end Example: Router(config-if)# <code>end</code>	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> <code>enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# <code>configure terminal</code>	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# <code>interface cable 7/1/0</code>	Specifies the cable interface line card on a Cisco CMTS router.

	Command or Action	Purpose
Step 4	cable upstream bonding-group <i>id</i> Example: Router(config-if)# cable upstream bonding-group 200	Creates the bonding group on the specified cable interface.
Step 5	end Example: Router(config-if)# end	Exits cable interface configuration mode and returns to privileged EXEC mode.

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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream bonding-group <i>id</i> Example: Router(config-if)# cable upstream bonding-group 200	Creates the bonding group on the specified interface.

	Command or Action	Purpose
Step 5	<p><code>upstream number</code></p> <p>Example: Router(config-upstream-bonding)# <code>upstream 1</code></p>	<p>Enters upstream bonding configuration submode and adds an upstream channel to the upstream bonding group.</p> <p>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:</p> <ul style="list-style-type: none"> • Group 1: upstream channel 0-7 • Group 2: upstream channel 8-15 <p>The upstream bonding-group should include all the upstream channels either from Group 1 or Group 2 only.</p>
Step 6	<p><code>end</code></p> <p>Example: Router(config-upstream-bonding)# <code>end</code></p>	<p>Exits upstream bonding configuration submode and returns to privileged EXEC mode.</p>

Adding Upstream Channel Ports to a Fiber Node

You must add upstream channel ports 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 channels 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 connectors 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. For details about the fiber node configuration, see the *Cable Fiber Node Best Practices for the Cisco uBR10012 Router* document at the following URL: http://www.cisco.com/en/US/tech/tk86/tk804/technologies_tech_note09186a00807f32fd.shtml

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	cable fiber-node <i>fiber-node-id</i> Example: Router(config)# cable fiber-node 2	Enters fiber node configuration mode.
Step 4	upstream cable <i>slot/subslot connector grouplist</i> Example: Router(config-fiber-node)# upstream cable 5/0 connector 2	Specifies the upstream channel ports for a fiber node.
Step 5	end Example: Router(config-fiber-node)# end	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	interface cable {slot/subslot/port slot/subslot/cable-interface-index slot/port slot/cable-interface-index} Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream qos wfq class Example: Router(config-if)# cable upstream qos wfq class	Enables class-based weighted fair queuing.
Step 5	end Example: Router(config-if)# end	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable {slot/subslot/port slot/subslot/cable-interface-index slot/port slot/cable-interface-index} Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream qos wfq activity Example: Router(config-if)# cable upstream qos wfq activity	Enables activity-based weighted fair queuing.

	Command or Action	Purpose
Step 5	end Example: Router(config-if)# end	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable {slot/subslot/port slot/subslot/cable-interface-index slot/port slot/cable-interface-index} Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream qos wfq weights priority0-priority7 Example: Router(config-if)# cable upstream qos wfq weights 10 20 30 40 50 60 70 80.	Enables custom weight configuration for all the service flow priorities in a service class. Note 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.
Step 5	end Example: Router(config-if)# end	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router (config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable sid-cluster-group [dynamic req-multiplier <i>value</i> num-of-cluster <i>number</i>] Example: Router (config-if)# cable sid-cluster-group dynamic Router (config-if)# cable sid-cluster-group req-multiplier 12 Router (config-if)# cable sid-cluster-group num-of-cluster 2	Creates a SID cluster group.
Step 5	cable sid-cluster-switching [max-outstanding-byte <i>value</i> max-request <i>value</i> max-time <i>seconds</i> max-total-byte <i>value</i>]	Specifies SID cluster switchover criteria.

	Command or Action	Purpose
	<p>Example: Router(config-if)# cable sid-cluster-switching max-outstanding-byte 4444</p> <p>Router(config-if)# cable sid-cluster-switching max-request 222</p> <p>Router(config-if)# cable sid-cluster-switching max-time 444</p> <p>Router(config-if)# cable sid-cluster-switching max-total-byte 67890</p>	
Step 6	<p>end</p> <p>Example: Router(config-if)# end</p>	Exits cable interface configuration mode and returns to privileged EXEC mode.

What to Do Next

Effective with Cisco IOS Release 12.2(33)SCH3, 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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example: Router> enable</p>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	Enters global configuration mode.

	Command or Action	Purpose
Step 3	interface cable {slot/subslot/port slot/subslot/cable-interface-index slot/port slot/cable-interface-index} Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable init-channel-timeout <i>value</i> Example: Router(config-if)# cable init-channel-timeout 160	Specifies the maximum time that a CM can spend performing initial ranging on the upstream channels.
Step 5	end Example: Router(config-if)# end	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.

Starting with Cisco IOS Release 12.2(33)SCG, 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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream resiliency { channel-down-detect <i>number</i> modem-offline-detect <i>number</i> on-failure { disable-channel extended-ranging reset-modem } sf-move { NRTPS RTPS UGS UGS-AD } } Example: Router(config-if)# cable upstream resiliency channel-down-detect 30 Router(config-if)# cable upstream resiliency modem-offline-detect 16 Router(config-if)# cable upstream resiliency on-failure disable-channel Router(config-if)# cable upstream resiliency sf-move NRTPS Router(config-if)# cable upstream resiliency sf-move RTPS Router(config-if)# cable upstream resiliency sf-move UGS Router(config-if)# cable upstream resiliency sf-move UGS-AD	Configures upstream resiliency for bonded upstream service flows.
Step 5	end Example: Router(config-if)# end	Exits cable interface configuration mode and returns to privileged EXEC mode.

Configuring Rate Limiting on the Cisco uBR10-MC5X20H Line Card

The rate limiting functionality is configured by default on the Cisco uBR10-MC5X20H line card. However, the default configuration can be modified using the cable upstream rate-limit-ccf command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: Router# <code>configure terminal</code>	Enters global configuration mode.
Step 3	cable upstream rate-limit-ccf [aggregated-burst value aggregated-throughput value cpu-burst value cpu-threshold value] Example: Router(config)# <code>cable upstream rate-limit-ccf aggregated-burst 25000</code> Router(config)# <code>cable upstream rate-limit-ccf aggregated-throughput 540000</code> Router(config)# <code>cable upstream rate-limit-ccf cpu-burst 30</code> Router(config)# <code>cable upstream rate-limit-ccf cpu-threshold 60</code>	Configures rate limiting parameters for upstream bonded service flows on a cable interface line card. <ul style="list-style-type: none"> • aggregated-burst value—(Optional) Specifies the burst rate for aggregated throughput-based rate limiting in bits. The valid range is from 0 to 250000000. The default value is 8000000. • aggregated-throughput value—(Optional) Specifies the throughput value for throughput-based rate limiting in bits per second (bps). The valid range is from 0 to 540000000. The default value is 115000000. • cpu-burst value—(Optional) Specifies the CPU burst for CCF in percentage. The valid range is from 0 to 100. The default value is 10. • cpu-threshold value—(Optional) Specifies the CPU threshold for CCF in percentage. The valid range is from 0 to 100. The default value is 50.
Step 4	end Example: Router(config)# <code>end</code>	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

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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream bonding-group <i>id</i> Example: Router(config-if)# cable upstream bonding-group 200	Creates the bonding group on the specified cable interface and enters the upstream bonding configuration mode.
Step 5	attributes <i>value</i> Example: Router(config-upstream-bonding)# attributes eeeeeeee	Modifies the attribute value for the specified bonding group.
Step 6	end Example: Router(config-upstream-bonding)# end	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 7 .



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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream ranging-poll [<i>interval value</i> t4-multiplier <i>timeout_value</i>] Example: Router(config-if)# cable upstream ranging-poll interval 24000 t4-multiplier 4	Specifies the ranging poll interval for upstream channels. Note If t4-multiplier <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.
Step 5	end Example: Router(config-if)# end	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable { <i>slot/subslot/port</i> <i>slot/subslot/cable-interface-index</i> <i>slot/port</i> <i>slot/cable-interface-index</i> } Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream max-channel-power-offset <i>dB-value</i> Example: Router(config-if)# cable upstream max-channel-power-offset 2	Specifies the power offset value for upstream channels.
Step 5	end Example: Router(config-if)# end	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.

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: Router> enable	Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cable {slot/subslot/port slot/subslot/cable-interface-index slot/port slot/cable-interface-index} Example: Router(config)# interface cable 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	cable upstream ext-power Example: Router(config-if)# cable upstream ext-power	Enables the DOCSIS Extended Transmit Power feature on the Cisco CMTS. Using the no form of this command disables the DOCSIS Extended Transmit Power feature.
Step 5	end Example: Router(config-if)# end	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 uBR-MC3GX60V line card interface 8/1/14 on the Cisco uBR10012 router:

```
interface Cable 8/1/14
  downstream Modular-Cable 8/1/0 rf-channel 0
```

```

downstream Modular-Cable 8/1/1 rf-channel 8
downstream Modular-Cable 8/1/2 rf-channel 16
cable mtc-mode
no cable packet-cache
cable bundle 1
cable upstream max-ports 4
cable upstream bonding-group 81
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes A000000
cable upstream 0 connector 0
cable upstream 0 frequency 15000000
cable upstream 0 channel-width 1600000 1600000
cable upstream 0 docsis-mode tdma
cable upstream 0 minislot-size 4
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 21
cable upstream 0 attribute-mask 20000000
no cable upstream 0 shutdown
cable upstream 1 connector 0
cable upstream 1 frequency 25000000
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 docsis-mode tdma
cable upstream 1 minislot-size 4
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 21
cable upstream 1 attribute-mask 20000000
no cable upstream 1 shutdown
cable upstream 2 connector 0
cable upstream 2 frequency 30000000
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 docsis-mode tdma
cable upstream 2 minislot-size 4
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 21
cable upstream 2 attribute-mask 20000000
no cable upstream 2 shutdown
cable upstream 3 connector 0
cable upstream 3 frequency 35000000
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 docsis-mode tdma
cable upstream 3 minislot-size 4
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 21
cable upstream 3 attribute-mask 20000000
no cable upstream 3 shutdown
end
cable fiber-node 1
  downstream Modular-Cable 8/1/0 rf-channel 0-7
  upstream Cable 8/1 connector 0
!
cable fiber-node 13
  downstream Modular-Cable 8/1/1 rf-channel 8-15
  upstream Cable 8/1 connector 0
!
cable fiber-node 23
  downstream Modular-Cable 8/1/2 rf-channel 16-23
  upstream Cable 8/1 connector 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**

Only two channel frequency stacking is supported for Cisco uBR-MC5x20H and Cisco uBR-MC20x20 cable interface line cards.

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 as shown in the following example:

```
Router# show cable mac-domain cable 8/1/14 upstream-service-group
Cable MD 8/1/14
  US-SG-ID : 1          US-Chan : U0,1,2,3
  Primary-DS: 8/1/0:0  US-SG-ID: 1
    MDD US-List : U0,1,2,3
    MDD Ambiguity : U0,1,2,3
  Primary-DS: 8/1/1:8  US-SG-ID: 1
    MDD US-List : U0,1,2,3
    MDD Ambiguity : U0,1,2,3
  Primary-DS: 8/1/2:16 US-SG-ID: 1
    MDD US-List : U0,1,2,3
    MDD Ambiguity : U0,1,2,3
```

To verify the configuration of a fiber node, use the **show cable fiber-node** command as shown in the following example:

```
Router# show cable fiber-node
Fiber-Node 1
  Channels      : downstream Modular-Cable    8/1/0:   0-7
  Channel IDs   : 169, 170, 171, 172, 173, 174, 175, 176
  upstream Cable 8/1: 0
  FN Config Status: Configured (status flags = 0x01)
  MDD Status: Valid
-----
Fiber-Node 2
  Channels      : downstream Modular-Cable    1/1/0:   0-1
  Channel IDs   : 193, 194
  upstream Cable 5/0: 0
  FN Config Status: Configured (status flags = 0x01)
  MDD Status: Valid
-----
Fiber-Node 13
  Channels      : downstream Modular-Cable    8/1/1:   8-15
  Channel IDs   : 177, 178, 179, 180, 181, 182, 183, 184
  upstream Cable 8/1: 0
  FN Config Status: Configured (status flags = 0x01)
  MDD Status: Valid
-----
Fiber-Node 23
  Channels      : downstream Modular-Cable    8/1/2:  16-23
  Channel IDs   : 185, 186, 187, 188, 189, 190, 191, 192
  upstream Cable 8/1: 0
  FN Config Status: Configured (status flags = 0x01)
  MDD Status: Valid
```

To verify the bonding groups configured on a cable interface line card, use the **show interface cable upstream** command as shown in the following example:

```
Router# show interface cable 8/1/14 upstream bonding-group
Cable8/1/14: Upstream Bonding Group 81
  12 packets input, 4614 octets input
  Segments: 12 valid, 0 discarded, 0 lost
  Reserved Bandwidth Max : 0 bits/sec
  Reserved Bandwidth      : 0 bits/sec
  Available Bandwidth     : 10240000 bits/sec
  Total Service Flows On This Bonding Group: 1
Cable8/1/14: Upstream Bonding Group 65536
  0 packets input, 0 octets input
  Segments: 0 valid, 0 discarded, 0 lost
  Reserved Bandwidth Max : 0 bits/sec
  Reserved Bandwidth      : 0 bits/sec
  Available Bandwidth     : 2560000 bits/sec
  Total Service Flows On This Bonding Group: 0
Cable8/1/14: Upstream Bonding Group 65537
  0 packets input, 0 octets input
  Segments: 0 valid, 0 discarded, 0 lost
  Reserved Bandwidth Max : 0 bits/sec
  Reserved Bandwidth      : 0 bits/sec
  Available Bandwidth     : 2560000 bits/sec
  Total Service Flows On This Bonding Group: 0
Cable8/1/14: Upstream Bonding Group 65538
  0 packets input, 0 octets input
  Segments: 0 valid, 0 discarded, 0 lost
  Reserved Bandwidth Max : 0 bits/sec
  Reserved Bandwidth      : 0 bits/sec
  Available Bandwidth     : 2560000 bits/sec
  Total Service Flows On This Bonding Group: 0
Cable8/1/14: Upstream Bonding Group 65539
  0 packets input, 0 octets input
  Segments: 0 valid, 0 discarded, 0 lost
  Reserved Bandwidth Max : 0 bits/sec
  Reserved Bandwidth      : 0 bits/sec
  Available Bandwidth     : 2560000 bits/sec
  Total Service Flows On This Bonding Group: 0
```

To verify upstream bonding information on a cable interface line card, use the **show interface cable service-flow** command as shown in the following example:

```
Router# show interface cable 8/1/14 service-flow 19 verbose

Sfid                               : 19
Mac Address                         : 001e.6bfb.3332
Type                               : Primary
Direction                          : Upstream
Current State                       : Active
Current QoS Indexes [Prov, Adm, Act] : [4, 4, 4]
Active Time                         : 1h25m
Required Attributes                 : 0x00000000
Forbidden Attributes                : 0x00000000
Aggregate Attributes                : 0x00000000
Sid                                 : 6
Traffic Priority                    : 0
Maximum Sustained rate              : 50000000 bits/sec
Maximum Burst                       : 3044 bytes
Minimum Reserved Rate               : 0 bits/sec
Minimum Packet Size                 : 0 bytes
Admitted QoS Timeout                : 200 seconds
Active QoS Timeout                  : 0 seconds
Packets                             : 0
Bytes                               : 0
Rate Limit Delayed Grants           : 0
Rate Limit Dropped Grants          : 0
Current Throughput                  : 0 bits/sec, 0 packets/sec
Application Priority                 : 0
US Bonded                           : YES
Upstream Bonding Group              : UBG-65535
Transmit Channel Set                : 0xF
Sid Cluster                         : SC-0, Sid [ 6 6 6 6 ]
Sid Cluster                         : SC-1, Sid [ 9 9 9 9 ]
Segments Valid                      : 0
Segments Discarded                  : 0
Segments Lost                       : 0
SID Cluster Switching Information
Total Bytes Requested               : 0
Total Time                          : 20
Outstanding Bytes                   : 25600
Max Requests                        : 8
Classifiers: NONE
```

To verify the transmit power levels on a CM, use the **show cable modem** command as shown in the following example:

```
Router# show cable modem 0014.f831.d596 verbose
MAC Address           : 001e.6bfa.f02e
IP Address            : 30.10.0.6
IPv6 Address          : ---
Dual IP               : N
Prim Sid              : 5
Host Interface        : C5/1/0/UB
MD-DS-SG / MD-US-SG  : 1 / 1
MD-CM-SG              : 0xF0101
Primary Wideband Channel ID : 48
Primary Downstream    : Mo3/0/0:0 (RfId : 120)
Wideband Capable      : Y
RCP Index             : 3
RCP ID                : 00 10 00 00 04
Multi-Transmit Channel Mode : Y
Upstream Channel      : US1      US2      US3      US4
Ranging Status        : sta      sta      sta      sta
Upstream Power (dBmV) : 0.00    0.00    0.00    0.00
Upstream SNR (dB)     : 36.12   36.12   36.12   33.1
Received Power (dBmV) : 0.00    1.00    0.00    -0.75
Reported Transmit Power (dBmV) : 45.00   45.00   45.00   54.75
Peak Transmit Power (dBmV) : 51.00   51.00   56.00   56.00
Minimum Transmit Power (dBmV) : 24.00   24.00   21.00   18.00
Timing Offset         (97.6 ns) : 2312    2281    2282    2282
```



```

Initial Timing Offset           : 2314          2058          2058          2058
Rng Timing Adj Moving Avg(0.381 ns) : 7            4            0            -94
Rng Timing Adj Lt Moving Avg     : 63           30           11           -144
Rng Timing Adj Minimum          : -512         -256         -256         -512
Rng Timing Adj Maximum          : 256          57088        57344        57344
Pre-EQ Good                     : 0            0            0            0
Pre-EQ Scaled                   : 0            0            0            0
Pre-EQ Impulse                   : 0            0            0            0
Pre-EQ Direct Loads              : 0            0            0            0
Good Codewords rx                : 5012         4996         4992         4990
Corrected Codewords rx           : 0            0            0            0
Uncorrectable Codewords rx       : 0            0            0            0
Phy Operating Mode                : atdma*       atdma*       tdma*        tdma*
sysDescr                         :
Downstream Power                 : 0.00 dBmV (SNR = ----- dB)
MAC Version                       : DOC3.0
QoS Provisioned Mode              : DOC1.1
Enable DOCSIS2.0 Mode             : Y
Modem Status                      : {Modem= w-online, Security=disabled}
Capabilities                       : {Frag=N, Concat=N, PHS=Y}
Security Capabilities              : {Priv=, EAE=Y, Key_len=}
L2VPN Capabilities                 : {L2VPN=N, eSAFE=N}
Sid/Said Limit                    : {Max US Sids=8, Max DS Sids=24}
Optional Filtering Support         : {802.1P=N, 802.1Q=N, DUT=N}
Transmit Equalizer Support        : {Taps/Symbol= 1, Num of Taps= 24}
Number of CPE IPs                 : 0(Max CPE IPs = 16)
CFG Max-CPE                       : 4
Flaps                              : 0()
Errors                             : 0 CRCs, 0 HCses
Stn Mtn Failures                  : 0 aborts, 0 exhausted
Total US Flows                     : 2(2 active)
Total DS Flows                     : 1(1 active)
Total US Data                      : 6 packets, 1557 bytes
Total US Throughput                 : 0 bits/sec, 0 packets/sec
Total DS Data                      : 0 packets, 0 bytes
Total DS Throughput                 : 0 bits/sec, 0 packets/sec
LB group ID assigned (index)       : N/A (N/A)
LB group ID in config file (index) : N/A (N/A)
LB policy ID                       : 0
LB policy ID in config file        : 0
LB priority                         : 0
Tag                                 :
Required DS Attribute Mask         : 0x0
Forbidden DS Attribute Mask        : 0x0
Required US Attribute Mask         : 0x0
Forbidden US Attribute Mask        : 0x0
Service Type ID                    :
Service Type ID in config file     :
Active Classifiers                  : 0 (Max = NO LIMIT)
CM Upstream Filter Group           : 0
CM Downstream Filter Group         : 0
CPE Upstream Filter Group          : 0
CPE Downstream Filter Group        : 0
DSA/DSX messages                   : permit all
Voice Enabled                       : NO
DS Change Times                    : 0
Boolean Services                   : 2
Number of Multicast DSIDs Support  : 24
MDF Capability Mode                 : 2
IGMP/MLD Version                   : IGMPv3
FCType10 Forwarding Support        : Y
Features Bitmask                   : 0x0
Total Time Online                   : 1d16h
CM Initialization Reason            : NO_PRIM_SF_USCHAN
CFG Max IPv6 CPE Prefix            : 16 (-1 used)

```

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 as shown in the following example:

```
Router# show interface cable 5/0/2 mac-scheduler 0
DOCSIS 1.1 MAC scheduler for Cable5/0/2/U0: rate 10240000
wfq:Class, weights: 1 2 3 4 5 6 7 8
Queue[Rng Polls] 0/128, 0 drops, flows 0 max 0
Queue[CIR Grants] 0/256, 0 drops, flows 0 max 0
Queue[BE(7) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(6) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(5) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(4) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(3) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(2) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(1) Grants] 0/32, 0 drops, flows 0 max 0
Queue[BE(0) Grants] 0/32, 0 drops, flows 0 max 0
Queue[LLQ Grants] 0/64, 0 drops, flows 0 max 0
BG pending grant list entries: 0
BG delay list entries: 0
Req Slots 265389868, Req/Data Slots 4
Init Mtn Slots 3798558, Stn Mtn Slots 0
Short Grant Slots 0, Long Grant Slots 0
Adv Phy Short Grant Slots 0, Adv Phy Long Grant Slots 0
Adv Phy UGS Grant Slots 0
Awacs Slots 0
Fragmentation count 0
Fragmentation test disabled
Avg upstream channel utilization : 0%
Avg percent contention slots : 97%
Avg percent initial ranging slots : 3%
Avg percent minislots lost on late MAPs : 0%
Sched Table Rsv-state: Grants 0, Reqpolls 0
Sched Table Adm-State: Grants 0, Reqpolls 0, Util 0%
UGS : 0 SIDs, Reservation-level in bps 0
UGS-AD : 0 SIDs, Reservation-level in bps 0
RTPS : 0 SIDs, Reservation-level in bps 0
NRTPS : 0 SIDs, Reservation-level in bps 0
BE : 0 SIDs, Reservation-level in bps 0
MAP TSS: lch_state 11, init_retries 0
late_initial_maps 0, late_ucd_maps 0
mac-phy tss errors 0
r4k ticks in lms 800000
Total scheduling events 0
No search was needed 0
Previous entry free 0
Next entry free 0
Could not schedule 0
Recovery failed 0
Curr time 251 entry 251
```

Verifying Rate Limiting for Upstream Bonded Service Flows

To verify the rate limiting criteria configured on the Cisco uBR10-MC5X20H line card for upstream bonded service flows, use the **show cable rate-limit-ccf** command as shown in the following example:

```
Router# show cable rate-limit-ccf
rate limiting config: aggr throughput: 215000000 aggr_burst: 240000
cpu_threshold: 50 cpu_burst: 10
5X20H rate limit: cpu-throttle 0 ccf-bw-drop 0 others 0
5X20H rate limit ccf info count: 0
```

**Note**

The **show cable rate-limit-ccf** command is applicable only to the Cisco uBR-MC5X20 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 as shown in the following example:

```
Router# show cable modem 0022.2d56.d42d verbose
.
.
.
Multi-Transmit Channel Mode : Y
Upstream Channel : US1 US2 US3 US4
Ranging Status : sta sta sta sta
Upstream SNR (dB) : 36.12 36.12 36.12 36.12
Received Power (dBmV) : 1.00 !2.00 !2.00 !2.50
Reported Transmit Power (dBmV): 54.00 54.00 54.00 54.00
Peak Transmit Power (dBmV) : 51.00 51.00 51.00 51.00
Minimum Transmit Power (dBmV): 21.00 21.00 21.00 21.00
Timing Offset 97.6 ns) : 2311 2311 2310 2311
!Compare the Reported Transmit Power and Peak Transmit Power values to verify that the cable
modem is transmitting at a higher power level.
```

To list all the CMs that are transmitting at higher power level, use the **show cable modem extended-power** command as shown in the following example:

```
Router# show cable modem extended-power
MAC Address      IP Address      I/F           MAC           Prim  Report  ECN
State           Sid   Power
001e.6bf3.3382  5.50.0.3        C7/0/0/UB    w-online      3     57.00   Y
0022.cea5.0214  5.50.1.102     C7/0/0/UB    w-online      5     54.00   Y
001e.6bf3.1378  5.50.6.83      C7/0/0/UB    w-online      6     54.00   Y
```

Additional References

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

Related Documents

Related Topic	Document Title
Commands on the Cisco CMTS routers	<i>Cisco IOS CMTS Cable Command Reference</i> http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html
DOCSIS 3.0 Downstream Channel Bonding	<i>Cisco Cable Wideband Solution Design and Implementation Guide</i> http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html

Related Topic	Document Title
Cisco uBR10-MC5X20S/U/H Cable Interface Line Card	<p><i>Cisco uBR10-MC5X20S/U/H Cable Interface Line Card Hardware Installation Guide</i></p> <p>http://www.cisco.com/en/US/docs/interfaces_modules/cable/broadband_processing_engines/ubr10_mc5x20s_u_h/installation/guide/ubrmc520.html</p>
Dynamic Bandwidth Sharing	<p><i>Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC</i></p> <p>http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_dyn_bw_sharing_ps2209_TSD_Products_Configuration_Guide_Chapter.html</p>
Upstream Scheduler Mode	<p><i>Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC</i></p> <p>http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_upstm_sch_md_ps2209_TSD_Products_Configuration_Guide_Chapter.html</p>

Standards and RFCs

Standard	Title
CM-SP-MULPIv3.0-I10-090529	Data-Over-Cable Service Interface Specifications DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification
CM-SP-PHYv3.0-I08-090121	Data Over Cable Service Interface Specifications DOCSIS 3.0 Physical Layer Specification

MIBs

MIB	MIBs Link
<ul style="list-style-type: none"> • DOCS-IF3-MIB • DOCS-SUBMGT3-MIB • CLAB-TOPO-MIB 	<p>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:</p> <p>http://www.cisco.com/go/mibs</p>

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>	<p>http://www.cisco.com/techsupport</p>

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	12.2(33)SCC	

Feature Name	Releases	Feature Information
		<p>The Upstream Channel Bonding feature helps cable operators offer higher upstream bandwidth per CM user by combining multiple physical RF channels to form a larger bonding group at the MAC layer.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Information About Upstream Channel Bonding, on page 3 • How to Configure Upstream Channel Bonding, on page 13 • Configuration Example for Upstream Channel Bonding, on page 28 <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • cable mtc-mode • cable mrc-mode • cable upstream bonding-group • cable upstream resiliency • cable upstream ranging-poll • clear cable modem cm-status • debug cable cm-ctrl • debug cable cm-status • debug cable mdd • debug cable md-sg • debug cable ubg • show cable fiber-node • show cable flap-list • show cable mac-domain upstream-service-group

Feature Name	Releases	Feature Information
		<ul style="list-style-type: none"> • show cable modem cnr • show cable signal-quality • show interface cable service-flow • show interface cable upstream • upstream • upstream cable connector
Cisco uBR10-MC5X20H Line Card Specific Rate Limiting	12.2(33)SCC	<p>The following commands were introduced:</p> <ul style="list-style-type: none"> • cable upstream rate-limit-ccf • show cable rate-limit-ccf
SID Tracking	12.2(33)SCC	<p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • debug cable interface sid • show interface cable upstream debug
Upstream Channel Bonding	12.2(33)SCD	<p>Added support for Cisco uBR7246VXR and Cisco uBR7225VXR routers.</p>
Upstream Weighted Fair Queuing	12.2(33)SCD2	<p>Added support for class-based and activity-based weighted fair queuing configuration for upstream service flows.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • cable upstream qos wfq • show interface cable mac-scheduler

Feature Name	Releases	Feature Information
Upstream Channel Bonding	12.2(33)SCE	<p>The following commands were modified to support the Cisco uBR-MC3GX60V cable interface line card:</p> <ul style="list-style-type: none"> • interface cable • show interface cable • show running-config interface cable
Extended Transmit Power and Reduced Transmit Channel Set	12.2(33)SCE3	<p>The Extended Transmit Power feature enables cable operators to have better control on the CMs 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.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • cable tx-power-headroom • cable upstream max-channel-power-offset
DOCSIS Extended Transmit Power	12.2(33)SCF2	<p>This feature introduces the extended transmit power capability on the Cisco CMTS as per the DOCSIS specification. The DOCSIS 3.0 CMs can now transmit at a higher power level to overcome the signal loss because of the attenuation in the US path.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> • cable upstream ext-power • show cable modem extended-power

Feature Name	Releases	Feature Information
Upstream Channel Resiliency for RTPS Service Flows	12.2(33)SCG	<p>This feature enables movement of the upstream service flows on an impaired upstream channel to another good upstream channel in the transmit channel set of the cable modem without resetting the cable modem.</p> <p>The following command was introduced:</p> <ul style="list-style-type: none"> • cable upstream resiliency sf-move
Data-burst Resiliency Polling Interval	Cisco IOS-XE Release 3.18.0S	<p>This feature enables to set data-stream resiliency polling interval of the upstream service flows.</p> <p>The following command was introduced:</p> <ul style="list-style-type: none"> • cable upstream resiliency data-burst polling-interval