



## **Cisco CMTS Router Downstream and Upstream Features Configuration Guide**

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## CHAPTER

# 1

# Cable Modem Upstream RF Adaptation

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The Cable Modem Upstream RF Adaptation feature uses per cable modem physical layer statistics to identify and automatically move cable modems to another logical upstream channel within the same physical port. This is to prevent unnecessary channel-wide parameter changes, which reduces throughput, disrupts traffic flow for all modems, and makes some modems to go offline in extreme cases.

### 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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# Prerequisites for Cable Modem Upstream RF Adaptation

- Multiple logical channels must be configured.
- Logical channels should be enabled per upstream.
- Logical channel 0 is the preferred primary logical channel, and logical channel 1 is the preferred secondary logical channel. This increases interoperability with other CMTS applications such as load balancing and upstream channel bonding.

The table below shows the hardware compatibility prerequisites for this feature.


**Note**

The hardware components introduced in a given Cisco IOS Release are supported in all subsequent releases unless otherwise specified.

**Table 1: Cable Hardware Compatibility Matrix for Cable Modem Upstream RF Adaptation**

Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• PRE2</li> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20H</li> <li>• Cisco UBR-MC20X20V<sup>1</sup></li> <li>• Cisco uBR-MC3GX60V<sup>2</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>3</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>1</sup> The Cisco UBR-MC20X20V cable interface line card has three variants—Cisco UBR-MC20X20V-0D, Cisco UBR-MC20X20V-5D, and Cisco UBR-MC20X20V-20D. The Cisco UBR-MC20X20V-0D line card supports 20 upstreams and zero (no) downstreams. The Cisco UBR-MC20X20V-5D line card supports 20 upstreams and 5 downstreams, and the Cisco UBR-MC20X20V-20D line card supports 20 upstreams and 20 downstreams.

<sup>2</sup> The Cisco uBR-MC3GX60V line card is not compatible with PRE2.

<sup>3</sup> The Cisco uBR-MC88V cable interface line card is not compatible with NPE-G1. You must use NPE-G2 with the Cisco uBR-MC88V cable interface line card.



## Restrictions for Cable Modem Upstream RF Adaptation

- Logical channel 1 cannot be part of an upstream bonding group.
- The Upstream Channel Bonding (USCB) feature coexists with the Cable Modem Upstream RF Adaptation feature; however, cable modems in the multiple transmits channel (MTC) mode are excluded.
- Cable modems that use the multiple receive channel (MRC) mode without MTC may participate in cable modem upstream RF adaptation because these cable modems can be moved using the dynamic channel change (DCC) method.
- Advanced spectrum management is not supported in multiple logical channel configurations.
- Dynamic channel-width configurations are not supported.
- A pair of logical upstream channels configured with a mix of DOCSIS modes (i.e. SCDMA on logical channel 0 and ATDMA on logical channel 1) is supported, however, the CMTS will request that the cable modem uses the initialization technique 1 for the DCC.

## Information About Cable Modem Upstream RF Adaptation

The Cable Modem Upstream RF Adaptation feature moves a single cable modem or a group of cable modems to a more robust channel when a user-defined set of per cable modem PHY statistics does not meet a set of user-specified thresholds. Similarly, it releases a single cable modem or a group of cable modems from the secondary channel when the user-defined set of per cable modem PHY statistics exceeds a set of user-specified thresholds.

The following relocation methods are used while moving a cable modem to and from the secondary logical upstream channel:

- UCC for DOCSIS 1.0 cable modems.
- DCC initialization technique 2 for DOCSIS 1.1 and newer cable modems. Initialization technique 2 performs periodic ranging. The cable modem is kept online and allowed to start on the new channel with periodic ranging.
- DCC initialization technique 1 for any configuration where at least one logical channel uses the SCDMA DOCSIS mode. The initialization technique 1 broadcasts the initial ranging. The cable modem is kept online and re-registration is avoided, but this technique requires completion of initial ranging.

The following PHY statistics are used while moving a cable modem to and from the secondary logical upstream channel:

- Ranging burst Modulation Error Ratio (MER)
- Data burst MER for JIB3-based line cards
- Correctable and uncorrectable Forward Error Correction (FEC)

The cable modems to be relocated from the primary logical upstream channel to the secondary channel are marked as downgrade candidates. Similarly, the cable modems to be relocated from the secondary logical upstream channel to the primary channel are marked as upgrade candidates. Tracking individual cable modem

statistics prevents a cable modem or a small group of cable modems from lowering the available bandwidth for the larger population of cable modems.

Following are the step-by-step timer-based events that occur during RF adaptation:

- 1 General timer event—The PHY statistics of the cable modems on the RF adapt-enabled channel are checked. The cable modems that fail or exceed the set threshold are flagged as either downgrade or upgrade candidates.
- 2 Candidate timer event—The PHY statistics of the cable modems that are flagged as downgrade or upgrade candidates are checked again to verify if the impairment still exists.
- 3 Relocation timer event—The cable modems that continue to fail or exceed the threshold are relocated.

After a line card switchover, the cable modems remain online on either the primary or secondary logical upstream channel depending on the state of the cable modem prior to the switchover. The upgrade and downgrade candidate cable modems, and the cable modem movement history from primary to secondary logical upstream channel and vice versa are not retained after a line card switchover. The Cable Modem Upstream RF Adaptation feature is not affected by a PRE switchover and the candidate information and history is retained during a PRE switchover.

The Cable Modem Upstream RF Adaptation feature is disabled by default. For information about how to enable this feature, see [How to Configure Cable Modem Upstream RF Adaptation](#), on page 5.

## Related CMTS Software Features

The Cable Modem Upstream RF Adaptation feature via spectrum management integrates with and leverages from the following CMTS software features:

- [Multiple Logical Channels](#), on page 4
- [CMTS PHY Measurement](#), on page 5

### Multiple Logical Channels

The ability to use a multiple logical channel configuration to relocate cable modems with PHY impairments is a key capability of the Cable Modem Upstream RF Adaptation feature. In a cable modem upstream RF adaptation configuration, the logical channels are used as:

- Logical Channel 0—This is the default primary logical channel that cable modems registers on. The primary logical channel should be configured with performance options such as 64 QAM modulation profile irrespective of the index value.
- Logical Channel 1—This is the default secondary logical channel. The secondary logical channel should be configured with robust options, such as QPSK-based modulation profile irrespective of the index value.

You can configure the primary and secondary logical channel. When multiple logical channels are configured, the upstream-related commands are categorized into physical port level and logical channel level groups. Logical channel level commands use the format of **cable upstream** *port logical-channel-index*, where *port* denotes the physical port number, and *logical-channel-index* denotes the logical channel index number.

The following logical channel-level configuration options have an impact on the Cable Modem Upstream RF Adaptation feature:

- DOCSIS mode. In the case of SCDMA, change in parameters like codes-per-minislot may also impact robustness.
- Modulation profile.
- Equalization-coefficient (that is pre-equalization).

For more details on the Multiple Logical Channel feature, see [S-CDMA and Logical Channel Support on the Cisco CMTS Routers](#) .

### CMTS PHY Measurement

The CMTS PHY measurements collected on a per cable modem basis is used during RF adaptation. For a cable modem upstream RF adaptation, the MER (also referred to as Signal-to-noise Ratio [SNR]), and FEC (both correctable and uncorrectable) measurements provide an accurate indication about the effect of any PHY impairments on a single cable modem.

The Cable Modem Upstream RF Adaptation feature uses the following thresholds:

- rf-adapt—Sets the RF adaptation percentage threshold.
- snr-profiles—Specifies the MER (SNR) threshold in dB.
- hysteresis—Specifies the hysteresis value.
- corr-fec—Specifies the allowable number of correctable FEC errors for the upstream.
- uncorr-fec—Specifies the allowable number of uncorrectable FEC errors for the upstream.



#### Note

All the above thresholds are configured at the physical port level to ensure that the same collection of thresholds is used for both upgrade and downgrade.

## How to Configure Cable Modem Upstream RF Adaptation

This section describes how to configure a physical upstream and its associated logical channels for cable modem upstream RF adaptation.

### Before You Begin

Multiple logical channels must be configured.



#### Restriction

The cable modem upstream RF adaptation is not applicable for modems that are registered in MTC mode.

### DETAILED STEPS

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

	Command or Action	Purpose
	<p><b>Example:</b> Router&gt; <code>enable</code></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> Router# <code>configure terminal</code></p>	Enters global configuration mode.
<b>Step 3</b>	<p><b>cable rf-adapt timer general <i>time</i></b></p> <p><b>Example:</b> Router(config)# <code>cable rf-adapt timer general 1</code></p>	<p>(Optional) Sets the timer for cable modem upstream RF adaptation.</p> <ul style="list-style-type: none"> <li>• <b>general <i>time</i></b>—Specifies the period when the RF adaptation process examines the physical layer statistics of all modems on RF adaptation-enabled upstream channels. The valid range is from 1 to 300 seconds.</li> </ul>
<b>Step 4</b>	<p><b>cable rf-adapt timer candidate <i>time</i></b></p> <p><b>Example:</b> Router(config)# <code>cable rf-adapt timer candidate 2</code></p>	<p>(Optional) Sets the timer for cable modem upstream RF adaptation.</p> <ul style="list-style-type: none"> <li>• <b>candidate <i>time</i></b>—Specifies the period when the RF adaptation process examines the physical layer statistics of modems flagged as downgrade or upgrade candidates, or both. The valid range is from 1 to 300 seconds.</li> </ul>
<b>Step 5</b>	<p><b>cable rf-adapt timer relocation <i>time</i></b></p> <p><b>Example:</b> Router(config)# <code>cable rf-adapt timer relocation 300</code></p>	<p>(Optional) Sets the timer for cable modem upstream RF adaptation.</p> <ul style="list-style-type: none"> <li>• <b>relocation <i>time</i></b>—Specifies the period when the RF adaptation process performs a single relocation of a candidate modem from its current upstream channel to the appropriate destination. The valid range is from 1 to 300 seconds.</li> </ul>
<b>Step 6</b>	<p><b>interface cable {<i>slot/cable-interface-index</i>   <i>slot/subslot/cable-interface-index</i>}</b></p> <p><b>Example:</b> Router(config)# <code>interface cable 8/0/0</code></p>	<p>Enters interface configuration mode.</p> <ul style="list-style-type: none"> <li>• <i>slot</i>—Slot where the line card resides. <ul style="list-style-type: none"> <li>◦ Cisco uBR7225VXR router—The valid value is 1 or 2.</li> <li>◦ Cisco uBR7246VXR router—The valid range is from 3 to 6.</li> <li>◦ Cisco uBR10012 router—The valid range is from 5 to 8.</li> </ul> </li> <li>• <i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. The valid subslot is 0 or 1.</li> <li>• <i>cable-interface-index</i>—Downstream port of the Cisco uBR10-MC5X20 and Cisco uBR-MC88V line cards, or MAC domain index of the Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V line cards. <ul style="list-style-type: none"> <li>◦ Cisco uBR7225VXR and Cisco uBR7246VXR routers—The valid port value is 0 or 1.</li> </ul> </li> </ul>

	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>◦ Cisco uBR10012 router—The valid range for the Cisco UBR-MC20X20V and Cisco uBR-MC5X20 line cards is from 0 to 4. The valid range for the Cisco uBR-MC3GX60V line card is from 0 to 14.</li> </ul>
<b>Step 7</b>	<b>cable upstream</b> <i>port</i> <b>max-logical-chans</b> <i>code</i>  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 max-logical-chans 2</pre>	Enables multiple logical channels on the physical upstream channel intended for RF adaptation. <ul style="list-style-type: none"> <li>• <i>port</i> —Upstream port. The valid range is from 0 to 3.</li> <li>• <i>code</i> —Number of logical channels per port. The valid values are 1 and 2.</li> </ul>
<b>Step 8</b>	<b>cable upstream</b> <i>port</i> <b>rf-adapt</b>  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 rf-adapt</pre>	Enables RF adaptation on the physical upstream channel. <ul style="list-style-type: none"> <li>• <i>port</i>—Upstream port. The valid range is from 0 to 3.</li> </ul>
<b>Step 9</b>	<b>cable upstream</b> <i>port</i> <b>threshold rf-adapt</b> <i>threshold1-in-percent</i>  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 threshold rf-adapt 25</pre>	(Optional) Sets the RF adaptation percentage threshold. <ul style="list-style-type: none"> <li>• <i>port</i> —Upstream port. The valid range is from 0 to 3.</li> <li>• <b>rf-adapt</b>—Specifies the ratio of candidate cable modems to total number of upstream cable modems, which disables further RF adaptation.</li> <li>• <i>threshold1-in-percent</i>—RF adapt disable threshold in percentage. The valid range is from 1 to 50.</li> </ul> <p><b>Note</b> You can bypass the RF adapt disable threshold by setting it to 0.</p>
<b>Step 10</b>	<b>cable upstream</b> <i>port</i> <b>thresholdsnr-profiles</b> <i>snr-threshold1 snr-threshold2</i>  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 threshold snr-profiles 25 0</pre>	(Optional) Specifies the MER (SNR) threshold in dB. <ul style="list-style-type: none"> <li>• <i>snr-threshold1</i>—MER (SNR) threshold for the primary modulation profile specified for the upstream. The valid range is from 5 to 35 dB, with a default value of 25 dB.</li> </ul> <p><b>Note</b> You can bypass the primary MER (SNR) threshold (<i>snr-threshold1-in-db</i>) by setting it to 0.</p> <ul style="list-style-type: none"> <li>• <i>snr-threshold2</i>—MER (SNR) threshold for the secondary modulation profile specified for the upstream. The valid range is from 5 to 35 dB, with a default value of 25 dB. For the Cable Modem Upstream RF Adaptation feature, it is recommended to set this value to 0.</li> </ul> <p><b>Note</b> <i>snr-threshold2</i> is ignored by the Cable Modem Upstream RF Adaptation feature.</p>
<b>Step 11</b>	<b>cable upstream</b> <i>port</i> <b>thresholdhysteresis</b> <i>hysteresis-value</i>	(Optional) Specifies the hysteresis value.

	Command or Action	Purpose
	<p><b>Example:</b>  Router(config-if)# <b>cable upstream 0</b>  <b>threshold hysteresis 3</b></p>	<ul style="list-style-type: none"> <li>• <i>hysteresis-value</i>—Hysteresis value. The valid range is from 0 to 10 dB, with a default value of 3 dB.</li> </ul> <p><b>Note</b> You can bypass the hysteresis threshold by setting the value to 0.</p>
<b>Step 12</b>	<p><b>cable upstream port threshold corr-fec</b> <i>fec-corrected</i></p> <p><b>Example:</b>  Router(config-if)# <b>cable upstream 0</b>  <b>threshold corr-fec 2</b></p>	<p>(Optional) Specifies the allowable number of correctable FEC errors for the upstream.</p> <ul style="list-style-type: none"> <li>• <i>fec-corrected</i> —Allowable number of correctable FEC errors for the upstream, given as a percentage of total packets received on the upstream during the polling period. It is given as a percentage of total packets received on the upstream during the polling period. The valid range is from 1 to 30 percent, with a default value of 3 percent.</li> </ul> <p><b>Note</b> You can bypass the corr-fec threshold by setting the value to 0.</p>
<b>Step 13</b>	<p><b>cable upstream port threshold uncorr-fec</b> <i>fec-uncorrected</i></p> <p><b>Example:</b>  Router(config-if)# <b>cable upstream 0</b>  <b>threshold uncorr-fec 10</b></p>	<p>(Optional) Specifies the allowable number of uncorrectable FEC errors for the upstream.</p> <ul style="list-style-type: none"> <li>• <i>fec-uncorrected</i> —Allowable number of uncorrectable FEC errors for the upstream, given as a percentage of total packets received on the upstream during the polling period. The valid range is from 1 to 30 percent of total packets, with a default of 1 percent.</li> </ul> <p><b>Note</b> You can bypass the uncorr-fec threshold by setting the value to 0.</p>
<b>Step 14</b>	<p><b>cable upstream port logical-channel-index rf-adapt</b> [primary   secondary]</p> <p><b>Example:</b>  Router(config-if)# <b>cable upstream 0 0</b>  <b>rf-adapt primary</b></p>	<p>(Optional) Specifies the primary upstream logical channel and the secondary upstream logical channel.</p> <ul style="list-style-type: none"> <li>• <i>port</i> —Upstream port. The valid range is from 0 to 3.</li> <li>• <i>logical-channel-index</i> —Logical channel index. The valid values are 0 and 1.</li> <li>• <b>primary</b>—Sets the logical channel as primary for RF adaptation. By default, the logical channel 0 is primary.</li> <li>• <b>secondary</b>—Sets the logical channel as secondary for RF adaptation. By default, the logical channel 1 is secondary.</li> </ul> <p><b>Note</b> When you set the primary channel, the secondary channel is automatically set.</p>
<b>Step 15</b>	<p><b>no cable upstream port logical-channel-index shutdown</b></p>	<p>Performs a “no shutdown” on logical channel 1.</p>

	Command or Action	Purpose
	<b>Example:</b> Router(config-if)# <code>no cable upstream 0 1 shutdown</code>	
<b>Step 16</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <code>end</code>	Exits the interface configuration mode and returns to privileged EXEC mode.

### What to Do Next

If you want to customize multiple logical channels, see [S-CDMA and Logical Channel Support on the Cisco CMTS Routers](#).

## Troubleshooting Tips

Following are some scenarios that you may encounter while configuring or after configuring the Cable Modem Upstream RF Adaptation feature. Follow the recommended action to resolve these issue.

### Cable Modem Does Not Downgrade to the Secondary Logical Channel

**Problem** A cable modem with PHY statistics less than the user-specified threshold is not downgraded to the secondary logical channel.

- **Possible Cause** The RF adaptation downgrade threshold has been met.
- **Possible Cause** The RF adaptation downgrade threshold is exceeded while the cable modem is still on the downgrade candidate list.
- **Possible Cause** The RF adaptation downgrade threshold is exceeded after a group of cable modems are moved to the secondary logical channel.

**Solution** Contact Cisco Technical Assistance Center (TAC).

### Cable Modem Does Not Upgrade to the Primary Logical Channel

**Problem** A cable modem with PHY statistics greater than the user-specified threshold is not upgraded to the primary logical channel.

- **Possible Cause** The cable modem was upgraded or downgraded five times.
- **Possible Cause** The SNR has not improved beyond the threshold and the hysteresis value.

**Solution** You can delete the cable modem history from the CMTS database using the **clear cable modem delete** command.

## Verifying Cable Modem Upstream RF Adaptation

Command	Purpose
<b>show cable rf-adapt downgrade-candidates</b>	To verify the downgrade candidate cable modems.
<b>show cable rf-adapt upgrade-candidates</b>	To verify the upgrade candidate cable modems.
<b>show cable modem rf-adapt</b>	To verify the RF adaptation history

## Configuration Examples for Cable Modem Upstream RF Adaptation

This section provides configuration examples for the Cable Modem Upstream RF Adaptation feature:

### Example: Configuring Cable Modem Upstream RF Adaptation on the Cisco uBR10012 Router

The following example shows how to configure the Cable Modem Upstream RF Adaptation feature on the Cisco uBR10012 router.

```
!
interface Cable8/0/0
load-interval 30
downstream Modular-Cable 1/1/0 rf-channel 0 upstream 0-3
cable mtc-mode
no cable packet-cache
cable bundle 1
cable upstream max-ports 4
cable upstream bonding-group 700
upstream 0
upstream 1
upstream 2
upstream 3
attributes A0000000
cable upstream 0 connector 0
cable upstream 0 frequency 13000000
cable upstream 0 channel-width 6400000 6400000
cable upstream 0 max-logical-chans 2
cable upstream 0 threshold snr-profiles 20 0
cable upstream 0 threshold corr-fec 0
cable upstream 0 threshold uncorr-fec 0
cable upstream 0 threshold rf-adapt 0
cable upstream 0 rf-adapt
cable upstream 0 0 docsis-mode scdma
cable upstream 0 0 spreading-interval 16
cable upstream 0 0 codes-per-minislot 16
```



```

cable upstream 0 0 active-codes 112
cable upstream 0 0 range-backoff 3 6
cable upstream 0 0 modulation-profile 321
cable upstream 0 0 attribute-mask 20000000
no cable upstream 0 0 shutdown
cable upstream 0 1 docsis-mode atdma
cable upstream 0 1 minislot-size 1
cable upstream 0 1 range-backoff 3 6
cable upstream 0 1 modulation-profile 223
cable upstream 0 1 attribute-mask 20000000
no cable upstream 0 1 shutdown
no cable upstream 0 shutdown
cable upstream 1 connector 1
cable upstream 1 frequency 20000000
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 load-balance group 80
cable upstream 1 docsis-mode scdma
cable upstream 1 spreading-interval 16
cable upstream 1 codes-per-minislot 4
cable upstream 1 active-codes 112
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 321
cable upstream 1 attribute-mask 20000000
no cable upstream 1 shutdown
cable upstream 2 connector 2
cable upstream 2 frequency 26400000
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 power-level 1
cable upstream 2 load-balance group 80
cable upstream 2 docsis-mode scdma
cable upstream 2 spreading-interval 16
cable upstream 2 codes-per-minislot 4
cable upstream 2 active-codes 112
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 321
cable upstream 2 attribute-mask 20000000
no cable upstream 2 shutdown
cable upstream 3 connector 3
cable upstream 3 frequency 32600000
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 power-level 1
cable upstream 3 load-balance group 80
cable upstream 3 docsis-mode scdma
cable upstream 3 spreading-interval 16
cable upstream 3 codes-per-minislot 4
cable upstream 3 active-codes 112
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 321
cable upstream 3 attribute-mask 20000000
no cable upstream 3 shutdown
cable sid-cluster-group num-of-cluster 2
cable sid-cluster-switching max-request 1
...
...

```

## Example: Configuring Cable Modem Upstream RF Adaptation on the Cisco uBR7200 Router

The following example shows how to configure the Cable Modem Upstream RF Adaptation feature on the Cisco 7200 router.

```

!
interface Cable1/1
 load-interval 30
 downstream Integrated-Cable 1/1 rf-channel 0-3 upstream 0-3
 cable mtc-mode
 no cable packet-cache

```

## Example: Non-Default Timer Configuration

```

cable bundle 2
cable upstream max-ports 4
cable upstream 0 connector 4
cable upstream 0 frequency 20000000
cable upstream 0 channel-width 6400000 6400000
cable upstream 0 max-logical-chans 2
cable upstream 0 threshold snr-profiles 26 0
cable upstream 0 threshold corr-fec 5
cable upstream 0 threshold uncorr-fec 2
cable upstream 0 threshold hysteresis 4
cable upstream 0 threshold rf-adapt 0
cable upstream 0 rf-adapt
cable upstream 0 0 docsis-mode atdma
cable upstream 0 0 minislots-size 4
cable upstream 0 0 range-backoff 3 6
cable upstream 0 0 modulation-profile 221
cable upstream 0 0 attribute-mask 20000000
no cable upstream 0 0 shutdown
cable upstream 0 1 docsis-mode atdma
cable upstream 0 1 minislots-size 4
cable upstream 0 1 range-backoff 3 6
cable upstream 0 1 modulation-profile 222
cable upstream 0 1 attribute-mask 20000000
no cable upstream 0 1 shutdown
no cable upstream 0 shutdown
cable upstream 1 connector 5
cable upstream 1 frequency 26600000
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 docsis-mode atdma
cable upstream 1 minislots-size 4
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 321
cable upstream 1 attribute-mask 20000000
no cable upstream 1 shutdown
cable upstream 2 connector 6
cable upstream 2 frequency 30000000
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 docsis-mode atdma
cable upstream 2 minislots-size 4
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 221
cable upstream 2 attribute-mask 20000000
no cable upstream 2 shutdown
cable upstream 3 connector 7
cable upstream 3 frequency 33500000
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 docsis-mode atdma
cable upstream 3 minislots-size 4
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 221
cable upstream 3 attribute-mask 20000000
no cable upstream 3 shutdown
end

```

## Example: Non-Default Timer Configuration

The following example shows how to configure non-default timer configuration.

```

Router# show running-config | in timer
cable rf-adapt timer general 60
cable rf-adapt timer candidate 15
cable rf-adapt timer relocation 5

```

## Additional References

### Related Documents

Related Topic	Document Title
Cisco IOS commands	<a href="#">Cisco IOS Master Commands List, All Releases</a>
CMTS cable commands	<a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a> Cisco IOS CMTS Cable Command Reference

### Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

## Feature Information for Cable Modem Upstream RF Adaptation

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



### Note

The table below lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

**Table 2: Feature Information for Cable Modem Upstream RF Adaptation**

<b>Feature Name</b>	<b>Releases</b>	<b>Feature Information</b>
Cable Modem Upstream RF Adaptation	12.2(33)SCF	

Feature Name	Releases	Feature Information
		<p>The Cable Modem Upstream RF Adaptation feature uses the per cable modem physical layer statistics to identify and automatically move cable modems to another logical upstream channel within the same physical port to prevent unnecessary channel-wide parameter changes.</p> <p>In Cisco IOS Release 12.2(33)SCF, this feature was introduced on the Cisco uBR10012 router and Cisco uBR7200 series routers.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Information About Cable Modem Upstream RF Adaptation, on page 3</a></li> <li>• <a href="#">How to Configure Cable Modem Upstream RF Adaptation, on page 5</a></li> <li>• <a href="#">Verifying Cable Modem Upstream RF Adaptation, on page 10</a></li> <li>• <a href="#">Configuration Examples for Cable Modem Upstream RF Adaptation, on page 10</a></li> </ul> <p>The following commands were introduced or modified: <b>cable rf-adapt timer, cable upstream rf-adapt(logical channel), cable upstream rf-adapt, cable upstream threshold rf-adapt, show cable modem rf-adapt, show cable rf-adapt, cable upstream threshold hysteresis, cable upstream threshold, show cable modem, show cable modem access-group, show cable modem calls, show cable modem connectivity, show cable modem counters, show cable modem docsis version, show cable modem domain-name, show cable modem errors, show cable</b></p>

Feature Name	Releases	Feature Information
		<b>modem flap, show cable modem ipv6, show cable modem mac, show cable modem maintenance, show cable modem offline, show cable modem phy, show cable modem primary channel, show cable modem registered, show cable modem rogue, show cable modem summary, show cable modem type, show cable modem unregistered, show cable modem vendor, show cable modem wideband.</b>



## CHAPTER 2

# Configuring Downstream Cable Interface Features on the Cisco CMTS Routers

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**Note**

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Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

---

The cable interface in the Cisco universal broadband routers serves as the cable TV radio frequency (RF) interface, supporting downstream and upstream signals. The downstream signal is output as an intermediate-frequency (IF) signal suitable for use with an external upconverter. Your cable plant, combined with your planned and installed subscriber base, service offering, and external network connections, determines the combination of cable interfaces, network uplink line cards, and other components that you should use.

The Cisco IOS software command-line interface (CLI) can be used to configure the Cisco cable interface line card for correct operation on the hybrid fiber-coaxial (HFC) cable network. This chapter provides a configuration summary for the various downstream cable interface features available on a Cisco CMTS router. Details about some of these features can be found in other chapters of this book.



**Note**

---

The configuration commands and examples in this chapter may show slot numbering or references to either Cisco uBR7200 series or Cisco uBR10012 Universal Broadband Routers. However, the features can be configured on either platform. Use the slot numbering appropriate for your CMTS router configuration.

---

### 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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# Prerequisites for Configuring Downstream Cable Interfaces on the Cisco CMTS Routers

The configuration of downstream cable interface features is supported on the Cisco CMTS routers in Cisco IOS Release 12.3BC and 12.2SC. The table below shows the hardware compatibility prerequisites for this feature.



**Table 3: Configuring Downstream Cable Interfaces on the Cisco CMTS Routers Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• PRE-2</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>

**Note**

In most applications, default values for the commands used in these configuration steps are adequate to configure the Cisco CMTS router. You do not need to specify individual parameters unless you want to deviate from system defaults.

## Activating Downstream Cable Address Resolution Protocol Requests

This configuration is required. Address Resolution Protocol (ARP) is an Internet protocol used to map IP addresses to MAC addresses on computers and other equipment installed in a network. You must activate ARP requests on the cable interface so that the Cisco uBR10000 series CMTS can perform IP address resolution on the downstream path.

**Note**

The default values for the commands used in this configuration step are adequate in most cases to configure the Cisco uBR7200 series CMTS.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable5/0</b>  <b>Example:</b> Router(config)# <b>interface cable5/0</b>	Enters cable interface configuration mode.  In this example, the interface is downstream port 0 on the cable interface card installed in slot 1 of the Cisco uBR7200 series CMTS.
Step 4	<b>cable arp</b>  <b>Example:</b> Router(config-if)# <b>cable arp</b>	Enables ARP. This is the default.

**What to Do Next**

To verify that cable ARP is activated, enter the **more system:running-config** command and look for the cable interface configuration information. If ARP is activated, it does not appear in this output. If ARP is deactivated, it appears in the output as

```
no cable arp
.

Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0
ip address 1.1.1.1 255.255.255.0
no keepalive
no cable arp
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream symbol-rate 5056941
cable upstream 0 frequency 15008000
no cable upstream 0 shutdown
```

**Tip**

If you are having difficulty with verification, verify that you entered the correct port and cable interface line card slot number when you activated ARP and when you entered the **show interface cable** command.

# Activating Downstream Ports

To activate a downstream port on a Cisco uBR7200 series cable interface card for digital data transmissions over the HFC network, complete the steps in the following table.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable5/0</b>  <b>Example:</b> Router(config)# <b>interface cable5/0</b>	Enters cable interface configuration mode.  In this example, the interface is downstream port 0 on the cable interface card installed in slot 1 of the Cisco uBR7200 series CMTS.
Step 4	Enter the following commands: <ul style="list-style-type: none"> <li>• <b>cable downstream if-output</b></li> <li>• <b>no cable downstream if-output</b></li> </ul> <b>Example:</b> Router(config-if)# <b>cable downstream if-output</b> Router(config-if)# <b>no cable downstream if-output</b>	Activates downstream digital data from the Cisco uBR7200 series router.  Deactivates downstream digital data. This command mutes the IF output of the cable interface card and shuts down the interfaces.
Step 5	<b>no shutdown</b>  <b>Example:</b> Router(config-if)# <b>no shutdown</b>	Places the downstream port in the “admin up” state.
Step 6	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b> Router#  %SYS-5-CONFIG_I: Configured from console by console	Returns to privileged EXEC mode.  This message is normal and does not indicate an error.

### What to Do Next

To determine if the downstream carrier is active (up), enter the **show controllers cable** command for the downstream port that you just configured. For National Television Standards Committee (NTSC) 6 MHz operations, see the following example:

```
Router# show controllers cable5/0 downstream

Cable5/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

## Assigning the Downstream Channel ID

To assign a numeric channel ID to the downstream port on the Cisco cable interface line card, use the following command in cable interface configuration mode.

```
Router(config-if)# cable downstream channel-id id
```



**Note** For Cisco IOS Release 12.2(33)SCB and later releases, the acceptable range is 1 to 255 (0 is reserved for network management) and for releases prior to Cisco IOS Release 12.2(33)SCB, the acceptable range is 0 to 255.



**Note** The **cable downstream channel-id** command must be used with the following command:  
 cable downstream frequency 54000000-1000000000 broadcast frequency - h

These commands are used in instances where you want to send multiple downstream frequencies to a single region that contains CMs that can connect only to upstream ports on the same cable interface line card. You must configure unique channel IDs for each downstream that any CM is capable of receiving. The downstream frequency setting must match the setting on the upconverter.



**Caution** After defining unique downstream IDs, test the CMs for correct operation. Cisco recommends that when using this feature, you re-test each subsequent software release of CM code to verify correct operation and to ensure reasonable acquisition time for new installations. Failure to use these commands in conjunction or to test the involved CMs can result in customer service outages of indefinite duration.

## Verifying the Downstream Channel ID

To verify the downstream channel ID, enter the **show controllers cable** command for the downstream port you have just configured. See the following example:

```
Router# show controllers cable5/0 downstream

Cable5/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
Downstream channel ID: 1
```

## Traffic Shaping

Traffic shaping basically uses queues to limit data surges that can congest a network. The data is buffered and then sent into the network in regulated amounts to ensure that the traffic fits within the expected traffic envelope for the particular connection.

Traffic shaping reduces the chance that information must be retransmitted to hosts on the cable plant. When cable modems (CMs) have rate limits established, the CMTS typically drops data packets to enforce the rate limit. Dropping packets from the requesting CM causes the host sending the information to retransmit its information, which wastes bandwidth on the network. If both hosts sending and requesting information are on the cable plant, the upstream bandwidth is wasted as well.

Traffic shaping allows the CMTS to perform upstream and downstream rate limiting on the DOCSIS upstream and downstream channels. Rate limiting restricts the data rate to and from a CM; the MAC scheduler supports traffic-shaping capabilities for downstream and upstream traffic. Rate limiting ensures that no single CM consumes all of the channel bandwidth and allows a CMTS administrator to configure different maximum data rates for different subscribers. Subscribers requiring higher sustained rates and willing to pay for higher rates can be configured with higher sustained rate limits in their CM DOCSIS configuration file over regular subscribers, who pay less and get lower rate limits.

Each time a packet belonging to a flow is transmitted on an output channel, the token-bucket policer function checks the rate limit status of the flow, passing the following parameters:

- Token bucket maximum sustained rate in bits per millisecond.
- Token bucket depth (maximum transmit burst) in bits.
- Length of current packet to be sent in bits.
- Pointer to the flow's token bucket.
- Pointer to the flow's token bucket last update time stamp.
- Variable to return the milliseconds buffering delay in case the packet needs to be shaped.
- Maximum buffering delay that the subsequent traffic shaper can handle in milliseconds.

Every flow has its own shaping buffer where rate-exceeded packets are typically held back in first-in/first-out (FIFO) order for later releases transmission.

**Tip**

---

Token bucket policing with shaping is the per-upstream default rate limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

---

## Downstream Traffic Shaping

The CMTS supports basic downstream traffic shaping by effecting data rate limiting on a per-modem basis. A downstream traffic shaping feature called downstream rate limiting with type of service (ToS) bits extends that capability by allowing the CMTS administrator to configure the ToS byte to calculate the data rate for a specified flow.

Downstream rate limiting with ToS bits enables you to partition downstream traffic for a CM into multiple classes of service and multiple data rates by using the three precedence bits in the ToS byte in the IP header

to specify a class of service assignment for each packet. Those packets with the precedence bit set in the ToS field are given higher priority. Using the ToS byte, you can calculate the data rate for a specified flow, in addition to the data rate configured on a per-CM basis. By specifying a maximum data rate for a particular ToS, you can override the common maximum downstream data rate.

The administrator can override the maximum common downstream data rate limits by configuring the ToS byte.

Packets that contain ToS bytes that have not been configured for downstream data rates continue to use the common data rate limits.

## Configuring Downstream Rate Limiting and Traffic Shaping

To configure downstream traffic shaping, use the following command in cable interface configuration mode.

Command	Purpose
<pre>Router(config-if)# [no] cable downstream rate-limit token-bucket [shaping] weighted-discard [expwt &lt;n&gt;]</pre>	Enables or disables rate limiting and traffic shaping on the downstream of a cable interface.



**Note** Using Cisco IOS Release 12.0(5)T1 or higher, the software adds downstream calendar queuing routines and grant shaping application of the calendar queues.



**Note** Effective with Cisco IOS Release 12.2(33)SCF, the **cable downstream rate-limit** command is not supported for Cisco uBR-MC88U line card in Cisco IOS software.

Details for key command usage are provided below:

- To enable rate limiting on the given downstream port using the token bucket policing algorithm, issue the **cable downstream rate-limit token-bucket** command.
- To enable rate limiting on the given downstream port using the token bucket policing algorithm with traffic shaping, issue the **cable downstream rate-limit token-bucket shaping** command.
- To enable rate limiting on the given downstream port using the token bucket policing algorithm with a specific traffic shaping time granularity, issue the **cable downstream rate-limit token-bucket shaping granularity 8** command. Acceptable values are 1, 2, 4, 8, or 16 msec.
- To enable rate limiting on the given downstream port using the token bucket policing algorithm with a specific maximum traffic shaping buffering delay, issue the **cable downstream rate-limit token-bucket shaping granularity 8** command. Acceptable values are 128, 256, 512, or 1028 msec.
- To remove rate limiting on the given downstream port, issue the **cable downstream rate-limit token-bucket** command.
- To enable rate limiting on the given downstream port using a weighted packet discard policing algorithm and to assign a weight for the exponential moving average of loss rate value, issue the **cable downstream rate-limit weighted-discard 3** command. Acceptable values are 1 to 4.

## Setting the Downstream Helper Address

Specify an IP address of a Dynamic Host Configuration Protocol (DHCP) server where User Datagram Protocol (UDP) broadcast packets will be sent. You can specify a DHCP server for UDP broadcast packets from cable interfaces, and a DHCP server for UDP broadcast packets from hosts. To set a downstream helper address, use the following commands in cable interface configuration mode.

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<b>cable helper-address 10.x.x.x cable-modem</b>  <b>Example:</b> Router(config-if)# <b>cable helper-address 10.x.x.x cable-modem</b>	Set the downstream helper address to the DHCP server at IP address 10.x.x.x for UDP broadcast packets from cable modems.  <b>Note</b> Use the IP address of the DHCP server. Both 10.x.x.x and 172.56.x.x are private ranges.
<b>Step 2</b>	<b>cable helper-address 172.56.x.x host</b>  <b>Example:</b> Router(config-if)# <b>cable helper-address 172.56.x.x host</b>	Set the downstream helper address to the DHCP server at IP address 172.56.x.x for UDP broadcast packets from hosts.

## Verifying the Downstream Helper Address

To verify the downstream helper address setting, enter the **show running-config** command and look for cable helper-address in the cable interface configuration information:

```
Router# show running-config

Building configuration...
Current configuration:
!
interface cable5/0
ip address 10.254.254.254 255.0.0.0
 no ip directed-broadcast
 cable helper-address 192.168.1.1
 no keepalive
```

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Check the cables, upconverters, RF levels, and frequencies if the cable interfaces do not find a downstream signal.
  - Step 2** Check the cables, RF levels, and upstream frequencies, and enter a no shut command if the cable interfaces find a downstream signal, but not an upstream signal.
  - Step 3** Check the provisioning servers.
    - Ping the DHCP server using the source IP address option—the primary IP address of a cable interface.
    - Check IP routing if the cable interfaces acquire an RF upstream and downstream lock, but do not stay up.

**Step 4** Check DHCP options and the IP address of the Time-of-Day (ToD) server:

- Ping the ToD server using the source IP address option.
- Check IP routing.
- Verify that the TFTP filename is correct.
- Verify that the TFTP file is in the correct directory on the TFTP server.
- Ensure that the TFTP file has read privileges.
- Ping the TFTP server using the source IP address option, and check IP routing if the cable interfaces acquire an RF and a DHCP, but fail on ToD or TFTP.

## Setting the Downstream Interleave Depth

Set the interleave depth for the downstream port on the Cisco cable interface line card. A higher interleave depth provides more protection from bursts of noise on the HFC network; however, it increases downstream latency.



**Note** The valid values are 8, 16, 32 (default), 64, and 128.

To set the downstream interleave depth in milliseconds, use the following command in cable interface configuration mode:

```
Router(config-if)# cable downstream interleave-depth {8 | 16 | 32 | 64 | 128}
```

## Verifying the Downstream Interleave Depth

To verify the downstream interleave depth setting, enter the **show controllers cable** command for the downstream port you have just configured:

```
Router# show controllers cable5/0 downstream
```

```
Cable5/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=
```



Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that the downstream carrier is active, using the **cable downstream if-output** command.
- 

## Setting the Downstream Modulation

To set the downstream modulation, define the speed in symbols per second at which data travels downstream to the subscriber's CM. A symbol is the basic unit of modulation. Quadrature Phase Shift Key (QPSK) encodes 2 bits per symbol, Quadrature Amplitude Modulation (QAM) -16 encodes 4 bits per symbol, QAM-64 encodes 6 bits per symbol, and QAM-256 encodes 8 bits per symbol.

**Note**

Setting a downstream modulation rate of QAM-256 requires approximately a 6 dB higher signal-to-noise ratio (SNR) than QAM-64 at the subscriber's cable interface. If your network is marginal or unreliable at QAM-256, use the QAM-64 format instead. Also, consider the significance of your data.

To set the downstream modulation, use the following command in cable interface configuration mode. The standard DOCSIS modulation rate (and the Cisco default) is QAM-64.

```
Router(config-if)# cable downstream modulation 64qam
```

## Verifying the Downstream Modulation

To verify the downstream modulation setting, enter the **show controllers cable** command for the downstream port you have just configured. See the following example:

```
Router# show controllers cable5/0 downstream
```

```
Cable5/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers
  - Step 5** Verify that the downstream carrier is active, using the **cable downstream if-output** command
  - Step 6** Verify that you have selected the default if you are not certain about the modulation rate needed.
- 

## Setting the Downstream MPEG Framing Format

The MPEG framing format must be compatible with DOCSIS specifications at: <http://www.cablelabs.com/cablemodem/> and your local cable plant operations.



**Tip**

Annex B is the DOCSIS MPEG framing format standard for North America.



**Note**

Annex B framing format is automatically set when configuring Cisco cable interface line cards. The cable interface line card's downstream ports and the connected CMs on the network must be set to the same MPEG framing format and must support DOCSIS operations as appropriate.

The following command appears in the Cisco uBR7200 series router configuration file to designate Annex B operation. This command sets the downstream MPEG framing format.

```
Router(config-if)# cable downstream annex {B}
```

## Verifying the Downstream MPEG Framing Format

To verify the downstream MPEG framing format setting, enter the **show controllers cable** command for the downstream port you have just configured. See the following example:

```
Router# show controllers cable5/0 downstream

Cable5/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
Downstream channel ID: 1
```

## Setting Downstream Traffic Shaping

Downstream traffic shaping enables you to use the token bucket policing algorithm with traffic shaping options or the weighted discard algorithm to buffer, shape, or discard packets that exceed a set bandwidth. Downstream traffic shaping is disabled by default.

To enable downstream traffic shaping for a downstream port on a Cisco cable interface line card, use one of the following commands in cable interface configuration mode.

## DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<p><b>cable downstream rate-limit token-bucket</b> [shaping [ granularity msec   max-delay msec]</p> <p><b>Example:</b> Router(config-if)# <b>cable downstream rate-limit token-bucket</b></p> <p>Router(config-if)# <b>cable downstream rate-limit token-bucket shaping</b></p> <p>Router(config-if)# <b>cable downstream rate-limit token-bucket shaping granularity 8</b></p> <p>Router(config-if)# <b>cable downstream rate-limit token-bucket shaping max-delay 256</b></p>	<p>Enables traffic shaping on the downstream port using the token bucket policing algorithm. With this command, the Cisco uBR7200 series router automatically drops packets that are in violation of the allowable bandwidth.</p> <p>Enables traffic shaping on the downstream port using the token bucket policing algorithm with traffic shaping.</p> <p>Enables traffic shaping on the downstream port using the token bucket policing algorithm with specific traffic shaping time granularity. Acceptable values are 1, 2, 4, 8, or 16 milliseconds.</p> <p>Enables traffic shaping on the downstream port using the token bucket policing algorithm with specific maximum traffic shaping buffering delay. Acceptable values are 128, 256, 512, or 1028 milliseconds.</p>
<b>Step 2</b>	<p><b>cable downstream rate-limit weighted-discard</b> <i>exp-weight</i></p> <p><b>Example:</b> Router(config-if)# <b>cable downstream rate-limit weighted-discard 3</b></p>	<p>Enables traffic shaping on the downstream port using the weighted discard algorithm and assigns a weight for the exponential moving average of the loss rate. Acceptable values are 1 to 4.</p>
<b>Step 3</b>	<p><b>end</b></p> <p><b>Example:</b> Router(config-if)# <b>end</b></p>	<p>Exits back to privileged EXEC mode so that you can verify the steps.</p>

## Verifying Downstream Traffic Shaping

To determine if downstream traffic shaping is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If downstream traffic shaping is configured and enabled, a traffic shaping entry appears in the output. If downstream traffic shaping is disabled, no traffic shaping entry appears.

```
Router# show running-config
Building configuration...
Current configuration:
!
interface cable5/0
ip address 10.254.254.254 255.0.0.0
no ip directed-broadcast
cable helper-address 192.168.1.1
no keepalive
cable downstream annex B
cable downstream modulation 64qam
```

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you selected the default if you are not certain about the modulation rate needed.
  - Step 6** Verify that the downstream carrier is active using the **cable downstream if-output** command.
- 

## Activating Host-to-Host Communication (Proxy ARP)

Cable proxy ARP allows a Cisco CMTS router to issue cable ARP requests on behalf of CMs on the same cable network subnet.



**Note** Because the downstream and upstreams are separate interfaces, modems cannot directly perform ARP with other modems on the cable plant.



**Note** The default values for the commands used in this configuration task are adequate in most cases to configure the Cisco CMTS routers.

## Activating Cable Proxy ARP Requests

This configuration is optional. To activate cable proxy ARP for host-to-host communications, use the following command in cable interface configuration mode.

Command	Purpose
Router(config-if)# <b>cable proxy-arp</b>	Enables proxy ARP on the cable interface. This is the default.

## Verifying Cable Proxy ARP Requests

To verify if cable proxy ARP has been activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If cable proxy ARP has been activated,

it does not appear in the output. If cable proxy ARP has been deactivated, it appears in the output as no cable proxy-arp.

```
Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable proxy-arp
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown
```

**Tip**

If you are having difficulty with verification, make sure that you entered the correct port and cable interface line card slot number when you activated cable proxy ARP.

## Activating Packet Intercept Capabilities

This configuration is optional. To activate packet intercept functionality, use the following commands in cable interface configuration mode.

Command	Purpose
Router(config-if)# <b>cable intercept</b> xxx.xxx.xxx	Specifies a MAC address on the cable network for which interception capabilities are to be activated. There is a limit of 10 MAC addresses.
Router(config-if)# <b>no cable intercept</b> xxx.xxx.xxx	Disables interception after it is enabled.

## Configuring Payload Header Suppression and Restoration

This configuration is optional. Payload Header Suppression (PHS) is a new feature in the DOCSIS1.1 MAC driver. The PHS feature is used to suppress repetitive or redundant portions in packet headers before transmission on the DOCSIS link. The upstream receive driver is now capable of restoring headers suppressed

by CMs, and the downstream driver is capable of suppressing specific fields in the packet header before forwarding the frame to the CM.

Command	Purpose
<code>show interface cable x/0/0 service-flow [sfid] phs</code>	Displays cable interface information.
<code>debug cable error</code>	Displays errors that occur in the cable MAC protocols. To disable debugging output, use the no form of the command.
<code>debug cable phs</code>	Displays the activities of the PHS and restoration driver. The no form of this command disables debugging output.

## Setting Optional Broadcast and Cable IP Multicast Echo

This configuration is optional. You can set additional IP parameters to enable downstream echoing of upstream data. This section contains two procedures to configure these optional IP parameters:



### Note

The default values for the commands used in these configuration steps are adequate in most cases to configure the Cisco CMTS routers.

## Setting IP Multicast Echo

The Cisco uBR10012 router echoes IP multicast packets by default. To activate IP multicast echo if it has been previously disabled, use the following command in cable interface configuration mode.

Command	Purpose
<code>Router(config-if)# cable ip-multicast-echo</code>	Enables IP multicast echo. This is the default.

To disable IP multicast echo, enter the **no cable ip-multicast-echo** command in cable interface configuration mode.

## Verifying IP Multicast Echo

To determine whether IP multicast echo is activated or deactivated, enter the **more system:running-config** command, and look for the cable interface configuration information. If IP multicast echo is activated, there is no notation in the output, because this is the default setting. If IP multicast echo is deactivated, a notation appears in the output:

```
Router# more system:running-config
```

```

Building configuration...

Current configuration:
!
interface cable5/0/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable ip-multicast-echo
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown

```

**Tip**

If you are having difficulty with verification, make sure that you entered the correct slot and port numbers when you entered cable interface configuration mode.

## Access Lists and the cable ip-multicast echo Command

The **cable ip-multicast-echo** command is enabled by default on the Cisco CMTS routers, so that multicast IP packets that arrive on the upstream at the Cisco CMTS are forwarded on the appropriate downstream ports so that they are delivered to the other CMs and CPE devices on that segment of the network. This allows the cable network to behave like a standard Ethernet network in terms of its handling of multicast IP traffic.

However, on the Cisco uBR10012 router, input access lists are not applied to the multicast traffic that is echoed on each downstream. To control the echoed multicast traffic, you therefore need to configure an output access list and apply it to each downstream interface.

Refer to the *Cisco IOS CMTS Cable Command Reference Guide* on Cisco.com for additional information on access lists and multicast echo:

[http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl\\_book.html](http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html)

## Setting IP Broadcast Echo

By default, the Cisco uBR10012 router does not echo IP broadcast packets. To activate IP broadcast echo, use the following command in cable interface configuration mode.

Command	Purpose
Router (config-if)# <b>cable ip-broadcast-echo</b>	Enables IP broadcast echo.

To disable IP broadcast echo when it is enabled, enter the **no cable ip-broadcast-echo** command in cable interface configuration mode.

## Verifying IP Broadcast Echo

To determine whether IP broadcast echo is activated or deactivated, enter the **more system:running-config** command and look for a notation in the cable interface configuration information:

```
Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0/0

ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable ip-broadcast-echo
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown
```

## Cable Interface Configuration Examples

This section provides the following configuration examples:

### Example: Subinterface Configuration

The following example shows how to define a subinterface on the cable5/0/0:

```
interface cable5/0/0
! No IP address
! MAC level configuration only

! first subinterface
interface cable5/0/0.1
description Management Subinterface
ip address 10.255.1.1 255.255.255.0
cable helper-address 10.151.129.2

! second subinterface
interface cable5/0/0.2
ip address 10.279.4.2 255.255.255.0
cable helper-address 10.151.129.2

! third subinterface
interface cable5/0/0.3
ip address 10.254.5.2 255.255.255.0
cable helper-address 10.151.129.2
```

### Example: Cable Interface Bundling

The following example shows how to bundle a group of physical interfaces. In this example, the interfaces int c5/0/0 and int c4/0 are bundled.

```
int c5/0/0
ip address 209.165.200.225 255.255.255.0
ip address 209.165.201.1 255.255.255.0 secondary
```



```

cable helper-address 10.5.1.5
! MAC level configuration
cable bundle 1 master
int c4/0/0
! No IP address
! MAC layer configuration only
cable bundle 1

```

## Example: Subinterface Definition on Bundle Master

The following example shows how to define subinterfaces on a bundle master and define Layer 3 configurations for each subinterface. In this example, the interfaces int c5/0/0 and int c4/0/0 are bundled.

```

int c5/0/0
! No IP address
! MAC level configuration only
cable bundle 1 master

int c4/0/0
! No IP address
! MAC layer configuration
cable bundle 1

! first subinterface
int c5/0/0.1
ip address 10.22.64.0 255.255.255.0
cable helper-address 10.4.1.2

! second subinterface
int c5/0/0.2
ip address 10.12.39.0 255.255.255.0
cable helper-address 10.4.1.2

! third subinterface
int c5/0/0.3
ip address 10.96.3.0 255.255.255.0
cable helper-address 10.4.1.2

```

## Example: Cable Interface Bundle Master Configuration

The following example shows how to configure cable interface bundles:

```

Displaying the contents of the bundle
Router(config-if)# cable bundle ?
  <1-255> Bundle number
Router(config-if)# cable bundle 25 ?
  master Bundle master
  <cr>
Router(config-if)# cable bundle 25 master ?
  <cr>
Router(config-if)# cable bundle 25 master
Router(config-if)#
07:28:17: %uBR10000-5-UPDOWN: Interface Cable5/0/0 Port U0, changed state to down
07:28:18: %uBR10000-5-UPDOWN: Interface Cable5/0/0 Port U0, changed state to up

```

## Example: PE Router Configuration

This example (system information display) identifies the version of Cisco IOS software installed and displays PE configurations:

```

! Defines the hostname of the Cisco uBR10012

```

```

hostname region-1-ubr
!
! Describes where the system is getting the software image it is running. In
! this configuration example, the system is loading a Cisco uBR10012 image named
! AdamSpecial from slot 0.
boot system flash slot0:uBR10000-p-mz.AdamSpecial
!
! Creates the enable secret password.
enable secret xxxx
enable password xxxx
!
! Sets QoS per modem for the cable plant.
no cable qos permission create
no cable qos permission update
cable qos permission modems
!
! Allows the system to use a full range of IP addresses, including subnet zero, for
! interface addresses and routing updates.
ip subnet-zero
!
! Enables Cisco Express Forwarding.
ip cef
!
! Configures a Cisco IOS Dynamic Host Configuration Protocol (DHCP) server to insert the
! DHCP relay agent information option in forwarded BOOTREQUEST messages.
ip dhcp relay information option
!
! Enters the virtual routing forwarding (VRF) configuration mode and maps a VRF table to
! the virtual private network (VPN) called MGMT-VPN. The VRF table contains the set of
! routes that points to or gives routes to the CNR device, which provisions the cable
! modem devices. Each VRF table defines a path through the MPLS cloud.
ip vrf MGMT-VPN
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
rd 100:1
!
! Creates a list of import and/or export route target communities for the VPN.
route-target export 100:2
route-target export 100:3
!
! Maps a VRF table to the VPN called ISP1-VPN.
ip vrf ISP1-VPN
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
rd 100:2
!
! Creates a list of import and/or export route target communities for the VPN.
route-target import 100:1
!
! Maps a VRF table to the VPN called ISP2-VPN.
ip vrf ISP2-VPN
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
rd 100:3
!
! Creates a list of import and/or export route target communities for the VPN.
route-target import 100:1
!
! Maps a VRF table to the VPN called MSO-isp. Note: MSO-isp could be considered ISP-3; in
! this case, the MSO is competing with other ISPs for other ISP services.
ip vrf MSO-isp
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
rd 100:4
!
! Creates a list of import and/or export route target communities for the VPN.
route-target import 100:1
!
! Builds a loopback interface to be used with MPLS and BGP; creating a loopback interface

```

```

! eliminates unnecessary updates (caused by physical interfaces going up and down) from
! flooding the network.
interface Loopback0
 ip address 10.0.0.0 255.255.255.0
 no ip directed-broadcast
!
! Assigns an IP address to this Fast Ethernet interface. MPLS tag-switching must be
! enabled on this interface.
interface FastEthernet0/0/0
 description Connection to MSO core.
 ip address 10.0.0.0 255.255.255.0
 no ip directed-broadcast
 full-duplex
 tag-switching ip
!
! Enters cable interface configuration mode and configures the physical aspects of the
! 5/0/0 cable interface. Please note that no IP addresses are assigned to this interface;
! they will be assigned instead to the logical subinterfaces. All other commands for
! this cable interface should be configured to meet the specific needs of your cable RF
! plant and cable network.
interface Cable5/0/0
 no ip address
 ip directed-broadcast
 no ip mroute-cache
 load-interval 30
 no keepalive
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 855000000
 cable upstream 0 frequency 30000000
 cable upstream 0 power-level 0
 no cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 cable upstream 4 shutdown
 cable upstream 5 shutdown
!
! Configures the physical aspects of the 5/0/0.1 cable subinterface. If cable modems have
! not been assigned IP addresses, they will automatically come on-line using the settings
! for subinterface X.1.
interface Cable5/0/0.1
 description Cable Administration Network
!
! Associates this interface with the VRF and MPLS VPNs that connect to the MSO cable
! network registrar (CNR). The CNR provides cable modems with IP addresses and other
! initialization parameters.
 ip vrf forwarding MSO
!
! Defines a range of IP addresses and masks to be assigned to cable modems not yet associated
! with an ISP.
 ip address 10.0.0.0 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
 no ip directed-broadcast
!
! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
 cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PCs that are not yet associated with an ISP.
 cable helper-address 10.4.1.2 host
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
 no cable proxy-arp
 no cable ip-multicast-echo
!
! Configures the physical aspects of the 5/0/0.2 cable subinterface.
interface Cable5/0/0.2
 description MSO as ISP Network
!

```

```

! Assigns this subinterface to the MPLS VPN used by the MSO to supply service to
! customers—in this case, MSO-isp.
ip vrf forwarding MSO-isp
!
! Defines a range of IP addresses and masks to be assigned to cable modems associated
! with the MSO as ISP network.
ip address 10.1.0.0 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
ip address 10.1.0.0 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
no ip directed-broadcast
!
! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PC host devices.
cable helper-address 10.4.1.2 host
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
no cable proxy-arp
no cable ip-multicast-echo
!
! Configures the physical aspects of the 5/0.3 cable subinterface
interface Cable5/0/0.3
description ISP1's Network
!
! Makes this subinterface a member of the MPLS VPN.
ip vrf forwarding ispl
!
! Defines a range of IP addresses and masks to be assigned to cable modems associated
! with the MSO as ISP network.
ip address 10.1.1.1 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
ip address 10.0.1.1 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
no ip directed-broadcast
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
no cable proxy-arp
no cable ip-multicast-echo
!
! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PC host devices.
cable helper-address 10.4.1.2 host
!
! Configures the physical aspects of the 5/0/0.4 cable subinterface
interface Cable5/0/0.4
description ISP2's Network
!
! Makes this subinterface a member of the MPLS VPN.
ip vrf forwarding isp2
!
! Defines a range of IP addresses and masks to be assigned to cable modems associated
! with the MSO as ISP network.
ip address 10.1.2.1 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
ip address 10.0.1.1 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.

```

```

no ip directed-broadcast
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
no cable proxy-arp
no cable ip-multicast-echo
!
!
cable dhcp-giaddr policy
!
!! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PC host devices.
cable helper-address 10.4.1.2 host
!
!
end

```

## Example: Router Configuration

This example (system information display) identifies the version of Cisco IOS software installed and displays PE configurations:

```

Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname R7460-7206-02
!
enable password xxxx
!
ip subnet-zero
ip cef
ip host brios 223.255.254.253
!
interface Loopback0
 ip address 10.2.1.3 255.255.255.0
 no ip directed-broadcast
!
interface Loopback1
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
!
interface FastEthernet0/0/0
 ip address 1.7.108.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 shutdown
 full-duplex
 no cdp enable
!
router ospf 222
 network 10.0.1.0 255.255.255.0 area 0
 network 10.0.2.0 255.255.255.0 area 0
 network 10.0.3.0 255.255.255.0 area 0
 network 10.0.4.0 255.255.255.0 area 0
 network 20.2.1.3 255.255.255.0 area 0
!
ip classless
no ip http server
!
!

```

```

map-list test-b
no cdp run
!
tftp-server slot0:master/120/ubr10k-p6-mz.122-2.XF
!
line con 0
  exec-timeout 0 0
  password xxxx
  login
  transport input none
line aux 0
line vty 0 4
  password xxxx
  login
!
no scheduler max-task-time
end

```

## Example: Configuring BGP Routing Sessions

To configure BGP routing sessions in a provider network, use the following commands in router configuration mode on the PE router:

---

**Step 1** Configure the BGP routing process with the autonomous system number:

**Example:**

```
Router(config)# router bgp 42
```

**Step 2** Specify a neighbor's IP address or BGP peer group, identifying it to the local autonomous system:

**Example:**

```
Router(config-router)# neighbor 200.28.28.40
Activate the advertisement of the IPv4address family.
Router(config-router)# neighbor 200.28.28.40 activate
```

---

## Example: Configuring PE-to-PE Routing Sessions

To configure PE-to-PE routing sessions in a provider network, use the following commands in router configuration mode on the PE router:

---

**Step 1** Define internal Border Gateway Protocol (iBGP) parameters for VPNv4 network-layer reachability information (NLRI) exchange:

**Example:**

```
Router(config-router)# address-family vpnv4 unicast
```

**Step 2** Define an iBGP session to exchange VPNv4 NLRIs:

```
Router(config-router)# neighbor <neighbor IP> activate
```

**Example:**

```
Router(config-router-af) # neighbor 200.28.28.45 remote-as 48
Router(config-router-af) # exit
```

**Step 3** Activate the advertisement of the IPv4 address family:

**Example:**

```
Router(config-router) # neighbor 200.28.28.45 activate
```

---

## Example: Configuring BGP PE-to-CE Routing Sessions

To configure BGP PE-to-CE routing sessions, use the following commands in router configuration mode on the PE router:

**Step 1** Define external Border Gateway Protocol (eBGP) parameters for PE-to-CE routing sessions:

**Example:**

```
Router(config-router) # address-family ipv4 unicast vrf
go_fast_internet_company
```

**Step 2** Define an eBGP session between PE and CE routers and activate the advertisement of the IPv4 address family:

**Example:**

```
Router(config-router-af) # neighbor 200.28.28.46 remote-as 49
Router(config-router-af) # neighbor 200.28.28.46 activate
```

---

## Example: Configuring RIP PE-to-CE Routing Sessions

To configure RIP PE-to-CE routing sessions, use the following commands in router configuration mode on the PE router:

Enable RIP, define RIP parameters for PE-to-CE routing sessions, and enable RIP on the PE-to-CE link:

**Example:**

```
Router(config) # router rip
Router(config-router) # address-family ipv4 unicast vrf
go_fast_internet_company
Router(config-router-af) # network 200.28.28.47
```

---

## Example: Configuring Static Route PE-to-CE Routing Sessions

To configure static route PE-to-CE routing sessions, use the following commands in router configuration mode on the PE router:

---

**Step 1** Define static route parameters for each PE-to-CE session and for each BGP PE-to-CE routing session.

**Example:**

```
Router(config)# ip route vrf go_fast_internet_company 200.28.28.46
255.255.255.0 200.28.28.50
Router(config-router)# address-family ipv4 unicast vrf
go_fast_internet_company
```

**Step 2** Redistribute VRF static routes and directly connected networks into the VRF BGP table.

**Example:**

```
Router(config-router-af)# redistribute static
Router(config-router-af)# redistribute static connected
```

---





# Configuring Upstream Cable Interface Features on the Cisco CMTS Routers

---

**First Published:** February 14, 2008

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**Note**

Cisco IOS Release 12.2(33)SCA and later releases integrate support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

The cable interface in the Cisco universal broadband router supports downstream and upstream signals, and serves as the cable TV radio frequency (RF) interface. The downstream signal is output as an intermediate-frequency (IF) signal suitable for use with an external upconverter. Your cable plant, combined with your planned and installed subscriber base, service offering, and external network connections, determines the combination of cable interfaces, network uplink line cards, and other components that you should use.

The Cisco IOS software command-line interface (CLI) can be used to configure the Cisco cable interface line card for correct operation on the hybrid fiber-coaxial (HFC) cable network. This chapter provides a configuration summary for the various upstream cable interface features available on a Cisco CMTS router. Details about some of these features can be found in other chapters of this book.



**Note**

The configuration commands and examples in this chapter may show slot numbering or references to either Cisco uBR7200 series or Cisco uBR10012 Universal Broadband Routers. However, the features can be configured on either platform. Use the slot numbering appropriate for your CMTS router configuration.

## 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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# Prerequisites for Configuring Upstream Cable Interfaces on the Cisco CMTS Routers

The configuration of upstream cable interface features is supported on the Cisco CMTS routers in Cisco IOS Release 12.3BC and Cisco IOS Release 12.2SC. The table below shows the hardware compatibility prerequisites for this feature.



---

**Note**

The hardware components introduced in a given Cisco IOS Release will be supported in all subsequent releases unless otherwise specified.

---

**Table 4: Configuring Upstream Cable Interfaces on the Cisco CMTS Routers Hardware Compatibility Matrix**

Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• PRE2</li> </ul> Cisco IOS Release 12.2(33)SCC <ul style="list-style-type: none"> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> </ul> Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul> Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>4</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>5</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>4</sup> Cisco uBR-MC3GX60V cable interface line card is not compatible with PRE2.

<sup>5</sup> Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2.

## Prioritizing Upstream Traffic to Initialize Cable Modems

When the Cisco CMTS is busy servicing data and bandwidth requests from a large number of online cable modems, it may deny new registration requests from offline cable modems. This denial of service occurs

because when a cable modem first begins initializing, its default upstream service flow is assigned a quality of service (QoS) profile-2 with a priority of zero. Zero is the lowest priority that can be scheduled. Depending on the priority and rate of bandwidth requests from other online cable modems, the priority-zero queue can either overflow or get ignored.

To ensure that the initializing cable modems can get online when a large number of online cable modems are actively transmitting data, the Cisco CMTS must allow the bandwidth request from an initializing cable modem to get priority over those requests from online cable modems.

In Cisco IOS Release 12.2(33)SCD2 and later releases, an operator can configure the priority of QoS profile-2 to a higher value.

## Configuring the Priority of the QoS Profile

This configuration is optional. This section describes how you can manually configure a non-zero value for the QoS profile-2 priority to ensure that initialization requests from offline cable modems are serviced.



**Note** It is up to the cable operator to determine the appropriate new priority value.

### DETAILED STEPS

	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 qos pre-registration us-priority</b> <i>priority-value</i>  <b>Example:</b> Router(config)# <b>cable qos</b> <b>pre-registration us-priority 2</b>	Sets the priority of the QoS profile-2 of the initializing cable modem.  <b>Note</b> The valid priority value range is 0 to 7 where 0 is the default value.  <ul style="list-style-type: none"> <li>• <b>us-priority</b>—Specifies the upstream priority to be assigned to the pre-registration traffic.</li> <li>• <b>priority-value</b>—User-defined priority value for the QoS profile-2.</li> </ul>
<b>Step 4</b>	<b>end</b>  <b>Example:</b> Router(config)# <b>end</b>	Exits global configuration mode.

After a cable modem has successfully completed registration, the QoS profile of the default upstream service flow is changed from QoS profile-2 to the QoS indicated through the DOCSIS configuration file.

### What to Do Next

To determine if the priority of the QoS profile-2 is configured, enter the **show cable qos profile** command in privileged EXEC mode.

```
Router# show cable qos profile
```

```

ID  Prio Max          Guarantee Max          Max  TOS  TOS  Create  B  IP  prec.
      upstream upstream  downstream tx  AND  OR  by  priv  rate
      bandwidth bandwidth bandwidth burst mask mask  cmts(r) enab enab
1    0    0              0              0      0  0xFF 0x0  cmts(r) no  no
2    2   64000         0              1000000  0  0xFF 0x0  cmts(r) no  no
3    7   31200         31200         0        0  0xFF 0x0  cmts   yes  no
4    7   87200         87200         0        0  0xFF 0x0  cmts   yes  no
Router#
```

The **Prio** column in the **ID 2** displays the user-defined value of the QoS profile-2.

## Activating the Upstream Minimum Reserved Traffic Rate Plus Excess Traffic Rate

This configuration is optional. Each service flow (SF) carries traffic based on certain defined parameters. One of them is the minimum reserved traffic rate.

The minimum reserved traffic rate specifies the minimum traffic rate, in bits/sec, reserved for a service flow. The value of minimum reserved traffic rate is calculated from the byte following the MAC header check sequence (HCS) to the end of the cyclic redundancy check (CRC), including every protocol data unit (PDU) in a concatenated MAC frame. If this parameter is omitted, then it defaults to a value of 0 bits/sec (that is, no bandwidth is reserved for the flow by default).

The Cisco CMTS schedules forwarding traffic of all service flows such that each flow receives at least its minimum reserved traffic rate when transmitting packets with the assumed minimum reserved rate packet size. If the service flow requests less bandwidth than its minimum reserved traffic rate, the Cisco CMTS reallocates the excess reserved bandwidth for other purposes. All best effort service flows with or without their minimum reserved traffic rate configured, share the excess bandwidth.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router# <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<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 rate-limit-algorithm min-plus-excess</b>  <b>Example:</b> Router(config)# <b>cable rate-limit-algorithm min-plus-excess</b>	Enables a service flow to receive its configured minimum reserved traffic rate plus the expected excess traffic rate bandwidth.
<b>Step 4</b>	<b>end</b>  <b>Example:</b> Router(config)# <b>end</b>	Exits global configuration mode.

### What to Do Next

To verify if the upstream min-plus-excess parameter is configured and activated, run the **show interface cable mac-scheduler** and the **show interface cable service flow** commands in privileged EXEC mode.

```
Router# show interface cable 8/0/0 mac-scheduler 0 |include rate
DOCSIS 1.1 MAC scheduler for Cable8/0/0/U0: rate 10240000

Router# show interface cable 8/0/0 service-flow qos us

Sfid  Dir  Curr  Sid  Sched  Prio  MaxSusRate  MaxBrst  MinRsvRate  Through
      State
7     US  act   1    BE    0    2000000    28000    500000     856051
134   US  act   120  BE    0    2000000    11000    0           403840
9     US  act   2    BE    0    2000000    28000    500000     856176
129   US  act   115  BE    0    2000000    11000    0           402647
11    US  act   3    BE    0    2000000    28000    500000     856019
132   US  act   118  BE    0    2000000    11000    0           402751
13    US  act   4    BE    0    2000000    28000    500000     856394
131   US  act   117  BE    0    2000000    11000    0           402754
15    US  act   5    BE    0    2000000    28000    500000     855977
135   US  act   121  BE    0    2000000    11000    0           403808
17    US  act   6    BE    0    2000000    28000    500000     685510
133   US  act   119  BE    0    2000000    11000    0           341456
25    US  act   13   BE    0    2000000    28000    500000     855598
130   US  act   116  BE    0    2000000    11000    0           403870
Router#
```

## Activating Upstream Admission Control

Upstream admission control tallies up the total amount of guaranteed minimum upstream throughput reserved by CMs on an upstream interface. When the total exceeds an allowable level, no more CMs requiring a guaranteed minimum upstream rate are allowed online on that upstream port.

The Cisco CMTS upstream admission control is turned off by default and must be activated. To set the upstream admission control as a percentage of the upstream channel capacity, use the following command in cable interface configuration mode. The admission control is set as a percentage of the specified upstream channel capacity. The acceptable range is from 10 to 1000 percent.

```
Router(config-if)# cable upstream usport admission-control percentage
```

For example:

```
Router(config-if)# cable upstream 0 admission-control ?
Max Reservation Limit As Percentage of Raw Channel Capacity
```



**Note**

If *percentage* is left blank or set to 100%, the Cisco CMTS will only allow the total of the actual available upstream bandwidth to be guaranteed. If *percentage* is set to its maximum of 1000, then up to 10 times of the actual interface bandwidth may be “guaranteed”.

## Verifying Upstream Admission Control

To determine if upstream admission control is configured and activated, enter the **show running-config** command in privileged EXEC mode and look for the cable interface configuration information. If upstream admission control is configured and enabled, an admission control entry appears in the **show running-config** command output, indicating the user-defined percentage of upstream channel capacity allowable. If upstream admission control is disabled, no admission control entry appears in the output.

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you selected a valid frequency for your router.
- 

## Activating Upstream Differential Encoding

Differential encoding on the upstream is a digital encoding technique whereby a binary value is denoted by a signal change rather than a particular signal level. To enable differential encoding on upstream traffic to a specified cable interface, use the following command in cable interface configuration mode. Upstream differential encoding is enabled by default.

```
Router(config-if)# cable upstream usport differential-encoding
```

## Verifying Upstream Differential Encoding

To determine if upstream differential encoding is activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream differential encoding is enabled, a differential encoding entry appears in the **show running-config** output. If upstream differential encoding is disabled, no differential encoding entry appears in the output.

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you selected a valid frequency for your router.
- 

## Activating Upstream Forward Error Correction

The Cisco uBR7200 series CMTS uses forward error correction (FEC) to attempt to correct any upstream data that might have been corrupted. When FEC is activated, all CMs on the network also activate FEC.



**Note** Although upstream FEC is an option, it is recommended that you use upstream FEC. FEC is activated by default and should not be disabled.

To activate the upstream forward error correction and to enable FEC, use the following command in cable interface configuration mode.

```
Router(config-if)# cable upstream usport fec
```

## Verifying Upstream FEC

To verify whether FEC is activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If FEC is enabled, an FEC entry appears in the **show running-config** command output. If FEC is disabled, no FEC entry appears in the output.

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you selected a valid frequency for your router.
-



# Activating the Upstream Ports

Each upstream port must be activated to enable upstream data transmission from the CMs on the HFC network to the Cisco uBR7200 series CMTS.



**Note** The upstream cable interface does not operate until you either set a fixed upstream frequency or create and configure a spectrum group. For more information, see the [Setting the Upstream Frequency](#), on page 61.

To activate the upstream ports, perform the following steps:

## DETAILED STEPS

	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 slot/port</b>  <b>Example:</b> Router(config)# <b>interface cable 5/0</b>	Specifies a cable interface and enters cable interface configuration mode.
<b>Step 4</b>	<b>no cable upstream usport shutdown</b>  <b>Example:</b> Router(config-if)# <b>no cable upstream 0 shutdown</b>	Enables upstream data traffic.

### What to Do Next

To determine if the upstream ports are activated or deactivated, enter the **show interface cable** command for the upstream port just configured:

```
Router# show interface cable5/0
```

```
Cable5/0 is up, line protocol is up
Hardware is BCM3210 FPGA, address is 00e0.1e5f.7a60 (bia 00e0.1e5f.7a60)
Internet address is 1.1.1.3/24
MTU 1500 bytes, BW 27000 Kbit, DLY 1000 usec, rely 255/255, load 1/255
Encapsulation, loopback not set, keepalive not set
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:25, output 00:00:00, output hang never
Last clearing of "show interface" counters never
Queuing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 0 bits/sea, 0 packets/sec
```

```

5 minute output rate 0 bits/sec, 0 packets/sec
10878 packets input, 853740 bytes, 0 no buffer
Received 3679 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
5401 packets output, 645885 bytes, 0 underruns
0 output errors, 0 collisions, 9 interface resets
0 output buffer failures, 0 output buffers swapped out

```

## Activating Upstream Power Adjustment

To enable upstream power adjustment for a specified cable interface, use one of the following commands in cable interface configuration mode.

Command	Purpose
Router(config-if)# <b>cable upstream power-adjust continue</b> <i>pwr-level</i>	Sets the minimum power adjustment in dB that allows continued ranging status. Valid values are 2 to 15 dB. Default = 4 dB.
Router(config-if)# <b>cable upstream usport power-adjust noise</b> <i>perc-pwr-adj</i>	Sets the minimum number (percentage) of power-adjustment packets required to justify changing the upstream power rating. Valid values are 10 to 100 percent. The default is 30 percent.
Router(config-if)# <b>cable upstream 0 power-adjust threshold</b> <i>value</i>	Sets the power-adjustment threshold in dB. Valid values are 0 to 2 dB. The default is 1 dB.
Router(config-if)# <b>end</b> Router#	Returns to enable (privileged EXEC) mode.

To return the automatic upstream power-adjustment ranging value to the default of 4 dB, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream n power-adjust continue
```

To return the automatic upstream power-adjustment noise value to the default of 30 percent, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream n power-adjust noise
```

To return the upstream power-adjustment threshold value to the default of 1 dB, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream n power-adjust threshold
```

### What to Do Next

To determine if upstream power adjustment is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream power adjustment is enabled, any or all three of the continue, noise, and threshold power-adjustment entries appear in the **show running-config** command output. If all three upstream power adjustments are disabled, no power-adjustment entry appears in the **show running-config** command output.

## Activating the Upstream Scrambler

The scrambler on the upstream RF carrier enables CMs on the HFC network to use built-in scrambler circuitry for upstream data transmissions. The scrambler circuitry improves reliability of the upstream receiver on the cable interface line card.

**Caution**

The upstream scrambler is activated by default and should not be disabled under normal circumstances. Disabling it can result in corrupted packets. Disable it only for prototype modems that do not support the upstream scrambler.

To activate the upstream scrambler, use the following command in cable interface configuration mode. The upstream scrambler is enabled by default.

```
Router(config-if)#  cable upstream usport scrambler
```

## Verifying the Upstream Scrambler

To determine if the upstream scrambler is activated, enter the **more system:running-config** command and look for the cable interface configuration information. Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you selected a valid frequency for your router.
-

## Activating Upstream Timing Adjustment

To enable upstream timing adjustment for a specified cable interface, use one of the following commands in cable interface configuration mode.

Command	Purpose
Router(config-if)# <b>cable upstream</b> <i>usport</i> <b>time-adjust continue</b> <i>seconds</i>	Sets the minimum timing adjustment that allows continued ranging status. Valid second values are 2 to 64 seconds. The default is 2 seconds.
Router(config-if)# <b>cable upstream</b> <i>usport</i> <b>time-adjust threshold</b> <i>seconds</i>	Sets the timing adjustment threshold value in seconds. Valid second values are 1 to 32 seconds. The default is 1 second.
Router(config-if)# <b>end</b> Router#	Returns to enable (privileged EXEC) mode.

To return the upstream time-adjustment ranging value to the default of 2 seconds, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport time-adjust continue
```

To return the upstream time adjustment threshold value to the default of 1 second, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport time-adjust threshold
```

## Verifying Upstream Timing Adjustment

To determine if upstream timing adjustment is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream timing adjustment is enabled, either or both of the continue and threshold timing-adjustment entries appear in the **show running-config** command output. If both the continue and threshold upstream timing adjustments are disabled, no timing adjustment entry appears in the **show running-config** command output.

Perform the following steps if you are having difficulty with verification:

- 
- Step 1** Verify that the cable connections are not loose or disconnected.
  - Step 2** Verify that the cable interface line card is firmly seated in its chassis slot
  - Step 3** Verify that the captive installation screws are tight.
  - Step 4** Confirm that you have entered the correct slot and port numbers.
-

## Traffic Shaping

Traffic shaping basically uses queues to limit data surges that can congest a network. The data is buffered and then sent into the network in regulated amounts to ensure that the traffic fits within the expected traffic envelope for the particular connection.

Traffic shaping reduces the chance of retransmitting information to hosts on the cable plant. When cable modems (CMs) have rate limits established, the CMTS typically drops bandwidth requests to enforce the rate limit. This causes the CM to retransmit the request, thereby putting additional latency in packet transmission. If both the hosts sending and requesting information are on the same cable plant, the upstream bandwidth is wasted as well.

On the DOCSIS downstream and upstream channels, traffic shaping allows the CMTS to perform downstream rate limiting and bandwidth request shaping allows the CMTS to perform upstream rate limiting. Rate limiting restricts the data rate to and from a CM; the MAC scheduler supports shaping capabilities for downstream and upstream traffic. Rate limiting ensures that no single CM consumes all of the channel bandwidth and allows a CMTS administrator to configure different maximum data rates for different subscribers. Subscribers requiring higher sustained rates and willing to pay for higher rates can be configured with higher sustained rate limits in their CM DOCSIS configuration file over regular subscribers, who pay less and get lower rate limits.

Each time a packet belonging to a flow is transmitted on an output channel, the token-bucket policer function checks the rate limit status of the flow, parsing the following parameters:

- Token bucket maximum sustained rate in bits per millisecond.
- Token bucket depth (maximum transmit burst) in bits.
- Length of current packet to be sent in bits.
- Pointer to the token bucket of the flow.
- Pointer to the flow's token bucket last update time stamp.
- Variable to return the milliseconds buffering delay in case the packet needs to be shaped.
- Maximum buffering delay that the subsequent traffic shaper can handle in milliseconds.

Every flow has its own shaping buffer where rate-exceeded packets are typically held back in first-in/first-out (FIFO) order for later releases transmission.

**Tip**

---

Token bucket policing with shaping is the per-upstream default rate limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

---

## Upstream Traffic Shaping

Upstream traffic shaping allows the CMTS to perform rate limiting on a DOCSIS upstream channel. The upstream traffic shaping feature delays the scheduling of the upstream packet, which in turn, causes the packet to be buffered on the cable modem device. This allows the user TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber's defined quality of service (QoS)

levels. Upstream traffic shaping enables the CMTS to enforce the peak upstream rate for each CM without degrading overall TCP performance for the subscriber CMs.

When you do not enable the shaping option for upstream rate limiting, the CMTS upstream-rate-policing code drops bandwidth requests from cable modems that are found to have exceeded their configured-peak-upstream rate (using different local drop policies). The effect of bandwidth requests (eventually upstream packets) being dropped causes degraded throughput performance of window-based protocols (like TCP) for these rate-exceeded modems.

Upstream grant shaping is on a per-CM (service identifier-SID) basis. The grant shaping feature is a configurable option for the current upstream token-bucket rate-limiting algorithm.

A traffic shaping feature is restricted QoS class assignment, which allows a CMTS administrator to override the class of service provisioned for a CM. When this feature is enabled, the user-defined QoS profile is enforced on the CM attempting to register with the CMTS, regardless of the CM's provisioned class of service. Use the **cable qos profile** command to configure a QoS profile.


**Note**

The restricted QoS class assignment feature is added to address instances where a cable operator implemented rate limiting incorrectly. The feature allows an administrator to override the statically provisioned QoS parameters of the CM and force the CM to use a specific QoS profile defined at the CMTS.

## Upstream Buffer Control for Maximum Queue Depth

Upstream traffic shaping uses queues to control the upstream data flow. The data packets are buffered in a queue on the CM to regulate traffic and avoid network congestion. Starting with Cisco IOS Release 12.2(33)SCF2, the Upstream Buffer Control feature enables the Cisco CMTS to control the size of this queue (or buffer) by controlling the amount of data that can be enqueued for transmission at any point of time.

The Upstream Buffer Control feature supports buffer control TLVs, which allows the user to configure the buffer size control parameters. These parameters are used to create buffer for each service flow on the CM. The buffer control parameters comprise of three values—minimum buffer, maximum buffer, and target buffer. The minimum buffer and maximum buffer parameters provide a range for the size of the service flow buffer, and the target buffer parameter indicates a desired size of the buffer. The Upstream Buffer Control feature supports the following sub-TLVs in the service flow TLV (24.35), to control these buffer parameters:

**Table 5: Supported Upstream Buffer Control TLVs**

TLV	TLV Description
24.35.1	Upstream minimum buffer.
24.35.2	Upstream target buffer
24.35.3	Upstream maximum buffer

The CM sends the buffer control TLVs in the registration request or in dynamic service add (or change) request to the Cisco CMTS. The Cisco CMTS stores the value of the buffer control TLVs and sends its response. On receiving the response CM creates a buffer for US service flow based on the TLVs.

The buffer control parameters can be configured in the CM configuration file, or by using the cable service class command in global configuration mode. For more information on how to configure upstream buffer control parameters, see [Setting Upstream Buffer Control Parameters](#), on page 69.

## Configuring Upstream Rate Limiting and Traffic Shaping

You can configure rate limiting and traffic shaping on a DOCSIS upstream channel. This delays the scheduling of the upstream packet, which in turn causes the packet to be buffered on the cable CPE device. This allows the user's TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber's defined QoS levels.

To configure this, use the following command in cable interface configuration mode.

Command	Purpose
Router(config-if)# [no] cable upstream <n1> rate-limit [token-bucket]	Enables or disables DOCSIS rate limiting or shaping on an upstream channel. <n1> depends on the number of upstream channels on the specific cable interface line card.

Using Cisco IOS Release 12.0(5)T1 or higher, the software supports:

- Generic calendar queuing routines
- New token bucket policing function
- Grant shaping application of the calendar queues
- Upstream rate shaping option to the token-bucket keyword
- A default state change from 1 second burst policing to token-bucket with shaping



### Tip

Upstream grant shaping is per CM (SID). Shaping can be enabled or disabled for the token-bucket algorithm.



### Note

Before the introduction of this feature, the CMTS would drop bandwidth requests from a CM it detected as exceeding its configured peak upstream rate. Such request dropping affects the throughput performance of IP-based protocols such as FTP, TCP, and SMTP. With this feature, the CMTS can shape (buffer) the grants for a CM that is exceeding its upstream rate, rather than dropping the bandwidth requests.

```
Router# show interface cable 3/0 sid 1 counters
```

```
Sid   Inpackets  Inoctets   Outpackets  Outoctets  Ratelimit  Ratelimit
      67859     99158800  67570      98734862  BWReqDrop  DSPktDrop
      2579      0
```

## Setting Upstream Backoff Values

The DOCSIS-specified method of contention resolution for CMs wanting to transmit data or requests on the upstream channel is a truncated binary exponential backoff value, with the initial backoff window and the maximum backoff window controlled by the CMTS. The Cisco uBR7200 series CMTS specifies backoff window values for both data and initial ranging, and sends these values downstream as part of the Bandwidth Allocation Map (MAP) MAC message.

The values are configurable on the Cisco uBR7200 series software and are power-of-two values. For example, a value of 4 indicates a window between 0 and 15; a value of 10 indicates a window between 0 and 1023. You can set fixed start and end values for data backoff on the upstream ports, or you can set the upstream ports for automatic data backoff. You have the same options for ranging backoff. For both backoff windows, the default start value is 0; the default end value is 4. Valid values are from 0 to 15.



**Note** It is not recommended that you adjust default values, but that you enable the automatic dynamic backoff algorithm.

To set data or ranging backoff values for an upstream port, use one or more of the following commands in cable interface configuration mode.

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	Enter one of the following commands: <ul style="list-style-type: none"> <li>• Router(config-if)#<b>cable upstream</b> <i>usport</i> <b>data-backoff</b> <i>start end</i></li> <li>• Router(config-if)#<b>cable upstream</b> <i>usport</i> <b>data-backoff</b> <b>automatic</b></li> </ul>	Optimizes the <b>automatic</b> setting for as many as 250 cable interfaces per upstream port. Sets manual values for data backoff windows only when operating with more than 250 cable interfaces per upstream port.  Configures the default backoff window values of 0 and 4.
<b>Step 2</b>	Enter one of the following commands: <ul style="list-style-type: none"> <li>• Router(config-if)#<b>cable upstream</b> <i>usport</i> <b>range</b> <i>start end</i></li> <li>• Router(config-if)#<b>cable upstream</b> <i>usport</i> <b>range</b> <b>automatic</b></li> </ul>	Optimizes the <b>automatic</b> setting for as many as 250 cable interfaces per upstream port. Sets manual values for data backoff windows only when operating with more than 250 cable interfaces per upstream port.  Configures the default backoff window values of 0 and 4.

When considering whether to adjust backoff values, keep the following considerations in mind:

- The cable interface reconnection time after a power outage is related to the following factors:
  - DHCP, ToD, and TFTP servers often operate well below 1 percent load under normal situations, but can jump to over 100 percent after an outage.



- Adjusting the backoffs to larger numbers slows cable interface reconnection and reduces server load.
  - Backoffs that are too small result in cable interfaces failing to range the upstream RF levels correctly and cycling to maximum power, thus increasing connection time and reducing network performance.
  - Backoffs that are too large result in increased recovery time after a large service outage.
  - There is significant variation in cable interface performance (brand to brand) in cable interface restart time.
- All cable interfaces should recover in 0 to 10 minutes after all services are restored (Cisco uBR7200 series, RF transport, DHCP, TFTP, and ToD servers). A CM that takes longer than 10 minutes could be experiencing a problem with the modem itself, a problem with CMTS settings, or a problem in the DOCSIS provisioning servers.

**Note**

Upstream segments serving a relatively large number of cable interfaces (for example, more than 1600) might suffer recovery times greater than 10 minutes.

**What to Do Next**

To verify backoff window settings, enter the **show controllers cable** command for the upstream port you configured:

```
Router# show controllers cable5/0 upstream 0

Cable5/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msp/s
Spectrum Group is overridden
SNR 33.2560 dB
Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
Ranging Backoff automatic (Start 0, End 3)
Ranging Insertion Interval automatic (60 ms)
Tx Backoff Start 0, Tx Backoff End 4
Modulation Profile Group 1
part_id=0x3137, rev_id=0x03, rev2_id=0xFF
nb_agc_thr=0x0000, nb_agc_nom=0x0000
Range Load Reg Size=0x58
Request Load Reg Size=0x0E
Minislot Size in number of Timebase Ticks is = 8
Minislot Size in Symbols = 64
Bandwidth Requests = 0xFE
Piggyback Requests = 0xD
Invalid BW Requests= 0x2
Minislots Requested= 0x2963
Minislots Granted = 0x2963
Minislot Size in Bytes = 16
Map Advance = 4000 usecs
UCD Count = 32964
DES Ctrl Reg#0 = C000C043, Reg#1 = 0
```

## Setting the Upstream Channel Width

Use the commands below to enter the upstream channel width in hertz (Hz). For NTSC operations, valid values are 200,000 Hz (160 kilo symbols per second [ksp/s]), 400,000 Hz (320 ksp/s), 800,000 Hz (640 ksp/s), 1,600,000 Hz (1280 ksp/s), and 3,200,000 Hz (2560 ksp/s). The default is 1,600,000 Hz.

If no acceptable channels of the specified width are found, the spectrum management card automatically begins to scan the upstream spectrum for the next largest available channel width; for example, if the spectrum management card is unable to find a usable 1.6 MHz upstream channel, it automatically begins searching for usable 800 kHz channels.

**Caution**

Higher symbol rates are more susceptible to RF noise and interference. If you use a symbol rate or modulation format beyond the capabilities of your HFC network, you might experience packet loss or loss of cable interface connectivity.

**Note**

For QAM-16 channel widths of 400 kHz (320 ksps) or greater, Cisco recommends that you use QAM-16 modulation for long and short data, and that you use QPSK for request, initial, and station communications. For QAM-16 channel widths of 200 kHz (160 ksps), all communication must be able to use QAM-16. That is, 160 ksps with QAM-16 requires an exceptional signal-to-noise ratio (SNR) in your upstream channels. When you use QAM-16 for request, initial, and station maintenance messages with channel widths greater than 400 kHz, the QAM-16 preamble and message data take longer to transmit than the QPSK format.

To set the upstream channel width, use the following commands in cable interface configuration mode:

**DETAILED STEPS**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	Router(config-if)# <b>cable upstream <i>usport</i> channel-width <i>width</i></b>	Enters the channel width for your upstream RF carrier in Hz.
<b>Step 2</b>	Router(config-if)# <b>no cable upstream <i>usport</i> channel-width</b>	Returns the channel width to its default setting of 1,600,000 Hz.

For additional information about channel width and minislots size, refer to the [Cable Radio Frequency \(RF\) FAQs](#) on Cisco.com.

## Verifying Upstream Channel Width

To verify the current value of the upstream channel width, enter the **show controllers cable** command for the upstream port you configured:

```
Router# show controllers cable5/0 upstream 0

Cable5/0 Upstream 0 is up
  Frequency 24.016 MHz, Channel Width 0.800 MHz, QPSK Symbol Rate 0.640 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Use a valid combination of modulation format (QPSK and QAM-16), minislot size, frequency, and the **no shutdown** command.
- Step 2** Use a recommended or previously tested modulation profile. It is not uncommon to create a modulation profile that does not allow cable interface-to-headend communication. Because each message type is individually specified, some messages might not work.
- Step 3** Verify using IP ping packets of varying lengths (64 to 1500 bytes). Ping from the headend to the cable interface.
- Step 4** Verify with your cable interface vendor that your CM software is fully certified or compatible with DOCSIS 1.0 and extensions, as appropriate.
- 

## Copy and Paste Support for TDMA to A-TDMA Upgrade

When configuration is copied from Method of Procedure (MOP) document and pasted, with 6400 kHz specified as channel width (as last-choice-width or first-choice-width or both) and the DOCSIS mode set to TDMA or mixed TDMA/A-TDMA mode, the 6400 kHz channel width is rejected. If the configuration is pasted twice, the 6400 kHz channel width is accepted.

To have the 6400 kHz accepted by pasting the configuration only once, Cisco IOS Release 12.2(33)SCG2 introduces the Copy and Paste Support for TDMA to A-TDMA Upgrade feature. If 6400 kHz is set as channel width in TDMA mode or mixed TDMA/A-TDMA mode, DOCSIS mode automatically changes to A-TDMA-only (DOCSIS 2.0) mode. The command interface displays a message to show the change in the DOCSIS mode.

The automatic change to the DOCSIS mode applies to logical upstream channels configured for a physical

**Note**

Only A-TDMA and SCDMA modes support 6400 kHz channel width. To configure 6400 kHz channel width with SCDMA mode, use manual configuration. The 6400 kHz channel width is hidden in CLI Interactive Help output for TDMA and mixed TDMA/A-TDMA modes.

---

## Setting the Upstream Frequency

The upstream channel frequency of your RF output must be set to comply with the expected input frequency of your Cisco cable interface line card. To configure upstream channel frequencies, perform one of the following tasks:

- Configure a fixed frequency from 5 to 42 MHz for NTSC operations, then enable the upstream port.
- Create a global spectrum group, assign the interface to it, and enable the upstream port.

**Note**

You can also select a default that does not set a specific fixed value.

---



**Note** The upstream port is frequency agile. If you define spectrum groups, the frequency can change while the interface is up and carrying traffic.

A modulation profile consists of a table of physical layer characteristics for the different types of upstream bursts; for example, initial maintenance, long grant, request/data, request, short grant, and station maintenance.



**Note** The upstream cable interface does not operate until you either set a fixed upstream frequency or create and configure a spectrum group. If you are setting a fixed upstream frequency, make sure that the frequency selected does not interfere with the frequencies used for any other upstream applications running on the cable plant.

To set a fixed upstream frequency, use the following commands in cable interface configuration mode.

## DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	Router(config-if)# <b>cable upstream</b> <i>usport</i> <b>frequency</b> <i>up-freq-hz</i>	Enters the fixed center frequency for your upstream RF carrier in Hz.
<b>Step 2</b>	Router(config-if)# <b>no cable upstream</b> <i>usport</i> <b>shutdown</b>	Places the upstream port in the "admin up" state.



**Tip** For National Television Standards Committee (NTSC) operations, valid ranges are 5000000 to 42000000 Hz.



**Caution** Some cable systems cannot reliably transport frequencies near these band edges. The wider the upstream channel (in MHz), the more difficulty you might have. Enter a center frequency between 20 and 38 MHz if you have difficulty.



**Note** You can also select a default that does not set a specific fixed value. The Cisco uBR7200 series software instructs the cable interfaces to use this frequency as the center frequency.



**Note** After the spectrum-band is changed, the spectrum management does not rearrange the frequency for each US channel if the previous frequency belongs to the range of new spectrum-band, which means that the US frequency will not be changed; if the previous frequency is out of range of new spectrum-band, those US channels will not get frequencies.

## Verifying the Upstream Frequency

To verify the current value of the upstream frequency, enter the **show controllers cable** command for the upstream port you configured:

```
Router# show controllers cable5/0 upstream 0

Cable5/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
Spectrum Group is overridden
SNR 33.2560 dB
Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
Ranging Backoff automatic (Start 0, End 3)
Ranging Insertion Interval automatic (60 ms)
Tx Backoff Start 0, Tx Backoff End 4
Modulation Profile Group 1
```

**Note**

The upstream frequency displayed in the **show controllers cable** command output might not match the frequency that you entered when you set the upstream frequency. The Cisco uBR7200 series CMTS might select an upstream frequency close to the frequency you entered that offers better performance. The Cisco uBR7200 series CMTS selects the closest frequency available.

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you have selected a valid frequency for your router.
- 

## Setting the Upstream Input Power Level

The Cisco uBR7200 series CMTS controls the output power levels of CMs to meet the desired upstream input power level. The nominal input power level for the upstream RF carrier is specified in decibels per millivolt (dBmV). The default setting of 0 dBmV is the optimal setting for the upstream power level.

The valid range for the input power level depends on the data rate. At 1.6 MHz, the valid range is -10 to 25 dBmV. If your power levels operate at greater than the maximum valid level, use an inline attenuator to bring the power level to within the valid range.

**Caution**

If you increase the input power level, CMs on your HFC network increase their transmit power level. This increases the carrier-to-noise ratio (C/N) on the network, but also increases distortion products. Composite Second Order Beat (CSO) and Composite Triple Beat (CTB) values worsen by 2 dB for every 1 dB-increased C/N. The return path laser immediately enters a nonlinear mode called clipping, and all communication becomes unreliable. Many return lasers send short bursts above the clipping thresholds and fail on longer or successive bursts.

You should not adjust your input power level by more than 5 dB in a 30-second interval. If you increase the power level by more than 5 dB within 30 seconds, cable interface service on your network is disrupted. If you decrease the power level by more than 5 dB within 30 seconds, cable interfaces on your network are forced offline.

**Note**

When you run the **cable upstream 0 power-level** command, Cisco recommends that the adjacent channel not have a large variation. The recommended maximum input power variance is 5 to 6 dBmV.

To set the upstream input power level in dBmV, use the following command in cable interface configuration mode. The default is 0 dBmV.

```
Router(config-if)# cable upstream usport power-level dbmv
```

## Verifying the Upstream Input Power Level

To verify the current value of the upstream input power level, enter the **show controllers cable** command for the upstream port you configured:

```
Router# show controllers cable5/0 upstream 0

Cable5/0 Upstream 0 is up
  Frequency 24.016 MHz, Channel Width 0.800 MHz, QPSK Symbol Rate 0.640 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Verify that the upstream amplitude of an optimal RF carrier (injected at the fiber node reference input point) reaches the cable interface line card input point at a consistent level (node-to-node and port-to-port).
- Step 2** Verify that this absolute level, as installed, matches both the design and software settings on the Cisco uBR7200 series CMTS.
-

**Note**

Software adjustments of 1 to 3 dB can be used to adjust for minor variations in measurement or setup and port-to-port calibration differences. These adjustments can significantly improve cable interface performance, especially in marginal situations. Larger adjustments should be made in conjunction with spectrum analyzer support at the headend or distribution hub.

## Specifying Upstream Minislot Size

To specify the minislot size (in ticks) for specific upstream cable interfaces, use the following command in cable interface configuration mode. Acceptable values are 2, 4, 8, 16, 32, 64, and 128. The default is 8.

```
Router(config-if)# cable upstream usport minislot-size size
```

For additional information about channel width and minislot size, refer to the [Cable Radio Frequency \(RF\) FAQs](#) on Cisco.com.

## Verifying Upstream Minislot Size

To verify upstream minislot size, enter the **show controllers cable** command for the upstream port you configured:

```
Router# show controllers cable5/0 upstream 0

Cable5/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
Spectrum Group is overridden
SNR 33.2560 dB
Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
Ranging Backoff automatic (Start 0, End 3)
Ranging Insertion Interval automatic (60 ms)
Tx Backoff Start 0, Tx Backoff End 4
Modulation Profile Group 1
part_id=0xFFFF, rev_id=0xFF, rev2_id=0xFF
nb_agc_thr=0x0000, nb_agc_nom=0x0000
Range Load Reg Size=0x58
Request Load Reg Size=0x0E
Minislot Size in number of Timebase Ticks is = 8
Minislot Size in Symbols = 64
Bandwidth Requests = 0xFE
Piggyback Requests = 0xD
Invalid BW Requests= 0x2
Minislots Requested= 0x2963
Minislots Granted = 0x2963
Minislot Size in Bytes = 16
Map Advance = 4000 usecs
UCD Count = 32964
DES Ctrl Reg#0 = C000C043, Reg#1 = 0
```

Perform these steps if you are having difficulty with verification:

- 
- Step 1** Ensure that the cable connections are not loose or disconnected.
  - Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
  - Step 3** Ensure that the captive installation screws are tight.
  - Step 4** Verify that you have entered the correct slot and port numbers.
  - Step 5** Verify that you selected a valid frequency for your router.
- 

## Setting Upstream Traffic Shaping

Upstream traffic shaping, available on the DOCSIS upstream channel, delays the scheduling of the upstream packet, which in turn causes the packet to be buffered on the cable customer premises equipment (CPE) device. This allows the user's TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber's defined quality of service (QoS) levels.

The bandwidth requests are buffered without incurring DOCSIS-related timeouts and retransmits. This enables the CMTS to enforce the peak upstream rate for each CM, without degrading overall TCP performance for the subscriber CPEs. Upstream grant shaping is per cable interface (per service ID (SID)).

Token-bucket policing with shaping is the per-upstream default rate-limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

To enable upstream shaping for an upstream port on a Cisco cable interface line card, use one of the following commands in cable interface configuration mode.

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	Enter the following commands:  <b>Example:</b> <pre>Router(config-if)# cable upstream usport rate-limit Router(config-if)# cable upstream usport rate-limit token-bucket Router(config-if)# cable upstream usport rate-limit token-bucket shaping</pre>	Enables traffic shaping for the specified upstream cable interface.  Enables traffic shaping for the upstream cable interface employing the token-bucket policing algorithm. Enables traffic shaping for the upstream cable interface employing the token-bucket policing algorithm with traffic shaping.
<b>Step 2</b>	<b>end</b>  <b>Example:</b> <pre>Router(config-if)# end</pre>	Exits back to the EXEC mode so that you can verify upstream traffic shaping.



To disable upstream traffic shaping for an upstream port, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport rate-limit
```

The software supports:

- Generic calendar queuing routines
- New token-bucket policing function
- Grant shaping application of the calendar queues
- Upstream rate-shaping option to the token-bucket keyword
- A default state change from 1-second burst policing to token bucket with shaping



**Tip** Upstream grant shaping is per CM (per service ID (SID)). Shaping can be enabled or disabled for the token-bucket algorithm.



**Note** Before the introduction of this feature, the CMTS would drop bandwidth requests from a CM it detected as exceeding its configured peak upstream rate. Such request dropping affects the throughput performance of IP-based protocols such as FTP, TCP, and Simple Network Management Protocol (SNMP). With this feature, the CMTS can shape (buffer) the grants for a CM that is exceeding its upstream rate, rather than dropping the bandwidth requests.

```
Router# show interface cable 5/0 sid 1 counters
```

```
00:02:23: %ENV3-3-LASTENV: Cannot save environmental data
Sid  Req-polls  BW-reqs  Grants  Packets  Frag  Concatpkts
      issued   received  issued  received complete  received
1     0          22       22      22       0       0
2     0          3        3       2       0       0
3     0          0        0       0       0       0
```

## Verifying Upstream Bandwidth Request Shaping

To determine if upstream bandwidth request shaping is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream bandwidth request shaping is configured and enabled, a shaping entry appears in the **show running-config** output. If upstream bandwidth request shaping is disabled, **no cable upstream rate-limit** appears in the output.

You can also perform the following tasks to verify that bandwidth request shaping is enabled on the upstream channel:

- Step 1** Configure a low-peak upstream rate limit for the CM in its QoS profile. Either use the CLI to modify the QoS profile of the modem, or edit the TFTP configuration file of the modem. For more information, see the [DOCSIS 1.1 for the Cisco uBR7200 Series Universal Broadband Routers](#) feature.
- Step 2** Use a regular rate-limiting algorithm on the upstream without rate shaping, and note the drops of the excess bandwidth requests from this CM when it exceeds its peak upstream rate.

Use the **show interface cx/y sid counters verbose** command to see the bandwidth request drops. Verify that the upstream rate received by that modem is less than its configured peak rate, due to the timeouts and backoffs produced by the drop in bandwidth requests. Enter the **show interface cx/y service flow qos** command to see the input rate at CMTS in bps.

**Step 3** Enable grant shaping on the upstream channel by using the new **shaping** keyword extension to the token-bucket algorithm CLI command.

**Step 4** Make the CM exceed its peak upstream rate by generating upstream traffic, and note the effect of grant buffering (shaping) at the CMTS. If you use CM-to-CMTS pings, there is a perceivable decrease in the frequency of the pings.

Let the pings run long enough to allow the averages at the CMTS to settle; then view the upstream rate received by this single modem. Use the **show interface cx/y** command and see the input rate in bps. This value should be close to the modem's peak upstream rate. Also note the drop counts for the modem's SID by using the **show interface sid counters** command, and verify that the CMTS no longer drops the bandwidth requests from the CM.

The bandwidth request drop count (from the previous nonshaping test) remains unchanged when upstream rate shaping is used, indicating that the CMTS is actually shaping (buffering) the grants for the modem. Verify that the input rate at the CMTS (from the single rate-exceeded CM) stabilizes close to the configured peak rate of 128 Kbps.

## Troubleshooting Tips

Perform these steps if you are having difficulty with verification:

- Step 1** Ensure that the cable connections are not loose or disconnected.
- Step 2** Ensure that the cable interface line card is firmly seated in its chassis slot.
- Step 3** Ensure that the captive installation screws are tight.
- Step 4** Verify that you have entered the correct slot and port numbers.
- Step 5** Verify that you selected a valid frequency for your router.

## Configuring Upstream Drop Classifier

This configuration is optional. A set of matching criteria is applied by the cable modems to packets to determine if a packet should be dropped. This set of matching criteria when applied to upstream traffic, is called the Upstream Drop Classifier (UDC).

The CMTS enables the UDC feature on the cable modems. The UDC configuration is done by the cable modem using a configuration file.

Effective with Cisco IOS Release 12.2(33)SCG5, the UDC feature can be enabled for all cable modems on any interface of a Cisco CMTS by using the **cable udc-capability** command in interface configuration mode.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  • Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable slot/subslot/port</b>  <b>Example:</b> Router(config)# <b>interface cable 7/1/0</b>	Enters the interface configuration mode
Step 4	<b>cable udc-capability</b>  <b>Example:</b> Router(config-if)# <b>cable udc-capability</b>	Enables the UDC feature on cable modems.
Step 5	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

**What to Do Next**

To verify that the UDC feature is enabled on a specified cable modem, use the **show cable modem *H.H.H* verbose** command (where *H.H.H* represents the MAC address of the cable modem) in privilege EXEC mode. The following example displays the output of the show command using the **|** and **section** keyword to show only the “UDC Enabled” field.

```
Router# show cable modem 4458.2945.3004 verbose | s UDC
UDC Enabled                : Y
Router#
```

If the UDC feature is not enabled, this field shows ‘N’ to denote that the cable modems have not configured UDC.

## Setting Upstream Buffer Control Parameters

This configuration is optional. To configure the upstream buffer control parameters for the CM queue using the service class name, use the cable service class command in global configuration mode.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  • Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable service class class-index max-buff-size   min-buff-size   tar-buff-size</b>  <b>Example:</b> Router(config)# <b>cable service class 10 min-buff-size 1000</b>	Configures the following buffer control parameters.  • <i>class-index</i> —The class ID for the class to be modified. • <b>max-buff-size</b> —Maximum CM buffer size. • <b>min-buff-size</b> —Minimum CM buffer size. • <b>tar-buff-size</b> —Target CM buffer size.
Step 4	<b>end</b>  <b>Example:</b> Router(config)# <b>end</b>	Exits global configuration mode and returns to privileged EXEC mode.

## Verifying Upstream Buffer Control Parameters

To verify the current values of the upstream buffer control parameters for a particular service class, use the **show cable service-class verbose** command in privilege EXEC mode. The following is a sample output of the **show cable service-class verbose** command for a service class with class-index 10:

```
Router# show cable service-class 10 verbose

Index:                10
Name:                 REG-US
Direction:            Upstream
Traffic Priority:      0
Maximum Sustained Rate: 0 bits/sec
Max Burst:             3044 bytes
Minimum Reserved Rate: 0 bits/sec
Minimum Packet Size   0 bytes
Peak Rate              0 bits/sec
Admitted QoS Timeout  200 seconds
Active QoS Timeout    0 seconds
Maximum Concatenated Burst: 1522 bytes
Scheduling Type:      Best Effort
Request/Transmission Policy: 0x0
IP ToS Overwrite [AND-mask,OR-mask]: 0xFF,0x0
Parameter Presence Bitfield: {0x8, 0x0}
!Upstream Buffer Control Parameters
Minimum Buffer Size:   1000 bytes
Target Buffer Size:    1500 bytes
```

Maximum Buffer Size: 2000 bytes

To verify if the upstream buffer control parameters have been correctly propagated to the CM, use the **show cable modem service-flow verbose** command, in privilege EXEC mode. The following is a sample output of the **show cable modem service-flow verbose** command for a particular CM:

```

Router# show cable modem 0022.cea5.02ba service-flow verbose

SUMMARY:
MAC Address      IP Address      Host          MAC          Prim Num Primary
DS
0022.cea5.02ba 5.60.122.132   C7/1/0/UB    w-online     10 0      Downstrea  RfId
In7/1/0:0 840
Sfid Dir Curr Sid Sched Prio MaxSusRate MaxBrst MinRsvRate Throughp
State Type
29 US act 10 BE 0 100000 3044 0 0
30 DS act N/A BE 0 200000 3044 0 0

CfrId SFID CM Mac Address Direction State Priority Matches
Reg Info Requests Tx : 2
Reg Info TLV len : 152

UPSTREAM SERVICE FLOW DETAIL:
Sfid : 29
Mac Address : 0022.cea5.02ba
Type : Primary
Direction : Upstream
Current State : Active
Current QoS Indexes [Prov, Adm, Act] : [3, 4, 4]
Active Time : 03:45
Required Attributes : 0x00000000
Forbidden Attributes : 0x00000000
Aggregate Attributes : 0x00000000
Sid : 10
Service Class Name : REG-US
Traffic Priority : 0
Maximum Sustained rate : 100000 bits/sec
Maximum Burst : 3044 bytes
Minimum Reserved Rate : 0 bits/sec
Minimum Packet Size : 0 bytes

!Upstream Buffer Control Parameters
Minimum Buffer Size : 1000 bytes
Target Buffer Size : 1500 bytes
Maximum Buffer Size : 2000 bytes
Peak Rate : 0 bits/sec
Admitted QoS Timeout : 200 seconds
Active QoS Timeout : 0 seconds
Packets : 3
Bytes : 1020
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-1
Transmit Channel Set : 0x6
Sid Cluster : SC-0, Sid [ 10 10 ]
Segments Valid : 3
Segments Discarded : 0
Segments Lost : 0
SID Cluster Switching Information
Total Bytes Requested : 0
Total Time : 0
Outstanding Bytes : 0
Max Requests : 1
Classifiers: NONE
Sid : 10
Request polls issued : 0
BWReqs {Cont,Pigg,RPoll,Other} : 4, 0, 0, 0
No grant buf BW request drops : 0, where:0
Rate exceeded BW request drops : 0
    
```

```

Grants issued : 4
Packets received : 4
Bytes received : 1488
rate-adapt : Disabled
rate-adapt {rcvd, Consec-PB} : 0, 0
Fragment reassembly completed : 0
Fragment reassembly incomplete : 0
Concatenated packets received : 0
Queue-indicator bit statistics : 0 set, 0 granted
Good Codewords rx : 8
Corrected Codewords rx : 0
Uncorrectable Codewords rx : 0
Concatenated headers received : 0
Fragmentation headers received : 0
Fragmentation headers discarded : 0
ARP Requests Received : 2

```

## Additional References

### MIBs

MIB	MIBs Link
DOCS-IF3-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:  <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

### Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>

## Feature Information for Configuring Upstream Cable Interface Features on the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



### Note

The table below 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 Configuring Upstream Cable Interface Features on the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
Configuring Upstream Cable Interface Features on the Cisco CMTS Routers	12.2(33)SCA	This feature was introduced on the 12.2(33)SC release train.
Configuring Upstream Cable Interface Features on the Cisco CMTS Routers	12.2(33)SCD5	The Upstream Minimum Reserved Traffic Rate Plus Excess Traffic Rate feature was introduced.
Upstream Buffer Control for Maximum Queue Depth	12.2(33)SCF2	This feature enables the Cisco CMTS to control the size of the upstream service-flow queue (or buffer) on a CM.  The following commands were modified: <ul style="list-style-type: none"> <li>• <b>cable service class</b></li> <li>• <b>show cable modem service-flow</b></li> <li>• <b>show cable service-class</b></li> </ul>
Copy and Paste Support for TDMA to A-TDMA Upgrade	12.2(33)SCG2	This feature automatically sets the DOCSIS mode to A-TDMA-only (DOCSIS 2.0) mode.  The following command was modified: <ul style="list-style-type: none"> <li>• <b>cable upstream channel-width, cable upstream docsis-mode</b></li> </ul>

Feature Name	Releases	Feature Information
Upstream Drop Classifier (UDC)	12.2(33)SCG5	<p>This feature enables the upstream drop classifier feature on the cable modems on a specific interface.</p> <p>The following commands were introduced or modified:</p> <p><b>cable udc-capability, show cable modem verbose</b></p>





## CHAPTER 4

# Cable Modem Steering on the Cisco CMTS Routers

---

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The cable modem steering feature helps to redirect or steer cable modems to multiple CMTS routers using downstream frequency overrides. A configurable string is used to bond the cable modem to the proper CMTS. Once the bonding is done, the CMTS can move the cable modem within itself for load balancing.

### 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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## Prerequisites for Cable Modem Steering

DOCSIS 3.0-defined type, length, values (TLVs) are required to aid channel selection. All TLVs encoded as general extension information in cable modem configuration files are backward compatible with DOCSIS 1.1 and DOCSIS 2.0 cable modems.

The table below shows the hardware compatibility prerequisites for this feature.



**Note** The hardware components introduced in a given Cisco IOS Release are supported in all subsequent releases unless otherwise specified.

**Table 7: Cable Modem Steering Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> </ul> Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul> Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V <a href="#">6</a></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V <a href="#">7</a></li> </ul>

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>6</sup> Cisco uBR3GX60V cable interface line card is not compatible with PRE2. You must use PRE4 with the Cisco uBR3GX60V cable interface line card.

<sup>7</sup> Cisco uBR-MC88V cable interface line card is not compatible with NPE-G1. You must use NPE-G2 with the Cisco uBR-MC88V cable interface line card.

## Restrictions for Cable Modem Steering

The Cable Modem Steering feature has the following general restrictions:

- To restrict the cable modem on the exact downstream on the target CMTS, the redirection must be configured on the target CMTS.
- You must manually execute the **clear cable modem service-type** command to clear the cable modem service type identifier stored at the CMTS during registration.
- You must manually execute the **clear cable modem attribute-masks** command to clear the cable modem attribute masks stored at the CMTS during registration. These attribute masks are used to restrict usage of upstream channels during ranging time.
- cable modem steering supports only upstream masks.
- Channel steering does not take place when the cable modem fails in initial ranging.
- The cable modem will take more time to come online when channel steering is deployed. The time taken is proportional to the number of modems, and the downstreams and upstreams that the cable modem can reach.
- A modem cannot be load balanced to any upstream channel with attributes that conflict with attribute masks of the modem.
- The keep alive detection feature may trigger an line card (LC) switchover. For more details on the Keep Alive feature, see [N+1 Redundancy for the Cisco Cable Modem Termination System](#).
- Each interface should have an active modem or use **no keepalive** on this interface.
- The required attribute mask and the forbidden attribute mask of an upstream should be configured in such a way that the bitwise AND of the two masks are zero. For example, if you configure required attribute mask with the value 0x30 and forbidden attribute mask with the value 0x20, the cable modem may not work properly, because the binary representation of both the configured masks will be 1 at the 5th bit.

# Information About Cable Modem Steering

Cable modem steering allows you to redirect or steer the cable modems to one or more CMTS routers using downstream frequency overrides. Once a cable modem registers on a downstream on the proper CMTS router, the CMTS router can move the cable modem to any location for load balancing.

The DOCSIS 3.0-compliant Service Type Identifier used as the configurable string in the cable modem configuration file is backward-compatible with DOCSIS 1.1 and DOCSIS 2.0 cable modems.

The CMTS router can also impose restrictions on the number of channels a cable modem can use. DOCSIS 3.0 defines several TLVs to aid the channel selection.

The following TLVs are used in cable modem steering:

- TLV 43.9 (Cable Modem Attribute Masks) limits the set of channels the CMTS router can assign to the cable modem by allowing or forbidding certain binary attributes. The cable modem attribute masks have four sub-TLVs and cable modem steering makes use of two sub-TLVs, which are listed below:
  - TLV 43.9.3—Cable Modem Upstream Required Attribute Mask (C.1.1.18.1.8.3 of CM-SP-MULPIv3.0-I07-080215). It is a 32-bit mask representing the set of binary upstream channel attributes required for the cable modem.
  - TLV 43.9.4—Cable Modem Upstream Forbidden Attribute Mask (C.1.1.18.1.8.4 of CM-SP-MULPIv3.0-I07-080215). It is a 32-bit mask representing the set of binary upstream channel attributes forbidden for the cable modem.
- TLV 43.11 is used for a redirection action based on the service type identifier field. The cable modem sends the TLV 43.11 in the REG-REQ MAC message. The DOCSIS 1.1 and DOCSIS 2.0 modems will also send this file ID when doing the registration.
- TLV43.1, defined as Policy ID in DOCSIS 2.0 and DOCSIS 3.0, is parsed and stored in the cable modem during registration. Before moving the cable modem during load balancing (LB), the CMTS router checks whether the cable modem has a preconfigured policy with the same Policy ID. If the policy does exist, the CMTS router disables LB for this cable modem and moves to the next cable modem. If the policy does not exist on the CMTS router, or the Policy ID is missing from the cable modem configuration file, LB prohibition is not performed.

The following TLVs are supported in cable modem steering:

- TLV 43.11 (Service type identifier) from section C.1.1.18.1.10 in CM-SP-MULPIv3.0-I07-080215.
- Cable modem attribute masks (TLV 43.9) from C.1.1.18.1.8.3 and C.1.1.18.1.8.4 of CM-SP-MULPIv3.0-I07-080215.
- TLV portion (43.1, Policy ID) of REQ-REQ
- TLV 19---Channel Class ID
- TLV 18--- Ranging Hold-off Priority Field

Cable modem steering contains three small featurettes: Channel Redirection, Channel Restriction, and Load Balancing. The Load Balancing feature is covered in the [Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers](#) document .

## Channel Redirection

The service type identifier-based channel redirection allows you to redirect or steer the cable modems to one or more CMTS routers using downstream frequency overrides. A configurable string in the cable modem configuration file is used to bond the cable modem to the correct CMTS router. A global CLI ties the string to the downstream frequency, which is configured on the CMTS router.

Once a cable modem registers on a downstream of a CMTS router, the CMTS router can move the cable modem to any location within the CMTS for load balancing.

A DOCSIS 3.0-compliant TLV (TLV 43.11) service identifier is used as the configurable string in the cable modem configuration file. It is backward-compatible with DOCSIS 1.1 and DOCSIS 2.0 cable modems. This TLV is used as the tag of the cable modem to decide whether to redirect or not. The method used to redirect is downstream frequency override in the ranging phase.

## Channel Restriction

The Cisco CMTS router can impose restrictions on the channels a cable modem uses based on the cable modem configuration file or its capabilities. For example, Advanced Time Division Multiple Access (ATDMA) capable cable modems should not use Time Division Multiple Access (TDMA) upstream channels.

DOCSIS 3.0 provides guidelines on how a CMTS router can choose a pair of channels for a cable modem at both registration time and during autonomous load balancing. DOCSIS 3.0 defines several TLVs to aid channel selection, including the service type identifier, load balancing group ID, and cable modem attribute masks and service flow attribute masks.

Except for the service flow attribute masks, the TLVs are encoded as general extension information in the cable modem configuration file, which are backward compatible with DOCSIS 1.1 and DOCSIS 2.0 cable modems.

Channel restriction looks only for upstream cable modem attribute masks, and is therefore compatible with DOCSIS 1.1, DOCSIS 2.0 and DOCSIS 3.0 cable modems in non-Multiple Transmit Channel (MTC) mode.

**Note**

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In Cisco IOS Release 12.2(33)SCC and later releases, it is recommended to assign a cable modem to different Restricted Load Balancing Groups (RLBGs) to restrict the usage of channels, instead of using attribute masks.

---

**Note**

---

In Cisco IOS Release 12.2(33)SCH1, the cable modems can come wideband online (w-online) with up to 16 downstream channels and 4 upstream channels. Effective with Cisco IOS Release 12.2(33)SCH2, the cable modems can come w-online with up to 24 downstream channels and 8 upstream channels. These features are not supported on the Cisco uBR10012 routers using PRE2, and the Cisco uBR7200 series routers using NPE-G1.

---

## Upstream Channel Descriptor TLV for Ranging Hold-off

The Upstream Channel Descriptor (UCD) TLV for Ranging Hold-off feature, introduced in Cisco IOS Release 12.2(33)SCH, enables the CMTS router to hold off a cable modem from initial ranging based on TLV 18 and 19 specified in the upstream channel descriptor (UCD) messages. The router can hold off a cable modem from initial ranging only for 5 minutes. This default value cannot be changed. This feature is supported with DOCSIS 2.0 and later releases cable modems using upstream logical channels.

**Note**

---

The UCD TLV for Ranging Hold-off feature is supported only with DOCSIS load balance.

---

### Ranging Class ID

The CMTS enables UCD TLV for ranging hold-off after detecting the TLVs from the cable modem registration request (REG-REQ) or multipart registration request (REG-REQ-MP), and saves these TLVs as a cable modem ranging class ID.

By default, DOCSIS load balance is supported for all cable modems with all types of ranging class IDs. In the event of DOCSIS load balance, a cable modem moves to the target upstream channel only if the ranging class ID matches with the upstream channel class ID.

### Cable Modem Exclusion for DOCSIS Load Balance

You can exclude a cable modem or a group of cable modems from DOCSIS load balance based on their device type, MAC address, and Organizational Unique Identifier (OUI) using the **cable load-balance exclude** command in global configuration mode.

## How to Configure Cable Modem Steering on the CMTS Router

This section describes the following required and optional procedures:

### Configuring a Channel Redirection

To configure a channel redirection that allows you to redirect or steer the cable modems to one or more CMTS using the downstream frequency override in the ranging phase, use the **cable service type ds-frequency** command.

**Restriction**

You can redirect cable modems matching the service type identifier to a downstream frequency. However, one service type identifier cannot be redirected to multiple downstream frequencies.

During registration, the cable modem service type identifier is stored in the CMTS to redirect target downstream frequency during ranging time. If you want to clear the stored service type identifier, you must manually execute the **clear cable modem service-type** command.

To restrict the cable modem on the exact downstream on the target CMTS, the redirection must be configured on the target CMTS. If the cable modems are redirected to the source CMTS, the dynamic load balance may not work properly and the cable modem may drop offline during load balancing. For the cable modems to be redirected it must reach the target frequency.

**DETAILED STEPS**

	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.
<b>Step 3</b>	<b>cable service type <i>service-type-id</i> ds-frequency frequency</b>  <b>Example:</b> Router(config)# <b>cable service type commercial ds-frequency 519000000</b>	Redirects matching service types to downstream frequency. <ul style="list-style-type: none"> <li>• <i>service-type-id</i>—Specifies the service type identifier to be redirected. Maximum length is 16.</li> <li>• <i>frequency</i>—Specifies the downstream frequency to which the cable modems are redirected.</li> </ul>

## Configuring a Channel Restriction

To impose restrictions on the channels a cable modem can use based on its configuration file or capabilities, use the **cable upstream attribute-mask** command.

**Before You Begin**

Advanced Time Division Multiple Access (ATDMA) capable cable modems should be restricted from using Time Division Multiple Access (TDMA) upstream channels.

**Restriction**

- The cable modem attribute masks (TLV 43.9) are a function of the CMTS support and are compatible only with legacy DOCSIS 1.1 and DOCSIS 2.0 cable modems.
- When the CMTS cannot find an appropriate US channel in the same legacy LB group, the cable modem steering checking is skipped and cable modems come online. The US channel must meet the requirement of cable modem upstream attribute masks if a load balancing group (LBG) is not configured.
- During registration, the cable modem attribute masks are stored at the CMTS. These are then used to restrict usage of upstream channels during ranging time. You must manually execute the **clear cable modem attribute-masks** command to clear the stored attribute masks.

**DETAILED STEPS**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  • Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
<b>Step 3</b>	<b>interface cable slot/subslot/port</b>  <b>Example:</b> Router (config)# <b>interface cable 5/0/4</b>	Enables the cable interface.
<b>Step 4</b>	<b>cable upstream upstream-interface attribute-mask attribute-mask</b>  <b>Example:</b> Router (config-if)# <b>cable upstream 0 attribute-mask ffff</b>	Configures the attribute mask on a particular upstream interface.  • <i>upstream-interface</i> —Specifies the upstream port. • <i>attribute-mask</i> —Specifies the attribute mask bitmap in hexadecimal format. Example: 0-FFFFFFFF  <b>Note</b> From Cisco IOS Release 12.2(33)SCC, the bit 0 in <i>attribute-mask</i> is bypassed when cable modem steering checks it.

## Configuring an Upstream Channel Class ID

This configuration is optional. A channel class ID must be configured for an upstream logical channel if you want to configure UCD TLV ranging hold-off on the CMTS router.



**Restriction**

Legacy load balance cannot be configured on a MAC domain if an upstream channel belonging to the MAC domain has a channel class ID configured. Similarly, a channel class ID cannot be configured on an upstream channel if legacy load balance is already configured on the MAC domain of the upstream channel.

**DETAILED STEPS**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. <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.
<b>Step 3</b>	<b>interface cable</b> <i>slot/subslot/cable-interface-index</i>  <b>Example:</b> Router(config)# <b>interface cable</b> 5/0/4	Specifies the cable interface and enters cable interface configuration mode. Arguments for this command may vary depending on the CMTS router, line card, and Cisco IOS software release. For details, see the <a href="#">Cisco IOS CMTS Cable Command Reference</a> . <ul style="list-style-type: none"> <li>• <i>Slot</i>—Slot where a line card resides.</li> <li>• <i>Subslot</i> (Cisco uBR10012 only)—Secondary slot number of a line card.</li> <li>• <i>cable-interface-index</i>—Downstream port or MAC domain index of a line card.</li> </ul>
<b>Step 4</b>	<b>cable upstream</b> <i>port-number</i> <b>chan-class-id</b> <i>id</i>  <b>Example:</b> Router(config-if)# <b>cable upstream</b> 0 <b>chan-class-id</b> ff	Configures the channel class ID for an upstream logical channel. <ul style="list-style-type: none"> <li>• <i>port-number</i>—Cable upstream port number. The valid range depends on the number of upstream channels configured in a MAC domain. For example, if the total number of upstream channels configured is 4, then the valid range for the upstream port number is from 0 to 3.</li> <li>• <i>id</i>—Channel class ID for the logical upstream channel in the hexadecimal format. The valid range is from 0 to ffffffff. The default value is 0.</li> </ul>
<b>Step 5</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Returns to privileged EXEC mode.

## Configuring an Upstream Ranging Hold-off Priority Value

This configuration is optional.

Maximum time that a cable modem can inhibit transmissions on an upstream channel in response to its ranging class ID matching a bit value in the Ranging Hold-off Priority field in the cable modem configuration file is 300 seconds (five minutes) per *DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification*. This default timer value cannot be changed.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable</b> <i>slot/subslot/cable-interface-index</i>  <b>Example:</b> Router(config)# <b>interface cable</b> <b>5/0/4</b>	Specifies the cable interface and enters cable interface configuration mode. Arguments for this command may vary depending on the CMTS router, line card, and Cisco IOS software release. For details, see the <a href="#">Cisco IOS CMTS Cable Command Reference</a> . <ul style="list-style-type: none"> <li>• <i>Slot</i>—Slot where a line card resides.</li> <li>• <i>Subslot</i> (Cisco uBR10012 only)—Secondary slot number of a line card.</li> <li>• <i>cable-interface-index</i>—Downstream port or MAC domain index of a line card.</li> </ul>
Step 4	<b>cable upstream <i>port-number</i> rng-holdoff <i>priority</i></b>  <b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 rng-holdoff 1</b>	Configures the ranging hold-off priority value for an upstream logical channel. <ul style="list-style-type: none"> <li>• <i>port-number</i>—Upstream port number. The valid range depends on the number of upstream channels configured in a MAC domain. For example, if the total number of upstream channels configured is 4, then the valid range for the upstream port number is from 0 to 3.</li> <li>• <b>rng-holdoff <i>priority</i></b>—Specifies the ranging hold-off priority value in the hexadecimal format. The valid range is from 0 to ffffffff. The default value is 0.</li> </ul>
Step 5	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Returns to privileged EXEC mode.

# Configuration Examples for Cable Modem Steering

This section provides the following configuration examples:

## Example: Configuring a Channel Class ID and Ranging Hold-off Priority Value

The following example shows configuration of a channel class ID and its ranging hold-off priority value on a cable interface line card on the Cisco uBR10012 router:

```
interface Cable8/1/0
downstream Integrated-Cable 8/1/0 rf-channel 0-3
cable mtc-mode
no cable packet-cache
cable bundle 1
cable upstream max-ports 4
cable upstream bonding-group 1
    upstream 1
    upstream 2
    upstream 3
    attributes 80000000
cable upstream bonding-group 2
    upstream 0
    upstream 2
    upstream 3
    attributes 80000000
cable upstream bonding-group 3
    upstream 0
    upstream 1
    upstream 2
    upstream 3
    attributes 80000000
cable upstream 0 connector 0
cable upstream 0 frequency 24400000
cable upstream 0 channel-width 1600000 1600000
cable upstream 0 max-logical-chans 1
cable upstream 0 docsis-mode atdma
cable upstream 0 minislot-size 4
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 221
cable upstream 0 chan-class-id FF
cable upstream 0 rng-holdoff F
no cable upstream 0 shutdown
cable upstream 1 connector 1
cable upstream 1 frequency 22800000
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 max-logical-chans 1
cable upstream 1 docsis-mode atdma
cable upstream 1 minislot-size 4
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 221
cable upstream 1 chan-class-id F
```

## Example: Clearing a Channel Redirection

To clear the cable modem attributes, use the **clear cable modem** command as shown in the following examples:

```
Router# clear cable modem all
Router# clear cable modem oui string
Router# clear cable modem cable slot/subslot/port offline
```

To clear the cable modem service type identifiers, use the **clear cable modem service-type** command as shown in the following examples:

```
Router# clear cable modem all service-type-id
Router# clear cable modem oui string service-type-id
Router# clear cable modem slot/subslot/port offline service-type-id
```

## Verifying and Troubleshooting Cable Modem Steering

This section provides the verification and troubleshooting information:

### Verifying a Channel Redirection

To verify configuration of channel redirection, use the **show cable modem verbose** command as shown in the following example:

```
Router# show cable modem verbose

MAC Address           : 0019.474d.e291
IP Address            : 41.42.0.0
IPv6 Address          : ---
Dual IP               : N
Prim Sid              : 15
Host Interface        : C5/0/4/U0
MD-DS-SG              : N/A
Wideband Capable     : Y
RCP Index             : 0
sysDescr              :
Upstream Power        : 0.00 dBmV (SNR = 36.12 dB)
Downstream Power      : 0.00 dBmV (SNR = ----- dB)
Timing Offset         : 1874
Initial Timing Offset : 1874
Curr US Timing Adjust : 0
Prev US Timing Adjust : 0
Received Power        : 0.00 dBmV
MAC Version           : DOC2.0
QoS Provisioned Mode  : DOC1.1
Enable DOCSIS2.0 Mode : Y
Phy Operating Mode    : tdma
Modem Status          : {Modem=online(pt), Security=assign(tek)}
Capabilities           : {Frag=Y, Concat=Y, PHS=Y}
Security Capabilities : {Priv=BPI+, EAE=N}
L2VPN Capabilities    : {L2VPN=N, eSAFE=N}
Sid/Said Limit        : {Max US Sids=16, Max DS Sids=15}
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           : 10
Flaps                 : 0()
Errors                 : 0 CRCs, 0 HCSes
Stn Mtn Failures      : 0 aborts, 0 exhausted
Total US Flows        : 1(1 active)
Total DS Flows        : 1(1 active)
Total US Data         : 1 packets, 401 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 index        : 0x0
LB reg_group_id       : 0x0
LB policy id          : 0
LB reg_policy_id      : 0
LB priority            : 0
Required DS Attribute Mask : 0x0
Forbidden DS Attribute Mask : 0x0
Required US Attribute Mask : 0x0
```

```

Forbidden US Attribute Mask      : 0x0
Service Type ID                 : commercial
Active Classifiers              : 0 (Max = NO LIMIT)
DSA/DSX messages                : permit all
Number of Multicast DSIDs Support : 15
MDF Capability Mode             : 0
FCType10 Forwarding Support     : N
Features Bitmask                : 0x0
Total Time Online               : 00:59

```

To view the modems having the service type identifier, use the **show cable modem service-type service-type-id** command as shown in the following example:

```

Router# show cable modem service-type commercial

MAC Address      IP Address      I/F      MAC      Prim Service-type-id  B D
                  State          State
0018.6812.29ae  41.42.2.212    C5/0/4/U2  offline  3838 commercial         N N
0018.6811.f9f8  41.42.0.140    C5/0/4/U2  offline  3225 commercial         N N
0018.6811.fba6  41.42.5.169    C5/0/4/U2  offline  3439 commercial         N N
0018.6812.225a  41.42.3.210    C5/0/4/U2  offline  3355 commercial         N N
0018.6811.fa8c  41.42.1.133    C5/0/4/U2  offline  3091 commercial         N N
0018.6812.37e8  41.42.0.136    C5/0/4/U2  offline  7439 commercial         N N
0018.6811.fbca  41.42.2.255    C5/0/4/U2  offline  6263 commercial         N N
0018.6811.fb44  41.42.2.17     C5/0/4/U2  offline  2996 commercial         N N
0018.6812.2f20  41.42.0.100    C5/0/4/U2  offline  3544 commercial         N N

```

## Verifying a Channel Restriction

To verify the service type identifier and cable modem attribute masks configured for a cable modem, use the **show cable modem verbose** command as shown in the following example:

```

Router# show cable modem 0019.474d.e291 verbose

MAC Address          : 0019.474d.e291
IP Address           : 40.3.100.16
IPv6 Address        : ---
Dual IP             : N
Prim Sid            : 35
Host Interface      : C5/0/4/U0
MD-DS-SG           : 1
MD-CM-SG           : 0x40100
Primary Downstream  : Mo1/0/0:0 (RfId : 0)
Wideband Capable    : N
RCP Index           : 0
sysDescr            :
Upstream Power      : 0.00 dBmV (SNR = 36.12 dB)
Downstream Power    : 0.00 dBmV (SNR = ----- dB)
Timing Offset       : 1573
Initial Timing Offset : 1573
Curr US Timing Adjust : 0
Prev US Timing Adjust : 0
Received Power      : -0.50 dBmV
MAC Version         : DOC2.0
QoS Provisioned Mode : DOC1.1
Enable DOCSIS2.0 Mode : Y
Phy Operating Mode  : tdma
Modem Status        : {Modem=online, Security=disabled}
Capabilities        : {Frag=Y, Concat=Y, PHS=Y}
Security Capabilities : {Priv=, EAE=N}
L2VPN Capabilities  : {L2VPN=N, eSAFE=N}
Sid/Said Limit      : {Max US Sids=16, Max DS Sids=15}
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         : 16
Flaps               : 0()
Errors              : 0 CRCs, 0 HCSes
Stn Mtn Failures    : 0 aborts, 0 exhausted

```

```

Total US Flows           : 1(1 active)
Total DS Flows           : 1(1 active)
Total US Data            : 7 packets, 619 bytes
Total US Throughput      : 0 bits/sec, 0 packets/sec
Total DS Data            : 2 packets, 148 bytes
Total DS Throughput      : 4 bits/sec, 0 packets/sec
LB group index           : 0x0
LB reg_group_id          : 0x0
LB policy id             : 2
LB reg_policy_id         : 2
LB priority              : 0
Required DS Attribute Mask : 0x0
Forbidden DS Attribute Mask : 0x0
Required US Attribute Mask : 0x1111
Forbidden US Attribute Mask : 0x0
Service Type ID           : commercial
Active Classifiers       : 0 (Max = NO LIMIT)
DSA/DSX messages        : permit all
Voice Enabled            : NO
DS Change Times         : 0
Boolean Services         : 0
Number of Multicast DSIDs Support : 0
MDF Capability Mode      : 0
FCType10 Forwarding Support : N
Features Bitmask         : 0x0
Total Time Online       : 00:19

```

## Verifying an Upstream Ranging Class ID Configuration

To verify an upstream ranging class ID of a cable modem, use the **show cable modem** command with the **verbose** keyword.

Following is a sample output of the **show cable modem verbose** command in Cisco IOS Release 12.2(33)SCH1:

```

Router# show cable modem 68b6.fcfe.2285 verbose

MAC Address : 68b6.fcfe.2285
IP Address : 192.168.0.8
IPv6 Address : 2001:DB8:10:1:9951:1972:33F9:9867
Dual IP : Y
Prim Sid : 235
Host Interface : C7/0/1/UB
MD-DS-SG / MD-US-SG : 1 / 1
MD-CM-SG : 0x3D0101
Primary Wideband Channel ID : 2305 (Wi7/0/0:0)
Primary Downstream : In7/0/0:3 (RfId : 1731)
Wideband Capable : Y
RCP Index : 3
RCP ID : 00 10 00 00 18
Downstream Channel DCID RF Channel : 117 7/0/0:0
Downstream Channel DCID RF Channel : 118 7/0/0:1
Downstream Channel DCID RF Channel : 119 7/0/0:2
Downstream Channel DCID RF Channel : 120 7/0/0:3
Downstream Channel DCID RF Channel : 121 7/0/1:0
Downstream Channel DCID RF Channel : 122 7/0/1:1
Downstream Channel DCID RF Channel : 123 7/0/1:2
Downstream Channel DCID RF Channel : 124 7/0/1:3
Downstream Channel DCID RF Channel : 125 7/0/2:0
Downstream Channel DCID RF Channel : 126 7/0/2:1
Downstream Channel DCID RF Channel : 127 7/0/2:2
Downstream Channel DCID RF Channel : 128 7/0/2:3
Downstream Channel DCID RF Channel : 129 7/0/3:0
Downstream Channel DCID RF Channel : 130 7/0/3:1
Downstream Channel DCID RF Channel : 131 7/0/3:2
Downstream Channel DCID RF Channel : 132 7/0/3:3
Extended Upstream Transmit Power : 61dB
Multi-Transmit Channel Mode : Y
Number of US in UBG : 4
Upstream Channel : US0 US1 US2 US3

```

```

Ranging Status : sta sta sta sta
Upstream SNR (dB) : 36.12 36.12 36.12 36.12
Upstream Data SNR (dB) : -- -- -- --
Received Power (dBmV) : -0.50 -0.50 0.00 -0.50
Reported Transmit Power (dBmV) : 38.25 38.25 38.25 38.25
Peak Transmit Power (dBmV) : 61.00 61.00 61.00 61.00
Phy Max Power (dBmV) : 51.00 51.00 51.00 51.00
Minimum Transmit Power (dBmV) : 24.00 24.00 24.00 24.00
Timing Offset (97.6 ns): 1348 1348 1348 1348
Initial Timing Offset : 1092 1092 1092 1348
Rng Timing Adj Moving Avg(0.381 ns): 0 0 -1 0
Rng Timing Adj Lt Moving Avg : 644 737 644 0
Rng Timing Adj Minimum : 0 0 -256 0
Rng Timing Adj Maximum : 65536 65536 65536 256
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 : 25 30 36 67
Corrected Codewords rx : 0 0 0 0
Uncorrectable Codewords rx : 0 0 0 0
Phy Operating Mode : atdma* atdma* atdma* atdma*
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=Y, eSAFE=Y}
Sid/Said Limit : {Max US Sids=8, Max DS Sids=64}
Optional Filtering Support : {802.1P=N, 802.1Q=N, DUT=Y}
Transmit Equalizer Support : {Taps/Symbol= 1, Num of Taps= 24}
Number of CPE : 1(Max CPE = 16)
Number of CPE IPs : 0(Max CPE IPs = 16)
CFG Max-CPE : 16
Flaps : 0()
Errors : 0 CRCs, 0 HCSes
Stn Mtn Failures : 0 aborts, 0 exhausted
Total US Flows : 1(1 active)
Total DS Flows : 1(1 active)
Total US Data : 29 packets, 8048 bytes
Total US Throughput : 0 bits/sec, 0 packets/sec
Total DS Data : 1 packets, 275 bytes
Total DS Throughput : 0 bits/sec, 0 packets/sec
LB group ID assigned (index) : 2151481601 (48385)
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 :
Ranging Class ID : 0x2
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 : 63
MDF Capability Mode : 2
IGMP/MLD Version : MLDv2
FCType10 Forwarding Support : Y
Features Bitmask : 0x0

```

Total Time Online : 08:06 (08:06 since last counter reset)  
 CM Initialization Reason : T4\_EXPIRED  
 CFG Max IPv6 CPE Prefix : 16 (-1 used)

Following is a sample output of the **show cable modem verbose** command in Cisco IOS Release 12.2(33)SCH2:

Router# **show cable modem 68b6.fcfe.22e5 verbose**

```

MAC Address                : 68b6.fcfe.22e5
IP Address                 : 192.168.0.8
IPv6 Address               : 2001:DB8:10:1:9951:1972:33F9:9867
Dual IP                   : Y
Prim Sid                   : 8
Host Interface             : C8/0/0/UB
MD-DS-SG / MD-US-SG      : 1 / 2
MD-CM-SG                  : 0x5A0102
Primary Wideband Channel ID : 3073 (Wi8/0/0:0)
Primary Downstream        : Mo8/0/0:0 (RfId : 2304)
Wideband Capable         : Y
RCP Index                  : 3
RCP ID                     : 00 10 00 00 18
Downstream Channel DCID RF Channel : 45      8/0/0:0
Downstream Channel DCID RF Channel : 46      8/0/0:1
Downstream Channel DCID RF Channel : 47      8/0/0:2
Downstream Channel DCID RF Channel : 48      8/0/0:3
Downstream Channel DCID RF Channel : 49      8/0/0:4
Downstream Channel DCID RF Channel : 50      8/0/0:5
Downstream Channel DCID RF Channel : 51      8/0/0:6
Downstream Channel DCID RF Channel : 52      8/0/0:7
Downstream Channel DCID RF Channel : 53      8/0/0:8
Downstream Channel DCID RF Channel : 54      8/0/0:9
Downstream Channel DCID RF Channel : 55      8/0/0:10
Downstream Channel DCID RF Channel : 56      8/0/0:11
Downstream Channel DCID RF Channel : 57      8/0/0:12
Downstream Channel DCID RF Channel : 58      8/0/0:13
Downstream Channel DCID RF Channel : 59      8/0/0:14
Downstream Channel DCID RF Channel : 60      8/0/0:15
Downstream Channel DCID RF Channel : 61      8/0/0:16
Downstream Channel DCID RF Channel : 62      8/0/0:17
Downstream Channel DCID RF Channel : 63      8/0/0:18
Downstream Channel DCID RF Channel : 64      8/0/0:19
Downstream Channel DCID RF Channel : 65      8/0/0:20
Downstream Channel DCID RF Channel : 66      8/0/0:21
Downstream Channel DCID RF Channel : 67      8/0/0:22
Downstream Channel DCID RF Channel : 68      8/0/0:23
UDC Enabled                : N
Extended Upstream Transmit Power : 61dB
Multi-Transmit Channel Mode : Y
Number of US in UBG       : 8
Upstream Channel          : US0          US1          US2          US3
Ranging Status            : sta          sta          sta          sta
Upstream SNR (dB)         : 30.62         32.32         18.25         24.26
Upstream Data SNR (dB)    : --           --           --           --
Received Power (dBmV)     : 0.50          0.00         -0.50         -0.50
Reported Transmit Power (dBmV) : 30.75         30.75         29.25         29.25
Peak Transmit Power (dBmV) : 61.00         61.00         61.00         61.00
Phy Max Power (dBmV)     : 48.00         48.00         48.00         48.00
Minimum Transmit Power (dBmV) : 21.00         21.00         21.00         21.00
Timing Offset              (97.6 ns) : 1800          1800          1800          1800
Initial Timing Offset     : 1544          1544          1544          1544
Rng Timing Adj Moving Avg(0.381 ns) : -1            0            -1            -1
Rng Timing Adj Lt Moving Avg : -7            0            -7            -7
Rng Timing Adj Minimum    : -256          0            -256          -256
Rng Timing Adj Maximum    : 65536         65536         65536         65536
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         : 1201          1262          833           656
Corrected Codewords rx    : 0             0             169           117
Uncorrectable Codewords rx : 0             0             205           335
Phy Operating Mode        : atdma*        atdma*        atdma*        atdma*
Upstream Channel          : US4           US5           US6           US7

```



```

Ranging Status                : sta      sta      sta      sta
Upstream SNR (dB)             : 15.53   31.62   31.1     31.87
Upstream Data SNR (dB)       : --      --      --      --
Received Power (dBmV)         : 0.00    0.00    -0.50    0.50
Reported Transmit Power (dBmV) : 29.25   30.75   30.75    30.75
Peak Transmit Power (dBmV)    : 61.00   61.00   61.00    61.00
Phy Max Power (dBmV)         : 48.00   48.00   48.00    48.00
Minimum Transmit Power (dBmV) : 21.00   21.00   21.00    21.00
Timing Offset (97.6 ns)      : 1800    1800    1800     1800
Initial Timing Offset         : 1544    1800    1544     1544
Rng Timing Adj Moving Avg(0.381 ns) : -1      -1      46       0
Rng Timing Adj Lt Moving Avg  : -7      -7      104      0
Rng Timing Adj Minimum        : -256    -256    0         0
Rng Timing Adj Maximum        : 65536   256     65536    65536
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             : 718     1328    1173     1252
Corrected Codewords rx        : 110     0       0         0
Uncorrectable Codewords rx    : 298     0       0         0
Phy Operating Mode            : atdma*  atdma*  atdma*   atdma*
sysDescr                      : DOCSIS 3.0 Cable Modem Router
Downstream Power              : 7.40 dBmV (SNR = 43.30 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=Y, eSAFE=Y}
Sid/Said Limit                : {Max US Sids=8, Max DS Sids=64}
Optional Filtering Support     : {802.1P=N, 802.1Q=N, DUT=Y}
Transmit Equalizer Support     : {Taps/Symbol= 1, Num of Taps= 24}
Number of CPE                  : 0 (Max CPE = 16)
Number of CPE IPs             : 0 (Max CPE IPs = 16)
Number of CPE IPv6            : 0 (Max CPE IPv6 = 16)
CFG Max-CPE                   : 16
Flaps                          : 19(Oct 11 04:00:25)
Errors                         : 0 CRCs, 0 HCSes
Stn Mtn Failures              : 0 aborts, 12 exhausted
Total US Flows                 : 1(1 active)
Total DS Flows                 : 1(1 active)
Total US Data                  : 3294 packets, 577031 bytes
Total US Throughput            : 0 bits/sec, 0 packets/sec
Total DS Data                  : 2263 packets, 200777 bytes
Total DS Throughput            : 0 bits/sec, 0 packets/sec
LB group ID assigned (index)   : 2153382146 (55810)
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 :
Ranging Class ID           : 0x2
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 : 63
MDF Capability Mode            : 2
IGMP/MLD Version              : MLDv2
FCType10 Forwarding Support    : Y

```

```

Features Bitmask           : 0x0
Total Time Online         : 9h27m (9h27m since last counter reset)
CM Initialization Reason  : BAD_DHCP_ACK
CFG Max IPv6 CPE Prefix   : 16 (-1 used)

```

## Clearing Attribute Masks

If the cable modem fails to come online after configuring attribute masks in the cable modem configuration file, you can use the following procedure to verify the contents of the cable modem configuration file and clear its contents if the attribute masks are configured differently.

### DETAILED STEPS

	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>show cable modem verbose</b>  <b>Example:</b> Router# <b>show cable modem verbose</b>	Verifies whether the cable modem attribute masks have been configured in the cable modem configuration file.  <b>Note</b> If the cable modem configuration file shows any change, use the <b>clear cable modem attribute-masks</b> command.
<b>Step 3</b>	<b>clear cable modem attribute-masks</b>  <b>Example:</b> Router# <b>clear cable modem all attribute-masks</b>	Clears the cable modem attribute masks stored in CMTS.
<b>Step 4</b>	<b>show running-config</b>  <b>Example:</b> Router# <b>show running-config</b>	Displays the running configuration.  Use it to verify whether upstream masks of the cable modem are configured on the corresponding upstream channel.

## Debugging Channel Redirection

Use the following steps to debug channel redirection:

### DETAILED STEPS

	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>show running config</b>	Displays the running configuration.

	Command or Action	Purpose
	<b>Example:</b> Router# <code>show running config</code>	<b>Note</b> You can use this information to verify the CMTS configuration to make sure that the cable modems can reach the configured downstream-frequency.
<b>Step 3</b>	<b>debug cable range</b>  <b>Example:</b> Router# <code>debug cable range</code>	Displays ranging messages from cable modems on the Hybrid Fiber-Coaxial (HFC) network.
<b>Step 4</b>	<b>debug cable registration</b>  <b>Example:</b> Router# <code>debug cable registration</code>	Displays debug messages for the cable modem registration process.
<b>Step 5</b>	<b>debug cable mac-address <i>mac</i> verbose</b>  <b>Example:</b> Router# <code>debug cable mac-address 00E0.1E00.0000 ffff.ff00.0000 verbose</code>	Displays debug information for a specific cable modem.
<b>Step 6</b>	<b>clear cable modem <i>mac</i> delete</b>  <b>Example:</b> Router# <code>clear cable modem 00E0.1E00.0000 ffff.ff00.0000 delete</code>	Removes the specified modem from the CMTS.  <b>Note</b> This allows the CMTS to re-register the cable modem's page.

## Troubleshooting Tips

This section provides tips and commands you can use to troubleshoot your cable modem steering configuration.

- [Clearing Attribute Masks, on page 92](#)
- [Debugging Channel Redirection, on page 92](#)
- Because empty rules are not allowed, if you remove the last rule of a policy, using **no cable load-balance docsis-policy *policy-id* rule *rule-id*** or **no cable load-balance rule *rule-id***, the policy itself will be removed.
- Use the **show running | include docsis-policy** command or the **show running-config | include rule** command to see the policy and rule configured in the system.

## Additional References

The following sections provide references related to the Cable Modem Steering feature.

**Related Documents**

Related Topic	Document Title
CMTS cable commands	<a href="#">Cisco IOS CMTS Cable Command Reference</a>
DOCSIS 1.1 as it relates to Cisco CMTS	<a href="#">Cisco IOS CMTS Cable Software Configuration Guide</a>
Load Balancing and Dynamic Channel Change (DCC)	<a href="#">Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers</a>
N+1 Redundancy	<a href="#">N+1 Redundancy for the Cisco Cable Modem Termination System</a>

**Standards and RFCs**

Standard	Title
CM-SP-MULPIv3.0-I07-080215	DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification
CM-SP-MULPIv3.0-I18-120329	DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification
CM-SP-RFI2.0-I13-080215	DOCSIS 2.0 Radio Frequency Interface Specification

**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/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

# Feature Information for Cable Modem Steering

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



## Note

The table below 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 8: Feature Information for Cable Modem Steering on the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
Channel Redirection	12.2(33)SCB	<p>Channel redirection allows you to redirect or steer the cable modems to one or more CMTS using downstream overrides.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Channel Redirection, on page 79</a></li> <li>• <a href="#">Configuring a Channel Redirection, on page 80</a></li> <li>• <a href="#">Verifying a Channel Redirection, on page 86</a></li> </ul> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable service type</b></li> <li>• <b>cable service type ds-frequency</b></li> <li>• <b>clear cable modem attribute-masks</b></li> <li>• <b>clear cable modem service-type</b></li> <li>• <b>show cable modem service-type-id</b></li> </ul>

Feature Name	Releases	Feature Information
Channel Restriction	12.2(33)SCB	<p>The CMTS can impose restrictions on the channels a cable modem can use based on the cable modem configuration file or its capabilities.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Channel Restriction, on page 79</a></li> <li>• <a href="#">Configuring a Channel Restriction, on page 81</a></li> <li>• <a href="#">Verifying a Channel Restriction, on page 87</a></li> </ul> <p>The following command is introduced: <b>cable upstream attribute-mask</b>.</p>
Channel Restriction	12.2(33)SCB4	<p>When the CMTS cannot find an appropriate US channel in the same legacy LB group, the cable modem steering checking is skipped and cable modems come online.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Configuring a Channel Restriction, on page 81</a></li> </ul>
RLBG/GLBG Support and NB DBS Interact with DLB Support	12.2(33)SCC	<p>The following sections have been updated with information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Channel Restriction, on page 79</a></li> <li>• <a href="#">Configuring a Channel Restriction, on page 81</a></li> </ul>

Feature Name	Releases	Feature Information
UCD TLV for Ranging Hold-off	12.2(33)SCH	<p>The UCD TLV for Ranging Hold-off feature enables the CMTS router to hold off a cable modem from initial ranging.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Upstream Channel Descriptor TLV for Ranging Hold-off, on page 80</a></li> <li>• <a href="#">Configuring an Upstream Channel Class ID, on page 82</a></li> <li>• <a href="#">Configuring an Upstream Ranging Hold-off Priority Value , on page 84</a></li> </ul> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable load-balance exclude</b></li> <li>• <b>cable upstream chan-class-id</b></li> <li>• <b>cable upstream rng-holdoff</b></li> <li>• <b>show cable modem verbose</b></li> </ul>
16x4 Cable Modem Support	12.2(33)SCH1	<p>The cable modems can come w-online with up to 16 downstream channels and 4 upstream channels.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Channel Restriction, on page 79</a></li> </ul>
24x8 Cable Modem Support	12.2(33)SCH2	<p>The cable modems can come w-online with up to 24 downstream channels and 8 upstream channels.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Channel Restriction, on page 79</a></li> </ul>







# DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers

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**Note**

Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

This document describes the DOCSIS 2.0 A-TDMA services feature, which provides support for DOCSIS 2.0 Advanced Time Division Multiple Access (A-TDMA) upstream modulation profiles on the Cisco uBR-MC16U/X, Cisco uBR-MC28U/X, and Cisco uBR-MC5X20S/U Broadband Processing Engine (BPE) cable interface line cards. This feature supplements the existing support for DOCSIS 1.0 and DOCSIS 1.1 Time Division Multiple Access (TDMA) modulation profiles.

## 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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## Prerequisites for DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers

The table below shows the hardware compatibility prerequisites for this feature.

**Table 9: DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(15)BC2 and later releases <ul style="list-style-type: none"> <li>• PRE-1</li> <li>• PRE-2</li> </ul> Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• PRE-2</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.3(15)BC2 and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul> Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(15)CX and 12.2(15)BC2 and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(15)CX and 12.2(15)BC2 and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul> Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>

- The cable physical plant must be capable of supporting the higher-bandwidth DOCSIS 2.0 A-TDMA modulation profiles.
- Cable modems must be DOCSIS-compliant. If cable modems go offline, or appear to be online but do not pass traffic when in the mixed TDMA/A-TDMA mode, upgrade the modem software to a DOCSIS-compliant version.
- The following are required to support the DOCSIS 2.0 A-TDMA features:
  - Cable modems must be DOCSIS 2.0 capable.
  - The DOCSIS configuration file for a DOCSIS 2.0 cable modem must either omit the DOCSIS 2.0 Enable field (TLV 39), or it must set TLV 39 to 1 (enable). If you set TLV 39 to 0 (disable), a DOCSIS 2.0 CM uses the TDMA mode.
  - The upstream must be configured for either A-TDMA-only or mixed TDMA/A-TDMA mode. To use the 6.4 MHz channel width, the upstream must be configured for A-TDMA-only mode.
- Complete a basic configuration of the Cisco uBR7246VXR or Cisco uBR10012 router; this includes, at a minimum, the following tasks:
  - Configure a host name and password for the router.
  - Configure the router to support Internet Protocol (IP) operations.
  - Install and configure at least one WAN adapter to provide backbone connectivity.
- Determine a channel plan for your Cisco uBR7246VXR or Cisco uBR10012 router and all of its cable interfaces.
- Verify that your headend site includes all necessary servers to support DOCSIS and Internet connectivity, including DHCP, ToD, and TFTP servers.
- The system clock on the Cisco uBR7246VXR or Cisco uBR10012 router should be set to a current date and time to ensure that system logs have the proper timestamp and to ensure that the BPI+ subsystem uses the correct timestamp for verifying cable modem digital certificates.

## Restrictions for DOCSIS 2.0 A-TDMA Services

- Does not support virtual channels, as described in DOCSIS 2.0 specification.
- Does not support Synchronous Code Division Multiple Access (S-CDMA) channels.

- Cisco IOS Release 12.2(15)CX, Release 12.2(15)BC2, and later releases support a maximum of 10 modulation profiles for each of the three DOCSIS modes (DOCSIS 1.x TDMA, mixed, and DOCSIS 2.0 A-TDMA), for a total maximum of 30 modulation profiles.
- Advanced hardware-based spectrum management is not supported for DOCSIS 2.0 mixed-mode and A-TDMA upstreams. Advanced spectrum management features (such as guided frequency hopping, dynamic upstream modulation, and proactive CNR-based frequency hopping and channel width changes) can be configured only on DOCSIS and EuroDOCSIS 1.X upstreams. You cannot use these features on channels configured for mixed mode or DOCSIS 2.0 A-TDMA mode. Advanced hardware-based spectrum management for A-TDMA operations is scheduled to be supported in a future release of the Cisco IOS software.
- Changing the DOCSIS mode of an upstream takes all cable modems on that upstream offline, which forces the cable modems to reregister, so that the CMTS can determine the capabilities of the cable modems on the new channels.

## Information About DOCSIS 2.0 A-TDMA Services

DOCSIS 2.0 A-TDMA services improve the maximum upstream bandwidth on existing DOCSIS 1.0 and DOCSIS 1.1 cable networks by providing a number of advanced PHY capabilities that have been specified by the new DOCSIS 2.0 specifications.

In Cisco IOS Release 12.2(15)BC2, DOCSIS 2.0 A-TDMA services are supported on the Cisco uBR-MC16U/X, Cisco uBR-MC28U/X, and Cisco uBR-MC5X20S/U Broadband Processing Engine (BPE) cable interface line cards.

DOCSIS 2.0 A-TDMA services incorporate the following advantages and improvements of DOCSIS 2.0 networks:

- Builds on existing DOCSIS cable networks by providing full compatibility with existing DOCSIS 1.0 and DOCSIS 1.1 cable modems. (The registration response (REG-RSP) message contains the DOCSIS version number to identify each cable modem's capabilities.)
- Upstreams can be configured for three different modes to support different mixes of cable modems:
  - An upstream can be configured for TDMA mode to support only DOCSIS 1.0 and DOCSIS 1.1 cable modems.
  - An upstream can be configured for A-TDMA mode to support only DOCSIS 2.0 cable modems.
  - An upstream can be configured for a mixed, TDMA/A-TDMA mode, to support both DOCSIS 1.0/DOCSIS 1.1 and DOCSIS 2.0 cable modems on the same upstream.



### Note

DOCSIS 2.0 A-TDMA cable modems will not register on a TDMA upstream if an A-TDMA or mixed upstream exists in the same MAC domain, unless the CMTS explicitly switches the cable modem to another upstream using an Upstream Channel Change (UCC) message. DOCSIS 1.0 and DOCSIS 1.1 cable modems cannot register on an A-TDMA-only upstream.

- A-TDMA mode defines new interval usage codes (IUC) of A-TDMA short data grants, long data grants, and Unsolicited Grant Service (UGS) grants (IUC 9, 10, and 11) to supplement the existing DOCSIS 1.1 IUC types.
- Increases the maximum channel capacity for A-TDMA upstreams to 30 Mbps per 6 MHz channel.
- A-TDMA and mixed modes of operation provide higher bandwidth on the upstream using new 32-QAM and 64-QAM modulation profiles, while retaining support for existing 16-QAM and QPSK modulation profiles. In addition, an 8-QAM modulation profile is supported for special applications.
- Supports a minislot size of 1 tick for A-TDMA operations.
- Increases channel widths to 6.4 MHz (5.12 Msymbol rate) for A-TDMA operations.
- A-TDMA and mixed modes of operation provide a more robust operating environment with increased protection against ingress noise and other signal impairments, using a number of new features:
  - Uses a symbol (T)-spaced adaptive equalizer structure to increase the equalizer tap size to 24 taps, compared to 8 taps in DOCSIS 1.x mode. This allows operation in the presence of more severe multipath and microreflections, and can accommodate operation near band edges where group delay could be a problem.
  - Supports new QPSK0 and QPSK1 preambles, which provide improved burst acquisition by performing simultaneous acquisition of carrier and timing lock, power estimates, equalizer training, and constellation phase lock. This allows shorter preambles, reducing implementation loss.
  - Increases the forward error correction (FEC) T-byte size to 16 bytes per Reed Solomon block (T=16) with programmable interleaving.

**Note**


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Cisco IOS Release 12.2(15)BC2 does not support the Synchronous Code Division Multiple Access (S-CDMA) modulation technique that is also specified in the DOCSIS 2.0 specification.

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## Modes of Operation

Depending on the configuration, the DOCSIS 2.0 A-TDMA Service feature supports either DOCSIS or Euro-DOCSIS operation:

- DOCSIS cable networks are based on the ITU J.83 Annex B physical layer standard and Data-over-Cable Service Interface Specifications (DOCSIS, Annex B) specification, which use 6 MHz National Television Systems Committee (NTSC) channel plans. In this mode, the downstream uses a 6 MHz channel width in the 85 to 860 MHz frequency range, and the upstream supports multiple channel widths in the 5 to 42 MHz frequency range.

Cisco IOS Release 12.2(15)BC2 also supports an extended frequency range for DOCSIS cable networks, in which the upstream channel widths can range from 5 to 55 MHz.

- EuroDOCSIS cable networks are based on the ITU J.112 Annex A physical layer standard and European DOCSIS (EuroDOCSIS, Annex A) specification, which use 8 MHz Phase Alternating Line (PAL) and Systeme Electronique Couleur Avec Memoire (SECAM) channel plans. In this mode, the downstream uses an 8 MHz channel width in the 85 to 860 MHz frequency range, and the upstream supports multiple channel widths in the 5 to 65 MHz frequency range.

**Note**

The difference between DOCSIS and EuroDOCSIS is at the physical layer. To support a DOCSIS or EuroDOCSIS network requires the correct configuration of the DOCSIS 2.0 A-TDMA Service card, as well as upconverters, diplex filters, and other equipment that supports the network type.

When using Cisco IOS Release 12.2(15)BC2, the Cisco uBR-MC16U/X, Cisco uBR-MC28U/X, and Cisco uBR-MC5X20S/U cards support all DOCSIS 1.1-specified and all DOCSIS 2.0-specified A-TDMA radio frequency (RF) data rates, channel widths, and modulation schemes.

The table below shows the maximum supported DOCSIS 1.1 data rates.

**Table 10: Maximum DOCSIS 1.1 Data Rates**

Upstream Channel Width	Modulation Scheme	Baud Rate Sym/sec	Maximum Raw Bit Rate Mbit/sec
3.2 MHz	16-QAM QPSK	2.56 M	10.24 5.12
1.6 MHz	16-QAM QPSK	1.28 M	5.12 2.56
800 kHz	16-QAM QPSK	640 K	2.56 1.28
400 kHz	16-QAM QPSK	320 K	1.28 0.64
200 kHz	16-QAM QPSK	160 K	0.64 0.32

The table below shows the maximum supported DOCSIS 2.0 (A-TDMA-mode) data rates.

**Table 11: Maximum DOCSIS 2.0 (A-TDMA-mode) Data Rates**

Upstream Channel Width	Modulation Scheme	Baud Rate Sym/sec	Maximum Raw Bit Rate Mbit/sec
6.4 MHz	64-QAM	5.12 M	30.72
	32-QAM		25.60
	16-QAM		20.48
	8-QAM		15.36
	QPSK		10.24
3.2 MHz	64-QAM	2.56 M	15.36
	32-QAM		12.80
	16-QAM		10.24
	8-QAM		7.68
	QPSK		5.12

Upstream Channel Width	Modulation Scheme	Baud Rate Sym/sec	Maximum Raw Bit Rate Mbit/sec
1.6 MHz	64-QAM	1.28 M	7.68
	32-QAM		6.40
	16-QAM		5.12
	8-QAM		3.84
	QPSK		2.56
800 kHz	64-QAM	640 K	3.84
	32-QAM		3.20
	16-QAM		2.56
	8-QAM		1.92
	QPSK		1.28
400 kHz	64-QAM	320 K	1.92
	32-QAM		1.60
	16-QAM		1.28
	8-QAM		0.96
	QPSK		0.64
200 kHz	64-QAM	160 K	0.96
	32-QAM		0.80
	16-QAM		0.64
	8-QAM		0.48
	QPSK		0.32

## Modulation Profiles

To simplify the administration of A-TDMA and mixed TDMA/A-TDMA modulation profiles, the DOCSIS 2.0 A-TDMA Service feature provides a number of preconfigured modulation profiles that are optimized for different modulation schemes. We recommend using these preconfigured profiles.

Each mode of operation also defines a default modulation profile that is automatically used when a profile is not specifically assigned to an upstream. These default modulation profiles (1, 21, 41, 101, 121, 141, 201, 221, and 241, depending on the cable interface line cards that are installed) cannot be deleted. The valid range for modulation profiles depends on the cable interface being used and the type of modulation profile being created. The table below lists the valid ranges according to cable interface and modulation type:

**Table 12: Allowable Ranges for Modulation Profiles**

Cable Interface	DOCSIS 1.X (TDMA)	Mixed DOCSIS 1.X/2.0	DOCSIS 2.0 (A-TDMA)
Cisco uBR7100 series	1 to 10 (default is 1)	N/A	N/A
Cisco uBR-MC16C	1 to 10 (default is 1)	N/A	N/A
Cisco uBR-MC16S	1 to 10 (default is 1)	N/A	N/A
Cisco uBR-MC28C	1 to 10 (default is 1)	N/A	N/A
Cisco uBR-MC5X20S/U	21 to 30 (default is 21)	121 to 130 (default is 121)	221 to 230 (default is 221)
Cisco uBR-MC16U/X, Cisco uBR-MC28U/X	41 to 50 (default is 41)	141 to 150 (default is 141)	241 to 250 (default is 241)

## Benefits

The DOCSIS 2.0 A-TDMA Service feature provides the following benefits to cable service providers and their partners and customers:

- Full compatibility with DOCSIS 1.0 and DOCSIS 1.1 cable modems (CMs) and cable modem termination systems (CMTS).
- Additional channel capacity in the form of more digital bits of throughput capacity in the upstream path.
- Increased protection against electronic impairments that occur in cable systems, allowing for a more robust operating environment.

## How to Configure DOCSIS 2.0 A-TDMA Services

This section contains the following:

### Creating Modulation Profiles

This section describes how to create modulation profiles for the different modes of DOCSIS operations, using the preconfigured modulation profile options.

#### Creating a TDMA Modulation Profile

This section describes how to create a modulation profile for the DOCSIS 1.0/DOCSIS 1.1 TDMA mode of operation, using one of the preconfigured modulation profiles.



## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable modulation-profile <i>profile</i></b> <b>{mix   qam-16   qpsk   robust-mix}</b>  <b>Example:</b> Router(config)# <b>cable modulation-profile 3 mix</b> Router(config)# <b>cable modulation-profile 4 qpsk</b>	<p>Creates a preconfigured modulation profile, where the burst parameters are set to their default values for each burst type:</p> <ul style="list-style-type: none"> <li>• <i>profile</i>— Specifies the modulation profile number. The valid range depends on the cable interface line card:               <ul style="list-style-type: none"> <li>◦ For the Cisco uBR-MC5X20S/U card, the valid range is 21 to 30. The system creates profile 21 as a default TDMA-only modulation profile.</li> <li>◦ For the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X card, the valid range is 41 to 50. The system creates profile 41 as a default TDMA-only modulation profile.</li> <li>◦ For all other cable interface line cards, the valid range is 1 to 10. The system creates profile 1 as a default TDMA-only modulation profile.</li> </ul> </li> <li>• The following preconfigured profiles are available:               <ul style="list-style-type: none"> <li>◦ <b>mix</b>— Default QPSK/16-QAM profile.</li> <li>◦ <b>qam-16</b>— Default 16-QAM profile.</li> <li>◦ <b>qpsk</b>— Default QPSK profile.</li> <li>◦ <b>robust-mix</b>— Default QPSK/16-QAM profile that is more robust and more able to deal with noise than the mix profile.</li> </ul> </li> </ul> <p><b>Note</b> You can also create custom modulation profiles with the <b>cable modulation-profile</b> command by configuring the values for the individual burst parameters. These parameters, however, should not be modified unless you are thoroughly familiar with how changing each parameter affects the DOCSIS MAC layer. We recommend using the preconfigured default modulation profiles for most cable plants.</p>
Step 4	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Creating a Mixed Mode Modulation Profile

This section describes how to create a modulation profile for the mixed TDMA/A-TDMA mode of operation, using one of the preconfigured modulation profiles.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><b>enable</b></p> <p><b>Example:</b> Router&gt; <b>enable</b></p>	<p>Enables privileged EXEC mode.</p> <p>Enter your password if prompted.</p>
Step 2	<p><b>configure terminal</b></p> <p><b>Example:</b> Router# <b>configure terminal</b></p>	<p>Enters global configuration mode.</p>
Step 3	<p><b>cable modulation-profile</b> <i>profile</i> {<b>mix-high</b>   <b>mix-low</b>   <b>mix-mid</b>   <b>mix-qam</b>   <b>qam-16</b>   <b>qpsk</b>   <b>robust-mix-high</b>   <b>robust-mix-mid</b>   <b>robust-mix-qam</b>}</p> <p><b>Example:</b> Router(config)# <b>cable</b> <b>modulation-profile 143 mix-medium</b></p> <p>Router(config)# <b>cable</b> <b>modulation-profile 144 mix-high</b></p>	<p>Creates a preconfigured modulation profile, where the burst parameters are set to their default values for each burst type:</p> <ul style="list-style-type: none"> <li>• <i>profile</i>— Specifies the modulation profile number. The valid range depends on the cable interface line card: <ul style="list-style-type: none"> <li>◦ For the Cisco uBR-MC5X20S/U card, the valid range is 121 to 130. The system creates profile 121 as a default mixed mode modulation profile.</li> <li>◦ For the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cards, the valid range is 141 to 150. The system creates profile 141 as a default mixed mode modulation profile.</li> </ul> </li> <li>• The following preconfigured profiles are available: <ul style="list-style-type: none"> <li>◦ <b>mix-high</b> and <b>robust-mix-high</b>—Default QPSK/64-QAM profile.</li> <li>◦ <b>mix-low</b>—Default QPSK/16-QAM profile.</li> <li>◦ <b>mix-mid</b> and <b>robust-mix-mid</b>— Default QPSK/32-QAM profile.</li> <li>◦ <b>mix-qam</b> and <b>robust-mix-qam</b>— Default 16-QAM/64-QAM profile.</li> <li>◦ <b>qam-16</b>— Default 16-QAM modulation profile.</li> <li>◦ <b>qpsk</b>— Default QPSK modulation profile.</li> </ul> </li> </ul> <p><b>Note</b> The <b>robust-mix</b> profiles are similar to but more robust than the <b>mix</b> profiles, so that they more able to detail with noise on the upstream.</p> <p><b>Note</b> You can also create custom modulation profiles with the <b>cable modulation-profile</b> command by configuring the values for the individual burst parameters. These parameters, however, should not be modified unless you are thoroughly familiar with how changing each parameter affects the DOCSIS MAC layer. We recommend using the preconfigured default modulation profiles for most cable plants.</p>

	Command or Action	Purpose
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Creating an A-TDMA Modulation Profile

This section describes how to create a modulation profile for the DOCSIS 2.0 A-TDMA mode of operation, using one of the preconfigured modulation profiles.

### DETAILED STEPS

	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 modulation-profile</b> <i>profile</i> { <b>mix-high</b>   <b>mix-low</b>   <b>mix-mid</b>   <b>mix-qam</b>   <b>qam-8</b>   <b>qam-16</b>   <b>qam-32</b>   <b>qam-64</b>   <b>qpsk</b>   <b>robust-mix-high</b>   <b>robust-mix-low</b>   <b>robust-mix-mid</b> }  <b>Example:</b> Router(config)# <b>cable</b> <b>modulation-profile 242 qam-32</b> Router(config)# <b>cable</b> <b>modulation-profile 243 qam-64</b>	Creates a preconfigured modulation profile, where the burst parameters are set to their default values for each burst type: <ul style="list-style-type: none"> <li>• <i>profile</i>— Specifies the modulation profile number. The valid range depends on the cable interface line card:               <ul style="list-style-type: none"> <li>◦ For the Cisco uBR-MC5X20S/U card, the valid range is 221 to 230. The system creates profile 221 as a default DOCSIS 2.0 A-TDMA mode modulation profile.</li> <li>◦ For the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cards, the valid range is 241 to 250. The system creates profile 241 as a default DOCSIS 2.0 A-TDMA mode modulation profile.</li> </ul> </li> <li>• The following preconfigured profiles are available:               <ul style="list-style-type: none"> <li>◦ <b>mix-high</b> and <b>robust-mix-high</b>— Default QPSK/64-QAM profile.</li> <li>◦ <b>mix-low</b> and <b>robust-mix-low</b>— Default QPSK/16-QAM profile.</li> <li>◦ <b>mix-mid</b> and <b>robust-mix-mid</b>— Default QPSK/32-QAM profile.</li> <li>◦ <b>mix-qam</b>— Default 16-QAM/64-QAM profile.</li> <li>◦ <b>qam-8</b>— Default 8-QAM profile.</li> </ul> </li> </ul>

	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>◦ <b>qam-16</b>— Default 16-QAM profile.</li> <li>◦ <b>qam-32</b>— Default 32-QAM profile.</li> <li>◦ <b>qam-64</b>— Default 64-QAM profile.</li> <li>◦ <b>qpsk</b>— Default QPSK modulation profile.</li> </ul> <p><b>Note</b> The <b>robust-mix</b> profiles are similar to but more robust than the <b>mix</b> profiles, so that they more able to detail with noise on the upstream.</p> <p><b>Note</b> You can also create custom modulation profiles with the <b>cable modulation-profile</b> command by configuring the values for the individual burst parameters. These parameters, however, should not be modified unless you are thoroughly familiar with how changing each parameter affects the DOCSIS MAC layer. We recommend using the preconfigured default modulation profiles for most cable plants.</p>
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Configuring the DOCSIS Mode and Profile on an Upstream

This section describes how to configure an upstream for a DOCSIS mode of operation, and then to assign a particular modulation profile to that upstream.



**Note** By default, all upstreams are configured for ATDMA-only mode, using the default modulation profile of 1, 21, or 41, depending on the cable interface line card.

### DETAILED STEPS

	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
Step 3	<b>interface cable</b> <i>x/y/z</i>  <b>Example:</b> <pre>Router(config)# interface cable c5/1/1</pre>	Enters interface configuration mode for the indicated cable downstream interface.
Step 4	<b>cable upstream</b> <i>n</i> <b>docsis-mode</b> { <b>atdma</b>   <b>tdma</b>   <b>tdma-atdma</b> }  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 docsis-mode atdma Router(config-if)# cable upstream 1 docsis-mode tdma-atdma</pre>	<p>Configures the upstream for the desired DOCSIS mode of operation:</p> <ul style="list-style-type: none"> <li>• <i>n</i>— Specifies the upstream port. Valid values start with 0 for the first upstream port on the cable interface line card.</li> <li>• <b>atdma</b>— Configures the upstream for DOCSIS 2.0 A-TDMA modulation profiles only (default).</li> <li>• <b>tdma</b>— Configures the upstream for DOCSIS 1.X TDMA modulation profiles only.</li> <li>• <b>tdma-atdma</b>— Configures the upstream for both A-TDMA and TDMA operation (mixed mode).</li> </ul>
Step 5	<b>cable upstream</b> <i>n</i> <b>modulation-profile</b> <i>profile</i> [ <i>profile2</i> ]  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 modulation-profile 241 Router(config-if)# cable upstream 1 modulation-profile 131</pre>	<p>Assigns the particular modulation profile to this upstream.</p> <ul style="list-style-type: none"> <li>• <i>n</i>— Specifies the upstream port. Valid values start with 0 for the first upstream port on the cable interface line card.</li> <li>• <i>profile</i>— Specifies the modulation profile to be used on this upstream. The valid range for the <i>profile</i> parameter depends on the current DOCSIS mode: <ul style="list-style-type: none"> <li>◦ If the upstream is configured for DOCSIS 1.0 and DOCSIS 1.1 mode, the valid range is 21 to 30 for the Cisco uBR-MC5X20S, and 41 to 50 for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X. The valid range is 1 to 10 for all other cards.</li> <li>◦ If the upstream is configured for DOCSIS 1.X and DOCSIS 2.0 mixed mode, the valid range is 121 to 130 for the Cisco uBR-MC5X20S, and 141 to 150 for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X.</li> <li>◦ If the upstream is configured for DOCSIS 2.0 A-TDMA mode, the valid range is 221 to 230 for the Cisco uBR-MC5X20S, and 241 to 250 for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X.</li> </ul> </li> <li>• <i>profile2</i>— (Optional) Specifies the number of a secondary modulation profile that the interface uses when noise on the upstream increases to the point that the primary modulation profile can no longer be used. (The secondary profile should specify a more robust profile, in terms of coping with noise, than the primary profile.)</li> </ul> <p><b>Note</b> The type of modulation profiles must match the DOCSIS mode configured for the upstream, using the <b>cable upstream docsis-mode</b> command.</p>

	Command or Action	Purpose
<b>Step 6</b>	<b>cable upstream <i>n</i> equalization-coefficient</b>  <b>Example:</b> Router(config-if)# <b>cable upstream 0 equalization-coefficient</b>	(Optional) Enables the use of a DOCSIS pre-equalization coefficient on an upstream.  <ul style="list-style-type: none"> <li>• <i>n</i>— Upstream port. Valid values start with 0 for the first upstream port on the cable interface line card.</li> </ul>
<b>Step 7</b>	<b>cable upstream <i>n</i> ingress-noise-cancellation <i>interval</i></b>  <b>Example:</b> Router(config-if)# <b>cable upstream 0 ingress-noise-cancellation 400</b>	(Optional) Configures how often, in milliseconds, the line card should sample the signal on an upstream to correct any ingress noise that has appeared on that upstream.  <ul style="list-style-type: none"> <li>• <i>n</i>— Upstream port. Valid values start with 0 for the first upstream port on the cable interface line card.</li> <li>• <i>interval</i>— Sample interval. Valid range is 10 to 3000 milliseconds, with a default value of 200 milliseconds.</li> </ul>
<b>Step 8</b>	<b>cable upstream <i>n</i> maintain-psd</b>  <b>Example:</b> Router(config-if)# <b>cable upstream 0 maintain-psd</b>	(Optional) Requires DOCSIS 2.0 cable modems that are operating on an ATDMA-only upstream to maintain a constant power spectral density (PSD) after a modulation rate change.  <ul style="list-style-type: none"> <li>• <i>n</i>— Upstream port. Valid values start with 0 for the first upstream port on the cable interface line card.</li> </ul> <p><b>Note</b> Repeat <a href="#">Step 3, on page 111</a> through <a href="#">Step 8, on page 112</a> for each cable interface and upstream to be configured.</p>
<b>Step 9</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## Monitoring the DOCSIS 2.0 A-TDMA Services

This section contains the following:

### Displaying Modulation Profiles

To display the modulation profiles that are currently defined on the CMTS, use the **show cable modulation-profile** command without any options:

```
Router# show cable modulation-profile

Mod IUC      Type  Preamb  Diff  FEC    FEC    Scrambl  Max  Guard  Last  Scrambl  Preamb
      length enco T      k      seed   B      size  size  time  CW     yes  no     offset
                                BYTES  BYTES
21  request qpsk  64     no    0x0    0x10   0x152   0    8     no   yes    0
21  initial qpsk  128    no    0x5    0x22   0x152   0    48    no   yes    0
```

```

21 station qpsk 128 no 0x5 0x22 0x152 0 48 no yes 0
21 short qpsk 72 no 0x5 0x4B 0x152 6 8 yes yes 0
21 long qpsk 80 no 0x8 0xDC 0x152 0 8 yes yes 0
121 request qpsk 64 no 0x0 0x10 0x152 0 8 no yes 0
121 initial qpsk 128 no 0x5 0x22 0x152 0 48 no yes 0
121 station qpsk 128 no 0x5 0x22 0x152 0 48 no yes 0
121 short qpsk 72 no 0x5 0x4B 0x152 6 8 yes yes 0
121 long qpsk 80 no 0x8 0xDC 0x152 0 8 yes yes 0
121 a-short 64qam 128 no 0x5 0x63 0x152 10 8 yes yes 0
121 a-long 64qam 128 no 0xF 0xC8 0x152 0 8 yes yes 0
221 request qpsk 64 no 0x0 0x10 0x152 0 8 no yes 0
221 initial qpsk 128 no 0x5 0x22 0x152 0 48 no yes 0
221 station qpsk 128 no 0x5 0x22 0x152 0 48 no yes 0
221 short qpsk 72 no 0x5 0x4B 0x152 6 8 yes yes 0
221 long qpsk 80 no 0x8 0xDC 0x152 0 8 yes yes 0
221 a-short 64qam 128 no 0x5 0x63 0x152 10 8 yes yes 0
221 a-long 64qam 128 no 0xF 0xC8 0x152 0 8 yes yes 0
Router#

```

To display a specific modulation profile in detail, specify the profile number with the **show cable modulation-profile** command:

```
Router# show cable modulation-profile 221
```

```

Mod IUC      Type  Pre Diff FEC  FEC  Scramb Max Guard Last Scramb Pre  Pre  RS
           len enco T   k    seed  B   time CW  offst Type
           BYTE BYTE  siz size short
221 request qpsk  68  no  0x0 0x10 0x152 0  8   no  yes  0   qpsk0 no
221 initial qpsk   2  no  0x0 0x10 0x0   0  0   no  no   0   qpsk1 no
221 station qpsk 128 no  0x5 0x22 0x152 0 48   no  yes  0   qpsk0 no
221 a-short 32qam 160 no  0x9 0x4C 0x152 6  8   yes  yes  0   qpsk1 no
221 a-long  64qam 132 no  0xC 0xE7 0x152 0  8   yes  yes  0   qpsk1 no
221 a-ugs   16qam  80  no  0x3 0xE7 0x152 0  8   yes  yes  0   qpsk1 no
Router#

```

## Displaying Cable Modem Capabilities and Provisioning

To display the capabilities of the online cable modems and how the modems were provisioned, use the **show cable modem mac** command:

```
Router# show cable modem mac
```

```

MAC Address  MAC      Prim Ver   Prov   Frag Concat PHS Priv DS  US
           State Sid
0007.0e03.69a1 online  2   DOC1.1 DOC1.1 yes  yes   yes BPI+ 0  4
0007.0e03.6a05 online  3   DOC1.1 DOC1.1 yes  yes   yes BPI+ 0  4
0007.0e03.6981 online  4   DOC1.1 DOC1.1 yes  yes   yes BPI+ 0  4
0007.0e03.69e9 online  2   DOC1.1 DOC1.1 yes  yes   yes BPI+ 0  4
0090.963e.d312 online(pt) 4   DOC1.1 DOC1.0 no   yes   yes BPI  8  4
0008.0e06.7a90 online(pt) 56  DOC1.0 DOC1.0 no   yes   no  BPI  0  0
0002.8a0e.a392 online(pt) 57  DOC1.0 DOC1.0 no   no    no  BPI  0  0
0000.39e8.9a4e online(pt) 58  DOC1.0 DOC1.0 no   yes   no  BPI  0  0
0000.39ac.4e57 online  151 DOC2.0 DOC1.0 no   yes   no  BPI  0  0
0090.963e.d314 online(pt) 152 DOC1.1 DOC1.0 no   yes   yes BPI  8  4
0008.0e06.7ab8 online(pt) 153 DOC2.0 DOC1.0 no   yes   no  BPI  0  0
0007.0e03.6cf5 online(pt) 154 DOC1.0 DOC1.0 no   yes   no  BPI  0  0
0007.0e03.69f1 online  155 DOC1.1 DOC1.0 no   yes   yes BPI+ 0  4
0007.0e03.6855 online  156 DOC1.1 DOC1.0 no   yes   yes BPI+ 0  4
0007.0e03.6ca1 online  157 DOC1.1 DOC1.0 no   yes   yes BPI+ 0  4
0050.daf8.0296 online(pt) 158 DOC1.0 DOC1.0 no   no    no  BPI  0  0
0002.8a0e.a38c online(pt) 159 DOC2.0 DOC2.0 no   no    no  BPI  0  0
Router#

```

To display how many cable modems of each DOCSIS type are online each upstream, use the **show cable modem mac summary** command:

```
Router# show cable modem mac summary
```

```

                                Cable Modem Summary
                                -----
                                Mac Version
                                -----
                                Provision Mode
                                -----
Interface      Total  DOC2.0  DOC1.1  DOC1.0  Reg/Online  DOC 2.0  DOC1.1  DOC1.0
Cable3/0/U1    1      0       1       0       1           0       1       0
Cable3/0/U2    1      0       1       0       1           0       1       0
Cable3/0/U3    1      0       1       0       1           0       1       0
Cable3/1/U0    1      0       1       0       1           0       0       1
Cable3/1/U1    1      0       0       1       1           0       0       1
Cable3/1/U2    3      0       1       2       3           0       1       2
Cable6/0/U1    9      1       5       3       9           1       0       8
Cable6/0/U2    1      0       1       0       1           0       0       1
Cable6/0/U2    2      2       0       0       2           2       0       0
Router#

```

## Configuration Examples for DOCSIS 2.0 A-TDMA services

This section contains the following:

### Creating Modulation Profiles Examples

This section contains the following:

#### Example: DOCSIS 1.0/DOCSIS 1.1 TDMA Modulation Profiles

The following sample configurations show typical modulation profiles for the DOCSIS 1.0/DOCSIS 1.1 TDMA mode of operation when using the Cisco uBR-MC5X20S/U cable interface line card:

- Profile 1 is the default profile for TDMA operations that is automatically created on the router for legacy cable interface line cards.
- Profile 21 is the default profile for TDMA operations that is automatically created on the router for the Cisco uBR-MC5X20S/U card.
- Profiles 24 and 25 use the preconfigured 16-QAM and QPSK modulation profiles.
- Profile 26 is a typical QPSK modulation profile using some customized burst parameters.

```

cable modulation-profile 1 request 0 16 0 8 qpsk scrambler 152 no-diff 64 fixed uw8
cable modulation-profile 1 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 1 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 1 short 4 76 12 8 qpsk scrambler 152 no-diff 72 shortened uw8
cable modulation-profile 1 long 9 236 0 8 qpsk scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 24 qam-16
cable modulation-profile 25 qpsk
cable modulation-profile 26 request 0 16 0 8 qpsk scrambler 152 no-diff 68 fixed
cable modulation-profile 26 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed
cable modulation-profile 26 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed
cable modulation-profile 26 short 4 76 12 8 qpsk scrambler 152 no-diff 80 shortened
cable modulation-profile 26 long 8 236 0 8 qpsk scrambler 152 no-diff 80 shortened

```



## Example: Mixed TDMA/A-TDMA Modulation Profiles

The following sample configurations show typical modulation profiles for the DOCSIS 1.X/DOCSIS 2.0 mixed TDMA/A-TDMA mode of operation:

- Profile 121 is the default profile for mixed mode operations that is automatically created on the router for the Cisco uBR-MC5X20S/U card.
- Profiles 122 through 126 use the preconfigured mixed mode modulation profiles.
- Profile 127 is a typical mixed mode modulation profile some customized burst parameters.

```

cable modulation-profile 121 request 0 16 0 8 qpsk scrambler 152 no-diff 64 fixed uw8
cable modulation-profile 121 initial 5 34 0 48 qpsk scrambler 152 no-diff 32 fixed uw16
cable modulation-profile 121 station 5 34 0 48 qpsk scrambler 152 no-diff 32 fixed uw16
cable modulation-profile 121 short 5 75 6 8 qpsk scrambler 152 no-diff 72 shortened uw8
cable modulation-profile 121 long 8 220 0 8 qpsk scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 121 a-short qpsk0 0 18 5 99 10 8 64qam scrambler 152 no-diff 128
shortened uw8
cable modulation-profile 121 a-long qpsk0 0 18 15 200 0 8 64qam scrambler 152 no-diff 128
shortened uw8
cable modulation-profile 122 mix-high
cable modulation-profile 123 mix-low
cable modulation-profile 124 mix-medium
cable modulation-profile 125 qam-16
cable modulation-profile 126 qpsk
cable modulation-profile 127 request 0 16 0 8 qpsk scrambler 152 no-diff 68 fixed
cable modulation-profile 127 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed
cable modulation-profile 127 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed
cable modulation-profile 127 short 6 76 7 8 16qam scrambler 152 no-diff 160 shortened
cable modulation-profile 127 long 8 231 0 8 16qam scrambler 152 no-diff 160 shortened
cable modulation-profile 127 a-short 9 76 6 8 32qam scrambler 152 no-diff 160 shortened
qpsk1 1 2048
cable modulation-profile 127 a-long 12 231 0 8 64qam scrambler 152 no-diff 132 shortened
qpsk1 1 2048

```

## Example: DOCSIS 2.0 A-TDMA Modulation Profiles

The following sample configurations show typical modulation profiles for the DOCSIS 2.0 A-TDMA mode of operation:

- Profile 221 is the default profile for A-TDMA mode operations.
- Profiles 222 through 226 use the preconfigured A-TDMA mode modulation profiles.
- Profile 227 is a typical A-TDMA mode modulation profile customized burst parameters.

```

cable modulation-profile 221 request qpsk0 0 0 0 16 0 8 qpsk scrambler 152 no-diff 64 fixed
uw8
cable modulation-profile 221 initial qpsk0 0 0 5 34 0 48 qpsk scrambler 152 no-diff 32 fixed
uw16
cable modulation-profile 221 station qpsk0 0 0 5 34 0 48 qpsk scrambler 152 no-diff 32 fixed
uw16
cable modulation-profile 221 short qpsk0 0 0 5 75 6 8 qpsk scrambler 152 no-diff 72 shortened
uw8
cable modulation-profile 221 long qpsk0 0 0 8 220 0 8 qpsk scrambler 152 no-diff 80 shortened
uw8
cable modulation-profile 221 a-short qpsk0 0 18 5 99 10 8 64qam scrambler 152 no-diff 128
shortened uw8
cable modulation-profile 221 a-long qpsk0 0 18 15 200 0 8 64qam scrambler 152 no-diff 128
shortened uw8

cable modulation-profile 222 qam-8

```

```

cable modulation-profile 223 qam-16
cable modulation-profile 224 qam-32
cable modulation-profile 225 qam-64
cable modulation-profile 226 qpsk

cable modulation-profile 227 request 0 16 0 8 qpsk scrambler 152 no-diff 68 fixed qpsk0 1
2048
cable modulation-profile 227 initial 0 16 0 0 qpsk no-scrambler no-diff 2 fixed qpsk1 0 18

cable modulation-profile 227 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed qpsk0
1 2048
cable modulation-profile 227 a-short 9 76 6 8 32qam scrambler 152 no-diff 160 shortened
qpsk1 1 2048
cable modulation-profile 227 a-long 12 231 0 8 64qam scrambler 152 no-diff 132 shortened
qpsk1 1 2048
cable modulation-profile 227 a-ugs 3 231 0 8 16qam scrambler 152 no-diff 80 shortened qpsk1
1 2048

```

## Assigning Modulation Profiles to Upstreams Examples

This section contains the following:

### Example: Assigning DOCSIS 1.0/DOCSIS 1.1 TDMA Modulation Profiles

The following sample configuration shows DOCSIS 1.0/DOCSIS 1.1 TDMA modulation profiles being assigned to the upstreams on two cable interfaces on the Cisco uBR-MC5X20S/U cable interface line card. The TDMA modulation profile (profile 21) is assigned to the upstreams on cable interface 5/1/0, and modulation profile 22 is assigned to the upstreams on cable interface 5/1/1.



#### Note

Starting with Cisco IOS Release 12.2(33)SCG, the **cable upstream docsis-mode atdma** command is the default configuration for upstreams, so this command is not shown in these sample configurations.

```

interface Cable5/1/0
ip address 22.0.0.1 255.0.0.0
ip helper-address 10.10.0.4
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream channel-id 2
cable upstream 0 frequency 30000000
cable upstream 0 power-level 0
cable upstream 0 channel-width 1600000
cable upstream 0 minislots-size 4
cable upstream 0 modulation-profile 21
no cable upstream 0 shutdown
cable upstream 1 channel-width 1600000
cable upstream 1 minislots-size 4
cable upstream 1 modulation-profile 21
cable upstream 1 shutdown
cable upstream 2 channel-width 1600000
cable upstream 2 minislots-size 4
cable upstream 2 modulation-profile 21
cable upstream 2 shutdown
cable upstream 3 channel-width 1600000
cable upstream 3 minislots-size 4
cable upstream 3 modulation-profile 21
cable upstream 3 shutdown
cable upstream 4 channel-width 1600000
cable upstream 4 minislots-size 4
cable upstream 4 modulation-profile 21
cable upstream 4 shutdown

```

```

cable upstream 5 channel-width 1600000
cable upstream 5 minislots-size 4
cable upstream 5 modulation-profile 21
cable upstream 5 shutdown
!
interface Cable5/1/1
ip address 21.0.0.1 255.0.0.0
ip helper-address 10.10.0.4
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream channel-id 2
cable upstream 0 frequency 30000000
cable upstream 0 power-level 0
cable upstream 0 channel-width 1600000 1600000
cable upstream 0 minislots-size 4
cable upstream 0 modulation-profile 22
no cable upstream 0 shutdown
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 minislots-size 4
cable upstream 1 modulation-profile 22
cable upstream 1 shutdown
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 minislots-size 4
cable upstream 2 modulation-profile 22
cable upstream 2 shutdown
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 minislots-size 4
cable upstream 3 modulation-profile 22
cable upstream 3 shutdown

```

### Example: Assigning Mixed TDMA/A-TDMA Modulation Profiles

The following sample configuration shows mixed mode TDMA/A-TDMA modulation profiles being assigned to the upstreams on a cable interface on the Cisco uBR-MC5X20S/U cable interface line card. All upstreams are configured for mixed mode and profile 121 is assigned to them, but only the first upstream is enabled.

```

interface Cable5/1/2
ip address 21.0.0.1 255.0.0.0
ip helper-address 10.10.0.4
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream channel-id 2
cable upstream 0 frequency 30000000
cable upstream 0 docsis-mode tdma-atdma
cable upstream 0 power-level 0
cable upstream 0 channel-width 1600000 1600000
cable upstream 0 minislots-size 4
cable upstream 0 modulation-profile 121
no cable upstream 0 shutdown
cable upstream 1 docsis-mode tdma-atdma
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 minislots-size 4
cable upstream 1 modulation-profile 121
cable upstream 1 shutdown
cable upstream 2 docsis-mode tdma-atdma
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 minislots-size 4
cable upstream 2 modulation-profile 121
cable upstream 2 shutdown
cable upstream 3 docsis-mode tdma-atdma
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 minislots-size 4
cable upstream 3 modulation-profile 121
cable upstream 3 shutdown

```

## Example: Assigning DOCSIS 2.0 A-TDMA Modulation Profiles

The following sample configuration shows DOCSIS 2.0 A-TDMA modulation profiles being assigned to the upstreams on two cable interfaces on the Cisco uBR-MC5X20S/U cable interface line card. Only the first upstream on cable interface c7/1/1 is enabled for A-TDMA mode and assigned an A-TDMA profile. The first three upstreams on cable interface c7/1/2 are enabled for A-TDMA mode, and they are using the default A-TDMA modulation profile of 221.

```
interface Cable7/1/1
ip address 20.0.0.1 255.0.0.0
ip helper-address 10.10.0.4
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream channel-id 1
cable upstream 0 frequency 30000000
cable upstream 0 docsis-mode atdma
cable upstream 0 power-level 0
cable upstream 0 channel-width 6400000 6400000
cable upstream 0 minislot-size 1
cable upstream 0 modulation-profile 221
no cable upstream 0 shutdown
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 minislot-size 4
cable upstream 1 modulation-profile 41
cable upstream 1 shutdown
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 minislot-size 4
cable upstream 2 modulation-profile 41
cable upstream 2 shutdown
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 minislot-size 4
cable upstream 3 modulation-profile 41
cable upstream 3 shutdown
!
interface Cable7/1/2
ip address 71.2.1.1 255.255.255.0 secondary
ip address 71.72.71.1 255.255.255.0
load-interval 30
no keepalive
cable map-advance static
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 459000000
cable downstream channel-id 2
no cable downstream rf-shutdown
cable upstream 0 frequency 30000000
cable upstream 0 docsis-mode atdma
cable upstream 0 power-level 0
no cable upstream 0 concatenation
no cable upstream 0 fragmentation
cable upstream 0 modulation-profile 221
no cable upstream 0 shutdown
cable upstream 1 frequency 5104000
cable upstream 1 docsis-mode atdma
cable upstream 1 power-level 6
cable upstream 1 channel-width 200000
cable upstream 1 minislot-size 32
cable upstream 1 modulation-profile 221
cable upstream 1 shutdown
cable upstream 2 frequency 38800000
cable upstream 2 power-level 0
cable upstream 2 channel-width 800000
cable upstream 2 minislot-size 32
cable upstream 2 modulation-profile 221
cable upstream 2 shutdown
cable upstream 3 docsis-mode atdma
```

```

cable upstream 3 frequency 1400000
cable upstream 3 power-level -6
cable upstream 3 channel-width 400000
cable upstream 3 minislot-size 32
cable upstream 3 modulation-profile 221
cable upstream 3 shutdown

```

## Additional References

### Related Documents

Related Topic	Document Title
Cisco CMTS Commands	<i>Cisco IOS CMTS Cable Command Reference</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
Configuring the Cisco uBR-MC16U/X Card	<i>Configuring the Cisco uBR-MC16U/MC16X Cable Interface Line Card</i> , at the following URL: <a href="http://www.cisco.com/en/US/docs/interfaces_modules/cable/line_cards/ubr16u_x/configuration/guide/mc16uxfm.html">http://www.cisco.com/en/US/docs/interfaces_modules/cable/line_cards/ubr16u_x/configuration/guide/mc16uxfm.html</a>
Configuring the Cisco uBR-MC28U/X Card	<i>Configuring the Cisco uBR-MC28U/MC28X Cable Interface Line Card</i> , at the following URL: <a href="http://www.cisco.com/en/US/docs/interfaces_modules/cable/line_cards/ubr28u_x/configuration/guide/mc28uxfm.html">http://www.cisco.com/en/US/docs/interfaces_modules/cable/line_cards/ubr28u_x/configuration/guide/mc28uxfm.html</a>

### Standards

Standards	Title
SP-RFIV1.1-I09-020830	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 1.1
SP-RFIV2.0-I03-021218	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 2.0
SP-OSSIV2.0-I03-021218	Data-over-Cable Service Interface Specifications Operations Support System Interface Specification, version 2.0
SP-BPI+-I09-020830	Data-over-Cable Service Interface Specifications Baseline Privacy Plus Interface Specification, version 2.0
RFC 2233	DOCSIS OSSI Objects Support

Standards	Title
RFC 2665	DOCSIS Ethernet MIB Objects Support
RFC 2669	Cable Device MIB

**MIBs**

MIBs	MIBs Link
<ul style="list-style-type: none"> <li>• DOCS-BPI-PLUS-MIB</li> <li>• DOCS-CABLE-DEVICE-MIB (RFC 2669)</li> <li>• DOCS-CABLE-DEVICE-TRAP-MIB</li> <li>• DOCS-IF-EXT-MIB</li> <li>• DOCS-IF-MIB (RFC 2670)</li> <li>• DOCS-QOS-MIB</li> <li>• DOCS-SUBMGT-MIB</li> <li>• IGMP-STD-MIB (RFC 2933)</li> </ul>	<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><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></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><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></p>

# Feature Information for DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

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The table below 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 13: Feature Information for DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers	12.2(15)CX	<p>This feature was introduced for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cable interface line cards on the Cisco uBR7246VXR router.</p> <p>The following commands are new or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable modulation-profile</b></li> <li>• <b>cable upstream channel-width</b></li> <li>• <b>cable upstream docsis-mode</b></li> <li>• <b>cable upstream equalization-coefficient</b></li> <li>• <b>cable upstream maintain-psd</b></li> <li>• <b>cable upstream minislot-size</b></li> <li>• <b>cable upstream modulation-profile</b></li> <li>• <b>show cable modulation-profile</b></li> <li>• <b>show interface cable mac-schedule</b></li> <li>• <b>show cable modem verbose</b></li> <li>• <b>show cable modem phy</b></li> <li>• <b>show controllers cable</b></li> </ul>
DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers	12.2(15)BC2	<p>This feature was supported on the Cisco uBR-MC5X20S/U cable interface line cards on the Cisco uBR10012 router.</p>
DOCSIS 2.0 A-TDMA Modulation Profiles for the Cisco CMTS Routers	12.2(33)SCA	<p>This feature was integrated into Cisco IOS Release 12.2(33)SCA. Support for the Cisco uBR7225VXR Universal Broadband Router was added.</p>





## CHAPTER 6

# DOCSIS 3.0 Downstream Bonding for Bronze Certification

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**First Published:** December 17, 2008

**Last Updated:** November 29, 2010

The DOCSIS 3.0 Downstream Bonding for Bronze Certification feature helps cable operators offer new, more bandwidth-intensive services by adding one or more additional downstream quadrature amplitude modulation (QAM) channels to the standard broadband DOCSIS system.

### 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

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- [Information About DOCSIS 3.0 Downstream Bonding for Bronze Certification, page 125](#)
- [How to Configure RCC Encoding, page 127](#)
- [How to Configure Attribute Masks, page 132](#)
- [How to Enable Service Flow Priority in Downstream Extender Header, page 138](#)
- [Enabling Verbose Reporting for Receive Channel Profiles, page 141](#)
- [Configuration Example for an RCC Template, page 142](#)
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# Prerequisites for DOCSIS 3.0 Downstream Bonding for Bronze Certification

The table below shows the hardware compatibility prerequisites for the DOCSIS 3.0 Downstream Bonding for the Bronze Certification feature.


**Note**

The hardware components introduced in a given Cisco IOS Release will be supported in all subsequent releases unless otherwise specified.

**Table 14: Cable Hardware Compatibility Matrix for Downstream Bonding**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2</li> </ul>	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> </ul>
	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul>
	Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V <sup>8</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> </ul>
		Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V <sup>9</sup></li> </ul>

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>8</sup> Cisco uBR3GX60V cable interface line card is not compatible with PRE2. You must use PRE4 with the Cisco uBR3GX60V cable interface line card.

<sup>9</sup> Cisco uBR-MC88V cable interface line card is not compatible with NPE-G1. You must use NPE-G2 with the Cisco uBR-MC88V cable interface line card.

## Restrictions for DOCSIS 3.0 Downstream Bonding for Bronze Certification

- Although verbose receive channel profile (RCP) reporting can be enabled on a given cable interface, this does not eliminate the need to define a receive channel configuration (RCC) template to support a non-standard RCP ID.
- An RCC template configuration cannot be modified or removed if it is associated to any MAC domain. The operator must remove the association first to make modifications to an existing RCC template.
- The CMTS does not create a new RCP or modify an existing RCP based on the verbose RCP report from a cable modem at run time. The operator should explicitly add an RCC template and the RCP ID association per RCP requirements.

## Information About DOCSIS 3.0 Downstream Bonding for Bronze Certification

The DOCSIS 3.0 Downstream Bonding for Bronze Certification enables high-speed broadband access and helps cable operators offer more bandwidth-intensive services by adding one or more additional downstream quadrature amplitude modulation (QAM) channels to the standard broadband DOCSIS system. This new set of downstream channels is grouped into one larger channel, known as a bonded channel.

Channel bonding combines several RF channels into one virtual channel. Data rates in this virtual channel range from hundreds of megabits to potentially gigabits per second, creating more available bandwidth in the network.

## Receive Channel Profile

An RCP is an encoding that represents the receive channels and receive modules of a cable modem. A cable modem communicates to the CMTS one or more RCP encodings within its registration request using either verbose description, which contains complete subtype encoding defined in DOCSIS 3.0, or simple description, which only contains RCP identifiers.

The cable modem reporting method is controlled by the CMTS using a MAC Domain Descriptor (MDD).

## Receive Channel Configuration

A cable modem reports its ability to receive multiple channels with one or more RCP encodings in a REG-REQ or REG-REQ-MP message. Each receive channel profile describes a logical representation of the cable modem's downstream physical layer in terms of receive channels (RCs) and receive modules (RMs). The CMTS initially configures the cable modem's receive channels and receive modules with an RCC encoding in the registration response.

Beginning Cisco IOS Release 12.2(33)SCB, this feature supports any arbitrary RCP ID configuration and receive channel configuration on a Cisco uBR10012 universal broadband router and Cisco IOS Release 12.2(33)SCD provides this support on the Cisco uBR7225VXR and Cisco uBR7246VXR routers.

## RCC Template

You can configure one or more RCC templates for an RCP. An RCC template configures the physical layer components described by an RCP, including receive modules and receive channels to specific downstream frequencies. The template also specifies the interconnections among receive modules, or between a receive module and a receive channel. An RCC template can be associated only to the cable interface (MAC domain).

## Channel Assignment

The CMTS assigns a receive channel configuration encoding to a DOCSIS 3.0-certified cable modem operating in a Multiple Receive Channel (MRC) mode during cable modem registration.

Prior to Cisco IOS Release 12.2(33)SCB, the channel assignment was based on a random selection from eligible bonding groups.

With the implementation of this feature, the DOCSIS 3.0-certified cable modem reports its receiving capabilities and characteristics using the receive channel profile type, length, value (TLV) list in the registration request message. Based on this report, the CMTS assigns an RCC encoding that is compatible with the reported RCP.

Cable modems operating in an MRC mode are assigned an RCC encoding that is derived from an RCC template, which is associated with an RCP.

RCC encodings may be derived from RCC templates or from a wideband-cable interface configuration.

**Note**

The cable modem can support up to 8 physical downstream channels. If you do not have 8 channel bonding group configured, the modem can lock a downstream primary channel and then decide to either use the bonding group that primary is part of or use the other 4-channel bonding group, which makes it appear as 5 downstream channels.

In the following example you can see the CMTS or cable modem add the 5th downstream channel when you use two wideband interfaces with 4 DS channels.

```
Downstream Channel DCID RF Channel : 40 1/2/0:16
Downstream Channel DCID RF Channel : 28 1/2/0:4
Downstream Channel DCID RF Channel : 29 1/2/0:5
Downstream Channel DCID RF Channel : 30 1/2/0:6
Downstream Channel DCID RF Channel : 31 1/2/0:7
```

## Downstream Traffic Forwarding

DOCSIS 3.0 introduces the concept of assigning downstream service flows of cable modems, which are operating in an MRC mode, to downstream (DS) channels or bonding groups. Forwarding interfaces assigned to service flows (SFs) can be either DS channel interfaces (cable, integrated cable interfaces or modular cable interfaces) or downstream bonding groups (wideband interfaces).

These forwarding interfaces will override the default CMTS assignment of a service flow to a wideband interface.

**Note**

Valid interfaces that are available for SF assignment must be a subset of the cable modem's assigned RCC encoding.

## Service Flow Priority in Downstream Extended Header

The purpose of the feature is to be able to reflect the traffic priority of downstream packets into the DOCSIS extended header. The priority is derived from the service flow that the packet is mapped to. Priority refers to the service flow priority specified in the CM configuration file, or the Cisco CMTS service class configuration.

The service flow priority can be set using cable modem configuration file, or dynamic configuration.

By default, this feature is disabled on Cisco cBR-8 router, user can use **cable service flow priority** command to enable this feature.

## How to Configure RCC Encoding

The following tasks describe how to configure a receive channel configuration encoding for a receive channel profile:

## Configuring an RCC Template

You must configure an RCC template with a unique RCP ID for a particular CMTS. A valid RCC template consists of a configured RCP ID, RMs, and RCs.

### Before You Begin

To configure an RCC template, the verbose encoding of the corresponding RCP ID must be available.

### DETAILED STEPS

	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.
<b>Step 3</b>	<b>cable rcc-template <i>index</i></b>  <b>Example:</b> Router (config) # <b>cable rcc-template 1</b>	Defines an RCC template. <ul style="list-style-type: none"> <li>• <i>index</i> —Specifies an RCC template ID in the range 1 to 255.</li> </ul>

## Configuring RCC Encoding

You can configure an RCC encoding after defining an RCC template. The CMTS derives an RCC or RCCs from the RCC template for each MAC Domain Downstream Service Group (MD-DS-SG). Each RCC encoding contains all operational DS channels with their channel parameters, including the frequency match RC attribute specified in the RCC template. An RCC template specifies the intended receive channel assignment in the available DS spectrum.

The following information is required for RCC configuration:

- The RCC templates associated to the MAC domain
- DS channel physical parameters including frequency and connected-receive-module index
- DS channel primary capable indicator
- DS channel membership to the MD-DS-SG
- Cable modem membership to the MD-DS-SG

**Note**

If an RCC template is removed from a MAC domain through configuration, the CMTS removes all of the RCC encodings derived from the RCC template, and all cable modems assigned to the RCC encodings are marked offline.

**Before You Begin**

At least one RC must be configured as a primary RC.

**DETAILED STEPS**

	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.
<b>Step 3</b>	<b>cable rcc-template</b> <i>index</i>  <b>Example:</b> Router(config)# <b>cable rcc-template 1</b>	Defines the RCC template. <ul style="list-style-type: none"> <li>• <i>index</i>—Specifies an RCC template ID in the range 1 to 255.</li> </ul>
<b>Step 4</b>	<b>rcp-id</b> <i>rcp-id</i>  <b>Example:</b> Router(config-rcc-template)# <b>rcp-id 00 10 00 00 03</b>	<ul style="list-style-type: none"> <li>• <i>rcp-id</i>—Specifies an RCP ID for the RCC template. The valid range is 00 00 00 00 00 to FF FF FF FF. By default the RCP ID is set to 00 00 00 00 00.</li> </ul>
<b>Step 5</b>	<b>receive-module</b> <i>index</i> <b>first-channel-center-frequency</b> <i>Hz</i> <b>[connected-receive-module</b> <i>index</i> ]  <b>Example:</b> Router(config-rcc-template)# <b>receive-module 1</b> <b>first-channel-center-frequency</b> <b>555000000 connected-receive-module 1</b>	Specifies a receive module configuration for the selected RCP. <ul style="list-style-type: none"> <li>• <i>index</i>—Specifies the index value for the receive module. The valid range is 1 to 10.</li> <li>• <b>first-channel-center-frequency</b>—Specifies the center frequency of the first channel of the receive module channel block. The first channel center frequency assignment defines a frequency within the minimum and maximum range of center frequencies configured for the RM.</li> <li>• <i>Hz</i>—Specifies the center frequency value in Hz. The valid range is from 55000000 to 1050000000.</li> <li>• <b>connected-receive-module</b>—(Optional) Specifies a nested receive module in the RCC template. Generally, only one receive module is configured for an RCC template.</li> <li>• <i>index</i>—(Optional) Specifies the index value for the connected receive module. The valid range is from 1 to 10.</li> </ul>

	Command or Action	Purpose
Step 6	<p><code>receive-channel</code> <i>index</i> <code>center-frequency</code> <i>Hz</i> <code>connected-receive-module</code> <i>index</i> [<code>primary</code>]</p> <p><b>Example:</b>  <pre>Router(config-rcc-template)# receive-channel 1 center-frequency 555000000 connected-receive-module 1 primary</pre></p>	<p>Specifies a receive channel configuration for the selected RCP.</p> <ul style="list-style-type: none"> <li><i>index</i>—Specifies the index value for the receive channel. The valid range is from 1 to 10.</li> <li><b>center-frequency</b>—Specifies the center frequency for the receive channel.</li> <li><i>Hz</i>—Specifies the center frequency value in Hz. The valid range is from 55000000 to 1050000000.</li> <li><b>connected-receive-module</b>—Specifies a nested receive module in the RCC template. Generally, only one receive module is configured for an RCC template.</li> <li><i>index</i>—Specifies the index value for the connected receive module. The valid range is from 1 to 10.</li> <li><b>Primary</b>—(Optional) Indicates that it is a primary channel and an RCC can be derived from this channel. At least one receive-channel must be configured as primary.</li> </ul>

### What to Do Next

After defining an RCC template, you must assign the template to a cable interface. See [Assigning an RCC Template to a Cable Interface](#), on page 130.

## Assigning an RCC Template to a Cable Interface

This section describes how to assign an RCC template to a cable interface.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><code>enable</code></p> <p><b>Example:</b>  <pre>Router&gt; enable</pre></p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> <li>Enter your password if prompted.</li> </ul>
Step 2	<p><code>configure terminal</code></p> <p><b>Example:</b>  <pre>Router# configure terminal</pre></p>	<p>Enters global configuration mode.</p>
Step 3	<p><code>interface cable</code> {<i>slot/port</i>   <i>slot/subslot/port</i>}</p>	<p>Specifies the cable interface line card on a Cisco CMTS router:</p> <ul style="list-style-type: none"> <li><i>slot</i>—Chassis slot number of the cable interface line card.</li> </ul>



	Command or Action	Purpose
	<p><b>Example:</b> Router(config)# <b>interface</b> <b>cable7/0/0</b></p>	<p>Cisco uBR7246VXR router: The valid range is from 3 to 6.</p> <p>Cisco uBR7225VXR router: The valid range is from 1 to 2.</p> <p>Cisco uBR10012 router: The valid range is from 5 to 8.</p> <ul style="list-style-type: none"> <li>• <i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. Valid subslots are 0 or 1.</li> <li>• <i>port</i>—Downstream port number.</li> </ul> <p>Cisco uBR7246VXR and Cisco uBR7225VXR routers: The valid port value is 0 or 1.</p> <p>Cisco uBR10012 router: The valid range is from 0 to 4 (depending on the cable interface).</p>
<b>Step 4</b>	<p><b>cable rcc-template</b> <i>index</i></p> <p><b>Example:</b> Router(config-if)# <b>cable</b> <b>rcc-template 1</b></p>	<p>Assigns the RCC template to the specified cable interface.</p> <ul style="list-style-type: none"> <li>• <i>index</i>—Specifies the template you want to assign to the cable interface. The valid range is from 1 to 255.</li> </ul>

## Verifying the RCC Configuration

To verify the runtime RCCs on a cable interface, use the **show cable mac-domain rcc** command as shown in the following example:

### Cisco uBR10012 Router

```
Router# show cable mac-domain c8/0/0 rcc
RCC-ID  RCP          RCs MD-DS-SG  CMs  WB/RCC-TMPL
1        00 00 00 00 00    2   0          0    WB (101)
2        00 10 00 00 03    3   2          0    RCC-TMPL (1)
```

### Cisco uBR7200 Series Routers

```
Router# show cable mac-domain cable 5/0 rcc
RCC-ID  RCP          RCs MD-DS-SG  CMs  WB/RCC-TMPL
1        00 00 00 00 00    3   0          3    WB (25)
```

The table below shows descriptions for the fields displayed by this command.

**Table 15: show cable mac-domain rcc Field Descriptions**

Field	Description
RCC-ID	RCC index per MAC domain.

Field	Description
RCP	The receive channel profile associated with the RCC object.
RCs	Total number of DS channels.
MD-DS-SG	Indicates the MAC domain DS service group for which the RCC is configured.
CM	Total number of cable modems associated with the RCC object.
WB/RCC-TMPL	Indicates the wideband interface or the RCC template.

**Note**

A zero (0) value in the RCP or MD-DS-SG field indicates that the RCC encoding is configured directly through a wideband interface configuration and not through any RCC templates.

## Verifying the MD-DS-SG Configuration

To verify the MD-DS-SG on a cable interface, use the **show cable mac-domain downstream-service-group** command as shown in the following example:

```
Router# show cable mac-domain cable 5/0 downstream-service-group
Cable      MD-DS-SG      RF
IF         Id           Resource      Chan      Primary Chan
C5/0      1             5/0          00-03     0
```

## How to Configure Attribute Masks

DOCSIS 3.0 introduces the concept of assigning service flows to channels or bonding groups based on binary attributes. The attribute masks configured on a cable, modular, integrated or wideband interface are called provisioned attribute masks.

The two types of attributes are as follows:

- Specification-defined attributes—Contain default values based on the characteristics of the channel or bonding group.
- Operator-defined attributes—Default to zero.

The operator can configure a provisioned attribute mask for each channel and provisioned bonding group to assign values to the operator-defined binary attributes. The operator can also assign new values to override the default values of the specification-defined attributes.

The operator can configure a required attribute mask and a forbidden attribute mask for a service flow in the cable modem configuration file. These required and forbidden attribute masks are optionally provided on the DOCSIS 3.0 service flows and are matched with the provisioned attribute masks of the interfaces.

Each service flow is optionally configured with the following TLV parameters:

- Service flow required attribute mask—To configure this, assign a service flow to a channel that has a 1-bit in all positions of its provisioned attribute mask corresponding to the 1-bit in the service flow required attribute mask.
- Service flow forbidden attribute mask—To configure this, assign a service flow to a channel that has a 0-bit in all positions of its provisioned attribute mask corresponding to the 1-bit in the service flow forbidden attribute mask.

Additionally, in a cable modem-initiated dynamic service request, the cable modem can include a required attribute mask and a forbidden attribute mask for a service flow. The CMTS assigns service flows to channels or bonding groups so that all required attributes are present and no forbidden attributes are present in the cable modem configuration file.

The table below lists the supported binary attributes for channels and bonding groups.

**Table 16: Binary Attributes**

Bit Position	Definition
Bit 0	Bonded—This bit is zero for all individual channel interfaces and one for all bonding groups.
Bit 1	Low latency—This bit is set when the interface can provide relatively low latency service. This bit is set to zero for all channels, and left up to the operator to define.
Bit 2	High availability—This bit is set to zero for all channels, and left up to the operator to define.
Bit 3:15	Reserved—Set to zero.
Bit 16:31	Operator defined—Set to zero by default.

You can configure provisioned attribute masks for cable, integrated cable, wideband cable, and modular cable interfaces.

### Prerequisites

- To assign an interface to a wideband cable modem's service flow, the interface must be a subset of the cable modem's RCC.
- To assign a service flow to a modular shared port adapter (SPA) channel, the corresponding modular cable interface must be configured and operational.
- To assign a service flow to an integrated cable (IC) channel, the corresponding integrated cable interface must be configured and operational.

**Restrictions**

- The dynamic bonding group is not supported.
- The service flow from a narrowband cable modem is always assigned to the primary interface of the cable modem. No attribute checking is performed in this case.

This section describes the following:

**Configuring Provisioned Attributes for a Cable Interface**

The default provisioned attribute is zero for a cable interface.



**Note** Provisioning the cable downstream attribute-mask command is not supported on the Cisco uBR7225VXR and Cisco uBR7246VXR routers.

**DETAILED STEPS**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. <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.
<b>Step 3</b>	<b>interface cable slot/subslot/port</b>  <b>Example:</b> Router(config)# <b>interface cable 7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router: <ul style="list-style-type: none"> <li>• <i>slot</i>—Chassis slot number of the cable interface line card. Cisco uBR10012 router: The valid range is from 5 to 8.</li> <li>• <i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. Valid subslots are 0 or 1.</li> <li>• <i>port</i>—Downstream port number. Cisco uBR10012 router: The valid range is from 0 to 4 (depending on the cable interface).</li> </ul>
<b>Step 4</b>	<b>cable downstream attribute-mask mask</b>  <b>Example:</b> Router(config-if)# <b>cable downstream attribute-mask 800000ff</b>	Specifies the mask for the interface.

## Configuring Provisioned Attributes for a Modular Cable Interface

This section describes how to configure the provisioned attributes for a modular cable interface on the Cisco uBR10012 universal broadband router. The default provisioned attribute is zero for a modular cable interface.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface modular-cable</b> <i>slot/bay/port:nb-channel-number</i>  <b>Example:</b> Router (config) # <b>interface modular-cable</b> <b>1/0/1:5</b>	Specifies the modular cable interface and enters interface configuration mode. <ul style="list-style-type: none"> <li>• <i>slot</i>—The slot where a SIP resides. On the Cisco uBR10012 router, slots 1 and 3 can be used for SIPs.</li> <li>• <i>bay</i>—The bay in a SIP where a SPA is located. Valid values are 0 (upper bay) and 1 (lower bay).</li> <li>• <i>port</i>—Specifies the interface number on the SPA.</li> <li>• <i>nb-channel-number</i>—Specifies the narrowband channel number.</li> </ul>
Step 4	<b>cable attribute-mask</b> <i>mask</i>  <b>Example:</b> Router (config-if) # <b>cable attribute-mask</b> <b>800000ff</b>	Specifies the mask for the modular-cable interface.

## Configuring Provisioned Attributes for an Integrated Cable Interface

The default provisioned attribute is zero for an integrated cable interface.

### DETAILED STEPS

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

	Command or Action	Purpose
	<b>Example:</b> Router> <b>enable</b>	<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.
<b>Step 3</b>	<b>interface integrated-cable</b> {slot/port   slot/subslot/port}:rf-channel  <b>Example:</b> Router(config)# <b>interface integrated-cable</b> 1/0/0:0	Specifies the cable interface line card on a Cisco CMTS router: <ul style="list-style-type: none"> <li><i>slot</i>—Chassis slot number of the cable interface line card. Cisco uBR7246VXR router: The valid range is from 3 to 6. Cisco uBR7225VXR router: The valid range is from 1 to 2. Cisco uBR10012 router: The valid range is from 5 to 8.</li> <li><i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. Valid subslots are 0 or 1.</li> <li><i>port</i>—Downstream port number. Cisco uBR7246VXR and Cisco uBR7225VXR routers: The valid port value is 0 or 1. Cisco uBR10012 router: The valid range is from 0 to 4 (depending on the cable interface).</li> <li><i>rf-channel</i>—RF channel number with a range of 0 to 3.</li> </ul>
<b>Step 4</b>	<b>cable attribute-mask</b> mask  <b>Example:</b> Router(config-if)# <b>cable attribute-mask</b> 800000ff	Specifies the mask for the interface.

## Configuring Provisioned Attributes for a Wideband Cable Interface

The default provisioned attribute is 0x80000000 for a wideband cable interface, and the zero bit is automatically added to the wideband cable interface whenever an attribute is configured for that interface.

### DETAILED STEPS

	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>	<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.
<b>Step 3</b>	<b>interface wideband-cable {slot/port   slot/subslot/port}:wideband-channel</b>  <b>Example:</b> Router (config) # <b>interface wideband-cable 1/0/1:4</b>	Specifies the wideband cable interface and enters interface configuration mode:
<b>Step 4</b>	<b>cable downstream attribute-mask mask</b>  <b>Example:</b> Router (config-if) # <b>cable downstream attribute-mask 800000ff</b>	Specifies the mask for the interface.

## Verifying the Attribute-Based Service Flow Assignments

To verify the attribute-based assignment of service flows on a cable interface, use the **show interface cable service-flow** or **show interface wideband-cable service-flow** command as shown in the following example:

```
Router# show interface cable 3/0 service-flow

Sfid  Sid   Mac Address      QoS  Param Index Type  Dir  Curr  Active  DS-ForwIf/
      Prov Adm  Act              State Time   US-BG/CH
17    4     001c.ea37.9aac   3    3    3    P    US    act    13h21m CH 3
18    N/A   001c.ea37.9aac   4    4    4    P    DS    act    13h21m Wi3/0:0
21    6     001c.ea37.9b5a   3    3    3    P    US    act    13h21m CH 4
22    N/A   001c.ea37.9b5a   4    4    4    P    DS    act    13h21m Wi3/0:0
23    7     0016.925e.654c   3    3    3    P    US    act    13h21m CH 3
24    N/A   0016.925e.654c   4    4    4    P    DS    act    13h21m In3/0:0

Router# show interface wideband-cable 5/1:0 service-flow
Sfid  Sid   Mac Address      QoS  Param Index Type  Dir  Curr  Active  DS-ForwIf/
      Prov Adm  Act              State Time   US-BG/CH
3     8193  ffff.ffff.ffff   3    3    3    S(s) DS    act    2h06m  Wi5/1:0
```

The table below shows descriptions for the fields displayed by this command:

**Table 17: show interface cable service-flow Field Descriptions**

Field	Description
Sfid	Identifies the service flow identification number.  <b>Note</b> Primary service flow IDs are displayed even for offline cable modems because they are needed for modem re-registration.

Field	Description
Sid	Identifies the service identification number (upstream service flows only).
Mac Address	Identifies the MAC address for the cable modem.
QoS Parameter Index Prov	Identifies the QoS parameter index for the provisioned state of this flow.
QoS Parameter Index Adm	Identifies the QoS parameter index for the Admitted state of this flow.
QoS Parameter Index Act	Identifies the QoS parameter index for the Active state of this flow.
Type	Indicates if the service flow is the primary flow or a secondary service flow. Secondary service flows are identified by an "S" (created statically at the time of registration, using the DOCSIS configuration file) or "D" (created dynamically by the exchange of dynamic service messages between the cable modem and CMTS).
Dir	Indicates if this service flow is DS or US.
Curr State	Indicates the current run-time state of the service flow.
Active Time	Indicates the length of time this service flow has been active.
DS-ForwIf/US-BG/CH BG/DS	Indicates the bonding group ID or the downstream RFID of the forwarding interface assigned to the downstream service flow.

## How to Enable Service Flow Priority in Downstream Extender Header

The following tasks describe how to enable service flow priority in downstream extender header:

### Enabling Service Flow Priority in Downstream Extender Header

This section describes how to enable service flow priority in downstream extender header on the Cisco cBR-8 routers:



## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable service flow priority</b>  <b>Example:</b> Router(config)# <b>cable service flow priority</b>	Enables the service flow priority in downstream extender header.

## Verifying the Enablement of the Service Flow Priority in Downstream Extended Header

To verify the enablement of the service flow priority in downstream extended header, use the **show running-config | in service flow cable service flow priority** or **show cable modem [ip-address | mac-address] verbose** command as shown in the following example:

```
Router# show running-config | in service flow
cable service flow priority

Router# show cable modem 100.1.2.110 verbose

MAC Address           : 0025.2e2d.74f8
IP Address            : 100.1.2.110
IPv6 Address          : 2001:420:3800:909:7964:98F3:7760:ED2
Dual IP               : Y
Prim Sid              : 1
Host Interface        : C3/0/0/U0
MD-DS-SG / MD-US-SG  : N/A / N/A
MD-CM-SG              : 0x900000
Primary Downstream    : In3/0/0:32 (RfId : 12320, SC-QAM)
Wideband Capable     : Y
DS Tuner Capability   : 8
RCP Index             : 6
RCP ID                : 00 00 00 00
Downstream Channel DCID RF Channel : 191 3/0/0:32 (SC-QAM)
UDC Enabled           : N
US Frequency Range Capability : Standard (5-42 MHz)
Extended Upstream Transmit Power : 0dB
Multi-Transmit Channel Mode : N
Upstream Channel      : US0
Ranging Status        : sta
Upstream SNR (dB)     : 39.8
Upstream Data SNR (dB) : 36.12
Received Power (dBmV) : -1.00
Timing Offset         (97.6 ns) : 1799
Initial Timing Offset : 1799
Rng Timing Adj Moving Avg(0.381 ns) : 0
```

## Verifying the Enablement of the Service Flow Priority in Downstream Extended Header

```

Rng Timing Adj Lt Moving Avg      : 0
Rng Timing Adj Minimum           : 0
Rng Timing Adj Maximum           : 0
Pre-EQ Good                      : 0
Pre-EQ Scaled                    : 0
Pre-EQ Impulse                   : 0
Pre-EQ Direct Loads              : 0
Good Codewords rx                 : 8468
Corrected Codewords rx           : 0
Uncorrectable Codewords rx       : 0
Phy Operating Mode                : atdma
sysDescr                          :
Downstream Power                  : 0.00 dBmV (SNR = ----- dB)
MAC Version                       : DOC3.0
QoS Provisioned Mode              : DOC1.1
Enable DOCSIS2.0 Mode             : Y
Service Flow Priority              : N
Modem Status                      : {Modem= online, Security=disabled}
Capabilities                      : {Frag=Y, Concat=Y, PHS=Y}
Security Capabilities             : {Priv=, EAE=N, Key_len=}
L2VPN Capabilities                : {L2VPN=N, eSAFE=N}
L2VPN type                       : {CLI=N, DOCSIS=N}
Sid/Said Limit                   : {Max US Sids=16, Max DS Sids=15}
Optional Filtering Support        : {802.1P=N, 802.1Q=N, DUT=N}
Transmit Equalizer Support        : {Taps/Symbol= 1, Num of Taps= 24}
CM Capability Reject              : {15,22,23,24,25,26,27,28,29,35,36,38}
Flaps                             : 3(Oct 8 16:22:23)
Errors                           : 0 CRCs, 0 HCSes
Stn Mtn Failures                 : 0 aborts, 2 exhausted
Total US Flows                   : 1(1 active)
Total DS Flows                   : 1(1 active)
Total US Data                    : 294 packets, 25903 bytes
Total US Throughput              : 143 bits/sec, 0 packets/sec
Total DS Data                    : 91 packets, 10374 bytes
Total DS Throughput              : 0 bits/sec, 0 packets/sec
LB group ID assigned             : 1
LB group ID in config file       : N/A
LB policy ID                     : 0
LB policy ID in config file      : 0
LB priority                      : 0
Tag                              : d30
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                 : 0
CM Energy Management Capable     : N
CM Enable Energy Management      : N
CM Enter Energy Management       : NO
Battery Mode                     : N
Battery Mode Status              :
Number of Multicast DSIDs Support : 16
MDF Capability Mode              : 2
IGMP/MLD Version                 : MLDv2
FCType10 Forwarding Support     : Y
Features Bitmask                 : 0x0
Total Time Online                : 6h00m (6h00m since last counter reset)
CM Initialization Reason         : POWER_ON

```

# Enabling Verbose Reporting for Receive Channel Profiles

A receive channel profile is an encoding that represents the receive channels and receive modules of a cable modem. A cable modem communicates to the CMTS one or more RCP encodings within its registration request using either verbose description, which contains complete subtype encodings defined in DOCSIS 3.0, or simple description, which only contains RCP identifiers.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable</b> { <i>slot/port</i>   <i>slot/subslot/port</i> }  <b>Example:</b> Router(config)# <b>interface cable7/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router: <ul style="list-style-type: none"> <li>• <i>slot</i>—Chassis slot number of the cable interface line card. Cisco uBR7246VXR router: The valid range is from 3 to 6. Cisco uBR7225VXR router: The valid range is from 1 to 2. Cisco uBR10012 router: The valid range is from 5 to 8.</li> <li>• <i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. Valid subslots are 0 or 1.</li> <li>• <i>port</i>—Downstream port number. Cisco uBR7246VXR and Cisco uBR7225VXR routers: The valid port value is 0 or 1. Cisco uBR10012 router: The valid range is from 0 to 4 (depending on the cable interface).</li> </ul>
Step 4	<b>cable rcp-control verbose</b>  <b>Example:</b> Router(config-if)# <b>cable rcp-control verbose</b>	Enables RCP reporting with verbose description.

## Configuration Example for an RCC Template

The following sample shows an RCC template configuration:

```

...
!
cable rcc-template 1
  rcp-id 00 10 00 00 03
  receive-module 1 first-center-frequency 555000000 connected-receive-module 1
  receive-channel 1 center-frequency 555000000 connected-receive-module 1 primary
  receive-channel 2 center-frequency 561000000 connected-receive-module 1
  receive-channel 3 center-frequency 567000000 connected-receive-module 1
!
...
!
interface Cable5/1
  downstream Integrated-Cable 5/1 rf-channel 0 upstream 0-3
  cable rcc-template 1
  cable rcp-control verbose
...

```

## Additional References

The following sections provide references related to the DOCSIS 3.0 Downstream Bonding for Bronze Certification feature.

### Related Documents

Related Topic	Document Title
Commands on the Cisco CMTS (universal broadband routers)	<i>Cisco IOS CMTS Cable Command Reference</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
Cisco DOCSIS 3.0 Downstream Solution	<i>Cisco DOCSIS 3.0 Downstream Solution Design and Implementation Guide</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_2.0/ds_solu.html">http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_2.0/ds_solu.html</a>
DOCSIS 3.0 Downstream Channel Bonding	<i>Cisco Cable Wideband Solution Design and Implementation Guide</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html">http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html</a>

### Standards and RFCs

Standard	Title
CM-SP-MULPIv3.0-I08-080522	MAC and Upper Layer Protocols Interface Specifications

**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><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></p>

## Feature Information for DOCSIS 3.0 Downstream Bonding for Bronze Certification

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

The table below 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 18: Feature Information for DOCSIS 3.0 Downstream Bonding for Bronze Certification**

Feature Name	Releases	Feature Information
DOCSIS 3.0 Downstream Bonding for Bronze Certification	12.2(33)SCB	<p>This feature was introduced to meet the Bronze requirements for the DOCSIS 3.0 downstream bonding. It also includes receive channel configuration for receive channel profiles.</p> <p>In Cisco IOS Release 12.2(33)SCB, this feature was introduced on the Cisco uBR10012 router.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">How to Configure RCC Encoding, on page 127</a></li> <li>• <a href="#">How to Configure Attribute Masks, on page 132</a></li> <li>• <a href="#">Enabling Verbose Reporting for Receive Channel Profiles, on page 141</a></li> </ul> <p>The following commands were introduced or modified in this release:</p> <ul style="list-style-type: none"> <li>• <b>cable rcc-template</b></li> <li>• <b>cable rcv-control verbose</b></li> <li>• <b>rcv-id</b></li> <li>• <b>receive-module</b></li> <li>• <b>receive-channel</b></li> <li>• <b>show cable mac-domain rcc</b></li> <li>• <b>show interface cable service-flow</b></li> <li>• <b>show cable modem</b></li> </ul>

Feature Name	Releases	Feature Information
DOCSIS 3.0 Downstream Bonding for Bronze Certification	12.2(33)SCD	<p>In Cisco IOS Release 12.2(33)SCD, this feature was introduced on the Cisco uBR7225VXR and Cisco uBR7246VXR routers.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"><li>• <b>interface cable</b></li><li>• <b>show cable mac-domain rcc</b></li><li>• <b>show cable mac-domain downstream-service-group</b></li></ul>







# Downstream Channel ID Assignment on the Cisco CMTS Routers

**First Published:** November 29, 2010

The DOCSIS downstream channel ID (DCID) is defined as an 8-bit identifier for recognizing a Downstream Channel within a MAC Domain. All CMTS downstream channels are assigned a DCID by default that may be subsequently changed by configuration. It is used in most DOCSIS downstream packet headers and its valid range is from 1 to 255 (0 is reserved for network management purposes).



**Note**

---

All downstream channels in a MAC domain must have a unique DCID within the MAC domain.

---

## 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 Downstream Channel ID Assignment on the Cisco CMTS Routers](#), page 148
- [Information About Downstream Channel ID Assignment on the Cisco CMTS Routers](#), page 149
- [How to Configure Downstream Channel ID Assignment on the Cisco CMTS Routers](#), page 152
- [Additional References](#), page 155
- [Feature Information for Downstream Channel ID Assignment on the Cisco CMTS Routers](#), page 156

# Prerequisites for Downstream Channel ID Assignment on the Cisco CMTS Routers

The table below shows the hardware compatibility matrix for this feature.


**Note**

The hardware components introduced in a particular Cisco IOS Release are supported in all subsequent releases unless otherwise specified.

**Table 19: Downstream Channel ID Assignment - Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul>
	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul>
	Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V <a href="#">10</a></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> </ul>
		Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V <a href="#">11</a></li> </ul>

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> <p>Cisco IOS Release 12.2(33)SCB and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> </ul> <p>Cisco IOS Release 12.2(33)SCD and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V 2</li> </ul>

<sup>10</sup> The Cisco uBR-MC3GX60V cable interface line card is not compatible with PRE2.

<sup>11</sup> The Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2, and not with NPE-G1.

## Information About Downstream Channel ID Assignment on the Cisco CMTS Routers

These are the downstream channel ID assignment features in the Cisco IOS Release 12.2(33)SCB and later releases:

- DCID uniqueness is provided by keeping the wideband SPA DCID range unique compared to the MAC domain host card range.
- Unique DCIDs are provided for all channels within controllers, such as the wideband SPA bay controller, Cisco uBR-MC2020V controller, Cisco uBR-MC88V controller, and Cisco uBR-MC3GX60V controller.



**Note** All DCIDs for all controllers on a card need not be unique, since channels from multiple controllers are most likely parts of different fiber nodes. DCIDs need to be unique only for default downstream channel ID assignments. With automatic Channel ID assignment, channel IDs may repeat within a controller depending on the fiber node configuration.

- Redundancy schemes are allowed where downstream channels from different cable interface line cards are bound to the same fiber node. If one card fails, cable modems are able to lock to a frequency on a channel from the other line card. Since DCID uniqueness is enforced for channels in a fibre node, channels from both line cards should have unique DCIDs.
- ID assignment for the Cisco uBR7225 universal broadband router with a line card in slot 1 begins at DCID 1 on slot 1 and for the Cisco uBR7246 universal broadband router, which begins with cable line card slots at slot 3, the ID assignment begins with DCID 1 on slot 3. A Cisco uBR10012 router begins assigning IDs with channel 1 at slot 5 and SPA slots follow as described in [Table 20: Downstream Channel ID Per Subslot Scheme](#), on page 150.



**Note** You can configure the DCIDs manually to suit your plant floor layout requirements.

- In the Cisco uBR-MC3GX60V cable line card where the channel count on the router is 576, with eight Cisco uBR-MC3GX60V line cards, or even greater if the router also includes Wideband SPAs, there is no slot-based default channel ID scheme that would avoid potential channel ID conflicts.

The Manual DCID scheme was introduced in the Cisco IOS Release 12.2(33)SCB1 and the automatic DCID that includes the Cisco uBR-MC3GX60V line card, was introduced in Cisco IOS Release 12.2(33)SCE.

## Manual Downstream Channel ID Assignment on the Cisco CMTS Routers

For the Cisco uBR10-MC5x20 cable interface line card, the manual downstream channel ID is configured on the cable interface. For controller-based line cards, such as Cisco Wideband SPA, Cisco UBR-MC20X20V, Cisco uBR-MC88V and Cisco uBR-MC3GX60V, the manual downstream channel ID is configured in the controller per RF channel.

The tables below describe the DCID scheme per subslot:

**Table 20: Downstream Channel ID Per Subslot Scheme**

	8/1	8/0	7/1	7/0	6/1	6/0	5/1	5/0	slot 3	slot 1
SPA Bay 0									217-240	193-216
SPA Bay 1									217-240	193-216
SPA Bay 2									217-240	193-216
SPA Bay 3									217-240	193-216
uBR-MC520 DS/0	169	145	121	97	73	49	25	1		
uBR-MC520 DS/1	173	149	125	101	77	53	29	5		
uBR-MC520 DS/2	177	153	129	105	81	57	33	9		
uBR-MC520 DS/3	181	157	133	109	85	61	37	13		
uBR-MC520 DS/4	185	161	137	113	89	65	41	7		
uBR-MC2020V	169-188	145-164	121-140	97-116	73-92	49-68	25-44	1-20		

	8/1	8/0	7/1	7/0	6/1	6/0	5/1	5/0	slot 3	slot 1
uBR-MC3GX60V controller 0	73-96	1-24	73-96	1-24	73-96	1-24	73-96	1-24		
uBR-MC3GX60V controller 1	97-120	25-48	97-120	25-48	97-120	25-48	97-120	25-48		
uBR-MC3GX60V controller 2	121-144	49-72	121-144	49-72	121-144	49-72	121-144	49-72		

**Table 21: Downstream Channel ID Per Subslot Scheme - Cisco IOS Release 12.3(23)BCx**

	8/1	8/0	7/1	7/0	6/1	6/0	5/1	5/0	slot 3	slot 1
SPA Bay 0									24- 47	24-47
SPA Bay 1									48-71	48-71
uBR-MC520	188-192	180-184	168-172	160-164	148-152	140-144	128-132	120-124		

## Automatic Downstream Channel ID Assignment on the Cisco CMTS Routers

Starting with Cisco IOS Release 12.2(33)SCE, it is possible to automatically assign a unique set of downstream channel IDs to meet all DOCSIS requirements. However, DCIDs are assigned automatically at the fiber node, therefore only those deployments that use fiber node configuration can use automatic DCID assignment.

DCID is computed automatically as channels are added to the fiber nodes.



### Note

Automatic DCID assignment is not supported on the Cisco uBR7225 and Cisco uBR7246 universal broadband routers.

### Service Impact

Changing the DOCSIS downstream channel ID causes cable modems to re-register. Cable modems receive MAC Domain Descriptor (MDD) and Upstream Channel Descriptor (UCD) messages with a changed DCID in their headers.

- Enabling the automatic DCID assignment displays the following message:

```
WARNING: Enabling automatic DCID assignment will cause modems to flap and will apply to all fiber nodes on this CMTS.
```

- Disabling the automatic DCID assignment displays the following message:

```
WARNING: Disabling automatic DCID assignment will no longer enforce channel-id uniqueness at fiber nodes. Channel ID changes may require manual verification to prevent conflicts.
```

- If there is a DCID conflict with another channel in the MAC Domain, the following error message is displayed:

```
ERROR: <slot>/<subslot>/<controller> rf-channel <channel>: The downstream channel id
conflicts with interface Mo<slot>/<subslot>/<controller>:channel. Downstream channel
id must be unique in a CGD.
```

- After automatic DCID assignment is configured, if there is a DCID conflict when a downstream channel that belongs to a fiber node is added to a MAC Domain, the automatic DCID feature tries to resolve the conflict by assigning another automatic DCID and the following message is displayed:

```
WARNING: The downstream channel id conflict for <slot>/<subslot>/<controller> rf-channel
<channel> was resolved by Automatic DCID Assignment.
Please run "interface <md-slot>/<md-subslot>/<md-index>" followed by
"<slot>/<subslot>/<controller> rf-channel <channel>" again in order to add the channel.
```

To add the channel, use this channel grouping domain (CGD) command again:

```
cable downstream x/y/z rf-channel channel
```




---

**Note** The resolved DCIDs may conflict with the other existing channels in the MAC Domain.

---

- If automatic DCID is configured and the channel does not belong to a fiber node, or if automatic DCID cannot resolve the conflict, the following message is displayed:

```
WARNING: The downstream channel id conflict for <slot>/<subslot>/<controller> rf-channel
<channel> could not be resolved by Automatic DCID Assignment.
```

To resolve this issue, add the channel to a fiber node.

## How to Configure Downstream Channel ID Assignment on the Cisco CMTS Routers

The following sections describe how to configure downstream channel ID assignment.

### Configuring Manual Downstream Channel ID Assignment



#### Restriction

- Shared bonding groups on the Cisco uBR-MC2020V do not require DCID user-renumbering intervention. However, SPA-based shared bonding groups may require renumbering using the range from 241 to 255. Shared bonding groups on the Cisco uBR-MC3GX60V require DCID user-renumbering if the shared bonding group and the modems data bonding group are on the same line card.
  - The DCID for a channel on a working line card must be carried forward to the channel on the protect line card upon failover. The opposite is true for revert.
-

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable slot/subslot/port</b>  <b>Example:</b> Router(config)# <b>interface cable 6/0/1</b>	Enters interface configuration mode for the Channel Grouping Domain host line card.
Step 4	<b>cable downstream-channel-id id</b>  <b>Example:</b> Router(config-if)# <b>cable downstream channel-id 44</b>	Configures the downstream channel ID.

## Configuring Automatic Downstream Channel ID Assignment

Automatic DCID assignment should be permanently configured. However, if you need to remove the feature, use the **no** or **default** commands.



**Note** The **no** or **default** form of the command is not written to startup-config file.

In this case, the DCIDs are retained as computed for all channels, and are not set to the defaults of the channels. Save the configuration containing the newly-assigned DCIDs to the startup-config file by using the **write memory** command.

When you enable automatic DCID assignment, any DCID conflict arising due to adding a channel in a fiber-node is resolved automatically.

**Restriction**

- After running the **cable downstream-channel-id automatic** command in the configuration, manually editing the configuration file in an editor to add RF channels to the fiber nodes could cause DCID conflicts. The feature assumes all channels in fiber nodes have unique automatic DCIDs in global configuration mode. If the configuration is manually edited and the feature does not verify the unique DCIDs, the DCIDs of the newly-added channels may conflict with those of the existing channels. To fix any DCID conflicts, undo and re-apply the global automatic DCID configuration.



**Note** Re-applying global automatic DCID configuration is a disruptive operation.

To avoid DCID conflicts, edit the configuration to configure the fiber nodes, then run the **cable downstream-channel-id automatic** command so all channels have unique automatic DCIDs.

Make additions to the fiber nodes on the Cisco uBR10012 router command line interface with the automatic DCID configured.

- The **cable downstream-channel-id automatic** command can be configured only on the Cisco uBR10012 universal broadband router.
- The **cable downstream-channel-id automatic** command should not be manually edited in to the startup-config file, since it does not guarantee unique DCIDs for channels in the fiber node.

**DETAILED STEPS**

	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 downstream-channel-id automatic</b>  <b>Example:</b> Router (config)# <b>cable downstream-channel-id automatic</b>	Specifies automatic assignment of the DCIDs by the Cisco CMTS.

**Example**

This example displays the restriction on manually editing configurations:

```
Router# show run | include automatic
cable downstream-channel-id automatic

Router# show cable fiber-node 3
```



```

-----
Fiber-Node 3
Channel(s) : downstream Modular-Cable 1/1/0: 0
Channel ID(s): 3
Channel : downstream Cable 6/1/0
Channel ID : 1
upstream Cable 6/1: 0-3
FN Config Status: Configured (status flags = 0x01)
MDD Status: Valid
router#

```

If you manually edit the startup-config file in an editor to add a downstream channel, for example, 5/0/0 rf-channel 0, from a newly-added line card, 5/0, it causes a conflict.

```

Router> configure terminal
Router# cable fiber-node 3
Router# downstream Modular-Cable 5/0/0 rf-channel 0

```

If this downstream channel is added on the Cisco uBR10012 router, the automatic DCID assignment feature automatically resolves it. However, since the startup-config file was manually edited to add the downstream channel, the automatic DCID assignment feature is unable to resolve it. This causes a DCID conflict when the edited startup-config file is loaded on the Cisco uBR10012 router and invalidates the fiber node.

```

down Modular-Cable 5/0/0 rf-channel 0
Fiber node 3 is invalid for:
DS frequency is not unique.
DS channel id is not unique.
Warning: D3.0 CMs cannot get w-online with an invalid fiber-node.
router#

```

### What to Do Next

Run the **show cable fibernode** command to view DCIDs assigned to all the channels in the fiber node.

```

Router# show cable fiber-node 5
Fiber-Node          Config Status
Fiber-Node 5
  Description: Interface c5/0/4
  Channels          DOCSIS Channel-IDs
-----
  Modular-Cable 3/3/0: 1-3      2,3,4
  Cable 5/0/4      1
  FN Config Status: Configured (status flags = 0x01)
  MDD Status: Valid

```

## Additional References

### Related Documents

Related Topic	Document Title
CMTS Command Reference	Cisco IOS CMTS Cable Command Reference, at the following URL: <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>

**Technical Assistance**

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></p>

## Feature Information for Downstream Channel ID Assignment on the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

The table below 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 22: Feature Information for Downstream Channel ID Assignment on the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
Downstream Channel ID Assignment on the Cisco CMTS Routers	12.2(33)SCE	This feature was introduced.



# Downstream Resiliency Bonding Group

**First Published:** July 2012

With more wideband (WB) modems being deployed in cable plants, WB modem resiliency is an important feature. The [Wideband Modem Resiliency](#) feature works well when a large number of WB modems experience an RF impairment. However, if a comparatively smaller number of cable modems (CMs) observe an impairment on an RF channel, then all CMs using that RF channel are shut down irrespective of whether they are affected or not. Instead, the solution should be to communicate with the affected CMs using the good RF channel, without affecting the other CMs.

In the [Wideband Modem Resiliency](#) feature, CMs with multiple impaired RF channels are moved to a single primary RF channel. Because the CMs are moved to a narrowband (NB) interface, this scenario may cause performance issues.

Starting with Cisco IOS Release 12.2(33)SCG, the Downstream Resiliency Bonding Group feature allows CMs with multiple impaired RF channels to be allocated to a dynamically-created wideband interface, which ensures that the performance of the wideband CMs is not drastically affected.

## 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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- [Configuration Examples of the Downstream Resiliency Bonding Group Feature, page 168](#)
- [Additional References, page 173](#)
- [Feature Information for Downstream Resiliency Bonding Group, page 174](#)

## Prerequisites for Downstream Resiliency Bonding Group

- Set aside WB interfaces so that new WB interfaces can be dynamically created from the reserved list of WB interfaces.
- Free up RF bandwidth so that those RF channels can be added to a resiliency bonding group (RBG).
- Remove all existing RBG configuration from the WB interface.

**Table 23: Downstream Resiliency Bonding Group – Hardware Compatibility Matrix**

Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCG and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCG and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20H</li> <li>• Cisco UBR-MC20X20V</li> <li>• Cisco UBR-MC3GX60V<sup>12</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router <sup>13</sup>	Cisco IOS Release 12.2(33)SCG and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCG and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCG and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCG and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>12</sup> The Cisco uBR-MC3GX60V line card is not compatible with PRE2.

<sup>13</sup> This feature is supported on the Cisco uBR7246VXR and Cisco uBR7225VXR routers only in Cisco IOS Release 12.2(33)SCG1 and later releases.

## Restrictions for the Downstream Resiliency Bonding Group

- If an existing wideband interface is reserved as a Resiliency Bonding Group (RBG) and later the RBG is removed (through the **no cable ds-resiliency** command), the modems using this RBG go offline and the RBG configuration itself is deleted. Therefore, it is highly recommended that users should not configure an existing BG as an RBG.

- This feature is enabled only when the number of cable modems observing an RF channel impairment is *below* the resiliency threshold. If the number of cable modems on an impaired RF channel is above the resiliency threshold, the impaired RF channel is temporarily removed from the bonding group.
- In Cisco IOS Release 12.2(33)SCG, a CM is assigned to an RBG on a first-come-first-served basis. To handle this feature optimally, it is recommended to set aside more WB interfaces and RF channel bandwidth.
- The Cisco CMTS controls the freeing of unused RBGs, when there is no modem using the RGB. The freeing of the unused RGB may take some time and the RGB, which is not completely free cannot be used by the modems. Irrespective of the number of configured RBGs, if all the old RBGs are not completely set free and if the Cisco CMTS tries to move the cable modem to a new RBG, the Cisco CMTS moves the cable modem to the primary DS channel instead of RBG.
- Only SFs on the WB interface associated with the primary SF are moved to an RBG. SFs on other interfaces will not be moved.
- Static SFs are assigned to an RBG on a best effort quality of service (QoS).
- If the **resiliency rf-change-trigger** setting does not have the **secondary** keyword set, only the primary SF is moved to the RBG or a NB interface.
- If the Downstream Resiliency Bonding Group feature is not enabled to use an RBG, only cable modems with impairments on the primary WB interface are moved to the NB interface.
- SFs carrying multicast traffic are not moved.
- The Cisco CMTS prevents configuration changes on a protect line card. Therefore, RBGs are not added or removed on a protect line card. Impaired SFs are moved only to a WB, NB, or existing RBGs on the protect line card.
- When the WB interface is in standby mode and after a line card switchover, if a cable modem experiences an RF channel impairment, and after impairment if there are no preexisting RBG that matches the new set of channels, in such case, the Cisco CMTS does not create a new Downstream Resiliency Bonding Group and channels are not assigned to it and the cable modem is moved to a Narrow Band state.

There may not be enough reserved bonding groups to support all modems facing an impairment at any given time thus the following restrictions must be considered:

- Each RBG has at least two RF channels.
- RBG RF assignments are always a subset of the RF channel assignment of the parent WB interface.
- If an RBG is unavailable for a cable modem, the SF of the CM is moved to a NB interface.
- If a high percentage of cable modems experience an RF impairment and there are no more available bonding group IDs, the impaired RF itself may be removed from the bonding group. Removal of an impaired RF from a parent bonding group is also reflected in the RBG. If an RBG drops to a single RF, all SFs are moved to the NB interface.

The Downstream Resiliency Bonding Group feature has the following cross-functional restrictions:

- Dynamic service flows that require a committed information rate (CIR), typically voice flows, are created on the NB interface when an RF channel is impaired. Because all SFs assigned to an RBG are best effort only, voice calls may report a quality issue.
- Cable modems participating in the resiliency mode do not take part in load balancing.

- The Downstream Resiliency Bonding Group feature is only supported in the Dynamic Bandwidth Sharing (DBS) mode.

## Information About Downstream Resiliency Bonding Group

In releases earlier than Cisco IOS Release 12.2 (33)SCG, bonding groups were static and created manually from the command line interface. The Cisco CMTS utilized the unused bonding groups for the Wideband Modem Resiliency feature.

However, starting with Cisco IOS Release 12.2 (33)SCG, you can set aside unused bonding groups as RBGs. Ensure that each RF channel is assigned at least 1% of the available bandwidth. Use the **cable rf-channel bandwidth-percent** command to configure the RF channel bandwidth.



### Note

If the bandwidth-percent is set to 100, the Cisco CMTS does not add any RFs to the RBG. In other words, this feature will not be enabled.

The Cisco CMTS controls the assignment and freeing of unused RBGs. If an RF channel is removed from a WB interface, it is also removed from any associated RBGs.



### Note

If the wideband interface is in standby mode, the Cisco CMTS does not assign or free up the unused downstream bonding group.

A suspended RF channel is restored for all affected wideband interfaces when a specified number of cable modems report (via CM-STATUS) that the channel connectivity is restored. The Wideband Modem Resiliency feature defines the specified number of cable modems as half of the configured count or percentage of rf-change-trigger, or both. For example, if the count is 20 and the percent is 10, then the number of cable modems reporting recovery should reduce the count to 10 and the percent to 5 for the suspended RF channel to be restored.

## Finding a Best-Fit RBG for the Cable Modem

A bonding group is a list of channels that provide a means to identify the channels that are bonded together. The Cisco CMTS assigns a service flow (SF) to an RBG based on the attributes of the SF and the attributes of the individual channels of the bonding group.

In the Downstream Resiliency Bonding Group feature, when a line card receives a CM-STATUS message from the cable modem informing the line card that there is an RF channel impairment, the line card checks for the number of good RF channels and:

- Moves the cable modem to narrowband mode if there is only one available RF channel.
- Moves the cable modem to wideband mode if the cable modem reports all RF channels are in good state.
- Moves the cable modem to an RBG if there are two or more good RF channels, with at least one RF channel impaired, and if the Downstream Resiliency Bonding Group feature is enabled.

When the Cisco CMTS receives a message from the line card to move a cable modem to an RBG, the Cisco CMTS attempts to find an existing RBG or creates an RBG that satisfies the impairment.



**Note** If two or more RBGs are reserved for the same wideband controller, the Cisco CMTS creates one RBG for each cable modem.



**Note** The Cisco CMTS creates more than one RBG from a parent WB interface if the user has set aside more than one WB interface as the RBG and the RF bandwidth does not exceed 100%.

If a matching RBG is not found or cannot be created, the Cisco CMTS looks for an RBG with a subset of the required RF channels and if available, the cable modem is assigned to such an RBG.

However, if no such RBG exists, the Cisco CMTS instructs the line card to move the cable modem to NB mode.

For more information about NB mode, see [Wideband Modem Resiliency](#).

## How to Configure Downstream Resiliency Bonding Group

This section contains the following:

### Enabling Downstream Resiliency Bonding Group

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable rf-change-trigger {percent value   count number} [secondary]</b>  <b>Example:</b> Router(config)# <b>cable rf-change-trigger percent 50 count 1 secondary</b>	Specifies the amount of time an event must persist before it triggers an action for the reporting CM. <ul style="list-style-type: none"> <li>• <b>percent value</b>—Indicates the percentage of cable modems that must report a particular non-primary RF channel is down before that channel is removed from the bonding group. The valid range is 1 to 100. The default value is 0.</li> <li>• <b>count number</b>—Specifies the number of cable modems reporting an impairment for a non-primary downstream channel. The default value is 0.</li> <li>• <b>secondary</b>—(Optional) Configures the Cisco CMTS to move the unicast secondary service flows to the primary channel interface, when the</li> </ul>

	Command or Action	Purpose
		<p>number of cable modems reporting RF channel impairment is less than the configured (percent or count) threshold.</p> <p><b>Note</b> Only those unicast secondary service flows, which share the same wideband interface as the primary interface, are moved to the primary channel interface.</p> <p>By default, the <b>secondary</b> keyword is not configured.</p>
<b>Step 4</b>	<p><b>cable resiliency ds-bonding</b></p> <p><b>Example:</b> Router(config)# <b>cable resiliency ds-bonding</b></p>	Enables the downstream resiliency bonding group.
<b>Step 5</b>	<p><b>exit</b></p> <p><b>Example:</b> Router(config)# <b>exit</b></p>	Returns to the global configuration mode.

### What to Do Next



**Note** The result of using the **cable rf-change-trigger** command with the **cable resiliency ds-bonding** command is different from using only the **cable rf-change-trigger** command. For more information, see [Table 24: Wideband Modem Resiliency Versus Downstream Resiliency - Scenario 1](#), on page 164 and [Table 25: Wideband Modem Resiliency Versus Downstream Resiliency - Scenario 2](#), on page 166. For more information, see [Wideband Modem Resiliency](#).

## Reserving a Resiliency Bonding Group for a Line Card

This section describes reserving a bonding group or a wideband interface for a line card per controller.



**Restriction** When you reserve a resiliency bonding group using the **cable ds-resiliency** command, the existing bundle and RF channel configurations on the wideband interface will be removed automatically. Other configurations like admission control, should be removed manually.

After downstream resiliency bonding group is configured, avoid other manual configurations.

### DETAILED STEPS

	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>	<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.
<b>Step 3</b>	<b>interface wideband-cable slot/{subslot   bay}/port:wideband-channel</b>  <b>Example:</b> Router(config)# <b>interface wideband-cable 1/0/0:7</b>	Configures a wideband cable interface. <ul style="list-style-type: none"> <li>• <i>slot</i>—Slot where the cable line card resides.</li> <li>• <i>subslot</i>—Subslot where the cable line card resides.</li> <li>• <i>port</i>—Port number on the WB interface.</li> <li>• <i>wideband-channel</i>—WB interface on the router.</li> </ul>
<b>Step 4</b>	<b>cable ds-resiliency</b>  <b>Example:</b> Router(config-if)# <b>cable ds-resiliency</b>	Reserves an individual bonding group or WB interface for usage on a line card, on a per controller basis.
<b>Step 5</b>	<b>exit</b>  <b>Example:</b> Router(config-if)# <b>exit</b>	Returns to the global configuration mode.

## Verifying Downstream Resiliency Bonding Group Configuration

This section contains the following:

### Verifying the Downstream Resiliency Bonding Group

To verify if the Downstream Resiliency Bonding Group feature is enabled, use the **show cable modem resiliency** command as shown in the following example:

```
Router# show cable modem resiliency
              Orig BG
I/F      MAC Address      ID  I/F      RFs ID  I/F      RFs
-----
C7/0/0   0025.2eaf.843e  897  Wi7/0/0:0  4  898  Wi7/0/0:1  3
C7/0/0   0025.2eaf.8356  897  Wi7/0/0:0  4  899  Wi7/0/0:2  3
C7/0/0   0015.d176.5199  897  Wi7/0/0:0  4  720  In7/0/0:0
```

The **Current BG I/F** field indicates whether Downstream Resiliency Bonding Group feature is enabled and if the cable modems are assigned to a WB interface.

## Verifying a Reserved Resiliency Bonding Group

To verify if a BG is reserved for a line card, use the **show cable resiliency** command as shown in the following example:

```
Router# show cable resiliency
      BG Resil BG
Resil BG I/F ID State Count Time Ctrl RF Num
-----
Wi1/2/0:10 10 Free
Wi1/2/0:20 20 Free
Wi7/0/0:1 1 Assigned 3 Nov 3 09:55:49 0 0
                                           1
                                           2
Wi7/0/0:2 2 Assigned 3 Nov 3 09:57:09 0 0
                                           1
                                           3
```

## Wideband Modem Resiliency Versus Downstream Resiliency

This section provides the sample outputs when using the **cable rf-change-trigger** command with the **cable resiliency ds-bonding** command and using only the **cable rf-change-trigger** command.

**Table 24: Wideband Modem Resiliency Versus Downstream Resiliency - Scenario 1**

Effect on	Using only cable rf-change-trigger command (Wideband Modem Resiliency)		Using cable rf-change-trigger command with cable resiliency ds-bonding (Downstream Resiliency Bonding Group)	
	Below Threshold	Above Threshold	Below Threshold	Above Threshold
Primary Service Flow	Moves to the primary channel.	Remains on the original bonding group while the impaired downstream channels are not used and are reported as DOWN.	Moves to dynamic bonding group.	Remains on the original bonding group while the impaired downstream channels are not used and are reported as DOWN.
Secondary Service Flows	Remain on the original WB interface.	Remains on the original bonding group while the impaired downstream channels are not used and are reported as DOWN.	Remains on the original bonding group.	Remains on the original bonding group while the impaired downstream channels are not used and are reported as DOWN.

The following is a sample output for a cable modem when the **cable rf-change-trigger** command is used with the **cable resiliency ds-bonding** command and the number of cable modems observing an RF channel impairment is *below* the resiliency threshold:

```
Router# show cable modem
      D
MAC Address IP Address I/F MAC State Prim RxPwr Timing Num I
      Sid (dBmV) Offset CPE P
0023.be83.1c9e 10.1.11.46 C5/0/0/UB w-online 922 -0.50 1055 0 N
```

```

0023.be83.1caa 10.1.11.28 C5/0/0/UB w-online 923 0.00 1043 0 N
0025.2ecf.f19c 10.1.11.53 C5/0/0/UB w-online 925 0.00 1057 0 N
0022.3a30.9fc0 10.1.11.47 C5/0/0/UB w-online 926 0.00 1055 0 N
001a.c3ff.e3d4 10.1.11.39 C5/0/0/UB p-online 927 0.00 1307 0 N
0023.be83.1c9a 10.1.11.61 C5/0/0/UB w-online 928 0.00 1057 0 N
0022.3a30.9fbc 10.1.11.60 C5/0/0/UB p-online 929 -0.50 1055 0 N
0023.be83.1c8c 10.1.11.38 C5/0/0/UB w-online 930 0.00 1061 0 N
001e.6bfb.1964 10.1.11.63 C5/0/0/UB p-online 931 0.50 1305 0 N
0025.2ecf.f196 10.1.11.29 C5/0/0/UB w-online 932 0.00 1057 0 N
0025.2ecf.f04e 10.1.11.54 C5/0/0/UB w-online 933 0.00 1054 0 N
0022.3a30.9fc8 10.1.11.43 C5/0/0/UB w-online 934 0.00 1056 0 N
0025.2ecf.f190 10.1.11.55 C5/0/0/UB w-online 935 0.00 1059 0 N
0022.3a30.9fd0 10.1.11.52 C5/0/0/UB p-online 936 0.00 1057 0 N
0022.ce97.8268 10.1.11.31 C5/0/0/UB w-online 937 -0.50 1056 0 N
0022.ce97.8281 10.1.11.25 C5/0/0/UB w-online 938 0.00 1058 0 N
001a.c3ff.e4ce 10.1.11.44 C5/0/0/UB w-online 940 -0.50 1304 0 N
0022.ce9c.839e 10.1.11.32 C5/0/0/UB w-online 941 -0.50 1305 0 N
0022.cea3.e768 10.1.11.41 C5/0/0/UB w-online 942 -1.00 1305 0 N
0022.ce9c.8398 10.1.11.33 C5/0/0/UB w-online 943 0.00 1306 0 N
001a.c3ff.e50a 10.1.11.59 C5/0/0/UB w-online 944 0.00 1304 0 N
001a.c3ff.e3f8 10.1.11.57 C5/0/0/UB w-online 945 -1.00 1306 0 N
001e.6bfb.1a14 10.1.11.37 C5/0/0/UB w-online 946 0.00 1305 0 N

```



**Note** p-online indicates that the cable modem is in downstream partial service mode.

```
Router# show cable resiliency
```

Resil	BG	I/F	BG ID	Resil State	Count	Time	RF Ctrl	RF Num
Wi5/0/0:2	2			Assigned	1	Mar 30 14:46:43	0	0
								1
								2
Wi5/0/0:3	3			Assigned	1	Mar 30 14:46:43	0	0
								1
								2
							1	0
								1
								2
								3
Wi5/0/0:4	4			Free	0			
Wi5/0/0:5	5			Free	0			

```
Router# show cable modem resiliency
```

I/F	MAC Address	ID	Orig I/F	RFs ID	Curr I/F	BG	RFs
C5/0/0	001a.c3ff.e3d4	258	Wi5/0/0:1	4	259	Wi5/0/0:2	3 <- Dynamic Bonding Group
C5/0/0	0022.3a30.9fbc	257	Wi5/0/0:0	8	260	Wi5/0/0:3	7 <- Dynamic Bonding Group
C5/0/0	001e.6bfb.1964	258	Wi5/0/0:1	4	259	Wi5/0/0:2	3 <- Dynamic Bonding Group
C5/0/0	0022.3a30.9fd0	257	Wi5/0/0:0	8	260	Wi5/0/0:3	7 <- Dynamic Bonding Group

The following is a sample output for a cable modem under the following conditions:

- **cable rf-change-trigger** command is used with the **cable resiliency ds-bonding** command
- Number of cable modems observing an RF channel impairment is *below* the resiliency threshold
- There is no available WB interface for the resiliency bonding group:

```
Router# show cable modem
```

```
0025.2ecf.f196 service-flow version
```

```
SUMMARY:
```

MAC Address	IP Address	Host Interface	MAC State	Prim Sid	Num CPE	Primary Downstream	DS RfId
-------------	------------	----------------	-----------	----------	---------	--------------------	---------

```

0025.2ecf.f196 10.1.11.29 C5/0/0/UB p-online
932 0 In5/0/0:0 240
Sfid Dir Curr Sid Sched Prio MaxSusRate MaxBrst MinRsvRate Throughput
State Type
1867 US act 932 BE 0 0 10000 0 294
1868 DS act N/A N/A 0 0 3044 0 154

```

Router# show cable resiliency

```

Resil BG I/F BG Resil BG Count Time Ctrl RF Num
-----
Wi5/0/0:2 2 Assigned 6 Mar 30 15:57:09 0 0
1
2
3
1 0
2
3
Wi5/0/0:3 3 Assigned 8 Mar 30 15:53:58 0 0
1
2
1 1
2
3
Wi5/0/0:4 4 Assigned 2 Mar 30 15:53:58 0 0
1
2
3
1 1
2
3
Wi5/0/0:5 5 Assigned 2 Mar 30 15:58:35 0 0
1
2
3
1 0
1
3

```

Router# show cable modem resiliency

```

I/F MAC Address ID Orig BG I/F RFs ID Curr BG RFs
-----
C5/0/0 0025.2ecf.f19c 257 Wi5/0/0:0 8 259 Wi5/0/0:2 7
C5/0/0 0025.2ecf.f196 257 Wi5/0/0:0 8 240 In5/0/0:0 <-- move NB for no available
WB interface
C5/0/0 0025.2ecf.f04e 257 Wi5/0/0:0 8 262 Wi5/0/0:5 7
C5/0/0 0022.3a30.9fbc 257 Wi5/0/0:0 8 260 Wi5/0/0:3 6
C5/0/0 0022.3a30.9fd0 257 Wi5/0/0:0 8 261 Wi5/0/0:4 7

```

Table 25: Wideband Modem Resiliency Versus Downstream Resiliency - Scenario 2

Effect on	Using only cable rf-change-trigger secondary command (Wideband Modem Resiliency)		Using cable rf-change-trigger secondary command with cable resiliency ds-bonding (Downstream Resiliency Bonding Group)	
	Below Threshold	Above Threshold	Below Threshold	Above Threshold
Primary Service Flow	Moves all service flows to the primary channel.	Remains on the original bonding group while the impaired downstream channels are not used and are reported as DOWN.	Moves all service flows to a dynamic bonding group.	Remains on the original bonding group while the impaired downstream channels are not used and are reported as DOWN.
Secondary Service Flows				

The following is a sample output for a cable modem when the **cable rf-change-trigger secondary** command is used with the **cable resiliency ds-bonding** command and the number of cable modems observing an RF channel impairment is *below* the resiliency threshold:

```
Router# show cable modem 0025.2ecf.f196 service-flow
SUMMARY:
MAC Address      IP Address      Host          MAC          Prim Num Primary DS
                  State          Interface    State        Sid  CPE Downstream RfId
0025.2ecf.f196  10.1.11.29     C5/0/0/UB    p-online     955  0   In5/0/0:0  240
Sfid Dir  Curr  Sid  Sched Prio MaxSusRate  MaxBrst  MinRsvRate  Throughput
      State
1913 US  act  955  BE    0    10000000    10000    0            425
1915 US  act  956  RTPS  7    0            3044    100000       0
1916 US  act  957  BE    0    0            3044    50000        0
1917 US  act  958  BE    4    0            3044    0            0
1914 DS  act  N/A  N/A   0    100000000   20000    0            0      <-- Primary
Service-Flow
1918 DS  act  N/A  N/A   0    0            3044    0            0      <-- Secondary
Service-Flow
1919 DS  act  N/A  N/A   0    0            3044    0            0      <-- Secondary
Service-Flow
1920 DS  act  N/A  N/A   4    4500000     3044    0            0      <-- Secondary
Service-Flow
UPSTREAM SERVICE FLOW DETAIL:
SFID  SID  Requests  Polls  Grants  Delayed  Dropped  Packets
      Grants
1913  955  83        0      83      0        0        92
1915  956  0         0      0        0        0        0
1916  957  0         0      0        0        0        0
1917  958  0         0      0        0        0        0
DOWNSTREAM SERVICE FLOW DETAIL:
SFID  RP_SFID  QID  Flg  Policer  Xmits  Drops  Scheduler  Drops  FrwdIF
      Xmits  Drops  Xmits  Drops
1914  33210   131555  90   0        0      0      6          0      Wi5/0/0:3 <-- Dynamic
Bonding Group
1918  33211   131556  0    0        0      0      0          0      Wi5/0/0:3
1919  33212   131557  0    0        0      0      0          0      Wi5/0/0:3
1920  33213   131558  0    0        0      0      0          0      Wi5/0/0:3
```

## Troubleshooting the Downstream Resiliency Bonding Group Configuration

Use the following commands to get information on the WB interface, number of CMs in an impaired state, resiliency bonding groups, their associated bonding groups, available RF channels, and the number of CMS and service flows assigned to them:

- **debug cable wbcmts resiliency**
- **debug cable wbcmts resiliency report**
- **show cable resiliency**
- **show cable modem resiliency**
- **show cable modem wideband rcs-status**
- **show cable modem service-flow verbose**
- **show cable rf-status**
- **show cable modem summary wb-rfs**

# Configuration Examples of the Downstream Resiliency Bonding Group Feature

The following is an example of the configuration of the Downstream Resiliency Bonding Group feature on a Cisco UBR-MC20X20V line card:

```

controller Integrated-Cable 5/0/0
rf-channel 0 frequency 387000000 annex B modulation 256qam interleave 32
  rf-channel 0 rf-power 52.0
  no rf-channel 0 rf-shutdown
rf-channel 1 frequency 393000000 annex B modulation 256qam interleave 32
  rf-channel 1 rf-power 52.0
  no rf-channel 1 rf-shutdown
rf-channel 2 frequency 399000000 annex B modulation 256qam interleave 32
  rf-channel 2 rf-power 52.0
  no rf-channel 2 rf-shutdown
rf-channel 3 frequency 405000000 annex B modulation 256qam interleave 32
  rf-channel 3 rf-power 52.0
  no rf-channel 3 rf-shutdown
interface Cable5/0/0
  downstream Integrated-Cable 5/0/0 rf-channel 0
  cable mtc-mode
  cable bundle 1
    cable upstream bonding-group 510
    upstream 0
    upstream 1
    upstream 2
    upstream 3
    attributes 80000000
  cable upstream 0 connector 0
  cable upstream 0 frequency 17000000
  cable upstream 0 channel-width 6400000 6400000
  cable upstream 0 docsis-mode atdma
  cable upstream 0 minislots-size 1
  cable upstream 0 range-backoff 3 6
  cable upstream 0 modulation-profile 221
  no cable upstream 0 shutdown
  cable upstream 1 connector 1
  cable upstream 1 frequency 24000000
  cable upstream 1 channel-width 6400000 6400000
  cable upstream 1 docsis-mode atdma
  cable upstream 1 minislots-size 1
  cable upstream 1 range-backoff 3 6
  cable upstream 1 modulation-profile 221
  no cable upstream 1 shutdown
  cable upstream 2 connector 2
  cable upstream 2 frequency 31000000
  cable upstream 2 channel-width 6400000 6400000
  cable upstream 2 docsis-mode atdma
  cable upstream 2 minislots-size 1
  cable upstream 2 range-backoff 3 6
  cable upstream 2 modulation-profile 221
  no cable upstream 2 shutdown
  cable upstream 3 connector 3
  cable upstream 3 frequency 38000000
  cable upstream 3 channel-width 6400000 6400000
  cable upstream 3 docsis-mode atdma
  cable upstream 3 minislots-size 1
  cable upstream 3 range-backoff 3 6
  cable upstream 3 modulation-profile 221
  no cable upstream 3 shutdown
interface Integrated-Cable5/0/0:0
  cable bundle 1
  cable rf-bandwidth-percent 10
  !
interface Wideband-Cable5/0/0:0

```

```

cable bundle 1
  cable rf-channel 0 bandwidth-percent 10
  cable rf-channel 1 bandwidth-percent 10
  cable rf-channel 2 bandwidth-percent 10
  cable rf-channel 3 bandwidth-percent 10
  cable rf-channel controller 1 channel 0 bandwidth-percent 10
  cable rf-channel controller 1 channel 1 bandwidth-percent 10
  cable rf-channel controller 1 channel 2 bandwidth-percent 10
  cable rf-channel controller 1 channel 3 bandwidth-percent 10
!
interface Wideband-Cable5/0/0:1
  cable bundle 1
  cable rf-channel 0 bandwidth-percent 10
  cable rf-channel 1 bandwidth-percent 10
  cable rf-channel 2 bandwidth-percent 10
  cable rf-channel 3 bandwidth-percent 10
!
interface Wideband-Cable5/0/0:2
  cable ds-resiliency
!
interface Wideband-Cable5/0/0:3
  cable ds-resiliency
!
interface Wideband-Cable5/0/0:4
  cable ds-resiliency
!
interface Wideband-Cable5/0/0:5
  cable ds-resiliency

cable fiber-node 50
  downstream Integrated-Cable 5/0/0 rf-channel 0-3
  downstream Integrated-Cable 5/0/1 rf-channel 0-3
  upstream Cable 5/0 connector 0-3

```

The following is an example of the configuration of the Downstream Resiliency Bonding Group feature with multiple Cisco UBR-MC20X20V line cards:

- Primary bonding group on the Cisco UBR-MC20X20V line card in slot 7/1
- Another bonding group on the Cisco UBR-MC20X20V line card in slot 8/1
- Resiliency Bonding Group is set aside on the Cisco UBR-MC20X20V line card in slot 7/1

```

interface Wideband-Cable7/1/0:0
  cable bundle 2
  cable rf-channel 0 bandwidth-percent 10
  cable rf-channel 1 bandwidth-percent 10
  cable rf-channel 2 bandwidth-percent 10
  cable rf-channel 3 bandwidth-percent 10
!
interface Wideband-Cable8/1/3:0
  cable bundle 2
  cable rf-channel 0 bandwidth-percent 10
  cable rf-channel 1 bandwidth-percent 10
  cable rf-channel 2 bandwidth-percent 10
  cable rf-channel 3 bandwidth-percent 10
!
interface Wideband-Cable7/1/0:3
  cable ds-resiliency
!
interface Wideband-Cable7/1/0:4
  cable ds-resiliency
interface Wideband-Cable8/1/3:3
  cable ds-resiliency
!
interface Wideband-Cable8/1/3:4
  cable ds-resiliency

```

The following is an example of the cross-controller configuration of the Downstream Resiliency Bonding Group feature with the Cisco UBR-MC20X20 line card:

```
interface Wideband-Cable8/1/3:2
 cable bundle 3
 cable rf-channel controller 1 channel 0 bandwidth-percent 10
 cable rf-channel controller 1 channel 1 bandwidth-percent 10
 cable rf-channel controller 1 channel 2 bandwidth-percent 10
 cable rf-channel controller 1 channel 3 bandwidth-percent 10
 cable rf-channel 0 bandwidth-percent 10
 cable rf-channel 1 bandwidth-percent 10
 cable rf-channel 2 bandwidth-percent 10
 cable rf-channel 3 bandwidth-percent 10
!
!
interface Wideband-Cable8/1/3:3
 cable ds-resiliency
!
interface Wideband-Cable8/1/3:4
 cable ds-resiliency
!
```

The following is an example of the configuration of the Downstream Resiliency Bonding Group feature with a shared port adapter (SPA):

```
interface Wideband-Cable1/2/0:0
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 25
 cable rf-channel 1 bandwidth-percent 25
 cable rf-channel 2 bandwidth-percent 25
 cable rf-channel 3 bandwidth-percent 25
!
interface Wideband-Cable1/2/0:3
 cable ds-resiliency
!
interface Wideband-Cable1/2/0:4
 cable ds-resiliency
!
```

The following is a sample output for the **show cable modem** command to display impaired CMs below the resiliency threshold value:

```
Router# show cable modem
```

MAC Address	IP Address	I/F	MAC State	Prim Sid	RxPwr (dBmv)	Timing Offset	Num CPE	D I P
0023.be83.1c9e	10.1.11.46	C5/0/0/UB	w-online	922	-0.50	1055	0	N
0023.be83.1caa	10.1.11.28	C5/0/0/UB	w-online	923	0.00	1043	0	N
0025.2ecf.f19c	10.1.11.53	C5/0/0/UB	w-online	925	0.00	1057	0	N
0022.3a30.9fc0	10.1.11.47	C5/0/0/UB	w-online	926	0.00	1055	0	N
<b>001a.c3ff.e3d4</b>	<b>10.1.11.39</b>	<b>C5/0/0/UB</b>	<b>p-online</b>	<b>927</b>	<b>0.00</b>	<b>1307</b>	<b>0</b>	<b>N</b>
0023.be83.1c9a	10.1.11.61	C5/0/0/UB	w-online	928	0.00	1057	0	N
<b>0022.3a30.9fbc</b>	<b>10.1.11.60</b>	<b>C5/0/0/UB</b>	<b>p-online</b>	<b>929</b>	<b>-0.50</b>	<b>1055</b>	<b>0</b>	<b>N</b>
0023.be83.1c8c	10.1.11.38	C5/0/0/UB	w-online	930	0.00	1061	0	N
<b>001e.6bfb.1964</b>	<b>10.1.11.63</b>	<b>C5/0/0/UB</b>	<b>p-online</b>	<b>931</b>	<b>0.50</b>	<b>1305</b>	<b>0</b>	<b>N</b>
0025.2ecf.f196	10.1.11.29	C5/0/0/UB	w-online	932	0.00	1057	0	N
0025.2ecf.f04e	10.1.11.54	C5/0/0/UB	w-online	933	0.00	1054	0	N
0022.3a30.9fc8	10.1.11.43	C5/0/0/UB	w-online	934	0.00	1056	0	N
0025.2ecf.f190	10.1.11.55	C5/0/0/UB	w-online	935	0.00	1059	0	N
<b>0022.3a30.9fd0</b>	<b>10.1.11.52</b>	<b>C5/0/0/UB</b>	<b>p-online</b>	<b>936</b>	<b>0.00</b>	<b>1057</b>	<b>0</b>	<b>N</b>
0022.ce97.8268	10.1.11.31	C5/0/0/UB	w-online	937	-0.50	1056	0	N
0022.ce97.8281	10.1.11.25	C5/0/0/UB	w-online	938	0.00	1058	0	N
001a.c3ff.e4ce	10.1.11.44	C5/0/0/UB	w-online	940	-0.50	1304	0	N
0022.ce9c.839e	10.1.11.32	C5/0/0/UB	w-online	941	-0.50	1305	0	N
0022.cea3.e768	10.1.11.41	C5/0/0/UB	w-online	942	-1.00	1305	0	N
0022.ce9c.8398	10.1.11.33	C5/0/0/UB	w-online	943	0.00	1306	0	N
001a.c3ff.e50a	10.1.11.59	C5/0/0/UB	w-online	944	0.00	1304	0	N
001a.c3ff.e3f8	10.1.11.57	C5/0/0/UB	w-online	945	-1.00	1306	0	N



```
001e.6bfb.1a14 10.1.11.37 C5/0/0/UB w-online 946 0.00 1305 0 N
```



**Note** p-online indicates that the CM is in downstream partial service mode.

When the impaired CMs have recovered, the **show cable modem** command displays the following output:

```
Router# show cable modem
MAC Address      IP Address      I/F              MAC              Prim RxFw  Timing Num I
                  IP Address      I/F              State            Sid  (dBmv)  Offset CPE P
0023.be83.1c9e  10.1.11.46     C5/0/0/UB       w-online         922  -0.50  1055  0  N
0023.be83.1caa  10.1.11.28     C5/0/0/UB       w-online         923  0.00   1043  0  N
0025.2ecf.f19c  10.1.11.53     C5/0/0/UB       w-online         925  0.50   1057  0  N
0022.3a30.9fc0  10.1.11.47     C5/0/0/UB       w-online         926  -0.50  1055  0  N
001a.c3ff.e3d4  10.1.11.39     C5/0/0/UB       w-online         927  0.00   1307  0  N
0023.be83.1c9a  10.1.11.61     C5/0/0/UB       w-online         928  0.00   1057  0  N
0022.3a30.9fbc  10.1.11.60     C5/0/0/UB       w-online         929  -0.50  1055  0  N
0023.be83.1c8c  10.1.11.38     C5/0/0/UB       w-online         930  0.00   1061  0  N
001e.6bfb.1964  10.1.11.63     C5/0/0/UB       w-online         931  0.50   1305  0  N
0025.2ecf.f196  10.1.11.29     C5/0/0/UB       w-online         932  0.00   1057  0  N
0025.2ecf.f04e  10.1.11.54     C5/0/0/UB       w-online         933  0.00   1054  0  N
0022.3a30.9fc8  10.1.11.43     C5/0/0/UB       w-online         934  0.00   1056  0  N
0025.2ecf.f190  10.1.11.55     C5/0/0/UB       w-online         935  0.00   1059  0  N
0022.3a30.9fd0  10.1.11.52     C5/0/0/UB       w-online         936  0.00   1057  0  N
0022.ce97.8268  10.1.11.31     C5/0/0/UB       w-online         937  -1.00  1056  0  N
0022.ce97.8281  10.1.11.25     C5/0/0/UB       w-online         938  0.00   1058  0  N
001a.c3ff.e4ce  10.1.11.44     C5/0/0/UB       w-online         940  -0.50  1304  0  N
0022.ce9c.839e  10.1.11.32     C5/0/0/UB       w-online         941  -0.50  1305  0  N
0022.cea3.e768  10.1.11.41     C5/0/0/UB       w-online         942  -1.00  1305  0  N
0022.ce9c.8398  10.1.11.33     C5/0/0/UB       w-online         943  -0.50  1306  0  N
001a.c3ff.e50a  10.1.11.59     C5/0/0/UB       w-online         944  -0.50  1304  0  N
001a.c3ff.e3f8  10.1.11.57     C5/0/0/UB       w-online         945  0.50   1306  0  N
001e.6bfb.1a14  10.1.11.37     C5/0/0/UB       w-online         946  0.00   1305  0  N
```

The following is a sample output for the **show cable modem** command to display impaired CMs above the resiliency threshold value:

```
Router# show cable modem
MAC Address      IP Address      I/F              MAC              Prim RxFw  Timing Num I
                  IP Address      I/F              State            Sid  (dBmv)  Offset CPE P
4458.294a.f3cc  10.1.11.27     C5/0/0/U3       init(o)         1020 0.00   1053  0  N
001e.6bfb.1964  10.1.11.63     C5/0/0/UB       w-online         1021 0.00   1305  0  N
0022.3a30.9fc0  10.1.11.47     C5/0/0/UB       p-online         1022 -0.50  1056  0  N
001a.c3ff.e3f8  10.1.11.57     C5/0/0/UB       p-online         1023 0.00   1305  0  N
0025.2ecf.f190  10.1.11.55     C5/0/0/UB       p-online         1027 0.00   1056  0  N
001a.c3ff.e4ce  10.1.11.44     C5/0/0/UB       p-online         1031 -0.50  1306  0  N
0022.ce9c.8398  10.1.11.33     C5/0/0/UB       p-online         1032 -0.50  1305  0  N
0025.2ecf.f04e  10.1.11.54     C5/0/0/UB       p-online         1039 -1.00  1056  0  N
0022.3a30.9fbc  10.1.11.60     C5/0/0/UB       w-online         1040 0.00   1055  0  N
001a.c3ff.e3d4  10.1.11.39     C5/0/0/UB       w-online         1041 0.00   1305  0  N
0025.2ecf.f196  10.1.11.29     C5/0/0/UB       p-online         1042 -1.00  1058  0  N
0025.2ecf.f19c  10.1.11.53     C5/0/0/UB       p-online         1043 0.00   1058  0  N
0022.3a30.9fd0  10.1.11.52     C5/0/0/UB       w-online         1047 -0.50  1059  0  N
0023.be83.1c8c  10.1.11.38     C5/0/0/UB       p-online         1051 0.00   1057  0  N
0022.3a30.9fc8  10.1.11.43     C5/0/0/UB       p-online         1061 -0.50  1056  0  N
0023.be83.1c9e  10.1.11.46     C5/0/0/UB       p-online         1065 0.00   1060  0  N
0023.be83.1caa  10.1.11.28     C5/0/0/UB       p-online         1069 0.00   1049  0  N
001a.c3ff.e50a  10.1.11.59     C5/0/0/UB       p-online         1070 -0.50  1306  0  N
0023.be83.1c9a  10.1.11.61     C5/0/0/UB       p-online         1071 0.00   1056  0  N
0022.ce9c.839e  10.1.11.32     C5/0/0/UB       p-online         1078 -1.00  1305  0  N
0022.cea3.e768  10.1.11.41     C5/0/0/UB       p-online         1079 0.00   1306  0  N
001e.6bfb.1a14  10.1.11.37     C5/0/0/UB       p-online         1089 0.00   1304  0  N
0022.ce97.8268  10.1.11.31     C5/0/0/UB       p-online         1102 -0.50  1058  0  N
0022.ce97.8281  10.1.11.25     C5/0/0/UB       p-online         1103 0.00   1056  0  N
```

The following is a sample of output for the **show cable resiliency** command that displays that resiliency bonding groups are free:

```
Router# show cable resiliency
```

Resil	BG I/F	BG ID	Resil BG State	Count	Time	RF Ctrl Num
Wi5/0/0:2	2	Free	9	Mar 30 17:18:21		
Wi5/0/0:3	3	Free	9	Mar 30 16:22:21		
Wi5/0/0:4	4	Free	2	Mar 30 15:53:58		
Wi5/0/0:5	5	Free	3	Mar 30 16:24:12		

The Cisco CMTS creates more than one RBG from a parent WB interface if the user has set aside more than one WB interface as an RBG and the RF bandwidth does not exceed 100 percent.

In the following example:

- Parent WB interface—wideband-cable 1/2/0:0
- RBGs—wideband-cable1/2/0:3, wideband-cable1/2/0:4, and wideband-cable1/2/0:5

```
!
interface Wideband-Cable1/2/0:0
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 25
 cable rf-channel 1 bandwidth-percent 25
 cable rf-channel 2 bandwidth-percent 25
 cable rf-channel 3 bandwidth-percent 25
end
!
interface Wideband-Cable1/2/0:3
 cable ds-resiliency
end
!
interface Wideband-Cable1/2/0:4
 cable ds-resiliency
end
!
interface Wideband-Cable1/2/0:5
 cable ds-resiliency
end
```

```
Router# show cable resiliency
```

Resil	BG I/F	BG ID	Resil BG State	Count	Time	RF Ctrl Num
Wi1/2/0:3	3	Free	1	May 24 09:58:35		
Wi1/2/0:4	4	Free	0			
Wi1/2/0:5	5	Free	0			

```
Router# show cable modem resiliency
```

I/F	MAC Address	ID	Orig BG I/F	RFs ID	Curr BG I/F	RFs
-----	-------------	----	-------------	--------	-------------	-----

```
Router# show cable modem c7/0/0
```

MAC Address	IP Address	I/F	MAC State	Prim Sid	RxPwr (dBmV)	Timing Offset	Num CPE	I P
001e.6bfc.d732	80.66.0.16	C7/0/0/U0	w-online	1	0.00	1989	0	N
0025.2e2d.74cc	80.66.0.14	C7/0/0/U1	w-online	5	0.00	1592	1	N
0025.2ebf.29dd	80.66.0.3	C7/0/0/U0	w-online	10	0.50	1591	0	N
0015.d176.5b9d	80.66.0.15	C7/0/0/U0	w-online	17	0.75	1990	0	N

In the following example, CM1 reports RF 1 failure, CM2 reports RF 2 failure, and CM3 reports RF 3 failure. In this case, three RBGs are created:

```
Router# show cable resiliency
          BG   Resil BG
Resil BG I/F  ID   State      Count Time          Ctrl  Num
-----
Wi1/2/0:3    3   Assigned    2   May 24 10:39:42  2     0
                                     2
                                     3
Wi1/2/0:4    4   Assigned    1   May 24 10:39:42  2     0
                                     1
                                     3
Wi1/2/0:5    5   Assigned    1   May 24 10:39:42  2     0
                                     1
                                     2

Router# show cable modem resiliency
          Orig BG
I/F      MAC Address  ID  I/F      RFs ID  I/F      RFs
-----
C7/0/0   001e.6bfc.d732 65  Wi1/2/0:0  4  68  Wi1/2/0:3  3
C7/0/0   0025.2e2d.74cc 65  Wi1/2/0:0  4  69  Wi1/2/0:4  3
C7/0/0   0025.2ebf.29dd 65  Wi1/2/0:0  4  70  Wi1/2/0:5  3
!
interface Wideband-Cable1/2/0:3
 cable bundle 1
 cable ds-resiliency
 cable rf-channel 0 bandwidth-percent 1
 cable rf-channel 2 bandwidth-percent 1
 cable rf-channel 3 bandwidth-percent 1
end
!
interface Wideband-Cable1/2/0:4
 cable bundle 1
 cable ds-resiliency
 cable rf-channel 0 bandwidth-percent 1
 cable rf-channel 1 bandwidth-percent 1
 cable rf-channel 3 bandwidth-percent 1
end
!
interface Wideband-Cable1/2/0:5
 cable bundle 1
 cable ds-resiliency
 cable rf-channel 0 bandwidth-percent 1
 cable rf-channel 1 bandwidth-percent 1
 cable rf-channel 2 bandwidth-percent 1
end
```

## Additional References

### Related Documents

Related Topic	Document Title
Cisco CMTS Command Reference	<a href="http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html">http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html</a>
Wideband Modem Resiliency	<a href="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</a>

**Technical Assistance**

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

## Feature Information for Downstream Resiliency Bonding Group

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

The table below 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 26: Feature Information for Downstream Resiliency Bonding Group**

Feature Name	Releases	Feature Information
Downstream Resiliency Bonding Group	12.2(33)SCG	This feature was introduced. The following commands were introduced: <ul style="list-style-type: none"> <li>• <b>cable resiliency ds-bonding</b></li> <li>• <b>cable ds-resiliency</b></li> <li>• <b>show cable modem resiliency</b></li> <li>• <b>show cable resiliency</b></li> </ul>



# IGMP-Triggered Dynamic Channel Change Load Balancing for DOCSIS 2.0 Cable Modems

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The Internet Group Management Protocol (IGMP) Triggered Dynamic Channel Change (DCC) Load Balancing (LB) feature is introduced to avoid rejection of new video streams either due to bandwidth constraints or repeated admission control failures on an interface.

If there are admission control failures during a session request, the load balancing infrastructure provides a list of downstream channels to which the cable modem (CM) can be moved. Downstream channels that already carry the existing session replication are given preference.



**Note**

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This feature is supported only on DOCSIS 2.0 CMs and DOCSIS 3.0 CMs operating in narrowband (NB) mode.

---

## 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 IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs, page 176](#)
- [Restrictions for IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs, page 177](#)
- [Information About IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs, page 177](#)
- [How to Configure IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs, page 182](#)

- [Verifying IGMP-Triggered DCC Load Balancing Operations](#), page 188
- [Additional References](#), page 190
- [Feature Information for IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs](#), page 191

## Prerequisites for IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs

The IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs feature is supported on the Cisco CMTS routers in Cisco IOS Release 12.2(33)SCF and later releases. The table below shows the hardware compatibility prerequisites for this feature.



### Note

The hardware components introduced in a given Cisco IOS Release will be supported in all subsequent releases unless otherwise specified.

**Table 27: IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs – Compatibility Matrix**

Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• PRE2<sup>14</sup></li> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> <li>• Cisco UBR-MC20X20V</li> <li>• Cisco uBR-MC3GX60V<sup>15</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>16</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCF and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>14</sup> PRE = Performance Routing Engine

<sup>15</sup> The Cisco uBR-MC3GX60V cable interface line card is compatible only with PRE4.

<sup>16</sup> The Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2.

### Software Prerequisites

- The IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs feature is enabled on every CM based on the load balancing policy.
- Load balancing infrastructure ensures that the CM is assigned to the intended load balancing group (LBG).
- CM is moved during session setup depending on the existing multicast replications and bandwidth requirements.
- CM cannot move the downstream channels that are forwarding any voice or video traffic if any active sessions are being forwarded on that CM.
- Route processor and line card high availability is supported.

## Restrictions for IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs

- IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs feature is only supported on NB CMs.
- When an IGMP-triggered DCC load balancing request is sent to the Cisco CMTS, the route processor (RP) queues the request and performs admission control checks and processes the request only if the result is a success.
- CMs with an active stream are not moved.
- DOCSIS 3.0 that are wideband (WB) CMs will not be moved for any optimization.
- Downstream selection and attribute checking is performed on the host line card for multicast sessions.
- For NB DOCSIS 2.0 and DOCSIS 3.0 modems that are either Multicast DSID Forwarding (MDF) enabled or MDF-disabled, combined optimization technique is applied at the time of session request. For more information, see [Combined Optimization Technique](#), on page 178.
- Encrypted multicast streams are not supported in IGMP-triggered DCC load balancing.

## Information About IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs

IGMP-triggered DCC load balancing for DOCSIS 2.0 CM ensures that new video streams are not rejected due to multiple admission control failures. This solution leverages the DOCSIS 3.0 load balancing infrastructure to identify a subset of downstream channels where the CMs can be moved. The downstream channel that is already carrying the existing session replication is preferred over other channels and the CM is moved to this channel to avoid further replication.

If no other downstream channel carries this video stream or does not support the required bandwidth, the CM is moved to a new downstream channel based on the downstream channel in the DCC request for DOCSIS 2.0 CMs—for CMs to be moved across MAC domains.

The following sections describe the technique used to load balance CMs, and the interaction of the IGMP-Triggered DCC Load Balancing feature with DOCSIS LB and Fairness Across DOCSIS Interfaces:

## Combined Optimization Technique

The IGMP-Triggered DCC Load Balancing feature combines replication-based and bandwidth-based optimization techniques to decide when and how load balancing take place.

**Replication-based optimization**—This technique minimizes the number of active replications by load balancing a CM to a downstream where the replications exits.

**Bandwidth-based optimization**—If a new replication needs to be created and the current downstream channel cannot handle the replication request due to insufficient committed information rate (CIR) bandwidth, the CM will be load balanced to a downstream that has the lowest CIR usage.

The combined optimization technique follows these rules:

- When a session request comes in, the replication-based optimization technique is given preference.
- When there are second streams and best effort (BE) traffic on the same bonding group (BG), the weighted RF utilization is measured before making a decision about whether a new replication should be created.
- If there are no existing replications or a new replication needs to be created, the bandwidth-based technique is used to move the CM to a new BG.
- For unicast sessions, the CIR bandwidth-based approach is used.




---

**Note** The IGMP-Triggered DCC Load Balancing feature is not supported for unicast sessions for Cisco IOS Release 12.2(33)SCF.

---

- When there are multiple overlapping BGs carrying the replication, no preference is given based on size.

### Session Creation Request

When a new session request is received, the IGMP-Triggered DCC Load Balancing feature moves CMs when:

- IGMP-triggered DCC load balancing is configured.
- There are no PacketCable Multimedia (PCMM) based multicast flows.
- There are no non-zero CIR unicast or IGMP-based multicast flows on the downstream channel.

The following rules apply during admission control decisions for the session replication request:

- For multicast session requests, the downstream channels carrying the existing replications are the primary candidates if:
  - The forwarding interface is a subset of the current downstream channels or receive channel configuration (RCC) of the CM. In this case, the CM is automatically assigned to the existing multicast session.
  - The replication is forwarding on an interface that is a subset of the LBG of the CM. In this case, the CM is moved to the candidate downstream channel.
- If the utility-based threshold is reached, such that non-video traffic is significantly affected, a new replication is created irrespective of an existing replication.



**Note**

Static multicast sessions are handled in the same way as dynamic sessions with an existing session replication.

The following rules apply when a new session replication is required to be created:

- A new session replication is created if its admission to the current downstream channel interfaces passes.
- If the new session replication admission fails, the downstream channels in the LBG of the CM are searched for target downstream channels. This search is to find the forwarding interface with the least-utilized CIR.

If no new candidates are found, the session replication creation fails and the request is rejected.

## Deployment of the IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 and DOCSIS 3.0 CMs

In an HFC plant with DOCSIS 2.0 and DOCSIS 3.0 CMs, the following points should be noted:

- Downstream forwarding to all DOCSIS 2.0 and NB CMs is done using cable, modular-cable (MC), and integrated-cable (IC) interfaces.

**Note**

Cable interfaces on the Cisco uBR10-MC5X20 cable interface line card that use MDF are not supported.

- While using MC and IC interfaces for downstream forwarding, it is crucial to ensure that the configured **rf-bandwidth-percentage** is sufficient to serve the need for that interface.
- DOCSIS 3.0 CMs in wideband mode can receive traffic that is forwarded on all interfaces whose downstream channels are a subset of the RCC of the CM. However, by default forwarding always occur on the corresponding wideband interface. To forward downstream data on the MC and IC interface, configure specific attributes-based forwarding.

The following rules apply to multicast forwarding selection with IGMP-Triggered DCC load balancing feature in the following hybrid environments:

- For DOCSIS 3.0 CMs:
  - The existing replication is used if the session replication exists on a downstream channel that is subset of the RCC of the CM and the flow attribute matches the existing replication flow.
  - A new replication is created when the session replication exists on a downstream channel that is subset of the RCC of the CM, but the flow attributes do not match the existing replication flow.
  - A new replication is created if the session replication does not exist on a downstream channel that is subset of the RCC of the CM, but exists on a downstream channel that is a subset of the LBG of the CM.
  - If the session replication does not exist, but the flow attributes specifically point to a particular downstream channel, then the first downstream to match the attribute requirements along with the

admission criteria of the flow is used for the forwarding. If the attributes match the BG and downstream channel, then the BG is used for forwarding.

- For DOCSIS 2.0 CMs:
  - Existing replication is used if the session replication already exists on a downstream channel that is a subset of the LBG of the CM. For more information, see [Session Creation Request](#), on page 178.
  - New replication is created if the session replication already exists on a BG that is a subset of the LBG of the CM.

## Interaction of IGMP-Triggered DCC Load Balancing With DOCSIS Load Balancing

DOCSIS load balancing is based on the following methods that the Cisco CMTS uses to determine when interfaces are balanced:

- Modems method
- Service-flow method
- Utilization method

For more information on these DOCSIS LB methods, see [Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers](#).

A single load balance group is used for both the DOCSIS and IGMP-triggered DCC load balancing. DOCSIS load balancing decisions are made during CM registration (static load balancing) as well as after registration (dynamic load balancing; depending on traffic conditions) to achieve a balanced system. IGMP-triggered DCC load balancing is triggered at the time of a video request.

CMs with active video-over-DOCSIS (VDOC) sessions are excluded from moving during the periodic dynamic balancing by DOCSIS load balancing. This can lead to situations where due to the number of CMs with active video session and the pattern of the usage, the interface is unbalanced. However, it is possible to have an unbalanced, but stable state based on the DOCSIS load balancing criteria.

- CMs with active video sessions are counted in the DOCSIS load balancing statistics, but are not allowed to move.
- IGMP-triggered DCC load balancing decisions are independent of the DOCSIS load balancing criteria.

**show cable load-balance vdoc** and **show cable load-balance docsis-group vdoc** commands provide detailed information on the state of the IGMP-triggered DCC load balancing for a particular LBG. These commands also include information to display why a non-balanced stable state is achieved.

## Interaction of IGMP-Triggered DCC Load Balancing With Fairness Across DOCSIS Interfaces

CIR is the average available bandwidth under normal conditions. There may be an allowance of burstable bandwidth, known as the excess information rate (EIR). The connection always supports the CIR rate, and

sometimes the EIR rate, provided there is adequate bandwidth. The CIR plus EIR is either equal to or less than the speed of the access port into the network.

The bandwidth allocation for BE traffic among BGs depends on:

- Statically configured bandwidth percentage
- Actual amount of admitted CIR
- Statically configured remaining ratio

Although the "remaining ratio" is meant for the bandwidth provisioning for the BE traffic, the actual amount of bandwidth used by the BE traffic depends on all three of the above factors.

So, the purpose is to adjust the guaranteed BG bandwidth adaptively to accommodate the CIR flow request by moving guaranteed bandwidth between the adjacent BGs (those that share RF channels). This is referred to as Adaptive CIR. After satisfying the CIR requests, the BG bandwidth is further adjusted based on the estimated traffic and active BE service flow count weighted by DOCSIS priority, so that flows with the same traffic priority get the same amount of bandwidth across BGs. This is referred to as EIR Fairness. The solution as a whole is called Fairness Across DOCSIS Interfaces.

For the IGMP-triggered DCC load balancing to work seamlessly with Fairness Across DOCSIS Interfaces, it relies on the non-guaranteed bonus bandwidth for each BG to determine the threshold and BG capacity.

**Note**

---

For NB and DOCSIS 3.0 load balancing operations, admission control does not utilize non-guaranteed bonus bandwidth for load balancing checks.

---

Therefore, if the admission control check passes, the probability that the service flow creation fails due to insufficient bandwidth is fairly low considering the requests will be serially processed.

**Restrictions**

- Because the host MAC domain does not have the complete information when the BG is shared across multiple MAC domains, due to bandwidth fragmentation in the service flow admission control (SFAC), admission control may fail even though the CIR bandwidth is available on the BG.
- Because the CIR bandwidth information is sent from the active route processor to the host MAC domain with the keepalives, the information is out of synchronization by 2 seconds. This may cause a race condition of possible incomplete or inaccurate knowledge at the time of the session creation.
- When Fairness Across DOCSIS Interfaces is configured, the MAC domain hosts must have the non-guaranteed bonus bandwidth information per bucket, per BG.
- For multicast sessions, there is a possibility that although a CM was moved to a different downstream to satisfy bandwidth requirements, the flow is rejected even though admission control had passed. The race condition here being that the bandwidth has been allocated to other flows in the meantime.

## DOCSIS 2.0 Multicast Enhancement for VDOC

This feature enables you to tune a DOCSIS 2.0 CM to a specific downstream and supports static and dynamic multicast video forwarding on it. The vdoc-enabled keyword enables the VDOC load balancing for static multicast groups.

The set-top boxes (STB) are configured with static video streams. The Cisco CMTS will check if the CMs that are connected to these STBs are already on the specific downstream interface with these multicast replications when the Cisco CMTS receives joins for these static streams. If the CMs are not on the correct downstreams, then a DCC message is sent to the line card to initiate the CM to move to the correct downstream interface.

Static multicast sessions are not a MUST to enable this rule. The CM(s) can be moved to use an existing replication, static or dynamic with preference being given to static flows.

This feature has the following restrictions:

- This feature is not supported on LBGs, which are derived from fiber node configuration and with multicast encryption.
- This feature does not support logical upstream channels.
- This feature works with DOCSIS 2.0 and NB DOCSIS 3.0 CMs, which are MDF-enabled.
- For MDF-enabled CMs, the CM may support DCC but do not receive traffic till the next join arrives.
- Multicast quality of service (QoS) must be configured either globally or on the bundle interface.
- The CMs that support DCC due to load-balancing will use initialization technique 0 irrespective of the initialization technique configured on the LBG.
- This feature does not support multicast encryption. However, if the static group is configured for multicast encryption, then this feature will process the join and move the CM if required.

## How to Configure IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs

The following sections describe how to create and configure LBGs to enable load balancing on the Cisco CMTS. Each task is marked as required or optional, as appropriate.

### Creating a Load Balancing Group

This section describes how to create an LBG. You must create at least one LBG before the Cisco CMTS can begin load balancing CMs.

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.

	Command or Action	Purpose
Step 3	<p><b>cable load-balance group <i>n</i> method [modems   service-flows   utilization]</b></p> <p><b>Example:</b>  <pre>Router(config)# cable load-balance group 10 method service-flows</pre></p>	<p>Creates an LBG with the following parameters:</p> <ul style="list-style-type: none"> <li>• <i>n</i>—Number of the LBG.</li> </ul> <p>In Cisco IOS Release 12.2(33)SCE3 and earlier, the valid range is from 1 to 80. In Cisco IOS Release 12.2(33)SCE4 and later releases, the valid range is from 1 to 256.</p> <p><b>Note</b> If downstream channels are not included in an LBG, then each downstream channel can be considered a separate domain.</p> <ul style="list-style-type: none"> <li>• <b>modems</b>—(Optional) Specifies that the LBG should use the number of active CMs on an interface to determine the current load (default).</li> <li>• <b>service-flows</b>—(Optional) Specifies that the LBG should use the number of active service flow IDs (SFIDs) on an interface to determine the current load.</li> <li>• <b>utilization</b>—(Optional) Specifies that the LBG should use the current percentage of utilization on an interface to determine the current load. (To avoid unnecessary movement of CMs, the utilization method does not perform load balancing until the amount of utilization on an interface is at 25 percent or more.)</li> </ul>
Step 4	<p><b>exit</b></p> <p><b>Example:</b>  <pre>Router(config)# exit</pre></p>	Exits global configuration mode.

## Creating a Load Balancing Rule

This configuration is optional. This section describes how to create a load balancing rule. You must create at least one load balancing rule before the Cisco CMTS can use load balancing policies.

### DETAILED STEPS

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

	Command or Action	Purpose
Step 3	<b>cable load-balance docsis-enable</b>  <b>Example:</b> <pre>Router(config)# cable load-balance docsis-enable</pre>	Enables DOCSIS load balancing on the Cisco CMTS.
Step 4	<b>cable load-balance rule rule-id vdoc-enabled</b>  <b>Example:</b> <pre>Router(config)# cable load-balance rule 1 vdoc-enabled</pre>	Creates a rule that prevents a CM from disabling or enabling load balancing. <ul style="list-style-type: none"> <li>• <b>vdoc-enabled</b>—Enables the VDOC LB for static and dynamic multicast groups.</li> <li>• <b>rule-id</b>—Rule ID of the rule to load balance CM</li> </ul>
Step 5	<b>cable load-balance docsis-policy policy-id rule rule-id</b>  <b>Example:</b> <pre>Router(config)# cable load-balance docsis-policy 1 rule 1</pre>	Creates a DOCSIS policy and associates an existing rule with the policy. <ul style="list-style-type: none"> <li>• <b>policy-id</b>—DOCSIS policy to be created.</li> <li>• <b>rule rule-id</b>—Specifies the rule to be used with the DOCSIS policy.</li> </ul>
Step 6	<b>cable load-balance docsis-group docsis-group-id index</b>  <b>Example:</b> <pre>Router(config)# cable load-balance docsis-group 1 index 81</pre>	Configures a DOCSIS LBG on the Cisco CMTS. <ul style="list-style-type: none"> <li>• <b>docsis-group-id</b>—DOCSIS LBG ID. A valid DOCSIS LBG ID ranges from 1 to 2147483647 and does not overlap with the legacy LBG ID.</li> </ul>
Step 7	<b>downstream Modular-Cable slot/subslot/controller rf-channel rf-channel</b>  <b>Example:</b> <pre>Router(config-lb-group)# downstream Modular-Cable 5/0/0 rf-channel 0-11</pre>	Associates a set of upstreams with individual modular cable downstream channels into a given cable MAC domain. <ul style="list-style-type: none"> <li>• <b>slot</b>—Cable interface slot. The valid values range from 5 to 8.</li> <li>• <b>subslot</b>—Cable interface subslot. The valid values are 0 or 1.</li> <li>• <b>controller</b>—Modular-cable controller number. The valid values range from 0 to 2.</li> <li>• <b>rf-channel</b>—Specifies the association of a continuous range of RF channels within the downstream.</li> <li>• <b>rf channels</b>—Range of RF channel physical ports.</li> </ul>
Step 8	<b>downstream cable slot/subslot/controller</b>  <b>Example:</b> <pre>Router(config-lb-group)# downstream Cable 7/0/0</pre>	Assigns a primary downstream channel for a fiber node. <ul style="list-style-type: none"> <li>• <b>slot</b>—Cable interface slot. The valid values range from 5 to 8.</li> <li>• <b>subslot</b>—Cable interface subslot. The valid values are 0 or 1.</li> <li>• <b>controller</b>—Modular-cable controller number. The valid values range from 0 to 2.</li> </ul>
Step 9	<b>upstream cable slot/subslot/port upstream-list</b>	Sets upstream channels in a DOCSIS LBG.

	Command or Action	Purpose
	<p><b>Example:</b> Router(config-lb-group) # <b>upstream cable</b> 7/0/0 0</p>	<ul style="list-style-type: none"> <li>• <b>cableslot/subslot/port</b>—Specifies the Cisco CMTS interface slot, subslot, and port number parameters. <ul style="list-style-type: none"> <li>◦ <i>slot</i>—Cable interface slot. The valid values range from 5 to 8.</li> <li>◦ <i>subslot</i>—Cable interface subslot. The valid values are 0 and 1.</li> <li>◦ <i>port</i>—Modular-Cable controller number. The valid values are 0 to 2.</li> </ul> </li> <li>• <i>upstream-list</i>—Upstream channel list ranging from 0 to 7.</li> </ul>
<b>Step 10</b>	<p><b>init-tech-list</b> <i>group-list</i> [<b>ucc</b>]</p> <p><b>Example:</b> Router(config-lb-group) # <b>init-tech-list</b> 1</p>	<p>Sets the DCC initialization techniques that the Cisco CMTS can use for load balancing CMs.</p> <ul style="list-style-type: none"> <li>• <i>group-list</i>—DCC initialization technique list.</li> </ul> <p><b>Note</b> It is not recommended to use <code>init-tech-list 0</code>.</p> <ul style="list-style-type: none"> <li>• <b>ucc</b>—(Optional) Determines whether Upstream Channel Change (UCC) can be used for modems during dynamic upstream load balancing.</li> </ul>
<b>Step 11</b>	<p><b>docsis-policy</b> <i>policy-id</i></p> <p><b>Example:</b> Router(config-lb-group) # <b>docsis-policy</b> 1</p>	<p>Assigns a policy to a DOCSIS LBG.</p> <ul style="list-style-type: none"> <li>• <i>policy-id</i>—LBG policy number. The policy number can range from 0 to 4294967295.</li> </ul>
<b>Step 12</b>	<p><b>exit</b></p> <p><b>Example:</b> Router(config) # <b>exit</b></p>	<p>Exits global configuration mode.</p>

## Creating a Load Balancing Policy

This configuration is optional. This section describes how to create a load balancing policy. You must create at least one load balancing rule before the Cisco CMTS can use a load balancing policy.

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b>	<ul style="list-style-type: none"> <li>• Enables privileged EXEC mode.</li> </ul>

	Command or Action	Purpose
	<b>Example:</b> Router> <b>enable</b>	<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.
<b>Step 3</b>	<b>cable load-balance docsis-policy <i>policy-id</i> rule <i>rule-id</i></b>  <b>Example:</b> Router (config)# <b>cable load-balance docsis-policy 2 rule 1</b>	Creates a load balancing rule with the following parameters: <ul style="list-style-type: none"> <li>• <i>policy-id</i>—DOCSIS policy to be created.</li> <li>• <b>rule <i>rule-id</i></b>—Specifies the rule to be used with the DOCSIS policy.</li> </ul>
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router (config)# <b>exit</b>	Exits global configuration mode.

## Configuring a Load Balancing Group

This section describes how to configure an LBG. All steps are optional, unless you want to change the default load balancing configuration.



### Restriction

When assigning cable interfaces to LBGs, be aware of the following restrictions:

- An upstream can belong to only one LBG.
- All downstreams and upstreams in an LBG must share physical connectivity to the same group of CMs. Downstreams can be in a separate LBG than upstreams, but all downstreams or all upstreams that have the same RF physical connectivity must be members of the same LBG. You cannot distribute downstreams or upstreams that share physical connectivity across multiple LBGs.

### DETAILED STEPS

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



	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>cable load-balance docsis-group</b> <i>docsis-group-id</i>  <b>Example:</b> Router(config)# <b>cable load-balance group</b> <b>1 index 81</b>	Configures a DOCSIS LBG on the Cisco CMTS. <ul style="list-style-type: none"> <li>• <i>n</i> —DOCSIS LBG ID. A valid DOCSIS LBG ID ranges from 1 to 2147483647 and does not overlap with the legacy LBG ID.</li> </ul>
<b>Step 4</b>	<b>downstream cable</b> <i>slot/subslot/controller</i>  <b>Example:</b> Router(config-lb-group)# <b>downstream</b> <b>cable 7/0/0</b>	Assigns a primary downstream channel for a fiber node. <ul style="list-style-type: none"> <li>• <i>slot</i>—Cable interface slot. The valid values range from 5 to 8.</li> <li>• <i>subslot</i>—Cable interface subslot. The valid value is 0 or 1.</li> <li>• <i>controller</i>—Modular-Cable controller number. The valid values range from 0 to 2.</li> </ul>
<b>Step 5</b>	<b>upstream cable</b> <i>slot/subslot/port upstream-list</i>  <b>Example:</b> Router(config-lb-group)# <b>upstream cable</b> <b>7/0/0 0</b>	Sets upstream channels in a DOCSIS LBG. <ul style="list-style-type: none"> <li>• <b>cable</b> <i>slot/subslot/port</i>—Cisco CMTS interface slot, subslot, and port number parameters.               <ul style="list-style-type: none"> <li>◦ <i>slot</i>—Cable interface slot. The valid values range from 5 to 8.</li> <li>◦ <i>subslot</i>—Cable interface subslot. The valid value is 0 or 1.</li> <li>◦ <i>port</i>—Modular-cable controller number. The valid values range from 0 to 2.</li> </ul> </li> <li>• <i>upstream-list</i>—Upstream channel list ranging from 0 to 7.</li> </ul>
<b>Step 6</b>	<b>init-tech-list</b> <i>grouplist [ucc]</i>  <b>Example:</b> Router(config-lb-group)# <b>init-tech-list</b> <b>1</b>	Sets the DCC initialization techniques that the Cisco CMTS can use to load balancing CMs. <ul style="list-style-type: none"> <li>• <i>grouplist</i>—DCC initialization technique list.</li> <li>• <b>ucc</b>—(Optional) Determines whether UCC can be used for modems during dynamic upstream load balancing.</li> </ul>
<b>Step 7</b>	<b>docsis-policy</b> <i>n</i>  <b>Example:</b> Router(config-lb-group)# <b>docsis-policy</b> <b>1</b>	Assigns a policy to a DOCSIS LBG. <ul style="list-style-type: none"> <li>• <i>n</i>—LBG policy number. The policy number can range from 0 to 4294967295.</li> </ul>

	Command or Action	Purpose
Step 8	<b>exit</b>  <b>Example:</b> Router(config-lb-group)# <b>exit</b>	Exits the DOCSIS LBG on the Cisco CMTS.
Step 9	<b>cable load-balance group <i>n</i> policy {pcmm   ugs   us-groups-across-ds}</b>  <b>Example:</b> Router(config)# <b>cable load-balance group 10 policy ugs</b> Router(config)# <b>cable load-balance group 10 policy pcmm</b> Router(config)# <b>cable load-balance group 10 policy us-groups-across-ds</b>	Sets the load balancing policy. <ul style="list-style-type: none"> <li>• <i>n</i>—Number of the LBG. In Cisco IOS Release 12.2(33)SCE3 and earlier, the valid range is from 1 to 80. In Cisco IOS Release 12.2(33)SCE4 and later releases, the valid range is from 1 to 256.</li> <li>• <b>pcmm</b>—Enables balancing of modems with active PCMM service flows.</li> <li>• <b>ugs</b>—Enables balancing of modems with active unsolicited grants service (UGS) service flows.</li> <li>• <b>us-groups-across-ds</b>—Enables load balancing on upstream groups across the downstream. The downstream group method will be ignored.</li> </ul>
Step 10	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Verifying IGMP-Triggered DCC Load Balancing Operations

This section describes how to use certain show commands to verify the configuration and operation of the IGMP-Triggered DCC Load Balancing feature on the Cisco CMTS.

- **show cable load-balance docsis-group *vdoc***
- **show cable multicast db detail**
- **show cable multicast db [*cm-mac-address*]**

### Examples

The following is a sample output of the **show cable load-balance docsis-group *vdoc*** command:

```
Router# show cable load-balance docsis-group 2 vdoc
Interface                State Group Util Total IGMP   CIR   High Low
                        Index Targeted Repl   Init  Util CIR
In7/0/0:0 (453 MHz)    up   81    0%  37(m)  12(m) 25(m) 10  10
In7/0/0:1 (459 MHz)    up   81    0%  37(15) 12(10) 25(5) 30  1
In7/0/0:2 (465 MHz)    up   81    0%  37(m)  12(m) 25(m) 20  10
Util: Current Utilization
Total Targeted: # of times the DS was targeted to be used by VDOC LB
```

```

w or w/o move
m: # of times the DS was targeted with a move required

IGMP Repl: subset of Total Targeted, # of times it was due to existing
repl
    m: Targeted via IGMP repl w/ a move required
CIR Init: subset of Total Targeted, # of times it was due to new CIR flow
    m: Targeted via CIR w/ a move required
High Util: #of times the DS was rejected w/ a existing replication due
to high
    util. (regardless of CMs exiting DS)
High CIR: #of times the DS was rejected due to low CIR

```

```

Router# show cable multicast db bundle 1 230.1.1.1 detail
Interface          Fwd Intfc  group      source      Cause
Bundle1           Mo3/0/0:0  230.1.1.1  N/A         No LB
ETDB received IGMP  ETDB processed IGMP
Jan 30 03:57:24.759  Jan 30 03:57:24.763
Sid      gc_id  Stat Index  DSID      Stat Index Allocated
DEFAULT  N/A    61322      0x4F259   Jan 30 03:57:24.759
8206    1      61323      0x4F259   Jan 30 03:57:24.759

```

The table below displays the conditions when a new replication is created.

**Table 28: Conditions When a New Replication is Created**

Cause	Description
NEW_REPLN_NO_LB	Load balancing is not configured.
NEW_REPLN	New replication.
NEW_REPLN_DS_HI_UTIL	Downstream has high utilization of bandwidth.
NEW_REPLN_NO_MOVE	CM move is not allowed.
NEW_REPLN_DS_NOT_LBG	Downstream is not part of the LBG.
NEW_W_EXIST_REPLN_FOR_WB	Replication exists for the wideband CM.
REPLN_FAIL	Replication failure; use existing replication.
REPLN_DCC	CM requested a DCC.
REPLN_DCC_FAIL	DCC of the CM failure.
REPLN_MDF_DIS	CM was MDF disabled.
REPLN_STATIC_CLI	Static CLI configured.
REPLN_STATIC_TLV	Static TLV configured.
REPLN_INTFC_GC	Interface GC configured.
REPLN_PCMM	PCMM replication.
REPLN_HA	Replication created after HA.

```

Router# show cable multicast db 001e.6bfb.248a
Session (S,G) : (*,230.1.1.1)
Fwd Intfc Sub Intfc Host Intfc Hosts Proxy Static DCC
Mo3/0/0:5 Bundle1 Cable7/0/0 1 N N N

```

## Additional References

### Related Documents

Document Title	URL
Cisco IOS Commands for the Cisco CMTS Routers	<a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC	<a href="http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/12_2sc/cbl_12_2sc_book.html">http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/12_2sc/cbl_12_2sc_book.html</a>
Cisco uBR10000 Series Universal Broadband Router Release Notes	<a href="http://www.cisco.com/en/US/products/hw/cable/ps2209/prod_release_notes_list.html">http://www.cisco.com/en/US/products/hw/cable/ps2209/prod_release_notes_list.html</a>

### Standards and RFCs

Standard/RFC	Title
CableLabs™ DOCSIS specifications	<a href="http://www.cablelabs.com/cablemodem/">http://www.cablelabs.com/cablemodem/</a>
CableLabs™ PacketCable MultiMedia specifications	<a href="http://www.cablelabs.com/packetcable/specifications/multimedia.html">http://www.cablelabs.com/packetcable/specifications/multimedia.html</a>

### Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

# Feature Information for IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



## Note

The table below 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 29: Feature Information for IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 CMs**

Feature Name	Releases	Feature Information
IGMP-Triggered DCC Load Balancing for DOCSIS 2.0 Cable Modems	12.2(33)SCF	<p>This feature was introduced.</p> <p>The <b>vdoc</b> keyword was added to the following commands:</p> <ul style="list-style-type: none"> <li>• <b>show cable load-balance vdoc</b></li> <li>• <b>show cable load-balance docsis-group vdoc</b></li> </ul>





# CHAPTER 10

## IGMP-Triggered VDOC Broadcast Support on the Cisco CMTS Routers

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**First Published:** December 17, 2008

**Last Updated:** May 27, 2013

The Cisco universal broadband router supports the Video over DOCSIS (VDOC) Broadcast feature enabling multiple service operators (MSOs) to broadcast video content on RF-spanned downstream signals.

### 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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- [Configuration Examples for VDOC Broadcast, page 208](#)
- [Configuration Examples for Inter Line Card RF Spanning, page 211](#)
- [Verifying VDOC Broadcast and Inter Line Card RF Spanning, page 213](#)
- [Additional References, page 217](#)
- [Feature Information for Configuring VDOC Broadcast, page 218](#)

## Prerequisites for Configuring VDOC Broadcast

The table below shows the hardware compatibility prerequisites for the VDOC broadcast feature.


**Note**

The hardware components introduced in a given Cisco IOS Release are supported in all subsequent releases unless otherwise specified.

**Table 30: Cable Hardware Compatibility Matrix for the VDOC Broadcast Feature**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> </ul> Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul> Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V <a href="#">17</a></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V <a href="#">18</a></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>



- 17 Cisco uBR3GX60V cable interface line card is compatible only with PRE4.  
18 Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2.

- The Cisco uBR10012 router must have the M-CMTS setup.
- The Cable Modem Termination System (CMTS) and the cable modem must have the latest DOCSIS 3.0 setup with the Multicast DSID-based Forwarding (MDF) and Dynamic Bonding Change (DBC) capability.
- The cable modem software must support the channel change capability via Receive Channel Configuration (RCC) TLV (49.5) in the DBC message.
- Support for DOCSIS 3.0 channel bonding.

## Restrictions for Configuring VDOC Broadcast

- The VDOC Broadcast feature supports:
  - Only one tuner per cable modem.
  - Only one video stream per IP set-top box.
  - Only one IP set-top box for every cable modem.
- Internet Group Management Protocol version 3 (IGMPv3) configuration is required on the bundle interface.
- Secondary bonding groups used for video streams must be created using one or more downstream RF channels.
- The secondary bonding group must not be used for forwarding by other features, such as video on demand (VOD) and service flow attribute-based forwarding interface selection.
- The DPC3010 cable modem (DPC3010 firmware version) might experience 3 seconds delay if receive channel configuration is changed using Dynamic Bonding Change (DBC).

## Information About Configuring VDOC Broadcast

The VDOC Broadcast feature facilitates broadcasting video over DOCSIS. Video streams are broadcast to one or more downstream RF channels using static multicast. Depending on the video stream selected for viewing by the IP set-top box, the multituner cable modem is tuned to the appropriate RF channel carrying the specific video stream.

The process to broadcast video over the cable is as follows:

- 1 When a channel is selected, the IP set-top box sends an IGMP join message to a particular bonding group.
- 2 The CMTS locates the secondary bonding group that has the video streaming channel and the RCC template that contains the channel corresponding to the secondary bonding group.
- 3 The CMTS sends a dynamic bonding change request (DBC-REQ) message to the modem. The DBC-REQ message contains the DSID. It also contains a new RCC (that contains frequencies for the primary bonding group and the secondary bonding group that was selected in Step 2), if the modem is not currently tuned to the frequencies selected in Step 2.

- 4 The cable modem retunes to the new channel and receives the video stream.

**Note**

---

In the case of subsequent channel changes, the IP set-top box sends an IGMP leave message for the old video stream. CMTS responds with the DBC-REQ message to remove the DSID corresponding to this stream.

---

## Inter Line Card RF Spanning

The Inter Line Card RF Spanning feature, introduced in Cisco IOS Release 12.2(33)SCF, supports sharing of downstream channels across line cards installed on the Cisco uBR10012 router. This feature is an extension to the existing downstream channel sharing functionality supported within the bonding groups configured on a single line card. This feature enables you to associate downstream channels of a line card to a service group that is hosted on a different line card.

**Note**

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The Inter Line Card RF Spanning feature is supported only on the Cisco uBR10012 router with Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V cable interface line cards.

---

The Inter Line Card RF Spanning feature supports the following two methods of downstream channel sharing:

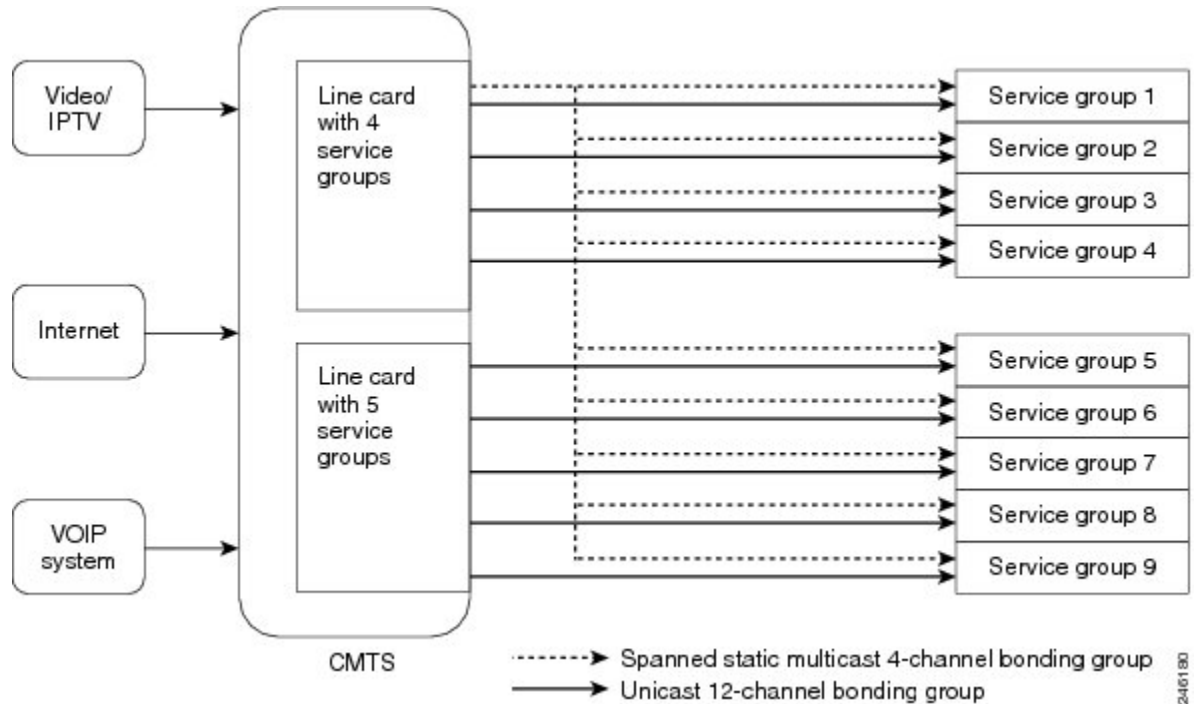
### RF Spanning of Bonding Groups Carrying Static Multicast Traffic

In this RF spanning (unrestricted RF spanning) method, a downstream bonding group is configured on one of the line cards and included in one or more fiber nodes as required. Then, one or more static multicast sessions are configured for the bonding group, and any service group can use this bonding group. When this is configured, a cable modem can send a multicast join request and receive multicast streams using this bonding group. This enables service providers to broadcast a set of popular channels and make them available to customers at any time.

As shown in the figure below, each service group is made of 16 downstream channels. Of these 16 channels, 12 downstream channels are from the local card and can carry unicast traffic. The remaining four channels are from one of the line cards and spanned to all downstream service groups. These four channels can carry multicast traffic so that all service groups can use the same channels without creating any replication.

The figure below illustrates how a bonding group carries static multicast traffic.

**Figure 1: RF Spanning of Bonding Groups Carrying Static Multicast Traffic**



## RF Spanning of Remote Bonding Groups

In the RF spanning of remote bonding groups method, downstream channels physically located on a single line card can be used by MAC domains of a different line card for VDOC services. This method supports both unicast VDOC services and static unencrypted multicast services over RF spanned downstream bonding groups. This is similar to the RF spanning functionality supported on the shared port adapter (SPA) bonding groups together with the Cisco uBR10-MC5X20 line card. With this extended RF spanning functionality, you can directly configure remote bonding groups on the Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V line cards for unicast VDOC services. Bonding groups configured on a remote line card are called remote bonding groups.



**Note**

We recommend using a remote bonding group and its associated channels on a single line card only to avoid bandwidth fragmentation and non-deterministic bandwidth allocation behavior.

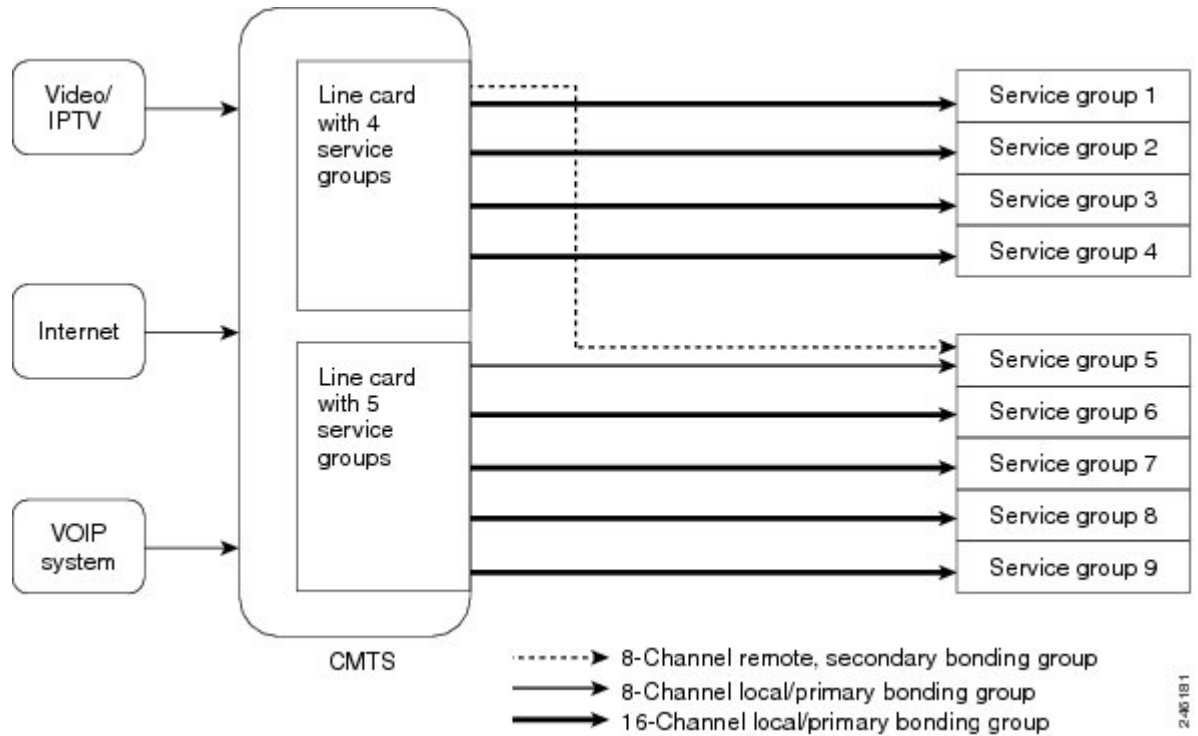
RF spanning of remote bonding groups is configured in the following ways:

### Remote Downstream to a Single Host Line Card

As shown in the figure below, each service group is made of 16 downstream channels. Because the Cisco uBR-MC3GX60V line card supports 72 downstream channels, a single line card is not sufficient to make five service groups. Therefore eight downstream channels are taken from another Cisco uBR-MC3GX60V line card to configure five service groups. Also, the service group is made of two or more bonding groups as downstream channels cannot be bonded across line cards.

The figure below illustrates how remote downstream works with a single host line card.

**Figure 2: Remote Downstream to a Single Host Line Card**



**Remote Downstream to Multiple Line Cards**

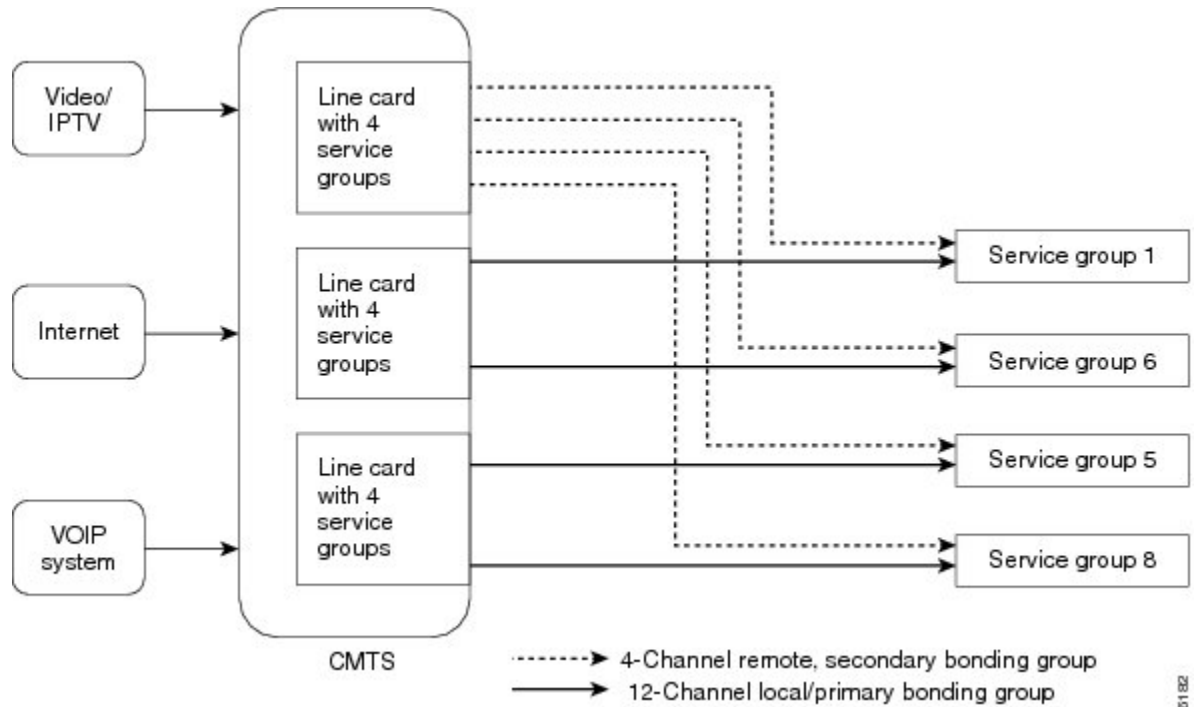
In this configuration, a Cisco uBR-MC3GX60V line card provides all its downstream channels to other Cisco uBR-MC3GX60V line cards installed on the Cisco uBR10012 router. As shown in the figure below, some of the downstream channels are shared with one line card and others are shared with another line card, and none are used locally.



**Note** This type of configuration may not be efficient even though it is supported to provide flexibility.

The figure below illustrates how remote downstream works with multiple line cards.

**Figure 3: Remote Downstream to Multiple Line Cards**



This feature also supports mixing of different types of line cards for downstream channel sharing. That is, a MAC domain configured on a Cisco UBR-MC20X20V line card can use a wideband interface configured on a Cisco uBR-MC3GX60V line card and vice versa. However, this type of configuration is generally not required and is not recommended.

## RCC Template

This section describes about the RCC template selection:

### Dynamic RCC Selection

The dynamic RCC selection feature facilitates multicast forwarding. The RCC selection occurs after the multicast forwarding selection algorithm identifies that the stream being requested is related to the VDOC Broadcast feature. It will select the RCC, which is superset of the primary bonding group of the cable modem, and the secondary bonding group where the stream is forwarded.



**Note**

The RCC template is selected only if the number of RF channels in the primary bonding group of the RCC template is same as the number of RF channels in the primary bonding group of the cable modem currently used.

### RCC Assignment Across SPAs

The VDOC Broadcast feature requires modems to be tuned to RF spanned channels carrying video streams. The RF spanned channels originate from a SPA other than the SPA hosting the primary bonding group assigned to the cable modem. RCCs are generated from RCC templates that contain Receive Channels (RC) from multiple SPAs.

Limitations while assigning RCCs are:

- For static multicast streams, only SPA downstream channels can be used in RCC templates.
- Encrypted multicast or unicast traffic is not supported on the RC from a secondary SPA.
- For encrypted or unicast downstream VDOC broadcast, traffic will not be forwarded to CPEs even when the cable modem is properly tuned to the downstream.

## How to Configure VDOC Broadcast

This section describes the configuration tasks that are performed when using the VDOC broadcast feature on the Cisco CMTS platform.

- 1 [Configuring the Primary and Secondary Bonding Group, on page 200](#) (required)
- 2 [Configuring the RCC Template, on page 201](#) (required)
- 3 [Configuring the Multicast Static Group, on page 203](#) (required)

## Configuring the Primary and Secondary Bonding Group

This section describes the tasks required to configure the MAC domain and the bonding group. Follow the summary steps to complete the configuration.

Configure the modular cable controller for four RF channels, two of which will be used for primary bonding group and the other two will be used for broadcasting video specific bonding groups.

Secondary bonding groups may be constructed using multiple RF channels.

### Before You Begin

- The modular controller is already configured for RF channels used for the primary and secondary bonding groups. The RF channels used for secondary bonding groups are non-primary capable and can be served by legacy Edge Quadrature Amplitude Modulation (EQAM) applications. The "udp-port" option can be used instead of Downstream External PHY Interface (DEPI) remote ID.
- The MAC domain is configured by specifying the fiber node configuration.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>

	Command or Action	Purpose
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface wideband-cable</b> <i>slot/subslot/port:wideband-channel</i>  <b>Example:</b> Router(config)# <b>interface</b> <b>wideband-cable 6/0/1:22</b>	Enters cable interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the <a href="#">Cisco IOS CMTS Cable Command Reference</a> . <ul style="list-style-type: none"> <li>• <i>slot</i>—Slot where the Cisco Wideband SIP or a cable line card resides. On the Cisco uBR10012 router, slots 1 and 3 can be used for the Cisco Wideband SIP. The valid range for a cable line card is from 5 to 8.</li> <li>• <i>subslot</i>—Subslot where the Cisco Wideband SIP or a cable line card resides. On the Cisco uBR10012 router, subslot 0 is always specified for the Cisco Wideband SIP. For a cable line card, subslot is 0 or 1.</li> <li>• <i>port</i>—Bay in the SIP where the Cisco Wideband SPA is located. Valid values are 0 (upper bay) and 1 (lower bay). It also refers to the downstream port of the line card. The valid range varies depending on the line card.</li> <li>• <i>wideband-channel</i>—Wideband channel number. The valid range varies depending on the Cisco CMTS router and the line card.</li> </ul>
Step 4	<b>cable bonding-group-secondary</b>  <b>Example:</b> Router(config-if)# <b>cable</b> <b>bonding-group-secondary</b>	Specifies a secondary bonding group.  <b>Note</b> The <b>cable bonding-group-secondary</b> command replaced the <b>cable bonding-group-id</b> command in Cisco IOS Release 12.2(33)SCE.
Step 5	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## Configuring the RCC Template

This section describes the tasks required to configure the RCC template and associate it to a MAC domain.

RCC templates must be configured and then applied to the MAC domain interface. With 3-channel cable modems, the first two channels are part of the primary bonding group, and the third channel is used for video. If two RF channels are used for carrying video streams, then two RCC templates must be configured.

### Before You Begin

Modular controller and MAC domain configuration must be complete before you proceed to configuring the RCC template.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable</b> { <i>slot/subslot/port</i>   <i>slot/subslot/cable-interface-index</i> }  <b>Example:</b> Router (config) # <b>interface cable 8/0/0</b>	Associates the RCC template to a MAC domain. Enters interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the <a href="#">Cisco IOS CMTS Cable Command Reference</a> . <ul style="list-style-type: none"> <li>• <i>slot</i>—Slot where the line card resides. The valid range is from 5 to 8 on the Cisco uBR10012 router.</li> <li>• <i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. The valid subslots are 0 or 1.</li> <li>• <i>port</i>—Downstream port number. The valid range is from 0 to 4 (depending on the cable interface) on the Cisco uBR10012 router.</li> <li>• <i>cable-interface-index</i>—Downstream port of the Cisco uBR10-MC5X20 and Cisco uBR-MC28 line cards, or MAC domain index of the Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V line cards. The valid range for the Cisco UBR-MC20X20V and Cisco uBR-MC5X20 line cards is from 0 to 4. The valid range for the Cisco uBR-MC3GX60V line card is from 0 to 14.</li> </ul>
Step 4	<b>cable rcc-template</b> <i>index</i>  <b>Example:</b> Router (config) # <b>cable rcc-template 1</b>	Defines the RCC template for a Receive Channel Profile (RCP) outside the MAC domain configuration mode. <ul style="list-style-type: none"> <li>• <i>index</i>—RCC index value. The valid range is from 1 to 255.</li> </ul>
Step 5	<b>rcp-id</b> <i>rcp-id</i>  <b>Example:</b> Router (config-rcc-template) # <b>rcp-id 0010000004</b>	Configures the RCP ID. <ul style="list-style-type: none"> <li>• <i>rcp-id</i>— RCP ID.</li> </ul>
Step 6	<b>receive-module</b> <i>index</i> <b>first-channel-center-frequency</b> <i>Hz</i>  <b>Example:</b> Router (config-rcc-template) # <b>receive-module 1</b> <b>first-channel-center-frequency 45300000</b>	Configures the receive module. <ul style="list-style-type: none"> <li>• <i>Hz</i>—Assigned center frequency of the first channel of the receive module channel block in hertz.</li> </ul>



	Command or Action	Purpose
Step 7	<p><code>receive-channel <i>index</i> center-frequency <i>Hz</i></code>  <code>connected-receive-module <i>index</i> [<i>primary</i>]</code></p> <p><b>Example:</b>  Router(config-rcc-template)#  <b>receive-channel 1 center-frequency</b>  <b>453000000 connected-receive-module 1</b>  <b>primary</b></p>	<p>Configures the receive channel.</p> <ul style="list-style-type: none"> <li>• <i>Hz</i>—Center frequency of a receive channel in Hz.</li> <li>• <b>connected-receive-module <i>index</i></b>—Specifies the index value for the connected receive module. The valid range is from 1 to 10. The configuration will be rejected if the connected receive module has not been previously configured.</li> <li>• <b>primary</b>— (Optional) Indicates an RCC can be derived with this channel designated as the primary channel of the cable modem.</li> </ul>
Step 8	<p><code>end</code></p> <p><b>Example:</b>  Router(config-rcc-template)# <b>end</b></p>	<p>Exits RCC template configuration mode and returns to privileged EXEC mode.</p>

### What to Do Next



#### Note

Run the `show cable mac-domain cable interface rcc` command to verify that RCC templates are applied to the MAC domain.

## Configuring the Multicast Static Group

Multicast static group configuration is used to statically forward (broadcast) video streams on secondary bonding groups. This configuration specifies certain video streams should be broadcast on particular bonding groups.

This section describes the tasks required to configure the multicast static group.

One or more IGMP static groups corresponding to the broadcast video channels are configured on the specified secondary bonding group. The same groups should be specified under the cable bundle interface as part of the `ip igmp static-group` command.

### Before You Begin

- Multicast routing must be configured on the Cisco CMTS.
- PIM sparse-mode must be configured on the bundle interface.
- IGMPv3 must be configured on the bundle interface.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface bundle</b> <i>bundle-number</i>  <b>Example:</b> Router# <b>interface bundle 1</b>	Indicates the bundle interface.
Step 4	<b>interface wideband-cable</b> <i>slot/subslot/port:wideband-channel</i>  <b>Example:</b> Router(config)# <b>interface</b> <b>wideband-cable 6/0/1:22</b>	Enters cable interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the <a href="#">Cisco IOS CMTS Cable Command Reference</a> . <ul style="list-style-type: none"> <li>• <i>slot</i>—Slot where the Cisco Wideband SIP or a cable line card resides. On the Cisco uBR10012 router, slots 1 and 3 can be used for the Cisco Wideband SIP. The valid range for a cable line card is from 5 to 8.</li> <li>• <i>subslot</i>—Subslot where the Cisco Wideband SIP or a cable line card resides. On the Cisco uBR10012 router, subslot 0 is always specified for the Cisco Wideband SIP. For a cable line card, subslot is 0 or 1.</li> <li>• <i>port</i>—Bay in the SIP where the Cisco Wideband SPA is located. Valid values are 0 (upper bay) and 1 (lower bay). It also refers to the downstream port of the line card. The valid range varies depending on the line card.</li> <li>• <i>wideband-channel</i>—Wideband channel number. The valid range varies depending on the Cisco CMTS router and the line card.</li> </ul>
Step 5	<b>cable igmp static-group</b> [ <i>multicast group</i> ] <b>source</b> [ <i>source IP</i> ] [ <i>subinterface number</i> ]  <b>Example:</b> Router(config-if)# <b>cable igmp</b> <b>static-group 224.0.0.0</b>	Configures the cable per physical downstream static multicast support on the Cisco CMTS. <ul style="list-style-type: none"> <li>• <i>multicast group</i>—Multicast IP address of the group.</li> <li>• <b>source</b> [<i>source IP</i>]— (Optional) Source IP address for SSM.</li> <li>• <i>subinterface number</i>—Subinterface number. The default is 0 for the main interface.</li> </ul> <p><b>Note</b> If the subinterface is configured at the virtual bundle interface, the subinterface number option must be configured to match up with the desired subinterface devices.</p>

	Command or Action	Purpose
Step 6	<b>end</b>  <b>Example:</b> Router (config-if) # <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## How to Configure Inter Line Card RF Spanning

The following tasks describe how to configure RF spanning of bonding groups carrying static multicast traffic and RF spanning of remote bonding groups to enable RF spanning on the line cards on the Cisco uBR10012 router:

### Configuring RF Spanning of Bonding Groups Carrying Static Multicast Traffic

To configure RF spanning of bonding groups carrying static multicast traffic, you need to associate downstream channels to one or more fiber nodes after configuring VDOC features on the Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V line cards.

#### Before You Begin

- An RCC template must be created and associated to a MAC domain. For details, see [Configuring the RCC Template, on page 201](#)
- A multicast static group must be created. For details, see [Configuring the Multicast Static Group, on page 203](#).



**Restriction** RF spanning of bonding groups carrying static multicast traffic is supported only with static, unencrypted multicast.

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable fiber-node</b> <i>fiber-node-id</i>	Enters fiber node configuration mode.

	Command or Action	Purpose
	<b>Example:</b> Router (config)# <b>cable fiber-node 70</b>	<ul style="list-style-type: none"> <li>• <i>fiber-node-id</i>—Unique numerical ID of the fiber node. The valid range is from 1 to 256.</li> </ul>
<b>Step 4</b>	<b>downstream modular-cable slot/subslot/controller rf-channel grouplist</b>  <b>Example:</b> Router(config-fiber-node)# <b>downstream modular-cable 6/1/0 rf-channel 7</b>	Associates the downstream channels to the fiber node of the cable interface line card. <ul style="list-style-type: none"> <li>• <i>slot</i>—Cable interface line card slot. The valid values range from 5 to 8.</li> <li>• <i>subslot</i>—Cable interface line card subslot. The valid values are 0 and 1.</li> <li>• <i>controller</i>—Cable interface number. The valid range is from 0 to 2.</li> <li>• <i>grouplist</i>—Group of RF channels. The valid range is from 0 to 23.</li> </ul>
<b>Step 5</b>	<b>upstream cable slot/subslot connector grouplist</b>  <b>Example:</b> Router(config-fiber-node)# <b>upstream Cable 6/1 connector 3</b>	Specifies the upstream channel ports for the fiber node. <ul style="list-style-type: none"> <li>• <i>slot</i>—Cable interface line card slot. The valid values range from 5 to 8.</li> <li>• <i>subslot</i>—Cable interface line card subslot. The valid values are 0 and 1.</li> <li>• <i>connector</i>—Specifies the physical upstream port connector on the cable interface line card.</li> <li>• <i>grouplist</i>—Range of physical port numbers on the cable interface line card. The grouplist can be one or more port numbers, or a range of port numbers separated by a hyphen or combinations of both. The valid range for port numbers is from 0 to 19.</li> </ul>
<b>Step 6</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 RF Spanning of Remote Bonding Groups

To configure RF spanning of remote bonding groups, you need to configure a wideband interface on the Cisco uBR10012 router.

### Before You Begin

- An RCC template must be created and associated to a MAC domain. For details, see [Configuring the RCC Template, on page 201](#)
- RF channels must be associated to a fiber node. For details, see [Configuring RF Spanning of Bonding Groups Carrying Static Multicast Traffic, on page 205](#).

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface wideband-cable</b> <i>slot/subslot/port:wideband-channel</i>  <b>Example:</b> Router(config)# <b>interface</b> <b>wideband-cable 6/0/1:22</b>	Enters cable interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the <a href="#">Cisco IOS CMTS Cable Command Reference</a> . <ul style="list-style-type: none"> <li>• <i>slot</i>—Slot where the Cisco Wideband SIP or a cable line card resides. On the Cisco uBR10012 router, slots 1 and 3 can be used for the Cisco Wideband SIP. The valid range for a cable line card is from 5 to 8.</li> <li>• <i>subslot</i>—Subslot where the Cisco Wideband SIP or a cable line card resides. On the Cisco uBR10012 router, subslot 0 is always specified for the Cisco Wideband SIP. For a cable line card, subslot is 0 or 1.</li> <li>• <i>port</i>—Bay in the SIP where the Cisco Wideband SPA is located. Valid values are 0 (upper bay) and 1 (lower bay). It also refers to the downstream port of the line card. The valid range varies depending on the line card.</li> <li>• <i>wideband-channel</i>—Wideband channel number. The valid range varies depending on the Cisco CMTS router and the line card.</li> </ul>
Step 4	<b>cable bundle</b> <i>bundle-id</i>  <b>Example:</b> Router(config-if)# <b>cable bundle</b> <b>1</b>	Configures the wideband cable interface to belong to an interface bundle. <ul style="list-style-type: none"> <li>• <i>bundle-id</i>—Bundle identifier. The valid range is from 1 to 255.</li> </ul>
Step 5	<b>cable rf-channel</b> <i>rf-channel</i> <b>bandwidth-percent</b> <i>bw-percent</i>  <b>Example:</b> Router(config-if)# <b>cable</b> <b>rf-channel 0 bandwidth-percent 25</b>	Configures the bandwidth of the RF channel that would be allocated to a specified wideband channel or bonding group. <ul style="list-style-type: none"> <li>• <i>rf-channel</i>—RF channel on the physical port of the field-programmable gate array (FPGA).</li> <li>• <b>bandwidth-percent</b> <i>bw-percent</i>—(Optional) Indicates the percentage of bandwidth from this RF channel that is used for the wideband interface. The valid range is from 0 to 100 percent. The default bandwidth value is 100.</li> </ul>
Step 6	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## Configuration Examples for VDOC Broadcast

This section describes a sample configuration example for configuring the VDOC broadcast feature.

This configuration supports four video channels (IGMP groups) over two bonding groups, with two channels over one bonding group each. Depending on the video channel selected by the set-top box, the cable modem tunes to frequencies in either RCC template 1 or 2.

### Example: Configuring the Primary and Secondary Bonding Groups

The following example shows how to configure the primary and secondary bonding groups. This example is valid for Cisco IOS Release 12.2(33)SCD and earlier.



#### Note

Secondary bonding group configuration is required only for the VDOC Broadcast feature. This configuration is not required for Inter Line Card RF Spanning.

```

controller modular-cable 1/0/0
 ip-address 192.0.2.0
 modular-host subslot 6/0
 rf-channel 0 cable downstream channel-id 24
 rf-channel 0 frequency 453000000 annex B modulation 256qam interleave 32
 rf-channel 0 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 20000
 rf-channel 1 cable downstream channel-id 25
 rf-channel 1 frequency 459000000 annex B modulation 256qam interleave 32
 rf-channel 1 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 21000
 rf-channel 2 cable downstream channel-id 26
 rf-channel 2 frequency 465000000 annex B modulation 256qam interleave 32
 rf-channel 2 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 21001
 rf-channel 3 cable downstream channel-id 27
 rf-channel 3 frequency 471000000 annex B modulation 256qam interleave 32
 rf-channel 3 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 21002
!
Router(config)# interface Wideband-Cable1/0/0:0
 cable bundle 1
  cable bonding-group-id 1

0 bandwidth-percent 80
 cable rf-channel 1
!
Router(config)# interface Wideband-Cable1/0/0:1
 cable bundle 1
  cable bonding-group-id 2 secondary
  cable rf-channel 2
!
Router(config)# interface Wideband-Cable1/0/0:2
 cable bundle 1
  cable bonding-group-id 3 secondary
  cable rf-channel 3
!
Router(config)# interface Modular-Cable1/0/0:0
 cable bundle 1
  cable rf-bandwidth-percent 10
!
cable fiber-node 1
 downstream Modular-Cable 1/0/0 rf-channel 0-3
!
```

The following example shows how to configure secondary bonding groups in Cisco IOS Release 12.2(33)SCE and later.

```

controller modular-cable 1/0/0
 ip-address 192.0.2.0
 modular-host subslot 6/0
 rf-channel 0 cable downstream channel-id 24
 rf-channel 0 frequency 453000000 annex B modulation 256qam interleave 32
 rf-channel 0 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 20000
 rf-channel 1 cable downstream channel-id 25
 rf-channel 1 frequency 459000000 annex B modulation 256qam interleave 32
 rf-channel 1 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 21000
 rf-channel 2 cable downstream channel-id 26
 rf-channel 2 frequency 465000000 annex B modulation 256qam interleave 32
 rf-channel 2 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 21001
 rf-channel 3 cable downstream channel-id 27
 rf-channel 3 frequency 471000000 annex B modulation 256qam interleave 32
 rf-channel 3 ip-address 192.0.2.0 mac-address 0090.f001.930c depi-remote-id 21002
!
Router(config)# interface Wideband-Cable1/0/0:0
cable bundle 1
cable bonding-group-secondary
cable rf-channel 0 bandwidth-percent 80 cable rf-channel 1
!
Router(config)# interface Wideband-Cable1/0/0:1
cable bundle 1
cable bonding-group-secondary
cable rf-channel 2
!
Router(config)# interface Wideband-Cable1/0/0:2
cable bundle 1
cable bonding-group-secondary
cable rf-channel 3
!
Router(config)# interface Modular-Cable1/0/0:0
cable bundle 1
cable rf-bandwidth-percent 10
!
cable fiber-node 1
  downstream Modular-Cable 1/0/0 rf-channel 0-3
!

```

## Example: Configuring the RCC Template

The following example shows how to apply RCC templates to the MAC domain host interface. The frequencies used to configure the MAC domain and bonding group are also used here.

```

cable rcc-template 1
 rcp-id 00 10 18 33 81
 receive-module 1 first-center-frequency 453000000
 receive-channel 1 center-frequency 453000000 connected-receive-module 1 primary
 receive-channel 2 center-frequency 459000000 connected-receive-module 1
 receive-channel 3 center-frequency 465000000 connected-receive-module 1
!
cable rcc-template 2
 rcp-id 00 10 18 80 61
 receive-module 1 first-center-frequency 465000000
 receive-module 2 first-center-frequency 489000000
 receive-channel 1 center-frequency 465000000 connected-receive-module 1 primary
 receive-channel 2 center-frequency 471000000 connected-receive-module 1
 receive-channel 3 center-frequency 477000000 connected-receive-module 1
 receive-channel 4 center-frequency 483000000 connected-receive-module 1
 receive-channel 5 center-frequency 489000000 connected-receive-module 2
 receive-channel 6 center-frequency 495000000 connected-receive-module 2
 receive-channel 7 center-frequency 501000000 connected-receive-module 2
 receive-channel 8 center-frequency 507000000 connected-receive-module 2
!

```

**Example: Configuring the Multicast Static Group**

```

interface Cable 6/0/0
  downstream Modular-Cable 1/0/0 rf-channel 0 upstream 0-3
  cable rcc-template 1
  cable rcc-template 2
  no cable packet-cache
  cable bundle 1
  cable downstream channel-id 119
  cable downstream annex B
  cable downstream modulation 256qam
  cable downstream interleave-depth 32
  cable downstream frequency 615000000
  cable downstream rf-shutdown
  cable upstream max-ports 4
  cable upstream 0 connector 0
  cable upstream 0 frequency 10000000
  cable upstream 0 docsis-mode tdma
  cable upstream 0 channel-width 1600000 1600000
  cable upstream 0 minislots-size 4
  cable upstream 0 range-backoff 3 6
  cable upstream 0 modulation-profile 21
  no cable upstream 0 shutdown
  cable upstream 1 connector 1
  cable upstream 1 docsis-mode tdma
  cable upstream 1 channel-width 1600000 1600000
  cable upstream 1 minislots-size 4
  cable upstream 1 range-backoff 3 6
  cable upstream 1 modulation-profile 21
  cable upstream 1 shutdown
  cable upstream 2 connector 2
  cable upstream 2 docsis-mode tdma
  cable upstream 2 channel-width 1600000 1600000
  cable upstream 2 minislots-size 4
  cable upstream 2 range-backoff 3 6
  cable upstream 2 modulation-profile 21
  cable upstream 2 shutdown
  cable upstream 3 connector 3
  cable upstream 3 docsis-mode tdma
  cable upstream 3 channel-width 1600000 1600000
  cable upstream 3 minislots-size 4
  cable upstream 3 range-backoff 3 6
  cable upstream 3 modulation-profile 21
  cable upstream 3 shutdown
!
```

**Example: Configuring the Multicast Static Group**

The following example shows how to configure multicast static groups on the bundle interface and on bonding groups in Cisco IOS Release 12.2(33)SCD and earlier:

```

interface Bundle 1
  ip address 192.0.2.8 255.255.255.0
  ip pim sparse-mode
  ip helper-address 2.39.16.1
  ip igmp static-group 224.0.2.1
  ip igmp static-group 224.0.2.2
  ip igmp static-group 224.0.2.3
  ip igmp static-group 224.0.2.4
  cable arp filter request-send 3 2
  cable arp filter reply-accept 3 2
!
Router(config)# interface Wideband-Cable1/0/0:1
  cable bundle 1
Router(config)#cable igmp static-group 224.0.2.3
Router(config)#cable igmp static-group 224.0.2.4
  cable bonding-group-id 2 secondary
  cable rf-channel 2
!
Router(config)#interface Wideband-Cable1/0/0:2
  cable bundle 1
```



```
Router(config)#cable igmp static-group 224.0.2.1
Router(config)#cable igmp static-group 224.0.2.2
cable bonding-group-id 3 secondary
cable rf-channel 3
```

The following example shows how to configure multicast static groups on the bundle interface and on bonding groups in Cisco IOS Release 12.2(33)SCE and later:

```
interface Bundle 1
 ip address 192.0.2.8 255.255.255.0
 ip pim sparse-mode
 ip helper-address 2.39.16.1
 ip igmp static-group 224.0.2.1
 ip igmp static-group 224.0.2.2
 ip igmp static-group 224.0.2.3
 ip igmp static-group 224.0.2.4
 cable arp filter request-send 3 2
 cable arp filter reply-accept 3 2
!
Router(config)# interface Wideband-Cable1/0/0:1
 cable bundle 1
Router(config)#cable igmp static-group 224.0.2.3
Router(config)#cable igmp static-group 224.0.2.4
 cable bonding-group-secondary
 cable rf-channel 2
!
Router(config)#interface Wideband-Cable1/0/0:2
 cable bundle 1
Router(config)#cable igmp static-group 224.0.2.1
Router(config)#cable igmp static-group 224.0.2.2
 cable bonding-group-secondary 3
 cable rf-channel 3
```

## Configuration Examples for Inter Line Card RF Spanning

This section provides configuration examples for the Inter Line Card RF Spanning feature.

### Example: RF Spanning of Bonding Groups Carrying Static Multicast Traffic

The following example shows how to configure RF spanning of bonding groups carrying static multicast traffic on the Cisco uBR100 router:

```
controller Modular-Cable 1/2/0
 modular-host subslot 7/0
 rf-channel 0 cable downstream channel-id 193
 rf-channel 0 frequency 549000000 annex B modulation 256qam interleave 32
 rf-channel 0 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500025
 rf-channel 1 cable downstream channel-id 194
 rf-channel 1 frequency 555000000 annex B modulation 256qam interleave 32
 rf-channel 1 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500026
 rf-channel 2 cable downstream channel-id 195
 rf-channel 2 frequency 561000000 annex B modulation 256qam interleave 32
 rf-channel 2 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500027
 rf-channel 3 cable downstream channel-id 196
 rf-channel 3 frequency 567000000 annex B modulation 256qam interleave 32
 rf-channel 3 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500028

interface Wideband-Cable1/2/0:0
 cable bundle 11
 cable rf-channel 0 bandwidth-percent 10
 cable rf-channel 1 bandwidth-percent 10
 cable rf-channel 2 bandwidth-percent 10
 cable rf-channel 3 bandwidth-percent 10
controller Modular-Cable 5/0/0
```

## Example: RF Spanning of Remote Bonding Groups

```

ip-address 60.3.2.4
rf-channel 0 cable downstream channel-id 5
rf-channel 0 frequency 501000000 annex B modulation 256qam interleave 32
rf-channel 0 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500017
rf-channel 1 cable downstream channel-id 1
rf-channel 1 frequency 507000000 annex B modulation 256qam interleave 32
rf-channel 1 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500018
rf-channel 2 cable downstream channel-id 2
rf-channel 2 frequency 513000000 annex B modulation 256qam interleave 32
rf-channel 2 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500019
rf-channel 3 cable downstream channel-id 3
rf-channel 3 frequency 519000000 annex B modulation 256qam interleave 32
rf-channel 3 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500020

interface Wideband-Cable5/0/0:0
cable bundle 11
cable rf-channel 0 bandwidth-percent 10
cable rf-channel 1 bandwidth-percent 10
cable rf-channel 2 bandwidth-percent 10
cable rf-channel 3 bandwidth-percent 10

controller Modular-Cable 6/0/0
ip-address 60.3.2.3
rf-channel 0 cable downstream channel-id 4
rf-channel 0 frequency 405000000 annex B modulation 256qam interleave 32
rf-channel 0 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500001
rf-channel 1 cable downstream channel-id 22
rf-channel 1 frequency 411000000 annex B modulation 256qam interleave 32
rf-channel 1 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500002
rf-channel 2 cable downstream channel-id 23
rf-channel 2 frequency 417000000 annex B modulation 256qam interleave 32
rf-channel 2 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500003
rf-channel 3 cable downstream channel-id 24
rf-channel 3 frequency 423000000 annex B modulation 256qam interleave 32
rf-channel 3 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500004
interface Wideband-Cable6/0/0:0
cable bundle 11
cable igmp static-group 230.1.1.1 1
cable igmp static-group 230.5.5.5 1
cable rf-channel 0 bandwidth-percent 10
cable rf-channel 1 bandwidth-percent 10
cable rf-channel 2 bandwidth-percent 10
cable rf-channel 3 bandwidth-percent 10
cable fiber-node 50
downstream Modular-Cable 5/0/0 rf-channel 0-3
downstream Modular-Cable 6/0/0 rf-channel 0-3
upstream Cable 5/0 connector 0-3
cable fiber-node 70
downstream Modular-Cable 1/2/0 rf-channel 0-3
downstream Modular-Cable 6/0/0 rf-channel 0-3
upstream Cable 7/0 connector 0-3

```

## Example: RF Spanning of Remote Bonding Groups

The following example shows how to configure RF spanning of remote bonding groups on the Cisco uBR100 router:

```

controller Modular-Cable 5/0/0
ip-address 60.3.2.4
rf-channel 0 cable downstream channel-id 5
rf-channel 0 frequency 501000000 annex B modulation 256qam interleave 32
rf-channel 0 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500017
rf-channel 1 cable downstream channel-id 1
rf-channel 1 frequency 507000000 annex B modulation 256qam interleave 32
rf-channel 1 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500018
rf-channel 2 cable downstream channel-id 2
rf-channel 2 frequency 513000000 annex B modulation 256qam interleave 32
rf-channel 2 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500019
rf-channel 3 cable downstream channel-id 3

```

```

rf-channel 3 frequency 519000000 annex B modulation 256qam interleave 32
rf-channel 3 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500020

interface Wideband-Cable5/0/0:0
 cable bundle 11
 cable rf-channel 0 bandwidth-percent 10
 cable rf-channel 1 bandwidth-percent 10
 cable rf-channel 2 bandwidth-percent 10
 cable rf-channel 3 bandwidth-percent 10

controller Modular-Cable 6/0/0
 ip-address 60.3.2.3
 rf-channel 0 cable downstream channel-id 4
 rf-channel 0 frequency 405000000 annex B modulation 256qam interleave 32
 rf-channel 0 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500001
 rf-channel 1 cable downstream channel-id 22
 rf-channel 1 frequency 411000000 annex B modulation 256qam interleave 32
 rf-channel 1 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500002
 rf-channel 2 cable downstream channel-id 23
 rf-channel 2 frequency 417000000 annex B modulation 256qam interleave 32
 rf-channel 2 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500003
 rf-channel 3 cable downstream channel-id 24
 rf-channel 3 frequency 423000000 annex B modulation 256qam interleave 32
 rf-channel 3 ip-address 60.3.2.1 mac-address 0022.9084.8d7f depi-remote-id 500004
interface Wideband-Cable6/0/0:0
 cable bundle 11
 cable igmp static-group 230.1.1.1 1
 cable igmp static-group 230.5.5.5 1
 cable rf-channel 0 bandwidth-percent 10
 cable rf-channel 1 bandwidth-percent 10
 cable rf-channel 2 bandwidth-percent 10
 cable rf-channel 3 bandwidth-percent 10
 cable fiber-node 50
 downstream Modular-Cable 5/0/0 rf-channel 0-3
 downstream Modular-Cable 6/0/0 rf-channel 0-3
 upstream Cable 5/0 connector 0-3

```

## Verifying VDOC Broadcast and Inter Line Card RF Spanning

To verify configuration of VDOC broadcast and inter line card RF spanning, use the following commands:

- **show controller integrated-cable**
- **show controller modular-cable**
- **show cable multicast db**
- **show cable mac-domain rec**
- **show cable modem service-flow**
- **show cable active-reman**

To verify that the bonding group being shared by service groups is associated with all relevant MAC domains of the Cisco UBR-MC20X20V line card, use the **show controller integrated-cable** command with the association keyword as shown in the following example:

```

Router# show controller integrated-cable 8/0/1 association
WB Association Info for 8/0 No of WB 30
WB          BG   Bundle  NB      NB chan  Reserved  Total
channel    ID   num   channel ID      CIR       CIR
Wideband-Cable8/0/0:0 1217 11   Cable7/0/0 0        0         6000000
                               Multicast 0         6000000
Wideband-Cable8/0/0:1 1218 11   Cable7/0/0 0        0         1500000
                               Multicast 0         1500000
Wideband-Cable8/0/0:2 1219 11   Cable7/0/0 0        0         1500000

```

```

Wideband-Cable8/0/1:0  1249 11      Multicast          0          1500000
                        Cable7/0/0  0          0          6000000
                        Multicast          0          6000000

```

To verify that the bonding group being shared by service groups is associated with all relevant MAC domains of the Cisco uBR-MC3GX60V line card, use the **show controller modular-cable** command with the association keyword as shown in the following example:

```

Router# show controller modular-cable 5/0/0 association
WB Association Info for 5/0 No of WB 96
WB      BG      Bundle  NB      NB chan  Reserved  Total
channel ID  num  channel  ID      CIR      CIR
Wideband-Cable5/0/0:0  257  11  Cable5/0/0  0      0      6000000
                        Multicast  0      6000000
Wideband-Cable5/0/0:1  258  11  Cable5/0/0  0      0      4500000
                        Multicast  0      4500000
Wideband-Cable5/0/0:2  259  11  Cable5/0/1  0      0      6000000
                        Multicast  0      6000000
Wideband-Cable5/0/0:3  260  11  Cable5/0/1  0      0      4500000
                        Multicast  0      4500000

```

To verify the multicast bundle interface, use the **show cable multicast db** command with the bundle keyword as shown in the following example:

```

Router# show cable multicast db bundle 11
Interface : Bundle11.1
Session (S,G) : (*,230.40.40.40)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo5/0/0:4  Bundle11.1      Ca5/0/1    ff05.0000.0024  1
Interface : Bundle11.1
Session (S,G) : (*,230.40.40.40)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo5/0/0:0  Bundle11.1      Ca5/0/0    ff05.0000.0020  1
Interface : Bundle11.1
Session (S,G) : (*,230.40.40.40)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo1/2/0:1  Bundle11.1      Ca7/0/0    ff01.0002.0021  1
Interface : Bundle11.1
Session (S,G) : (*,230.40.40.40)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo1/2/0:0  Bundle11.1      Ca7/0/0    ff01.0002.0020  1
Interface : Bundle11.1
Session (S,G) : (*,230.50.50.50)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo5/0/0:4  Bundle11.1      Ca5/0/1    ff05.0000.0024  1
Interface : Bundle11.1
Session (S,G) : (*,230.50.50.50)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo5/0/0:0  Bundle11.1      Ca5/0/0    ff05.0000.0020  1
Interface : Bundle11.1
Session (S,G) : (*,230.50.50.50)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo1/2/0:1  Bundle11.1      Ca7/0/0    ff01.0002.0021  1
Interface : Bundle11.1
Session (S,G) : (*,230.50.50.50)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Mo1/2/0:0  Bundle11.1      Ca7/0/0    ff01.0002.0020  1
Interface : Bundle11.1
Session (S,G) : (*,230.7.7.7)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Wi6/0/0:1  Bundle11.1      Ca6/0/0    ff06.0000.0001  1
Interface : Bundle11.1
Session (S,G) : (*,230.5.5.5)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Wi6/0/0:0  Bundle11.1      Ca6/0/0    ff06.0000.0000  1
Interface : Bundle11.1
Session (S,G) : (*,230.2.2.2)
Fwd Intfc  Sub Intfc      Host Intfc  CM Mac      Hosts
Wi6/0/0:1  Bundle11.1      Ca6/0/0    ff06.0000.0001  1

```

```

Interface : Bundle11.1
Session (S,G) : (*,230.1.1.1)
Fwd Intfc Sub Intfc      Host Intfc  CM Mac      Hosts
Wi6/0/0:0 Bundle11.1      Ca6/0/0    ff06.0000.0000  1
Interface : Bundle11.1
Session (S,G) : (*,230.30.30.30)
Fwd Intfc Sub Intfc      Host Intfc  CM Mac      Hosts
Mo5/0/0:4 Bundle11.1      Ca5/0/1    ff05.0000.0024  1
Interface : Bundle11.1
Session (S,G) : (*,230.30.30.30)
Fwd Intfc Sub Intfc      Host Intfc  CM Mac      Hosts
Mo5/0/0:0 Bundle11.1      Ca5/0/0    ff05.0000.0020  1
Interface : Bundle11.1
Session (S,G) : (*,230.30.30.30)
Fwd Intfc Sub Intfc      Host Intfc  CM Mac      Hosts
Mo1/2/0:1 Bundle11.1      Ca7/0/0    ff01.0002.0021  1
Interface : Bundle11.1
Session (S,G) : (*,230.30.30.30)
Fwd Intfc Sub Intfc      Host Intfc  CM Mac      Hosts
Mo1/2/0:0 Bundle11.1      Ca7/0/0    ff01.0002.0020  1

```

To verify that the right RCC templates are available for the remote MAC domain, use the **show cable mac-domain rcc** command as shown in the following example:

```

Router# show cable mac-domain cable 5/0/0 rcc
RCC-ID RCP RCs MD-DS-SG CMs WB/RCC-TMPL
1 00 10 00 00 04 4 1 0 RCC-TMPL (1)
2 00 10 00 00 04 4 1 8 RCC-TMPL (2)
3 00 10 00 00 04 8 1 2 RCC-TMPL (5)
4 00 10 00 00 04 8 1 2 RCC-TMPL (6)
5 00 00 00 00 00 4 0 0 WB (Wi5/0/0:0)
6 00 00 00 00 00 3 0 0 WB (Wi5/0/0:1)
7 00 00 00 00 00 2 0 0 WB (Wi5/0/0:4)
8 00 00 00 00 00 1 0 0 WB (Wi5/0/0:5)
9 00 00 00 00 00 1 0 0 WB (Wi5/0/0:6)
10 00 00 00 00 00 1 0 0 WB (Wi5/0/0:7)
11 00 00 00 00 00 1 0 0 WB (Wi5/0/0:8)
12 00 00 00 00 00 2 0 0 WB (Wi5/0/0:9)
13 00 00 00 00 00 4 0 0 WB (Wi6/0/0:1)
14 00 00 00 00 00 1 0 0 WB (Wi6/0/0:2)
15 00 00 00 00 00 1 0 0 WB (Wi6/0/0:3)
16 00 00 00 00 00 3 0 0 WB (Wi6/0/0:6)
17 00 00 00 00 00 3 0 0 WB (Wi6/0/0:7)
18 00 00 00 00 00 2 0 0 WB (Wi6/0/0:8)

```

To verify that the service flows are established correctly on local and remote bonding groups, use the **show cable modem service-flow** command as shown in the following example:

```

Router# show cable modem 0022.ce89.9664 service-flow
SUMMARY:
MAC Address      IP Address      Host           MAC           Prim Num Primary
DS
                                Interface      State         Sid   CPE Downstream
RfId
0022.ce89.9664 30.13.2.74     C5/0/0/UB     w-online(pt)  1     0   Mo5/0/0:0
240
Sfid  Dir  Curr  Sid  Sched  Prio  MaxSusRate  MaxBrst  MinRsvRate  Throughput
      State
15   US  act   1    BE    0    0           3044     0           0
16   DS  act  N/A  BE    0    1000012     6000000  0           0
33   DS  act  N/A  BE    0    1000012     6000000  0           0
UPSTREAM SERVICE FLOW DETAIL:
SFID  SID  Requests  Polls  Grants  Delayed  Dropped  Packets
      Grants
15    1    0          0      401     0        0        416
DOWNSTREAM SERVICE FLOW DETAIL:
SFID  RP_SFID  QID  Flg  Policer  Scheduler  Drops  FrwdIF
      Xmits  Drops
16    33559  132579  51   0        51         0      Wi5/0/0:1
33    33560  132580  0    0        0         0      Wi6/0/0:2

```

Flags Legend:  
 \$: Low Latency Queue (aggregated)  
 ~: CIR Queue

To verify the line card high availability information for all interfaces, use the **show cable active-reman** command as shown in the following example:

```
Router# show cable active-reman all
-----
Active Reman info on LC 5/0:
[slot_index 0]: work_slot:1/0, active_slot:1/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 1]: work_slot:3/0, active_slot:3/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 2]: work_slot:5/0, active_slot:5/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 3]: work_slot:5/1, active_slot:5/1, is_protect:TRUE , is_standby
:TRUE
[slot_index 4]: work_slot:6/0, active_slot:6/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 5]: work_slot:6/1, active_slot:6/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 6]: work_slot:7/0, active_slot:7/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 7]: work_slot:7/1, active_slot:7/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 8]: work_slot:8/0, active_slot:8/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 9]: work_slot:8/1, active_slot:8/1, is_protect:FALSE, is_standby
:FALSE
-----
Active Reman info on LC 5/1:
[slot_index 0]: work_slot:1/0, active_slot:1/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 1]: work_slot:3/0, active_slot:3/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 2]: work_slot:5/0, active_slot:5/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 3]: work_slot:5/1, active_slot:5/1, is_protect:TRUE , is_standby
:TRUE
[slot_index 4]: work_slot:6/0, active_slot:6/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 5]: work_slot:6/1, active_slot:6/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 6]: work_slot:7/0, active_slot:7/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 7]: work_slot:7/1, active_slot:7/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 8]: work_slot:8/0, active_slot:8/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 9]: work_slot:8/1, active_slot:8/1, is_protect:FALSE, is_standby
:FALSE
-----
Active Reman info on LC 6/0:
[slot_index 0]: work_slot:1/0, active_slot:1/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 1]: work_slot:3/0, active_slot:3/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 2]: work_slot:5/0, active_slot:5/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 3]: work_slot:5/1, active_slot:5/1, is_protect:TRUE , is_standby
:TRUE
[slot_index 4]: work_slot:6/0, active_slot:6/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 5]: work_slot:6/1, active_slot:6/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 6]: work_slot:7/0, active_slot:7/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 7]: work_slot:7/1, active_slot:7/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 8]: work_slot:8/0, active_slot:8/0, is_protect:FALSE, is_standby
```

```

:FALSE
[slot_index 9]: work_slot:8/1, active_slot:8/1, is_protect:FALSE, is_standby
:FALSE
-----
Active Reman info on LC 7/0:
[slot_index 0]: work_slot:1/0, active_slot:1/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 1]: work_slot:3/0, active_slot:3/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 2]: work_slot:5/0, active_slot:5/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 3]: work_slot:5/1, active_slot:5/1, is_protect:TRUE , is_standby
:TRUE
[slot_index 4]: work_slot:6/0, active_slot:6/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 5]: work_slot:6/1, active_slot:6/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 6]: work_slot:7/0, active_slot:7/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 7]: work_slot:7/1, active_slot:7/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 8]: work_slot:8/0, active_slot:8/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 9]: work_slot:8/1, active_slot:8/1, is_protect:FALSE, is_standby
:FALSE
-----
Active Reman info on LC 8/0:
[slot_index 0]: work_slot:1/0, active_slot:1/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 1]: work_slot:3/0, active_slot:3/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 2]: work_slot:5/0, active_slot:5/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 3]: work_slot:5/1, active_slot:5/1, is_protect:TRUE , is_standby
:TRUE
[slot_index 4]: work_slot:6/0, active_slot:6/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 5]: work_slot:6/1, active_slot:6/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 6]: work_slot:7/0, active_slot:7/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 7]: work_slot:7/1, active_slot:7/1, is_protect:FALSE, is_standby
:FALSE
[slot_index 8]: work_slot:8/0, active_slot:8/0, is_protect:FALSE, is_standby
:FALSE
[slot_index 9]: work_slot:8/1, active_slot:8/1, is_protect:FALSE, is_standby

```

## Additional References

The following sections provide references related to configuring the VDOC Broadcast feature.

### Related Documents

Related Topic	Document Title
CMTS Command Reference	<i>Cisco IOS CMTS Cable Command Reference</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>

Related Topic	Document Title
PacketCable and PacketCable Multimedia	<i>PacketCable and PacketCable Multimedia for the Cisco CMTS Routers</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_pktcable_mm.html">http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_pktcable_mm.html</a>
DOCSIS 3.0 multicast	DOCSIS 3.0 Multicast Support on the CMTS Routers <a href="http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_d30_mcast_support.html">http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_d30_mcast_support.html</a>

### Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

## Feature Information for Configuring VDOC Broadcast

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



### Note

The table below 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 31: Feature Information for Configuring VDOC Broadcast**

Feature Name	Releases	Feature Information
IGMP-Triggered VDOC Broadcast Support	12.2(33)SCB	<p>The Cisco universal broadband router supports VDOC feature enabling MSOs to broadcast video content on RF spanned downstream signals.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Information About Configuring VDOC Broadcast</a>, on page 195</li> <li>• <a href="#">How to Configure VDOC Broadcast</a>, on page 200</li> <li>• <a href="#">Configuration Examples for VDOC Broadcast</a>, on page 208</li> <li>• <a href="#">Verifying VDOC Broadcast and Inter Line Card RF Spanning</a>, on page 213</li> </ul>
Inter Line Card RF Spanning	12.2(33)SCF	<p>The Inter Line Card RF Spanning feature supports sharing of downstream channels among the line cards installed on the Cisco uBR10012 router.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Inter Line Card RF Spanning</a>, on page 196</li> <li>• <a href="#">How to Configure Inter Line Card RF Spanning</a>, on page 205</li> <li>• <a href="#">Configuration Examples for Inter Line Card RF Spanning</a>, on page 211</li> </ul> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>show cable active-reman</b></li> <li>• <b>show cable multicast db</b></li> </ul>





## CHAPTER 11

# Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers

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Load Balancing (LB) for the Cisco CMTS allows system operators to distribute cable modems across radio frequency (RF) downstream (DS) and upstream (US) channels on the same cable interface line card, or across multiple cable interface line cards in some circumstances. Load balancing maximizes bandwidth and usage of the cable plant.



### Note

Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

Load balancing supports multiple methods to achieve greater bandwidth availability and performance of the Cisco CMTS with subscriber benefits. These include static and dynamic load balancing schemes, inter-line card and intra-line card support, in some circumstances, configuration of load balancing groups (LBGs) that entail multiple interfaces, multiple load balancing policies, and the option to configure multiple additional load balancing parameters.

The load balancing policies can be configured on the Cisco CMTS, indexed by an ID, to limit the movement of CMs within a Load Balancing Group (LBG). The CM will forward TLV43.1 in its registration request (REG-REQ) message, which is then parsed and stored in the Cisco CMTS. A policy defines whether and when CMs can be moved within their load balancing groups.

During dynamic load balancing, the specified policy of the CM is checked to determine whether the CM is allowed to move. However, existing static load balancing using a frequency override technique and passive load balancing still take action at ranging time.

Effective with Cisco IOS Release 12.3(17a)BC, and later 12.3 BC releases, load balancing is enhanced and supported with Dynamic Channel Change (DCC). DCC in DOCSIS 1.1 dynamically changes cable modem upstream or downstream channels without forcing a cable modem to go offline, and without reregistration after the change.

Effective with Cisco IOS Release 12.3(17b)BC4, and later releases, load balancing is enhanced to distribute downstream load balancing with upstream channel loads in the same upstream load balancing group. This improves upon the prior load balancing limitation, in which load balancing was implemented on the basis of the entire downstream channel load.

Effective with Cisco IOS Release 12.2(33)SCB, and later releases, load balancing is enhanced to use rules and policies to decide on moving the CMs within their LB groups. These policies are created on the Cisco CMTS and chosen on a per-CM basis using type-length-value (TLV) portion (43.1, Policy ID) of REG-REQ. These policies prohibit a modem from being moved or restricted.

A policy contains a set of rules. When the policy is defined by multiple rules, all rules apply in combinations. A rule can be defined as “enabled”, “disabled”, or “disabled during time period.” Each rule can be used by more than one policy.

Effective with Cisco IOS Release 12.2(33)SCF1, DOCSIS 3.0 static modem count-based load balancing is enhanced to use the dynamic bonding change (DBC) to modify the following parameters of DOCSIS 3.0 cable modem with multiple transmit channel (MTC) mode or multiple receive channel (MRC) mode without primary channel change:

- Transmit channel set (TCS)
- Receive channel set (RCS)
- Downstream IDs (DSID) or DSID-associated attributes
- Security association for encrypting downstream traffic

These parameters and additional load balancing schemes are supported on the Cisco CMTS, and described in this document. This document describes all implementations of load balancing on the Cisco CMTS, dependent upon the Cisco IOS release installed and the desired parameters.

Effective with Cisco IOS Release 12.2(33)SCG1, the Cisco uBR-MC3GX60V line card and up to five shared port adapters (SPAs) can be configured to the same LBG. You can:

- Include all the downstreams and upstreams of the SPA cards and the Cisco uBR-MC3GX60V line card in the LBG.
- Configure the MAC domain to include the SPA cards and the Cisco uBR-MC3GX60V line card.
- Configure the fiber-node to include all the downstreams and upstreams of the SPA cards and the Cisco uBR-MC3GX60V line card.

### 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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## Prerequisites

The Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change feature is supported on the Cisco CMTS routers in Cisco IOS Releases 12.3BC and 12.2SC. The table below shows the hardware compatibility prerequisites for this feature.



### Note

The hardware components introduced in a given Cisco IOS release are supported in all subsequent releases unless otherwise specified.

**Table 32: Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change Hardware Compatibility Matrix**

Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2<sup>19</sup></li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> </ul>
	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul>
	Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>20</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U</li> </ul>
		Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>21</sup></li> </ul>

Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U</li> </ul>
	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>19</sup> PRE = Processor Routing Engine

<sup>20</sup> Cisco uBR-MC3GX60V cable interface line card is not compatible with PRE2.

<sup>21</sup> Cisco uBR-MC88V cable interface line card is only compatible with NPE-G2.

## Prerequisites for Load Balancing

The Load Balancing feature has the following prerequisites:

- Load balancing can be done only on upstreams and downstreams that share physical connectivity with the same group of cable modems.
- When performing load balancing among downstreams, you must also configure the known downstream center frequency to be used on each downstream interface, using the **cable downstream frequency** command. (This is an information-only configuration on cable interfaces that use an external upconverter, but it is still required for load balancing so that the Cisco CMTS knows what frequencies it should use when moving cable modems from one downstream to another.)

## Prerequisites for Dynamic Channel Change for Load Balancing

- DCC can be done only to a cable modem that is physically connected to both source and target upstream or downstream channels, or both.
- Upstreams and downstream channels that share the same physical connectivity must have different center frequencies separated by channel width.
- The difference between the physical layer parameters on the source and target DCC channels must be within the threshold required by the desired DCC initialization technique.
- DOCSIS 1.1 must be enabled for a modem to behave properly for the DCC operation. Note that not all DOCSIS 1.1 certified modems are DCC-capable, as the CableLabs DCC ATP tests need enhancement for complete coverage.

## Prerequisites for Dynamic Bonding Change for DOCSIS 3.0 Static Modem Count-Based Load Balancing

- Initialization techniques 1 to 4, when used, require the Cisco CMTS to include the upstream channel descriptor (UCD) TLV (TLV46.5) in the DBC-REQ message.
- Bandwidth must be sufficient on the target bonding group to support DBC. This is determined by the admission control APIs.
- Fiber nodes must be configured before configuring DOCSIS 3.0 static modem count-based load balancing.

## Restrictions

The following sections describe the restrictions applicable for the Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change feature:

### Restrictions for Load Balancing

The Load Balancing feature has the following restrictions:

- Load balancing can be done only on a per-chassis basis—all interfaces in a load balancing group must be provided by the same chassis.  
Load balancing can be done only on a per-line card basis—all interfaces in a load balancing group must be provided by the same line card.
- A downstream or upstream can belong to only one load balancing group.
- All downstreams and upstreams in a load balancing group must share physical connectivity to the same group of cable modems. Downstreams can be in a separate load balancing group than upstreams, but all downstreams or all upstreams that have the same RF physical connectivity must be members of the same load balancing group.
- You can configure only one load balancing group per shared physical domain (upstream or interface). You cannot configure multiple load balancing groups to distribute downstreams or upstreams that share physical connectivity.
- You can create a maximum of 80 load balancing groups on each chassis (the older limitation was 20).
- If an upstream port is operational, using the **no shutdown** command, and is not being used and not connected, load balancing attempts to use the port even though there are no cable modems registered on that port. When the upstream port is up, it is put into INIT state and load balancing includes this port as a potential target. However, if the load balancing sees multiple failures moving to this upstream, it is set to DISABLE state and the port is avoided later on in load balancing processes.
- The load balancing algorithms assume a relatively even distribution of usage among modems. In the situation where one cable modem creates the bulk of the load on an interface, the load balancing thresholds should be configured for a value above the load created by that single modem.
- Load balancing is done on cable modems in real time, using current load-usage statistics. You cannot perform load balancing according to the time of day or using a schedule.

- You cannot select particular cable modems to be automatically moved for load balancing, although you can exclude cable modems from load balancing operations altogether on the basis of their MAC address or organization unique identifier (OUI). (You can use the **test cable load-balance** command to manually move a particular cable modem among upstreams, but this is done typically to test the configuration of the load balancing groups.)
- If you have configured upstream shared spectrum groups while doing downstream load balancing, the downstream in each MAC domain must not use overlapping upstream groups. For example, the downstream in one MAC domain could use an upstream spectrum band of 10 to 30 MHz, while the downstream in a second MAC domain could use an upstream spectrum band of 30 to 42 MHz. Each MAC domain has its own upstream shared spectrum group, allowing the load balancing group to contain the downstreams for both MAC domains.




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**Note** A MAC domain is one downstream and its associated upstreams.

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- All upstream ports coming from the same splitter must be using different center frequencies that are separated by the channel width. For example, if the upstreams are using a channel width of 3.2 MHz, the center frequencies for all upstreams must be separated by at least 3.2 MHz.
- You can use four initialization techniques for Dynamic Channel Change (DCC).
- As required by cable interface bundling, all interfaces in a load balancing group must also be in the same Hot Standby Connection-to-Connection Protocol (HCCP) interface bundle.
- If you have configured load balancing, the provisioning system must not assign specific upstream channels or downstream frequencies to individual cable modems in their DOCSIS configuration files. Any cable modems requiring specific upstream channels or downstream frequencies must be excluded from load balancing operations (using the **cable load-balance exclude** command).
- Do not use the utilization method of load balancing on cable interfaces that have a small number of cable modems and where a single modem is responsible for the majority of the interface load. In this condition, the Cisco CMTS could end up continually moving cable modems from one interface to another in an endless attempt to load balance the interfaces. To avoid this, configure the utilization threshold to a value that is higher than what can be caused by any single cable modem.
- You should not configure an interface for both dynamic load balancing and Hot-Standby Connection-to-Connection (HCCP) N+1 redundancy, because cable modems will go offline after a switchover. You can configure the interface for HCCP N+1 redundancy when you are using only static and passive load balancing.
- Load balancing, however, does not continue after a switchover from a Working to a Protect interface. Load balancing resumes when the Cisco CMTS switches back to the Working interface. (One possible workaround is to preconfigure the Protect interface with the appropriate load balancing commands, but you must be certain that the downstreams and upstreams in each load balancing group after the switchover have the same physical connectivity.)
- When deployed with channel restriction features, if the target upstream channel attribute masks are against that of the cable modem, then the cable modem on the higher load upstream will not be load balanced, as the current load balancing moves cable modems only to the target upstream. However, cable modems that do not have an attribute mask can still be load balanced. You should consider the following while deploying the load balancing groups: the target upstream will always be the upstream that has the lowest load. If some other upstreams have the same load, the upstream with the lowest index will be chosen as the target upstream.



- A TLV in a cable modem configuration file restricts dynamic load balancing on per modem basis. Still, existing static load balancing using frequency override technique and passive load balancing takes action at ranging time.
- If you remove the last rule of a DOCSIS policy, the policy itself will be removed.
- The Cisco CMTS load balancing feature moves a cable modem based on the load of the channels in a load balancing group, without checking if the cable modem supports the extended frequency range (5Mhz-85Mhz). This may result in moving a cable modem that supports standard frequency range (5Mhz-65Mhz) to a channel that has extended frequency configured. To overcome such scenarios, operators should not mix upstreams that have standard and extended frequencies configured into the same load balancing group, unless all modems in the group support extended frequency range.
- DOCSIS 3.0 Upstream Load Balancing is not supported for Cisco IOS Release 12.2(33)SCI3.

## Restrictions for Dynamic Channel Change for Load Balancing

- DCC initialization techniques 1-4 are strictly for downstream channel changes within a distributed line card (intra-card), and can not be used for load balancing between cards (inter-card). For load balancing between cards (inter-card), DCC initialization technique 0 will be used in all cases, regardless of what technique is set for the LB group or what card types are used.
- For load balancing between multiple cable interface line cards (inter-card implementation), DCC initialization technique 0 is to be used in all cases, regardless of what technique is set for the load balancing group or which cable interface line card types are used.
- The source and target upstreams and downstreams must share physical connectivity with the modem desired for a DCC transaction.
- Independent downstream change is not supported, and cross-MAC domain upstream changes must occur with the associated downstream changes.
- The source and target downstream interfaces must belong to the same virtual bundle and the same load balancing group if DCC is used for load balancing.
- For DCC initialization techniques 1 to 4, all the configuration variables of the cable modem must remain constant with the exception of the configuration variables that are explicitly changed by the Dynamic Channel Change request (DCC-REQ) messages encoding.
- DCC initialization techniques 2 to 4 must not be used if the propagation delay differences between the old and new channels exceeds the ranging accuracy requirement defined in DOCSIS, for example,  $\pm 0.25$  usec plus  $\pm$  symbol time.  
For example, for a symbol rate of 1.28 Msps, the timing offset difference between the source and target upstream channel is  $\pm \text{floor}[(0.250 \text{ us} + 0.5 * 0.781 \text{ us}) / (1/10.24)] = \pm 6$ .
- The attenuation or frequency response differences between the old and new upstream channels causes the received power at the Cisco CMTS to change by more than 6 dB.
- DCC initialization technique 3 must not be used if the conditions for using technique 2 are not met.
- DCC initialization technique 4 must not be used if the conditions for using technique 2 cannot be met.
- Micro-reflections on the new upstream channel result in an unacceptable BER (greater than  $1e-8$ ) with pre-equalization coefficients set to the initial setting.

- DCC is used only for dynamic downstream load balancing on DOCSIS 1.1 and later CMs. Upstream Channel Change (UCC) is always used for dynamic upstream load balancing on DOCSIS 1.x CMs. For DOCSIS 2.x CMs, UCC is used when the *ucc* option is configured. For DOCSIS 3.x CMs, DCC is used irrespective of whether the *ucc* option is configured or not.
- Prolonged interruption of the multicast traffic is expected if the cable modem moved by DCC is the first one in a dynamic multicast group on the target interface. The downstream multicast service flow cannot be reestablished until the Cisco CMTS receives an Internet Group Management Protocol (IGMP) join message from the customer premises equipment (CPE) as the result of the Cisco CMTS IGMP query, where the IGMP query interval is set to one minute. This is an IGMPv2 limitation.
- Effective with Cisco IOS Release 12.2(33)SCB5, multiple statically-assigned IP addresses to a CPE can be pinged. However, this works only if all the security features, such as verification of IP addresses for cable modems and CPE devices on the upstream, and other security mechanism are disabled.
- Multiple statically-assigned IP addresses to a CPE can be pinged. However, this works only if all the security features, such as verification of IP addresses for cable modems and CPE devices on the upstream, and other security mechanism are disabled.
- The TCS and RCS assigned to the DOCSIS 3.0 cable modems are restricted by the upstream and downstream bonding groups configured by the Cisco CMTS.
- Load balancing and DCC are not supported for CMs that are enabled for Layer 2 VPN (L2VPN) support.
- When a DCC occurs, the cable modem US and DS counters are reset. The US and DS counters include counters such as data and throughput seen in the **show cable modem (mac-address) verbose** command output and packets and bytes seen in the **show cable modem (mac-address) counters** command output.

## DCC Restrictions with N+1 Redundancy and Inter-Card Load Balancing

- Inter-card load balancing is not supported with cable interface line cards using N+1 redundancy. Refer to general DCC restrictions for additional information.
- Dynamic load balancing should not be used together with N+1 redundancy. Cable modems with outstanding DCC transactions go offline after a switchover event.



**Note** When cable modems go offline during a switchover event, the load balancing feature activates. Cable modems move in relation to the switchover event. When the cable modems return online, load balancing may need to initiate again.

To facilitate load balancing during a switchover, you can increase the dynamic load balance threshold, if a certain percentage of cable modems that reset during switchover is configured in the system. An alternate method is to use static load balancing with N+1 redundancy. For more information, see the [Types of Load Balancing Operations](#).

## Restrictions for DOCSIS 3.0 Static Modem Count-Based Load Balancing

- Effective with Cisco IOS Release 12.2(33)SCF, static modem count-based load balancing is supported on MTC and MRC-only cable modems. Single-channel, narrowband cable modems will continue to be

supported with dynamic load balancing as in the Cisco IOS Release 12.2(33)SCE and earlier releases. MRC-only modems are supported by dynamic load balancing on upstream channels.



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**Note** DOCSIS 3.0 static modem count-based load balancing is not supported on:

- Multiple line cards.
- Load balancing groups and downstream channels shared across multiple line cards. However, autonomous load balancing-based CM steering and load balancing group assignment is supported across multiple line cards.

- 
- In Cisco IOS Release 12.2(33)SCF, DOCSIS 3.0 static modem count-based load balancing does not support service flow method of load balancing.

## Restrictions for Dynamic Bonding Change for DOCSIS 3.0 Static Modem Count-Based Load Balancing

- The Cisco CMTS can use only DBC messaging to move modems within a MAC domain and applies only to cable modems operating in MTC mode or MRC-only mode without a primary downstream change.
- The Cisco CMTS moves the MRC-only cable modems with a primary channel change using DCC with initialization technique 0.
- The Cisco CMTS moves cable modems across MAC domains using only DCC with initialization technique 0.
- The Cisco CMTS must ensure minimum interruption to existing QoS services while considering an initialization technique that is suitable for the cable plant conditions.
  - Initialization Technique 0—(Reinitializing the MAC) results in the longest interruption of service. This technique is used when QoS resources are not reserved on the new channel(s), when the downstream channel of an MRC CM is changed, or when the upstream channel of a CM to which a transmit channel change (TCC) was assigned in the registration process, is changed.



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**Note** Initialization technique 0 is used only with DCC, and not with DBC.

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- Initialization Technique 1—(Broadcast initial ranging) may result in a lengthy interruption of service, which is mitigated by the reservation of QoS resources on the new channel(s). The service interruption can be further reduced if the Cisco CMTS supplies the UCD TLV in the DBC request in addition to providing more frequent initial ranging opportunities on the new channel.
- Initialization Technique 2—(Unicast ranging) offers the possibility of only a slight interruption of service. To use this technique, the Cisco CMTS must include the UCD TLV in the DBC message if the upstream channel is changing.
- Initialization Technique 3—(Broadcast or unicast ranging) offers the possibility of only a slight interruption of service. Use this technique when there is uncertainty when the CM may execute the DBC command and thus a chance that it might miss station maintenance slots. However, the

Cisco CMTS should not use this technique if the conditions for using techniques 1 and 2 are not completely satisfied.

- Initialization Technique 4—(Use the new channel directly) results in the least interruption of service.
- For a DOCSIS 3.0 cable modem that in a DOCSIS 3.0 static load balancing group, the multicast join will be dropped before REG-HOLD time elapses.

## Restrictions for MRC-Only Cable Modems

- MRC-only cable modems use single channel non-bonded upstreams (similar to narrowband (NB) modems) and multi-channel bonding groups on the downstream.




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**Note** The following restrictions apply only to DOCSIS 2.0 and DOCSIS 3.0 cable modems in MRC-only mode.

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- cable modems are moved across upstream channels using DCC.
- cable modems are moved across downstream channels using DBC, if there is no change in the primary downstream channel; otherwise DCC with init tech 0 is used.
- cable modems are moved to different downstream channels through DBC, if there is a change in the upstream channel and downstream channel bonding group, but not in the primary downstream channel and the upstream channel change is ignored.  
However, if there is a change in the primary downstream channel also, DCC with init tech 0 is used to balance the cable modems.
- MRC-only modems are treated similar to cable modems operating in MTC mode, to move modems across downstream channels. For change in upstream channel, MRC-only cable modems are treated similar to single-channel NB cable modems.

# Information on the Load Balancing on the Cisco CMTS

This section describes the operation, concepts, and benefits of the Load Balancing on the Cisco CMTS feature:

## Feature Overview

The Load Balancing on the Cisco CMTS feature allows service providers to optimally use both downstream and upstream bandwidth, enabling the deployment of new, high-speed services such as voice and video services. This feature also can help reduce network congestion due to the uneven distribution of cable modems across the cable network and due to different usage patterns of individual customers.

By default, the Cisco CMTS platforms use a form of load balancing that attempts to equally distribute the cable modems to different upstreams when the cable modems register. You can refine this form of load balancing by imposing a limit on the number of cable modems that can register on any particular upstream, using the **cable upstream admission-control** command.

However, this default form of load balancing affects the cable modems only when they initially register with the Cisco CMTS. It does not dynamically re-balance the cable modems at later times, such as when they might change upstream channels in response to RF noise problems, or when bandwidth conditions change rapidly because of real-time traffic such as Voice over IP (VoIP) and video services. It also does not affect how the cable modems are distributed among downstream channels.

This feature has been enhanced to make use of DOCSIS policies and rules to limit the movement of cable modems within a Load Balancing Group. A policy defines whether and when cable modems can be moved within their load balancing groups.

A policy consists of a set of rules. Each rule can be defined as “enabled”, “disabled”, or “disabled during time period.” Multiple policies can share a single rule. However, if you remove the last rule of a policy, that will also remove the policy.

Each rule can be used in any number of policies. When it is defined by multiple rules, all rules apply in combinations. Each rule helps to prohibit load balancing using a particular cable modem and to prohibit load balancing using a particular cable modem during certain times of the day.

Following are the general guidelines for the rules and policies:

- The policy or rule is recognized by a 32-bit ID.
- Each cable modem can have one policy only.
- Each rule can be associated to one or more policies.
- Each policy is described by at least one rule, otherwise it cannot be created.
- The zero Policy ID is reserved by Cisco CMTS indicating “Do nothing to LB prohibition.”
- If the policy ID specified by the cable modem configuration file is not configured on Cisco CMTS, no LB prohibition is applied to that CM. However, after the policy with the matched ID is configured, LB prohibition takes effect immediately.

## DOCSIS 3.0 Static Modem Count-Based Load Balancing

Effective from Cisco IOS Release 12.2(33)SCF1, DOCSIS 3.0 static modem count-based load balancing supports the following:

The static modem count-based load balancing supports the following:

- DOCSIS General and Restricted load balancing group assignment to include DOCSIS 3.0 cable modems in MTC and MRC-only modes.



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**Note** DOCSIS 3.0 static modem count-based load balancing is not supported:

- Across multiple line cards.
  - For load balancing groups and downstream channels shared across multiple line cards. However, autonomous load balancing-based CM steering and load balancing group assignment is supported across multiple line cards
- 
- Use of DCC and DBC in load balancing.
  - Use of DBC for MRC-only modems during downstream move.

- Use of DCC with init tech 0 if the primary downstream channel is changed for MRC-only CMs.
- Use of DBC for cable modems in MTC mode for all upstream and downstream modem move.
- Separate counters for NB and wideband (WB)/upstream bonding (UB) CMs. For more information, see the **show cable load-balance docsis-group** command in the [Cisco IOS CMTS Cable Command Reference](#).
- Aggregate logical channels to physical channels for load balancing. Physical channel load is calculated by using average weights among all logical channels.
- Non-primary downstream channels load where utilization of SPA QAM is considered




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**Note** Dynamic DOCSIS load balancing is not supported in Cisco IOS Release 12.2(33)SCF.

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**Note** DOCSIS 3.0 static modem count-based load balancing is the only LB method for wideband modems. When the CM counts across different WB interfaces are within predefined threshold levels, the load is always considered as balanced; no more CM move is initiated by the LB system. No service flow count, whether primary or secondary, is taken into consideration during this LB process.

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**Note** When the CM counts across different WB interfaces are within predefined threshold levels, the load is always considered as balanced; no more CM move is initiated by the LB system. No service flow count, whether primary or secondary, is taken into consideration during this LB process.

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**Note** The attributes considered for the forward interface for the service flow (SF) are attribute mask and available bandwidth, and *not* the number of service flows on each channel. If a channel is within the new RCS, then irrespective of the type of narrowband SF, (whether primary or secondary, or static or dynamic) the SF continues to use its current channel.

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**Note** The US Phy Mode counters (scdma, atdma, and tdma) remain 0 for the UB interfaces.

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DOCSIS 3.0 static modem count-based load balancing is based on legacy load balancing and supports any type of channel combination (upstream and downstream)—MxN, with 1x1 combination being the subset.

DOCSIS 3.0 static modem count-based load balancing controls dynamic changes to the set of downstream and upstream channels used by a registered CM. It supports the following:

- Multiple channel load balancing operation.
- Load balancing operation based on policies and priorities.
- Load balancing with multicast. DOCSIS 3.0 static modem count-based load balancing does not move any CM with active video sessions.

DOCSIS 3.0 static modem count-based load balancing supports the modem count-based load balancing in a hybrid deployment of DOCSIS 1.x, 2.0 and 3.0 cable modems.

Static modem count-based load balancing is supported only for DOCSIS 3.0 CMs. Single-channel, narrowband cable modems will continue to be supported with dynamic load balancing as in the Cisco IOS Release 12.2(33)SCE and earlier releases. MRC-only cable modems are supported by dynamic load balancing on upstream channels.

### Error Handling of Channel Assignment

In Cisco IOS Release 12.2(33)SCE and earlier releases, the interface state of the channels is considered when determining LBG assignment. Only those channels that are in the "initial", "up", "suspicious", or "testing" states are available for LBG assignment.

However, in Cisco IOS Release 12.2(33)SCF, this restriction is modified. As long as the interface state of the channels is not "administratively down", all channels are available for LBG assignment. For other load balancing operations, such as moving modems using DCC, UCC, or DBC, the interface state of the channels should be in "initial", "up", "suspicious", or "testing" states.

As long as the interface state of the channels is not "administratively down", all channels are available for LBG assignment. For other load balancing operations, such as moving modems using DCC, or UCC, the interface state of the channels should be in "initial", "up", "suspicious", or "testing" states.

### Multiple Channel Load Balancing Operation

CMs load balance in MRC and MTC modes. The following rules apply while load balancing CMs operating in these modes:

- For CMs operating in MRC and MTC modes, DBC is used to move CMs across downstreams by changing the RCS of the CM within same MAC domain.

CMs operating in MRC-only mode can be moved across upstreams only through a DCC request. However, the Cisco CMTS uses DCC with initialization technique 0 (reinitializing the MAC domain) when changing the downstream channel of a CM operating in MRC mode.

- During CM registration, the Cisco CMTS may send a multipart registration response (REG-RSP-MP) message to include a TCC TLV encoding to the CM. This CM is marked as TCC-capable.

For CMs operating in MRC, non-MTC, non-TCC-capable mode, load balancing uses:

- DBC to change RCS of the CM
- DCC to change upstream channel of the CM

- For CMs operating in narrowband mode, DCC is used to move CMs within and across MAC domains.

The tables below provide a snapshot view of the load balancing methods and the operations used to move bonded and non-bonded CMs in Cisco IOS Release 12.2(33)SCF1.

Table 33: Load Balancing Method to Move Bonded and Non-bonded CMs

Modem Mode	Load Balancing Method	Load Balancing Counters	Channels	Dynamic Service Charge (Initialization Technique)	
				Within MAC Domain	Across MAC Domains
DOCSIS 3.0 CM in MTC mode	DOCSIS 3.0 static modem count-based load balancing (MCBLB) DOCSIS 3.0 dynamic load balancing	WB/UB	DS/US	DBC <b>Note</b> When DOCSIS 3.0 LB is enabled, and the MTC CM is outside RLBG, CM is moved inside RLBG.	DCC init tech 0
DOCSIS 3.0/D2.x CMs in MRC-only mode	DOCSIS 3.0 static MCBLB DOCSIS 3.0 dynamic load balancing	WB/UB	No change to the primary DS channel	DBC <b>Note</b> When DOCSIS 3.0 LB is enabled and CM with all DSs is outside RLBG, CM is moved inside RLBG.	DCC init tech 0
			Change to the primary DS channel	DCC init tech 0 <b>Note</b> CM with primary DS outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC init tech 0
DOCSIS 3.0 CMs in MRC-only mode	DOCSIS 2.0 static and dynamic MCBLB, dynamic utilization	NB	US	DCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC init tech 0
D2.x CMs in MRC-only mode	DOCSIS 2.0 static and dynamic MCBLB, dynamic utilization	NB	US	DCC/UCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC init tech 0



Modem Mode	Load Balancing Method	Load Balancing Counters	Channels	Dynamic Service Charge (Initialization Technique)	
DOCSIS 2.0 /DOCSIS 1.1 CMs in NB mode	DOCSIS 2.0 dynamic MCBLB, dynamic utilization	NB	DS	DCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC init tech 0
			US	UCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	UCC
DOCSIS 1.0 in NB mode	DOCSIS 2.0 dynamic MCBLB, dynamic utilization	NB	DS	Force reinitialize CM <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	Force reinitialize CM
			US	UCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	UCC

**Table 34: Using DCC/DBC to Load Balance Bonded and Non-bonded Cable Modems**

Channel	CM in MRC, MTC Mode	CM in MRC, non-MTC Mode	DOCSIS 1.1/2.0 CMs with Single US/DS	DOCSIS 1.0 CMs with Single US/DS
Upstream (US)	DBC	DCC	DCC	UCC
Downstream (DS)	DBC (within the same MAC domain)	DBC (within the same MAC domain)	DCC (within the same MAC domain)	Force reinitialize CM
	DCC with initialization technique 0 when moving CMs across MAC domains	DCC with initialization technique 0 when moving CMs across MAC domains	DCC with initialization technique 0 when moving CMs across MAC domains	Force reinitialize CM

## Using DBC for DOCSIS 3.0 Load Balancing Movement

Effective from Cisco IOS Release 12.2(33)SCF1 and as part of the DOCSIS 3.0 specifications, at any time after registration, the Cisco CMTS uses the DBC command to change any of the following parameters in a DOCSIS 3.0 CM:

- Receive channel set
- Transmit channel set
- DSID(s) or DSID associated attributes
- Security association(s) for encrypting downstream traffic
- Service Flow Cluster Assignments

**Note**

In Cisco IOS Release 12.2(33)SCF, only RCS and TCS are used by the DOCSIS 3.0 static modem count-based load balancing.

Use the **show cable load-balance docsis-group** command to display the current, real-time statistics for load balancing operations. For more information, see the [Cisco IOS CMTS Cable Command Reference](#).

### Using DBC to Change the Receive Channel Set

The Cisco CMTS can add, delete, or change the channels in the RCS of a cable modem by including a RCC in the DBC-REQ.

If an RCS change affects the primary downstream channel of the cable modem, the cable modem is required to re-register on its upstream channels.

If channels are deleted from the RCS, the Cisco CMTS may stop sending traffic on the downstream channel to be removed, which may cause loss of traffic. The Cisco CMTS minimizes packet loss by duplicating traffic on the new and old RCS until it receives a DBC-RSP from the cable modem.

If the Cisco CMTS does not receive the DBC-RSP after six retries of the DBC-REQ, and the RCC change affects the primary downstream channel of the cable modem, the Cisco CMTS reinitializes the cable modem. If the RCC change does not affect the primary downstream channel of the cable modem, the RCS of the cable modem must be synchronized between the cable modem and the CMTS.

If the Cisco CMTS does not receive the DBC-RSP after six retries of the DBC-REQ, the Cisco CMTS reinitializes the cable modem.

**Note**

For cable modems in MRC-only mode, a downstream channel move is initiated by a DBC message. However, DCC initialization technique 0 is used if there is a change in the primary downstream channel.

### Using DBC to Change the Transmit Channel Set

The Cisco CMTS can add, delete, or replace one or multiple channels in the TCS in a single DBC message. Whenever the TCS of the cable modem changes, the CMTS appropriately modifies the service identifiers (SIDs) associated with the affected service flows.

A change in the TCS is accompanied by a valid initialization technique.

### Using DBC to Change the Downstream ID

Using DBC, the Cisco CMTS can change the following attributes of a downstream ID (DSID):

- Re-sequencing encodings:
  - Downstream re-sequencing channel list—The CMTS can add, delete, and replace channels in the DS re-sequencing channel list.
  - DSID re-sequencing wait time—The CMTS can indicate a change in skew due to network or configuration changes through DSID re-sequencing wait time.
- re-sequencing Warning Threshold
- CM-STATUS Hold-Off Timer for Out-of-range Events
- Multicast Encoding—The CMTS can initiate a DBC transaction to either add, deleted, or change attributes of an existing multicast DSID:
  - Client MAC Address
  - Multicast cable modem interface Mask
  - Group MAC Address

### Using DBC to Change the Security Association for Encrypting Downstream Traffic

- The CMTS can initiate a DBC transaction to add or delete Security Associations (SA) used to encrypt downstream traffic.
- The CMTS cannot send a DBC request to a cable modem that is not in the "Authorized" State.
- The CMTS can send a DBC request with an SA that uses a cryptographic suite unsupported by the cable modem. However, if the cable modem receives a DBC request with an SA that it is not capable of using, the cable modem rejects the DBC request.

### Using DBC to Change the Service Flow SID Cluster Assignments

The Cisco CMTS uses the Service Flow SID Cluster Assignments TLV in the DBC request to assign new channels to a service flow, remove channels from a service flow, or replace one channel with another for a service flow.



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**Note** Multiple actions can occur within a single DBC message.

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## Types of Load Balancing Operations

The Load Balancing on the Cisco CMTS feature provides a more comprehensive load balancing solution by adding new forms of registration-based and dynamic load balancing. In Cisco IOS Release 12.2(15)BC1, the Load Balancing on the Cisco CMTS feature supports the following configurable types of load balancing:

- Static load balancing—This is a form of registration-based load balancing that is done at the time a cable modem registers. When a cable modem sends its registration request (REG-REQ) and ranging request (RNG-REQ) messages, the Cisco CMTS responds with a ranging response (RNG-RSP) message that

includes either a Downstream Frequency Override or an Upstream Channel ID Override field that instructs the cable modem which channels it should use.

- **Static load balancing**—This is a form of registration-based load balancing that is done at the time a cable modem registers. The first phase of static load balancing is completed when the cable modem registers and path-selection occurs. The static load balancing operation is completed when the second phase occurs after the mandatory REG-HOLD time elapses after the cable modem is registered. .
- **Passive load balancing**—This is a form of registration-based load balancing that can be configured for individual cable modems. In this mode, the Cisco CMTS does not need to send any type of messaging to the modem. The Cisco CMTS ignores the RNG-REQ message from a cable modem that is attempting to register using a downstream or upstream that is currently overloaded. The cable modem repeats its registration request until it reaches a channel that can accept additional modems.




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**Note** By default, the Cisco CMTS uses static load balancing, but passive load balancing can be specified for individual older cable modems (using the **cable load-balance exclude** command) that do not respond well to the static form. This method should be used only as needed because when used for a large number of modems, it could generate a large volume of ranging retry messages.

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- **Dynamic load balancing**—This is a form of load balancing in which cable modems are moved among upstreams and downstreams after their initial registration and they come online, while potentially passing traffic. Cable modems that are currently online are moved when the load difference between two interfaces exceeds a user-defined percentage.




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**Note** The dynamic form of load balancing could be considered a form of traffic-based load balancing, in that cable modems could be moved between interfaces while they are passing traffic. However, the load balancing algorithms do not take into account the nature of traffic when considering which cable modems should be moved.

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When using dynamic load balancing and an upstream channel is overloaded, the Cisco CMTS sends an UCC request to a cable modem to instruct it to move to another upstream. The cable modem should move to the new upstream channel, without going offline or having to re-register with the Cisco CMTS.

When using dynamic load balancing and a downstream channel is overloaded, the Cisco CMTS sends an abort response to a cable modem's ranging request (RNG-REQ) message. When the cable modem sends new REG-REQ and RNG-REQ messages, the Cisco CMTS specifies the new downstream channel in the Downstream Frequency Override field in its RNG-RSP message. The cable modem must go offline and re-register on the new downstream channel, so as to conform to the DOCSIS 1.0 specifications.

During dynamic load balancing, the specified policy of the cable modem is checked to determine whether the cable modem is allowed to move. The load balancing policies are configured on the Cisco CMTS to limit the movement of CMs within a LBG. The cable modem will forward TLV43.1 in its REG-REQ message, which is then parsed and stored in the Cisco CMTS. A policy defines whether and when CMs can be moved within their load balancing groups.

**Note**

The dynamic load balancing method results in cable modems going offline and having to re-register whenever the modems are moved between downstreams. This is because the DOCSIS 1.0 specification requires cable modems to re-register whenever the downstream is changed using the Downstream Frequency Override message. Cable modems should not go offline when being moved between upstreams.

In all cases, the load balancing is done by moving cable modems from the interface with the higher load to an interface with a lower load. For dynamic load balancing, the Cisco CMTS determines which online cable modems should be moved in a round-robin fashion. For static and passive load balancing, the Cisco CMTS moves cable modems only when they register or re-register.

## Methods to Determine When Interfaces Are Balanced

In addition to selecting how interfaces should be balanced (using the static, passive, or dynamic types of load balancing), you can also select one of the following methods that the Cisco CMTS should use to determine when interfaces are balanced:

- Modems Method—Uses the number of active cable modems on an interface.
- Utilization Method—Uses the current percentage of utilization of an interface.
- Service-Flows Method—Uses the number of active service flow IDs (SFIDs) on an interface.

See the following sections for more information about each method.

### Modems Method

The modem method of load balancing uses the number of active cable modems on an interface to determine the current load. This is a form of distribution-based load balancing, in which the absolute numbers of modems are used to determine whether interfaces are load balanced.

This method does not take into account the amount of traffic flowing through the cable modems, but the system does take into account the relative bandwidth of the channels being used, so that channels with higher bandwidths are allocated higher numbers of cable modems. This means that when interfaces are using different channel widths or modulation profiles, the system can assign different numbers of cable modems to the interfaces to achieve a balanced load. For example:

- Channel widths— If two upstreams are being load balanced, and one upstream is configured with a channel width of 1.6 MHz and the other upstream is configured for a channel width of 3.2 MHz, the Cisco CMTS allocates twice as many cable modems to the second upstream because its channel width is twice as large as the first upstream channel width.
- Modulation profiles— If one downstream is configured for 64-QAM and the other downstream is configured for 256-QAM, the Cisco CMTS allocates a proportionately larger number of cable modems to the second downstream so as to achieve a balanced load.

When both the channel width and modulation profile are set differently on two interfaces, the system calculates a “weight” value to use as a guide to determine the relative bandwidths of the interfaces.

**Tip**


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In a system with balanced loads, the interfaces will contain the same number of cable modems only when the interfaces are configured with the same channel width and modulation parameters.

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**Algorithm for Bonded Channel Cable Modem Load Balancing**

Effective with Cisco IOS Release 12.2(33)SCF, during registration of the cable modem, the modem count-based method uses the number of active cable modems on the allowed RCS to determine the current load on each channel. After the modem is assigned an RCS, the Cisco CMTS does not move the cable modem even when traffic conditions change.

When a cable modem sends a registration request, modem count-based method of load balancing ranks the allowed receive channel sets (RCS) based on their modem count and assigns the set with the lowest number of CMs, to the ranging cable modem.

**Primary Channel Load Display for Target RCS**

Starting with SCH, this feature enables the bonded modems to be moved at the time of registration such that the primary channels are distributed evenly among the primary-capable channels apart from the load being balanced on the target DS channels. Modem method ranks the RCS based on their primary loads and assigns the set with the lowest primary load to the ranging cable modem.

An optional keyword **primary-load** has been added to the **show cable load-balance docsis-group** command to display the primary load of an RCS. For more information, see the [Cisco CMTS Command Reference](#).

Although the modem count-based method distributes the cable modems fairly as they register, the following conditions may cause a system imbalance:

- A channel or groups of channels fail because of a planned (administrative shutdown) or unplanned event.
- While some cable modems may continue to operate in partial mode, some may re-register because of the failure and are reassigned to the channels that are active.
- When the failed channels become operational again, the cable modems do not re-register and the system is unbalanced.

In this case, the modem count-based method sends an SNMP trap to alert the operator, and the operator can choose to manually intervene to re-balance the cable modems by resetting the MAC domain to force all cable modems to re-register.

**Note**


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For cable modems in MRC and MTC modes, the modem count based load balancing method considers the number of active modems and service flows on the primary channels in the RCS and TCS of the cable modem.

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**Note**


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Because a wideband SPA channel can be used by different line cards and across multiple MAC domains, the accurate modem count per channel is calculated by aggregating the actual count from all line cards.

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## Utilization Method



**Note** Only narrowband cable modems and upstreams of MRC-only cable modems participate in the utilization method.

The utilization method uses an interface's current percentage of utilization to determine the current load. This method uses the amount of traffic being sent over an interface, in the form of the percentage of total bandwidth being used. The system takes into account the relative throughput and bandwidth (as determined by the modulation profiles and channel widths) of each interface when evaluating the load on those interfaces.

For example, if two upstreams are being load balanced using the utilization method, and the first upstream has twice the bandwidth of the second upstream, the two upstreams are considered balanced when they reach the same percentage of utilization. The first upstream is carrying more traffic than the second upstream because it has a larger capacity for traffic, but the percentage of utilization will be the same.



**Note** The average utilization figure is reset only when the upstream is shut down, allowing the load balancing operation to be more accurate.

When either DBS or the Fairness Across DOCSIS Interfaces is enabled, the channel load will vary, which may affect the load balancing result.

### Configurable Minimum Threshold under Utilization Method



**Note** The utilization method does not move cable modems for load balancing until the utilization of at least one of the interfaces reaches 25 percent. This is done to avoid the unnecessary moving of cable modems due to temporary spikes in an interface's utilization rate. The minimum utilization threshold of 25 percent is fixed and cannot be configured.

Cisco IOS Release 12.2(33)SCH introduces an enhancement to enable configuration of the minimum utilization threshold under Utilization Method. The minimum utilization threshold may be configured in a range of 10 to 90 percent. As a result the cable modems will be moved only when the configured minimum utilization threshold is reached on an interface.

To configure the minimum threshold under the Utilization method, use the **cable load-balance method-utilization min-threshold** command in global configuration mode. For more information, refer to **cable load-balance method-utilization min-threshold** command reference.

## Service-Flows Method



**Note** Effective with Cisco IOS Release 12.2(33)SCF, the Service-Flows Method is deprecated.

The Service Flows method of load balancing uses the number of active service flows on an interface to determine the current load. This is a form of distribution-based load balancing, where the absolute numbers of service flows are used to determine whether interfaces are load balanced.

This method does not take into account the amount of traffic flowing on each SFID, but the system does take into account the relative bandwidth of the channels being used, so that channels with higher bandwidths are allocated higher numbers of SFIDs. This means that when interfaces are using different channel widths or modulation profiles, the system can assign different numbers of SFIDs to the interfaces to achieve a balanced load. For example:

- Channel widths—If two upstreams are being load balanced, and one upstream is configured with a channel width of 1.6 MHz and the other upstream is configured for a channel width of 3.2 MHz, the Cisco CMTS allocates twice as many SFIDs to the second upstream because its channel width is twice as large as the first upstream channel width.
- Modulation profiles—If one downstream is configured for 64-QAM and the other downstream is configured for 256-QAM, the Cisco CMTS allocates a proportionately larger number of SFIDs to the second downstream so as to achieve a balanced load.

When both the channel width and modulation profile are set differently on two interfaces, the system calculates a “weight” value to use as a guide to determine the relative bandwidths of the interfaces.

**Tip**

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In a system with balanced loads, the interfaces will contain the same number of SFIDs only when the interfaces are configured with the same channel width and modulation parameters.

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## Using Both Static and Dynamic Load Balancing

Dynamic load balancing can be used together with static load balancing. The user-configured threshold for dynamic load balancing must be equal to or larger than the user-configured threshold for static load balancing.

With this configuration, when a load imbalance occurs, the system initially uses static load balancing, moving cable modems among interfaces when the modems register. If the load imbalance continues to grow and eventually passes the dynamic threshold, the system begins moving cable modems using dynamic load balancing. Then, when enough cable modems have been moved to push the imbalance below the dynamic threshold, the system reverts to static load balancing until the load imbalance falls below the static threshold value.

## Load Balancing Parameters

The Load Balancing on the Cisco CMTS feature supports static, passive, and dynamic load balancing on both upstream and downstream channels. You can configure downstreams and upstreams to use the same load balancing parameters, or you can configure upstreams and downstreams separately.

You can determine which cable interfaces should participate in load balancing operations. You can also choose which of the following methods should be used to determine the current load on a cable interface, and therefore determine whether cable modems should be moved:

- Number of active cable modems
- Number of active service flows
- Channel bandwidth utilization

You can also specify the threshold values that the Cisco CMTS should use to determine how to assign new cable modems to upstreams and downstreams for both types of load balancing. You can also configure whether



cable modems with active Voice-over-IP (VoIP) calls should be moved, and if so, what thresholds should be used. You can also exclude certain cable modems from one or all of the different forms of load balancing.

## Load Balancing Groups

To enable the load balancing on the Cisco CMTS feature, you first must create and configure a load balancing group, which specifies how load balancing should be performed. You then must assign cable interfaces to the load balancing group, at which point the Cisco CMTS begins performing load balancing on those cable interfaces.

You can use separate load balancing groups for upstreams or downstreams, or you can use the same load balancing group for both upstreams and downstreams. However, all cable interfaces in a load balancing group must share the same physical RF connectivity.



**Note**

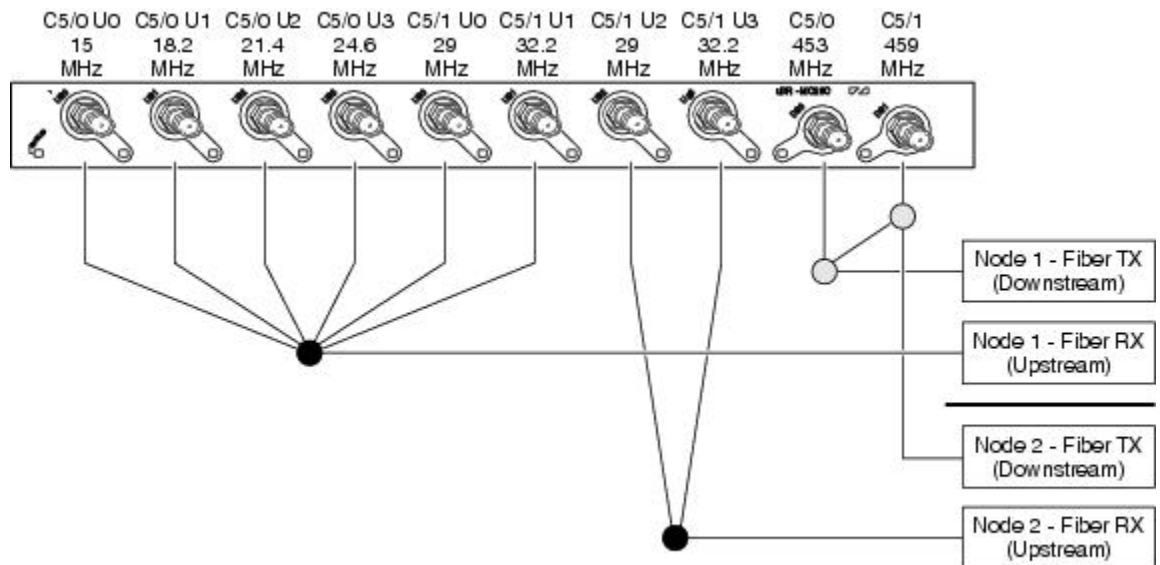
In later Cisco IOS releases, such as Cisco IOS Release 12.3(17a)BC, you can create a maximum of 80 load balancing groups on each chassis (the older limitation was 20). However, in prior Cisco IOS releases, you can reuse those load balancing groups on different sets of cable interfaces. If downstreams are not included in a load balancing group, then each downstream can be considered a separate domain.

Also, the same load balancing group must be used for all downstreams or upstreams that share RF connectivity and that are participating in load balancing. You cannot distribute downstreams or upstreams that share physical connectivity across multiple load balancing groups.

If you assign downstreams and upstreams to different load balancing groups, the Cisco CMTS performs load balancing independently on the upstreams and downstreams. If both downstreams and upstreams are assigned to the same load balancing group, the Cisco CMTS attempts to balance both the downstream and upstream load.

The figure below shows a simple example of how load balancing groups can be created.

**Figure 4: Example of Load Balancing Groups**



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As shown in this figure, three load balancing groups are being used:

- All four upstreams for downstream C5/0 (U0-U3) and the first two upstreams (U0 and U1) for downstream C5/1 are used for the same node and are therefore part of the same load balancing group.
- The last two upstreams for downstream C5/1 (U2 and U3) are used for a different node and are therefore part of a separate load balancing group.
- The two downstreams, C5/0 and C5/1, are part of the same load balancing group, and this group is separate from the groups being used for the upstreams. (However, these downstreams could also be combined with one of the upstream load balancing groups.)

**Note**

To see a sample configuration for this configuration, see the [Example: Configuration for Upstreams and Downstreams](#), on page 268.

### Support for 256 Legacy LBGs

To support effective configuration of legacy LBGs on the Cisco uBR-MC3GX60V line card, the valid range for the legacy load balance group is increased in Cisco IOS Release 12.2(33)SCE4. In Cisco IOS Release 12.2(33)SCE3 and earlier releases, the valid range was from 1 to 80. In Cisco IOS Release 12.2(33)SCE4 and later releases, the valid range is from 1 to 256.

**Note**

Reuse of legacy LBGs across line cards of the same type is supported only on the Cisco uBR10-MC5X20, Cisco UBR-MC20X20V, Cisco uBR-MC28U, and Cisco uBR-MC88V line cards.

For an in-service downgrade, we recommend you remove the LBG configuration before the downgrade process, if legacy LBGs are configured with group IDs higher than 80. If you do not remove the configuration, these LBGs are automatically removed during the in-service downgrade process.

## Downstream Load Balancing Distribution with Upstream Load Balancing

Downstream load balancing provides equalized load balancing with upstream group members. This enhancement synchronizes the “pending” statistic between different cable interface line cards in the load balancing group. The result is an alternative downstream load balancing scheme that makes use of per-upstream loads rather than total downstream loads.

This enhancement performs downstream load balancing that accounts for upstream channel loads in the same upstream load balancing group, rather than on the basis of the entire downstream channel load. Prior Cisco IOS releases may not have distributed cable modems evenly over individual upstream channels, nor in a way that accounted for downstream and upstream together.

The load balancing enhancement applies when downstream load balancing occurs on a headend system with separate upstream load balancing segments; the upstream segments are spread over multiple downstream segments.

The configuration and operation of making downstream load balancing decisions is enabled as follows:

- The target downstream segment is in the same downstream load balancing group as the source downstream segment.

- The upstream load balancing group can be set for the corresponding channel on which a cable modem is balanced.
- The Cisco CMTS automatically locates the upstream segment for a load balancing group and processes the upstream group status on the source interface that has the lowest load.
- The target downstream segment must have an upstream channel set in the upstream load balancing group.
- The highest target upstream segment must carry less load than any other potential target—the highest upstream segment on other interfaces.

For example, several upstream segments can be configured across multiple downstream segments as follows:

	U0	U1	U2	U3	Downstream
3/0	LB10	LB11	LB12	LB13	LB1
4/0	LB10	LB11	LB12	LB13	LB1
5/0	LB10	LB11	LB12	LB13	LB1
6/0	LB10	LB11	LB12	LB13	LB1

In this example, a cable modem that comes online on the interface cable 5/0 Upstream 2 could potentially come online on the following interfaces:

- cable 3/0 upstream 2
- cable 4/0 upstream 2
- cable 6/0 upstream 2

With downstream load balancing prior to Cisco IOS Release 12.3(17b)BC4, having 100 cable modems per segment would be possible in an extreme case that distributes cable modems as follows:

	U0	U1	U2	U3	Downstream
3/0	97	1	1	1	100
4/0	1	97	1	1	100
5/0	1	1	97	1	100
6/0	1	1	1	97	100

The enhancement enables the following advantages and behaviors:

- This enhancement adds support for synchronizing the “pending” statistic between different cable interface line cards and the network processing engine (NPE) so that a better decision can be made about where cable modems should be moved. This function can be used as a normal downstream load balancing implementation, if desired.
- This enhancement adds the **us-groups-across-ds** keyword to **cable load-balance group** command for configuring downstream load balancing groups with upstream resources.

## Upstream Load Balancing for DOCSIS 3.0 Cable Modems in Single Upstream Mode

The upstream load balancing functionality enables the Cisco CMTS router to effectively handle upstream traffic for wideband and narrowband cable modems that are in single upstream mode. Single upstream mode (Mx1) means that the modems cannot send upstream traffic on multiple upstream channels. In the event of traffic overload on a single upstream channel of a wideband or narrowband cable modem, the Cisco CMTS router automatically moves the cable modem to another upstream channel in the same load balancing group.

**Note**

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A cable modem operating in single upstream mode is assigned to a load balancing group based on the primary channel of the modem. A cable modem in single upstream mode can support multiple receive channel (MRC) mode or narrowband mode. However, a cable modem in single upstream mode cannot support multiple transmit channel mode (MTC).

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## Disabling Upstream Load Balancing for DOCSIS 3.0 Modems

Effective with Cisco IOS Release 12.2(33) SCH1 and Cisco IOS Release 12.2(33)SCG6, you can activate load balancing only on downstream channels. This ensures that upstream load balancing is not activated, allowing a maximum number of channels to be used to bring the upstream bonding cable modems online. This also prevents the CMTS from dynamically generating TCS different from the default single channel USBG, and user configured USBGs. For more information see Section *DOCSIS 3.0 Load Balancing with USBG Smaller than Cable Modem Capabilities* in the [Upstream Channel Bonding](#)

The Disabling Upstream Load Balancing for DOCSIS 3.0 Modems feature can be configured using the **downstream-only** keyword of the **cable load-balance docsis30-enable** command.

## Disabling Upstream Load Balancing for DOCSIS 3.0 Modems

Effective with Cisco IOS Release 12.2(33) SCH1 and Cisco IOS Release 12.2(33)SCG6, you can activate load balancing only on downstream channels. This ensures that upstream load balancing is not activated, allowing a maximum number of channels to be used to bring the upstream bonding cable modems online. This also prevents the CMTS from dynamically generating TCS different from the default single channel USBG, and user configured USBGs. For more information see Section *DOCSIS 3.0 Load Balancing with USBG Smaller than Cable Modem Capabilities* in the [Upstream Channel Bonding](#)

The Disabling Upstream Load Balancing for DOCSIS 3.0 Modems feature can be configured using the **downstream-only** keyword of the **cable load-balance docsis30-enable** command.

## DOCSIS 3.0 Dynamic Load Balancing

Effective with Cisco IOS Release 12.2(33) SCI, you can activate the DOCSIS 3.0 dynamic load balancing on the downstream channels. The DOCSIS 3.0 dynamic load balancing is based on the utilization method. It is used to balance the traffic across the QAM channels per load balance interval.

The DOCSIS 3.0 Dynamic Load Balancing feature can be configured using the **cable load-balance docsis30-dynamic-enable** command.

**Note**

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The DOCSIS 2.0 and DOCSIS 3.0 load balancing has to be enabled before configuring the DOCSIS 3.0 dynamic load balancing on Cisco CMTS.

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## Interaction with Spectrum Management

Cisco cable interface line cards support a number of features to maximize channel bandwidth and to minimize the impact of ingress noise on cable modem traffic. These features have the following impacts upon load balancing operations:

- Frequency hopping—Frequency hopping does not affect the load balancing algorithm, because it does not change either the bandwidth of a channel nor the number of cable modems on an interface.
- Dynamic modulation changes—The dynamic modulation feature affects the load balancing algorithm because it typically switches an interface from a higher-bandwidth modulation profile to a lower-bandwidth modulation profile in response to noise conditions on the interface.

For example, if an upstream is configured for 16-QAM, sufficient noise levels could switch the upstream to a QPSK modulation profile. Depending on the load balancing configuration, this could then result in the movement of cable modems to other channels. Similarly, when the noise conditions improve, and the modulation is returned to the original, higher-bandwidth profile, the cable modems could be moved again to rebalance the upstream channels.

- Channel width changes—Multiple Cisco cable interface line cards, such as the Cisco uBR-MC16S/U/X, Cisco uBR-MC28U/X, and Cisco uBR10-MC5X20S/U/H, support automatic changes to the channel width in response to noise conditions. Because changing the channel width affects the throughput of a channel, this also affects the load balancing algorithm.

For example, if noise makes the current channel width unusable, the Cisco cable interface line card reduces the channel width until it finds a usable channel width. Because this reduces the available bandwidth on the channel, the load balancing algorithm moves cable modems to rebalance the upstreams.

In addition, the Cisco cable interface line card does not automatically restore the original channel width when noise conditions improve. Instead, the card changes the channel width only when it performs a subsequent frequency hop, either in response to additional noise conditions or when an operator performs a manual frequency hop. When the hop occurs, the card then searches for the largest possible channel width, and this could result in another movement of cable modems to rebalance the channels.

## DOCSIS 2.0 Multicast Enhancement for VDOC

This feature enables the customer to tune a DOCSIS 2.0 cable modem to a specific downstream and supports static multicast video forwarding on it. The **vdoc-enabled** keyword enables the video over DOCSIS (VDOC) load balancing for static multicast groups.

The set-top boxes (STB) are configured with static video streams. The Cisco CMTS will check if the modems that are connected to these STBs are already on the specific downstream interface with these multicast replications when it receives joins for these static streams. If the modems are not on the correct downstreams, then a DCC message is sent to the line card to initiate the cable modem move to the correct downstream interface.

This feature is restricted by the following issues:

- Static multicast groups should be configured on the appropriate bundle interface as well as on the correct forwarding interfaces to enable this rule.
- This feature is not supported on load balancing groups which are derived from fiber node configuration and with multicast encryption.

- This feature does not support logical upstream channels.
- This feature works with DOCSIS 2.0 and 3.0 Multicast DSID-based Forwarding (MDF)-disabled cable modems.
- For MDF-enabled modems, the modem may support DCC but will not receive traffic till the next join arrives.
- It is highly recommended to have multicast QoS.
- The modems that support DCC due to load balancing will use init-tech 0 irrespective of the initialization technique configured on the load balancing group.
- This feature does not support multicast encryption. However, if the static group is configured for multicast encryption, then this feature will process the join and move the cable modem if required.

## Benefits of Load Balancing

The Load Balancing feature on the Cisco CMTS provides the following benefits to cable service providers and their partners and customers:

- Provides a method that service providers can use for efficient bandwidth utilization, especially when using multiple upstream channels per fiber node.
- Allows service providers to expand their networks in an efficient manner, avoiding the cost of having to install additional fiber optic equipment and further segmenting the physical plant.
- Load balancing on downstream channels enables efficient bandwidth usage when using multiple downstream channels per fiber node to enable Video over IP and other services that require high-bandwidth real-time streams.
- Load balancing of upstream and downstream channels does not require any change to the provisioning servers or to any DOCSIS configuration files.
- Load balancing of upstream and downstream channels does not require any administrator or user intervention (such as manually resetting cable interfaces or manually rebooting cable modems).
- Load balancing can be used with the virtual interfaces feature, and with virtual interface bundling, on the Cisco uBR10-MC5X20S/U/H cable interface line cards, to provide load balancing for configurable MAC domains. Load balancing is also supported for virtual interface bundling with Cisco uBR-MC28U/X cable interface line cards.
- Allows service providers to equally balance their downstreams as cable modems register, so that cable modems do not all attempt to register on the same downstream, resulting in many cable modems failing to register and having to search for a new downstream.
- Cable modems can be moved among downstream and upstream channels without having to change any network parameters in manual fashion, such as IP address.
- Allows service providers to stay ahead of customers' bandwidth demands by dynamically responding to current load-usage conditions.
- Allows service providers to optimize the load balancing parameters for critical services, such as Voice over IP (VoIP).

## Exclude Cable Modems from Load Balancing Groups

### Load Balancing Process

The load balancing process has two phases.

- Assignment phase.

When a modem is coming online in the assignment phase, the modem is moved to the load balance group by assigning it a load balancing group (LBG) ID. The assignment phase occurs only when a modem is coming online.

- Balancing phase.

In the balancing phase, a modem is re-assigned to an LBG to balance the load.

### Excluding Cable Modems from Load Balancing

Effective with Cisco IOS Release 12.2(33)SCH, there are four options that are used to exclude cable modems from an LBG:

- The **assignment** option:

The **assignment** option is used to exclude a modem during the assignment phase. The modem is not assigned an LBG and LBG ID is not displayed in the output of the **show cable modem verbose** command. The **assignment** option cannot be used when a modem is already online.

- The **static** option:

The **static** option is used to exclude a modem during the Balancing phase. The modem is assigned to an LBG with an LBG ID. The **static** option is used to exclude a modem during static load balancing.

- The **enforce** option:

The **enforce** option is similar to the **static** option, except that the **enforce** option is used to exclude a modem during dynamic load balancing.

When a cable modem is excluded from load balancing using the **assignment** option, the cable modem is not available for load balancing using the **static** or the **enforce** options.

- The **strict** option:

The **strict** option excludes a modem in both the phases of load balancing. When a modem is online already, the **strict** option applies the **static** and the **enforce** options. It applies the **assignment** option only when the modem comes online again.

## How to Configure Load Balancing

To configure load balancing groups, and to enable load balancing, refer to the configurations in the *DOCSIS Load Balancing Groups* document. Each task is marked as required or optional, as appropriate.

## Creating a Load Balancing Group

This section describes how to create a load balancing group. You must create at least one load balancing group before the Cisco CMTS will begin load balancing cable modems.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable load-balance group <i>n</i> method [modems   service-flows   utilization]</b>  <b>Example:</b> Router(config)# <b>cable load-balance group 10 method service-flows</b>	Creates a load balancing group.
Step 4	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Creating a Load Balancing Rule

This configuration is optional. You must create at least one load balancing rule before the Cisco CMTS can use load balancing policies.

### DETAILED STEPS

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



	Command or Action	Purpose
Step 3	<p><b>cable load-balance rule</b> <i>rule-id</i> {<b>disable-period</b>   <b>disabled</b>   <b>enabled</b>   <b>vdoc-enabled</b>} [<b>dis-start</b> <i>start-time</i>   <b>dis-period</b> <i>disable-period</i>]</p> <p><b>Example:</b> Router (config) # <b>cable load-balance rule 1 disabled</b></p>	Creates a load balancing rule with the following parameters:
Step 4	<p><b>exit</b></p> <p><b>Example:</b> Router (config) # <b>exit</b></p>	Exits global configuration mode.

## Troubleshooting Tips

**Problem** When you disable load balancing and enable it for the next day using the **cable load-balance rule** *rule-id* **disable-period** **dis-start** *start-time* **dis-period** *disable-period* command, the load balancing is enabled at 12.00 am instead of the configured *disable-period*.

**Possible Cause** Load balancing rule cannot be disabled and enabled on the next day (that is, after 24 hours) using a single load balancing rule.

**Solution** Configure separate load balancing rules for disabling load balancing and enabling it on the next day. Configure the rule to disable load balancing using the **cable load-balance rule** *rule-id* **disable-period** **dis-start** *start-time* **dis-period** **0** command. Configure the rule to enable load balancing using the **cable load-balance rule** *rule-id* **disable-period** **dis-start** **0** **dis-period** *disable-period* command to enable it for the next day.

## Creating a Load Balancing Policy

This configuration is optional. You must create at least one load balancing rule before the Cisco CMTS can use a load balancing policy.

### DETAILED STEPS

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

	Command or Action	Purpose
<b>Step 3</b>	<b>cable load-balance docsis-policy <i>policy-id</i> rule <i>rule-id</i></b>  <b>Example:</b> Router(config)# <b>cable load-balance docsis-policy 2 rule 1</b>	Creates a load balancing rule with the following parameters: <ul style="list-style-type: none"> <li>• <i>policy-id</i>—Specifies the DOCSIS policy to be created.</li> <li>• <b>rule <i>rule-id</i></b>—Specifies the rule to be used with the DOCSIS policy.</li> </ul>
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Configuring a Load Balancing Group

This section describes how to configure a load balancing group. All steps are optional, unless you want to change the default load balancing configuration.

### DETAILED STEPS

	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 load-balance group <i>n</i> [interval <i>seconds</i>]</b>  <b>Example:</b> Router(config)# <b>cable load-balance group 10 interval 30</b>	Modifies the frequency by which the Cisco CMTS checks for exceeded thresholds in order to launch the load balancing feature. <ul style="list-style-type: none"> <li>• <i>n</i>—Number of the load balancing group. In Cisco IOS Release 12.2(33)SCE3 and earlier, the valid range is from 1 to 80. In Cisco IOS Release 12.2(33)SCE4 and later, the valid range is from 1 to 256.</li> <li>• <b>interval <i>seconds</i></b>—Minimum time interval taken for the CMs to move to load balance the interfaces. At least one CM is moved during each time interval. In Cisco IOS Release 12.2(33)SCE and earlier releases, the valid range is 1 to 1000 seconds, with a default value of 10. In Cisco IOS Release 12.2(33)SCE1 and later releases, the valid range is 1 to 1000 seconds, with a default value of 30.</li> </ul>

	Command or Action	Purpose
Step 4	<p><b>cable load-balance group <i>n</i> threshold</b>  <b>{load <i>load-value</i> [enforce <i>threshold</i>]  </b>  <b>load minimum <i>number</i>   stability</b>  <b><i>percent</i>   ugs <i>band-value</i>}</b></p> <p><b>Example:</b>  Router(config)# <b>cable</b>  <b>load-balance group 10 threshold</b>  <b>load 20 enforce 30</b></p>	<p>Specifies the thresholds to be used to determine when cable modems should be moved to achieve the desired load balancing.</p> <ul style="list-style-type: none"> <li>• <b>load <i>load-value</i></b>—Specifies the maximum load difference that can exist between interfaces in a group before the Cisco CMTS performs load balancing. The valid range for <i>load-value</i> is 1 to 100 percent, with a default of 10 percent. This value applies to static load balancing, used during cable modem registration.</li> </ul> <p><b>Note</b> The default of 10 percent is the minimum recommended threshold. Do not set this threshold below 10 percent unless you have been instructed to do so by Cisco TAC.</p> <ul style="list-style-type: none"> <li>• <b>enforce <i>threshold</i></b>—Enables dynamic load balancing, which moves online cable modems. The range for the <i>threshold</i> parameter starts from the current value of the <i>load-value</i> parameter up to 100 percent. The default equals the current value of the <i>load-value</i> parameter.</li> <li>• <b>load minimum <i>number</i></b>—Specifies that cable modems should be moved only if the load between the two interfaces is greater than the specified number of cable modems or service flows (valid only when the method being used is the number of modems or service flows; it is not used for the utilization method).</li> <li>• <b>stability <i>percent</i></b>—Specifies the minimum allowable percentage of good periodic ranging requests that is acceptable. When the channel has a lower <i>percent</i> of modems responding to the ranging requests in a one minute period, the Cisco CMTS begins moving modems. The valid range is 1 to 100 percent, with a default of 50 percent.</li> <li>• <b>ugs <i>band-value</i></b>—Specifies that the Cisco CMTS should move cable modems with active Unsolicited Grant Service (UGS) service flows when the current UGS usage reaches the <i>band-value</i> percentage. The valid range for <i>band-value</i> is 0 to 100 percent, with a default of 70 percent.</li> </ul>
Step 5	<p><b>cable load-balance group <i>n</i> policy</b>  <b>{pcmm   ugs   us-groups-across-ds}</b></p> <p><b>Example:</b>  Router(config)# <b>cable</b>  <b>load-balance group 10 policy ugs</b>  Router(config)# <b>cable</b>  <b>load-balance group 10 policy pcmm</b>  Router(config)# <b>cable</b>  <b>load-balance group 10 policy</b>  <b>us-groups-across-ds</b></p>	<p>Allows the Cisco CMTS to move cable modems that have active UGS service flows to enforce the load balancing policy.</p> <ul style="list-style-type: none"> <li>• <b><i>n</i></b>—Number of the load balancing group. In Cisco IOS Release 12.2(33)SCE3 and earlier, the valid range is from 1 to 80. In Cisco IOS Release 12.2(33)SCE4 and later, the valid range is from 1 to 256.</li> </ul>
Step 6	<p><b>exit</b></p> <p><b>Example:</b>  Router(config)# <b>exit</b></p>	<p>Exits global configuration mode.</p>

**Note**

The load balancing algorithms assume a relatively even distribution of usage among modems. In the situation where one cable modem creates the bulk of the load on an interface, the load balancing thresholds should be configured for a value above the load created by that single modem. You should check for this situation whenever the load balancing algorithm is moving a large number of modems from one interface to another.

## Configuring the DOCSIS 3.0 Dynamic Load Balancing

This configuration is optional. This section describes how to enable the DOCSIS 3.0 dynamic load balancing on the downstream channels.

### DETAILED STEPS

	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>	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
<b>Step 3</b>	<b>cable load-balance docsis-enable</b>  <b>Example:</b> Router(config)# <b>cable load-balance docsis-enable</b>	Enables DOCSIS 2.0 load balancing on the Cisco CMTS.
<b>Step 4</b>	<b>cable load-balance docsis30-enable</b>  <b>Example:</b> Router(config)# <b>cable load-balance docsis30-enable</b>	Enables DOCSIS 3.0 load balancing on the Cisco CMTS.
<b>Step 5</b>	<b>cable load-balance docsis30-dynamic-enable</b>  <b>Example:</b> Router(config)# <b>cable load-balance docsis30-dynamic-enable</b>	Enables DOCSIS 3.0 dynamic load balancing on the Cisco CMTS.

	Command or Action	Purpose
Step 6	<b>exit</b>  <b>Example:</b> Router (config) # <b>exit</b>	Exits global configuration mode.

## Assigning Interfaces to a Load Balancing Group

This section describes how to assign cable interfaces (both downstreams and upstreams) to a load balancing group. A cable interface does not participate in load balancing operations until it is a member of a load balancing group.



### Restriction

- A downstream or upstream can belong to only one load balancing group.
- All downstreams and upstreams in a load balancing group must share physical connectivity to the same group of cable modems. Downstreams can be in a separate load balancing group than upstreams, but all downstreams or all upstreams that have the same RF physical connectivity must be members of the same load balancing group. You cannot distribute downstreams or upstreams that share physical connectivity across multiple load balancing groups.
- All interfaces in a load balancing group use the same load balancing parameters. By default, all cable modems on those interfaces are included in load balancing operations. However, you can exclude one or more particular cable modems from being moved in load balancing operations.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>interface cable slot/port</b>  <b>Example:</b> Router (config) # <b>interface cable 5/1</b>	Enters interface configuration mode for the specified cable interface.

	Command or Action	Purpose
Step 4	<b>cable load-balance group <i>n</i></b>  <b>Example:</b> <pre>Router(config-if)# cable load-balance group 10</pre>	Assigns the downstream interface to the specified load balancing group.
Step 5	<b>cable downstream frequency <i>freq-hz</i></b>  <b>Example:</b> <pre>Router(config-if)# cable downstream frequency 453000000</pre>	<p>Specifies the known downstream center frequency to be used on this cable interface. This is an information-only configuration on cable interfaces that use an external upconverter, but it is still required for load balancing so that the Cisco CMTS knows what frequencies it should use when moving cable modems from one downstream to another.</p> <p>The <i>freq-hz</i> parameter specifies the frequency in Hz, with a valid range of 54,000,000 to 858,000,000. Depending on the channel width, the range of center frequency that is acceptable to a CM is 91,000,000 to 857,000,000 Hz.</p>
Step 6	<b>cable upstream <i>uport</i> load-balance group <i>n</i></b>  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 load-balance group 10</pre>	<p>Assigns an upstream port to the specified load balancing group.</p> <p><b>Note</b> Repeat <a href="#">Step 3, on page 255</a> through <a href="#">Step 6, on page 256</a> as needed for each downstream cable interface and its upstream ports that should belong to this group.</p>
Step 7	<b>end</b>  <b>Example:</b> <pre>Router# end</pre>	Returns to privileged EXEC mode.

## Excluding Cable Modems from a Load Balancing Group

This configuration is optional. This section describes how to exclude a particular cable modem, or all cable modems from a particular vendor, from participating in static or dynamic load balancing operations, and optionally marking the modems for passive load balancing. This task is optional, because, by default, cable modems on an interface participate in whatever load balancing operations have been configured.



### Note

This step might be required for some cable modems that are not DOCSIS-compliant. Such cable modems can go offline for long periods of time when load balancing is attempted using DOCSIS MAC messages. If this is the case, use the **cable load-balance exclude** command to exclude such cable modems from load balancing operations until the modem can be upgraded to DOCSIS-compliant software.



### Tip

You must exclude cable modems that require specific upstream channels or downstream frequencies. Load balancing cannot be done when cable modems are assigned specific channels or frequencies in their DOCSIS configuration files.

### Support for Excluding Old Devices

Load balancing for old cable devices like Set Top Boxes (STBs) which do not support load balancing, will fail. In the output for **show cable load-balance group** command, these devices will show as 'suspicious' and then as 'disabled'. This will disrupt normal operations of other modems in the load balancing group. To exclude these STBs, a **cable load-balance exclude** command is configured to exclude each STB.



**Note** Starting with Cisco IOS Release 12.2(33)SCH, you can configure the **cable load-balance exclude** command once to exclude all the STBs, that do not support load balancing, instead of configuring the command several times with matched MAC addresses. You can also move cable modems that were moved to a load balancing group in assignment phase.

In Cisco IOS Release 12.2(33)SCH, the **cable load-balance exclude** modem command is modified to include the *mask* argument as an optional argument. The MAC address of a cable modem that belongs to the range specified by the MAC address mask, will be excluded by matching the "1" bit in mask. While configuring a new range rule using the *mask* argument, an existent rule with the same range is overwritten.

In Cisco IOS Release 12.2(33)SCH, the **cable load-balance exclude** modem command is modified to include the **assignment** option. This option allows you to exclude a cable modem that was moved into a load balancing group in assignment phase.



**Note** You can configure the **cable load-balance exclude** command once to exclude all the STBs, that do not support load balancing, instead of configuring the command several times with matched MAC addresses. You can also move cable modems that were moved to a load balancing group in assignment phase.

The **cable load-balance exclude** modem command is modified to include the *mask* argument as an optional argument. The MAC address of a cable modem that belongs to the range specified by the MAC address mask, will be excluded by matching the "1" bit in mask. While configuring a new range rule using the *mask* argument, an existent rule with the same range is overwritten.

The **cable load-balance exclude** modem command is modified to include the **assignment** option. This option allows you to exclude a cable modem that was moved into a load balancing group in assignment phase.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable load-balance exclude</b> { <i>modem mac-address</i> [ <i>mac-mask</i> ]   <i>oui oui-value</i> } [ <b>assignment</b>   <b>enforce</b>   <b>static</b>   <b>strict</b> ]	Specifies that one or more cable modems should be excluded from load balancing operations.

	Command or Action	Purpose
	<b>Example:</b> <pre>Router(config)# cable load-balance exclude oui 00:00:0c</pre>	By default, the cable modems are excluded from dynamic and static load balancing, but they continue to participate in passive load balancing. Use the following options to exclude the cable modems from others combinations of load balancing:
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> <pre>Router(config)# exit</pre>	Exits global configuration mode.

## Disabling Load Balancing

This configuration is optional. Use the following commands to disable DOCSIS 3.0 static modem count-based load balancing:

```
Router(config)# cable load-balance docsis-group FN 1 MD cable 6/0/0
Router(config-lb-group)# disable
Router(config-lb-group)#
```

Legacy load balancing requires cable modems to re-register when load balancing configuration is changed. With DOCSIS 3.0 static modem count-based load balancing, when load balancing related configuration within the LBG is changed as follows, the cable modems are forced to re-register:

- Partial shut or no shut interfaces under the LBG domain
- MRC or MTC mode in cable modems is turned on or turned off
- Change in fiber node for GLBG
- Change in wideband configuration for downstream group
- Change in the upstream bonding group

Use the following commands to force cable modems to re-register:

- **clear cable modem delete**
- **clear cable load state**
- **clear cable load counters**

## Distributing Downstream Load Balancing with Upstream Load Balancing

Two commands are used to configure or display the configuration and status of distributed load balancing on the Cisco CMTS:

- **cable load-balance group *ds-lb-group-id* policy {pcmm | ugs | us-groups-across-ds}**
- **show cable load all**



The optional configuration of making downstream load balancing decisions is enabled as follows:

- The target downstream segment is in the same downstream load balancing group as the source downstream segment. This feature finds the target frequency and interface based on the upstream loads within the same upstream group as the source.
- The upstream load balancing group can be set for the corresponding channel on which a cable modem is balanced on the downstream channels.
- The Cisco CMTS automatically locates the upstream segment for a load balancing group and processes the upstream group status on the source interface that has the lowest load.
- The target downstream segment must have an upstream channel set in the upstream load balancing group.
- The highest target upstream segment must carry less load than any other potential target—the highest upstream segment on other interfaces.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable load-balance group <i>ds-lb-group-id</i> policy {pcmm   ugs   us-groups-across-ds}</b>  <b>Example:</b> Router(config)# <b>cable load-balance group 1 policy us-groups-across-ds</b>	Sets the type of service flow policy for use with Load Balancing. This command synchronizes the pending statistic between different cable interface line cards in the load balancing group. The result is an alternative downstream load balancing scheme that makes use of per-upstream loads rather than total downstream loads when making load balancing decisions.
Step 4	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.
Step 5	<b>show cable load all</b>  <b>Example:</b> Router# <b>show cable load all</b>	Displays load balancing statistics and status of load balancing configurations on the Cisco CMTS, to include distributed upstream-to-downstream load balancing when configured.

## Examples

The following example illustrates this command and one supported implementation:

```
Router(config)# cable load-balance group 1 policy us-groups-across-ds
```

In this example, a cable modem that comes online on the interface cable 5/0 Upstream 2 could potentially come online on the following interfaces:

- cable 3/0 upstream 2
- cable 4/0 upstream 2
- cable 6/0 upstream 2

With downstream load balancing prior to Cisco IOS Release 12.3(17b)BC4, having 100 cable modems per segment would be possible in an extreme case that distributes cable modems as follows:

U0	U1	U2	U3	Downstream	
3/0	97	1	1	1	100
4/0	1	97	1	1	100
5/0	1	1	97	1	100
6/0	1	1	1	97	100

The following example explores one collective configuration that follows the best practices and command syntax for this feature. In this example, additional configuration commands described elsewhere in this document configure Load Balancing as follows:

```
Router> enable
Router# configure terminal
Router(config)# cable load-balance group 6 method utilization
Router(config)# cable load-balance group 6 interval 60
Router(config)# cable load-balance group 6 threshold load 10 enforce
Router(config)# cable load-balance group 6 policy us-groups-across-ds
```

The following **show** command illustrates distributed downstream and upstream load balancing according to this feature in Cisco IOS Release 12.3(17b)BC4 and later releases:

```
Router# show cable load all
```

Group	Interval	Method	DCC Init Technique	Threshold Minimum	Static	Enforc gs	PCMM
1	10	modems	0	1	2%	2%	---
10	1	modems	0	1	1%	---	---
11	1	modems	0	1	1%	---	---

Current load:

Interface	State	Group	Utilization	Reserved	Modems	Flows	Weight
Cable5/0 (525 MHz)	up	1	0% (0%/0%)	0%	14	28	37
Cable5/0/U0	up	10	0%	0%	9	9	2.5
Cable5/0/U1	up	11	0%	0%	5	5	2.5
Cable6/0 (411 MHz)	up	1	0% (0%/0%)	0%	30	60	37
Cable6/0/U0	up	10	0%	0%	19	19	5.1
Cable6/0/U1	up	11	0%	0%	11	11	5.1

Target assignments:

Interface	State	Group	Target
Cable5/0 (525 MHz)	up	1	
Cable5/0/U0	up	10	
Cable5/0/U1	up	11	
Cable6/0 (411 MHz)	up	1	
Cable6/0/U0	up	10	
Cable6/0/U1	up	11	

Statistics:

Target interface	State	Transfers			
		Complete	Pending	Retries	Failures
Cable5/0 (525 MHz)	up	18	1	3	0
Cable5/0/U0	up	0	0	0	0
Cable5/0/U1	up	0	0	0	0
Cable6/0 (411 MHz)	up	12	0	6	0
Cable6/0/U0	up	0	0	0	0
Cable6/0/U1	up	0	0	0	0

## How to Configure Dynamic Channel Change for Load Balancing

DCC and DCC for Load Balancing is supported on the Cisco uBR7246VXR router and the Cisco uBR10012 router with the Cisco MC28U and the Cisco MC5X20S/U/H cable interface line cards.

DCC in DOCSIS 1.1 dynamically changes cable modem upstream or downstream channels without forcing a cable modem to go offline, and without reregistration after the change. DCC supports five different initialization methods (0-4), instead of one, as in earlier DOCSIS support.

Dynamic Channel Change (DCC) and DCC for Load Balancing on the Cisco CMTS supports the following:

- Load balancing techniques allow for moving cable modems with DCC by using configurable initialization techniques.
- DCC allows line card channel changes across separate downstream channels in the same cable interface line card, with the DCC initialization techniques ranging from 0 to 4.
- DCC transfers cable modem state information from the originating downstream channel to the target downstream channel, and maintains synchronization of the cable modem information between the cable interface line card and the Network Processing Engine (NPE) or Route Processor (RP).
- Applications that are sensitive to delay, such as PacketCable (PC) and PacketCable MultiMedia (PCMM), may use DCC initialization technique 4 to retain services while the cable modem is performing DCC.
- If the channel is in mixed or ATDMA-only mode, the primary Service Identifier (SID) must be switched to ATDMA-only mode.

## Configuring DCC for Load Balancing on the Cisco CMTS

To configure the DCC feature for load balancing, use the following steps. Values indicated are sample values that may differ from your own.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>

	Command or Action	Purpose
<b>Step 2</b>	<b>configure terminal</b>  <b>Example:</b> Router# <code>configure terminal</code>	Enters global configuration mode.
<b>Step 3</b>	<b>cable load-balance group <i>group-num</i> dcc-init-technique <i>number</i></b>  <b>Example:</b> Router(config)# <code>cable load-balance group 1 dcc-init-technique 0</code>	Sets the DCC initialization technique for the specified load balancing group. The initialization technique number can range from 0 to 4.
<b>Step 4</b>	<b>cable load-balance group <i>group-num</i> policy {pcmm   ugs   us-groups-across-ds}</b>  <b>Example:</b> Router(config)# <code>cable load-balance group 1 policy pcmm</code>	Enables load balancing of cable modems with PacketCable MultiMedia (PCMM) service flows, Unsolicited Grant Service (UGS) service flows, or both PCMM and UGS service flows. Applies these setting to the specified load balancing group.
<b>Step 5</b>	<b>cable load-balance group <i>group-num</i> threshold {load   pcmm   stability   ugs} {1-100}</b>  <b>Example:</b> Router(config)# <code>cable load-balance group 1 threshold ugs 75</code>	Selects the type of service flow threshold and sets the respective threshold in a percentage for the load balancing group.
<b>Step 6</b>	<b>cable load-balance group <i>group-num</i> threshold load {1-100} {minimum}</b>  <b>Example:</b> Router(config)# <code>cable load-balance group 1 threshold load 75 minimum</code>	Sets the load threshold for the specified load balancing group.
<b>Step 7</b>	<b>cable load-balance group <i>group-num</i> threshold load {1-100} {enforce}</b>  <b>Example:</b> Router(config)# <code>cable load-balance group 1 threshold load 75 enforce</code>	Sets the enforce threshold for the specified load balancing group.
<b>Step 8</b>	<b>end</b>  <b>Example:</b> Router(config)# <code>end</code>	Returns to privileged EXEC mode.

### What to Do Next

To test and verify DCC for load balancing, use the following two commands:

- `test cable dcc`
- `show controllers cable`

These commands are described in the *Cisco CMTS Cable Command Reference* .

## Verifying Load Balancing Operations

This section describes how to use certain test and show commands to verify the configuration and operation of the Load Balancing feature or Dynamic Channel Change feature on the Cisco CMTS.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>test cable load-balance</b> <i>mac-address</i> [ <b>ucc</b>   <b>upstream</b> ] [ <i>count</i> ]  <b>Example:</b> Router# <b>test cable load-balance</b> 0000.394e.4e59	Tests the operation of the current load balancing configuration by moving a cable modem to a new upstream.  <b>Note</b> You can create a maximum of 80 load balancing groups on each chassis.
Step 3	<b>show cable load-balance</b> [ <b>group</b> <i>n</i> ] [ <b>all</b>   <b>load</b>   <b>pending</b>   <b>statistics</b>   <b>target</b> ]  <b>Example:</b> Router# <b>show cable load-balance group 1</b>	Displays real-time statistical and operational information for load balancing operations. If given without any options, this command displays information for the load balancing groups and each cable interface's current load and load balancing status. You can also specify the following options:
Step 4	<b>test cable dcc</b> [ <i>mac-addr</i>   <i>ip-addr</i>   <i>cable-if-src sid</i> ] <i>cable-if-target uschan</i> { <i>ranging-tech</i> }  <b>Example:</b> Router# <b>test cable dcc 0000.394e.4e59</b>	Tests Dynamic Channel Change (DCC) by moving a target cable modem, as specified by MAC address, IP address, or the primary service ID (SID) value. Applies to a cable modem on the source interface to an upstream channel on a target downstream interface using the initialization technique specified.

## Troubleshooting Tips

**Problem** Packets are dropped when a cable modem moves from one channel to another.

**Possible Cause** Effective with Cisco IOS Release 12.2(33)SCF, when the **test cable dcc** command is used to move a cable modem from one channel to another with DCC initialization technique 3:

- If the pre-equalization coefficient is enabled, the cable modem moves and packet drop occurs for 5 seconds.
- If the pre-equalization coefficient is disabled, the cable modem moves and packet drop occurs for less than 1 second.

**Possible Cause** Effective with Cisco IOS Release 12.2(33)SCF, when the **test cable dcc** command is used to move a cable modem from one channel to another with DCC initialization technique 4:

- If the pre-equalization coefficient is enabled, the cable modem moves and packet drop occurs for less than 1 second.
- If the pre-equalization coefficient is disabled, the cable modem moves without any packet drop.

**Solution** No action is required.

## Examples

Use the **show cable load-balance target** command to display the interfaces being used for load balancing, use the **test cable load-balance** command to test whether a cable modem can move between interfaces, and use the **show cable load-balance statistics** command to display the results of the test.

The following example shows how to test whether a specific cable modem responds to both a UCC request and to an upstream channel override to move from one upstream to another in its load balancing group:

```
Router# show cable load-balance target

Target assignments:
Interface          State      Group  Target
Cable1/0/0 (669 MHz) up         1
Cable1/0/0/U0      up         1      Cable1/0/0/U1 [enforce]
Cable1/0/0/U1      up         1
```

```
Router# show cable load-balance statistics

Statistics:

Target interface    State      Transfers
                   Complete  Pending  Retries  Failures
Cable1/0/0 (669 MHz) up         15        0         1         0
Cable1/0/0/U0      up         33        0         1         0
Cable1/0/0/U1      up         22        0         2         0
```

```
Router# test cable load-balance 0000.394e.4e59

Sending UCC request: Cable1/0/0/U0 --> U1
Waiting for test completion .....
Test results:
  UCC Response: 0.0s
  Initial Ranging: 8.5s
  Ranging Complete: failed.
  Modem replied to DOCSIS ping.
Test summary:
  UCC Response: success rate 100% min 0.0s max 0.0s avg 0.0s
  Initial Ranging: success rate 100% min 8.5s max 8.5s avg 8.5s
Testing US Channel Override: Cable1/0/0/U1 --> U0
Waiting for test completion .....
Test results:
  Initial Ranging: 8.5s
  Ranging Complete: failed.
  Modem replied to DOCSIS ping.
Test summary:
  UCC Response: success rate 100% min 0.0s max 0.0s avg 0.0s
  Initial Ranging: success rate 100% min 8.5s max 8.5s avg 8.5s
```

```
Router# show cable load-balance statistics

Statistics:

Target interface    State      Transfers
                   Complete  Pending  Retries  Failures
Cable1/0/0 (669 MHz) up         15        0         1         0
Cable1/0/0/U0      up         34        0         1         0
Cable1/0/0/U1      up         23        0         2         0
```

The following example shows how to test whether a specific modem responds to a UCC request to move from one upstream to another in its load balancing group:

```
Router# show cable load-balance statistics

Statistics:

Target interface      State      Transfers
                   Complete Pending  Retries  Failures
Cable1/0/0 (669 MHz) up          15       0         1         0
Cable1/0/0/U0        up          34       0         1         0
Cable1/0/0/U1        up          23       0         2         0

Router# test cable load-balance 0007.0e01.4129 ucc 1

Sending UCC request: Cable1/0/0/U0 --> U1
Waiting for test completion .....
Test results:
  UCC Response: 0.0s
  Initial Ranging: 10.3s
  Ranging Complete: 11.2s
  Modem replied to DOCSIS ping.
Test summary:
  UCC Response: success rate 100% min 0.0s max 0.0s avg 0.0s
  Initial Ranging: success rate 100% min 10.3s max 10.3s avg 10.3s
  Ranging Complete: success rate 100% min 11.2s max 11.2s avg 11.2s

Router# show cable load-balance statistics

Statistics:

Target interface      State      Transfers
                   Complete Pending  Retries  Failures
Cable1/0/0 (669 MHz) up          15       0         1         0
Cable1/0/0/U0        up          35       0         1         0
Cable1/0/0/U1        up          24       0         2         0
```

The following example shows information when moving a cable modem to a different upstream channel using DCC initialization technique 1. This example moves the cable modem 0012.17ea.f563 from interface c7/1/0 upstream 1 to interface c7/1/1 upstream 0 using DCC initialization technique 1:

```
Router# show cable modem

MAC Address      IP Address      I/F      MAC      Prim RxPwr  Timing  Num BPI
State           Sid (dB)      Offset  CPE Enb  State      Sid (dB)  Offset  CPE Enb
0012.17ea.f563 12.0.0.2      C7/1/0/U1 online    4      0.00  2449    0  N

Router# test cable dcc 0012.17ea.f563 c7/1/1 0 1

Router# show cable modem

MAC Address      IP Address      I/F      MAC      Prim RxPwr  Timing  Num BPI
State           Sid (dB)      Offset  CPE Enb  State      Sid (dB)  Offset  CPE Enb
0012.17ea.f563 12.0.0.2      C7/1/1/U0 online    3      0.00  2451    0  N
```

## Verifying Dynamic Bonding Change for Load Balancing

To verify the DBC parameters for load balancing, use the following commands:

- `show cable load-balance docsis-group`
- `show cable modem verbose`
- `show cable mac-domain cable slot/subslot/interface-index rcc`

The following is a sample output for the **show cable mac-domain cable rcc** command:

```
Router# show cable mac-domain cable 6/0/0 rcc 1

RCC ID          : 1
RCP             : 00 00 00 00 00
Created Via     : Wideband - W11/0/0:0
Receive Channels : 4
  Receive Channel : 1
    Center Frequency : 423000000
    Primary Capability : YES
  Receive Channel : 2
    Center Frequency : 429000000
    Primary Capability : NO
  Receive Channel : 3
    Center Frequency : 435000000
    Primary Capability : NO
  Receive Channel : 4
    Center Frequency : 441000000
    Primary Capability : NO
Receive Modules : 1
  Receive Module : 1
  First Frequency : 423000000
```

## Debugging Load Balancing

To debug load balancing, use the following commands:

- **debug cable load-balance error**
- **debug cable interface**
- **debug cable dcc**
- **debug cable dbc**
- **debug cable mac-address**



### Note

Use these commands only when you debug load balancing.

## Extended Load Balance Debugging

There are different levels of debugging on the load balancing module.

- **debug cable load-balance docsis-lb**  
This command displays debugging messages for load balancing operations on the router.
- **debug cable load-balance docsis-lb lb\_docsis\_group\_id docsis-load-balance-group-number error**  
This command displays all load balancing debug messages under this load balancing group. The DOCSIS load balancing group can be either a general load balancing group or restricted load balancing group.
- **debug cable load-balance docsis-lb lb\_docsis\_group\_id docsis-load-balance-group-number assignment**  
This command displays debug messages for CMs added to assignment list.
- **debug cable load-balance docsis-lb lb\_docsis\_group\_id docsis-load-balance-group-number pending-list**



This command displays debug messages for the CMs in the pending list.

To test DBC for load balancing, use the following command:

```
test cable dbc [ip-address | mac-address ]
```

## Configuration Examples for Load Balancing

This section provides the following configuration examples:

### Example: Load Balancing Group (Static Load Balancing)

This sample configuration shows a number of load balancing groups being configured for static load balancing operations, with at least one example for each method of calculating the load on an interface.

```
cable load-balance group 1 method modem
cable load-balance group 2 method service-flows
cable load-balance group 3 method utilization
cable load-balance group 3 threshold load 20
cable load-balance group 3 interval 30
cable load-balance group 5 method modem
cable load-balance group 5 threshold load 20
cable load-balance group 5 threshold ugs 60
cable load-balance group 5 policy ugs
cable load-balance group 10 method service-flows
cable load-balance group 10 threshold load 10
```

### Example: Load Balancing Group (Passive Load Balancing)

This sample configuration shows a number of load balancing groups being configured for static load balancing operations. The **cable load-balance exclude** command marks a number of cable modems for passive load balancing, while excluding them from static load balancing operations.

```
cable load-balance group 1 method modem
cable load-balance group 2 method service-flows
cable load-balance group 3 method utilization
cable load-balance group 3 threshold load 20
cable load-balance group 3 interval 30
cable load-balance group 5 method modem
cable load-balance group 5 threshold load 20
cable load-balance group 5 threshold ugs 60
cable load-balance group 5 policy ugs
cable load-balance group 10 method service-flows
cable load-balance group 10 threshold load 10
!
cable load-balance exclude oui 00.04.00
cable load-balance exclude oui 00.03.00 static
cable load-balance exclude oui 0C.00.00
cable load-balance exclude modem 0001.0203.0405 static
cable load-balance exclude modem 0C0B.0A09.0807
```

### Example: Load Balancing Group (Dynamic Load Balancing)

This sample configuration shows a number of load balancing groups being configured for dynamic load balancing operations.

```
cable load-balance group 1 method modem
cable load-balance group 1 threshold load 20 enforce 20
```

```

cable load-balance group 2 method service-flows
cable load-balance group 2 threshold load 10 enforce 10
cable load-balance group 3 method utilization
cable load-balance group 3 threshold load 20 enforce 40
cable load-balance group 3 interval 30
cable load-balance group 5 method modem
cable load-balance group 5 threshold load 20 enforce 25
cable load-balance group 5 threshold ugs 60
cable load-balance group 5 policy ugs
cable load-balance group 10 method service-flows
cable load-balance group 10 threshold load 10 enforce 10

```

## Example: Interface Configuration

This sample configuration for a cable interface shows a downstream and its four upstreams being assigned to the same load balancing group:

```

interface Cable3/0
ip address 10.10.71.1 255.255.255.0
ip helper-address 10.10.71.1
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream channel-id 0
cable upstream 0 frequency 8000000
cable upstream 0 channel-width 200000
cable upstream 0 minislots-size 64
cable upstream 0 load-balance group 1
no cable upstream 0 shutdown
cable upstream 1 frequency 30000000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 load-balance group 1
no cable upstream 1 shutdown
cable upstream 2 frequency 22000000
cable upstream 2 power-level 0
cable upstream 2 load-balance group 1
no cable upstream 2 shutdown
cable upstream 3 frequency 15008000
cable upstream 3 power-level 0
cable upstream 3 load-balance group 1
no cable upstream 3 shutdown
cable load-balance group 1

```




---

**Note** Interface configuration is not required for DOCSIS 3.0 static modem count-based load balancing.

---

## Example: Configuration for Upstreams and Downstreams

The following example shows the configuration necessary to create the load balancing groups that are shown in [Figure 4: Example of Load Balancing Groups](#), on page 243, with load balancing group 1 being used for the two downstreams, load balancing group 2 being used for six upstreams, and load balancing group 3 being used for the remaining two upstreams.

```

! Load-balance group for the two downstreams
cable load-balance group 1 threshold load 10 enforce 20
! Load-balance group for the first six upstreams
cable load-balance group 2 threshold load 10 enforce 20
! Load-balance group for the last two upstreams
cable load-balance group 3 threshold load 10 enforce 20
!
interface Cable5/0

```

```
ip address 11.1.0.1 255.255.0.0 secondary
ip address 1.2.3.1 255.255.255.0
cable bundle 1 master
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 453000000
cable downstream channel-id 1
cable upstream 0 frequency 15000000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot 4
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 frequency 18200000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot 4
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 frequency 21400000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislot 4
cable upstream 2 load-balance group 2
no cable upstream 2 shutdown
cable upstream 3 frequency 24600000
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislot 4
cable upstream 3 load-balance group 2
no cable upstream 3 shutdown
cable load-balance group 1
cable dhcp-giaddr policy
interface Cable5/1
cable bundle 1
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 459000000
cable downstream channel-id 2
cable upstream 0 frequency 29000000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot 4
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 frequency 32200000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot 4
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 frequency 29000000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislot 4
cable upstream 2 load-balance group 3
no cable upstream 2 shutdown
cable upstream 3 frequency 32200000
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislot 4
cable upstream 3 load-balance group 3
no cable upstream 3 shutdown
cable load-balance group 1
cable dhcp-giaddr policy
```

For DOCSIS 3.0 static modem count-based load balancing, load balancing need not be configured for downstream/upstream under the MAC domain.

The following example shows how to configure the downstream and upstream for the MAC domain:

```

!
interface Cable6/1/0
  downstream Modular-Cable 6/1/0 rf-channel 0-7
  cable mtc-mode
  no cable packet-cache
  cable bundle 1
  cable upstream max-ports 4
  cable upstream bonding-group 1
    upstream 0
    upstream 1
      attributes 80000000
  cable upstream bonding-group 2
    upstream 2
    upstream 3
      attributes 80000000
  cable upstream 0 connector 0
  cable upstream 0 frequency 31600000
  cable upstream 0 channel-width 1600000 1600000
  cable upstream 0 docsis-mode atdma
  cable upstream 0 minislots-size 4
  cable upstream 0 range-backoff 3 6
  cable upstream 0 modulation-profile 221
  no cable upstream 0 shutdown
  cable upstream 1 connector 0
  cable upstream 1 frequency 33200000
  cable upstream 1 channel-width 1600000 1600000
  cable upstream 1 docsis-mode atdma
  cable upstream 1 minislots-size 4
  cable upstream 1 range-backoff 3 6
  cable upstream 1 modulation-profile 221
  no cable upstream 1 shutdown
  cable upstream 2 connector 0
  cable upstream 2 frequency 34800000
  cable upstream 2 channel-width 1600000 1600000
  cable upstream 2 docsis-mode atdma
  cable upstream 2 minislots-size 4
  cable upstream 2 range-backoff 3 6
  cable upstream 2 modulation-profile 221
  no cable upstream 2 shutdown
  cable upstream 3 connector 0
  cable upstream 3 frequency 36400000
  cable upstream 3 channel-width 1600000 1600000
  cable upstream 3 docsis-mode atdma
  cable upstream 3 minislots-size 4
  cable upstream 3 range-backoff 3 6
  cable upstream 3 modulation-profile 221
  no cable upstream 3 shutdown
end

cable load-balance docsis-group 3
  downstream Modular-Cable 6/1/0 rf-channel 0-7
  upstream Cable6/1/0 0-3
  threshold load 1
  threshold load minimum 1
  init-tech-list 1-4
!

```

## Example: Configuring Dynamic Channel Change for Load Balancing

The following example of the running configuration illustrates DCC for load balancing.

```
Router# show cable load all
```

```
*Nov 11 15:42:18.955: %SYS-5-CONFIG I: Configured from console by conscable load all
Group Interval Method DCC Init Threshold
Technique Minimum Static Enforce Ugs PCMM
1 10 modems 0 5 10% --- --- ---
```

Current load:

Interface	State	Group	Utilization	Reserved	Modems	Flows	Weight
Cable3/0 (0 MHz)	initial	1	0%(0%/0%)	0%	0	0	26

Target assignments:

Interface	State	Group	Target
Cable3/0 (0 MHz)	initial	1	

Statistics:

Target interface	State	Transfers			
		Complete	Pending	Retries	Failures
Cable3/0 (0 MHz)	initial	0	0	0	0

Pending:

Modem	Group	Source interface	Target interface	Retries

The following example of the running configuration illustrates DCC for load balancing.

Router# **show running configuration**

```
Building configuration...
Current configuration : 11889 bytes
!
version 12.3
no service pad
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
!
enable secret 5 $1$tEvV$8xICVVbFm10hx0hAB7D090
enable password lab
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable load-balance group 1 threshold load 75 enforce
cable load-balance group 1 threshold stability 75
cable load-balance group 1 policy ugs
cable load-balance group 1 threshold ugs 75
cable load-balance group 1 policy pcmm
cable load-balance group 1 threshold pcmm 75
no aaa new-model
ip subnet-zero
!
!
ip cef
no ip domain lookup
!
!
interface GigabitEthernet0/1
 ip address 10.14.1.130 255.255.0.0
 duplex auto
 speed auto
 media-type rj45
 no negotiation auto
!
interface GigabitEthernet0/2
```

The following example of the show cable load all command illustrates DCC for load balancing.

Router# **show cable load all**

```
*Nov 11 15:43:39.979: %SYS-5-CONFIG I: Configured fromconf t
Group Interval Method DCC Init Threshold
Technique Minimum Static Enforce Ugs PCMM
1 10 modems 0 5 75% 75% 75% 75%
```

Current load:

Interface	State	Group	Utilization	Reserved	Modems	Flows	Weight
Cable3/0 (0 MHz)	initial	1	0% (0%/0%)	0%	0	0	26

Target assignments:

Interface	State	Group	Target
Cable3/0 (0 MHz)	initial	1	

Statistics:

Target interface	State	Transfers			
		Complete	Pending	Retries	Failures
Cable3/0 (0 MHz)	initial	0	0	0	0

Pending:

Modem	Group	Source interface	Target interface	Retries

The following example illustrates a DCC load balancing group with the default DCC initialization technique. This command configures load balancing group 1:

```
Router(config)# cable load-balance group 1 threshold load 10 enforce
```

This configuration creates a dynamic load balancing group with the following default settings:

```
cable load-balance group 1 method modem
cable load-balance group 1 threshold load 10 enforce
cable load-balance group 1 interval 10
cable load-balance group 1 dcc-init-technique 0
```

The following example changes this DCC load balancing configuration to initialization technique 4:

```
Router# cable load-balance group 1 dcc-init-technique 4
```



#### Note

By default, UGS and PCMM policies are not turned on, so that CMs with active voice calls or PCMM calls participate in load balancing.

## Additional References

For additional information related to Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS, see the following references:

#### Related Documents

Related Topic	Document Title
Cable commands	Cisco IOS CMTS Cable Command Reference, at the following URL: <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>

Related Topic	Document Title
Cisco IOS Release 12.2 Command Reference	Cisco IOS Release 12.2 Configuration Guides and Command References, at the following URL: <a href="http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html">http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html</a>

### Standards and RFCs

Standard/RFC <sup>22</sup>	Title
<a href="#">SP-RFIV1.1-I09-020830</a>	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 1.1
<a href="#">RFC 1163</a>	Border Gateway Protocol
<a href="#">RFC 1164</a>	Application of the Border Gateway Protocol in the Internet
<a href="#">RFC 1483</a>	Multiprotocol Encapsulation over ATM Adaptation Layer 5
<a href="#">RFC 2233</a>	DOCSIS OSSI Objects Support
<a href="#">RFC 2283</a>	Multiprotocol Extensions for BGP-4
<a href="#">RFC 2665</a>	DOCSIS Ethernet MIB Objects Support
<a href="#">RFC 2669</a>	Cable Device MIB

<sup>22</sup> Not all supported standards and RFCs are listed.

### MIBs

MIBs <sup>23</sup>	MIBs Link
<p>New MIBs are introduced in Cisco IOS Release 12.3(17a)BC in support of DCC for load balancing.</p> <ul style="list-style-type: none"> <li>• docsQosDCCReqs OBJECT-TYPE</li> <li>• docsQosDCCRsp OBJECT-TYPE</li> <li>• docsQosDCCAcks OBJECT-TYPE</li> <li>• docsQosDCCs OBJECT-TYPE</li> <li>• docsQosDCCFails OBJECT-TYPE</li> </ul>	<p>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></p>

<sup>23</sup> Not all supported MIBs are listed.

#### Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>

## Feature Information for Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



#### Note

The table below 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 35: Feature Information for Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
Load Balancing on the Cisco CMTS Routers	12.2(15)BC1	<p>This feature was introduced on the Cisco uBR10012 and Cisco uBR7246VXR Universal Broadband Routers.</p> <p>The following commands were introduced:</p> <p><b>cable load-balance exclude , cable load-balance group (global configuration), cable load-balance group (interface) , cable load-balance group interval, cable load-balance group policy ugs, cable load-balance group threshold, cable upstream load-balance group, clear cable load-balance, debug cable load-balance, show cable load-balance, test cable load-balance</b></p>
Load Balancing on the Cisco CMTS Routers	12.3(9a)BC	<p>This feature was introduced on the Cisco uBR7100 Series Universal Broadband Routers.</p>
Dynamic Channel Change (DCC) for Load Balancing on the Cisco CMTS Routers	12.3(17a)BC	<p>This feature was introduced on the Cisco uBR10012 and Cisco uBR7246VXR Universal Broadband Routers.</p> <p>The following commands were introduced or modified:</p> <p><b>cable load-balance group dcc-init-technique , cable load-balance group policy, cable load-balance group threshold, show controllers cable, test cable dcc</b></p>

## Feature Information for Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers

Feature Name	Releases	Feature Information
Enhancements to Downstream Load Balancing on the Cisco CMTS Routers	12.3(17b)BC4	Downstream load balancing is further enhanced to equalize downstream load balancing with upstream load balancing group members.  The following commands were modified:  <b>cable load-balance group policy , show cable load-balance all</b>
Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers	12.2(33)SCA	This feature was integrated into Cisco IOS Release 12.2(33)SCA. Support for the Cisco uBR7225VXR Universal Broadband Router was added.
Load balancing Prohibition Based on Group Policy ID	12.2(33)SCB	Load balancing is further enhanced with the addition of rules and policies.  The following commands were added:  <b>cable load-balance rule, cable load-balance docsis-policy</b>
Upstream Load Balancing for DOCSIS 3.0 Cable Modems in Single Upstream Mode	12.2(33)SCC	The upstream load balancing functionality enables the Cisco uBR10012 router to effectively handle upstream traffic for wideband and narrowband cable modems that are in single upstream mode.
DOCSIS 2.0 multicast enhancement for VDOC.	12.2(33)SCD5	This feature enables the customer to tune a DOCSIS 2.0 cable modem to a specific downstream and supports static multicast video forwarding on it.  The following command was modified:  • <b>cable load-balance rule</b>
Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers	12.2(33)SCE	This feature was integrated into Cisco IOS Release 12.2(33)SCE.

Feature Name	Releases	Feature Information
Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers	12.2(33)SCF	The error handling of channel assignment was modified. The Service Flows method was deprecated.
Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers	12.2(33)SCE4	Support for 256 legacy LBGs was added. The following commands are modified: <ul style="list-style-type: none"> <li>• <b>cable load-balance group</b></li> <li>• <b>cable load-balance group (interface)</b></li> <li>• <b>cable load-balance group interval</b></li> <li>• <b>cable load-balance group policy ugs</b></li> <li>• <b>cable load-balance group threshold</b></li> <li>• <b>cable upstream load-balance group</b></li> <li>• <b>show cable load-balance</b></li> </ul>
Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers	12.2(33)SCF1	DBC was added to the load balancing feature.
Display Status Information of modems in a Load Balancing Group	12.2(33)SCH	The output of the following command is modified to display the status of the modems in a Load Balancing Group: <b>show cable load-balance docsis-group</b>
Default settings for D3.0 and D2.0 GLBG	12.2(33)SCH	Support for additional default configuration settings for DOCSIS 3.0 and DOCSIS 2.0 GLBGs. The following commands are modified: <b>cable load-balance d30-ggrp-default, cable load-balance d20-ggrp-default</b>

Feature Name	Releases	Feature Information
<b>Minimum Threshold under Utilization Method</b>	12.2(33)SCH	Support for configuring minimum threshold for load balancing under Utilization method was added.  The following new command was introduced:  <b>cable load-balance method-utilization min-threshold</b>
Support for Excluding Old Devices	12.2(33)SCH	Support for Exclusion of Old Devices using Address Mask and in Assignment Phase  The following command was modified:  <b>cable load-balance exclude</b>
Primary Channel Load Display for Target RCS	12.2(33)SCH	Support for primary channel load-based RCS selection for DOCSIS 3.0 static load balancing.  The following command was modified:  <b>show cable load-balance docsis-group</b>
Disabling Upstream Load Balancing for DOCSIS 3.0 Modems	12.2(33)SCH1 12.2(33)SCG6	Support for activating load balancing only on downstream channels.  The following commands are modified:  <ul style="list-style-type: none"> <li>• <b>cable load-balance docsis30-enable</b></li> <li>• <b>show cable load-balance</b></li> </ul> For more information, see <a href="#">Disabling Upstream Load Balancing for DOCSIS 3.0 Modems</a> , on page 246.

Feature Name	Releases	Feature Information
D30 Dynamic Load Balancing	12.2(33)SCI	<p>Support for activating the DOCSIS 3.0 dynamic load balancing on the downstream channels.</p> <p>The following commands are introduced or modified:</p> <ul style="list-style-type: none"><li>• <b>cable load-balance docsis30-dynamic-enable</b></li><li>• <b>clear cable load-balance error-statistics</b></li><li>• <b>show cable load-balance docsis-group</b></li><li>• <b>show cable load-balance statistics</b></li></ul> <p>For more information, see <a href="#">DOCSIS 3.0 Dynamic Load Balancing</a>, on page 246.</p>

Feature Information for Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers



## M-CMTS DEPI Control Plane

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**First Published:** November 16, 2009

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The Downstream External PHY Interface (DEPI) control plane feature is based upon Layer Two Tunneling Protocol-Version 3 (L2TPv3) signaling. Downstream External PHY Interface is a communication protocol between the Modular Cable Modem Termination System (M-CMTS) core and the Edge Quadrature Amplitude Modulation (EQAM). It is an IP tunnel between the MAC (M-CMTS Core) and PHY (EQAM) in an M-CMTS system, which contains both a data path for Data-Over-Cable Service Interface Specifications (DOCSIS) frames and a control path for setting up, maintaining, and tearing down data sessions.

The DEPI Latency Measurement (DLM) packet is a special type of data packet used for measuring the network latency between the M-CMTS core and the EQAM. There are two types of DLM packets, ingress DLM packet and egress DLM packet. The ingress DLM measures the latency between the M-CMTS core and the ingress point in the EQAM, and the egress DLM measures the latency between the M-CMTS core and the egress point of the EQAM. The DEPI Control Plane is supported with a direct connection between the SPA and the EQAM, or between the Cisco uBR-MC3GX60V line card and the EQAM.

The Converged Interconnect Network (CIN) is the standard term used for the network between the M-CMTS and the Radio Frequency Gateway (RFGW). This network can be a direct connection or a Layer 2 or Layer 3 network. Since the CIN is a private network, a Virtual Routing and Forwarding (VRF) instance ensures that only valid traffic is routed to it by removing the IP Address of the interface from the global routing table (and from the interface).



**Note**

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Layer 3 CIN support is limited to the case where the primary GigE link of the M-CMTS DEPI port is connected directly to the EQAM and the secondary link is connected through a Layer 3 router. The Layer 3 router between the M-CMTS and the EQAM must support modifying the MAC addresses on its Layer 3 interface.

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VRF for DEPI session is used only on the M-CMTS router. It is recommended to configure VRF for the GigE interfaces, to ensure that the CIN routes are isolated from the default routing table of the CMTS router. When connecting two SPAs to a Layer 2 CIN, the GigE interfaces for these SPAs need to be configured with different VRFs.

PortFast mode-enabled switches have to be used when Gigabit Ethernet link redundancy is configured for the Gigabit Ethernet (GigE) interfaces. For more information on the switches that support PortFast mode, see

[http://www.cisco.com/en/US/tech/tk389/tk621/technologies\\_tech\\_note09186a008009482f.shtml](http://www.cisco.com/en/US/tech/tk389/tk621/technologies_tech_note09186a008009482f.shtml).

### 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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## Prerequisites for M-CMTS DEPI Control Plane

The following are the prerequisites for the M-CMTS DEPI Control Plane feature:

- Support of bidirectional communication using the GigE ports on the Cisco Wideband SPA or Cisco uBR-MC3GX60V line card.
- Support DLM (Ingress).
- Support of EQAM configuration from the M-CMTS router (with EQAM in learn mode). The learn feature is supported only on Cisco RFGW-10.
- Provide connectivity verification, and link failure detection.
- Support Management Information Base (MIB).

The table below shows the hardware compatibility prerequisites for this feature.



#### Note

The hardware components introduced in a given Cisco IOS Release are supported in all subsequent releases unless otherwise specified.



**Table 36: Cable Hardware Compatibility Matrix for M-CMTS DEPI Control Plane**

Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• PRE2</li> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco Wideband SPA</li> </ul> Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>24</sup></li> </ul>

<sup>24</sup> Cisco uBR-MC3GX60V cable interface line card is not compatible with PRE2.

## Restrictions for M-CMTS DEPI Control Plane

- Supports only DOCSIS MPEG-TS (DMPT) mode.
- Modular QoS CLI (MQC) or access control lists (ACL) related features are *not* supported on the DEPI interface.
- The IP address of the DEPI interface must be configured manually. It *cannot* be assigned by the DHCP server.
- VLAN subinterfaces are *not* supported only on the following:
  - Cisco uBR-MC3GX60V line card
  - Cisco Wideband SPA
- Secondary IP address are *not* supported on the DEPI interface.
- Mixed DEPI configuration of manual DEPI and remote DEPI is *not* permitted on the same Cisco uBR-MC3GX60V line card or the Cisco Wideband SPA.
- Configuring or removing an IP address on the controller is *not* permitted when the DEPI interface with an IP address exists in manual DEPI configuration.
- Configuring an IP address on the controller is not permitted in remote DEPI configuration.
- In the DEPI configuration involving L2TP class or tunnel, the direct removal of L2TP class or tunnel is not supported. You need to remove the usage of the L2TP class or tunnel first from the DEPI configuration and then remove the L2TP class or tunnel.

## Information About M-CMTS DEPI Control Plane

To configure the M-CMTS DEPI Control Plane feature, you should understand the following concepts:

## Benefits of M-CMTS DEPI Control Plane

- The DEPI control plane provides the capability to detect failures in a multi-hop network between the M-CMTS router and EQAM.
- The Cisco RFGW-10 (EQAM) learns the configuration from the M-CMTS router via the DEPI control plane.
- The DEPI control plane facilitates an automatic and accurate method to determine delay via the DLM.
- The DEPI control plane allows interoperability.

## DEPI Control Connections

The DEPI control plane configuration is possible only with the following devices that have GigE ports:

- Cisco Wideband SPA—Cisco IOS Release 12.2(33)SCC and later releases
- Cisco uBR-MC3GX60 line card—Cisco IOS Release 12.2(33)SCE and later releases

Configuring a DEPI tunnel on a SPA or Cisco uBR-MC3GX60 line card downstream channel will establish a DEPI control connection (if it does not exist). The M-CMTS router (not the EQAM) initiates the control session connection. At least one DEPI control connection must exist for each SPA or Cisco uBR-MC3GX60 line card that has RF channels configured, to establish a DEPI session with an EQAM. There can be multiple control connections from one SPA or Cisco uBR-MC3GX60 line card to one or more EQAMs. When a DEPI control connection is disconnected, all the associated DEPI data sessions will be disconnected.

When the primary link on the SPA or Cisco uBR-MC3GX60 line card toggles more than five times within 30 seconds, and the secondary link is up, the secondary link is selected for traffic. The link switches back to the primary link during the next primary link transition after 30 seconds or when the secondary link fails. To get the primary link (port 0) or secondary link (port 1) status, use the **show controller gigabitethernet** command.

## DEPI Data Sessions

For both primary and non-primary downstream channels, the DEPI data session is established when the DEPI control connection is active. The Transport Stream Identifier (TSID) must be configured on both the M-CMTS router and EQAM, as it is used to bind the logical wideband channel to a physical QAM of the EQAM. Only the M-CMTS router initiates the DEPI data session creation, not the EQAM.

## DEPI SSO

The Cisco RFGW-10 supervisor redundancy and the route processor (RP) redundancy on the Cisco uBR10012 router in stateful switchover (SSO) mode support both DEPI manual mode and DEPI protocol mode (control plane DEPI). Minimal disruption might occur in manual DEPI in the case of RP redundancy on the Cisco uBR10012 router. The control plane and data sessions are reestablished after the RP switchover in control plane DEPI while the data plane non-stop forwarding continues to send DEPI data traffic to the EQAM.

With supervisor redundancy, the supervisor switchover does not affect the statically configured DEPI connections in DEPI manual mode. Hence, the switchover interruption to DEPI data traffic is in subseconds. In DEPI protocol mode, the DEPI control plane is SSO-unaware as the underlying IOS L2TPv3 protocol is SSO-unaware. Neither the L2TPv3 protocol state nor the DEPI state is check pointed from the active Supervisor to the standby Supervisor. During Supervisor switchover, the DEPI control plane and data plane are recovered as follows with minimal service outage time:

- **DEPI control plane and data plane re-establishment:** At Supervisor switchover, the newly active Supervisor card re-establishes the DEPI control connections and data sessions with its M-CMTS peer. The IDs of re-established sessions fall into the same DEPI session ID range as before.
- **DEPI data plane non-stop forwarding:** While the newly active Supervisor is re-establishing the DEPI connections and data sessions, the Cisco RFGW-10 receives and processes DEPI data traffic that the M-CMTS router continues to forward through the existing data sessions. This non-stop forwarding function minimizes the service outage time for a couple of seconds. The existing data sessions are removed after the new sessions are established.

For more information on Supervisor Redundancy, see [1:1 Supervisor Card Redundancy](#) feature guide.

## N+1 DEPI Redundancy

The N+1 DEPI redundancy feature enables the M-CMTS router to protect downstream data path in the event of the Cisco uBR-MC3GX60V line card failure or switchover, using a secondary DEPI session configured on the protect line card. Beginning with Cisco IOS Release 12.2(33)SCE1, the N+1 redundancy feature including DEPI redundancy is supported on the Cisco uBR-MC3GX60V cable interface line card.

This feature allows you to configure a secondary DEPI session on the protect card using the **protect-tunnel** command in DEPI tunnel configuration mode. In this mode, the protect line card has a fully operational secondary DEPI control connection and sessions for the QAM channels on the working line card. The primary DEPI control connection and session is established on the GigE ports on the working line card. These primary and secondary DEPI sessions are paired using the common TSID, which uniquely identifies the target QAM channel.

The N+1 DEPI redundancy feature is supported only on the Cisco uBR-MC3GX60 line card. This feature is not supported on the Cisco Wideband SPA.

The N+1 DEPI redundancy feature requires an EQAM that supports data path redundancy based on CableLabs Downstream External PHY Interface Specification (CM-SP-DEPI-I08-100611).

The Cisco uBR-MC3GX60V line card supports up to six DEPI tunnels per GigE port and a separate DEPI session per downstream channel. Each DEPI session is associated with only one DEPI tunnel and multiple DEPI sessions can be associated with a single DEPI tunnel.

In N+1 DEPI redundancy, the protect line card initiates DEPI control sessions on each QAM channel at bootup. When the M-CMTS router detects a line card failure, the protect line card enables all the sessions that were backing up the sessions of the failed line card.

The network connectivity must be set up to ensure that the Cisco RF Gateway is reachable through the protect Cisco uBR-MC3GX60V line card.

### DEPI CIN Failover

The **depi cin-failover** command is introduced to enable CIN failure triggered line card switchover when DEPI control plane is used and N+1 is configured.

When the CPU utilization is high, DEPI CIN failover may get rejected. Starting Cisco IOS Release 12.2(33)SCF4 and later releases, **cpu-threshold** values can be configured using the **depi cin-faiover cpu-threshold** command. For more information, see [Cisco IOS CMTS Cable Command Reference](#).

### Downstream Failure Detection

The control plane DEPI detects the downstream device or connection failure on the Cisco uBR-MC3GX60V line card using the “hello” keepalive packets. It triggers the line card switchover if the protect line card DEPI sessions are the superset of the working line card. You can configure the interval used to exchange the “hello” keepalive packets in a Layer 2 control channel using the **hello** command in L2TP class configuration mode.

## GigE Port-level Redundancy

The Cisco uBR-MC3GX60V line card also supports GigE port-level redundancy. The port-level redundancy is configured by default on the Cisco Wideband SPA and Cisco uBR-MC3GX60V line card. You do not have to manually configure port-level redundancy on the M-CMTS router.

## Difference Between Manual DEPI and Control Plane DEPI Configuration

The manual DEPI configuration also supports N+1 DEPI redundancy and port-level redundancy on the Cisco uBR-MC3GX60V line card.

The following are the differences between the manual DEPI and control plane DEPI configuration:

- In manual DEPI configuration, you do not have to configure the protect tunnel. The working card configuration is automatically applied to the protect card through IPC messages. In DEPI control plane redundancy, you must configure the protect tunnel on both the M-CMTS router and the EQAM.
- For manual DEPI configuration, the GigE ports on the Cisco uBR-MC3GX60V line card must be in active-passive mode.
- The DEPI connection between the M-CMTS router and the EQAM is static in manual DEPI configuration. Whereas, the data sessions are established dynamically in the DEPI control plane configuration.

## DEPI EQAM Statistics

The DEPI EQAM statistics feature enables EQAM to send QAM channel statistics to the M-CMTS router for all data sessions in every DEPI tunnel. Support for this feature was introduced in Cisco IOS Release 12.2(33)SCE. The DEPI EQAM statistics feature is configured by default on the M-CMTS router. To disable this configuration use the **no** form of the **depi eqam-stats** command in global configuration mode.



### Note

Cisco RF Gateway 10 sends EQAM statistics to the M-CMTS router. No other EQAM supports the EQAM statistics feature.

To verify EQAM statistics, use the **show depi session** command with the **verbose** keyword in privileged EXEC mode.

# How to Configure M-CMTS DEPI Control Plane

For a quick tour on how to configure DEPI on the Cisco M-CMTS router and the EQAM device, view the following videos available on Cisco.com:

- [Configuring the Downstream External PHY Interface Feature on the Cisco M-CMTS and EQAM Device \[Part 1 of 2\]](#)
- [Configuring the Downstream External PHY Interface Feature on the Cisco M-CMTS and EQAM Device \[Part 2 of 2\]](#)

This section contains the following procedures:

## Configuring DEPI Control Plane on the M-CMTS Router

This section describes how to configure DEPI control plane on the M-CMTS router.



### Note

The DEPI control plane configuration steps for the Cisco Wideband SPA and Cisco uBR-MC3GX60 line card are the same. [Step 17, on page 289](#) is applicable only for the Cisco Wideband SPA and is not required for Cisco uBR-MC3GX60 line card.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  • Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>l2tp-class l2tp-class-name</b>  <b>Example:</b> Router(config)# <b>l2tp-class class1</b>	Creates an L2TP class template. The template must be configured but the optional settings are not mandatory.  <b>Note</b> If all the control channels have the same parameters then a separate template must be created for the M-CMTS.
Step 4	<b>hello seconds</b>  <b>Example:</b> Router(config-l2tp-class)# <b>hello 5</b>	(Optional) Configures the interval used to exchange the “hello” keepalive packets in a Layer 2 control channel.  • <i>seconds</i> —Number of seconds that a router at one end of a Layer 2 control channel waits between sending the “hello” keepalive packets to its peer router. The valid range is from 0 to 1000 seconds. The default value is 60 seconds.

	Command or Action	Purpose
		<p><b>Note</b> If you want the DEPI tunnel to be less sensitive to network disturbances, increase the interval for the “hello” keepalive packets. We recommend that you specify 5 seconds on the M-CMTS router.</p>
<b>Step 5</b>	<p><b>retransmit retries</b> <i>max-retransmissions</i></p> <p><b>Example:</b> Router(config-l2tp-class)# <b>retransmit retries 5</b></p>	<p>(Optional) Configures the retransmission retry settings of the control packets.</p> <ul style="list-style-type: none"> <li>• <i>max-retransmissions</i>—Number of retransmission cycles that occur before determining that the peer provider edge (PE) router does not respond. The valid range is from 5 to 1000. The default value is 15. Specify a smaller value for faster failure detection.</li> </ul> <p><b>Note</b> We recommend that you specify 5 on the M-CMTS router.</p>
<b>Step 6</b>	<p><b>retransmit timeout</b> {<b>max</b>   <b>min</b>} <i>retransmit-timeout</i></p> <p><b>Example:</b> Router(config-l2tp-class)# <b>retransmit timeout max 1</b></p>	<p>Specifies maximum and minimum retransmission intervals (in seconds) for resending the control packets.</p> <ul style="list-style-type: none"> <li>• {<b>max</b>   <b>min</b>} <i>retransmit-timeout</i>—The valid range is from 1 to 8. The default maximum interval is 8; the default minimum interval is 1.</li> </ul> <p><b>Note</b> We recommend that you specify 1 second on the M-CMTS router.</p>
<b>Step 7</b>	<p><b>exit</b></p> <p><b>Example:</b> Router(config-l2tp-class)# <b>exit</b></p>	<p>Exits the L2TP class configuration mode.</p>
<b>Step 8</b>	<p><b>depi-class</b> <i>depi-class-name</i></p> <p><b>Example:</b> Router(config)# <b>depi-class SPA0</b></p>	<p>Creates a DEPI class template.</p>
<b>Step 9</b>	<p><b>exit</b></p> <p><b>Example:</b> Router(config-depi-class)# <b>exit</b></p>	<p>Exits the DEPI class configuration mode.</p>
<b>Step 10</b>	<p><b>depi-tunnel</b> <i>working-depi-tunnel-name</i></p> <p><b>Example:</b> Router(config)# <b>depi-tunnel SPA0</b></p>	<p>Creates a DEPI tunnel template.</p>
<b>Step 11</b>	<p><b>l2tp-class</b> <i>l2tp-class-name</i></p> <p><b>Example:</b> Router(config-depi-tunnel)# <b>l2tp-class class1</b></p>	<p>Specifies the L2TP control channel parameters to be inherited.</p>
<b>Step 12</b>	<p><b>depi-class</b> <i>depi-class-name</i></p> <p><b>Example:</b> Router(config-depi-tunnel)# <b>depi-class SPA0</b></p>	<p>Specifies the DEPI control channel parameters to be inherited.</p>

	Command or Action	Purpose
Step 13	<b>dest-ip</b> <i>dest-ip-address</i>  <b>Example:</b> Router(config-depi-tunnel) # <b>dest-ip</b> 192.0.2.103	Specifies the destination IP address of the termination point for the DEPI tunnel. When configuring on the M-CMTS router, destination IP address is the IP address of the EQAM. When configuring on the EQAM, this is the IP address of the M-CMTS router.
Step 14	<b>tos</b> <i>value</i>  <b>Example:</b> Router(config-depi-tunnel) # <b>tos</b> 100	(Optional) Sets the value of the ToS byte for IP packets in the L2TPv3 data session. The valid range is from 0 to 255. The default value is 0.
Step 15	<b>exit</b>  <b>Example:</b> Router(config-depi-tunnel) # <b>exit</b>	Exits the data session configuration mode.
Step 16	<b>controller modular-cable</b> { <i>slot/bay/port</i>   <i>slot/subslot/controller</i> }  <b>Example:</b> Router(config) # <b>controller</b> <b>modular-cable</b> 1/0/0	Specifies the modular cable controller interface for the SPA or the line card. <ul style="list-style-type: none"> <li>• <i>slot</i>—SPA interface processor (SIP) or the line card slot. Slots 1 and 3 are used for SIPs. The valid range is from 5 to 8 for the line card slot.</li> <li>• <i>bay</i>—The bay in a SIP where a SPA is located. Valid values are 0 (upper bay) and 1 (lower bay).</li> <li>• <i>port</i>—Specifies the interface number on the SPA.</li> <li>• <i>subslot</i>—Cable interface line card subslot. Valid values are 0 and 1.</li> <li>• <i>controller</i>—Controller index for the modular cable. The valid range is from 0 to 2.</li> </ul>
Step 17	<b>modular-host subslot</b> <i>slot/subslot</i>  <b>Example:</b> Router(config-controller) # <b>modular-host</b> <b>subslot</b> 6/0	Specifies the modular host line card that is used for DOCSIS 3.0 downstream or downstream channel bonding operations.
Step 18	<b>rf-channel</b> <i>rf-port</i> <b>cable downstream</b> <b>channel-id</b> <i>channel-id</i>  <b>Example:</b> Router(config-controller) # <b>rf-channel</b> 0 <b>cable downstream</b> <b>channel-id</b> 24	Assigns a downstream channel ID to an RF channel. <ul style="list-style-type: none"> <li>• <i>rf-port</i>—RF channel physical port on the SPA or the line card. Valid values for the RF port depend on the configuration of the annex modulation.</li> <li>• <i>channel-id</i>—Unique channel ID. The valid range is from 1 to 255.</li> </ul>
Step 19	<b>rf-channel</b> <i>rf-port</i> <b>frequency</b> [ <i>freq</i>   <b>none</b> ] [ <b>annex</b> {A   B} <b>modulation</b> {64   256} [ <b>interleave-depth</b> {8   12   16   32   64   128}]]	Configures the frequency of an RF channel in modular cable controller configuration mode. <ul style="list-style-type: none"> <li>• <i>rf-port</i>—RF channel physical port on the SPA or the line card. Valid values for the RF port depend on the configuration of the annex modulation.</li> </ul>

	Command or Action	Purpose
	<p><b>Example:</b></p> <pre>Router(config-controller)# rf-channel 0 freq 555000000 annex B mod 64qam inter 32</pre>	<ul style="list-style-type: none"> <li>• <i>freq</i>—Center frequency of the RF channel. The valid range for each RF channel is different based on the Annex type.</li> <li>• <b>none</b>—Removes the specified frequency if the RF channel is shut down. This can be configured on the modular cable controller of the N+1 protect line card as no frequency is required to be configured on that controller.</li> <li>• <b>annex {A   B}</b>—Indicates the MPEG framing format for each RF channel. <ul style="list-style-type: none"> <li>◦ <b>A</b>—Annex A. Indicates that the downstream is compatible with the European MPEG framing format specified in ITU-TJ.83 Annex A.</li> <li>◦ <b>B</b>—Annex B. Indicates that the downstream is compatible with the North American MPEG framing format specified in ITU-TJ.83 Annex B.</li> </ul> </li> <li>• <b>modulation {64   256}</b>—Indicates the modulation rate (64 or 256 QAM) for each RF channel.</li> <li>• <b>interleave-depth</b>—Indicates the downstream interleave depth. For annex A, the interleave value is 12. For annex B, valid values are 8, 16, 32, 64, and 128.</li> </ul>
<b>Step 20</b>	<p><b>rf-channel</b> <i>rf-channel</i> <b>depi-tunnel</b> <i>depi-tunnel-name</i> <b>tsid</b> <i>id</i></p> <p><b>Example:</b></p> <pre>Router(config-controller)# rf-channel 0 depi-tunnel SPA0 tsid 100</pre>	<p>Binds the DEPI tunnel, which inherits the configuration of the specified L2TP class and DEPI class, to an RF channel under a modular controller.</p> <ul style="list-style-type: none"> <li>• <i>rf-channel</i>—RF channel physical port on the SPA or the line card.</li> <li>• <i>depi-tunnel-name</i>—Name of the DEPI tunnel.</li> <li>• <b>tsid</b> <i>id</i>—Specifies the Transport Stream Identifier (TSID) value on the QAM subinterface. The TSID is used to associate the logical RF channel of the SPA or the line card to a physical QAM on RF Gateway 10.</li> </ul>
<b>Step 21</b>	<p><b>rf-channel</b> <i>rf-port</i> <b>rf-power</b> <i>power-level</i></p> <p><b>Example:</b></p> <pre>Router(config-controller)# rf-channel 0 rf-power 46</pre>	<p>Configures the RF power of an RF channel on the SPA or the line card.</p> <ul style="list-style-type: none"> <li>• <i>rf-port</i>—RF channel physical port on the SPA or the line card. Valid values for the RF port depend on the configuration of the annex modulation.</li> <li>• <i>power-level</i>—Desired RF output power level in dBmV. The valid range is dependent on the cable interface. The format is XY.Z. By default, .Z is added as .0.</li> </ul>
<b>Step 22</b>	<b>no rf-channel</b> <i>rf-port</i> <b>rf-shutdown</b>	Enables the RF channel.



	Command or Action	Purpose
	<b>Example:</b> Router(config-controller)# <b>no rf-channel 0 rf-shutdown</b>	<ul style="list-style-type: none"> <li>• <i>rf-port</i>—RF channel physical port on the SPA or the line card. Valid values for the RF port depend on the configuration of the annex modulation.</li> </ul>
<b>Step 23</b>	<b>exit</b>  <b>Example:</b> Router(config-controller)# <b>exit</b>	Exits the controller configuration mode.
<b>Step 24</b>	<b>interface gigabitethernet slot/subslot/port</b>  <b>Example:</b> Router(config)# <b>interface gigabitethernet 1/0/0</b>	Specifies the location of the Gigabit Ethernet interface on the M-CMTS router. <ul style="list-style-type: none"> <li>• <i>slot</i>—SPA interface processor (SIP) or the line card slot. Slots 1 and 3 are used for SIPs. The valid range is from 5 to 8 for the line card slot.</li> <li>• <i>subslot</i>—Specifies the secondary slot of the SIP where the SPA is installed or the <i>cable interface line card subslot</i>. Valid values are 0 and 1.</li> <li>• <i>port</i>—Specifies the interface number.</li> </ul>
<b>Step 25</b>	<b>ip-address ip-address mask-ip-address</b>  <b>Example:</b> Router(config-if)# <b>ip-address 192.0.2.155 255.255.255.0</b>	Sets the IP address for the SPA or the line card field-programmable gate array (FPGA). This address is used as the source IP address for packets that the router transmits to the EQAM device.
<b>Step 26</b>	<b>negotiation {forced   auto}</b>  <b>Example:</b> Router(config-if)# <b>negotiation auto</b>	Enables negotiation on the SPA or the line card interface.
<b>Step 27</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Returns to privileged EXEC mode.

## Configuring DEPI Control Plane on Cisco RFGW-10

This section describes how to configure DEPI control plane on Cisco RFGW-10 in learn mode. Learn mode is the recommended mode of operation if you use Cisco RFGW-10 with the Cisco uBR10012 router.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>l2tp-class l2tp-class-name</b>  <b>Example:</b> Router(config)# <b>l2tp-class class1</b>	Creates an L2TP class template. The template must be configured but the optional settings are not mandatory. <p><b>Note</b> If all the control channels have the same parameters then one template must be created for the Cisco RFGW-10.</p>
Step 4	<b>hello seconds</b>  <b>Example:</b> Router(config-l2tp-class)# <b>hello 15</b>	(Optional) Configures the interval used to exchange the “hello” keepalive packets in a Layer 2 control channel. <ul style="list-style-type: none"> <li>• <i>seconds</i>—Number of seconds that a router at one end of a Layer 2 control channel waits between sending the “hello” keepalive packets to its peer router. The valid range is from 0 to 1000 seconds. The default value is 60 seconds.</li> </ul> <p><b>Note</b> The “hello” value on the Cisco RFGW-10 can be different from what is configured on the M-CMTS router. We recommend that you specify 15 seconds on the Cisco RFGW-10. A value of less than 10 seconds might subject the system to session flaps and may trigger line card switchover, if the M-CMTS router experiences loss of network connectivity.</p>
Step 5	<b>retransmit retries max-retransmissions</b>  <b>Example:</b> Router(config-l2tp-class)# <b>retransmit retries 5</b>	(Optional) Configures the retransmission retry settings of the control packets. <ul style="list-style-type: none"> <li>• <i>max-retransmissions</i>—Number of retransmission cycles that occur before determining that the peer provider edge (PE) router does not respond. The valid range is from 5 to 1000. The default value is 15. Specify a smaller value for faster failure detection.</li> </ul> <p><b>Note</b> We recommend that you specify 5 on the Cisco RFGW-10.</p>
Step 6	<b>retransmit timeout [max   min]</b> <i>retransmit-timeout</i>  <b>Example:</b> Router(config-l2tp-class)# <b>retransmit timeout max 1</b>	Specifies maximum and minimum retransmission intervals (in seconds) for resending the control packets. <ul style="list-style-type: none"> <li>• <i>{max   min} retransmit-timeout</i>—The valid range is from 1 to 8. The default maximum interval is 8; the default minimum interval is 1.</li> </ul> <p><b>Note</b> We recommend that you specify 1 second on the Cisco RFGW-10.</p>

	Command or Action	Purpose
<b>Step 7</b>	<b>exit</b>  <b>Example:</b> Router(config-l2tp-class)# <b>exit</b>	Exits the L2TP class configuration mode.
<b>Step 8</b>	<b>depi-class <i>depi-class-name</i></b>  <b>Example:</b> Router(config)# <b>depi-class SPA0</b>	Creates a DEPI class template.
<b>Step 9</b>	<b>exit</b>  <b>Example:</b> Router(config-depi-class)# <b>exit</b>	Exits the DEPI class configuration mode.
<b>Step 10</b>	<b>depi-tunnel <i>working-depi-tunnel-name</i></b>  <b>Example:</b> Router(config)# <b>depi-tunnel SPA0</b>	Creates a DEPI tunnel template.
<b>Step 11</b>	<b>l2tp-class <i>l2tp-class-name</i></b>  <b>Example:</b> Router(config-depi-tunnel)# <b>l2tp-class class1</b>	Specifies the L2TP control channel parameters to be inherited.
<b>Step 12</b>	<b>depi-class <i>depi-class-name</i></b>  <b>Example:</b> Router(config-depi-tunnel)# <b>depi-class SPA0</b>	Specifies the DEPI control channel parameters to be inherited.
<b>Step 13</b>	<b>dest-ip <i>dest-ip-address</i></b>  <b>Example:</b> Router(config-depi-tunnel)# <b>dest-ip 192.0.2.155</b>	Specifies the destination IP address of the M-CMTS Gigabit Ethernet port.
<b>Step 14</b>	<b>exit</b>  <b>Example:</b> Router(config-depi-tunnel)# <b>exit</b>	Exits the DEPI configuration mode.
<b>Step 15</b>	<b>interface {qam   qam-red} slot/port[.channel]</b>  <b>Example:</b> Router(config)# <b>interface qam 6/4.1</b>	Specifies a QAM interface or redundancy-configured (QAM-red) interface. <ul style="list-style-type: none"> <li>• <i>slot</i>—The QAM or QAM-red slot for the line card on Cisco RF Gateway 10. If line card redundancy is configured on the QAM, the interface is QAM-red. The valid range is from 3 to 12.</li> <li>• <i>port</i>—Interface number on the line card. The valid range is from 1 to 12.</li> <li>• <i>.channel</i>—(Optional) Specifies the channel on the port. The valid range is from 1 to 4.</li> </ul>

	Command or Action	Purpose
<b>Step 16</b>	<p><b>cable mode</b> {depi   video} {local   remote} [learn]</p> <p><b>Example:</b>  Router(config-subif) # <b>cable mode depi remote learn</b></p>	<p>Sets the mode of the QAM channel.</p> <ul style="list-style-type: none"> <li>• <b>depi</b>—Specifies the DEPI mode of the QAM channel.</li> <li>• <b>video</b>—Specifies the video mode of the QAM channel.</li> <li>• <b>local</b>—Specifies that the QAM channel is manually configured.</li> <li>• <b>remote</b>—Specifies that the QAM channel is remotely configured.</li> <li>• <b>learn</b>—(Optional) Specifies that the QAM channel is in “learn” mode and the Cisco RFGW-10 can learn the channel configuration from the M-CMTS router. All QAM channels on a single port must be in “learn” mode for this configuration to work.</li> </ul> <p><b>Note</b> When the QAM is in “learn” mode, there is no need to configure all the QAM channel parameters. <a href="#">Step 17, on page 294</a> to <a href="#">Step 24, on page 295</a> should not be executed as the parameters in these steps cannot be changed when the Cisco RFGW-10 is in “learn” mode.</p>
<b>Step 17</b>	<p><b>cable downstream stacking</b> <i>stacking</i></p> <p><b>Example:</b>  Router(config) # <b>cable downstream stacking 4</b></p>	<p>Configures the stacking level. Stacking level can be 1, 2, or, 4.</p> <ul style="list-style-type: none"> <li>• QAM channel 1 is enabled on the specified RF port for stacking level 1.</li> <li>• QAM channels 1, and 2 are enabled on the specified RF port for stacking level 2.</li> <li>• QAM channels 1, 2, 3, and 4 are enabled on the specified RF port for stacking level 4.</li> </ul>
<b>Step 18</b>	<p><b>no cable downstream rf-shutdown</b></p> <p><b>Example:</b>  Router(config-if) # <b>no cable downstream rf-shutdown</b></p>	<p>Enables the integrated upconverter.</p>
<b>Step 19</b>	<p><b>cable downstream annex</b> {A   B}</p> <p><b>Example:</b>  Router(config-if) # <b>cable downstream Annex A</b></p>	<p>Configures the MPEG framing format for a downstream port.</p> <ul style="list-style-type: none"> <li>• <b>annex {A   B}</b>—Indicates the MPEG framing format for each RF channel. <ul style="list-style-type: none"> <li>◦ <b>A</b>—Annex A. Indicates that the downstream is compatible with the European MPEG framing format specified in ITU-TJ.83 Annex A.</li> <li>◦ <b>B</b>—Annex B. Indicates that the downstream is compatible with the North American MPEG framing format specified in ITU-TJ.83 Annex B.</li> </ul> </li> </ul> <p>The default is Annex B for all Cisco cable interface line cards.</p>

	Command or Action	Purpose
Step 20	<p><b>cable downstream frequency</b> <i>frequency</i></p> <p><b>Example:</b>  Router(config-if)# <b>cable downstream frequency</b> 52000000</p>	<p>Configures the downstream center frequency for the cable interface line card.</p> <ul style="list-style-type: none"> <li><i>frequency</i>—QAM channel frequency in Hz.</li> </ul>
Step 21	<p><b>cable downstream interleave-level</b> {1   2}</p> <p><b>Example:</b>  Router(config-subif)# <b>cable downstream interleave-level</b> 1</p>	<p>Configures the interleave level. The default interleave level is 2.</p> <p><b>Note</b> This command is for Annex B only.</p>
Step 22	<p><b>cable downstream interleave-depth</b> <i>depth</i></p> <p><b>Example:</b>  Router(config-subif)# <b>cable downstream interleave-depth</b> 5</p>	<p>Configures the interleave depth.</p> <p><b>Note</b> This command is for Annex B only.</p> <p>As you can configure various combinations of the I/J values for Annex B, the input for this command is the fee-code that is derived from the I/J values. The default I/J values are 32/4.</p>
Step 23	<p><b>cable downstream modulation</b> {64qam   256qam}</p> <p><b>Example:</b>  Router(config-subif)# <b>cable downstream modulation</b> 256qam</p>	<p>Configures the modulation format for a downstream port on a cable interface line card.</p> <p>If you change the modulation format, the interface is shut down and all the cable modems are disconnected. The default modulation is set to 64 QAM on all cable interface cards.</p>
Step 24	<p><b>cable downstream rf-power</b> <i>power</i></p> <p><b>Example:</b>  Router(config-subif)# <b>cable downstream rf-power</b> 50</p>	<p>Configures the RF power output level on an integrated upconverter.</p> <ul style="list-style-type: none"> <li><i>power</i>—RF power value in tenth of a dBmV. To reset the RF output power level to its default value, use the no form of this command.</li> </ul>
Step 25	<p><b>cable downstream tsid</b> <i>id</i></p> <p><b>Example:</b>  Router(config-subif)# <b>cable downstream tsid</b> 100</p>	<p>Configures the Transport Stream Identifier value on the QAM subinterface. The valid range is from 0 to 65535.</p>
Step 26	<p><b>depi depi-tunnel</b> <i>working-depi-tunnel-name</i></p> <p><b>Example:</b>  Router(config-subif)# <b>depi depi-tunnel working1</b></p>	<p>Binds the DEPI tunnel to the QAM.</p>
Step 27	<p><b>exit</b></p> <p><b>Example:</b>  Router(config-subif)# <b>exit</b></p>	<p>Exits the subinterface configuration mode.</p> <p>The Cisco RFGW-10 is now ready to accept incoming control connection requests from the M-CMTS router but cannot initiate a control connection with the router.</p>

	Command or Action	Purpose
Step 28	<b>interface gigabitethernet</b> <i>slot/port</i>  <b>Example:</b> Router(config)# <b>interface</b> <b>gigabitethernet 6/13</b>	Specifies the Gigabit Ethernet interface.
Step 29	<b>no switchport</b>  <b>Example:</b> Router(config-if)# <b>no switchport</b>	Disables switching mode.
Step 30	<b>ip-address</b> <i>ip-address mask-ip-address</i>  <b>Example:</b> Router(config-if)# <b>ip-address</b> <b>192.0.2.103 255.255.255.0</b>	Sets the IP address for the SPA or the line card field-programmable gate array (FPGA). This address is used as the source IP address of Cisco RFGW-10.
Step 31	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Returns to privileged EXEC mode.

## Examples

The following is an example for configuring DEPI on Cisco RFGW-10, which is in **learn** mode.

```
Router> enable
Router# configure terminal
Router(config)# l2tp-class class1
Router(config-l2tp-class)# hello 15
Router(config-l2tp-class)# retransmit retries 5
Router(config-l2tp-class)# retransmit timeout max 1
Router(config-l2tp-class)# exit
Router(config)# depi-class 0
Router(config-depi-class)# exit
Router(config)# depi-tunnel 0
Router(config-depi-tunnel)# l2tp-class class1
Router(config-depi-tunnel)# depi-class 0
Router(config-depi-tunnel)# dest-ip 192.0.2.155
Router(config-depi-tunnel)# exit
Router(config)# interface qam 6/4.1
Router(config-subif)# cable mode depi remote learn
Router(config-subif)# cable downstream tsid 100
Router(config-subif)# depi depi-tunnel working1
Router(config-subif)# exit
Router(config)# interface gigabitethernet 6/13
Router(config-if)# no switchport
Router(config-if)# ip-address 192.0.2.103 255.255.255.0
Router(config-if)# end
```

The following is an example for configuring DEPI on Cisco RFGW-10, which is not in “learn” mode.

```
Router> enable
Router# configure terminal
Router(config)# l2tp-class class1
Router(config-l2tp-class)# exit
Router(config)# depi-class 0
```

```

Router(config-depi-class)# exit
Router(config)# depi-tunnel 0
Router(config-depi-tunnel)# l2tp-class class1
Router(config-depi-tunnel)# depi-class 0
Router(config-depi-tunnel)# dest-ip 192.0.2.155
Router(config-depi-tunnel)# exit
Router(config)# interface qam 6/4.1
Router(config-subif)# cable mode depi remote learn
Router(config-subif)# cable downstream stacking 4
Router(config-subif)# no cable downstream rf-shutdown
Router(config-subif)# cable downstream Annex B
Router(config-subif)# cable downstream frequency 52000000
Router(config-subif)# cable downstream tsid 100
Router(config-subif)# cable downstream interleave-level 2
Router(config-subif)# cable downstream interleave-depth 5
Router(config-subif)# cable downstream modulation 256qam
Router(config-subif)# cable downstream rf-power 50
Router(config-subif)# depi depi-tunnel 0
Router(config-subif)# end

```

## Configuring N+1 DEPI Redundancy on the M-CMTS Router and Cisco RFGW-10

This configuration is optional. This section describes how to configure N+1 DEPI redundancy on the M-CMTS router and Cisco RFGW-10.



### Note

The N+1 DEPI redundancy feature is supported only on the Cisco uBR-MC3GX60V line card. This feature is not supported on the Cisco Wideband SPA.

The procedure is the same for configuring N+1 DEPI redundancy on the M-CMTS router and Cisco RFGW-10. You must configure N+1 DEPI redundancy on the M-CMTS router before configuring it on the Cisco RFGW-10.

The working tunnel and the protect tunnel are configured using the same **depi-tunnel** command. The protect tunnel inherits L2TP class and DEPI class parameters from the working tunnel. When you configure the protect tunnel and specify the destination IP address for the protect tunnel, the protect tunnel inherits the QAM channel parameters specified for the working tunnel.

### Before You Begin

- You must configure N+1 line card redundancy for the Cisco uBR-MC3GX60V line card before configuring N+1 DEPI redundancy.
- The tunnel names for the working and protect tunnels must be distinct and the protect tunnel must be associated with the corresponding working tunnel.
- The working tunnel must be configured on the M-CMTS router before configuring the protect tunnel.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>

	Command or Action	Purpose
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>depi-tunnel protect-depi-tunnel-name</b>  <b>Example:</b> Router(config)# <b>depi-tunnel protect1</b>	Specifies a protect tunnel name and enters DEPI tunnel configuration mode.
Step 4	<b>dest-ip dest-ip-address</b>  <b>Example:</b> Router(config-depi-tunnel)# <b>dest-ip 192.0.2.103</b>	Specifies the destination IP address of the termination point for the protect tunnel.  <b>Note</b> When configuring on the M-CMTS router, destination IP address is the IP address of the EQAM. When configuring on the EQAM, this is the IP address of the M-CMTS router.
Step 5	<b>exit</b>  <b>Example:</b> Router(config-depi-tunnel)# <b>exit</b>	Exits the DEPI tunnel configuration mode.
Step 6	<b>depi-tunnel working-depi-tunnel-name</b>  <b>Example:</b> Router(config)# <b>depi-tunnel working1</b>	Specifies a working tunnel name that is already configured with QAM channel parameters, and enters DEPI tunnel configuration mode.
Step 7	<b>protect-tunnel protect-depi-tunnel-name</b>  <b>Example:</b> Router(config-depi-tunnel)# <b>protect-tunnel protect1</b>	Associates the protect tunnel to the corresponding working tunnel.  <b>Note</b> Use the same protect tunnel that you created using the <b>depi-tunnel</b> command to associate the protect tunnel to the corresponding working tunnel.
Step 8	<b>end</b>  <b>Example:</b> Router(config-depi-tunnel)# <b>end</b>	Exits DEPI tunnel configuration mode and returns to privileged EXEC mode.

## Configuring DLM on the M-CMTS Router

This section describes how to configure DLM on the M-CMTS router.

### DETAILED STEPS

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



	Command or Action	Purpose
	<p><b>Example:</b> Router&gt; <b>enable</b></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> Router# <b>configure terminal</b></p>	Enters global configuration mode.
<b>Step 3</b>	<p><b>controller modular-cable</b> {<i>slot/bay/port</i>   <i>slot/subslot/controller</i>}</p> <p><b>Example:</b> Router(config)# <b>controller modular-cable</b> 1/0/0</p>	<p>Specifies the modular cable controller interface for the SPA or the line card.</p> <ul style="list-style-type: none"> <li>• <i>slot</i>—SPA interface processor (SIP) or the line card slot. Slots 1 and 3 are used for SIPs. The valid range is from 5 to 8 for the line card slot.</li> <li>• <i>bay</i>—The bay in a SIP where a SPA is located. Valid values are 0 (upper bay) and 1 (lower bay).</li> <li>• <i>port</i>—Specifies the interface number on the SPA.</li> <li>• <i>subslot</i>—Cable interface line card subslot. Valid values are 0 and 1.</li> <li>• <i>controller</i>—Controller index for the modular cable. The valid range is from 0 to 2.</li> </ul>
<b>Step 4</b>	<p><b>rf-channel</b> <i>rf-port</i> <b>network-delay</b> {<i>delay</i>   <b>auto</b>} [<b>sampling-rate</b> <i>rate</i>]</p> <p><b>Example:</b> Router(config-controller)# <b>rf-channel rf6 network-delay auto sampling-rate 1</b></p>	<p>Configures the network delay for an RF channel.</p> <ul style="list-style-type: none"> <li>• <i>rf-port</i>—RF channel physical port on the SPA or the line card. Valid values for the RF port depend on the configuration of the annex modulation.</li> <li>• <i>delay</i>—The Converged Interconnect Network (CIN) delay. The default value is 550 usec. The permitted range is from 0 to 3000 usec.</li> <li>• <b>auto</b>—Determines the delay through DLM packets automatically.</li> <li>• <b>sampling-rate</b> <i>rate</i>—(Optional) Specifies how often the DLM is sent. This option is available only when the network delay value is set as auto. The permitted range is from 1 to 500 sec. The default value is 10 sec.</li> </ul>
<b>Step 5</b>	<p><b>end</b></p> <p><b>Example:</b> Router(config-controller)# <b>end</b></p>	Returns to privileged EXEC mode.

## Disabling a DEPI Data Session on the M-CMTS Router

This configuration is optional. This section describes how to disable a DEPI data session on the M-CMTS router.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>controller modular-cable</b> { <i>slot/bay/port</i>   <i>slot/subslot/controller</i> }  <b>Example:</b> Router(config)# <b>controller modular-cable 1/0/0</b>	Specifies the modular cable controller interface for the SPA or the line card. <ul style="list-style-type: none"> <li>• <i>slot</i>—SPA interface processor (SIP) or the line card slot. Slots 1 and 3 are used for SIPs. The valid range is from 5 to 8 for the line card slot.</li> <li>• <i>bay</i>—The bay in a SIP where a SPA is located. Valid values are 0 (upper bay) and 1 (lower bay).</li> <li>• <i>port</i>—Specifies the interface number on the SPA.</li> <li>• <i>subslot</i>—Cable interface line card subslot. Valid values are 0 and 1.</li> <li>• <i>controller</i>—Controller index for the modular cable. The valid range is from 0 to 2.</li> </ul>
Step 4	<b>no rf-channel</b> <i>rf-channel</i> <b>depi-tunnel</b> <i>depi-tunnel-name</i> [ <i>tsid id</i> ]  <b>Example:</b> Router(config-controller)# <b>rf-channel 0 depi-tunnel SPA0 tsid 100</b>	Removes the specified DEPI data session under the modular controller. <ul style="list-style-type: none"> <li>• <i>rf-channel</i>—RF channel physical port on the SPA or the line card.</li> <li>• <i>depi-tunnel-name</i>—Name of the DEPI tunnel.</li> <li>• <i>tsid id</i>—(Optional) Specifies the TSID value on the QAM subinterface. The TSID is used to associate the logical RF channel of the SPA or the line card to a physical QAM on Cisco RFGW-10.</li> </ul>
Step 5	<b>end</b>  <b>Example:</b> Router(config-controller)# <b>end</b>	Returns to Privileged EXEC mode.

## Configuration Examples for M-CMTS DEPI Control Plane

This section provides the following configuration examples:

## Example: DEPI Control Plane Configuration on the M-CMTS Router

The following example shows how to configure DEPI control plane on the M-CMTS:

```
Router# show running-config
.
.
.
l2tp-class rf6
!
depi-class rf6
mode mpt
!
depi-tunnel rf6
tos 128
dest-ip 192.0.2.103
l2tp-class rf6
depi-class rf6
!
controller Modular-Cable 1/0/0
ip-address 192.0.2.155
modular-host subslot 6/0
rf-channel 6 cable downstream channel-id 7
rf-channel 6 frequency 717000000 annex B modulation 64qam interleave 64
rf-channel 6 depi-tunnel rf6 tsid 6
rf-channel 6 rf-power 46
rf-channel 6 network-delay auto sampling-rate 1
no rf-channel 6 rf-shutdown
.
.
.
```

## Example: DEPI Control Plane Configuration on Cisco RFGW-10

The following example shows how to configure DEPI control plane on Cisco RFGW-10:

```
Router# show running-config
.
.
.
l2tp-class rf6
!
depi-class rf6
!
depi-tunnel rf6
dest-ip 192.0.2.155
l2tp-class rf6
depi-class rf6
!
.
.
.
interface Qam6/4
no ip address
!
interface Qam6/4.1
cable mode depi remote learn
cable downstream tsid 6
depi depi-tunnel rf6
snmp trap link-status
!
```

## Example: N+1 DEPI Redundancy Configuration on the M-CMTS Router

The following example shows how to configure N+1 DEPI redundancy on the Cisco CMTS router:

```
Router# show running-config
.
.
.
l2tp-class rf6
!
depi-class rf6
mode mpt
!
depi-tunnel rf6
tos 128
dest-ip 192.0.2.103
l2tp-class rf6
depi-class rf6
protect-tunnel test1_protect
!
depi-tunnel test1_protect
 dest-ip 24.30.14.103
controller Modular-Cable 8/0/0
ip-address 192.0.2.155
modular-host subslot 6/0
rf-channel 6 cable downstream channel-id 7
rf-channel 6 frequency 717000000 annex B modulation 64qam interleave 64
rf-channel 6 depi-tunnel rf6 tsid 6
rf-channel 6 rf-power 46
rf-channel 6 network-delay auto sampling-rate 1
no rf-channel 6 rf-shutdown
.
.
.
```

## Example: GigabitEthernet Interface Configuration on the M-CMTS Router

The following example shows the GigabitEthernet configuration on the M-CMTS:

```
Router# show running-config interface gigabitEthernet 1/0/0
.
.
.
interface GigabitEthernet1/0/0
ip address 192.0.2.155 255.255.255.0
negotiation auto
.
.
.
```

## Example: GigabitEthernet Interface Configuration on Cisco RFGW-10

The following example shows the GigabitEthernet configuration on RFGW-10:

```
Router# show running-config interface gigabitEthernet 6/13
.
.
.
interface GigabitEthernet6/13
no switchport
ip address 192.0.2.103 255.255.255.0
```

·  
·  
·

## Verifying M-CMTS DEPI Control Plane

This section explains how to verify DEPI control plane configuration on the M-CMTS router, and it contains the following topics:

### Verifying DEPI Tunnel Information

To verify a DEPI tunnel information, use the **show depi tunnel** command in privileged EXEC mode.



#### Note

This command works on both the M-CMTS router and the Cisco RFGW-10.

The following is a sample output of the **show depi tunnel** command for all the active control connections:

```
Router# show depi tunnel
LocTunID  RemTunID  Remote Name  State  Remote Address  Sessn L2TP Class/
Count VPDN Group
1834727012 3849925733 RFGW-10     est    192.0.2.155    1     rf6
```

The following is a sample output of the **show depi tunnel** command for a specific active control connection identified using the depi-tunnel-name:

```
Router# show depi tunnel 1834727012 verbose
Tunnel id 1834727012 is up, remote id is 3849925733, 1 active sessions
  Locally initiated tunnel
  Tunnel state is established, time since change 04:10:38
  Remote tunnel name is RFGW-10
    Internet Address 192.0.2.155, port 0
  Local tunnel name is myankows ubr10k
    Internet Address 192.0.2.103, port 0
  L2TP class for tunnel is rf6
  Counters, taking last clear into account:
    0 packets sent, 0 received
    0 bytes sent, 0 received
  Last clearing of counters never
  Counters, ignoring last clear:
    0 packets sent, 0 received
    0 bytes sent, 0 received
  Control Ns 255, Nr 254
  Local RWS 1024 (default), Remote RWS 8192
  Control channel Congestion Control is enabled
    Congestion Window size, Cwnd 256
    Slow Start threshold, Ssthresh 8192
  Mode of operation is Slow Start
  Retransmission time 1, max 1 seconds
  Unsent queuesize 0, max 0
  Resend queuesize 0, max 2
  Total resends 0, ZLB ACKs sent 252
  Total peer authentication failures 0
  Current no session pak queue check 0 of 5
  Retransmit time distribution: 0 0 0 0 0 0 0 0 0
  Control message authentication is disabled
```



#### Note

The counters in the **show depi tunnel verbose** command output are not supported.

The following is a sample output of the **show depi tunnel endpoints** command that shows DEPI tunnel endpoints in Cisco IOS Release 12.2(33)SCE and later releases. The **endpoints** keyword is supported only on the M-CMTS router.

```
Router# show depi tunnel endpoints
DEPI Tunnel           Modular Controller   State  Remote Address  Sessn
Count
depi_working_tunnel_8_0_4 Mod8/0/2             est    1.30.84.100     24
depi_protect_tunnel_5_1_0 Mod8/0/0:5/1/0      est    1.30.50.100     24
depi_protect_tunnel_5_1_4 Mod8/0/2:5/1/2      est    1.30.54.100     24
depi_working_tunnel_8_0_0 Mod8/0/0             est    1.30.3.100      24
```

## Verifying DEPI Session Information

To verify a DEPI session, use the **show depi session** command in privileged EXEC mode.



### Note

This command works on both the M-CMTS router and the Cisco RFGW-10.

The following is a sample output of the **show depi session** command for all the established DEPI data sessions:

```
Router# show depi session
LocID      RemID      TunID      Username, Intf/   State  Last Chg  Uniq ID
          Vcid, Circuit
1252018468 1252055513 1834727012 6,                est    04:06:10 1
```

The following is a sample output of the **show depi session** command for a specific established DEPI data session identified using the *session-id*:

```
Router# show depi session 1252018468 verbose
Session id 1252018468 is up, tunnel id 1834727012
  Remote session id is 1252055513, remote tunnel id 3849925733
  Locally initiated session
Qam Channel Parameters
  Group Tsid is 0
  Frequency is 717000000
  Modulation is 64qam
  Annex is B
  Interleaver Depth I=32 J=4
  Power is 0
  Qam channel status is 0
  Unique ID is 1
Call serial number is 326100007
Remote tunnel name is RFGW-10
  Internet address is 192.0.2.155
Local tunnel name is myankows ubr10k
  Internet address is 192.0.2.103
IP protocol 115
  Session is L2TP signaled
  Session state is established, time since change 04:06:24
    0 Packets sent, 0 received
    0 Bytes sent, 0 received
  Last clearing of counters never
  Counters, ignoring last clear:
    0 Packets sent, 0 received
    0 Bytes sent, 0 received
  Receive packets dropped:
    out-of-order:      0
    total:             0
  Send packets dropped:
    exceeded session MTU: 0
    total:             0
```

```

DF bit on, ToS reflect enabled, ToS value 0, TTL value 255
UDP checksums are disabled
Session PMTU enabled, path MTU is 1492 bytes
No session cookie information available
FS cached header information:
  encaps size = 28 bytes
  45000014 00004000 FF73706F 01030467
  0103049B 4AA0D9D9 00000000
Sequencing is on
  Ns 0, Nr 0, 0 out of order packets received
  Packets switched/dropped by secondary path: Tx 0, Rx 0
Conditional debugging is disabled

```

Beginning with Cisco IOS Release 12.2(33)SCE, you can verify DEPI EQAM statistics (this feature is enabled by default), using the **show depi session** command with the **verbose** keyword as shown in the following example:

```

Router# show depi session 1252018468 verbose
Session id 1252018468 is up, tunnel id 1834727012
  Remote session id is 1252055513, remote tunnel id 3849925733
  Locally initiated session
Qam Channel Parameters
  Group Tsid is 0
  Frequency is 717000000
  Modulation is 64qam
  Annex is B
  Interleaver Depth I=32 J=4
  Power is 0
  Qam channel status is 0
  Unique ID is 1
.
.
.
Sequencing is on
  Ns 0, Nr 0, 0 out of order packets received
  Packets switched/dropped by secondary path: Tx 0, Rx 0
.
.
.
Peer Session Details
Peer Session ID : 1073808091
Peer Qam ID : Qam3/12.2
Peer Qam State : ACTIVE
Peer Qam Type : Secondary
Peer Qam Statistics
Total Pkts : 35177
Total Octets : 6613276
Total Discards : 0
Total Errors : 0
Total In Pkt Rate : 0
Bad Sequence Num : 0
Total In DLM Pkts : 0
Conditional debugging is disabled

```

**Note**

The counters in the **show depi session verbose** command output are not supported.

The following is a sample output of the **show depi session** command for all the configured DEPI data sessions:

```

Router# show depi session configured
Session Name          State      Reason          Time
Modular-Cable1/0/0:0 IDLE      Power mismatch  Jun 10 09:59:07

```

The following is a sample output of the **show depi session endpoints** command that shows DEPI session endpoints in Cisco IOS Release 12.2(33)SCE and later releases. The **endpoints** keyword is supported only on the M-CMTS router.

```
Router# show depi session endpoints
DEPI Tunnel          RF Channel          EQAM rf-port  Tsid  State  Type
depi_working_tunnel_8_0_0 Mod8/0/0:0        Qam3/7.1     371   est    P
depi_protect_tunnel_5_1_0 Mod8/0/0:5/1/0:0 Qam3/7.1     371   est    S
non_cisco_eqam_tunnel Mod8/0/0:6        -            11012 est    P
```

## Verifying DLM Configuration Information

To verify the DLM configuration information, use the **show interface modular-cable dlm** command in privileged EXEC mode.

The following example shows sample output of the **show interface modular-cable slot/bay/port:interface\_number dlm** command:

```
Router# show interface modular-cable 1/0/0:6 dlm
DEPI Latency Measurements for Modular-Cable1/0/0:6
Current CIN Delay: 146 usecs
Current DLM: 4566
Average DLM (last 10): 1514
Max DLM: 5115
Min DLM: 913
Ingress DLM
#          SysUpTime          Delay (Ticks)
x-----x-----x-----
0          831149          949
1          831159          1168
2          831170          4566
3          831076          1005
4          831087          983
5          831097          1185
6          831108          1139
7          831118          1144
8          831128          2013
9          831139          996
```



### Note

The M-CMTS sends either ingress or egress DLM requests based on the EQAM capabilities that EQAM reports during DEPI data session establishment.

## Additional References

The following sections provide references related to the M-CMTS DEPI Control Plane feature.



**Related Documents**

Related Topic	Document Title
Cisco Wideband SPA	<i>Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide</i> <a href="http://www.cisco.com/en/US/docs/interfaces_modules/shared_port_adapters/configuration/ubr10012/b_10k_sip_spa_scg.html">http://www.cisco.com/en/US/docs/interfaces_modules/shared_port_adapters/configuration/ubr10012/b_10k_sip_spa_scg.html</a>
Cisco uBR-MC3GX60V	<i>Configuring the Cisco uBR-MC3GX60V Cable Interface Line Card</i> <a href="http://www.cisco.com/en/US/products/hw/cable/ps2209/products_installation_and_configuration_guides_list.html">http://www.cisco.com/en/US/products/hw/cable/ps2209/products_installation_and_configuration_guides_list.html</a>
Command Reference	<i>Cisco IOS CMTS Cable Command Reference</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>

**Standards and RFCs**

Standard	Title
CM-SP-DEPI-I08-100611	Data-Over-Cable Service Interface Specification, Modular Headend Architecture, Downstream External PHY Interface Specification
RFC 3931	Layer Two Tunneling Protocol - Version 3 (L2TPv3)

**MIBs**

MIB	MIBs Link
<ul style="list-style-type: none"> <li>• DOCS-IF-M-CMTS-MIB</li> <li>• DOCS-DRF-MIB</li> </ul>	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

**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><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></p>

## Feature Information for M-CMTS DEPI Control Plane

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**


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The table below 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.

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Table 37: Feature Information for M-CMTS DEPI Control Plane

Feature Name	Releases	Feature Information
M-CMTS DEPI Control Plane	12.2(33)SCC	<p>This feature was introduced in Cisco IOS Release 12.2(33)SCC.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>depi-class</b></li> <li>• <b>depi-tunnel</b></li> <li>• <b>dest-ip</b></li> <li>• <b>rf-channel depi-tunnel</b></li> <li>• <b>rf-channel rf-power</b></li> <li>• <b>rf-channel rf-shutdown</b></li> <li>• <b>show depi</b></li> <li>• <b>show depi session</b></li> <li>• <b>show depi tunnel</b></li> </ul>
Ingress DLM	12.2(33)SCC	<p>This feature was introduced in Cisco IOS Release 12.2(33)SCC.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>show interface Modular-Cable dlm</b></li> <li>• <b>rf-channel network-delay</b></li> </ul>
N+1 DEPI Redundancy	12.2(33)SCE	<p>Cisco IOS Release 12.2(33)SCE introduces support for the N+1 redundancy for DEPI control plane feature to protect against the Cisco uBR-MC3GX60V line card failure or switchover.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>protect-tunnel</b></li> <li>• <b>show depi session</b></li> <li>• <b>show depi tunnel</b></li> </ul>

Feature Name	Releases	Feature Information
DEPI EQAM Statistics	12.2(33)SCE	<p>The DEPI EQAM statistics feature enables the EQAM to send RF channel statistics to the M-CMTS router.</p> <p>The following command was introduced:</p> <ul style="list-style-type: none"> <li>• <b>depi eqam-stats</b></li> </ul>
DEPI CIN Failover	12.2(33)SCF4	<p>The DEPI CPU threshold values can be configured. The following command was modified:</p> <p><b>depi cin-failover cpu-threshold</b></p>



# CHAPTER 13

## Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

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In Cisco IOS Release 12.2(33)SCC and later releases, support for the restricted load balancing group (RLBG)/general load balancing group (GLBG) is based on DOCSIS 2.0 and 3.0 specifications. Narrowband (NB) dynamic bandwidth sharing (DBS) with dynamic load balancing (DLB) is also supported in Cisco IOS Release 12.2(33)SCC and later releases, and uses RF channel instead of the interface for load balancing.

### 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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## Prerequisites for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

The Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing feature has the following prerequisites:

- A RLBG and a DOCSIS 2.0 GLBG should have a load balancing group (LBG) ID.
- A LBG should have a default policy ID.
- During registration, a cable modem (CM) that has been assigned to a LBG must also be assigned a policy ID and priority, through Simple Network Management Protocol (SNMP), the CM configuration file, or Cisco Cable Modem Termination System (CMTS) configuration.
- The CM must send service type identifier (STID), service class name, and DOCSIS version and capability type/length/value (TLV) settings to the Cisco CMTS for registration if the fields are used by general tagging.

The table below shows the Cisco CMTS hardware compatibility prerequisites for this feature.

**Note**

The hardware components introduced in a given Cisco IOS Release will be supported in all subsequent releases unless otherwise specified.

Table 38: RLBG/GLBG and NB DBS with Downstream DLB Hardware Compatibility Matrix

Cisco CMTS Platform	Processor Engine	Cable Interface Card
Cisco uBR10012 Universal Broadband Router	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• PRE2<sup>25</sup></li> </ul> <p>Cisco IOS Release 12.2(33)SCB and later releases</p> <ul style="list-style-type: none"> <li>• PRE4</li> </ul> <p>Cisco IOS Release 12.2(33)SCH and later releases</p> <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	<p>Cisco IOS Release 12.2(33)SCB and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20U/H</li> </ul> <p><b>Note</b> Starting with Cisco IOS Release 12.2(33)SCH, Cisco uBR10-MC5X20U/H line card is not supported.</p> <p>Cisco IOS Release 12.2(33)SCC and later releases</p> <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul> <p>Cisco IOS Release 12.2(33)SCE and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>26</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U</li> </ul> <p>Cisco IOS Release 12.2(33)SCD and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>27</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> <p>Cisco IOS Release 12.2(33)SCB and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U</li> </ul> <p>Cisco IOS Release 12.2(33)SCD and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>25</sup> PRE = Processor Routing Engine

<sup>26</sup> The Cisco uBR3GX60V cable interface line card is compatible only with PRE4.

<sup>27</sup> The Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2.

# Restrictions for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

The RLBG/GLBG Support and NB DBS Interact with DLB Support feature has the following restrictions:

- Either Cisco load balancing (LB) or DOCSIS LB can be enabled for a MAC domain, but not both.
- A maximum of 256 DOCSIS policies and 256 rules per chassis are supported.
- The **init-tech-ovr** command does not support cross-line card (LC) configuration, as Cisco CMTS always use Dynamic Channel Change (DCC) initialization technique 0 for cross-LC DCC.
- For the restriction about target upstream channel attribute masks, see the “Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers” chapter in the *Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC* guide, at the following link:  
[http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr\\_load-bal\\_dcc.html#wp1176797](http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_load-bal_dcc.html#wp1176797)
- We recommend all LBGs that share channels must use the same LB method.
- If a channel is a part of a DOCSIS LBG, use channel selection for CM steering.

The RLBG/GLBG Support and NB DBS Interact with DLB Support feature have the following cross functional restrictions:

- CMs operating in the multiple transmit channel (MTC) mode do not register for a RLBG assignment, even if their configuration file contains relevant TLVs, such as STID and LBG ID. However, CMs operating in the multiple receive channel (MRC) can register for a RLBG assignment.
- A modular cable (MC) interface in DBS mode can join LB operations, using either the modems or service-flows method. However, using the utilization method, if the MC interface is in the DBS mode and sharing the QAM channel with any other wideband (WB) interface that is not using the DBS mode, the LB state of this interface goes down. The MC interface can join LB operations if the interface is not in the DBS mode, or if the interface is in DBS mode and all the WB interfaces sharing the QAM channel are using the DBS mode.
- The Cisco CMTS does not support an MC interface using DBS and sharing the same QAM channel with any other WB interface that is not using DBS. Therefore, the Cisco CMTS does not let the MC interface join a utilization-based LBG. In such cases, the MC interface is in a down status in the utilization-based LBG.

**Note**

The Integrated Cable (IC) interface in DBS mode has the same restrictions as the MC interface.

- The Cisco CMTS can parse a specific TLV encoded in CM configuration file, and prohibit any DCC operation on the CMs.
- DOCSIS MAC domain downstream service group (MD-DS-SG) channels in MDD messages are incorrect when a combination of channels from multiple line card types are placed in the same fiber node. The Cisco uBR-MC20X20V line card MAC domains should only include SPA channels, but if channels



from two or more Cisco uBR-MC20X20V line cards are placed in the same fiber node, the MD-DS-SG from one card will include channels from the other line card too.

In a complex fiber node setup, with channels from more than one line card, or downstream channels of one MAC domain in more than one fiber node, some modems may not come w-online (wideband online). If a MAC domain has more than one MD-DS-SG, the MDD will contain more than one MD-DS-SG and cause the modem to perform downstream ambiguity resolution. When the modem analyzes the downstream channels from the other line card, it will not see MDD packets and disqualify the channel and the MD-DS-SG. The modem then sends a requested MD-DS-SG of 0 to the CMTS implying it will not participate in a bonding group.

Use the **show cable mac-domain downstream-service-group** command to see the channels in the same MD-DS-SG.

Use the **debug cable mdd** and **debug cable interface mac-domain** on the line card to see that MDDs contain MD-DS-SG with channels from multiple line cards.

The RLBG/GLBG Support and NB DBS Interact with the DLB Support feature have the following scaling limitations:

- The total number of RLBGs and DOCSIS 2.0 GLBGs cannot exceed 256.
- The total number of tags in a Cisco CMTS cannot exceed 256.
- The total number of DOCSIS 3.0 GLBGs is bounded by free memory.
- A CM reset occurs if a CM moves from one cable interface to another because DCC init-tech 0 resets a CM during a LB move. A CM also resets if the two cable interfaces have been configured with a mismatched **cable ip-init** command.

## Information About Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

The Cisco implementation on LB is based on the interface and channel on which CMs register, imposing a restriction that a particular DOCSIS channel, upstream (US) or downstream (DS), can only be part of one LBG.

The DOCSIS 2.0 "Autonomous Load Balancing" specification is CM-centric, allowing a channel (US or DS) to be part of multiple RLBGs. Therefore, with the DOCSIS 2.0 specifications, you can decide on which channel the CM can be load balanced.

To configure the Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing feature, you should understand the following concepts:

### Service-Based Load Balancing

Using the DOCSIS 3.0 modem-based load balancing specifications, you can manage the LB activity on a per-modem basis as follows:

- 1 Modem to RLBG association through STID

- 2 Modem to RLBG association through LBG ID
- 3 Per-modem LB policy assignment
- 4 Per-modem LB priority assignment
- 5 Per-modem channel restriction

Implementing the DOCSIS 3.0 modem-based LB specifications enables the Cisco CMTS to provide an advanced service-based LB. The service-based LB can be used to alleviate the burden for the modem-based provisioning and provide the operator an ability to selectively control LB activity based on modem service type. For example, for LB purposes modems can be classified based on:

- Device type
- DOCSIS version
- Service class

The results of the classification can then be used to selectively control the modem LB activity by mapping the modem to the following settings:

- LBG
- Policy

With the service-based LB enabled, existing service-based cable modem segregation features and channel restriction become special cases and can be handled within the same LB framework. However, the device type-based classification is not available in Cisco IOS Release 12.2(33)SCC.

### Functionality

The Cisco CMTS functions in the following ways for general tagging and service-based LB:

- The Cisco CMTS can classify some modems with user-defined modem classifiers using the STID, service class name, DOCSIS version and capability TLVs and MAC Organization Unique Identifier (OUI).
- Each modem classifier has a unique tag. The Cisco CMTS allows each modem to carry one tag. When multiple tags match one cable modem, the tag that has the least index gets applied on the cable modems.
- The Cisco CMTS classifies a CM and assigns a tag, and if a RLBG with that tag is configured, the CM gets assigned to that RLBG.
- The Cisco CMTS can match multiple tags to a RLBG and a DOCSIS policy.
- On the Cisco CMTS, a user can configure whether the general tagging overrides the RLBG or DOCSIS policy assignment using TLVs in the CM configuration file and SNMP when a conflict occurs.
- When doing autonomous LB, the Cisco CMTS ensures that the target channels are available to a specific CM with regard to admission control, the SF attribute masks, and CM attribute masks.
- The user can configure the number of times that a DCC fails a CM before the CM is removed from dynamic LB on the Cisco CMTS.
- The user can configure DCC initialization techniques or whether to use Upstream Channel Change (UCC) for a LBG or for a particular source and target pair on the Cisco CMTS. However, DCC is not issued to cable modems provisioned in DOCSIS 1.0 mode. By default, the UCC for a LBG is not configured and therefore, all channel changes are done through DCC.

- The Cisco CMTS supports LB on at least one logical channel on a physical US channel that has multiple logical US channels.
- As per the DOCSIS 3.0 specifications, a lower load balancing priority indicates a higher likelihood that a CM will be moved due to load balancing operations.
- You can create a policy to set the lower bandwidth for CMs. the LBG can only move cable modems with throughput that is above the threshold.

### Compatibility

Both downstream and upstream autonomous load balancing is supported for single channel cable modems on the Cisco uBR10-MC5X20U/H, Cisco UBR-MC20X20V, Cisco uBR-MC88V, Cisco uBR-MC3GX60V line cards, and wideband SPA.

**Note**

The Cisco uBR-MC88V cable interface line card is supported only in Cisco IOS Release 12.2(33)SCD and later releases.

## RLBG/GLBG Assignment

Cable modems operating in the MTC mode do not participate in registration for RLBG assignment, even if their configuration file contains relevant TLVs such as STID and LBG ID.

The user can configure one or more service type IDs for each RLBG. The user can also configure the Cisco CMTS, using CLI or SNMP, to restrict a particular cable modem to a certain STID and RLBG ID. However, if such a configuration is made, both the STID and RLBG ID in the configuration file are ignored by the Cisco CMTS.

When the STID is configured by CLI or SNMP or the STID is present in the cable modem configuration file, the Cisco CMTS selects an upstream and downstream channel, which offers the signaled service type, from a RLBG, if such channels exist. However, if an upstream and downstream channel do not exist that provide the signaled service type the Cisco CMTS assigns an upstream and downstream channel that does not offer the signaled service type.

When the LBG ID is configured by CLI or SNMP or the LBG ID is present in the cable modem configuration file, the Cisco CMTS examines the available choices for upstream and downstream channels and, if they include a channel pair associated with the signaled LBG, the Cisco CMTS assigns the cable modem to the signaled LBG. If these conditions are not met, the Cisco CMTS disregards the LBG ID.

If there are multiple upstream and downstream channels available that meet the requirements of the STID, if present, and the LBG ID, if present, the Cisco CMTS selects an upstream and/or downstream channel that meet the cable modem required and forbidden attribute masks requested in the configuration file. If upstream and downstream channels are not available that meet these criteria, the Cisco CMTS can disregard the cable modem attribute masks and select an alternative upstream and/or downstream channel.

In determining a target channel pair for a cable modem during registration time, the Cisco CMTS tries to find the target channel pair that can actually reach the cable modem by checking the current channel pair, the MD-DS-SG-ID (Media Access Control Domain Downstream Service Group Identifier) of cable modem (CM-DS-SG-ID) and the MD-US-SG-ID (Media Access Control Domain Upstream Service Group Identifier) of cable modem (CM-US-SG-ID), if present, and fiber node (FN) configurations. If the target channel pair is available to the cable modem and is different from the current channel pair, the Cisco CMTS is required to move the CM by means of DCC technique 0 or downstream frequency override (DFO).

In Cisco IOS Release 12.2(33)SCE and earlier releases, when the Cisco CMTS identifies multiple candidate RLBGs for a CM, but cannot determine which fiber node configuration the cable modem is actually wired to, or cannot determine if the wired RLBG is unusable (when interfaces in the load balance group are disabled or in an administratively down state), the Cisco CMTS assigns the cable modem to the RLBG with the lowest group index. This assignment causes the Cisco CMTS to attempt to move the cable modem to interfaces it is not physically connected to, resulting in service outages for the CM.

However, in Cisco IOS Release 12.2(33)SCE1 and later releases, the Cisco CMTS enforces fiber node checking during RLBG assignment.

The Cisco CMTS follows the following RLBG assignment rules:

- If there is no fiber node configuration, there is no change in the candidate RLBG list. However, if the fiber node is configured, the fiber node must be configured correctly to reflect the real fiber node connection.
- If the cable modem is inside a fiber node, only those RLBGs that are inside that fiber node are selected.
- If the cable modem is not inside any fiber node, that is, the fiber node configuration does not cover all the channels, only those RLBGs that are not inside any fiber node are selected.
- If an RLBG spans across multiple fiber nodes, it is not considered to be inside any fiber node.
- If no candidate RLBG is found, cable modems are assigned to the GLBG, if the GLBG exists.

## Channel Assignment

For cable modems operating in MRC mode, the registration request message can have multiple TLVs to influence the selection of upstream and downstream channels that the Cisco CMTS assigns. To avoid conflicts between the multiple TLVs, the Cisco CMTS follows the precedence order defined below:

- 1 TLV 56—Channel Assignment
- 2 TLV 43.11—Service Type Identifier
- 3 TLV 43.3—Load Balancing Group ID
- 4 TLVs 24/25.31-33—Service Flow Attribute Masks
- 5 TLV 43.9—CM Attribute Masks

The Cisco CMTS must follow this TLV precedence order for cable modems not operating in MRC mode:

- 1 TLV 43.11—Service Type Identifier
- 2 TLV 43.3—Load Balancing Group ID
- 3 TLV 43.9—CM Attribute Masks
- 4 TLVs 24/25.31-33—Service Flow Attribute Masks

**Note**

Starting with Cisco IOS Release 12.2(33)SCF, cable modems in MTC mode are assigned to load balancing groups.



**Note**

When a target for the new receive channel configuration (RCC) is selected, ensure that the service level for cable modems is not decreased. Target total RCCs must not be less than the source total RCCs so that cable modems can keep their service level unchanged. This may cause some unbalanced results when high capacity cable modems come online, later releases. This limitation will be addressed in a later releases release.

The Cisco CMTS also considers the DOCSIS 3.0 cable modem capabilities defined in the registration request message and assigns the maximum number of channels that the CM requests.

The tables below define the load balancing matrix for RLBG and GLBG assignment:

**Table 39: RLBG Assignment for DOCSIS Cable Modems**

Operational Mode	MAC Version				
	DOCSIS 3.0 CM	DOCSIS 2.x CM	DOCSIS 2.0 CM	DOCSIS 1.1 CM	DOCSIS 1.0 CM
Non-MRC mode (online)	Assigned	Assigned	Assigned	Assigned	Assigned
MRC mode only (w-online)	Assigned	Assigned	Assigned	NA	NA
MRC/MTC mode (UB-online)	Not assigned	NA	NA	NA	NA
	In Cisco IOS Release 12.2(33)SCF, DOCSIS 3.0 cable modems are assigned to the DOCSIS 3.0 RLBG	NA	NA	NA	NA

**Table 40: GLBG Assignment for DOCSIS Cable Modems**

Operational Mode	MAC Version				
	DOCSIS 3.0 CM	DOCSIS 2.x CM	DOCSIS 2.0 CM	DOCSIS 1.1 CM	DOCSIS 1.0 CM
Non-MRC mode (online)	Assigned to the DOCSIS 2.0 GLBG without MD-DS-SG-ID/MD-US-SG-ID				
	Assigned to the DOCSIS 3.0 GLBG with MD-DS-SG-ID/MD-US-SG-ID		NA	NA	NA
MRC mode only (w-online)	Assigned to the DOCSIS 2.0 GLBG without MD-DS-SG-ID/MD-US-SG-ID				
	Assigned to the DOCSIS 3.0 GLBG with MD-DS-SG-ID/MD-US-SG-ID		NA	NA	NA

Operational Mode	MAC Version				
	MRC/MTC mode (UB-online)	Not assigned	NA	NA	NA
	In Cisco IOS Release 12.2(33)SCF, DOCSIS 3.0 cable modems are assigned to the DOCSIS 3.0 RLBG	NA	NA	NA	NA

The table below displays the change in behavior in channel assignment between Cisco IOS Release 12.2(33)SCE and earlier releases, and Cisco IOS Release 12.2(33)SCF:

**Table 41: Comparison of Load Balancing Move of cable modems with LBG Assignment**

Modem Mode	Load Balancing Method	Load Balancing Counters	Channels	Cisco IOS Release 12.2(33)SCE and earlier	Cisco IOS Release 12.2(33)SCF
DOCSIS 3.0 CM in MTC mode	NA	WB/UB	DS/US	NA	<ul style="list-style-type: none"> <li>• If RLBG is not found in the FN to get cable modems online, is not assigned an RLBG ID.</li> <li>• CM is assigned an LBG ID if any RLBG is available in the FN.</li> <li>• cable modems inside an RLBG or GLBG are added to the modem list.</li> <li>• cable modems outside an RLBG stay outside, are not added to the modem list</li> </ul>

Modem Mode	Load Balancing Method	Load Balancing Counters	Channels	Cisco IOS Release 12.2(33)SCE and earlier	Cisco IOS Release 12.2(33)SCF
DOCSIS 3.0/DOCSIS 2.x cable modems in MRC-only mode	NA	WB/UB	DS	<ul style="list-style-type: none"> <li>• If RLBG is not found in the FN to get cable modems online, is not assigned an RLBG ID.</li> <li>• CM is assigned an LBG ID if any RLBG is available in the FN.</li> <li>• Primary channel of the CM and upstream inside RLBG or GLBG is added to modem list.</li> <li>• cable modems outside an RLBG are added to the modem list after moving the primary channel and upstream channels inside the RLBG.</li> </ul>	Same as in Cisco IOS Release 12.2(33)SCE.
DOCSIS 3.0 cable modems in MRC-only mode	DOCSIS 2.0 dynamic modem count-based LB (MCBLB), dynamic utilization	NB	US	Same as above.	Same as in Cisco IOS Release 12.2(33)SCE.
DOCSIS 2.0 /DOCSIS 1.1 cable modems in NB mode	DOCSIS 2.0 dynamic MCBLB, dynamic utilization	NB	DS/US	Same as above.	Same as in Cisco IOS Release 12.2(33)SCE.

Table 42: Comparison of Load Balancing Move of cable modems with LBG Assignment

Modem Mode	Load Balancing Method	Load Balancing Counters	Channels	Movement
DOCSIS 3.0 CM in MTC mode	NA	WB/UB	DS/US	<ul style="list-style-type: none"> <li>• If RLBG is not found in the FN to get cable modems online, is not assigned an RLBG ID.</li> <li>• CM is assigned an LBG ID if any RLBG is available in the FN.</li> <li>• Cable modems inside an RLBG or GLBG are added to the modem list.</li> <li>• Cable modems outside an RLBG stay outside, are not added to the modem list</li> </ul>
DOCSIS 3.0/DOCSIS 2.x cable modems in MRC-only mode	NA	WB/UB	DS	<ul style="list-style-type: none"> <li>• If RLBG is not found in the FN to get cable modems online, is not assigned an RLBG ID.</li> <li>• Cable modem is assigned an LBG ID if any RLBG is available in the FN.</li> <li>• Primary channel of the cable modem and upstream inside RLBG or GLBG is added to modem list</li> <li>• Cable modems outside an RLBG are added to the modem list after moving the primary channel and upstream channels inside the RLBG</li> </ul>
DOCSIS 3.0 cable modems in MRC-only mode	DOCSIS 2.0 dynamic modem count-based LB (MCBLB), dynamic utilization	NB	US	Same as above.



Modem Mode	Load Balancing Method	Load Balancing Counters	Channels	Movement
DOCSIS 2.0 /DOCSIS 1.1 cable modems in NB mode	DOCSIS 2.0 dynamic MCBLB, dynamic utilization	NB	DS/US	Same as above.

The tables below give a snapshot view of the load balancing methods and the operations used to "move" bonded and non-bonded CMs.

**Table 43: Load Balancing Method to Move Bonded and Non-bonded cable modems**

Modem Mode	Dynamic Service Charge (Initialization Technique)	
	Within MAC Domain	Across MAC Domains
DOCSIS 3.0 cable modems in MTC mode	NA	DCC initialization technique 0
DOCSIS 3.0/DOCSIS 2.x cable modems in MRC-only mode	DCC initialization technique 0 <b>Note</b> CM with primary DS outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC initialization technique 0
DOCSIS 3.0 cable modems in MRC-only mode	DCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC initialization technique 0
DOCSIS 2.x cable modems in MRC-only mode	DCC/UCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC initialization technique 0
DOCSIS 2.0 /DOCSIS 1.1 cable modems in NB mode	DCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	DCC initialization technique 0
	UCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	UCC
DOCSIS 1.0 in NB mode	Force reinitialize CM <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	Force reinitialize CM
	UCC <b>Note</b> CM outside RLBG moves inside RLBG with DOCSIS 2.0 LB.	UCC

Table 44: Using DCC/DBC to Load Balance Bonded and Non-bonded Cable Modems

Channel	CM in MRC, non-MTC Mode	DOCSIS 1.1/DOCSIS 2.0 cable modems with Single US/DS	DOCSIS 1.0 cable modems with Single US/DS
Upstream (US)	DCC	DCC	UCC
Downstream (DS)	NA (within the same MAC domain)	DCC (within the same MAC domain).	Force reinitialize CM
	DCC with initialization technique 0 when moving cable modems across MAC domains.	DCC with initialization technique 0 when moving cable modems across MAC domains.	Force reinitialize CM

### Error Handling of Channel Assignment

In Cisco IOS Release 12.2(33)SCE and earlier releases, the interface state of the channels is considered when determining load balancing groups (LBG) assignment. Only those channels that are in the "initial", "up", "suspicious", or "testing" states are available for LBG assignment.

However, in Cisco IOS Release 12.2(33)SCF, this restriction is modified. As long as the interface state of the channels is not "administratively down", all channels are available for LBG assignment. For other load balancing operations, such as moving modems using DCC, UCC, or DBC, the interface state of the channels should be in "initial", "up", "suspicious", or "testing" states.

Effective with Cisco IOS Release 12.2(33)SCF1, the following conditions apply when an LBG is disabled:

- cable modems that match all load balancing criteria can be assigned to an LBG.
- cable modem moves for load balancing are disabled, but cable modem moves from outside of the LBG to inside of the LBG are allowed.

## Upstream Load Balancing for DOCSIS 3.0 Cable Modems in Single Upstream Mode

The upstream load balancing functionality enables the Cisco CMTS router to effectively handle upstream traffic for wideband and narrowband cable modems that are in single upstream mode. Single upstream mode (Mx1) means that the modems cannot send upstream traffic on multiple upstream channels. In the event of traffic overload on a single upstream channel of a wideband or narrowband cable modem, the Cisco CMTS router automatically moves the cable modem to another upstream channel in the same load balancing group.



**Note**

A cable modem operating in single upstream mode is assigned to a load balancing group based on the primary channel of the modem. A cable modem in single upstream mode can support multiple receive channel (MRC) mode or narrowband mode. However, a cable modem in single upstream mode cannot support multiple transmit channel mode (MTC).

## Narrowband LB with DBS

In earlier releases, there was a restriction on an MC interface using dynamic bandwidth sharing to be included in a LBG. Starting with Cisco IOS Release 12.2(33)SCC, a new measurement of link utilization is introduced to overcome this restriction of load balancing on an MC interface using DBS. The modem count and service flow count-based loads in DBS are refined to be consistent with the DBS functionality.

**Note**

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The Integrated Cable (IC) interface in DBS mode has the same measurement as the MC interface.

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### Functionality

The Cisco CMTS can balance the utilization of underlying QAM channels across LBG using the utilization method. There is no restriction for all MC interfaces in the LBG to use DBS.

The Cisco CMTS can balance the modem count or service flow count as follows:

- The guaranteed bandwidth of each MC interface across LBG using the modem count or service flow count method, if all MC interfaces in that LBG are using DBS.
- The guaranteed bandwidth of an MC interface using DBS and the nominal bandwidth of an MC interface that is not using DBS across the LBG using the modem count or service flow count method, even if all MC interfaces in that LBG are not using DBS.

### Compatibility

Narrowband LB with DBS is supported on the Cisco 10000 SIP-600 and Cisco uBR-MC88V cable interface line card.

**Note**

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The Cisco uBR-MC88V cable interface line card is supported only in Cisco IOS Release 12.2(33)SCD and later releases.

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## Auto-generate DOCSIS 2.0 GLBG

Cisco CMTS does not automatically implement DOCSIS 2.0 GLBG. DOCSIS 2.0 GLBG is configured manually after a new fiber node - MAC domain (FN-MD) pair is added.

Cisco IOS Release 12.2(33)SCH introduces an enhancement to automatically generate DOCSIS 2.0 GLBG after adding a new FN-MD pair and resolving a new combination of MAC domain, cable modem, and service group (MD-CM-SG). This enhancement is implemented through a new command **cable load-balance d20 GLBG auto-generate**. The command has options to renew and update DOCSIS 2.0 GLBGs for a fiber node configuration.

## Independent Upstream/Downstream Throughput Rules

Currently, during upstream or downstream load balancing, to move modems in load balancing operations, Cisco CMTS applies the DOCSIS policy throughput rules to both upstream and downstream throughput to

upstream or downstream load balancing operations. In other words, for downstream load balancing, both upstream and downstream sets of rules are applied and similarly for upstream load balancing both set of rules are applied. This prevents movement of modems with low upstream or high downstream throughput and high upstream or low downstream throughput.

Effective with Cisco IOS Release 12.2(33)SCH, upstream or downstream throughput rules are checked independently to corresponding upstream or downstream load balancing operations. During upstream load balancing, only upstream throughput rules are checked, and during downstream load balancing, only downstream throughput rules are checked.

The following important points are implemented for independent upstream/downstream throughput rules:

- If a load balancing operation involves a change only in the downstream channel of a cable modem without any change to the upstream channel, then only the downstream lower boundary rules are checked.
- If a load balancing operation involves a change only in the upstream channel of a cable modem without any change to the downstream channel, then only the upstream lower boundary rules are checked.
- If a load balancing operation involves a change in both the upstream and downstream channels of a cable modem, then the modem rule check must pass all the rules for that (upstream or downstream) load balancing.
- If the load balancing policy configured is **pure-ds-load**, then only the downstream rules are checked.
- If the load balancing policy configured is **us-across-ds** or both **us-across-ds** and **pure-ds-load**, then two types of target interfaces occur as follows:
  - Local interface—where the cable modem shares the upstream with the source. Only downstream load balancing operation occurs.
  - Remote interface—where the the cable modem does not share the upstream with the source. The upstream/downstream load balancing is triggered by upstream load.

If the load balancing policy configured is neither **us-across-ds** nor **pure-ds-load**, then the load balancing is done based on Mac domain load.

## How to Configure Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

The Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing feature can be configured as follows:

- A user can configure a DOCSIS 2.0 general load balancing group (GLBG) on the Cisco CMTS according to DOCSIS specification. The Cisco CMTS creates a DOCSIS 3.0 GLBG for each Media Access Control Domain Cable Modem Service Group (MD-CM-SG) automatically and checks whether the GLBG contains both upstream and downstream channels.
- A CM that is not provisioned to any RLBG and cannot resolve its MD-CM-SG gets assigned to a DOCSIS 2.0 GLBG. However, if the CM resolves its MD-CM-SG, it gets assigned to a DOCSIS 3.0 GLBG.

- A user can configure RLBGs and any upstream or downstream channel into multiple RLBGs on the Cisco CMTS. The Cisco CMTS checks whether a RLBG contains both upstream and downstream channels. A RLBG can cross multiple MDs.
- A backward compatibility with existing Cisco LB schemes is maintained. The users can switch between the old and new DOCSIS 3.0 compliant LB schemes.



**Note**

When the Cisco IOS system is upgraded from Cisco IOS Release 12.2(33)SCE6 to Cisco IOS Release 12.2(33)SCH2, the `docsis-policy` configuration of the DOCSIS load balancing groups, is missing in the output of the **show running-config** command. Legacy load balancing groups are not affected by this software upgrade.

Effective with Cisco IOS Release 12.2(33)SCH2, after the software is upgraded from Cisco IOS Release 12.2(33)SCE6 to Cisco IOS Release 12.2(33)SCH2, apply the `docsis-policy` to the DOCSIS load balancing groups using the **docsis-policy** *policy-id* command again.

The following sections describe how to create and configure DOCSIS load balancing groups to enable DOCSIS load balancing on the Cisco CMTS:

## Configuring DOCSIS 3.0 and 2.0 RLBG and DOCSIS 2.0 GLBG

This section describes how to create and configure a DOCSIS load balancing group. There is a separate configuration mode for a DOCSIS load balancing group that is different from the legacy load balancing group.

### DETAILED STEPS

	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>	<p>Enters global configuration mode.</p>
<b>Step 3</b>	<p><b>cable load-balance docsis-enable</b></p> <p><b>Example:</b></p> <pre>Router(config)# cable load-balance docsis-enable</pre>	<p>Enables DOCSIS load balancing on the Cisco CMTS.</p>

	Command or Action	Purpose
Step 4	<p><b>cable load-balance docsis-group</b> <i>docsis-group-id</i></p> <p><b>Example:</b></p> <pre>Router(config)# cable load-balance docsis-group 1</pre>	<p>Creates a DOCSIS load balance group on the Cisco CMTS, with the following parameter:</p> <p>The router enters DOCSIS load balancing group configuration mode.</p>
Step 5	<p><b>init-tech-list</b> <i>tech-list</i> [<b>ucc</b>]</p> <p><b>Example:</b></p> <pre>Router(config-lb-group)# init-tech-list 1 ucc</pre>	<p>Sets the DCC initialization techniques that the Cisco CMTS can use to load balance cable modems.</p>
Step 6	<p><b>downstream</b> {<b>Cable</b> {<i>slot/subslot/port</i>   <i>slot/port</i>}   <b>Integrated-Cable</b> {<i>slot/subslot/bay</i>   <i>slot/port</i>} {<b>rf-channel</b> <i>group list</i>}   <b>Modular-Cable</b> {<i>slot/subslot/bay</i>   <i>slot/port</i>} {<b>rf-channel</b> <i>group list</i>}}</p> <p><b>Example:</b></p> <pre>Router(config-lb-group)# downstream integrated-Cable 5/0/0 rf-channel 2</pre>	<p>Sets the downstream RF channels.</p> <p><b>Note</b> The <b>Integrated-Cable</b> and <b>Modular-Cable</b> parameters are available only on the Cisco uBR10012 universal broadband router.</p>
Step 7	<p><b>upstream Cable</b> {<i>slot/subslot/port</i>   <i>slot/port</i>} <i>upstream-list</i></p> <p><b>Example:</b></p> <pre>Router(config-lb-group)# upstream Cable 1/0 2</pre>	<p>Sets upstream channels with the following parameters:</p>
Step 8	<p><b>docsis-policy</b> <i>policy-id</i></p> <p><b>Example:</b></p> <pre>Router(config-lb-group)# docsis-policy 0</pre>	<p>Assigns a policy to a group with the parameter that becomes the default policy assigned to the CM, if the CM does not choose a different policy.</p>
Step 9	<p><b>restricted</b></p> <p><b>Example:</b></p> <pre>Router(config-lb-group)# restricted</pre>	<p>Selects the restricted group type. By default, the general group type is selected.</p>
Step 10	<p><b>init-tech-ovr Cable</b> {<i>slot/subslot/port</i>   <i>slot/port</i>} <i>upstream Cable</i> {<i>slot/subslot/port</i> }   <i>slot/port upstream</i> <b>init-tech-list</b> <i>0-4</i> [<b>ucc</b>]</p> <p><b>Example:</b></p> <pre>Router(config-lb-group)# init-tech-ovr Cable 8/1/0 0 Cable 8/1/1 1 init-tech-list 1 ucc</pre>	<p>Sets DCC initialization techniques that overrides the physical upstream channel pair. The <b>init-tech-ovr</b> command can also be used to determine whether the UCC can be used for modems during dynamic upstream load balancing.</p> <p>The following parameters override the physical upstream channel pair:</p>

	Command or Action	Purpose
		<p><b>Note</b> The <b>init-tech-list</b> keyword accepts an upstream that is not added into the load balancing group. The upstream channel pair is invalid until the upstream is added. When the load balancing group is removed, all upstream channel pairs are also removed.</p>
<b>Step 11</b>	<p><b>service-type-id</b> <i>string</i></p> <p><b>Example:</b></p> <pre>Router (config-lb-group) # service-type-id commercial</pre>	<p>Adds a service type ID, with the following parameter, that is compared against the cable modem provisioned service type ID, to determine an appropriate restricted load balancing group (RLBG):</p>
<b>Step 12</b>	<p><b>tag</b> <i>tag name</i></p> <p><b>Example:</b></p> <pre>Router (config-lb-group) # tag t1</pre>	<p>Adds a tag to the RLBG.</p>
<b>Step 13</b>	<p><b>interval</b> <i>&lt;1-1000&gt;</i></p> <p><b>Example:</b></p> <pre>Router (config-lb-group) # interval 60</pre>	<p>Sets the time interval, the Cisco CMTS waits before checking the load on an interface.</p>
<b>Step 14</b>	<p><b>method</b> {modems   service-flows   utilization} {us-method {modems   service-flows   utilization}}</p> <p><b>Example:</b></p> <pre>Router (config-lb-group) # method modems us-method modems</pre>	<p>Selects the method the Cisco CMTS use to determine the load.</p>
<b>Step 15</b>	<p><b>policy</b> {pcmm   ugs   us-across-ds   pure-ds-load}</p> <p><b>Example:</b></p> <pre>Router (config-lb-group) # policy us-across-ds Router (config-lb-group) # policy ugs Router (config-lb-group) # policy pure-ds-load</pre>	<p>Selects the modems based on the type of service flow that are balanced.</p>
<b>Step 16</b>	<p><b>threshold</b> {load {minimum <i>&lt;1-100&gt;</i>   <i>&lt;1-100&gt;</i>}   pcmm <i>&lt;1-100&gt;</i>   stability <i>&lt;0-100&gt;</i>   ugs <i>&lt;1-100&gt;</i>}</p> <p><b>Example:</b></p> <pre>Router (config-lb-group) # threshold load minimum 10 Router (config-lb-group) # threshold pcmm 70 Router (config-lb-group) # threshold load 10 Router (config-lb-group) # threshold stability 50 Router (config-lb-group) # threshold ugs 70</pre>	<p>Selects the percentage of use beyond which load balancing occurs.</p>

	Command or Action	Purpose
Step 17	<b>exit</b>  <b>Example:</b> Router# <b>exit</b>	Exits DOCSIS LBG configuration.

## Configuring DOCSIS 3.0 GLBG

The following sections describe how to configure a DOCSIS 3.0 GLBG and also how to configure default values of DOCSIS 3.0 certification for the DOCSIS 3.0 general group:



**Note** Starting with Cisco IOS Release 12.2(33)SCF1, when a Cable interface on the Cisco uBR10-MC5X20U/H line card is shut down, the associated DOCSIS 3.0 GLBGs are removed from the running-configuration. However, if the Cable interface is later releases 'no shut', the configuration of the GLBGs is restored in the running-configuration. This behavior is now consistent with the Cable interfaces on the Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V line cards.

### Configuring a DOCSIS 3.0 General Load Balancing Group

This section describes how to configure a DOCSIS 3.0 general load balancing group.

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable load-balance docsis-enable</b>  <b>Example:</b> Router (config)# <b>cable load-balance docsis-enable</b>	Enables DOCSIS load balancing on the Cisco CMTS.



	Command or Action	Purpose
<b>Step 4</b>	<p><b>cable load-balance docsis-group FN <i>fn-id</i> MD <i>cable</i> {<i>slot/subslot/port</i>   <i>slot/port</i>}</b></p> <p><b>Example:</b> Router(config)# <b>cable load-balance docsis-group FN 1 MD c5/0/0</b></p>	Enters the DOCSIS load balancing group configuration mode.
<b>Step 5</b>	<p><b>init-tech-list <i>tech-list</i> [ucc]</b></p> <p><b>Example:</b> Router(config-lb-group)# <b>init-tech-list 1 ucc</b></p>	Sets the DCC initialization technique list, with the following parameters.
<b>Step 6</b>	<p><b>disable</b></p> <p><b>Example:</b> Router(config-lb-group)# <b>disable</b></p>	Disables the load balance group.
<b>Step 7</b>	<p><b>docsis-policy <i>policy-id</i></b></p> <p><b>Example:</b> Router(config-lb-group)# <b>docsis-policy 0</b></p>	Sets the load balance group policy.
<b>Step 8</b>	<p><b>interval <i>I-1000</i></b></p> <p><b>Example:</b> Router(config-lb-group)# <b>interval 10</b></p>	Sets the interface polling interval.
<b>Step 9</b>	<p><b>method {<i>modems</i>   <i>service-flows</i>   <i>utilization</i>} {<i>us-method</i> {<i>modems</i>   <i>service-flows</i>   <i>utilization</i>}}</b></p> <p><b>Example:</b> Router(config-lb-group)# <b>method modems us-method modems</b></p>	Sets the load balancing type or method.
<b>Step 10</b>	<p><b>policy {<i>pcmm</i>   <i>ugs</i>   <i>us-across-ds</i>   <i>pure-ds-load</i>}</b></p> <p><b>Example:</b> Router(config-lb-group)# <b>policy us-across-ds</b></p>	Sets load balancing policy.
<b>Step 11</b>	<p><b>threshold {<i>load</i> {<i>minimum</i> <i>I-100</i>   <i>I-100</i>}   <i>pcmm</i> <i>I-100</i>   <i>stability</i> <i>0-100</i>   <i>ugs</i> <i>I-100</i>}</b></p> <p><b>Example:</b> Router(config-lb-group)# <b>threshold pcmm 70</b></p>	Sets the load balancing threshold in percentage.
<b>Step 12</b>	<p><b>exit</b></p> <p><b>Example:</b> Router# <b>exit</b></p>	Exits the DOCSIS load balancing group configuration mode.

## Configuring Default Values of DOCSIS 3.0 Load Balancing Group

This section describes how to configure default values of DOCSIS 3.0 certification for a DOCSIS 3.0 general group on the Cisco CMTS. A DOCSIS 3.0 general group is automatically created for each MD-CM-SG derived from the fiber node (FN) configuration, and the group parameters are set as default values.



**Note** The configured default values of DOCSIS 3.0 certification are applicable to the new automatically created DOCSIS 3.0 GLBGs and do not affect the existing DOCSIS 3.0 GLBGs. When a DOCSIS 3.0 GLBG is removed and recreated, its group parameters do not change.



**Note** Starting with Cisco IOS Release 12.2(33)SCH, the default settings for interface polling interval, load balancing method, policy for modems selection, and threshold usage in percent, can be configured for DOCSIS 3.0 general group. For more information, see the [Cisco IOS CMTS Cable Command Reference](#).

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<code>enable</code>  <b>Example:</b> Router> <code>enable</code>	Enables privileged EXEC mode.  • Enter your password if prompted.
<b>Step 2</b>	<code>configure terminal</code>  <b>Example:</b> Router# <code>configure terminal</code>	Enters global configuration mode.
<b>Step 3</b>	<code>cable load-balance d30-ggrp-default disable</code>  <b>Example:</b> Router(config)# <code>cable load-balance d30-ggrp-default disable</code>	Disables the default values of the DOCSIS 3.0 general load balance group (GLBG).
<b>Step 4</b>	<code>cable load-balance d30-ggrp-default init-tech-list tech-list</code>  <b>Example:</b> Router(config)# <code>cable load-balance d30-ggrp-default init-tech-list 1</code>	Sets the default DOCSIS 3.0 GLBGs DCC and dynamic bonding change (DBC) initialization techniques.
<b>Step 5</b>	<code>cable load-balance d30-ggrp-default docsis-policy 0-0xffffffff</code>  <b>Example:</b> Router(config)# <code>cable load-balance d30-ggrp-default docsis-policy 2</code>	Sets the default DOCSIS 3.0 GLBGs policy ID.

	Command or Action	Purpose
Step 6	<b>exit</b>  <b>Example:</b> Router# <b>exit</b>	Exits the global configuration mode.

## Configuring Cable Modems to RLBG or a Service Type ID

This section shows how to configure a list of cable modems that are statically provisioned at the Cisco CMTS to a RLBG or a service type ID.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable load-balance restrict modem</b> <i>index mac-addr [mac-mask] {docsis-group docsis-group-id   service-type-id string}</i>  <b>Example:</b> Router(config)# <b>cable load-balance restrict modem 1 001a.c30c.7eee FFFF.FFFF.0000 docsis-group 100</b>	Assigns a modem or a group of modems with a common MAC mask to a load balancing group or a service type ID.
Step 4	<b>exit</b>  <b>Example:</b> Router# <b>exit</b>	Exits the global configuration mode.

## Configuring Rules and Policies

This section shows how to create and configure rules and DOCSIS policies to restrict the movement of modems during load balancing. Rules determine whether a modem can be moved and during which time periods. The time periods are measured in seconds with the start time being an offset from midnight measured in seconds. Rules are created individually and can be combined into policies. The user is able to create DOCSIS policies

that consist of one or more rules. When more than one rule is part of a DOCSIS policy, all rules apply. Each group has a default DOCSIS policy.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><b>enable</b></p> <p><b>Example:</b> Router&gt; <b>enable</b></p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
Step 2	<p><b>configure terminal</b></p> <p><b>Example:</b> Router# <b>configure terminal</b></p>	<p>Enters global configuration mode.</p>
Step 3	<p><b>cable load-balance rule rule-id</b></p> <p><b>Example:</b> Router(config)# <b>cable load-balance rule 1</b></p>	<p>Creates a rule to prevent the modem from being moved.</p>
Step 4	<p><b>cable load-balance rule rule-id {enabled   disabled   {disable-period dis-start 0-86400 dis-period &lt;0-86400&gt;}   disable-throughput-lowerbound ds   us thrupt in kbps   vdoc-enabled}</b></p> <p><b>Example:</b> Router(config)# <b>cable load-balance rule 1 disable-period dis-start 40 dis-period 50</b></p>	<p>Configures the rule.</p> <p><b>Note</b> Static multicast groups should be configured on the appropriate bundle interface as well as on the correct forwarding interfaces to enable this rule. This feature will not be supported on load balancing groups which are derived from fiber node configuration and with multicast encryption.</p>
Step 5	<p><b>cable load-balance docsis-policy policy-id rule rule-id</b></p> <p><b>Example:</b> Router(config)# <b>cable load-balance docsis-policy 2 rule 1</b></p>	<p>Associates a particular rule with the DOCSIS policy with the following parameters:</p>
Step 6	<p><b>exit</b></p> <p><b>Example:</b> Router# <b>exit</b></p>	<p>Exits the global configuration mode.</p>

## Troubleshooting Tips

**Problem** When you disable load balancing and enable it for the next day using the **cable load-balance rule rule-id disable-period dis-start start-time dis-period disable-period** command, the load balancing is enabled at 12.00 am instead of the configured *disable-period*.

**Possible Cause** Load balancing rule cannot be disabled and enabled on the next day (that is, after 24 hours) using a single load balancing rule.

**Solution** Configure separate load balancing rules for disabling load balancing and enabling it on the next day. Configure the rule to disable load balancing using the **cable load-balance rule rule-id disable-period dis-start**

*start-time* **dis-period 0** command. Configure the rule to enable load balancing using the **cable load-balance rule rule-id disable-period dis-start 0 dis-period disable-period** command to enable it for the next day.

## Configuring Load Balancing Parameter for a Cable Modem Movement Failure

This section describes how to configure the number of times a CM can fail before the CM is removed from the dynamic load balancing group.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  • Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable load-balance modem max-failures 0-100</b>  <b>Example:</b> Router(config)# <b>cable load-balance modem max-failures 10</b>	Configures the number of times a CM can fail before the CM is removed from the dynamic load balancing group.
Step 4	<b>exit</b>  <b>Example:</b> Router# <b>exit</b>	Exits the global configuration mode.

## Creating and Configuring TLV type Tag

Cisco IOS Release 12.2(33)SCH introduces the **tlv** command for TLV type configuration.

The tags for TLV type matching rule are created and configured in this section.

### DETAILED STEPS

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

	Command or Action	Purpose
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable tag 1-1000</b>  <b>Example:</b> Router (config)# <b>cable tag 1</b>	Creates a tag. Enters the cmts-tag configuration mode.
Step 4	<b>name tag name</b>  <b>Example:</b> Router (cmts-tag)# <b>name CSCO</b>	Specifies the name of the tag.
Step 5	<b>[exclude] service-type-id service-type-id</b>  <b>Example:</b> Router (cmts-tag)# <b>service-type-id HSD</b>	Configures the specified service type ID for the tag.
Step 6	<b>[exclude]service-class service-class-name</b>  <b>Example:</b> Router (cmts-tag)# <b>service-class work</b>	Configures the specified service class name for the tag.
Step 7	<b>[exclude] docsis-version docsis version</b>  <b>Example:</b> Router (cmts-tag)# <b>docsis-version docsis20</b>	Configures the specified DOCSIS version of the cable modem for the tag.
Step 8	<b>[exclude] oui oui of CM</b>  <b>Example:</b> Router (cmts-tag)# <b>oui 00.1a.c3</b>	Configures the specified OUI of the cable modem for the tag.
Step 9	<b>[exclude] tlv type value</b>  <b>Example:</b> Router (cmts-tag)# <b>tlv mrccs 4</b>	Configures the specified TLV type for the tag.
Step 10	<b>override</b>  <b>Example:</b> Router (cmts-tag)# <b>override</b>	Overrides the TLV or SNMP during load balancing an RLBG.
Step 11	<b>exit</b>  <b>Example:</b> Router (cmts-tag)# <b>exit</b>	Exits the cmts-tag configuration mode.

	Command or Action	Purpose
Step 12	<b>cable load-balance docsis-group</b> <i>docsis-group-id</i>  <b>Example:</b> Router(config)# <b>cable load-balance docsis-group 1</b>	Creates a DOCSIS load balancing group on the Cisco CMTS.  If the DOCSIS load balancing group is already present, the router enters the specified DOCSIS load balancing group configuration mode.
Step 13	<b>tag</b> <i>tag name</i>  <b>Example:</b> Router(config-lb-group)# <b>tag CSCO</b>	Adds a tag to the load balancing group.
Step 14	<b>exit</b>  <b>Example:</b> Router(config-lb-group)# <b>exit</b>	Exits the DOCSIS load balancing group configuration mode.
Step 15	<b>cable load-balance docsis-policy</b> <i>policy-id tag tag name [override]</i>  <b>Example:</b> Router(config)# <b>cable load-balance docsis-policy 2 tag CSCO</b>	Creates a DOCSIS policy and associates a new rule or an existing rule with the policy.
Step 16	<b>exit</b>  <b>Example:</b> Router# <b>exit</b>	Exits the global configuration mode.

## Configuration Examples for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

This section describes a sample configuration example for configuring Restricted/General Load Balancing and narrowband dynamic bandwidth sharing with downstream dynamic load balancing:

### Example: Configuring a Tag

The following example shows how you can configure the tag to exclude a DOCSIS version, a MAC address, a service class name or a service type ID:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# cable tag 1
Router(cmts-tag)# exclude ?
    docsis-version  set the match rule for docsis version
```

Example: Disabling Load Balancing

```

    oui                set the match rule for oui
    service-class      set the match rule for service class name
    service-type-id    set the match rule for service type id
Router(cmts-tag)# exclude docsis-version ?
docsis10 Match docsis 1.0 modems
docsis11 Match docsis 1.1 modems
docsis20 Match docsis 2.0 modems
docsis30 Match docsis 3.0 modems
Router(cmts-tag)# exclude docsis-version docsis10
Router(cmts-tag)# exclude oui ?
WORD OUI of the vendor in the format xx.xx.xx or xx:xx:xx
Router(cmts-tag)# exclude oui 00.1a.c3
Router(cmts-tag)# exclude service-class ?
WORD Service class name
Router(cmts-tag)# exclude service-class work
Router(cmts-tag)# exclude service-type-id ?
WORD Service Type ID
Router(cmts-tag)# exclude service-type-id commercial

```

## Example: Disabling Load Balancing

Use the following commands to disable DOCSIS 3.0 GLBG:

```

Router(config)# cable load-balance docsis-group FN 1 MD cable 6/0/0
Router(config-lb-group)# disable
Router(config-lb-group)#

```

Use the following commands to disable DOCSIS 3.0 RLBG:

```

Router(config)# cable load-balance docsis-group 1
Router(config-lb-group)# disable
Router(config-lb-group)#

```

# Verifying Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

This section describes how to use certain show commands to verify the configuration of the Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing feature.

### DETAILED STEPS

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



	Command or Action	Purpose
Step 2	<p><b>show cable load-balance docsis-group</b> <i>{docsis-group-id}</i> <b>FN</b> <i>fn-id</i> <b>MD</b> <i>slot/subslot/port</i>   <i>slot/port</i> } <b>[all   load   pending   statistics   target   modem-list   primary-load]</b></p> <p><b>Example:</b>                      Router# <b>show cable load-balance docsis-group 1</b>                      Router# <b>show cable load-balance docsis-group fn 1 MD c8/1/4</b></p>	Displays real-time configurational, statistical, and operational information of the load balancing operations on the router.
Step 3	<p><b>show cable fiber-node</b> <i>fiber-node-id</i> <b>[spectrum]</b></p> <p><b>Example:</b>                      Router# <b>show cable fiber-node 3</b></p>	Displays information about a fiber node.
Step 4	<p><b>show cable load-balance</b> <b>[group n]</b>   <b>[all   load   pending   statistics   target   fiber-node-validation]</b></p> <p><b>Example:</b>                      Router# <b>show cable load-balance group 1</b></p>	Displays real-time statistical and operational information for load balancing operations. If given without any options, this command displays information for the load balancing groups and each cable interface's current load and load balancing status.
Step 5	<p><b>show cable modem</b> <b>[ip-address   mac-address   cable slot/port [upstream port ]   name fqdn]</b> <b>[verbose]</b></p> <p><b>Example:</b>                      Router# <b>show cable modem 40.3.160.15 verbose</b></p>	Displays information for the registered and unregistered CMs.

### Examples

Use the **show cable load-balance docsis-group** command to see the DOCSIS group status and to see the list of modems in the group, use the **show cable fiber-node** command to see the information on fiber nodes, use the **show cable load-balance** command to see information on LBG and DOCSIS channels, and use the **show cable modem** command to see the information on all the CMs.

The following examples show the output of the **show cable load-balance docsis-group** command:

```

Router# show cable load-balance docsis-group 2
DOCSIS LB Enabled: Yes
DOCSIS Group Status Interval DCC mask Policy Method Threshold
Group Index /UCC DS/US M/E/U/P/S
2 82 RE 10 0xF8(0)/N 0 s/s 1/1/70/70/50
Router# show cable load-balance docsis-group 1 modem-list
US Group Index Mac Address Priority
Mo1/0/0:0/U0 81 (1) 0000.ca45.9898 0
Mo1/0/0:0/U1 81 (0) 0013.711c.0820 0
Mo1/0/0:0/U2 81 (2) 0016.924f.8300 0
    
```

Effective from Cisco IOS Release 12.2(33)SCH, the output of the **show cable load-balance docsis-group** command is modified to include an additional field MUPFXLR to display more status information on the modems in the DOCSIS groups. For more information, see the [Cisco IOS CMTS Cable Command Reference](#).

The following example shows the modified output of the **show cable load-balance docsis-group** command:

```
Router#show cable load docsis-group fn 1 md c6/0/0 modem-list
Load for five secs: 1%/0%; one minute: 2%; five minutes: 1%
Time source is NTP, 13:39:31.300 PDT Thu Mar 28 2013
Codes: M - Multicast, U - UGS, P - PCMM, F - Max-Failures, X - eXcluded
       L - L2vpn, R - RSVP
Primary DS      Grp Idx MAC Address      RCC-ID Bad Rfid Priority MUPFXLR
In6/0/0:0/UB   40448      (6)
                e448.c70c.98af 1                2      -----
                e448.c70c.9b76 1                2      -----
                e448.c70c.9c15 1                2      -----
                e448.c70c.9a92 1                2      -----
                e448.c70c.99e4 1                2      -----
                e448.c70c.9a35 1                2      -----
In6/0/0:0/U0   40448      (0)
In6/0/0:0/U1   40448      (1)
                e448.c70c.9915                2      -----
In6/0/0:0/U2   40448      (0)
In6/0/0:0/U3   40448      (0)
In6/0/0:1/UB   40448      (5)
                e448.c70c.9abc 1                2      -----
                e448.c70c.993f 1                2      -----
                e448.c70c.9927 1                2      -----
                e448.c70c.9b82 1                2      -----
                4458.2945.2cb8 1                2      -----
In6/0/0:1/U0   40448      (0)
In6/0/0:1/U1   40448      (0)
In6/0/0:1/U2   40448      (0)
In6/0/0:1/U3   40448      (0)
In6/0/0:2/UB   40448      (5)
                e448.c70c.9759 1                2      -----
                e448.c70c.9a0e 1                2      -----
                e448.c70c.992d 1                2      -----
                e448.c70c.9a38 1                2      -----
                0025.2ed9.9984 1                2      -----L-
In6/0/0:2/U0   40448      (0)
In6/0/0:2/U1   40448      (0)
In6/0/0:2/U2   40448      (0)
In6/0/0:2/U3   40448      (0)
In6/0/0:3/UB   40448      (5)
                e448.c70c.9c00 1                2      -----
                e448.c70c.99a5 1                2      -----
                e448.c70c.9a5f 1                2      -----
                e448.c70c.9a3b 1                2      -----
                e448.c70c.96b1 1                2      -----
In6/0/0:3/U0   40448      (0)
In6/0/0:3/U1   40448      (0)
In6/0/0:3/U2   40448      (0)
In6/0/0:3/U3   40448      (0)
```

The following example shows the output of the **show cable fiber-node** command:

```
Router# show cable fiber-node
Fiber-Node          Config Status
Fiber-Node 1
  Modular-Cable 1/0/0: 0-1
  FN Config Status: Configured (status flags = 0x01)
  MDD Status: Valid
```

The following examples show the output of the **show cable load-balance** command:

```
Router#show cable load-balance
Group Interval Method      DCC Init  Threshold
                Technique  Minimum  Static  Enforce  Ugs  PCMM
1      10      service-flows  1         1         2%      2%      ---      ---
2      10      modems        0         5         10%     ---      ---
```

```

DOCSIS LB Enabled: No
Router# show cable load-balance load
Interface          State      Group  Utilization  Reserved Modems  Flows  Weight
                  Index
Cable5/0/3 (459 MHz) up         1      0% (0%/0%)   0%      7      7      37
Cable5/0/3/U0      up         1      0%           0%      2      2      1.2
Cable5/0/3/U1      up         1      0%           0%      2      2      1.2
Cable5/0/3/U2      up         1      0%           0%      2      2      1.2
Cable5/0/3/U3      up         1      0%           0%      1      1      1.2
Cable5/0/4 (465 MHz) up         1      0% (0%/0%)   0%      7      7      37
Cable5/0/4/U0      up         1      0%           0%      1      1      1.2
Cable5/0/4/U1      up         1      0%           0%      2      2      1.2
Cable5/0/4/U2      up         1      0%           0%      2      2      1.2
Cable5/0/4/U3      up         1      0%           0%      2      2      1.2
Mo1/0/0:0 (555 MHz) down       1      0% (0%/0%)   0%      0      0      0
Router# show cable load-balance fiber-node-validation
DOCSIS LBG ID      Match      Channel      Fiber-node list
1                  match      Ca5/0/0/U0 {1}
                  Ca5/0/0/U1 {1}
                  Ca5/0/0/U2 {1}
                  Ca5/0/0/U3 {1}
                  Mo1/0/0:0 {1}
                  Mo1/0/0:1 {1}
2                  mismatch  Ca5/0/0/U0 {1}
                  Ca5/0/0/U1 {1}
                  Ca5/0/0/U2 {1}
                  Ca5/0/0/U3 {1}
                  Ca5/0/0 {}
    
```

The following example shows the output of the **show cable modem** command:

```

Router# show cable modem 40.3.160.19 verbose
LB group ID assigned(index)      : 1(81)
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      :
    
```

In Cisco IOS Release 12.2(33)SCF, DOCSIS 3.0 GLBG is generated dynamically by the fiber node configuration, if a valid fiber node is configured.

For example, if the fiber node configuration is:

```

cable fiber-node 2
  downstream Modular-Cable 1/0/0 rf-channel 0-3
  downstream Cable7/0/0
  upstream Cable 7/0 connector 0-3
!
    
```

The GLBG generated by this fiber node is similar to:

```

Router# show cable load-balance docsis-group fn 2 md cable 7/0/0
DOCSIS 3.0 General LB
MD      FN      Group S Intv DCC mask Policy      Mtd MD-CM-SG Threshold
Index                                     /UCC      M/E/U/P/S
Ca7/0/0 2      48129 E 30  0xF8(0)/N 0      m/m 0x3C0101 5/10/70/70/50
    
```

```

Router# show cable load-balance docsis-group fn 2 md cable 7/0/0 all
DOCSIS 3.0 General LB
MD      FN      Group S Intv DCC mask Policy      Mtd MD-CM-SG Threshold
Index                                     /UCC      M/E/U/P/S
Ca7/0/0 2      48129 E 30  0xF8(0)/N 0      m/m 0x3C0101 5/10/70/70/50
    
```

Verifying Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

```

Current load:
DOCSIS load-balancing load
Interface          State   Group  Utilization  Rsvd  NBCM  WB/UB  Flows  Weight
                  State   Index
Cable7/0/0 (333 MHz) up      48129  0%(0%/0%)   0%    2     8     7     37
Cable7/0/0/U0      up      48129  0%           0%   22     7     29    7.6
Cable7/0/0/U1      up      48129  0%           0%   21     8     28    7.6
Cable7/0/0/U2      up      48129  0%           0%   21     8     28    7.6
Cable7/0/0/U3      up      48129  0%           0%   20    10     30    7.6
Mo1/0/0:0 (501 MHz) up      48129  0%(0%/0%)   0%    2    63     2     36
Mo1/0/0:0/U0      up      48129  0%           0%   22     7     29    7.6
Mo1/0/0:0/U1      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:0/U2      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:0/U3      up      48129  0%           0%   20    10     30    7.6
Mo1/0/0:1 (507 MHz) up      48129  0%(0%/0%)   0%    1    58     1     36
Mo1/0/0:1/U0      up      48129  0%           0%   22     7     29    7.6
Mo1/0/0:1/U1      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:1/U2      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:1/U3      up      48129  0%           0%   20    10     30    7.6
Mo1/0/0:2 (513 MHz) up      48129  0%(0%/0%)   0%    2    59     2     36
Mo1/0/0:2/U0      up      48129  0%           0%   22     7     29    7.6
Mo1/0/0:2/U1      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:2/U2      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:2/U3      up      48129  0%           0%   20    10     30    7.6
Mo1/0/0:3 (519 MHz) up      48129  0%(0%/0%)   0%    1    61     1     36
Mo1/0/0:3/U0      up      48129  0%           0%   22     7     29    7.6
Mo1/0/0:3/U1      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:3/U2      up      48129  0%           0%   21     8     28    7.6
Mo1/0/0:3/U3      up      48129  0%           0%   20    10     30    7.6
Target assignments:
Interface          State   Group  Target
                  State   Index
Cable7/0/0 (333 MHz) up      48129
Cable7/0/0/U0      up      48129
Cable7/0/0/U1      up      48129
Cable7/0/0/U2      up      48129
Cable7/0/0/U3      up      48129
Mo1/0/0:0 (501 MHz) up      48129  Mo1/0/0:1 (507 MHz)
Mo1/0/0:0/U0      up      48129
Mo1/0/0:0/U1      up      48129
Mo1/0/0:0/U2      up      48129
Mo1/0/0:0/U3      up      48129
Mo1/0/0:1 (507 MHz) up      48129
Mo1/0/0:1/U0      up      48129
Mo1/0/0:1/U1      up      48129
Mo1/0/0:1/U2      up      48129
Mo1/0/0:1/U3      up      48129
Mo1/0/0:2 (513 MHz) up      48129
Mo1/0/0:2/U0      up      48129
Mo1/0/0:2/U1      up      48129
Mo1/0/0:2/U2      up      48129
Mo1/0/0:2/U3      up      48129
Mo1/0/0:3 (519 MHz) up      48129
Mo1/0/0:3/U0      up      48129
Mo1/0/0:3/U1      up      48129
Mo1/0/0:3/U2      up      48129
Mo1/0/0:3/U3      up      48129
Statistics:
Target interface   State   Transfers
                  State   Complete Pending  Retries  Failures
Cable7/0/0 (333 MHz) up      8         0         0         0
Cable7/0/0/U0      up     30         0         0         0
Cable7/0/0/U1      up     83         0         0         0
Cable7/0/0/U2      up     48         0         0         0
Cable7/0/0/U3      up     34         0         0         0
Mo1/0/0:0 (501 MHz) up     19         0         0         0
Mo1/0/0:0/U0      up     33         0         0         0
Mo1/0/0:0/U1      up     46         0         0         0
Mo1/0/0:0/U2      up     22         0         0         0
Mo1/0/0:0/U3      up     22         0         0         0
Mo1/0/0:1 (507 MHz) up     22         0         0         0
Mo1/0/0:1/U0      up     9          0         0         0
Mo1/0/0:1/U1      up    19         0         0         0

```

Mo1/0/0:1/U2	up	15	0	0	0		
Mo1/0/0:1/U3	up	21	0	0	0		
Mo1/0/0:2 (513 MHz)	up	21	0	0	0		
Mo1/0/0:2/U0	up	4	0	0	0		
Mo1/0/0:2/U1	up	3	0	0	0		
Mo1/0/0:2/U2	up	6	0	0	0		
Mo1/0/0:2/U3	up	7	0	0	0		
Mo1/0/0:3 (519 MHz)	up	9	0	0	0		
Mo1/0/0:3/U0	up	1	0	0	0		
Mo1/0/0:3/U1	up	2	0	0	0		
Mo1/0/0:3/U2	up	4	0	0	0		
Mo1/0/0:3/U3	up	4	0	0	0		
Pending:							
Modem	Grp Idx	Primary RF/RCC	MD/TCS	Action	Active Retries		
	Src	Target	Src	Target	Time		

## Additional References

The following sections provide references related to the Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing feature.

### Related Documents

Related Topic	Document Title
Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change	Load Balancing, Dynamic Channel Change, and Dynamic Bonding Change on the Cisco CMTS Routers  <a href="http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_load-bal_dcc.html">http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_load-bal_dcc.html</a>
Cable commands	Cisco IOS CMTS Cable Command Reference, at the following URL:  <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>

### Standards and RFCs

Standards	Title
CM-SP-MULPIv3.0-I09-090121	Data-Over-Cable Service Interface Specifications MAC and Upper Layer Protocols Interface Specification

**MIBs**

MIB	MIBs Link
<ul style="list-style-type: none"> <li>• DOCS-LOADBALANCING-MIB</li> <li>• DOCS-LOADBAL3-MIB</li> </ul>	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

**Technical Assistance**

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

# Feature Information for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



**Note**

The table below 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 45: Feature Information for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing**

Feature Name	Releases	Feature Information
Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing	12.2(33)SCC	

Feature Information for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

Feature Name	Releases	Feature Information
		<p>In Cisco IOS Release 12.2(33)SCC, this feature was introduced on Cisco uBR10012 routers.</p> <p>The following section provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">Information About Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing, on page 315</a></li> <li>• The following commands were introduced or modified: <ul style="list-style-type: none"> <li>◦ <b>cable load-balance docsis-group</b></li> <li>◦ <b>cable load-balance d30-ggrp-default</b></li> <li>◦ <b>cable load-balance modem max-failures</b></li> <li>◦ <b>cable load-balance restrict modem</b></li> <li>◦ <b>cable tag</b></li> <li>◦ <b>show cable load-balance docsis-group</b></li> <li>◦ <b>show cable fiber-node</b></li> <li>◦ <b>cable load-balance docsis-enable</b></li> <li>◦ <b>docsis-policy</b></li> <li>◦ <b>docsis-version</b></li> <li>◦ <b>downstream</b></li> <li>◦ <b>init-tech-list</b></li> <li>◦ <b>init-tech-ovr</b></li> <li>◦ <b>interval</b></li> <li>◦ <b>method</b></li> <li>◦ <b>name</b></li> <li>◦ <b>oui</b></li> <li>◦ <b>override</b></li> <li>◦ <b>policy</b></li> <li>◦ <b>restricted</b></li> </ul> </li> </ul>



Feature Name	Releases	Feature Information
		<ul style="list-style-type: none"> <li>◦ <b>service-class (cmts-tag)</b></li> <li>◦ <b>service-type-id</b></li> <li>◦ <b>service-type-id (cmts-tag)</b></li> <li>◦ <b>tag</b></li> <li>◦ <b>threshold</b></li> </ul>
		<ul style="list-style-type: none"> <li>• <b>upstream (config-lb-group)</b></li> <li>• <b>cable load-balance rule</b></li> <li>• <b>show cable load-balance</b></li> <li>• <b>cable load-balance docsis-policy</b></li> </ul>
Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing	12.2(33)SCD	In Cisco IOS Release 12.2(33)SCD, this feature was introduced on Cisco uBR7200 series routers.
DOCSIS 2.0 multicast enhancement for VDOC.	12.2(33)SCD5	<p>This feature enables the customer to tune a DOCSIS 2.0 cable modem to a specific downstream having static multicast video forwarding on it.</p> <p>The following command was modified:</p> <ul style="list-style-type: none"> <li>• <b>cable load-balance rule</b></li> </ul>
Channel Assignment for RLBG/GLBG	12.2(33)SCF	<p>RLBG/GLBG channel assignment varies for different DOCSIS versions of cable modems.</p> <p>The following command was modified:</p> <ul style="list-style-type: none"> <li>• <b>show cable load-balance docsis-group</b></li> </ul>
Handling of Channel Assignment	12.2(33)SCF1	Handling of channel assignment when an LBG is disabled, is changed.
Auto-generate DOCSIS 2.0 GLBG	12.2(33)SCH	<p>Generates GLBG automatically for DOCSIS 2.0 fiber node configurations.</p> <p>The following command was introduced:</p> <p><b>cable load-balance d20 GLBG auto-generate</b></p>

Feature Information for Restricted/General Load Balancing and Narrowband Dynamic Bandwidth Sharing with Downstream Dynamic Load Balancing

Feature Name	Releases	Feature Information
Independent Upstream/Downstream Throughput Rules	12.2(33)SCH	Support for independent checking for upstream or downstream rules for load balancing. For upstream load balancing, upstream throughput rules are checked, and for downstream load balancing, downstream throughput rules are checked.
TLV type Tag	12.2(33)SCH	Configures a TLV type matching rule. The following command was modified: <b>cable tag</b> The following command was introduced: <b>tlv</b>



# CHAPTER 14

## RSVP-Based Video on Demand Support Over DOCSIS

---

**First Published:** December 17, 2008

The Cisco universal broadband router supports Video on Demand (VoD) over DOCSIS (Data Over Cable Service Interface Specification) services using a Resource ReSerVation Protocol (RSVP) bandwidth request from the VoD server. RSVP is used by the Cable Modem Termination System (CMTS) to request video data from the network for specific application data flows.

### 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 Configuring RSVP-Based Video on Demand Support Over DOCSIS](#), page 350
- [Restrictions for Configuring RSVP-Based Video on Demand Support Over DOCSIS](#), page 350
- [Information About RSVP-Based Video on Demand Support Over DOCSIS](#), page 351
- [How to Configure RSVP-Based Video over DOCSIS](#), page 352
- [Additional References](#), page 353
- [Feature Information for RSVP-Based Video over DOCSIS](#), page 354

## Prerequisites for Configuring RSVP-Based Video on Demand Support Over DOCSIS

The table below shows the hardware compatibility prerequisites for RSVP-Based video on demand support over DOCSIS.

**Table 46: Cable Hardware Compatibility Matrix for RSVP-Based Video on Demand Support Over DOCSIS**

CMTS Platform	Processor Engine	Cable Interface Line Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE2</li> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco uBR10-MC5X20S/U/H

The software prerequisites for the RSVP-based video on demand support over DOCSIS are:

- This feature does not require DOCSIS3.0 setup.
- The cable modems should be compliant with DOCSIS 1.1 or higher.
- The **ip rsvp bandwidth** command on the cable bundle interface should provide actual reserved bandwidth available.
- This feature is supported on all CMTS platforms.
- The **ip rsvp bandwidth** command should be configured on the WAN interface on the CMTS.
- IP routing is configured on CMTS so that the bundle interface can be reached from the video source.

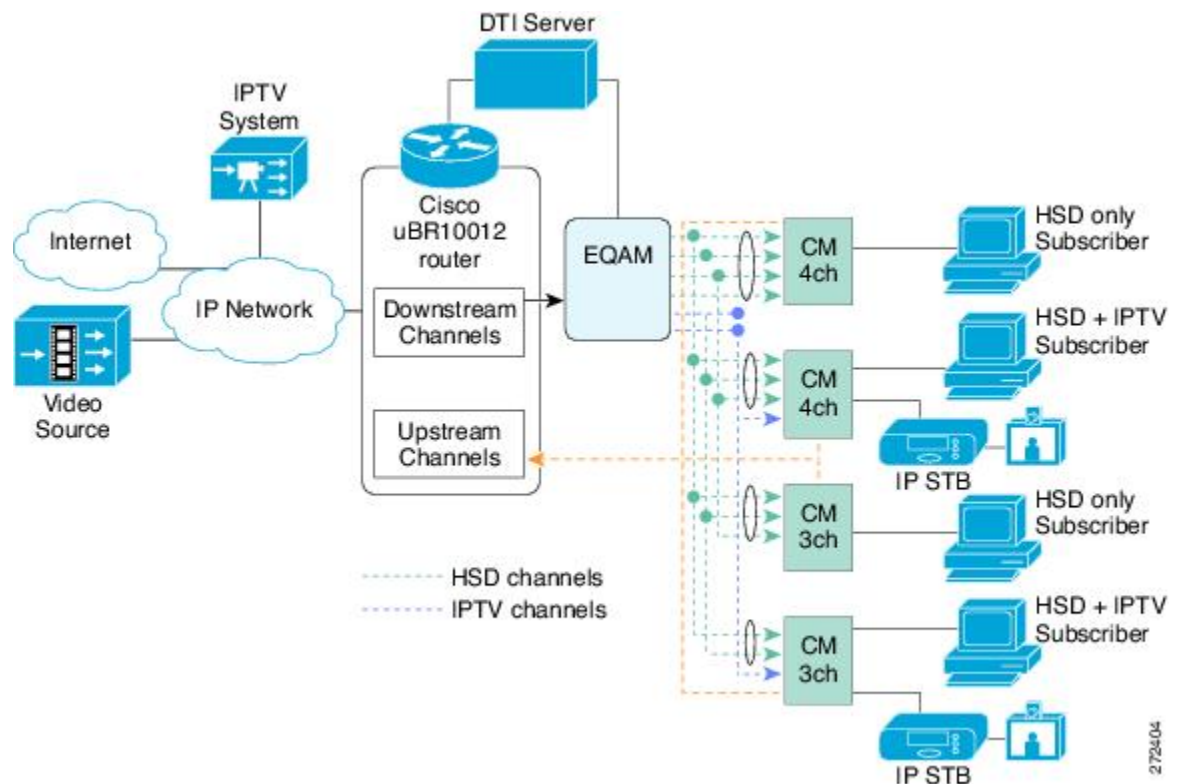
## Restrictions for Configuring RSVP-Based Video on Demand Support Over DOCSIS

- RSVP implementation supports IPv4 only.
- Upstream service flow creation is not supported.
- RSVP receiver proxy supports controlled-load service only.
- RSVP over MPLS VPN is not supported.

# Information About RSVP-Based Video on Demand Support Over DOCSIS

RSVP is used by a host to request specific quality of service (QoS) from the network for particular application data streams or flows. RSVP is used by the CMTS to deliver video requests along the data path of the flows and maintains the state to provide the requested service. RSVP requests generally result in resources being reserved in each node along the data path.

**Figure 5: Configuring RSVP-Based Video on Demand Support Over DOCSIS**



The following process is used to reserve DOCSIS resources on CMTS based on RSVP:

- 1 The CMTS intercepts the RSVP requests that are intended for the set-top boxes in the CMTS service area and reserves DOCSIS resources.
- 2 When a path message reaches the CMTS, it determines the DOCSIS resources required.
- 3 The CMTS creates a service flow and classifier to the cable modem.
- 4 The CMTS responds with a RSVP reserve message in the direction of the streamer.

# How to Configure RSVP-Based Video over DOCSIS

This section describes the configuration tasks that are performed when using the RSVP-based video over DOCSIS feature on the Cisco CMTS platforms. You can use the command-line interface (CLI) commands to complete the configuration.

## Configuring the RSVP Service Class

To specify the default service class for RSVP, use the **cable rsvp default-scn** command in global configuration mode. This command is used to specify DOCSIS service flow parameters such as activity time-out and service-flow attribute mask.

### DETAILED STEPS

	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 rsvp default-scn</b> <i>service-class name</i>  <b>Example:</b> Router(config)# <b>cable rsvp default-scn</b> <b>RSVPClass</b>	Specifies the default service class for RSVP.  • <i>service-class name</i> — The DOCSIS service class name.

## Displaying the RSVP-DOCSIS Flow Data

The RSVP-DOCSIS flow data contains details of the RSVP session and DOCSIS service flow identifier data structure.

### DETAILED STEPS

	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# <code>configure terminal</code>	Enters global configuration mode.
<b>Step 3</b>	<b>show cable rsvp flow-db [mac-addr]</b>  <b>Example:</b> Router(config)# <code>show cable rsvp flow-db</code>	Displays contents of the RSVP to DOCSIS service flow mapping database. <ul style="list-style-type: none"> <li>• <i>mac-addr</i>—(Optional) The MAC address of the specific cable modem in hexadecimal format.</li> </ul>

## Additional References

The following sections provide references related to configuring RSVP-based Video over DOCSIS.

### Related Documents

Related Topic	Document Title
CMTS cable commands	<i>Cisco IOS CMTS Cable Command Reference</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
Cisco uBR10012 Universal Broadband Router Documentation	<i>Cisco uBR10012 Universal Broadband Router Hardware</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/installation/guide/hig.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/installation/guide/hig.html</a>  <i>Cisco uBR10012 Universal Broadband Router Software Configuration Guide</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/configuration/guide/scg.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/configuration/guide/scg.html</a>  Cisco uBR10012 Universal Broadband Router Release Notes <a href="http://www.cisco.com/en/US/products/hw/cable/ps2209/prod_release_notes_list.html">http://www.cisco.com/en/US/products/hw/cable/ps2209/prod_release_notes_list.html</a>

### Standards and RFCs

RFC	Title
RFC 2205	Resource ReSerVation Protocol

RFC	Title
RFC 2210	The Use of RSVP with IETF Integrated Services

### Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>

## Feature Information for RSVP-Based Video over DOCSIS

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



### Note

The table below 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 47: Feature Information for RSVP-Based Video over DOCSIS**

Feature Name	Releases	Feature Information
RSVP-Based Video on Demand Support Over DOCSIS	12.2(33)SCB	<p>The Cisco universal broadband router supports VoD over DOCSIS services using a RSVP bandwidth request from the VoD server. RSVP is used by the CMTS to request video data from the network for specific application data flows.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"><li>• <a href="#">Configuring the RSVP Service Class, on page 352</a></li><li>• <a href="#">Displaying the RSVP-DOCSIS Flow Data, on page 352</a></li></ul>





# S-CDMA and Logical Channel Support on the Cisco CMTS Routers

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**First Published:** November 9, 2009

**Last Updated:** November 29, 2010

Cisco IOS Release 12.2(33)SCC introduces the S-CDMA and Logical Channel Support feature, which provides support for Synchronous Code Division Multiple Access (S-CDMA) upstream modulation profiles and logical channels on the Cisco cable modem termination systems (CMTS) routers.

## 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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- [Prerequisites for S-CDMA and Logical Channel Support, page 358](#)
- [Restrictions for S-CDMA and Logical Channel Support, page 359](#)
- [Information About S-CDMA and Logical Channel Support, page 360](#)
- [How to Configure S-CDMA and Logical Channel Support, page 364](#)
- [Monitoring the S-CDMA and Logical Channel Support, page 371](#)
- [Configuration Examples for S-CDMA and Logical Channel Support, page 374](#)
- [Additional References, page 380](#)
- [Feature Information for S-CDMA and Logical Channel Support on the Cisco CMTS Routers, page 382](#)

## Prerequisites for S-CDMA and Logical Channel Support

The table below shows the hardware compatibility prerequisites for this feature.

**Table 48: S-CDMA and Logical Channel Support for the Cisco CMTS Routers Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20H<sup>28</sup></li> <li>• Cisco UBR-MC20X20V<sup>29</sup></li> </ul> Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>30</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>31</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>32</sup></li> </ul>

<sup>28</sup> The S-CDMA feature is not supported on the Cisco uBR10-MC5X20H cable interface line card.

<sup>29</sup> The Cisco UBR-MC20X20V cable interface line card has three variants: Cisco UBR-MC20X20V-0D, Cisco UBR-MC20X20V-5D, and Cisco UBR-MC20X20V-20D. The Cisco UBR-MC20X20V-0D line card supports 20 upstreams and zero (no) downstreams. The Cisco UBR-MC20X20V-5D line card supports 20 upstreams and 5 downstreams, and the Cisco UBR-MC20X20V-20D line card supports 20 upstreams and 20 downstreams.

<sup>30</sup> Cisco uBR3GX60V cable interface line card is not compatible with PRE2. You must use PRE4 with the Cisco uBR3GX60V cable interface line card.

<sup>31</sup> The Cisco uBR-MC88V cable interface line card is not compatible with NPE-G1. You must use NPE-G2 with the Cisco uBR-MC88V cable interface line card.

<sup>32</sup> The Cisco uBR-MC88V cable interface line card is not compatible with NPE-G1. You must use NPE-G2 with the Cisco uBR-MC88V cable interface line card.



### Note

Any reference to the Cisco UBR-MC20X20V cable interface line card used in this document is also applicable to its three variants—Cisco UBR-MC20X20V-0D, Cisco UBR-MC20X20V-5D, and Cisco UBR-MC20X20V-20D.

- The cable physical plant must be capable of supporting the higher bandwidth S-CDMA modulation profiles.

- DOCSIS 2.0 compliant cable modems (CMs).
- DOCSIS 1.0 or DOCSIS 1.1 provisioned DOCSIS configuration file.
- Upstream configured for DOCSIS 2.0 S-CDMA or DOCSIS 3.0 S-CDMA mode.
- Complete a basic configuration of the Cisco uBR10012 router; this includes, at a minimum, the following tasks:
  - Configure a host name and password for the router.
  - Configure the router to support Internet Protocol (IP) operations.
  - Install and configure at least one Wide Area Network (WAN) adapter to provide backbone connectivity.
- Determine a channel plan for your router and all of its cable interfaces.
- Verify that your headend site includes all necessary servers to support DOCSIS and Internet connectivity, including Dynamic Host Configuration Protocol (DHCP), Time of Day (ToD), and Trivial File Transfer Protocol (TFTP) servers.
- The system clock on the router should be set to the current date and time to ensure that the system logs have the proper timestamp and the Baseline Privacy Interface Plus (BPI+) subsystem uses the correct timestamp for verifying cable modem digital certificates.

## Restrictions for S-CDMA and Logical Channel Support

The S-CDMA feature has the following restrictions and limitations:

- The S-CDMA feature is not supported on the Cisco uBR10-MC5X20H cable interface line card.
- DOCSIS 1.0 provisioned CM configuration file is not recommended or allowed for cable modems on the S-CDMA channel.
- The Cisco IOS Release 12.2(33)SCC supports a maximum of 10 modulation profiles for each of the DOCSIS 2.0 A-TDMA and S-CDMA modes. However, if you enable the global modulation profile there is no restriction on the number of modulation profiles you can use, and can assign any modulation profile number to any DOCSIS mode.
- Advanced hardware-based spectrum management features (such as guided frequency hopping, dynamic upstream modulation, and proactive carrier-to-noise ratio [CNR] based frequency hopping and channel width changes) are not supported for S-CDMA upstreams.
- Changing the DOCSIS mode of an upstream takes all cable modems on that upstream offline, which forces the cable modems to reregister, so that the CMTS can determine the capabilities of the cable modems on the new channels.
- For the S-CDMA high availability, there should be timestamp, minislot, and frame counters synchronization between the working and the protect line cards.
- The DOCSIS 3.0 option scdma-d3 (4SR) is available only when the CMTS is configured to operate in the global modulation profile format.
- If you revert to the legacy modulation profile from the global modulation profile, all the modulation profiles that are outside of the legacy number space range are lost.

The Logical Channel Support feature has the following restrictions and limitations:

- The CMTS must support the logical channel types 3S and 4SR individually on the Cisco uBR-MC88V cable interface line card.
- The Cisco uBR10-MC5X20H, Cisco UBR-MC20X20V, and Cisco uBR-MC88V cable interface line cards can only support up to two logical channels per physical port.
- The upstream bonding at the logical channel level is supported with the following limitations:
  - The upstream bonding of the logical channels from the same physical port (on the same radio frequency spectrum) is not allowed.
  - The upstream bonding is available only to the first logical channel on each physical port.
- Admission control policy cannot be configured at the logical channel level.
- Load balancing is restricted only to the first logical channel. However, the secondary logical channel can be selected as the source channel and not the target channel. That is, load balancing can only move modems from the secondary logical channel, and not to the secondary logical channel.

## Information About S-CDMA and Logical Channel Support

The following sections describe the S-CDMA and Logical Channel Support feature:

### S-CDMA Services

S-CDMA provides a number of advanced physical layer (PHY) capabilities as per the new DOCSIS 3.0 specifications, which improves the maximum upstream bandwidth on cable networks.

The S-CDMA feature allows the same physical RF upstream channel to receive multiple bursts simultaneously. It uses a two-dimensional (time and code) data transmission technique where multiple modems can simultaneously send their data, each using their own codes, in the same time slot. The codes are orthogonal in nature and do not interfere with each other.

Data is sent over an array of up to 128 spreading codes and all modems are required to transmit their data at precisely the same time. This means that the CMTS and modems have to be synchronized at the symbol clock level (known as synchronous CDMA).

A burst from a particular cable modem may be transmitted on two or more codes (out of the available 128 codes) in one or more frames. A frame can contain bursts transmitted simultaneously from multiple CMs (each on a separate subset of codes) defined as per MAP messages.

The S-CDMA feature allows cable system operators to utilize parts of the upstream below 20 MHz that was previously unusable due to noise conditions. This type of noise cannot be removed with the ingress noise cancellation technology available as part of the DOCSIS 2.0 standard.

The S-CDMA feature incorporates the following advantages and improvements on DOCSIS 3.0 networks:

- Upstreams can be configured for two different modes to support different mixes of cable modems:
  - S-CDMA mode to support DOCSIS 2.0 cable modems.
  - S-CDMA-d3 mode to support DOCSIS 3.0 cable modems.

- S-CDMA-d3 mode allows DOCSIS 3.0 modems to use all data interval usage codes (IUC) like IUC 5, 6, 9, 10, and 11 for data bursts.
- S-CDMA mode of operation provides higher bandwidth on the upstream using 64-QAM, 32-QAM, 16-QAM, 8-QAM, and QPSK modulation profiles.

The table below shows the maximum data rates supported on S-CDMA.

**Table 49: Maximum S-CDMA Data Rates**

Upstream Channel Width	Modulation Scheme	Baud Rate Sym/sec	Maximum Raw Bit Rate Mbit/sec
6.4 MHz	64-QAM	5.12 M	30.72
	32-QAM		25.60
	16-QAM		20.48
	8-QAM		15.36
	QPSK		10.24
3.2 MHz	64-QAM	2.56 M	15.36
	32-QAM		12.80
	16-QAM		10.24
	8-QAM		7.68
	QPSK		5.12
1.6 MHz	64-QAM	1.28 M	7.68
	32-QAM		6.40
	16-QAM		5.12
	8-QAM		3.84
	QPSK		2.56

## Modulation Profiles

To simplify the administration of Advanced Time Division Multiple Access (A-TDMA) and S-CDMA modulation profiles, the S-CDMA feature provides a number of preconfigured modulation profiles that are optimized for different modulation schemes. We recommend using these preconfigured profiles.

Each mode of operation also defines a default modulation profile that is automatically used when a profile is not specifically assigned to an upstream. These default modulation profiles (321 and 381) cannot be deleted.

A new global modulation profile is introduced in Cisco IOS Release 12.2(33)SCC, which allows you to assign any modulation profile number to any DOCSIS mode.

The table below lists the valid modulation profile ranges according to the cable interface and modulation type:

**Table 50: Allowable Ranges for Modulation Profiles**

Cable Interface	DOCSIS 2.0 (S-CDMA)	DOCSIS 3.0 (S-CDMA)
Cisco UBR-MC20X20V	321 to 330 (default is 321)	1 to 400 (default is 381)
Cisco uBR-MC88V	321 to 330 (default is 321)	1 to 400 (default is 381)

### Global Modulation Profile

Cisco IOS Release 12.2(33)SCC introduces the global modulation profile scheme, which allows you to assign any modulation profile number to any DOCSIS mode up to 400. It eliminates the number space restriction and increases the number of modulation profiles that can be created per DOCSIS mode. Currently, there is a restriction of 10 modulation profiles per DOCSIS mode.

In global modulation profile scheme, you can assign any number between 1 to 400 to any modulation profiles. The global modulation profile mode allows you to create and configure DOCSIS 3.0 channel type 4SR (scdma-d3). When the DOCSIS mode of an upstream is changed into scdma-d3, it is initially assigned to the system created default modulation profile as shown in [Table 50: Allowable Ranges for Modulation Profiles](#), on page 362.



#### Note

Though you can assign any number between 1 to 400 to any modulation profile, the default modulation profile number assigned to an upstream channel for a given channel type will remain the same. That is, modulation profile numbers 21, 121, 221, 321, and 381 will be applicable for TDMA, mixed, A-TDMA, S-CDMA, and DOCSIS 3.0 S-CDMA channel types.

All the existing and previously defined modulation profiles are converted to the new format. However, all the newly created modulation profiles, which are outside of the legacy number space range, will be lost when you revert to the legacy modulation profile.

The new global modulation profile scheme is enabled using the cable modulation-profile global-scheme command. For more details on this command, refer to the [Cisco IOS CMTS Cable Command Reference](#).

## Benefits

The S-CDMA feature provides the following benefits:

- Provides full compatibility with DOCSIS 2.0 and DOCSIS 3.0 cable modems (CMs) and cable modem termination systems (CMTS).
- Increases protection against electronic impairments that occur in cable systems, allowing for a more robust operating environment.
- Supports S-CDMA ingress noise cancellation technology that provide more knobs for fine tuning.
- Supports all existing upstream bonding capabilities for Time Division Multiple Access (TDMA) and A-TDMA channels under S-CDMA.
- Supports up to two logical channel combinations for the Cisco UBR-MC20X20V and Cisco uBR-MC8X8V cable interface line cards.
- Supports the In-Service Software Upgrade (ISSU) feature.



## Logical Channels

The concept of a logical channel refers to time-division multiplexing (TDM) of the same radio frequency (RF) spectrum allocated to one physical upstream port. All logical upstream channels defined within the physical upstream port share the same upstream RF spectrum or the bandwidth. The MAC-scheduler is responsible for managing how that common bandwidth is shared or distributed.

Using the Logical Channel Support feature, cable system operators can segment and time-multiplex one spectrum for supporting the legacy modems, near and far modems, and newer DOCSIS 3.0 modems with various service levels.

The Logical Channel Support feature provides the following benefits to cable service providers and their partners and customers:

- Switchovers between the same cable interface line cards at the logical channel level, as part of high availability (HA). For example, switchover from Cisco uBR10-MC5X20H line card to Cisco uBR10-MC5X20H line card is supported.
- Support for the In-Service Software Upgrade (ISSU) feature.

Each logical channel has its own Upstream Channel ID, upstream channel descriptor (UCD) messages, and Mini-slot Allocation Packet (MAP) messages. The logical channels on their own must satisfy the ranging and UCD change requirements that are imposed on a legacy standalone upstream channel.

The Cisco uBR10-MC5X20H and Cisco UBR-MC20X20V cable interface line cards support two logical channel combinations per physical port.

When two logical channels are configured through the **cable upstream max-logical-chans** command, both logical channels are mapped to the same physical port specified and the physical upstream bandwidth is shared between the two logical channels. However, from the cable modem perspective, each logical channel appears as an independent upstream channel.

When multiple logical channels are configured, the upstream-related commands are categorized into physical port level and logical channel level groups. Logical channel level commands use the format of **cable upstream n m**, where *n* denotes the physical port number, and *m* denotes the logical channel index number.

For more details on the **cable upstream max-logical-chans** command, refer to the [Cisco IOS CMTS Cable Command Reference](#).

## Spectrum Management on Logical Channels

Spectrum management allows you to prevent long-term service interruptions caused by upstream noise events in the cable plant. Spectrum management is also used for fault management and troubleshooting the cable network.

The Logical Channel Support feature supports all the basic spectrum management features. Some spectrum management features operate on the physical port level while others operate at the logical channel level.

The spectrum group assignment feature operates at the physical port level, and the Dynamic Upstream Modulation feature using Signal-to-Noise Ratio (SNR) operates at the logical channel level.

For more information on spectrum management, refer to the *Spectrum Management and Advanced Spectrum Management for the Cisco CMTS Routers* document at the following location: [http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts\\_spcrm\\_mgt.html](http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_spcrm_mgt.html)

## Load Balancing on Logical Channels

The Load Balancing (LB) feature allows cable system operators to distribute cable modems across RF downstream and upstream channels on the same cable interface line card, or across multiple cable interface line cards in some circumstances. Load balancing maximizes bandwidth and usage of the cable plant.

Load balancing is supported on logical channels using a two-tiered approach—the first level uses the traditional load balancing to move modems between the physical channels, and the second level moves modems amongst the logical channels.

The first level of load balancing (known as Cisco LB implementation) moves the modems amongst the physical upstream channels, identified in the load balancing group. It uses the aggregate upstream channel utilization statistics of a physical channel, including that of all logical channels, to perform load balancing.

The second level of load balancing moves modems among the logical channels defined within a physical channel (no outside moves). It is referred to as “per CM spectrum management” as it is strictly based on the physical channel parameters or conditions, or the physical layer capabilities of the CM.

For more information on the LB feature, refer to the *Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers* document at the following location: [http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr\\_load-bal\\_dcc.html](http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_load-bal_dcc.html)

## How to Configure S-CDMA and Logical Channel Support

This section describes the following tasks that are required to implement S-CDMA and Logical Channel Support:

### Creating Modulation Profiles

This section describes how to create modulation profiles for the different modes of DOCSIS operations, using the preconfigured modulation profile options.

**Note**

You can also create custom modulation profiles with the **cable modulation-profile** command by configuring the values for the individual burst parameters. These parameters, however, should not be modified unless you are thoroughly familiar with how changing each parameter affects the DOCSIS MAC layer. We recommend using the preconfigured default modulation profiles for most cable plants.

### Creating a DOCSIS 2.0 S-CDMA Modulation Profile

This section describes how to create a modulation profile for the DOCSIS 2.0 S-CDMA mode of operation, using one of the preconfigured modulation profiles.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable modulation-profile <i>profile</i> qam-16</b>  <b>Example:</b> Router(config)# <b>cable modulation-profile 322 qam-16</b>	Creates a preconfigured modulation profile, where the burst parameters are set to their default values for each burst type: <ul style="list-style-type: none"> <li>• <i>profile</i> —Modulation profile number. The valid range is from 321 to 330. The system creates profile 321 as the default modulation profile.</li> <li>• <b>qam-16</b>—Default 16-QAM profile.</li> </ul>
Step 4	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode and returns to privileged EXEC mode.

## Configuring a Global Modulation Profile

This section describes how to enable or configure a global modulation profile. The global modulation profile scheme eliminates the number space restriction associated with the legacy mode allowing you to assign any number between 1 to 400 to any modulation profiles.

**Note**

When you configure a global modulation profile, all the previous modulation profiles are automatically converted. However, when you revert back to the legacy mode, all the profiles that are outside of the legacy number space range are lost.

## DETAILED STEPS

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

	Command or Action	Purpose
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <code>configure terminal</code>	Enters global configuration mode.
Step 3	<b>cable modulation-profile global-scheme</b>  <b>Example:</b> Router(config)# <code>cable modulation-profile global-scheme</code>	Activates the global modulation profile scheme, where you can assign any number between 1 to 400 to any modulation profile.
Step 4	<b>exit</b>  <b>Example:</b> Router(config)# <code>exit</code>	Exits global configuration mode and returns to privileged EXEC mode.

## Creating a DOCSIS 3.0 S-CDMA Modulation Profile

This section describes how to create a modulation profile for the DOCSIS 3.0 S-CDMA mode of operation, using one of the preconfigured modulation profiles.



**Note** The `scdma-d3` option is available only after configuring the CMTS to operate in the global modulation profile mode. This option is not available in the default mode.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <code>enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <code>configure terminal</code>	Enters global configuration mode.
Step 3	<b>cable modulation-profile <i>profile</i> scdma-d3 qam-16</b>  <b>Example:</b> Router(config)# <code>cable modulation-profile 382 scdma-d3 qam-16</code>	Creates a preconfigured modulation profile, where the burst parameters are set to their default values for each burst type: <ul style="list-style-type: none"> <li><i>profile</i>—Modulation profile number. The valid range is from 1 to 400. The system creates profile 381 as the default modulation profile.</li> <li><code>scdma-d3</code>—Configures the upstream only for DOCSIS 3.0 S-CDMA modulation profiles.</li> </ul>

	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>• <b>qam-16</b>—Default 16-QAM profile.</li> </ul>
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode and returns to privileged EXEC mode.

## Configuring the DOCSIS Mode and Profile on an Upstream

This section describes how to configure an upstream for a DOCSIS mode of operation, and then to assign a particular modulation profile to that upstream.

### DETAILED STEPS

	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/port</i>   <i>slot/subslot/port</i> }  <b>Example:</b> Router(config)# <b>interface cable</b> 5/0/0	Enters interface configuration mode for the indicated cable downstream interface. <ul style="list-style-type: none"> <li>• On the Cisco uBR7246VXR router, the valid values are: <ul style="list-style-type: none"> <li>◦ <i>slot</i>—3 to 6</li> <li>◦ <i>port</i>—0 or 1 (depending on the cable interface)</li> </ul> </li> <li>• On the Cisco uBR7225VXR router, the valid values are: <ul style="list-style-type: none"> <li>◦ <i>slot</i>—1 and 2</li> <li>◦ <i>port</i>—0 or 1 (depending on the cable interface)</li> </ul> </li> <li>• On the Cisco uBR10012 router, the valid values are: <ul style="list-style-type: none"> <li>◦ <i>slot</i>—5 to 8</li> <li>◦ <i>subslot</i>—0 or 1</li> <li>◦ <i>port</i>—0 to 4 (depending on the cable interface)</li> </ul> </li> </ul>

	Command or Action	Purpose
<b>Step 4</b>	<p><b>cable upstream</b> <i>n</i> <b>docsis-mode</b> {<b>atdma</b>   <b>scdma</b>   <b>scdma-d3</b>   <b>tdma</b>   <b>tdma-atdma</b>}</p> <p><b>Example:</b>  <pre>Router(config-if)# cable upstream 0 docsis-mode atdma</pre></p>	<p>Configures the upstream for the desired DOCSIS mode of operation:</p> <ul style="list-style-type: none"> <li>• <i>n</i>—Upstream port number. Valid values are 0 to 3 by default, but can be increased to a maximum of 7 using the <code>cable upstream max-ports</code> command.</li> <li>• <b>atdma</b>—Configures the upstream only for DOCSIS 2.0 A-TDMA modulation profiles.</li> <li>• <b>scdma</b>—Configures the upstream only for DOCSIS 2.0 S-CDMA modulation profiles.</li> <li>• <b>scdma-d3</b>—Configures the upstream only for DOCSIS 3.0 S-CDMA modulation profiles.</li> <li>• <b>tdma</b>—Configures the upstream only for DOCSIS 1.X TDMA modulation profiles.</li> <li>• <b>tdma-atdma</b>—Configures the upstream for both, A-TDMA, and TDMA operations (mixed mode).</li> </ul> <p><b>Note</b> The <b>scdma-d3</b> mode is available only when the global modulation profile is used.</p>
<b>Step 5</b>	<p><b>cable upstream</b> <i>n</i> <b>modulation-profile</b> <i>profile</i> [<i>profile2</i>] [<i>profile3</i>]</p> <p><b>Example:</b>  <pre>Router(config-if)# cable upstream 0 modulation-profile 241</pre></p>	<p>Assigns the particular modulation profile to this upstream.</p> <ul style="list-style-type: none"> <li>• <i>profile</i>—Modulation profile used on this upstream. The valid range for the <i>profile</i> parameter depends on the current DOCSIS mode: <ul style="list-style-type: none"> <li>◦ If the upstream is configured for DOCSIS 2.0 S-CDMA, the valid range is from 321 to 330.</li> <li>◦ If the upstream is configured for DOCSIS 3.0 S-CDMA mode, the valid range is from 1 to 400.</li> </ul> </li> <li>• <i>profile2</i> —(Optional) Secondary modulation profile that the interface uses when noise on the upstream increases to the point that the primary modulation profile can no longer be used. (The secondary profile should specify a more robust profile than the primary profile to cope with the noise.)</li> <li>• <i>profile3</i> —(Optional) Tertiary modulation profile that the interface uses when noise on the upstream increases to the point that the secondary modulation profile can no longer be used.</li> </ul> <p><b>Note</b> The tertiary modulation profile is available only for the basic dynamic modulation. You cannot use the tertiary modulation profile when a spectrum group is defined for the upstream.</p> <p><b>Note</b> The type of modulation profiles must match the DOCSIS mode configured (using the <b>cable upstream docsis-mode</b> command) for the upstream.</p>

	Command or Action	Purpose
Step 6	<p><b>cable upstream <i>n</i> active-codes</b> <i>active-codes</i></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 active-codes 64</b></p>	<p>(Optional) Configures the number of active codes on an upstream channel.</p> <ul style="list-style-type: none"> <li>• <i>active-codes</i>—Number of active codes. The valid values range from 64 to 128. The active-codes have a default value of 112, when ingress noise cancellation is enabled; and a default value of 128, when ingress noise cancellation is disabled.</li> </ul>
Step 7	<p><b>cable upstream <i>n</i> channel-width</b> <i>first-choice-width</i></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 channel-width 3200000</b></p>	<p>(Optional) Specifies an upstream channel width for an upstream port.</p> <ul style="list-style-type: none"> <li>• <i>first-choice-width</i>—Upstream channel width in hertz (Hz). For valid values refer to the <b>cable upstream channel-width</b> command.</li> </ul>
Step 8	<p><b>cable upstream <i>n</i> codes-per-minislot</b> <i>minislot-code</i></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 codes-per-minislot 8</b></p>	<p>(Optional) Specifies the number of codes-per-minislot allowed on an upstream channel.</p> <ul style="list-style-type: none"> <li>• <i>minislot-code</i>—Number of codes-per-minislot. The valid values range from 2 to 32.</li> </ul>
Step 9	<p><b>cable upstream <i>n</i> max-codes-per-subframe</b> <i>subframe-codes</i></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 max-codes-per-subframe 128</b></p>	<p>(Optional) Specifies the upper limit that overrides the maximum value of codes-per-subframe defined in the individual modulation profile setting for an upstream channel.</p> <ul style="list-style-type: none"> <li>• <i>subframe-codes</i>—Number of codes-per-subframe. The valid values range from 1 to 128, with a default value of 2.</li> </ul>
Step 10	<p><b>cable upstream <i>n</i> spreading-interval</b> <i>spreading-interval</i></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 spreading-interval 32</b></p>	<p>(Optional) Specifies the spreading interval for S-CDMA channels on an upstream channel.</p> <ul style="list-style-type: none"> <li>• <i>spreading-interval</i>—Spreading interval for S-CDMA channels. The valid values range from 1 to 32, with a default value of 16.</li> </ul>
Step 11	<p><b>cable upstream <i>n</i> equalization-coefficient</b></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 equalization-coefficient</b></p>	<p>(Optional) Enables the use of a DOCSIS preequalization coefficient on an upstream.</p>
Step 12	<p><b>cable upstream <i>n</i> ingress-noise-cancellation <i>interval</i></b></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream</b> <b>0 ingress-noise-cancellation 400</b></p>	<p>(Optional) Configures, in milliseconds, how often the cable interface line card should sample the signal on an upstream to correct any ingress noise that has appeared on that upstream.</p> <ul style="list-style-type: none"> <li>• <i>interval</i>—Sample interval. The valid range is from 10 to 3000 milliseconds, with a default value of 200 milliseconds.</li> </ul> <p><b>Note</b> The ingress noise cancellation has to be disabled to use a default value of 128 for active-codes. When ingress noise cancellation is enabled, the active-codes has a default value of 112.</p>

	Command or Action	Purpose
		<b>Note</b> Repeat <a href="#">Step 3, on page 367</a> through <a href="#">Step 12, on page 369</a> for each cable interface and upstream to be configured.
<b>Step 13</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## Configuring the Logical Channel Support

This section describes how to configure logical channels for the Cisco uBR10-MC5X20H and Cisco UBR-MC20X20V cable interface line cards.

### DETAILED STEPS

	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/port</i>   <i>slot/subslot/port</i> }  <b>Example:</b> Router(config)# <b>interface cable</b> 5/0/0	Enters interface configuration mode for the indicated cable downstream interface. <ul style="list-style-type: none"> <li>• On the Cisco uBR7246VXR router, the valid values are: <ul style="list-style-type: none"> <li>◦ <i>slot</i>—3 to 6</li> <li>◦ <i>port</i>—0 or 1 (depending on the cable interface)</li> </ul> </li> <li>• On the Cisco uBR7225VXR router, the valid values are: <ul style="list-style-type: none"> <li>◦ <i>slot</i>—1 and 2</li> <li>◦ <i>port</i>—0 or 1 (depending on the cable interface)</li> </ul> </li> <li>• On the Cisco uBR10012 router, the valid values are: <ul style="list-style-type: none"> <li>◦ <i>slot</i>—5 to 8</li> <li>◦ <i>subslot</i>—0 or 1</li> <li>◦ <i>port</i>—0 to 4 (depending on the cable interface)</li> </ul> </li> </ul>



	Command or Action	Purpose
Step 4	<b>cable upstream <i>n</i> max-logical-chans num-of-logical-channels</b>  <b>Example:</b> Router(config-if)# <b>cable upstream 0 max-logical-chans 2</b>	Creates the specified number of logical channels per port on an upstream channel. <ul style="list-style-type: none"> <li>• <i>n</i>—Upstream port. Valid values start with 0 for the first upstream port on the cable interface line card, but can be increased to a maximum of 7.</li> <li>• <i>num-of-logical-channels</i>—Number of logical channels per port.</li> </ul>
Step 5	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## Monitoring the S-CDMA and Logical Channel Support

To monitor the S-CDMA and Logical Channel Support feature, use the following procedures:

### Displaying Modulation Profiles

To display the modulation profiles that are currently defined on the CMTS, use the **show running-config** command as shown in the example:

```
Router# show running-config | begin cable modulation-profile

cable modulation-profile global-scheme
cable modulation-profile 222 atdma request 0 16 0 22 qpsk scrambler 152 no-diff8
cable modulation-profile 222 atdma initial 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 222 atdma station 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 222 atdma a-short 6 76 6 22 64qam scrambler 152 no-dif8
cable modulation-profile 222 atdma a-long 9 232 0 22 64qam scrambler 152 no-dif8
cable modulation-profile 222 atdma a-ugs 9 232 0 22 64qam scrambler 152 no-diff8
cable modulation-profile 223 atdma request 0 16 0 22 qpsk scrambler 152 no-diff8
cable modulation-profile 223 atdma initial 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 223 atdma station 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 223 atdma a-short 6 76 6 22 64qam scrambler 152 no-dif8
cable modulation-profile 223 atdma a-long 14 220 0 22 64qam scrambler 152 no-di8
cable modulation-profile 223 atdma a-ugs 14 220 0 22 64qam scrambler 152 no-dif8
cable modulation-profile 400 scdma-d3 request 0 16 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 initial 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 station 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 short 3 76 12 64qam scrambler 152 no-diffm
cable modulation-profile 400 scdma-d3 long 9 232 0 64qam scrambler 152 no-diff m
cable modulation-profile 400 scdma-d3 a-short 6 76 6 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 a-long 9 232 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 a-ugs 9 232 0 64qam scrambler 152 no-diffm
--More--
```

To display a specific modulation profile in detail, specify the profile number with the **show cable modulation-profile** command as shown in the example:

```
Router# show cable modulation-profile 381
```

Mod	IUC	Type	Pre len	Diff enco	FEC T	FEC k	ScrmB seed	Max B	Guard time	Last CW	ScrmB short	Pre offst	Pre Type	RS
					BYTE	BYTE	siz	size						
381	request	qpsk	64	no	0x0	0x10	0x152	0	0	no	yes	0	qpsk0	n
381	initial	qpsk	98	no	0x5	0x22	0x152	0	0	no	yes	0	qpsk0	n
381	station	qpsk	98	no	0x5	0x22	0x152	0	0	no	yes	0	qpsk0	n
381	short	qpsk	64	no	0x3	0x4C	0x152	12	0	yes	yes	0	qpsk0	n
381	long	qpsk	64	no	0x9	0xE8	0x152	0	0	yes	yes	0	qpsk0	n
381	a-short	64qam	64	no	0x6	0x4C	0x152	6	0	yes	yes	0	qpsk1	n
381	a-long	64qam	64	no	0x9	0xE8	0x152	0	0	yes	yes	0	qpsk1	n
381	a-ugs	64qam	64	no	0x9	0xE8	0x152	0	0	yes	yes	0	qpsk1	n

## Displaying Cable Modem Capabilities and Provisioning

To display the capabilities of the online cable modems and how the modems were provisioned, use the **show cable modem mac** command:

```
Router# show cable modem mac
```

MAC Address	MAC State	Prim Sid	Ver	QoS Prov	Frag	Concat	PHS	Priv	DS	US
										Saids Sids
0014.bfbe.4fc3	offline	1	DOC1.0	DOC1.0	no	no	yes		15	16
0014.bfbe.4f59	offline	2	DOC1.0	DOC1.0	no	no	yes		15	16
0018.6830.2813	offline	3	DOC1.0	DOC1.0	no	no	yes		15	16
001a.c3ff.d208	online	4	DOC2.0	DOC1.1	yes	no	yes		24	8
0014.bfbe.4fbb	w-online	7	DOC3.0	DOC1.1	yes	yes	yes		15	16
0014.bfbe.4f9b	w-online	8	DOC3.0	DOC1.1	yes	yes	yes		15	16
0014.bfbe.4efd	init(t)	9	DOC1.0	DOC1.0	no	yes	yes		15	16
0018.684a.3f46	online	10	DOC2.0	DOC1.1	yes	yes	yes		15	16
0014.bfbe.4086	init(t)	11	DOC1.0	DOC1.0	no	yes	yes		15	16
001a.c3ff.d53a	w-online	12	DOC3.0	DOC1.1	no	no	yes		24	8

To display how many cable modems of each DOCSIS type are online on each upstream, use the **show cable modem mac summary** command:

```
Router# show cable modem mac summary
```

Cable Modem Summary									
Interface	Total	Mac Version				QoS Provision Mode			
		DOC3.0	DOC2.0	DOC1.1	DOC1.0	Reg/Online	DOC1.1	D0	
Cable7/1/0/U0	4	0	1	0	3	1	1	0	
Cable8/0/0/UB	1	1	0	0	0	1	1	0	
Cable8/0/0/U0.0	2	0	1	0	1	1	1	0	
Cable8/0/0/U2	1	0	1	0	0	1	1	0	
Cable8/0/0/U3	1	0	1	0	0	1	1	0	
Cable8/0/0/U0.1	1	0	0	0	1	0	0	0	

## Displaying the Logical Channel Support

To display the logical channels within the physical upstream port, use the **show cable modem** command without any options:

```
Router# show cable modem
```

MAC Address	IP Address	I/F	MAC State	Prim Sid	RxPwr (dBmv)	Timing Offset	Num CPE	B D P I
0014.bfbe.4f9b	1.60.0.6	C5/0/0/U0.0	online	1	1.00	1406	0	N N

```
0014.bfbc.4efd 1.60.0.2      C5/0/0/U0.1 online      637  1.00  1409  0  N N
0014.bfbc.4efa 1.60.0.3      C5/0/0/U1  online      635  1.00  1409  0  N N
```

The following example shows a typical output of the **show controllers cable** command for a cable interface line card that is configured with multiple logical channels:

```
Router# show controllers cable 7/1/0 upstream 0
Cable7/1/0 Upstream 0 is up
  Frequency 10.000 MHz, Channel Width 6.400 MHz, Symbol Rate 5.120 Msps
  Modulations - A-short 64-QAM, A-long 64-QAM, A-ugs 64-QAM
  This upstream is mapped to physical port 0
  Spectrum Group is overridden
  US phy MER(SNR) estimate for good packets - 23.4731 dB
  Nominal Input Power Level 3 dBmV, Tx Timing Offset 1645
  Ranging Backoff Start 3, Ranging Backoff End 6
  US timing offset adjustment type 0, value 0
  Ranging Insertion Interval automatic (60 ms)
  US throttling off
  Tx Backoff Start 3, Tx Backoff End 5
  Modulation Profile Group 322
  Concatenation is enabled
  Fragmentation is enabled
  part_id=0x3140, rev_id=0x03, rev2_id=0x00
  nb_agc_thr=0x0000, nb_agc_nom=0x0000
  Range Load Reg Size=0x58
  Request Load Reg Size=0x0E
  Minislot Size in number of Timebase Ticks is = 1
  Minislot Size in Symbols = 32
  Bandwidth Requests = 0x31
  Piggyback Requests = 0x0
  Invalid BW Requests= 0x0
  Minislots Requested= 0x22C
  Minislots Granted = 0x31
  Minislot Size in Bytes = 24
  Map Advance (Dynamic) : 2465 usecs
  Map Count = 17393154
  Remote Map Counts: (none)
  UCD Count = 17875
  Remote UCD Counts: (none)
  SCDMA mode enabled
  PHY: us errors 0 us recoveries 0
  MAC PHY TSS: tss error start 0 tss error end 0
  MAC PHY Status: bcm3140 status 0 lookout status 0
  MAP/UCD Replication Instructions:
```

To display the modulation profile of a single logical channel, for default and legacy cable interface line cards, use the **show cable modulation** command:

```
Router# show cable modulation cable 5/0/0 upstream 0
```

Mod	IUC	Type	Pre len	Diff enco	FEC T	FEC k	ScrmB seed	Max B	Guard time	Last CW	ScrmB short	Pre offst	Pre Type	RS
381	request	qpsk	64	no	0x0	0x10	0x152	0	0	no	yes	400	qpsk0	n
381	initial	qpsk	384	no	0x5	0x22	0x152	0	0	no	yes	6	qpsk0	n
381	station	qpsk	384	no	0x5	0x22	0x152	0	0	no	yes	6	qpsk0	n
381	short	qpsk	64	no	0x3	0x4C	0x152	12	0	yes	yes	400	qpsk0	n
381	long	qpsk	64	no	0x9	0xE8	0x152	136	0	yes	yes	400	qpsk0	n
381	a-short	64qam	64	no	0x6	0x4C	0x152	6	0	yes	yes	400	qpsk1	n
381	a-long	64qam	64	no	0x9	0xE8	0x152	46	0	yes	yes	400	qpsk1	n
381	a-ugs	64qam	64	no	0x9	0xE8	0x152	35	0	yes	yes	400	qpsk1	n

The following example shows a typical output of the **show interface cable** command when multiple logical channels are configured on the indicated cable interface:

```
Router# show interface cable 7/1/0 mac-scheduler 0
DOCSIS 1.1 MAC scheduler for Cable7/1/0/U0: rate 26880000
wfg:None
Queue[Rng Polls] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 1
Queue[CIR Grants] 0/256, 0 drops, flows 0 fs_demand_ms 0, max 0
```

```

Queue[BE(7) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(6) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(5) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(4) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(3) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(2) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(1) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 0
Queue[BE(0) Grants] 0/128, 0 drops, flows 0 fs_demand_ms 0, max 1
Req Slots 17301958, Req/Data Slots 1440804
Init Mtn Slots 498660, Stn Mtn Slots 28134
Short Grant Slots 0, Long Grant Slots 0
Adv Phy Short Grant Slots 26, Adv Phy Long Grant Slots 23
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 : 3 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

```

Router#

## Configuration Examples for S-CDMA and Logical Channel Support

This section lists the following sample configurations for the S-CDMA and Logical Channel Support feature on a Cisco CMTS router:

### Creating Modulation Profiles Examples

This section lists sample configurations for creating the following types of upstream modulation profiles:

#### Example: DOCSIS 2.0 S-CDMA Modulation Profiles

The following sample configuration shows typical modulation profiles for the DOCSIS 2.0 S-CDMA mode of operation:

- Profile 321 is the default profile for S-CDMA operations that is automatically created on the router for the cable interface line card.
- Profiles 321 through 330 can be used to create S-CDMA modulation profiles.
- Profiles 1 through 400 can be used to create S-CDMA mode modulation profiles, while using the global configuration.

```

cable modulation-profile 321 scdma request 1 16 0 qpsk scrambler 152 no-diff 64m
cable modulation-profile 321 scdma initial 5 34 0 qpsk scrambler 152 no-diff 98m

```

```

cable modulation-profile 321 scdma station 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 321 scdma a-short 5 131 6 32qam scrambler 152 no-diff 6m
cable modulation-profile 321 scdma a-long 5 131 0 32qam scrambler 152 no-diff 6m
cable modulation-profile 321 scdma a-ugs 9 232 0 64qam scrambler 152 no-diff 64m
cable modulation-profile 322 scdma request 0 16 0 qpsk scrambler 152 no-diff 64m
cable modulation-profile 322 scdma initial 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 322 scdma station 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 322 scdma a-short 6 76 6 64qam scrambler 152 no-diff 6m
cable modulation-profile 322 scdma a-long 9 232 0 64qam scrambler 152 no-diff 6m
cable modulation-profile 322 scdma a-ugs 9 232 0 64qam scrambler 152 no-diff 64m
cable modulation-profile 333 scdma request 0 16 0 qpsk scrambler 152 no-diff 64m
cable modulation-profile 333 scdma initial 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 333 scdma station 5 34 0 qpsk scrambler 152 no-diff 98m
--More--

```

## Example: Global Modulation Profiles

The following sample configuration shows typical modulation profiles for the global mode of operation. Profiles 1 through 400 can be used to create any modulation profile in global modulation profile mode.

```

cable modulation-profile global-scheme
cable modulation-profile 222 atdma request 0 16 0 22 qpsk scrambler 152 no-diff8
cable modulation-profile 222 atdma initial 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 222 atdma station 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 222 atdma a-short 6 76 6 22 64qam scrambler 152 no-dif8
cable modulation-profile 222 atdma a-long 9 232 0 22 64qam scrambler 152 no-dif8
cable modulation-profile 222 atdma a-ugs 9 232 0 22 64qam scrambler 152 no-diff8
cable modulation-profile 223 atdma request 0 16 0 22 qpsk scrambler 152 no-diff8
cable modulation-profile 223 atdma initial 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 223 atdma station 5 34 0 48 qpsk scrambler 152 no-diff8
cable modulation-profile 223 atdma a-short 6 76 6 22 64qam scrambler 152 no-dif8
cable modulation-profile 223 atdma a-long 14 220 0 22 64qam scrambler 152 no-di8
cable modulation-profile 223 atdma a-ugs 14 220 0 22 64qam scrambler 152 no-dif8
cable modulation-profile 321 scdma request 1 16 0 qpsk scrambler 152 no-diff 64m
cable modulation-profile 321 scdma initial 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 321 scdma station 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 321 scdma a-short 5 131 6 32qam scrambler 152 no-diff m
cable modulation-profile 321 scdma a-long 5 131 0 32qam scrambler 152 no-diff 6m
cable modulation-profile 321 scdma a-ugs 9 232 0 64qam scrambler 152 no-diff 64m
cable modulation-profile 322 scdma request 0 16 0 qpsk scrambler 152 no-diff 64m
cable modulation-profile 322 scdma initial 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 322 scdma station 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 322 scdma a-short 6 76 6 64qam scrambler 152 no-diff 6m
cable modulation-profile 322 scdma a-long 9 232 0 64qam scrambler 152 no-diff 6m
cable modulation-profile 322 scdma a-ugs 9 232 0 64qam scrambler 152 no-diff 64m
cable modulation-profile 333 scdma request 0 16 0 qpsk scrambler 152 no-diff 64m
cable modulation-profile 333 scdma initial 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 333 scdma station 5 34 0 qpsk scrambler 152 no-diff 98m
cable modulation-profile 333 scdma a-short 6 76 6 64qam scrambler 152 no-diff 6m
cable modulation-profile 333 scdma a-long 9 232 0 64qam scrambler 152 no-diff 6m
cable modulation-profile 333 scdma a-ugs 9 232 0 64qam scrambler 152 no-diff 64m
cable modulation-profile 400 scdma-d3 request 0 16 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 initial 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 station 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 short 3 76 12 64qam scrambler 152 no-diffm
cable modulation-profile 400 scdma-d3 long 9 232 0 64qam scrambler 152 no-diff m
cable modulation-profile 400 scdma-d3 a-short 6 76 6 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 a-long 9 232 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 a-ugs 9 232 0 64qam scrambler 152 no-diffm
cable service class 1 name def_sclass
--More--

```

## Example: DOCSIS 3.0 S-CDMA Modulation Profiles

The following sample configuration shows typical modulation profiles for the DOCSIS 3.0 S-CDMA mode of operation:

- Profile 381 is the default profile for DOCSIS 3.0 S-CDMA mode operations that is automatically created on the router.
- Profiles 1 through 400 can be used to create DOCSIS 3.0 S-CDMA mode modulation profiles, while using the global configuration.

```

cable modulation-profile 381 scdma-d3 request 0 16 0 64qam scrambler 152 no-difm
cable modulation-profile 381 scdma-d3 initial 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 381 scdma-d3 station 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 381 scdma-d3 short 3 76 12 64qam scrambler 152 no-diffm
cable modulation-profile 381 scdma-d3 long 9 232 0 64qam scrambler 152 no-diff m
cable modulation-profile 381 scdma-d3 a-short 6 76 6 64qam scrambler 152 no-difm
cable modulation-profile 381 scdma-d3 a-long 9 232 0 64qam scrambler 152 no-difm
cable modulation-profile 381 scdma-d3 a-ugs 9 232 0 64qam scrambler 152 no-diffm
cable modulation-profile 400 scdma-d3 request 0 16 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 initial 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 station 5 34 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 short 3 76 12 64qam scrambler 152 no-diffm
cable modulation-profile 400 scdma-d3 long 9 232 0 64qam scrambler 152 no-diff m
cable modulation-profile 400 scdma-d3 a-short 6 76 6 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 a-long 9 232 0 64qam scrambler 152 no-difm
cable modulation-profile 400 scdma-d3 a-ugs 9 232 0 64qam scrambler 152 no-diffm
--More--

```

## Assigning Modulation Profiles to Upstreams Examples

This section lists sample configurations for assigning the following types of modulation profiles to upstreams:

### Example: Assigning DOCSIS 2.0 S-CDMA Modulation Profiles

The following sample configuration shows DOCSIS 2.0 S-CDMA modulation profiles being assigned to the upstreams on two cable interfaces. The default S-CDMA modulation profile (profile 321) is assigned to the upstreams on cable interface 7/1/0, and custom modulation profile 322 is assigned to the upstreams on cable interface 7/1/1.

```

interface Cable7/1/0
 cable init-channel-timeout 160
 no cable mtc-mode
 cable cm-status enable 1-5
 no cable packet-cache
 cable bundle 1
 cable downstream channel-id 13
 cable downstream annex B
 cable downstream modulation 256qam
 cable downstream interleave-depth 32
 cable downstream frequency 459000000
 no cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream ranging-poll interval 25000
 cable upstream 0 connector 0
 cable upstream 0 frequency 10000000
 cable upstream 0 channel-width 3200000
 cable upstream 0 power-level 3
 cable upstream 0 docsis-mode scdma
 cable upstream 0 spreading-interval 16
 cable upstream 0 codes-per-minislot 4
 cable upstream 0 active-codes 112
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 321
 no cable upstream 0 shutdown
interface Cable7/1/1
 shutdown

```

```

cable cm-status enable 1-5
no cable packet-cache
cable downstream channel-id 180
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream rf-shutdown
cable upstream max-ports 4
cable upstream 0 connector 4
cable upstream 0 frequency 10000000
cable upstream 0 channel-width 1600000
cable upstream 0 docsis-mode scdma
cable upstream 0 spreading-interval 16
cable upstream 0 codes-per-minislot 4
cable upstream 0 active-codes 112
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 322
no cable upstream 3 shutdown
!
```

### Example: Assigning Global Modulation Profiles

The following sample configuration shows user-defined DOCSIS 3.0 S-CDMA modulation profiles being assigned to the upstreams on two cable interfaces. Only the first upstream on cable interface 7/1/0 is enabled for A-TDMA mode and assigned an A-TDMA profile. The other two upstreams on cable interface (7/1/1 and 7/1/2) are enabled for custom-defined DOCSIS 3.0 S-CDMA modulation profiles.

```

interface Cable7/1/0
cable init-channel-timeout 160
no cable mtc-mode
cable cm-status enable 1-5
no cable packet-cache
cable bundle 1
cable downstream channel-id 13
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 459000000
no cable downstream rf-shutdown
cable upstream max-ports 4
cable upstream ranging-poll interval 25000
cable upstream 0 connector 0
cable upstream 0 frequency 10000000
cable upstream 0 channel-width 3200000
cable upstream 0 ingress-noise-cancellation 112
cable upstream 0 power-level 3
cable upstream 0 docsis-mode atdma
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 221
cable upstream 0 equalization-coefficient
no cable upstream 0 shutdown
!
interface Cable7/1/1
shutdown
cable cm-status enable 1-5
no cable packet-cache
cable downstream channel-id 180
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream rf-shutdown
cable upstream max-ports 4
cable upstream 0 connector 4
cable upstream 0 frequency 10000000
cable upstream 0 channel-width 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
```

```

no cable upstream 0 shutdown
cable upstream 1 connector 5
cable upstream 1 frequency 18000000
cable upstream 1 channel-width 3200000
cable upstream 1 ingress-noise-cancellation 112
cable upstream 1 docsis-mode scdma-d3
cable upstream 1 spreading-interval 16
cable upstream 1 codes-per-minislot 4
cable upstream 1 active-codes 64
cable upstream 1 max-codes-per-subframe 128
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 382
cable upstream 1 equalization-coefficient
no cable upstream 1 shutdown
cable upstream 2 connector 6
cable upstream 2 frequency 25000000
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
no cable upstream 2 shutdown
cable upstream 3 connector 7
cable upstream 3 frequency 32000000
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
no cable upstream 3 shutdown
!
interface Cable7/1/2
shutdown
cable cm-status enable 1-5
no cable packet-cache
cable downstream channel-id 181
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream rf-shutdown
cable upstream max-ports 4
cable upstream 0 connector 8
cable upstream 0 frequency 20000000
cable upstream 0 channel-width 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
no cable upstream 0 shutdown
cable upstream 1 connector 9
cable upstream 1 channel-width 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
no cable upstream 1 shutdown
cable upstream 2 connector 10
cable upstream 2 channel-width 3200000
cable upstream 2 ingress-noise-cancellation 112
cable upstream 2 docsis-mode scdma-d3
cable upstream 2 spreading-interval 16
cable upstream 2 codes-per-minislot 4
cable upstream 2 active-codes 64
cable upstream 2 max-codes-per-subframe 128
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 382
cable upstream 2 equalization-coefficient
!
```



## Example: Assigning DOCSIS 3.0 S-CDMA Modulation Profiles

The following sample configuration shows DOCSIS 3.0 S-CDMA modulation profiles being assigned to the upstreams on two cable interfaces. The default DOCSIS 3.0 S-CDMA modulation profile (profile 381) is assigned to the upstreams on cable interface 7/1/0, and custom modulation profile 382 is assigned to the upstreams on cable interface 7/1/1.

```
interface Cable7/1/0
 cable init-channel-timeout 160
 no cable mtc-mode
 cable cm-status enable 1-5
 no cable packet-cache
 cable bundle 1
 cable downstream channel-id 13
 cable downstream annex B
 cable downstream modulation 256qam
 cable downstream interleave-depth 32
 cable downstream frequency 459000000
 no cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream ranging-poll interval 25000
 cable upstream 0 connector 0
 cable upstream 0 frequency 10000000
 cable upstream 0 channel-width 3200000
 cable upstream 0 power-level 3
 cable upstream 0 docsis-mode scdma-d3
 cable upstream 0 spreading-interval 16
 cable upstream 0 codes-per-minislot 4
 cable upstream 0 active-codes 64
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 381
 cable upstream 0 equalization-coefficient
 no cable upstream 0 shutdown
!
interface Cable7/1/1
 shutdown
 cable cm-status enable 1-5
 no cable packet-cache
 cable downstream channel-id 180
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream ranging-poll interval 25000
 cable upstream 0 connector 0
 cable upstream 0 frequency 10000000
 cable upstream 0 channel-width 3200000
 cable upstream 0 power-level 3
 cable upstream 0 docsis-mode scdma-d3
 cable upstream 0 spreading-interval 16
 cable upstream 0 codes-per-minislot 4
 cable upstream 0 active-codes 64
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 382
 cable upstream 0 equalization-coefficient
 no cable upstream 0 shutdown
```

## Example: Creating Logical Channels

The following example shows the configuration of an interface that has two of four physical ports configured to have two logical channels per physical port:

```
interface Cable5/0/0
 no cable packet-cache
```

```

cable downstream channel-id 167
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 453000000
no cable downstream rf-shutdown
cable upstream max-ports 4
cable upstream 0 connector 0
cable upstream 0 frequency 10000000
cable upstream 0 channel-width 1600000 1600000
cable upstream 0 max-logical-chans 2
cable upstream 0 load-balance group 1
cable upstream 0 0 docsis-mode atdma
cable upstream 0 0 minislots-size 4
cable upstream 0 0 power-adjust continue 3
cable upstream 0 0 range-backoff 3 6
cable upstream 0 0 modulation-profile 21
no cable upstream 0 0 shutdown
cable upstream 0 1 docsis-mode tdma
cable upstream 0 1 minislots-size 2
cable upstream 0 1 power-adjust continue 6
cable upstream 0 1 range-backoff 3 6
cable upstream 0 1 modulation-profile 221
no cable upstream 0 1 shutdown
no cable upstream 0 shutdown
cable upstream 1 connector 1
cable upstream 1 spectrum-group 1
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 max-logical-chans 2
cable upstream 1 0 docsis-mode atdma
cable upstream 1 0 minislots-size 4
cable upstream 1 0 range-backoff 3 6
cable upstream 1 0 modulation-profile 21
no cable upstream 1 0 shutdown
cable upstream 1 1 docsis-mode tdma
cable upstream 1 1 minislots-size 2
cable upstream 1 1 range-backoff 3 6
cable upstream 1 1 modulation-profile 221
cable upstream 1 1 equalization-coefficient
no cable upstream 1 1 shutdown
no cable upstream 1 shutdown
cable upstream 2 connector 2
cable upstream 2 docsis-mode scdma
cable upstream 2 frequency 10000000
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 322
no cable upstream 2 shutdown
cable upstream 3 connector 3
cable upstream 3 docsis-mode scdma
cable upstream 3 spectrum-group 2
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 321
no cable upstream 3 shutdown
end

```

## Additional References

The following sections provide references related to the S-CDMA and Logical Channel Support feature.

### Related Documents

Related Topic	Document Title
CMTS commands	<a href="#">Cisco IOS CMTS Cable Command Reference</a>

Related Topic	Document Title
Spectrum Management and Advanced Spectrum Management	<a href="#">Spectrum Management and Advanced Spectrum Management for the Cisco CMTS Routers</a>
Load Balancing and Dynamic Channel Change	<a href="#">Load Balancing and Dynamic Channel Change on the Cisco CMTS Routers</a>

### Standards and RFCs

Standards	Title
<a href="#">CM-SP-SECv3.0-I09-090121</a>	Data-over-Cable Service Interface Specifications Security Specification, version 3.0
<a href="#">CM-SP-CMCIv3.0-I01-080320</a>	Data-over-Cable Service Interface Specifications Cable Modem to Customer Premise Equipment Interface Specification, version 3.0
<a href="#">CM-SP-PHYv3.0-I08-090121</a>	Data-over-Cable Service Interface Specifications Physical Layer Specification, version 3.0
<a href="#">CM-SP-MULPIv3.0-I09-090121</a>	Data-over-Cable Service Interface Specifications MAC and Upper Layer Protocols Interface Specification, version 3.0
<a href="#">CM-SP-OSSIV3.0-I08-090121</a>	Data-over-Cable Service Interface Specifications Operations Support System Interface Specification, version 3.0
<a href="#">RFC 2233</a>	<a href="#">DOCSIS OSSI Objects Support</a>
<a href="#">RFC 2665</a>	<a href="#">DOCSIS Ethernet MIB Objects Support</a>
<a href="#">RFC 2669</a>	<a href="#">Cable Device MIB</a>

**MIBs**

MIBs	MIBs Link
<ul style="list-style-type: none"> <li>• DOCS-BPI-PLUS-MIB</li> <li>• DOCS-CABLE-DEVICE-MIB (RFC 2669)</li> <li>• DOCS-CABLE-DEVICE-TRAP-MIB</li> <li>• DOCS-IF-EXT-MIB</li> <li>• IF-MIB</li> <li>• DOCS-IF-MIB (RFC 2670)</li> </ul>	<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><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></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><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></p>

## Feature Information for S-CDMA and Logical Channel Support on the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

The table below 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 51: Feature Information for S-CDMA and Logical Channel Support on the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
S-CDMA and Logical Channel Support on the Cisco CMTS Routers	12.2(33)SCC	<p>This feature was introduced for the Cisco uBR10012 router.</p> <p>The following commands are new or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream active-codes</b></li> <li>• <b>cable upstream channel-width</b></li> <li>• <b>cable upstream codes-per-minislot</b></li> <li>• <b>cable upstream docsis-mode</b></li> <li>• <b>cable upstream max-codes-per-subframe</b></li> <li>• <b>cable upstream max-interleave-step</b></li> <li>• <b>cable upstream max-logical-chans</b></li> <li>• <b>cable upstream spreading-interval</b></li> <li>• <b>cable upstream modulation-profile</b></li> <li>• <b>cable upstream modulation-profile global-scheme</b></li> <li>• <b>show controllers cable</b></li> <li>• <b>show interface cable mac-scheduler</b></li> </ul>
S-CDMA and Logical Channel Support on the Cisco CMTS Routers	12.2(33)SCD	Support was added for the Cisco uBR7246VXR and Cisco uBR7225VXR routers.





# Spectrum Management and Advanced Spectrum Management for the Cisco CMTS

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## Note

Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

This chapter describes the spectrum management features supported for the Cisco Cable Modem Termination System (CMTS) routers. Spectrum management support is divided into two main groups:

- Guided and scheduled spectrum management features (supported in software)
- Intelligent and advanced spectrum management features (supported in hardware only on specific cable interfaces)

Cisco IOS Release 12.3(13a)BC introduces advanced spectrum management support (software and hardware) for the Cisco uBR10-MC5X20S/U/H broadband processing engine (BPE) in the Cisco uBR10012 universal broadband router.

## 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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## Prerequisites for Spectrum Management and Advanced Spectrum Management

The table below shows the hardware compatibility prerequisites for the spectrum management and advanced management feature supported for the Cisco CMTS routers.



### Note

The hardware components introduced in a given Cisco IOS Release will be supported in all subsequent releases unless otherwise specified.

**Table 52: Spectrum Management and Advanced Spectrum Management for the Cisco CMTS Routers Hardware Compatibility Matrix**

Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases	Cisco IOS Release 12.2(33)SCB and later releases
	<ul style="list-style-type: none"> <li>• PRE2</li> </ul>	<ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul>
	Cisco IOS Release 12.2(33)SCB and later releases	Cisco IOS Release 12.2(33)SCC and later releases
	<ul style="list-style-type: none"> <li>• PRE4</li> </ul>	<ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul>
		Cisco IOS Release 12.2(33)SCE and later releases
		<ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V <a href="#">33</a></li> </ul>



Cisco CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V <sup>34</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> </ul> Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>33</sup> Cisco uBR3GX60V cable interface line card is compatible with PRE4.

<sup>34</sup> Cisco uBR-MC88V cable interface line card is compatible with NPE-G2.

- Guided and scheduled spectrum management features require one of the following Cisco CMTS routers, and one or more of the indicated cable interfaces:

Cisco uBR7200 series router and one or more of the following cable interfaces:

- Cisco uBR-MC16U/X cable interface line cards
- Cisco uBR-MC28U/X cable interface line cards
- Cisco uBR-MC88V cable interface line cards

Cisco uBR10012 router and one or more of the following cable interfaces:

- Cisco uBR10-MC5X20S/U/H cable interface line cards
- Cisco UBR-MC20X20V cable interface line cards
- Cisco uBR-MC3GX60V cable interface line cards

- Intelligent and advanced spectrum management (hardware-based, carrier-to-noise ratio [CNR] frequency hopping) requires the following Cisco CMTS routers and one or more of the indicated cable interfaces:

Cisco uBR7200 series router and one or more of the following cable interfaces:

- Cisco uBR-MC16U/X cable interface line cards
- Cisco uBR-MC28U/X cable interface line cards

- Cisco uBR-MC88V cable interface line cards

Cisco uBR10012 router and one or more of the following cable interfaces:

- Cisco uBR10-MC5X20S/U/H cable interface line cards
- Cisco UBR-MC20X20V cable interface line cards
- Cisco uBR-MC3GX60V cable interface line cards




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**Note** You must have Cisco IOS Release 12.3(13a)BC or a later release installed in your router if you are using the Cisco uBR10-MC5X20S/U/H BPE.

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- Ensure that your network is designed to support reliable broadband data transmission. At minimum, your network must include:
  - A Dynamic Host Configuration Protocol (DHCP) server to assign IP addresses to cable modems or set-top boxes on the hybrid fiber-coaxial (HFC) network. This can be a server on the WAN side of the Cisco uBR7200 series universal broadband router or a Cisco CMTS router that has been configured to act as the DHCP server.
  - If you are not using cable interface line cards with integrated upconverters, you must install the appropriate IF-to-RF external upconverter between the Cisco CMTS router and the combiner.




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**Note** The term “combiner” refers to all cables, amplifiers, and taps at the headend or cable distribution center that connect the Cisco CMTS router to the HFC network.

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- Diplex filters installed in the downstream RF path between the cable modems and the cable interface cards in the router. RG-59 headend coaxial cable with the maximum braid available (60 percent + 40 percent braid), double foil, and the correct connector for this cable.
- Avoid frequencies with known ingress problems such as amateur radio bands or short-wave bands.
- Avoid hostile spectrums below 20 MHz.
- When designing your channel plan, allow extra bands for frequency hopping.
- Use the receive power level setting to perform slight equalization adjustments.
- Due to the nature of CATV technology, upstream noise management is a significant issue. We recommend that you follow the rigorous North American plant maintenance procedures documented in the NCTA Supplement on Upstream Transport Issues (available from the National Cable and Telecommunications Association, <http://www.ncta.com> ) to adjust return amplifiers and lasers.

## Restrictions for Spectrum Management

This section describes the restrictions for the following spectrum management features:

## Shared Spectrum Groups

- Advance spectrum management does not support inter-line-card shared spectrum groups.
- Guided spectrum management does support inter-line-card shared spectrum groups.

## Cisco IOS Releases and Cable Interface Line Card Support

The guided and scheduled spectrum management features are available for all currently supported cable interface line cards. These features were released in phases. The table below summarizes the individual features in this basic spectrum management feature set, and the initial Cisco IOS software releases that introduced them.

**Table 53: Summary of Guided and Scheduled Spectrum Management Features by Release**

Feature	Cisco IOS Release Supported
<a href="#">Frequency Hopping Capabilities, on page 401</a>	12.1(2)EC1, 12.3(4)BC1, and later releases
<a href="#">Dynamic Upstream Modulation (MER [SNR]-Based), on page 403</a> <a href="#">Frequency Hopping Capabilities, on page 401</a>	12.1(3a)EC1, 12.0(13)SC, 12.3(4)BC1, and later releases
<a href="#">Input Power Levels, on page 405</a>	12.0(6)SC, 12.1(2)EC1, 12.3(4)BC1, and later releases
<a href="#">Advanced Spectrum Management Support Using the Cisco uBR10-MC5X20S/U/H BPE, on page 406</a>	12.3(13a)BC and later releases

The intelligent and advanced spectrum management features were also released in phases. The table below shows the minimum software releases that are needed for these features on the cable interface line cards that support them.

**Table 54: Minimum Cisco IOS Releases for Intelligent and Advanced Spectrum Management Support**

Cable Interface Line Card	Minimum Cisco IOS Release
<b>Cisco uBR7200 Series Universal Broadband Routers</b>	
Cisco uBR-MC16U/X	12.2(15)CX, 12.3(15)BC2
Cisco uBR-MC28U/X	12.2(15)CX, 12.3(15)BC2
<b>Cisco uBR10012 Universal Broadband Router</b>	
Cisco uBR10-MC5X20S/U/H	12.3(13a)BC

## Dynamic Upstream Modulation

- The Cisco CMTS router has one preconfigured (primary) modulation profile that defines a typical profile for quadrature phase-shift keying (QPSK) modulation. To use the Dynamic Upstream Modulation feature, you must create a secondary modulation profile that has a higher modulation scheme than the preconfigured profile. The Three Step Dynamic Modulation feature, supported from Cisco IOS Release 12.2(33)SCB3 onwards, allows you to create and use a third modulation profile. However, the third modulation profile is optional.
- Upstream modulation profiles are assigned to upstream ports and affect all cable modems on those upstream ports.
- Modulation profiles affect the physical layer of the cable network, so only trained technicians who are familiar with the Data-over-Cable Service Interface Specifications (DOCSIS) specifications should create modulation profiles.
- When using the Dynamic Upstream Modulation feature with Voice over IP (VoIP) services, frequent changes to the upstream modulation or channel width could briefly impact the quality of voice calls.

## Fixed-Frequency Spectrum Groups with Advanced Spectrum Management

When using cable interface line cards that support advanced spectrum management, do not configure fixed-frequency spectrum groups by specifying a frequency using the **cable spectrum-group frequency** command (for example, **cable spectrum-group 3 frequency 7600000**). If fixed-frequency spectrum groups are desired, configure a band with a starting and ending range, which along with the desired channel width specifies the desired center frequency. In this situation, you must also configure a static channel width so that the Dynamic Upstream Modulation feature does not attempt to hop to a different frequency using a smaller channel width.

For example, to specify a center frequency of 7.6 MHz with a 3.2-MHz channel width, specify a starting frequency of 6.0 MHz (7.6 MHz - 1.6 MHz) and an ending frequency of 9.2 MHz (7.6 MHz + 1.6 MHz):

```
Router(config)# cable spectrum-group 15 band 6000000 9200000
Router(config)# interface cable 6/0
Router(config-if)# cable upstream 0 channel-width 3200000 3200000
Router(config-if)# cable upstream 0 spectrum-group 15
```



### Note

Cisco IOS Release 12.2(8)BC2 does not support spectrum groups with fixed frequencies on the Cisco uBR10012 router.

## Limitations on Upstream Modulation Parameters for PacketCable VoIP Calls

We recommend the use of a channel width that is 800 KHz and above while configuring upstreams for PacketCable operations and VoIP calls. (All DOCSIS channel widths and upstream parameter combinations are supported, but not optimum when offering VoIP.)

## N+1 Redundancy Support

N+1 redundancy requires the working and protect cable interface line cards to be identical. This ensures that the protect interface supports the same exact configuration as the working interface.

When protecting cards that support intelligent and advanced spectrum management, a switchover preserves the spectrum management configuration, and the protect interface initially uses the same upstream frequency as the working interface. The protect interface does not begin using the advanced spectrum management features until the system stabilizes to avoid any unnecessary frequency hops or channel width changes.

## Intelligent and Advanced Spectrum Management Support

- Intelligent and advanced spectrum management is supported on the Cisco uBR10-MC5X20S/U/H cable line interface card in Cisco IOS Release 12.3(13a)BC.
- Cable interfaces use standard DOCSIS, EuroDOCSIS, and the extended Japanese frequency ranges (5 to 55 MHz for upstream interfaces) to support the intelligent and advanced spectrum management features.
- Intelligent and advanced spectrum management features are supported only in the DOCSIS 1.0 and DOCSIS 1.1 Time Division Multiple Access (TDMA) mode of operation. These features cannot be used when a cable interface is operating in the DOCSIS 2.0 mixed, Advanced TDMA (A-TDMA), and Synchronous Code Division Multiple Access (S-CDMA) modes of operation. Similarly, these features are also not available when the cable interface is configured to use multiple logical channels. However, these restrictions do not apply for guided spectrum management.
- Upstream channels must meet the carrier-to-noise plus interference ratio (CNI<sub>R</sub> [CNR]), and carrier-to-ingress power ratio values given in the DOCSIS specifications. The minimum value for both parameters is 25 dB in the 5 to 65 MHz frequency range.
- The intelligent and advanced spectrum management features do not support inter-line card shared spectrum groups. Spectrum management features require that upstream ports on different line cards have their own RF domain (a unique set of non-overlapping frequencies).
- N+1 redundancy is not supported on any cable interface line card that has defined spectrum groups, which typically is the normal configuration for advanced spectrum management.
- If you are using only one modulation profile and are using a software release prior to Cisco IOS Release 12.2(8)BC2, you need to change the CNR (CNI<sub>R</sub>) and forward error correction (FEC) threshold parameters from their default values to prevent undesired frequency hopping. This is because in these releases, a frequency hop would occur if just one of the measured values (CNR [CNI<sub>R</sub>] value, correctable FEC counter, or uncorrectable FEC counter) crossed the configured threshold value. Reducing the CNR (CNI<sub>R</sub>) threshold or increasing one of the FEC threshold values limits the number of frequency hops. This situation no longer occurs in Cisco IOS Release 12.2(8)BC2 and later releases, because a frequency hop can occur only when both the CNR (CNI<sub>R</sub>) value and one of the FEC counters falls below its threshold value.
- The intelligent and advanced spectrum management feature is activated by assigning spectrum groups on cards with built-in spectrum analyzer.

# Information About Spectrum Management

Spectrum management allows a Cisco Cable Modem Termination System (CMTS) to sense upstream plant impairments, report them to a management entity, and automatically correct them where possible. The spectrum management feature performs these functions without reducing throughput or latency and without creating additional packet overhead on the radio frequency (RF) plant.

In particular, because the cable interfaces on the router receive upstream packets, it can directly detect upstream transmission errors. The router can also indirectly monitor the condition of the plant by keeping a record of modem state changes, such as the number and frequency of cable modems that are “flapping” (modems that either miss a station maintenance message or that go offline and then come back online).

**Note**

For more information about the cable modem flapping and how to monitor the cable modem flap list, see the [Flap List Troubleshooting for the Cisco CMTS Routers](#).

Spectrum management can prevent long-term service interruptions caused by upstream noise events in the cable plant. It is also used for fault management and troubleshooting the cable network. When cable modems are detected to go online and offline by flap detectors, the cable operators can look at the flap list and spectrum tables to determine the possible causes.

Because of the nature of cable television (CATV) technology, upstream noise management is a significant issue. Frequency bands must have a sufficient CNR (CNI<sub>R</sub>) and carrier-to-ingress power ratio to support the transmission of QPSK and quadrature amplitude modulation (QAM) data. The DOCSIS sets the minimum value for both of these ratios to 25 dB in the 5 to 65 MHz frequency range. If the CNR (CNI<sub>R</sub>) drops below 25 dB on a particular channel due to noise, the cable modem on that channel degrades and can drop off the hybrid fiber-coaxial (HFC) network.

This overview contains the following subsections:

- [Spectrum Management Measurements, on page 393](#)—Provides an overview of fundamental concepts and terms that are used in spectrum management.
- [Upstream Signal Channel Overview, on page 396](#)—Describes how signals are sent and how changes occur in upstream channels.
- [Upstream Segments and Combiner Groups, on page 398](#)—Describes sparse and dense segments and combiner groups.
- [Frequency Management Policy, on page 399](#)—Describes the types of noise impairments and how to counteract ingress noise with spectrum groups and frequency hopping.
- [Guided and Scheduled Spectrum Management, on page 401](#)—Describes the following guided and scheduled spectrum management features: frequency hopping capabilities, dynamic upstream modulation (signal-to-noise ratio-based), and input power levels.
- [Intelligent and Advanced Hardware-Based Spectrum Management, on page 406](#)—Describes spectrum management features that are supported by a number of cable interface line cards that have onboard spectrum management hardware. These features include a real-time spectrum analyzer, CNR-based, proactive frequency hopping, and a more robust dynamic upstream modulation.
- [Benefits, on page 408](#)—Describes the spectrum management features provided on the Cisco CMTS router platforms.

## Spectrum Management Measurements

Measuring the signal-to-noise ratio (SNR [MER]) and carrier-to-noise ratio (CNR [CNiR]) are the major ways of determining the quality of a downstream or upstream signal. The following sections provide an overview of these two ratios, as well as explaining the differences between them, and some additional values that might be useful:

### Signal and Carrier Noise Ratios

Measuring the Modulation Error Ratio (MER [SNR]) and CNR (CNiR) of a downstream or upstream is the first step in determining the quality of the signal, and whether spectrum management needs to be performed to correct any errors. The following are brief descriptions of these two values:

- **Modulation Error Ratio (MER [SNR])**—This is an estimate of the signal strength on the upstream after ingress noise cancellation is performed. This means that the MER (SNR) takes into account a variety of modulation impairments, including frequency response distortions (such as in-channel amplitude tilt and ripple), group delay, microreflections, and phase noise. The MER (SNR) is a good gauge of the overall end-to-end quality of the cable network, because it includes the impact that the transmitter circuitry, receiver circuitry, and transmission media have on the upstream signal.



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**Note** The MER (SNR) value was incorrectly calculated in early Cisco IOS software images, reporting a value that was 4 dB larger than expected. This was corrected in Cisco IOS Release 12.1(10)EC1 and Cisco IOS Release 12.2(4)BC1, and later releases. For more information, see Field Notice 44400.

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- **Carrier-to-Noise Ratio (CNR)**—This is an ratio of the measured modulated power, in dB, on the upstream (before ingress noise cancellation is done) that compares the channel power to the noise power.

The term CNiR is part of the CableLabs nomenclature for the CNR measurement. Therefore these two terms, CNR and CNiR, can be used interchangeably.

The CNR (CNiR) measurement is usually provided only by an external spectrum analyzer, but the cable interface line cards that support intelligent and advanced hardware spectrum management features also provide CNR (CNiR) measurement.



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**Note** Starting with Cisco IOS Release 12.2(33)SCF, the CNR (CNiR) measurement is supported for all upstream (US) channels irrespective of whether spectrum management feature is enabled or not for the upstream channels. For all the releases prior to Cisco IOS Release 12.2(33)SCF, the CNR (CNiR) measurement is supported for only those US channels that have spectrum management feature enabled.

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The following two types of CNR (CNiR) measurements are supported on the Cisco CMTS:

- **CNR (CNiR) measured for a particular upstream**—This is the overall CNR (CNiR) for all of the cable modems on an upstream, which is determined by measuring the RF power of the upstream receiver at the cable interface. This value is always just a snapshot in time for a particular upstream. The cable interface measures the RF power at a time when no bursts are expected from the cable

modems, but it can be skewed by a small number of cable modems that are experiencing or creating signal problems.

- Per-modem CNR (CNiR)—This is the CNR (CNiR) for a particular cable modem, which is signal strength of the burst transmissions of the modem at the upstream receiver of the cable interface. The per-modem CNR (CNiR) measurement is a very accurate measure of a particular cable modem's signal, but you should not use a single modem's CNR (CNiR) to make assumptions about other cable modems on that upstream or about the upstream itself. However, you can get a good picture of the upstream's signal quality by polling the CNR (CNiR) for a number of cable modems over a representative time period.



**Tip**

Changing the channel width has a direct impact on the CNR (CNiR). Doubling the channel width (for example, from 400 KHz to 800 KHz) decreases the CNR (CNiR) for an upstream by approximately 3 dB. Cutting the channel width in half (for example, from 3.2 MHz to 1.6 MHz) increases the CNR (CNiR) for an upstream by approximately 3 dB.

## Differences Between the MER (SNR) and CNR (CNiR) Values

In a perfect network, such as a test lab where the only impairment is additive white Gaussian noise (AWGN), you can expect the CNR (CNiR) and MER (SNR) values to be comparable throughout all of the allowable power levels and frequency ranges. In a live network, however, it is expected that the MER (SNR) value should be a few dB lower than the CNR (CNiR) value, given that the MER (SNR) value takes into account noise impairments and distortions that are not accounted for by the CNR (CNiR) power measurements.

In general, when the CNR (CNiR) value is in the 15 to 25 dB range, you can expect the MER (SNR) value to have a comparable value. The difference between the MER (SNR) and CNR (CNiR) values is expected to be larger when the CNR (CNiR) value falls outside of the 15 to 25 dB range.

The table below provides a comparison between the MER (SNR) and CNR (CNiR) values, listing the major reasons for why the MER (SNR) and CNR (CNiR) values might diverge on an active network that is passing live traffic:

**Table 55: Comparison of MER (SNR) and CNR (CNiR) in a DOCSIS Cable Network**

Signal-to-Noise (SNR)	Carrier-to-Noise (CNR)
Post-detection measurement of the RF signal.	Pre-detection measurement of the RF signal.
Measurement of the baseband domain.	Measurement of the RF frequency domain.



<b>Signal-to-Noise (SNR)</b>	<b>Carrier-to-Noise (CNR)</b>
<p>Includes the effect of signal distortions and impairments on the signal. These include:</p> <ul style="list-style-type: none"> <li>• Group delay in the channel such as occurs during operation near the diplexer band edge.</li> <li>• Channel amplitude variation and echoes.</li> <li>• Data collisions.</li> <li>• Microreflections.</li> <li>• Narrow band ingress in the channel.</li> <li>• Non-linearities in the cable plant.</li> <li>• Phase noise.</li> <li>• Poor selection of the preamble.</li> <li>• Poor symbol fidelity in the transmission of a cable modem, despite a good MER (SNR) value.</li> <li>• Unrecoverable carrier offsets.</li> <li>• Unrecoverable symbol timing offsets.</li> </ul>	<p>Measures only the RF modulated carrier power versus noise power.</p>
<p>Provides an indication of overall, end-to-end network quality (what the transmitter, receiver, and transmission media are doing to the signal).</p>	<p>Provides an indication of network performance (what the transmission media or network is doing to the signal).</p>
<p>Average over time with current data traffic patterns, useful for tracking long-term trends in signal quality.</p>	<p>Real-time spectrum analysis.</p>
<p>Reflects the CNR (CNiR) value as part of its value.</p>	<p>Does not reflect the MER (SNR) value as part of its value.</p>
<p>Averaged over 10,000 symbols, and an accurate reading requires that short and long grants are being transferred.</p>	<p>Unaffected by the type of traffic being transmitted.</p>
<p>Does not use packets with uncorrectable FEC errors to determine its value. Bursts of uncorrectable errors, therefore, could result in a deceptively high MER (SNR) value.</p>	<p>Unaffected by uncorrectable FEC packet bursts.</p>
<p>DOCSIS specifications do not define any required MER (SNR) values for upstreams and downstreams.</p>	<p>Minimum downstream CNR of 35 dB in a 6-MHz band (44 dB in DOCSIS 2.0 for 8-MHz band)</p> <p>Minimum upstream CNR (CNiR) of 25 dB.</p>

## Additional Measurements

In addition to MER (SNR) and CNR (CNiR) values, you should be aware of and monitor the following indicators of signal quality:

- **MER**—This is the measure of RF signal quality, in dB, which is equivalent to SNR and similar to CNR (CNiR) under additive white Gaussian noise (AWGN) impairments. However, MER is preferred for data networks, because it also includes additional factors that affect the signal, such as analog-to-digital and digital-to-analog conversions, rounding errors, distortions, and signal impairments such as phase noise, group delay, and jitter. For this reason, the DOCSIS 2.0 RF specification adds a requirement for the minimum MER value for a signal, supplementing the existing CNR (CNiR) minimum requirements.

A simple formula for calculating the MER value for an upstream is:

$$\text{MER} = 20 \times \log (\text{RMS error magnitude} / \text{Average symbol magnitude})$$

You can also calculate the Error Vector Modulation (EVM) to find the equivalent value expressed as a percentage of noise on an upstream:

$$\text{EVM} = \text{Average error magnitude} / \text{Max symbol magnitude} * 100$$

See the DOCSIS 2.0 specification for more complete information on calculating and using the MER value.

- **FEC Counters**—These are counters that keep track of how many correctable and uncorrectable FEC errors occur on the upstream. The FEC error counters are useful for tracking fast transient errors such as impulse noise that are not usually reflected in MER (SNR) or CNR (CNiR) values.
 

A correctable error count of more than 1 percent can be used as a warning sign of possible physical plant or cable modem problems that might be developed. An uncorrectable error count of more than 1 percent can indicate an existing problem that is blocking traffic on the upstream. Cable interface line cards that support the intelligent and advanced spectrum management features can use the FEC counters as one of the indicators to be monitored to determine whether an upstream must change frequencies so as to correct noise problems.
- **Microreflections**—Additional copies of a signal that arrive at the receiver, usually at different times and attenuated by different amounts, causing the receiver to misidentify the incoming signal's true phase and amplitude. Microreflections typically are caused by impedance mismatches in the physical cable plant, and can indicate either equipment that has been degraded by weather or other causes, or equipment that has not been installed correctly.

## Upstream Signal Channel Overview

The upstream channel is characterized by many cable modems transmitting to the CMTS. These signals operate in a burst mode of transmission. Time in the upstream channel is slotted. The CMTS provides time slots and controls the usage for each upstream interval. The CMTS periodically broadcasts Upstream Channel Descriptor (UCD) messages to all cable modems. The UCD message contains the upstream frequency and transmission parameters associated with an upstream channel. These messages define upstream channel characteristics including the upstream frequencies, symbol rates and modulation schemes, forward error correction (FEC) parameters, and other physical layer values.

Cisco supports all DOCSIS error-correction encoding and modulation types and formats. Upstream signals are demodulated using QPSK or QAM. QPSK carries information in the phase of the signal carrier, whereas QAM uses both phase and amplitude to carry information.

Sending data reliably in the upstream direction is an issue. Because upstream spectrum varies greatly between cable plants, select upstream parameters based on your cable plant's return paths. Select or customize upstream profiles for the maximum trade-off between bandwidth efficiency and upstream channel robustness. For example, QAM-16 requires approximately 7 dB higher CNR (CNiR) to achieve the same bit error rate as QPSK, but it transfers information at twice the rate of QPSK.

**Note**

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The above specifications are based on predetermined sets of frequencies that may or may not have an adequate CNR (CNiR) at any given time.

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Upstream frequencies can be assigned as follows:

- Fixed—Configuring a spectrum group disables the fixed upstream frequency setting.
- Single subband—The CMTS administrator can define a center frequency and symbol rate such that the boundaries of the upstream carrier stay within the subband. The frequency and symbol rate can change within the boundary in response to noisy line conditions, based on the defined upstream parameters.
- Multiple subbands—The data carrier can remain in a particular subband for a duration of time and then hop to another subband based on the defined upstream parameters.

**Tip**

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Measurement of noise power levels with a spectrum analyzer should be part of the procedure in initially selecting and setting up frequency allocations. We recommend having fixed frequency settings during early deployment, at least until amplifier cascade adjustments or plant repair have become infrequent enough that they no longer significantly affect the nodes connected to the upstream port.

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### Upstream Frequency Changes

As stated in the DOCSIS radio frequency interface (RFI) specification, RF channel migration or upstream frequency change occurs when a change in the UCD message is broadcast to all cable interfaces.

The speed of channel migration via the UCD message is typically less than 20 milliseconds (ms). During this time, upstream transmission is interrupted until the cable interface transmitter adjusts to its new frequency. Data is stored in the cable interface buffers during this time and is sent when the frequency hop is complete.

Station maintenance intervals are used to perform per modem keepalive polling. The CMTS polls each cable modem at least once every 30 seconds, with the default being once every 20 seconds. When ingress noise causes loss of keepalive messages from a configurable percentage of all cable interfaces, resulting in missed polls, a new frequency is selected from the allocation table and a UCD update is performed. The migration time is 2 msec for any upstream UCD update. After the UCD is updated, the hop occurs. The system must wait until a hop threshold time interval has elapsed before it can change the UCD a second time.

## Upstream Segments and Combiner Groups

The Cisco routers divide a cable plant into downstream channels. Downstream channels contain upstream segments. Each upstream segment typically serves more than one fiber node. Upstream segments can be defined as one of the following:

- Sparse segment—Containing one upstream channel per upstream segment.
- Dense segment—Containing multiple upstream channels per upstream segment; frequencies must be different.



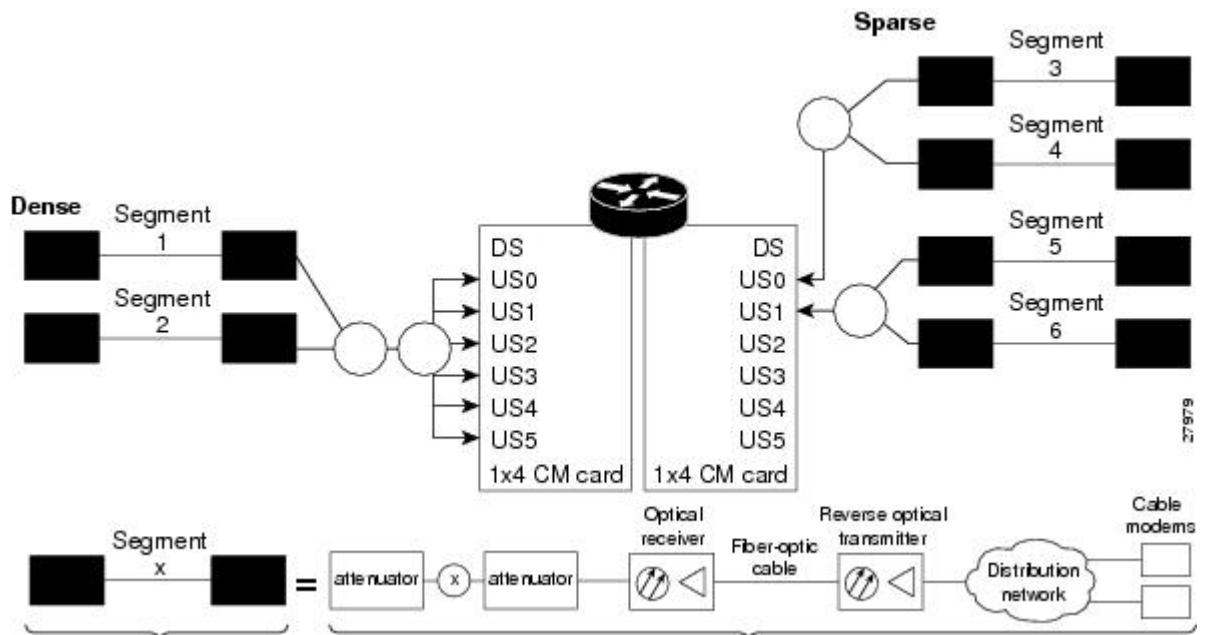
### Note

A cable interface line card can support sparse or dense segments, or both.

Defining sparse segments allows the cable operator to share upstream bandwidth among fiber nodes with fewer subscribers. Defining dense segments allows the cable operator to provide larger upstream bandwidth to fiber nodes with many subscribers.

The figure below illustrates sparse versus dense segments.

**Figure 6: Sparse Versus Dense Segment Illustrations**



As shown in the figure above, the downstream segment can contain multiple upstream segments. Two fiber nodes can be in one downstream segment but in different upstream segments.

The return path of several fiber nodes can be combined at a single point to form a single RF frequency domain called a combiner group. The CMTS software allows a frequency hop table called a spectrum group to be associated with a combiner group.

**Note**

A combiner group refers to an RF topology point. A spectrum group refers to the frequency hop table associated with a combiner group.

## Frequency Management Policy

Spectrum management applies a common frequency-management policy to a set of upstream ports to ensure that data is delivered reliably over the cable plant. Cable plant operators must make noise measurements and determine the cable plant's spectrum management policy. Different modulation schemes, upstream frequency techniques, and symbol rates are used based on the cable plant characteristics and the cable interface line card in the chassis.

See the following sections for more information about these topics:

### Noise Impairments

Upstream noise impairments such as signal degradation on cable networks can negatively affect service to subscribers. Two-way digital data signals are more susceptible than one-way signals to stresses in the condition of the HFC network. Degradation in video signal quality might not be noticeable in one-way cable TV service, but when two-way digital signals share the network with video signals, digital signals can be hampered by:

- **Impulse and electrical signal ingress**—Noise can enter the network from electrical sources within a residence or from high-voltage lines that run near cable television cabling. Two types of ingress noise include broadband and narrowband. Broadband noise is generally of lower frequency (below 10 MHz) and results in harmonic rolloff. Narrowband noise is a more significant interference source. Cable equipment and infrastructure often pick up noise from amateur radio transmissions, citizen band radios, or high-power shortwave broadcast signals. Implement a signal leakage maintenance program to locate and repair areas of signal ingress.
- **Amplifier noise**—Amplifiers add noise to the HFC network that typically goes unnoticed in video signals, but degrades digital data signals if amplifiers are improperly configured. The larger the network, the higher the probability of amplifier noise affecting signals.
- **Noise funneling**—The upstream data path to the headend is susceptible to interference from the entire network. All upstream noise ultimately ends up at the headend because the cumulative nature of noise becomes concentrated at the headend. As a network serviced by a single RF receiver increases in size, the probability of noise funneling also increases.
- **Variable transmit levels**—Temperature affects signal loss over coaxial cable. This can cause variations of 6 to 10 dB per year.
- **Clipping**—The lasers in fiber-optic transmitters can stop transmitting light when input levels are excessive. Excessive input levels introduce bit errors in both the upstream and downstream transmissions. If a laser is overdriven as briefly as a fraction of a second, clipping can occur.

To adjust your return amplifiers and lasers, follow rigorous plant maintenance procedures documented in the NTSC Supplement on Upstream Transport Issues or appropriate cable plant standard.

## Spectrum Groups and Frequency Hopping

We recommend that CMTS administrators configure upstream frequency hopping to counteract long-term, narrowband noise. Cisco CMTS routers support a combination of guided frequency hopping and time-scheduled frequency hopping.

The frequency hop to proactively avoid noise ingress is sometimes called frequency agility. Frequency agility is configured and activated using spectrum groups. Spectrum management supports the creation of a number of cable spectrum groups, allowing multiple upstream ports in a single spectrum group. Each spectrum group defines the table of frequencies to be used in a specific frequency plan. Upstream frequencies can be a fixed single frequency, a single continuous range of frequencies (band), or multiple ranges (or bands) of frequencies.

The cable interface does not operate until you assign a frequency to the upstream, which can be done either by configuring and assigning a spectrum group or assigning a fixed frequency. The spectrum group takes precedence, so if you configure both a spectrum group and a fixed frequency on an upstream, the spectrum group overrides the fixed upstream frequency setting.

From the interface point of view, a spectrum group also represents the set of upstreams connected to the same group of fiber nodes. The spectrum manager software in Cisco routers examines all the RF parameters that have been configured on an upstream to determine whether the upstream frequencies need to be managed together. For example, if you configure a spectrum group with several fixed frequencies, but those frequencies are all within the configured channel width, the spectrum manager software combines the frequencies into a single band.

The upstream ports use the spectrum group to determine which frequencies are available if frequency hopping is needed to deal with noise or other path impairments. The types of frequency hopping techniques are guided, time-scheduled, and combined guided and time-scheduled. See the [Frequency Hopping Capabilities](#), on page 401 for more information on the types of frequency hopping techniques.

**Note**

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When each upstream port has its own RF domain, the group is called a nonshared spectrum group. When multiple upstream ports share the same RF domain, the group is called a shared spectrum group.

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## Guidelines for Spectrum Management

In general, when defining your spectrum, use the following guidelines:

- Avoid frequencies with known ingress problems, such as amateur radio bands or short-wave bands.
- Avoid a hostile spectrum below 20 MHz.
- Allow extra bands for frequency hopping.
- Take the possible channel widths into account when creating frequency bands. The range of frequencies being used must be able to hop between at least two different frequencies when using the channel width that is configured on the upstream.
- Place upstream ports in the same combiner group in a shared spectrum group.
- Use the receive power level setting to perform slight equalization adjustments.
- If you combine multiple upstream ports to provide increased bandwidth, you must avoid overlapping frequency bands. Each port should be using a discrete band of frequencies that does not overlap the

bands being used by other ports in the group. We recommend adding at least 20 KHz between the ending frequency of one band and the starting frequency of the next band, to ensure that the bands do not overlap.

## Guided and Scheduled Spectrum Management

Guided and scheduled spectrum management constitutes a set of basic features for all currently supported cable interface line cards. These features are considered basic because they are available for all cable interfaces, and constitute the elementary, cornerstone features upon which the intelligent and advanced spectrum management features are built.

See the following sections for more information about each feature:

### Frequency Hopping Capabilities

Noise in the upstream transmission line, that is from the consumer to the service provider, can degrade data transmission from the subscriber's home. If the noise impairment is of substantial duration, it may cause the cable modem to temporarily lose communication with the headend facility. As a contingency plan, the multiple service operators (MSOs) can reserve multiple channels or upstream frequencies for their subscribers. If one channel suffers too much interference, the CMTS requests that the cable modems "hop" to another channel.

To provide frequency hopping capability, Cisco CMTS routers contain a spectrum manager that continuously monitors the noise in unused upstream channels. If the CNR (CNiR) reaches an unacceptable level on a particular channel, the spectrum manager automatically assigns a new upstream channel to the cable modem using that channel.

Cisco CMTS routers support the following techniques for upstream frequency hopping when the frequency band in use is not clean:

- Guided frequency hopping—In guided frequency hopping (also known as blind hopping), the spectrum manager automatically assigns a new upstream channel frequency when a configurable threshold of station maintenance (keepalive) messages fails. Failed station maintenance messages represent an impairment of the upstream channel due to noise, plant, or equipment failure. Explicit frequency subbands and associated input power levels are assigned in a spectrum group in guided frequency hopping.
- Time-scheduled frequency hopping—Frequency reassignment is scheduled by the time of day or by a specific day of the week.
- Combined guided and time-scheduled frequency hopping.

**Note**

Frequency hopping is not effective against broadband noise phenomena such as impulse noise.

Time-scheduled and guided hopping techniques are independent concepts:

- The spectrum is controlled by a script, not a frequency table.
- The available spectrum is time-scheduled as an option.
- A guided hopping frequency is selected from the available spectrum at the current time.

You can configure and activate frequency hopping by using spectrum groups. You can create up to 40 cable spectrum groups, each containing multiple upstream ports. The configured channel width is used for each upstream frequency.

After you have created one or more spectrum groups for your cable network, you can add characteristics to them, providing you with more definitive control over frequency usage and frequency hopping.

You can configure hopping thresholds. For example, the frequency hop threshold percentage method prevents a single failing cable modem from affecting service to other working cable modems. As long as a high enough threshold is configured, the system does not hop endlessly due to a single cable modem failing to respond to 90 percent of its station maintenance (keepalive) messages.

You can also configure the minimum period between frequency hops, with a default setting of 30 seconds. If the destination channel is expected to be impaired, you can reduce the minimum period between frequency hops to a small value, such as 10 seconds. This allows the frequency hop to continue more rapidly until a clear channel is found. If excessive frequency hop is an issue, you can increase the minimum period between hops.

To configure different techniques of frequency hopping, see the [Creating and Configuring Spectrum Groups, on page 410](#).

**Note**

Spectrum management is not supported for one-way (telco return) cable modems, because spectrum management capabilities focus on the upstream path over an HFC network.

**Note**

After the spectrum-band is changed, the spectrum management does not rearrange the frequency for each US channel if the previous frequency belongs to the range of new spectrum-band, which means that the US frequency will not be changed; if the previous frequency is out of range of new spectrum-band, those US channels will not get frequencies.

### Guided Frequency Hopping

Guided frequency hopping is called “guided” because the frequency hopping uses the frequencies that are specified in the spectrum group, which can be either a set of discrete frequencies or a band. The cable interface line cards that support guided frequency hopping do not have a “look-ahead” mechanism that would allow them to determine the quality of the new frequency or band ahead of time, which is why previous documents referred to this as blind hopping. Because of this, though, the cable interface does not need to perform any search on the new potential frequencies, so the switching time between frequencies is only approximately 20 milliseconds.

You can specify some rules the system uses when hopping to another frequency when the frequency band in use is not clean. You can assign explicit frequency subbands and associated input power levels in a spectrum group. All cable modems then on the upstream port migrate to the next frequency with an assigned input power level. The number of lost station management messages exceeding a configured threshold can initiate an upstream channel frequency reassignment. For example, you can specify a frequency hop based on lost station management messages that exceed a threshold. The default threshold may be 10 to 20 percent depending on the Cisco IOS release. The frequency change occurs rapidly without data loss and with minimal latency.

Take care to reduce the spectrum allocation when it is used with small channel widths. Otherwise, there will be a large number of upstream channel slots. For example, if the allocation is from 20.0 to 28.0 MHz and an upstream port has its channel width set to 0.2 MHz, there are 40 possible slots for that channel width. Guided frequency hopping can require a long time to find the clean slot, because it tries each available slot, one at a time, for several seconds during each try.



### Time-Scheduled Frequency Hopping

You can specify upstream channel frequency reassignment based on a configured time of every day or of a specific day of the week. If your cable plant has an upstream noise characteristic on a weekly cycle, use time-scheduled spectrum allocation. With a time-scheduled policy, a single frequency becomes valid at any given time.

## Dynamic Upstream Modulation (MER [SNR]-Based)

The basic Dynamic Upstream Modulation feature is supported on all Cisco cable interface line cards beginning with Cisco IOS Release 12.1(3a)EC1, Cisco IOS Release 12.2(4)BC1b, Cisco IOS Release 12.2(33)SCC and later releases.

This section describes the operation of this feature, which is based on evaluating the MER (SNR) of an upstream.

**Note**

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A more advanced version of dynamic upstream modulation, which uses the carrier-to-noise ratio (CNR [CNiR]), is supported on the cards that support intelligent and advanced spectrum management.

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### Feature Overview

Cisco cable interface line cards monitor the MER (SNR) values and the forward error correction (FEC) counters in the active return path of each upstream port. The Dynamic Upstream Modulation feature determines whether upstream channel signal quality can support the modulation scheme configured, and adjusts to the most robust modulation scheme when necessary. When return path conditions improve, this feature returns the upstream channel to the higher modulation scheme that includes the modulation profile.

A modulation profile is a collection of burst profiles that are sent out in a UCD message to configure modem transmit parameters for the upstream. The Dynamic Upstream Modulation feature adjusts the modulation profiles of an upstream channel based on upstream signal quality.

The Dynamic Upstream Modulation feature is configured on interfaces with fixed upstream frequencies or on interfaces with assigned spectrum groups.

The following examples show two different configurations of the Dynamic Upstream Modulation feature, using two and three modulation profiles.

### Example Showing Dynamic Upstream Modulation Using Two Modulation Profiles

You can configure the Dynamic Upstream Modulation feature on the Cisco CMTS router using the following primary and secondary modulation profiles:

- The primary modulation profile uses 64-QAM or 16-QAM, which is a more bandwidth-efficient modulation scheme and has a higher throughput than a QPSK profile.
- The secondary modulation profile uses QPSK, which uses a more robust modulation scheme, but is not bandwidth-efficient.

We recommend that the primary profile use 64-QAM or 16-QAM modulation and the secondary use QPSK. However, this is optional as both modulation profiles can either be QPSK or QAM. It is not mandatory for one profile to be QAM and the other QPSK, but modulation profile switchover is tied to the QAM and QPSK thresholds.

### Example Showing Dynamic Upstream Modulation Using Three Modulation Profiles

You can configure the Dynamic Upstream Modulation feature on the Cisco CMTS router using the following primary, secondary, and tertiary modulation profiles:

- The primary modulation profile uses 64-QAM, which is a more bandwidth-efficient modulation scheme and has a higher throughput than a 16-QAM profile.
- The secondary modulation profile uses 16-QAM, which is a more bandwidth-efficient modulation scheme and has a higher throughput than a QPSK profile.
- The tertiary modulation profile uses QPSK, which uses a more robust modulation scheme, but is not bandwidth-efficient.

We recommend that the primary profile use 64-QAM modulation, the secondary profile use 16-QAM, and the tertiary profile uses QPSK. However, this is optional as the modulation profiles can either be QPSK or QAM. It is not mandatory that one is QPSK and the other two are QAM, but modulation profile switchover is tied to the QAM and QPSK thresholds.



#### Note

Support for Three Step Dynamic Modulation is available from Cisco IOS Release 12.2(33)SCB3 onwards.



#### Tip

Cisco IOS Release 12.2(15)BC2 introduced a series of robust predefined modulation profiles that can also be used with the Dynamic Upstream Modulation feature. See the description of the **cable modulation-profile** command in the [Cisco IOS CMTS Command Reference](#) for more information.

### Criteria for Switching Modulation Profiles

The Dynamic Upstream Modulation feature uses the following criteria to determine whether it should switch from the primary modulation profile (the more bandwidth-efficient, but less robust profile) to the secondary modulation profile (more robust, but less bandwidth-efficient profile) or to the (optional) tertiary modulation profile (most robust, but less bandwidth-efficient profile):

The modulation switch from the primary profile (high performance) to the secondary profile (mid-level performance) uses the following criteria:

- The upstream MER (SNR) is less than MER (SNR) threshold one and the percentage of correctable FEC (cFEC) errors is greater than or equal to the correctable FEC error threshold or the percentage of uncorrectable FEC (uFEC) errors is greater than or equal to the uncorrectable FEC error threshold.

Before switching back to the primary profile from the secondary profile, the following criteria must be satisfied:

- The upstream MER (SNR) is greater than or equal to the sum of MER (SNR) threshold one and the hysteresis value and the percentage of correctable FEC errors is less than or equal to the correctable FEC error threshold and the percentage of uncorrectable FEC errors is less than or equal to the uncorrectable FEC error threshold and the hop period equals to the default value of 15 seconds.

The modulation switch from the secondary profile (mid-level performance) to the tertiary profile (most robust) uses the following criteria:

- The upstream MER (SNR) is less than MER (SNR) threshold two and the percentage of correctable FEC (cFEC) errors is greater than or equal to the correctable FEC error threshold or the percentage of uncorrectable FEC (uFEC) errors is greater than or equal to the uncorrectable FEC error threshold.

Before switching back to the secondary profile from the tertiary profile, the following criteria must be satisfied:

- The upstream MER (SNR) is greater than or equal to the sum of MER (SNR) threshold two and the hysteresis value and the percentage of correctable FEC errors is less than or equal to the correctable FEC error threshold and the percentage of uncorrectable FEC errors is less than or equal to the uncorrectable FEC error threshold.

The modulation switch from the primary profile to the tertiary profile uses the following criteria:

- The upstream MER (SNR) is less than MER (SNR) threshold two and the percentage of correctable FEC (cFEC) errors is greater than or equal to the correctable FEC error threshold or the percentage of uncorrectable FEC (uFEC) errors is greater than or equal to the uncorrectable FEC error threshold.

Before switching back to the primary profile from the tertiary profile, the following criteria must be satisfied:

- The modulation switch from the tertiary profile to the primary profile is a two-step process:
  - 1 The modulation switch happens from tertiary profile to the primary profile, when the upstream MER (SNR) is greater than or equal to the sum of MER (SNR) threshold one and the hysteresis value.
  - 2 After a 15-second (non-configurable) delay, the modulation switch occurs from secondary profile to the primary profile, when the upstream MER (SNR) remains greater than or equal to the sum of MER (SNR) threshold one and the hysteresis value.

If the only problem is that the upstream is experiencing a large number of uncorrectable errors, then a situation could occur where the router continues to switch back and forth between profiles. The uncorrectable errors occur with the primary profile, so the router switches to the secondary profile. The secondary profile does not experience any problems, so the router switches back to the primary profile. But the uncorrectable errors reoccur and the router switches back to the secondary profile, and this cycle continues indefinitely.

To avoid this problem, make sure that the cable plant is capable of supporting the modulation scheme being used in the primary profile (for example, 64-QAM). If you cannot guarantee successful operation on an upstream using this modulation scheme, then you should select a primary profile that uses a more bandwidth-efficient set of burst parameters (such as QPSK). The Cisco IOS software includes predefined modulation profiles that can be used for the primary, secondary, and tertiary profiles.

## Input Power Levels

Upstream input power level modifications were made in Cisco IOS Releases 12.0(6)SC, 12.1(1), 12.1(1)T, 12.1(2)EC1, and 12.2(4)BC1b.

The input power level, *power-level-dBmV*, is an option in the **cable spectrum-group** command. The option allows you to specify the expected upstream input power levels on the upstream receivers on the CMTS when the cable modems are hopping from one fixed frequency to another or from one band to another. Each upstream frequency has an associated upstream input power level in dBmV. The power level is the modem transmit power that each spectrum group can use when an upstream frequency change is necessary. The input power level may be set at the time of the frequency hop.

Specifying an input power level is done so that the cable modems do not have to increase or decrease their transmit power with every hop. The cable operator can perform minor power equalizations as a function of

frequency. The valid range is  $-10$  to  $10\text{dBmV}$ . The power level value should be changed only if you want to change the power level as part of spectrum management. Some cable plants may want to change only the input power level, and not the frequency, on a daily time schedule.

For information on how to configure input power levels, see the [Configuring and Assigning Spectrum Groups, on page 421](#).

## Intelligent and Advanced Hardware-Based Spectrum Management

Several cable interface line cards include hardware-based spectrum management features that provide enhancements to the basic features supported by the other Cisco cable interface line cards.

### Intelligent Spectrum Management Enhancements

The following features are part of the intelligent spectrum management feature set:

- Integrates a DOCSIS cable interface line card with an onboard spectrum analyzer that continuously analyzes the upstream spectrum quality in the DOCSIS frequency range of 5 to 42 MHz.
- Includes hardware-assisted frequency hopping, providing for more intelligent and faster frequency selection than software-only solutions.
- Reduces the response time to ingress noise that could cause modems to drop offline.
- Eliminates blind frequency hopping by initiating frequency hops to known clean channels.
- Improves frequency agility to help eliminate dropped packets and thereby maintain full upstream data rates.
- Supports frequency agility in dense-mode combining environments across a shared spectrum.
- Restricts frequency hopping to a set of discrete fixed frequencies or to a range of frequencies, as desired.
- Allows frequency hop conditions to be customized for specific plant environments and requirements.
- Optionally schedules frequency hops to take advantage of known usage patterns or plant conditions.
- Optionally dynamically reduces channel width to allow cable modems to remain online, even in noisy upstream conditions.

### Advanced Spectrum Management Support Using the Cisco uBR10-MC5X20S/U/H BPE

The advanced spectrum management features were introduced on the Cisco uBR10-MC5X20S/U/H BPE as a software-only upgrade. These enhancements are supported on additional line cards on the Cisco IOS Releases that are shown in [Table 54: Minimum Cisco IOS Releases for Intelligent and Advanced Spectrum Management Support, on page 389](#).

The following additional features are part of the advanced spectrum management feature set:

- Supports proactive channel management, to avoid the impacts of ingress and keep subscribers online and connected.
- Offers flexible configuration choices, allowing users to determine the priority of the actions to be taken when ingress noise on the upstream exceeds the allowable thresholds. The configurable actions are frequency hopping, switching the modulation profile, and reducing the channel width.

- Performs carrier-noise ratio (CNR [CNiR]) calculations in real time on a per-interface and a per-modem basis.




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**Note** In Cisco IOS Release 12.3(13a)BC and later Cisco IOS 12.3 BC releases, the CNR (CNiR) value is before the Ingress Noise Cancellation, while the MER (SNR) value is after the Ingress Noise Cancellation. For this reason, the CNR (CNiR) and MER (SNR) values might not exactly match for any particular period.

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- Determines when to modify the frequency, channel width, or modulation profile, based on the CNR (CNiR) and MER (SNR) calculations in the active channel and the number of correctable FEC errors and uncorrectable FEC errors. Frequency hopping, channel width change, or profile change occurs in the following circumstances:
  - The CNR (CNiR) and MER (SNR) values fall below the user-defined threshold value for the primary modulation profile and the correctable FEC error value or the uncorrectable FEC error exceeds its user-defined threshold.

This logic can be expressed as the following formula:

```
[(CNR <= threshold) AND (MER(SNR) <= threshold)] AND
[(correctable FEC >= threshold) OR (uncorrectable FEC >= threshold)]
```

This approach helps avoid unneeded channel changes due to transient noise problems that do not actually cause any errors in the data stream. The channel changes only when the noise affects both the CNR (CNiR) and MER (SNR) of the upstream and generates an unacceptable number of FEC errors in the data. If you want channel changes to occur only in response to the CNR (CNiR), you must set the MER (SNR) threshold and the FEC error threshold values to zero.

Separate CNR (CNiR) threshold values are configured for the primary and secondary modulation profiles. When the upstream has moved to the secondary modulation profile, further frequency hopping or channel width changes occur only when the CNR (CNiR) and the MER (SNR) values fall below the user-defined threshold value for the secondary profile.




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**Note** Previously, channel hopping occurred when the number of missed station maintenance polls exceeded a user-defined threshold or the MER (SNR) exceeded a certain threshold.

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- Enhances the Dynamic Upstream Modulation feature for the Cisco uBR10-MC5X20S/U/H BPE. This feature supports dynamic modulation using two upstream profiles. The primary profile (typically using QAM-16 “mix” modulation) remains in effect at low noise conditions, but if upstream conditions worsen, the cable modems switch to the secondary profile (typically using QPSK modulation) to avoid going offline. When the noise conditions improve, the modems are moved back to the primary profile.
- Provides an SNMP interface so that a network management workstation or other graphical tool can obtain spectrum information for either a particular cable modem or for an entire upstream. The frequency resolution can be as fine as 10 KHz for Cisco uBR10-MC5X20S/U cable interface line card and 20 KHz for Cisco uBR-MC28U and Cisco uBR10-MC5X20H cable interface line cards.



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**Note** The CISCO-CABLE-SPECTRUM MIB has been enhanced to provide this support.

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## Benefits

The spectrum management features provided on the Cisco CMTS router platforms provide several key system benefits:

- Improves response time to ingress noise impairments that appear in the upstream return path.
- Boosts the percentage of modems online.
- Mitigates the impact of ingress to subscriber services.
- Saves time and effort by MSO staff when troubleshooting minor plant outages.
- Increases cable plant reliability.
- Maximizes spectrum utilization.

### Guided and Scheduled Spectrum Management Benefits

The following summarizes the specific benefits of the guided and scheduled spectrum management features that are supported for all Cisco CMTS router platforms.

#### Input Power Levels

Allows the cable plant operator to perform minor power level equalization as a function of frequency.

#### Frequency Hopping Capabilities

Proactively countermeasures upstream noise impairments by assigning a new upstream channel to the cable modem. MSOs can take advantage of this feature especially when they have less than an optimal carrier-to-noise ratio in the upstream frequencies or when their cable plants exhibit random bursts of ingress noise that affect reliability.

#### Dynamic Upstream Modulation

- Reduces the risk associated with transitioning to QAM-16 modulation in the return path and provides assurance that subscribers remain online and connected during return path impairments.
- Checks that the active upstream signal quality can support the configured modulation scheme and proactively adjusts to the more robust modulation scheme when necessary.
- Eliminates the necessity to hop channels for cable modems to stay online by automatically switching from the primary modulation profile to the secondary modulation profile.

## Intelligent and Advanced Spectrum Management Benefits

The following summarizes the specific benefits of the advanced spectrum management features that are supported on Cisco CMTS routers using supported cable interface line cards.

### Dynamic Channel Width Change

- Improves the DOCSIS upstream channel availability by finding the maximum possible channel width for an upstream when noise conditions make the current channel width unusable.
- Provides the maximum RF spectrum utilization efficiency for current plant conditions.
- Customizable range of channel widths that can be used to respond to noise problems.

### Intelligent Frequency Hopping

- Proactively changes upstream frequency for an interface before noise conditions become severe enough to force cable modems offline.
- Dedicated hardware intelligent frequency hopping performs “look-ahead” to choose new upstream frequency to find a stable channel.
- Flexible priority configuration allows hopping decision criteria to be tailored to the individual cable plant environment.
- Improves responsiveness to ingress impairments, by matching the hopping decision criteria to the fluctuating plant conditions.
- Pinpoints CNR (CNiR) variations with per-modem accuracy to isolate problematic cable modems.
- Sustains or even improves subscriber online percentages through user-programmable proactive channel management techniques.

### Dynamic Upstream Modulation

- Reduces the risk associated with switching between QPSK and QAM-16 modulation in the upstream to respond to ingress noise, so that subscribers remain online and connected.
- Checks the current upstream signal to ensure that it can support the configured modulation scheme, and proactively adjusts to the secondary more robust modulation scheme when necessary.
- Improves DOCSIS upstream channel availability and provides maximum RF spectrum utilization efficiency.
- Eliminates unnecessary frequency hopping by switching modulation profiles to one that allows cable modems to remain online while using the currently assigned upstream.
- Provides assurance that subscribers remain online and connected during periods of return path impairments.

### SNMP Interface

- Provides a way to remotely obtain the current status of noise on an upstream. This information can then be inserted into third-party or custom reporting and graphing applications.

- Provides visibility to ingress and impulse noise under the carrier frequency on a per-port basis.
- Provides an easy-to-use, distributed method to remotely gather real-time display of the DOCSIS upstream spectrum for individual cable modems and set-top boxes (STBs).
- Reduces the reliance on costly spectrum analyzers at every headend or hub.
- Quickly provides spectrum views through an intuitive interface, without the complicated setup time of a spectrum analyzer.
- Allows the technician to troubleshoot the network remotely, as opposed to having to be physically present to connect and use a spectrum analyzer.

### Default Hop Priority

For Intelligent and Advanced Spectrum Management feature, the default hop priority is as given below:

- Frequency, modulation, and channel width (when using spectrum groups on spectrum cards).
- Modulation, guided frequency hop, and channel width (when using analyzer cards with spectrum groups).
- Modulation only (when not using spectrum groups [fixed frequency]).

## How to Configure Spectrum Management

This section describes the configuration tasks that are most commonly performed when using the spectrum management features on the Cisco CMTS platforms. See the following sections for the configuration tasks that are appropriate for your platform and cable interface line cards.

## Guided and Scheduled Spectrum Management Configuration Tasks

The following tasks configure the guided and scheduled spectrum management features that are supported on all Cisco CMTS platforms:

### Creating and Configuring Spectrum Groups

A spectrum group defines the frequencies that an upstream is allowed to use when frequency hopping is done, as well as other parameters that control the frequency hops. When creating and configuring spectrum groups, you can specify the following parameters:

- Frequencies that are assigned to the group. The cable interface uses these frequencies to determine what frequencies are available to use when frequency hopping is needed. You can specify either a list of fixed frequencies or a band of frequencies, or both. The Cisco CMTS uses the following rules when adding frequencies to a spectrum group:
  - When specifying a fixed frequency, the Cisco CMTS assumes it is a center frequency with a 6.4-MHz channel width to allow that frequency to operate at all possible channel widths. For example, specifying a frequency of 17,700,000 Hz is equivalent to specifying a frequency band from 14,500,000 Hz to 20,900,000 Hz (a band that is 6.4 MHz wide).
  - If you configure multiple fixed frequencies or bands of frequencies that overlap, the spectrum group combines them into one band. For example, if you specify a fixed frequency of 17,700,000



Hz and a band from 15,800,000 Hz to 25,200,000 Hz, the spectrum group is configured with one band from 14,500,000 Hz to 25,200,00 Hz.

- If you want more control over a spectrum group's frequencies, configure bands of frequencies with the same width as the desired channel width. For example, if you want to use a center frequency of 17,700,000 Hz with a 3.2-MHz channel width, specify a band that ranges from 16,100,000 Hz to 19,300,000 Hz. To ensure you configure non-overlapping bands, separate the bands by a minimum of 20 KHz.
- Upstream input power level—(Optional) Power level, in dBmV, that the upstream should use when hopping to a new frequency. (Some cable plants might want to change only the input power level, and not the frequency, on a daily time schedule.)
- Hop threshold—(Optional) Percentage of cable modems that start missing station maintenance messages before a frequency hop can occur. Configure the hop threshold percentage as needed to prevent a single failing cable interface from affecting service to other good cable interfaces. This ensures that the system does not hop endlessly because one cable modem is generating 90 percent of the errors and 90 percent of the traffic.
- Hop period—(Optional) Minimum time period that must elapse between frequency hops. This allows you to specify a time period long enough to allow an upstream to stabilize before another frequency hop can be performed.
- Scheduled hop time—(Optional) Time of day at which a frequency hop should be scheduled.
- Shared—(Optional) Specifies that all the upstream ports using a spectrum group should use a unique frequency.

**Tip**

Before adding a list of upstream frequencies (or frequency hop tables), start by determining which upstream ports are assigned to a combiner group. Refer to the [Example: Determining the Upstream Ports Assigned to a Combiner Group](#), on page 441 for an example.

**Restriction**

- The Cisco uBR10012 universal broadband router does not support spectrum management groups with fixed frequencies for the Cisco MC5X20S/U/H. The Cisco uBR7246VXR universal broadband router does not support spectrum groups with fixed frequencies for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X line cards.
- The Cisco uBR10012 universal broadband router does not support inter-line card shared spectrum groups for the Cisco MC5X20S/U/H. The Cisco uBR7246VXR universal broadband router does not support inter-line card shared spectrum groups for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X line cards.

To create and configure a spectrum group, use the following procedure.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable spectrum-group</b> <i>group-number</i> [ <b>time day</b> <i>hh:mm:ss</i> ] <b>frequency</b> <i>up-freq-Hz</i> [ <i>power-level-dBmV</i> ]  <b>Example:</b> Router(config)# <b>cable spectrum-group 4 time Monday 12:00:00 frequency 40000000</b>	Creates the spectrum group (if it does not already exist), and adds the specified fixed frequency to the group.
Step 4	<b>cable spectrum-group</b> <i>group-number</i> [ <b>time day</b> <i>hh:mm:ss</i> ] <b>band</b> <i>up-freq-Hz up-freq2-Hz</i> [ <i>power-level-dBmV</i> ]  <b>Example:</b> Router(config)# <b>cable spectrum-group 4 band 20000000 24000000 13</b>	Creates the spectrum group (if it does not already exist), and adds the specified band of frequencies to the group.  <b>Note</b> Repeat Step 3 and Step 5 as needed for each fixed frequency and frequency band that should be a member of this spectrum group. You must assign at least two fixed frequencies, or a frequency band that contains at least two center frequencies, to a spectrum group before frequency hopping can occur.
Step 5	<b>cable spectrum-group</b> <i>group-number</i> <b>hop period</b> <i>seconds</i>  <b>Example:</b> Router(config)# <b>cable spectrum-group 4 hop period 60</b>	Specifies the minimum time, in seconds, between frequency hops.  <b>Note</b> We recommend a configuration of 30 seconds when using a Cisco uBR-MC5X20S/U/H BPE.
Step 6	<b>cable spectrum-group</b> <i>group-number</i> <b>hop threshold</b> [ <i>percent</i> ]  <b>Example:</b> Router(config)# <b>cable spectrum-group 4 hop threshold 25</b>	Specifies the frequency hop threshold for a spectrum group.  <ul style="list-style-type: none"> <li><b>percent</b>—(Optional) Frequency hop threshold as a percentage of station maintenance messages that are lost. Valid range is from 1 to 100 percent, with a default of 50 percent.</li> </ul>
Step 7	<b>cable spectrum-group</b> <i>group-number</i> <b>shared</b>  <b>Example:</b> Router(config)# <b>cable spectrum-group 4 shared</b>	(Optional) Specifies that the upstream ports in a spectrum group should use a unique upstream frequency.
Step 8	<b>end</b>  <b>Example:</b> Router(config)# <b>end</b>	Exits global configuration mode and returns to privileged EXEC mode.

## Assigning a Spectrum Group to One or More Upstream Ports

After a spectrum group has been created and configured, you must assign it to one or more upstream ports before the group's frequency spectrum is used for frequency hopping. You can assign a spectrum group to an upstream in the following ways:

- Use the **cable spectrum-group** interface configuration command to assign a spectrum group to all of the upstreams on a cable interface.
- Use the **cable upstream spectrum-group** interface configuration command to assign a spectrum group to one individual upstream. This command overrides a group that might have been assigned to all of the upstreams on the interface by the **cable spectrum-group** command.

To assign a spectrum group to one or all upstream ports on an interface, use the following procedure.

### DETAILED STEPS

	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>	Use one of the following commands:  • <b>interface cable x/y</b>  • <b>interface cable x/y/z</b>  <b>Example:</b> Router(config)# <b>interface cable 5/1</b>	Enters interface configuration mode for the specified cable interface.
<b>Step 4</b>	<b>cable spectrum-group group-number</b>  <b>Example:</b> Router(config-if)# <b>cable spectrum-group 4</b>	Assigns the specified spectrum group as the default group for all upstreams on this cable interface. The valid range for <i>group-number</i> is from 1 to 32, or from 1 to 40, depending on the Cisco IOS software release.
<b>Step 5</b>	<b>cable upstream n spectrum-group group-number</b>  <b>Example:</b> Router(config-if)# <b>cable upstream 1 spectrum-group 5</b>	Assigns the specified spectrum group to this individual upstream, overriding any previous assignment that was done for all upstreams on the interface using the <b>cable spectrum-group</b> command.  <b>Note</b> Repeat this step for each upstream to be configured.

	Command or Action	Purpose
		<b>Note</b> Repeat <a href="#">Step 3, on page 413</a> through <a href="#">Step 5, on page 413</a> for each cable interface to be configured.
<b>Step 6</b>	<b>end</b>  <b>Example:</b> Router(config-if) # <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

### What to Do Next



#### Note

For help in determining which upstream ports to assign in a combiner group, refer to the, [Example: Determining the Upstream Ports Assigned to a Combiner Group, on page 441](#).



#### Tip

To verify the spectrum group configuration, use the **show cable spectrum-group** command in privileged EXEC mode.

## Configuring Shared Spectrum Groups (Fiber Node Groups) for DOCSIS 3.0

Cisco IOS Release 12.3(21)BC, and later releases, support shared spectrum groups, otherwise known as fiber node groups, for DOCSIS 3.0 on the Cisco uBR10012 router.

This feature supports shared spectrum groups that cross multiple cable interface line cards on the Cisco CMTS router, and shared spectrum groups within a single cable interface line card.

For additional information about configuring fiber node groups on the Cisco CMTS, see:

- [Creating and Configuring Spectrum Groups, on page 410](#)
- [Assigning a Spectrum Group to One or More Upstream Ports, on page 413](#)
- [Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide](#)

## Configuring Dynamic Upstream Modulation (MER [SNR]-Based)

To use the Dynamic Upstream Modulation feature on cable interface line cards that support only the MER (SNR) version of this feature, you must do the following:

- 1 Create a primary modulation profile. This typically is a more bandwidth-efficient but a less robust profile.
- 2 Optionally create a secondary modulation profile. This typically is a less bandwidth-efficient but a moderately robust profile.
- 3 Optionally create a tertiary modulation profile. This typically is a less bandwidth-efficient but a more robust profile.

- 4 Assign the profiles to the desired cable interfaces and upstreams.

**Tip**

When creating the modulation profiles, we recommend that you use the predefined modulation profiles, as opposed to manually specifying each burst parameter for each modulation profile.

**Restriction**

- The Dynamic Upstream Modulation feature is supported only for DOCSIS 1.0 or DOCSIS 1.1 TDMA-only modulation profiles for advanced spectrum management.
- The DOCSIS 2.0 mixed-mode or ATDMA-only mode modulation profiles are supported only for basic spectrum management (MER [SNR]-based) and not for advanced spectrum management.
- The Three Step Dynamic Modulation feature supports only basic spectrum management features. It does not support modulation profile changes based on CNR (CNiR) thresholds and CNR (CNiR) measurements.
- The Dynamic Upstream Modulation feature is not enabled for single modulation profile configurations.
- You can configure only two modulation profiles when an upstream is already assigned to a spectrum group for frequency hopping. The spectrum group here implies advanced spectrum management and/or the use of CNR (CNiR).
- A single profile is automatically removed from the configuration if three modulation profiles are assigned to an upstream interface before assigning spectrum group, based on the following conditions:
  - The robust profile is dropped if the upstream port is using a high performance profile.
  - The high performance profile is dropped if the upstream port is using a mid-level or robust profile.

To create and assign the primary, secondary, and tertiary modulation profiles to an upstream, use the following procedures.

Starting with Cisco IOS Release 12.2(33)SCC, you can configure two logical channels on a single physical port for the uBR10012 router. When you configure logical channels, the upstream related commands are categorized into two groups: physical port level and logical channel level.

**Physical Port Level**

Physical port level commands use the format of **cable upstream *n***, where *n* denotes the physical port number.

**Logical Channel Level**

Logical channel level commands use the format of **cable upstream *n m***, where *n* denotes the physical port number, and *m* denotes the logical channel index number of 0 or 1.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><b>enable</b></p> <p><b>Example:</b> Router&gt; <b>enable</b></p>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<p><b>configure terminal</b></p> <p><b>Example:</b> Router# <b>configure terminal</b></p>	Enters global configuration mode.
Step 3	<p><b>cable modulation-profile</b> <i>profile</i> {<b>mix</b>   <b>qam-64</b>   <b>qam-16</b>   <b>qpsk</b>   <b>robust-mix</b>}</p> <p><b>Example:</b> Router(config)# <b>cable modulation-profile 3 mix</b></p>	<p>Creates the primary modulation profile for use on a DOCSIS 1.0 or DOCSIS 1.1 TDMA or A-TDMA upstream.</p> <p>Typically, the primary profile is either <b>qam-16</b> or <b>mix</b>.</p> <p><b>Note</b> Repeat this command to create the secondary and tertiary profile for use on a DOCSIS 1.0 or DOCSIS 1.1 TDMA or A-TDMA upstream. Typically, the secondary and tertiary profiles are either <b>robust-mix</b> or <b>qpsk</b>.</p> <p><b>Note</b> You can also create custom modulation profiles with the <b>cable modulation-profile</b> command by configuring the values for the individual burst parameters. These parameters, however, should not be modified unless you are thoroughly familiar with how changing each parameter affects the DOCSIS MAC layer. We recommend using the preconfigured default modulation profiles for most cable plants.</p>
Step 4	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> <li>• <b>interface cable</b> <i>x/y</i></li> <li>• <b>interface cable</b> <i>x/y/z</i></li> </ul> <p><b>Example:</b> Router(config)# <b>interface cable 5/1</b></p>	Enters interface configuration mode for the specified cable interface.
Step 5	<p><b>cable upstream</b> <i>n</i> <b>modulation-profile</b> <i>primary-profile-number</i> [<i>secondary-profile-number</i>] [<i>tertiary-profile-number</i>]</p> <p><b>Example:</b> Router(config-if)# <b>cable upstream 0 modulation-profile 3 4 5</b></p>	<p>Assigns a primary modulation profile, and the optional secondary and tertiary modulation profiles, to the specified upstream port.</p> <p><b>Note</b> For Cisco IOS Release 12.3(13a)BC and later, the MER (SNR), correctable FEC, uncorrectable FEC thresholds, and hysteresis can be user defined using the steps from <a href="#">Step 6, on page 416</a> to <a href="#">Step 9, on page 417</a>.</p>
Step 6	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream</b> <i>n</i> <b>threshold snr-profiles</b> <i>threshold1-in-db threshold2-in-db</i></li> </ul>	(Optional) Specifies the MER (SNR) threshold in dB.

	Command or Action	Purpose
	<ul style="list-style-type: none"> <li>• <b>cable upstream <i>n m</i> threshold snr-profiles <i>threshold1-in-db threshold2-in-db</i></b></li> </ul> <p><b>Example:</b>  Router(config-if)# <b>cable upstream 0 threshold snr-profiles 25 15</b></p>	
<b>Step 7</b>	Use one of the following commands: <ul style="list-style-type: none"> <li>• <b>cable upstream <i>n</i> threshold corr-fec <i>corr-fec</i></b></li> <li>• <b>cable upstream <i>n m</i> threshold corr-fec <i>corr-fec</i></b></li> </ul> <p><b>Example:</b>  Router(config-if)# <b>cable upstream n threshold corr-fec 20</b></p>	(Optional) Specifies the allowable number of correctable FEC errors for the upstream.
<b>Step 8</b>	Use one of the following commands: <ul style="list-style-type: none"> <li>• <b>cable upstream <i>n</i> threshold uncorr-fec <i>uncorr-fec</i></b></li> <li>• <b>cable upstream <i>n m</i> threshold uncorr-fec <i>uncorr-fec</i></b></li> </ul> <p><b>Example:</b>  Router(config-if)# <b>cable upstream n threshold uncorr-fec 10</b></p>	(Optional) Specifies the allowable number of uncorrectable FEC errors for the upstream.
<b>Step 9</b>	<b>cable upstream <i>n</i> threshold hysteresis <i>hysteresis-in-db</i></b> <p><b>Example:</b>  Router(config-if)# <b>cable upstream n threshold hysteresis 10</b></p>	(Optional) Specifies the hysteresis value to be used in conjunction with the dynamic modulation upgrade thresholds.
<b>Step 10</b>	<b>end</b> <p><b>Example:</b>  Router(config-if)# <b>end</b></p>	Exits interface configuration mode and returns to privileged EXEC mode.

### What to Do Next



#### Tip

See the [Dynamic Upstream Modulation \(MER \[SNR\]-Based\)](#), on page 403 for a complete description of the Dynamic Upstream Modulation feature.

## Verifying Frequency Hopping

You can verify frequency hopping on the CMTS by using the command-line interface (CLI).

For Cisco IOS Release 12.3(13a)BC and later releases, two more show commands have been added:

- **show cable hop upstream history**
- **show cable hop upstream threshold**

### Verifying Frequency Hopping Using CLI Commands

To verify frequency hopping using CLI commands, use the following procedure:

- Step 1** Verify that the interface being tested is up, using the **show interfaces cable** command in privileged EXEC mode. The first line of the output shows whether both the interface and line protocol are up.

#### Example:

```
Router# show interfaces cable 6/0
Cable6/0 is up, line protocol is up
  Hardware is BCM3210 ASIC, address is 000a.13e8.1ca8 (bia 000a.13e8.1ca8)
  Internet address is 10.20.114.33/27
  MTU 1500 bytes, BW 27000 Kbit, DLY 1000 usec,
```

- Step 2** Verify that the upstream being tested is up, using the **show interfaces cable upstream** command. The first line shows whether the upstream is up.

#### Example:

```
Router# show interfaces cable 6/0 upstream 5
Cable6/0: Upstream 5 is up
  Received 8 broadcasts, 0 multicasts, 6388105 unicasts
  0 discards, 0 errors, 0 unknown protocol
  6388113 packets input, 0 uncorrectable
  0 noise, 0 microreflections
  Total Modems On This Upstream Channel : 23 (22 active)
```

- Step 3** Use the **show cable hop upstream** command to display the frequency that the upstream is currently using:

#### Example:

```
Router# show cable hop cable 6/0 upstream 5
Upstream   Port      Poll Missed Min   Missed Hop   Hop   Corr   Uncorr
Port       Status    Rate Poll  Poll  Poll  Thres Period FEC   FEC
           (ms) Count Sample Pcnt  Pcnt (sec) Errors Errors
Cable6/0/U5 16.816 Mhz 1000 0    10    0%   20%  25    0    0
```

- Step 4** Use the **show cable hop upstream history** command to display the frequency change, modulation change, and channel width change action history of the upstreams:

#### Example:

```
Router# show cable hop cable 7/0/0 upstream 0 history
```



```

F = Frequency Hop, M = Modulation Change, C = Channel Width Change
Upstream Action Chg Chg Action
Port Time Code From To Reason
Ca7/0/0/U0 Sep 17 17:00:24 C 1.6 3.2 Configuration changed
Sep 14 19:38:55 F 41.117 26.358 Interface state changed
Sep 14 19:38:55 F 0.000 41.117 Interface state changed
Sep 14 19:38:24 M 21 221 Configuration changed

```

**Note** Cisco IOS Release 12.3(23)BC7 modifies the **show cable hop upstream history** command to show the identifier for the modulation profile.

**Step 5** Use the **show cable hop upstream threshold** command to display the user-defined thresholds and current CNR, MER (SNR), correctable FEC percentage, uncorrectable FEC percentage, and missed station maintenance percentage values of the upstreams:

**Example:**

```
Router# show cable hop cable 6/0/0 upstream threshold
```

Upstream Port	SNR (dB)		CNR (dB)			CorrFEC%		UncorrFEC%		MissedSM%		
	Val	Thre1	Thre2	Val	Thre1	Thre2	Pcnt	Thre	Pcnt	Thre	Pcnt	Thre
Ca6/0/0/U0	27	25	15	39	35	25	0	3	0	1	75	75
Ca6/0/0/U1	31	25	15	51	35	25	0	3	0	1	90	75
Ca6/0/0/U2	--	35	25	--	35	25	0	3	0	1	0	75
Ca6/0/0/U3	--	35	25	--	35	25	0	3	0	1	0	75

**Step 6** Use the **test cable hop** command to force the desired upstream to perform a frequency hop. A few seconds after giving the command, a console message should appear informing you of the hop. Repeat the command as needed to verify that the upstream hops through all the frequencies that have been assigned to the upstream's spectrum group.

**Example:**

```
Router# test cable hop cable 6/0 upstream 5
```

```
2w0d: %UBR7200-5-USFREQCHG: Interface Cable6/0 Port U5, frequency changed to 15.760 MHz
```

```
Router# test cable hop cable 6/0 upstream 5
```

```
2w0d: %UBR7200-5-USFREQCHG: Interface Cable6/0 Port U5, frequency changed to 26.832 MHz
```

**Step 7** Use the **test cable channel-width** command to force the desired upstream to perform a channel-width change. A few seconds after giving the test command, use the show cable hop command to verify the channel-width change.

**Example:**

```
Router# test cable channel-width cable 7/0/0 upstream 0
```

```
Channel width changed to 1600000 Hz for Cable7/0/0 U0
```

```
Router# *Sep 17 17:06:46.882: %UBR10000-5-USCWCHG: Interface Cable7/0/0 U0, channel width changed to 1600 kHz
SLOT 7/0: Sep 17 17:06:46.898: %UBR10000-5-USCWCHG: Interface Cable7/0/0 U0, channel width changed to 1600 kHz
```

```
Router# Sep 17 17:06:46.898: %Interface Cable7/0/0 U0 With channel width 1600 kHz, the minislots size is now changed to 4 ticks.
```

```
Router# show cable hop cable 7/0/0 upstream 0 history
```

```

F = Frequency Hop, M = Modulation Change, C = Channel Width Change
Upstream Action Chg Chg Action

```

```

Port          Time          Code From To Reason
Ca7/0/0/U0   Sep 17 17:06:46 C 3.2 1.6 Test command enforced
Sep 17 17:06:02 M 222 221 SNR 36>=28 CFEC 0<=3 UnCFEC 0<=1
Sep 17 17:06:00 M 221 222 Test command enforced
Sep 17 17:03:21 M 222 221 SNR 36>=28 CFEC 0<=3 UnCFEC 0<=1
Sep 17 17:03:19 M 221 222 Test command enforced
Sep 17 17:01:44 F 26.358 19.742 Test command enforced
Sep 17 17:01:17 F 21.528 26.358 Test command enforced
Sep 17 17:00:24 C 1.6 3.2 Configuration changed
Sep 14 19:38:55 F 41.117 21.528 Interface state changed
Sep 14 19:38:55 F 0.000 41.117 Interface state changed
Sep 14 19:38:24 M 21 221 Configuration changed
Router#

```

**Step 8** Use the **test cable freq-hop** command to force the desired upstream to perform a dynamic frequency change. A few seconds after giving the test command, use the **show cable hop** command to verify the frequency change.

#### Example:

```
Router# test cable freq-hop cable 7/0/0 upstream 0
```

```
SLOT 7/0: Sep 17 17:01:44.650: %UBR10000-5-USFREQCHG: Interface Cable7/0/0 U0, changed to Freq 19.742 MHz
```

```
Router# show cable hop cable 7/0/0 upstream 0 history
```

```

F = Frequency Hop, M = Modulation Change, C = Channel Width Change
Upstream Action Chg Chg Action
Port Time Code From To Reason
Ca7/0/0/U0 Sep 17 17:01:44 F 26.358 19.742 Test command enforced
Sep 17 17:00:24 C 1.6 3.2 Configuration changed
Sep 14 19:38:55 F 41.117 26.358 Interface state changed
Sep 14 19:38:55 F 0.000 41.117 Interface state changed
Sep 14 19:38:24 M 21 221 Configuration changed

```

**Step 9** Use the **test cable modulation-change** command to force the desired upstream to perform a dynamic modulation change. A few seconds after giving the test command, use the **show cable hop** command to verify the modulation change.

#### Example:

```
Router# test cable modulation-change cable 7/0/0 upstream 0
```

```

SLOT 7/0: Sep 17 17:03:19.038: %UBR10000-5-USMODCHANGE: Interface Cable7/0/0 U0, dynamic modulation changed to QPSK
SLOT 7/0: Sep 17 17:03:19.038: %UBR10000-6-PREAMLENADJUST: request burst's preamble length in mod profile 222 is adjusted to 38 bits.
SLOT 7/0: Sep 17 17:03:19.038: %UBR10000-6-PREAMLENADJUST: initial burst's preamble length in mod profile 222 is adjusted to 100 bits.
SLOT 7/0: Sep 17 17:03:19.038: %UBR10000-6-PREAMLENADJUST: station burst's preamble length in mod profile 222 is adjusted to 100 bits.

```

```
Router# show cable hop cable 7/0/0 upstream 0 history
```

```

F = Frequency Hop, M = Modulation Change, C = Channel Width Change
Upstream Action Chg Chg Action
Port Time Code From To Reason
Ca7/0/0/U0 Sep 17 17:03:19 M 221 222 Test command enforced
Sep 17 17:01:44 F 26.358 19.742 Test command enforced
Sep 17 17:01:17 F 21.528 26.358 Test command enforced
Sep 17 17:00:24 C 1.6 3.2 Configuration changed
Sep 14 19:38:55 F 41.117 21.528 Interface state changed
Sep 14 19:38:55 F 0.000 41.117 Interface state changed
Sep 14 19:38:24 M 21 221 Configuration changed

```

### Troubleshooting Spectrum Group Characteristics

To troubleshoot the configuration, make sure that you entered a valid spectrum group number, time, frequency, and input power level. Also, when defining your spectrum, use the following guidelines:

- Avoid frequencies with known ingress problems, such as amateur radio bands or short-wave bands.
- Avoid a hostile spectrum below 20 MHz.
- Allow extra bands for frequency hopping.
- Place upstream ports in the same combiner group in a shared spectrum group.
- Use the receive power level setting to perform slight equalization adjustments.

## Intelligent and Advanced Spectrum Management Configuration Tasks

The following sections describe the configuration tasks that are needed to configure a Cisco uBR7200 series or Cisco uBR10012 universal broadband router for the intelligent and advanced spectrum management features that are available with the Cisco cable interface line cards.

### Configuring and Assigning Spectrum Groups

You must create and configure a spectrum group before you can use the intelligent and advanced spectrum management features. These procedures are the same as those used for guided and scheduled spectrum management, which are given in the following sections:

- [Creating and Configuring Spectrum Groups, on page 410](#)
- [Assigning a Spectrum Group to One or More Upstream Ports, on page 413](#)

After the spectrum groups have been configured and assigned to upstreams, the Cisco IOS software automatically uses the advanced frequency hopping algorithms on the cable interface line cards that support it.

**Note**

---

For efficient use of the intelligent and advanced spectrum management features, we recommend configuring only frequency bands, and not fixed frequencies, when creating spectrum groups. A spectrum group must contain a frequency band that is wide enough for the cable interface to find at least two center frequencies at the configured channel width, before frequency hopping can occur.

---

### Configuring Dynamic Upstream Modulation (CNR-Based)

Configuring the CNR-based version of the Dynamic Upstream Modulation feature is similar to configuring the MER (SNR)-version of this feature:

- 1 Create a primary modulation profile. This typically is a more bandwidth-efficient but a less robust profile.
- 2 Create a secondary modulation profile. This typically is a less bandwidth-efficient but a more robust profile.

**Tip**

When creating the modulation profiles, we recommend that you use the predefined modulation profiles, as opposed to manually specifying each burst parameter for each modulation profile.

### 3 Assign the profiles to the desired cable interfaces and upstreams.

After the modulation profiles have been created and assigned to upstreams, the Cisco IOS software automatically uses the advanced CNR-based version of the Dynamic Upstream Modulation feature on the cable interface line cards that support it.

**Restriction**

- The Dynamic Upstream Modulation feature is supported only for DOCSIS 1.0 or DOCSIS 1.1 TDMA-only modulation profiles. It is not supported for DOCSIS 2.0 mixed-mode or A-TDMA-only mode modulation profiles.
- If you are using a software release between Cisco IOS Release 12.2(8)BC2 and Cisco IOS Release 12.2(11)BC2 inclusive, you must perform an additional configuration when using the **mix** and **qam-16** predefined modulation profiles. This is because the short and long grant bursts of the **mix** and **qam-16** profiles default to a unique word offset of 8 (uw8). These values should be changed to **uw16** for optimal performance. To do this, first create the modulation profiles using the procedure given in this section, and then issue the following commands for each modulation profile that uses the **mix** or **qam-16** predefined modulation profiles:

```
cable modulation-profile n short 6 75 6 8 16qam scrambler 152 no-diff 144
fixed uw16
cable modulation-profile n long 8 220 0 8 16qam scrambler 152 no-diff 160
fixed uw16
```

**Note**

The defaults for these predefined profiles were corrected in Cisco IOS Release 12.2(11)BC3 and later releases, and this step is no longer needed.

- Three Step Dynamic Modulation is not supported on the CNR-based version of dynamic upstream modulation.
- The CNR-based Dynamic Upstream Modulation feature does not support A-TDMA modulation profiles. However, A-TDMA is supported in the MER (SNR)-based Dynamic Upstream Modulation feature.

To assign the primary and secondary profiles to an upstream, use the following procedure.

**DETAILED STEPS**

	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>cable modulation-profile</b> <i>profile</i> { <b>mix</b>   <b>qam-16</b>   <b>qpsk</b>   <b>robust-mix</b> }  <b>Example:</b> Router(config)# <b>cable modulation-profile</b> 3 <b>mix</b>	Creates the primary modulation profile for use on a DOCSIS 1.0 or DOCSIS 1.1 TDMA upstream.  Typically, the primary profile is either <b>qam-16</b> or <b>mix</b> .  <b>Note</b> Repeat this command to create the secondary profile for use on a DOCSIS 1.0 or DOCSIS 1.1 TDMA upstream. Typically, the secondary profile is either <b>robust-mix</b> or <b>qpsk</b> .  <b>Note</b> You can also create custom modulation profiles with the <b>cable modulation-profile</b> command by configuring the values for the individual burst parameters. These parameters, however, should not be modified unless you are thoroughly familiar with how changing each parameter affects the DOCSIS MAC layer. We recommend using the preconfigured default modulation profiles for most cable plants.
<b>Step 4</b>	Use one of the following commands:  <ul style="list-style-type: none"> <li>• <b>interface cable</b> <i>x/y</i></li> <li>• <b>interface cable</b> <i>x/y/z</i></li> </ul> <b>Example:</b> Router(config)# <b>interface cable</b> 5/1	Enters interface configuration mode for the specified cable interface.
<b>Step 5</b>	<b>cable upstream</b> <i>n</i> <b>modulation-profile</b> <i>primary-profile-number</i> <i>secondary-profile-number</i>  <b>Example:</b> Router(config-if)# <b>cable upstream</b> 0 <b>modulation-profile</b> 3 4	Assigns a primary modulation profile, and an optional secondary modulation profile, to the specified upstream port.
<b>Step 6</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

## Configuring Proactive Channel Management

The cable interface line cards that support the advanced spectrum management features can be configured with the following parameters to fine-tune the operation of proactive channel management on the upstreams of the cards:

- Priority of the corrective actions to be taken when noise on an upstream exceeds the threshold for its modulation profile.
- CNR (CNiR) and MER (SNR) threshold and FEC values for the upstream and its two modulation profiles.
- Allowable range of channel widths that can be used if frequency hopping or modulation switching cannot avoid the upstream problems.

These parameters all have default settings, so you do not need to perform this procedure unless you want to change these parameters to better match the characteristics of your physical plant.

A major exception to this is if you are using only one modulation profile and are using a software release prior to Cisco IOS Release 12.2(8)BC2. In these releases, a frequency hop would occur if just one of the measured values (CNR [CNiR] value, correctable FEC counter, or uncorrectable FEC counter) crosses the configured threshold value. Because of this, if you are using only one modulation profile (QPSK) with one of these software releases, you might need to reduce the CNR (CNiR) threshold value and increase the correctable FEC error value to prevent undesired frequency hopping.



**Note** This situation no longer occurs in Cisco IOS Release 12.2(8)BC2 and later releases, because a frequency hop can occur only when both the CNR (CNiR) value and one of the FEC counters falls below the threshold value.

To configure the parameters, use the following procedure.



**Note** Starting with Cisco IOS Release 12.3(13a)BC, the **cable upstream n threshold** command was changed to provide more functionality.

## Configuring Proactive Channel Management for Releases Prior to 12.3(13a)BC

### DETAILED STEPS

	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>	Use one of the following commands:  <ul style="list-style-type: none"> <li>• <b>interface cable x/y</b></li> <li>• <b>interface cable x/y/z</b></li> </ul>	Enters interface configuration mode for the specified cable interface.

	Command or Action	Purpose
	<p><b>Example:</b> Router(config)# <b>interface cable 5/1</b></p>	
<b>Step 4</b>	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream <i>n</i> hop-priority frequency modulation channel-width</b></li> <li>•</li> <li>• <b>cable upstream <i>n</i> hop-priority modulation frequency channel-width</b></li> <li>•</li> <li>• <b>cable upstream <i>n</i> hop-priority frequency channel-width modulation</b></li> </ul> <p><b>Example:</b> Router(config-if)# <b>cable upstream 0 hop-priority frequency channel-width modulation</b></p>	<p>Specifies the priority of the three types of corrective actions (<b>modulation</b>, <b>frequency</b>, and <b>channel-width</b>) to be taken when the noise for the upstream exceeds the threshold specified for the current modulation profile. The default priority is <b>frequency</b>, <b>modulation</b>, and <b>channel-width</b>.</p> <ul style="list-style-type: none"> <li>• <i>n</i> —Upstream port number. Valid values start with 0 for the first upstream port on the cable interface line card.</li> </ul> <p><b>Note</b> The <b>channel-width</b> option must always appear after the <b>frequency</b> option.</p>
<b>Step 5</b>	<p><b>cable upstream <i>n</i> threshold cnr-profile1 threshold1-in-db cnr-profile2 threshold2-in-db corr-fec fec-corrected uncorr-fec fec-uncorrected</b></p> <p><b>Example:</b> Router(config-if)# <b>cable upstream 5 threshold cnr-profile1 20 cnr-profile2 10 corr-fec 5 uncorr-fec 1</b></p>	<p>Specifies the CNR (CNRiR) threshold and FEC values for the upstream and its two modulation profiles.</p> <ul style="list-style-type: none"> <li>• <i>n</i> —Upstream port number. Valid values start with 0 for the first upstream port on the cable interface line card.</li> <li>• <b>cnr-profile1 threshold1-in-db</b> —Specifies the CNR (CNRiR) threshold for the primary modulation profile (5 to 35 dB, with a default of 25).</li> <li>• <b>cnr-profile2 threshold2-in-db</b> —Specifies the CNR (CNRiR) threshold for the secondary modulation profile (5 to 35 dB, must be less than that for the primary modulation profile, with a default of 13).</li> <li>• <b>corr-fec fec-corrected</b> —Specifies the permitted number of correctable FEC errors for the upstream, which is the percentage of total packets received on the upstream during the polling period. The valid range is from 0 to 30 percent of total packets, and a default of 3 percent.</li> <li>• <b>uncorr-fec fec-uncorrected</b> —Specifies the permitted number of uncorrectable FEC errors for the upstream, which is the percentage of total packets received on the upstream during the polling period. The valid range is from 0 to 30 percent of total packets, with a default of 1 percent.</li> </ul> <p><b>Note</b> For normal plant use, we recommend that the uncorrectable FEC threshold remain at its default of 1 percent to avoid an unacceptable number of errors on the channel.</p>
<b>Step 6</b>	<p><b>cable upstream <i>n</i> channel-width first-choice-width [last-choice-width ]</b></p>	<p>Specifies the range of allowable channel widths that can be used when ingress noise conditions require changing the channel width. The upstream begins</p>

	Command or Action	Purpose
	<p><b>Example:</b>  Router(config-if)# <b>cable upstream 0</b>  <b>channel-width 800000 800000</b></p>	<p>with the first-choice channel width and decreases in half until it hits the secondary channel width.</p> <ul style="list-style-type: none"> <li>• <i>first-choice-width</i> —Upstream channel width in hertz (Hz). The valid values are: <ul style="list-style-type: none"> <li>• 200,000 (160,000 symbols/sec)</li> <li>• 400,000 (320,000 symbols/sec)</li> <li>• 800,000 (640,000 symbols/sec)</li> <li>• 1,600,000 (1,280,000 symbols/sec) (Default)</li> <li>• 3,200,000 (2,560,000 symbols/sec)</li> <li>• 6,400,000 (5,120,000 symbols/sec) (DOCSIS 2.0 A-TDMA-only upstreams only)</li> </ul> </li> <li>• <i>last-choice-width</i> —(Optional) Upstream channel width in hertz. Supports the same values as <i>first-choice-width</i>, but must be less than or equal to <i>first-choice-width</i> .</li> </ul> <p><b>Note</b> Repeat <a href="#">Step 4, on page 425</a> through <a href="#">Step 6, on page 425</a> for each upstream to be configured.</p>
<b>Step 7</b>	<p><b>end</b></p> <p><b>Example:</b>  Router(config-if)# <b>end</b></p>	<p>Exits interface configuration mode and returns to privileged EXEC mode.</p>

### Configuring Proactive Channel Management for Release 12.3(13a)BC, 12.2(33)SCC, and Later

Starting with Cisco IOS Release 12.2(33)SCC, you can configure two logical channels on a single physical port of the uBR10012 universal broadband router. When you configure logical channels, the upstream related commands are categorized into two groups: physical port level and logical channel level.

#### Physical Port Level

Physical port level commands use the format of **cable upstream *n***, where *n* denotes the physical port number.

#### Logical Channel Level

Logical channel level commands use the format of **cable upstream *n m***, where *n* denotes the physical port number, and *m* denotes the logical channel index number of 0 or 1.



## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	Use one of the following commands: <ul style="list-style-type: none"> <li>• <b>interface cable <i>x/y</i></b></li> <li>• <b>interface cable <i>x/y/z</i></b></li> </ul> <b>Example:</b> Router(config)# <b>interface cable 5/1</b>	Enters interface configuration mode for the specified cable interface.
Step 4	Use one of the following commands: <ul style="list-style-type: none"> <li>• <b>cable upstream <i>n</i> hop-priority frequency modulation channel-width</b></li> <li>•</li> <li>• <b>cable upstream <i>n</i> hop-priority modulation frequency channel-width</b></li> <li>•</li> <li>• <b>cable upstream <i>n</i> hop-priority frequency channel-width modulation</b></li> </ul> <b>Example:</b> Router(config-if)# <b>cable upstream 0 hop-priority frequency channel-width modulation</b>	Specifies the priority of the three types of corrective actions ( <b>modulation</b> , <b>frequency</b> , and <b>channel-width</b> ) to be taken when the noise for the upstream exceeds the threshold specified for the current modulation profile. The default priority is <b>frequency</b> , <b>modulation</b> , and <b>channel-width</b> . <ul style="list-style-type: none"> <li>• <i>n</i>—Upstream port number. Valid values start with 0 for the first upstream port on the cable interface line card.</li> </ul> <b>Note</b> The <b>channel-width</b> option must always appear after the <b>frequency</b> option.
Step 5	<b>cable upstream <i>n</i> threshold cnr-profiles <i>threshold1-in-db threshold2-in-db</i></b>  <b>Example:</b> Router(config-if)# <b>cable upstream 2 threshold cnr-profiles 23 14</b>	(Optional) Specifies the CNR (CNiR) threshold and FEC values for the upstream and its two modulation profiles. <ul style="list-style-type: none"> <li>• <i>threshold1-in-db</i>—CNR (CNiR) threshold for the primary modulation profile (5 to 35 dB, with a default of 25).</li> <li>• <i>threshold2-in-db</i>—CNR (CNiR) threshold for the secondary modulation profile (5 to 35 dB, must be less than that for the primary modulation profile, with a default of 15).</li> </ul>

	Command or Action	Purpose
		<p><b>Note</b> To bypass both the primary and secondary CNR (CNiR) thresholds, set the first parameter (<i>threshold1-in-db</i>) to 0. This disallows the second parameter (<i>threshold2-in-db</i>), enabling you to bypass both the CNR (CNiR) thresholds.</p>
<b>Step 6</b>	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream n upstream threshold snr-profiles</b> <i>threshold1-in-db threshold2-in-db</i></li> <li>•</li> <li>• <b>cable upstream n m upstream threshold snr-profiles</b> <i>threshold1-in-db threshold2-in-db</i></li> <li>•</li> </ul> <p><b>Example:</b>  <pre>Router(config-if)# cable upstream 2 threshold snr-profiles 23 14</pre></p>	<p>(Optional) Specifies the MER (SNR) threshold and FEC values for the upstream and its two modulation profiles.</p> <ul style="list-style-type: none"> <li>• <i>m</i>—Logical channel index. Valid values are 0 and 1.</li> <li>• <i>threshold1-in-db</i>—MER (SNR) threshold for the primary modulation profile (5 to 35 dB, with a default of 25)</li> <li>• <i>threshold2-in-db</i>—MER (SNR) threshold for the secondary modulation profile (5 to 35 dB, must be less than that for the primary modulation profile, with a default of 15)</li> </ul> <p><b>Note</b> You can bypass the primary MER (SNR) threshold (<i>threshold1-in-db</i>) by setting it to 0. However, you must enter the second parameter (<i>threshold2-in-db</i>).</p>
<b>Step 7</b>	<p><b>cable upstream n threshold hysteresis</b> <i>hysteresis-in-db</i></p> <p><b>Example:</b>  <pre>Router(config-if)# cable upstream 2 threshold hysteresis 3</pre></p>	<p>(Optional) Specifies the hysteresis value to be used in conjunction with the dynamic modulation upgrade thresholds.</p> <ul style="list-style-type: none"> <li>• <b>hysteresis</b> <i>hysteresis-in-db</i>—Permitted number of hysteresis value to be used in conjunction with the dynamic modulation upgrade thresholds. The valid range is 0 to 10.</li> </ul> <p><b>Note</b> You can bypass the <b>hysteresis</b> threshold by setting the value to 0.</p>
<b>Step 8</b>	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream n threshold corr-fec</b> <i>corr-fec-threshold</i></li> <li>• <b>cable upstream n m threshold corr-fec</b> <i>corr-fec-threshold</i></li> </ul> <p><b>Example:</b>  <pre>Router(config-if)# cable upstream 5 threshold corr-fec 5</pre></p>	<p>(Optional) Specifies the CNR (CNiR) threshold and FEC values for the upstream and its two modulation profiles.</p> <ul style="list-style-type: none"> <li>• <i>corr-fec-threshold</i>—Permitted number of correctable FEC errors for the upstream, which is the percentage of the total packets received on the upstream during the polling period. The valid range is from 0 to 30 percent of total packets, and a default of 3 percent.</li> </ul> <p><b>Note</b> You can bypass the <b>corr-fec</b> threshold by setting the value to 0.</p>
<b>Step 9</b>	<p>Use one of the following commands:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream n threshold uncorr-fec</b> <i>uncorr-fec-threshold</i></li> <li>• <b>cable upstream n m threshold uncorr-fec</b> <i>uncorr-fec-threshold</i></li> </ul>	<p>(Optional) Specifies the CNR (CNiR) threshold and FEC values for the upstream and its two modulation profiles.</p> <ul style="list-style-type: none"> <li>• <i>uncorr-fec-threshold</i>—Permitted number of uncorrectable FEC errors for the upstream, as given as a percentage of total packets received on the upstream during the polling period. The valid range is 0 to 30 percent of total packets, with a default of 1 percent.</li> </ul>

	Command or Action	Purpose
	<p><b>Example:</b>  Router(config-if)# <b>cable upstream 5 threshold uncorr-fec 1</b></p>	<p><b>Note</b> You can bypass the <b>uncorr-fec</b> threshold by setting the value to 0.</p> <p><b>Note</b> For normal plant use, we recommend that the uncorrectable FEC threshold remain at its default of 1 percent to avoid an unacceptable number of errors on the channel.</p>
<b>Step 10</b>	<p><b>cable upstream <i>n</i> channel-width <i>first-choice-width</i> [<i>last-choice-width</i> ]</b></p> <p><b>Example:</b>  Router(config-if)# <b>cable upstream 0 channel-width 800000 800000</b></p>	<p>(Optional) Specifies the range of allowable channel widths that can be used when ingress noise conditions require changing the channel width. The upstream begins with the first-choice channel width and decreases in half until it hits the secondary channel width.</p> <ul style="list-style-type: none"> <li>• <i>first-choice-width</i>—Upstream channel width in hertz (Hz). The valid values are: <ul style="list-style-type: none"> <li>◦ 200,000 (160,000 symbols/sec)</li> <li>◦ 400,000 (320,000 symbols/sec)</li> <li>◦ 800,000 (640,000 symbols/sec)</li> <li>◦ 1,600,000 (1,280,000 symbols/sec) (Default)</li> <li>◦ 3,200,000 (2,560,000 symbols/sec)</li> <li>◦ 6,400,000 (5,120,000 symbols/sec) (DOCSIS 2.0 A-TDMA-only upstreams only)</li> </ul> </li> <li>• <i>last-choice-width</i>—(Optional) Upstream channel width in hertz. Supports the same values as <i>first-choice-width</i>, but must be less than or equal to <i>first-choice-width</i>.</li> </ul> <p><b>Note</b> Repeat Step 4 through Step 10 for each upstream to be configured.</p>
<b>Step 11</b>	<p><b>end</b></p> <p><b>Example:</b>  Router(config-if)# <b>end</b></p>	<p>Exits interface configuration mode and returns to privileged EXEC mode.</p>

## Verifying the Spectrum Management Configuration

Follow the steps given below to verify the spectrum management configuration.

**Step 1** To check the value of the settings you have entered, use the **show running-config** command in privileged EXEC mode:

**Example:**

```
Router# show running-config
```

- Step 2** To display the configuration for each modulation profile, use the **show cable modulation-profile** command in privileged EXEC mode:

**Example:**

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

To display the configuration for a specific modulation profile, add the profile number to the **show cable modulation-profile** command in privileged EXEC mode:

**Example:**

```
Router# show cable modulation-profile 6
```

- Step 3** To display the status and configuration of each upstream, use the **show controllers cable upstream** command in privileged EXEC mode. The following example displays information for upstreams 0 on a cable line card:

**Example:**

```
Router# show controller cable 8/1/14 upstream 0
```

```
Cable8/1/14 Upstream 0 is up
Frequency 19.504 MHz, Channel Width 3.200 MHz, Symbol Rate 2.560 Msps
Modulations (64-QAM) - A-short 64-QAM, A-long 64-QAM, A-ugs 64-QAM
Mapped to shared connector 18 and receiver 56
Spectrum Group 8
MC3Gx60 CNR measurement : 30 dB
US phy MER(SNR)_estimate for good packets - 32.5530 dB
Nominal Input Power Level 0 dBmV, Tx Timing Offset 1547
Ranging Backoff Start 3, Ranging Backoff End 6
US timing offset adjustment type 0, value 0
Ranging Insertion Interval automatic (60 ms)
US throttling off
Tx Backoff Start 3, Tx Backoff End 5
Modulation Profile Group 221
Concatenation is enabled
Fragmentation is enabled
part_id=0x3142, rev_id=0xC0, rev2_id=0x00
nb_agc_thr=0x0000, nb_agc_nom=0x0000
Range Load Reg Size=0x58
Request Load Reg Size=0x0E
Minislot Size in number of Timebase Ticks is = 2
Minislot Size in Symbols = 32
Bandwidth Requests = 0xEE3AF
Piggyback Requests = 0x6A24F
Invalid BW Requests= 0x76
Minislots Requested= 0xC33362
Minislots Granted = 0x158609
Minislot Size in Bytes = 24
Map Advance (Dynamic) : 2581 usecs
Map Count Internal = 330309891
No MAP buffer= 0x0 No Remote MAP buffer= 0x0
Map Counts: Controller 8/1/0 = 1321230158
UCD Counts:
  Controller 8/1/0:0 = 336057
  Controller 8/1/0:1 = 336057
  Controller 8/1/0:2 = 336057
  Controller 8/1/0:3 = 336057

UCD procedures on lch 0
UCD ucd-succeeds(5) ucd-shut(0) init-state-err(0)
UCD init-tss-err(0) init-timeout(0) init-start-err(0)
```

```

UCD ucd-ccc-time(0) ucd-timeout(0) ucd-tss-err(0)
UCD ucd-state-err(0) ucd-process(0) ucd-retries(0)
UCD stale-tss(0)
ATDMA mode enabled
PHY: us errors 0 us recoveries 0 (enp 0)
MAC PHY TSS: tss error start 0 tss error end 0
MAC PHY Status: bcm3140 status 0 lookout status 0
PHY: TSS late 0 discontinuous 0
PHY: TSS mis-match 0 not-aligned 0
PHY: TSS missed snapshots from phy 0
MAP/UCD Replication Instructions:
  Controller 8/1/0 index = 477, bitmap = 0x000F
Dynamic Services Stats:
  DSA: 0 REQs 0 RSPs 0 ACKs
  0 Successful DSAs 0 DSA Failures
  DSC: 0 REQs 0 RSPs 0 ACKs
  0 Successful DSCs 0 DSC Failures
  DSD: 0 REQs 0 RSPs
  0 Successful DSDs 0 DSD Failures
  Dropped MAC messages: (none)

```

**Step 4** To display the hop period and hop threshold values for each upstream, use the **show cable hop** command in privileged EXEC mode:

**Example:**

```
Router# show cable hop
```

Upstream Port	Port Status	Frequency	Poll Rate (ms)	Missed Poll Count	Min Poll Sample	Missed Poll Pcnt	Hop Thres Pcnt	Hop Period (sec)	Corr FEC Errors	Uncorr FEC Errors
Cable3/0/U0	20.800 Mhz	105	0	20	0%	25%	45	1	4	
Cable3/0/U1	20.800 Mhz	105	0	48	0%	25%	45	2	19	
Cable3/0/U2	23.120 Mhz	105	0	45	0%	25%	45	0	5	
Cable3/0/U3	22.832 Mhz	105	0	26	0%	25%	45	0	6	
Cable3/0/U4	22.896 Mhz	105	0	43	0%	25%	45	0	7	
Cable3/0/U5	23.040 Mhz	105	0	54	0%	25%	45	1	3	
Cable4/0/U0	22.896 Mhz	117	0	26	0%	25%	45	0	2	
Cable4/0/U1	23.168 Mhz	117	0	87	0%	25%	45	4	2	
Cable4/0/U2	22.896 Mhz	117	0	23	0%	25%	45	1	0	
Cable4/0/U3	20.800 Mhz	117	0	54	0%	25%	45	0	0	
Cable4/0/U4	22.928 Mhz	117	0	22	0%	25%	45	0	1	
Cable4/0/U5	22.960 Mhz	117	0	0	-----	25%	45	0	0	

**Step 5** To display changes from one state to another, at any time and for any reason, for frequency, modulation, and channel width, use the **history** option of the **show cable hop** command.

**Example:**

```
Router# show cable hop c8/1/1 u0 history
```

```

F = Frequency Hop, M = Modulation Change, C = Channel Width Change
Upstream Action          Chg  Chg  Action
Port      Time          Code From  To    Reason
C8/1/1 U0  Feb 20 12:21:29 M  142  141  SNR 28>=28 CFEC 0<=3 UnCFEC 0<=1
          Feb 20 12:09:08 F   0.000 24.000 Configuration changed

```

**Step 6** To display thresholds for MER (SNR), CNR (CNIr), and FEC, use the **threshold** option of the **show cable hop** command.

**Example:**

```
Router# show cable hop c8/1/1 u0 threshold
```

Upstream Port	SNR (dB) Val	SNR (dB) Thre1	SNR (dB) Thre2	CNR (dB) Val	CNR (dB) Thre1	CNR (dB) Thre2	CorrFEC% Pcnt	CorrFEC% Thre	UncorrFEC% Pcnt	UncorrFEC% Thre	MissedSM% Pcnt	MissedSM% Thre
---------------	--------------	----------------	----------------	--------------	----------------	----------------	---------------	---------------	-----------------	-----------------	----------------	----------------

```
C8/1/1 u0 33 23 14 60 25 15 0 1 0 2 0 50
```

**Step 7** To display the assignment of each spectrum group, use the **show cable spectrum-group** command in privileged EXEC mode:

**Example:**

```
Router# show cable spectrum-group
```

Group No.	Frequency Band (Mhz)	Upstream Port	Weekly Scheduled Availability From Time: To Time:	Power Level (dBmV)	Shared Spectrum
1	20.000-21.600			0	No
1	22.000-24.000			0	No
1	20.784 [1.60]	Cable3/0 U0		0	
1	20.784 [1.60]	Cable3/0 U1		0	
1	23.120 [1.60]	Cable3/0 U2		0	
1	22.832 [1.60]	Cable3/0 U3		0	
1	22.896 [1.60]	Cable3/0 U4		0	
1	23.024 [1.60]	Cable3/0 U5		0	
1	23.152 [1.60]	Cable4/0 U1		0	
1	22.896 [1.60]	Cable4/0 U0		0	
1	22.896 [1.60]	Cable4/0 U2		0	
1	20.784 [1.60]	Cable4/0 U3		0	
1	22.928 [1.60]	Cable4/0 U4		0	
1	22.960 [1.60]	Cable4/0 U5		0	

**Step 8** To display the current CNR (CNiR) value for a particular cable modem, use the **show cable modem cnr** command in privileged EXEC mode:

**Example:**

```
Router# show cable modem 5.100.1.94 cnr
```

MAC Address	IP Address	I/F	MAC State	Prim Sid	snr/cnr (dB)
0018.689c.17b8	5.100.1.94	C7/0/0/U1	online	428	36.12

**Note** Starting Cisco IOS Release 12.2(33)SCF, the output of the **show cable modem cnr** command will always display CNR (CNiR) values for all the US channels for a specific CM, irrespective of whether spectrum management is enabled or not for the US channels. For all the releases prior to Cisco IOS Release 12.2(33)SCF, the command output will display CNR (CNiR) when you use specific groups, otherwise it will be MER (SNR).

## Monitoring Spectrum Management

You can use Cisco IOS CLI commands to monitor spectrum management activity on the Cisco CMTS. If you are using Cisco IOS Release 12.2(8)BC2 or later 12.2 BC releases, you can also use SNMP to monitor the spectrum management activity.



**Note** When using the Cisco uBR10-MC5X20S/U/H BPE you must also use Cisco IOS Release 12.3(13a)BC or a later release.

See the following sections for more information:

## Using CLI Commands

The following commands provide information on the spectrum condition of an upstream:

Command	Purpose
Router# <b>show cable hop</b> [cable x/y] [upstream usport]	Displays the hop period and hop threshold values, as well as the FEC error counters, for all upstreams in the router, all upstreams on one cable interface line card, or a single upstream.
Router# <b>show cable hop</b> [cable x/y[z]] [upstream n] [thresholds]	Displays the configured and current value of MER (SNR) in dB, CNR (CNIr) in dB, CorrFEC in percentage, UncorrFEC in percentage, and missed station maintenance in percentage for a specified upstream.  <b>Note</b> Supported in Cisco IOS Release 12.3(13a)BC or later release.
Router# <b>show cable hop history</b>	<ol style="list-style-type: none"> <li>1 With the <b>show cable hop history</b> command for entire CMTS, the most recent change of each action is displayed.</li> <li>2 With the <b>show cable hop history</b> command for a MAC domain, the most recent three changes of each action are displayed.</li> <li>3 With the <b>show cable hop history</b> command for a specific upstream, the last ten changes of each action are displayed. Changes are sorted by time with the most recent at the top.</li> </ol> <b>Note</b> Supported in Cisco IOS Release 12.3(13a)BC or later release.
Router# <b>show cable hop</b> [cable x/y[z]] [upstream n] [summary]	Displays hourly, daily, weekly, 30 days running average, and average since the system was brought up for each specified upstream.  <b>Note</b> Supported in Cisco IOS Release 12.3(13a)BC or later release.
Router# <b>show cable hop</b> [cable x/y[z]] [upstream n] [history]	

Command	Purpose
	<p>Displays changes from one state to another, at any time and for any reason, for frequency, modulation, and channel width.</p> <p><b>Note</b> Supported in Cisco IOS Release 12.3(23)BC7 or later release. The output of the <b>show cable hop history</b> is modified to include more information in the “change from” and “change to” fields of the output. Now, the modulation profile number is displayed when a change occurs, instead of the modulation order.</p>
Router# <b>show cable modem</b> [ <i>ip-address</i>   <i>interface</i>   <i>mac-address</i> ] [ <i>options</i> ]	<p>Displays information, including MER (SNR) values, for the registered and unregistered cable modems.</p> <p><b>Note</b> Cisco IOS Release 12.3(13a)BC supports a <b>cnr</b> option that displays the CNR (CNiR) value for a specific cable modem, if it is using an upstream on the Cisco uBR10-MC5X20S/U/H BPE line card.</p>
Router# <b>show cable modulation-profile</b> [ <i>num</i> ] [ <i>initial</i>   <i>long</i>   <i>reqdata</i>   <i>request</i>   <i>short</i>   <i>station</i> ]	Displays the configuration for all modulation profiles, for a particular modulation profile, or for a specific burst type for a particular modulation profile.
Router# <b>show cable spectrum-group</b> [ <i>groupnum</i> ] [ <i>detail</i> ]	<p>Displays information about the spectrum groups that have been configured.</p> <p><b>Note</b> The <b>detail</b> keyword is supported only in Cisco IOS Release 12.2(8)BC2 and later 12.2 BC releases.</p>
Router# <b>show controllers cable</b> <i>x/y upstream</i> <i>n</i> [ <i>ip-address</i>   <i>mac-address</i> ] <i>start-freq</i> <i>end-freq</i> <i>res-freq</i>	Displays the upstream status, including the current frequency, channel width, modulation rate, and spectrum groups.
Router# <b>show controllers cable</b> <i>x/y upstream</i> <i>n</i> <b>spectrum</b> [ <i>ip-address</i>   <i>mac-address</i> ] <i>start-freq</i> <i>end-freq</i> <i>res-freq</i>	Displays the noise levels for a particular cable modem or displays the background noise for an entire upstream.

**Note**

The **show cable flap-list** command displays the flap list of the CMTS router, which provides additional information about whether cable modems on an upstream are experiencing problems, and if so, what type of problems are occurring. For more information about the cable modem flapping and how to monitor the cable modem flap list, see the [Flap List Troubleshooting for the Cisco CMTS Routers](#) .



## Using SNMP

You can use SNMP to monitor the spectrum management activity. The SNMP manager can be a graphically-based SNMP manager such as CiscoView or the Cable Broadband Troubleshooter (Release 3.0 or later).

The CISCO-CABLE-SPECTRUM-MIB has been enhanced to provide this SNMP support using the following MIB attributes:

### ccsSNRRequestTable

The table below lists the attributes in the ccsSNRRequestTable table, which contains the CNR (CNiR) measurements that are made for individual cable modems on an upstream.

**Table 56: ccsSNRRequestTable Attributes**

Attribute	Type	Description
ccsSNRRequestIndex	Integer32	Arbitrary index to uniquely identify each table entry.
ccsSNRRequestMacAddr	MacAddress	MAC address of the remote online cable modem being reported on.
ccsSNRRequestSNR	Integer32	MER (SNR) value, in dB, that has been measured. This value is 0 when the Operation State is "running."
ccsSNRRequestOperation	CCSRequestOperation	Sets the current operation: start, pending, running, or abort.
ccsSNRRequestOperState	CCSRequestOperState	Reports on the current operation state: idle, pending, running, noError, aborted, notOnLine, invalidMac, timeOut, fftBusy, fftFailed, others.
ccsSNRRequestStartTime	TimeStamp	Contains the time when the MER (SNR) measurement operation starts.
ccsSNRRequestStoppedTime	TimeStamp	Contains the time when the MER (SNR) measurement stops.
ccsSNRRequestStatus	RowStatus	Controls the modification, creation, and deletion of table entries.

## ccsSpectrumRequestTable

The table below lists the attributes for each entry in the ccsSpectrumRequestTable table, which is used to obtain the spectrum profile for a particular cable modem or to obtain the background MER (SNR) for an entire upstream.

**Table 57: ccsSpectrumRequestTable Attributes**

Attribute	Type	Description
ccsSpectrumRequestIndex	Integer32	Arbitrary index to uniquely identify each table entry.
ccsSpectrumRequestIfIndex	InterfaceIndexOrZero	Interface identifying the upstream.
ccsSpectrumRequestMacAddr	MacAddress	MAC address to specify an MER (SNR) value for a particular cable modem, or 0000.0000.0000 to indicate background noise for the entire spectrum.
ccsSpectrumRequestUpperFreq	CCSFrequency	Upper frequency for the frequency range to be monitored (5000 to 42000 KHz, with a default of 42000 KHz).
ccsSpectrumRequestLowFreq	CCSFrequency	Lower frequency (in KHz) for the frequency range to be monitored (5000 to 42000 KHz, with a default of 5000 KHz).
ccsSpectrumRequestResolution	Integer32	Requested resolution to determine how the frequency range should be sampled (12 to 37000 KHz, with a default of 60 KHz).
ccsSpectrumRequestStartTime	TimeStamp	Time when the spectrum measurement began.
ccsSpectrumRequestStoppedTime	TimeStamp	Time when the spectrum measurement finished.
ccsSpectrumRequestOperation	CCSRequestOperation	Starts a new spectrum management request or aborts the current one.
ccsSpectrumRequestOperState	CCSRequestOperState	Provides the operational state of the current spectrum management request.

Attribute	Type	Description
ccsSpectrumRequestStatus	RowStatus	Controls the modification, creation, and deletion of table entries.

## ccsSpectrumDataTable

The table below lists the attributes in each entry of the ccsSpectrumDataTable table, which contains the results for a spectrum request.

**Table 58: ccsSpectrumDataTable Attributes**

Attribute	Type	Description
ccsSpectrumDataFreq	CCSMeasuredFrequency	Frequency in KHz for which this power measurement was made.
ccsSpectrumDataPower	INTEGER	Measured received power for the given frequency (–50 to 50 dBmV).



### Note

The ccsSpectrumRequestTable and ccsSpectrumDataTable tables provide the same information as that provided by the **show controllers cable upstream spectrum** command.

This command is obsolete in Cisco IOS Release 12.3(21)BC.

## ccsUpSpecMgmtTable

The table below lists the attributes in the ccsUpSpecMgmtTable table, which provides an entry describing each frequency hop.

**Table 59: ccsUpSpecMgmtEntry Attributes**

Attribute	Type	Description
ccsUpSpecMgmtHopPriority	INTEGER	Specifies the priority of frequency, modulation profile, and channel width in determining corrective action for excessive noise on the upstream (default is frequency, modulation profile, and channel width).
ccsUpSpecMgmtSnrThres1	Integer32	Specifies the upper MER (SNR) threshold for modulation profile 1 (5 to 35 dB, default of 25).

Attribute	Type	Description
ccsUpSpecMgmtSnrThres2	Integer32	Specifies the upper MER (SNR) threshold for modulation profile 2 (5 to 35 dB, default of 13, and must be lower than that specified for ccsUpSpecMgmtSnrThres1).
ccsUpSpecMgmtFecCorrectThres1	Integer32	Specifies the FEC correctable error threshold for modulation profile 1 (1 to 20 percent)
ccsUpSpecMgmtFecCorrectThres2	Integer32	Deprecated and no longer used.
ccsUpSpecMgmtFecUnCorrectThres1	Integer32	Specifies the FEC uncorrectable error threshold for modulation profile 1 (1 to 20 percent).
ccsUpSpecMgmtFecUnCorrectThres2	Integer32	Deprecated and no longer used.
ccsUpSpecMgmtSnrPollPeriod	Integer32	Deprecated and no longer used.
ccsUpSpecMgmtHopCondition	INTEGER	Reports the condition that triggers a frequency hop (MER [SNR] value or percentage of modems going offline).
ccsUpSpecMgmtFromCenterFreq	CCSFrequency	Provides the center frequency (in KHz) before the latest frequency hop.
ccsUpSpecMgmtToCenterFreq	CCSFrequency	Provides the current center frequency (in KHz) after the latest frequency hop.
ccsUpSpecMgmtFromBandWidth	CCSFrequency	Provides the channel width (in KHz) before the latest frequency hop.
ccsUpSpecMgmtToBandWidth	CCSFrequency	Provides the current channel width (in KHz) after the latest frequency hop.
ccsUpSpecMgmtFromModProfile	Integer32	Provides the modulation profile number before the latest frequency hop.
ccsUpSpecMgmtToModProfile	Integer32	Provides the current modulation profile number after the latest frequency hop.

Attribute	Type	Description
ccsUpSpecMgmtSNR	Integer32	Provides the current MER (SNR) value (in dB) for the upstream.
ccsUpSpecMgmtCnrThres1	Integer32	Specifies the upper CNR (CNiR) threshold for modulation profile 1 (5 to 35 dB, default of 25).
ccsUpSpecMgmtCnrThres2	Integer32	Specifies the upper CNR (CNiR) threshold for modulation profile 2 (5 to 35 dB, default of 13, and must be lower than that specified for ccsUpSpecMgmtCnrThres1).
ccsUpSpecMgmtCNR	Integer32	Provides the current CNR (CNiR) value (in dB) for the upstream.
ccsUpSpecMgmtMissedMaintMsgThres	Integer32	Provides the frequency hop threshold, as a percentage of station maintenance messages that are lost for a spectrum group.
ccsUpSpecMgmtHopPeriod	Integer32	Provide the minimum time, in seconds, between frequency hops.

## ccsHoppingNotification

The table below describes the attributes contained in the notification that is sent after each frequency hop.

**Table 60: ccsHoppingNotification Attributes**

Attribute	Type	Description
ccsUpSpecMgmtHopCondition	INTEGER	Reports the condition that triggers a frequency hop (MER [SNR] value or percentage of modems going offline).
ccsUpSpecMgmtFromCenterFreq	CCSFrequency	Provides the center frequency (in KHz) before the latest frequency hop.
ccsUpSpecMgmtToCenterFreq	CCSFrequency	Provides the current center frequency (in KHz) after the latest frequency hop.

Attribute	Type	Description
ccsUpSpecMgmtFromBandWidth	CCSFrequency	Provides the channel width (in KHz) before the latest frequency hop.
ccsUpSpecMgmtToBandWidth	CCSFrequency	Provides the current channel width (in KHz) after the latest frequency hop.
ccsUpSpecMgmtFromModProfile	Integer32	Provides the modulation profile number before the latest frequency hop.
ccsUpSpecMgmtToModProfile	Integer32	Provides the current modulation profile number after the latest frequency hop.

## Configuration Examples

This section provides the following configuration examples:

### Spectrum Group and Combiner Group Examples

The following examples help you to determine whether spectrum group and combiner groups are configured and activated.

#### Example: Verifying Spectrum Group Creation

To verify that a spectrum group has been created, enter the **show cable spectrum-group** command:

```
Router# show cable spectrum-group
spectrum-group 1
spectrum-group 2
spectrum-group 3
```

#### Example: Time-Scheduled Spectrum Group

If your cable plant has an upstream noise characteristic on a weekly cycle, use time-scheduled spectrum allocation.

```
Router(config)# cable spectrum-group 1 time Mon 08:00:00 frequency 21600000
```

Deletion is performed using the **delete** keyword:

```
Router(config)# cable spectrum-group 1 time Mon 18:00:00 delete frequency 21600000
```

## Example: Verifying Spectrum Group Configuration

To verify if spectrum groups have been configured and activated, enter the **show cable spectrum-group** command. This command displays each spectrum group, the frequencies assigned to it, the upstream port to which it has been assigned, whether a schedule exists for it, the currently measured power level, and whether it is a shared spectrum group.

```
Router# show cable spectrum-group
```

```
22:07:46: %SYS-5-CONFIG_I: Configured from console by console
Group  Frequency      Upstream      Weekly Scheduled      Power      Shared
No.    Band              Port          Availability          Level      Spectrum
      (Mhz)
1      5.000-15.000
1      12.000
1      22.000          Cable6/0 U5      7            Yes
2      29.000          Cable6/0 U4      6            No
2      26.000
3      35.000-41.000
3      16.000-19.000   Cable6/0 U3      5            No
5*     5.000-10.000   Thu 21:50:00   Thu 21:45:00   0            Yes
```

## Example: Determining the Upstream Ports Assigned to a Combiner Group

Following is a sample topology for a CMTS with combiner groups designated A through J. Combiner groups C and E have multiple upstream ports that should be configured in a shared spectrum group. The other upstreams should be configured in a nonshared spectrum group.

In this example, ten combiner groups are served with frequency hop tables from three spectrum groups:

```
Cable3/0
DS +-----+ Upconverter +----- laser group 1
U0 +----- combiner group A
U1 +----- combiner group B
U2 +-----combiner group C
U3 +-----combiner group C
U4 +----- combiner group D
U5 +-----combiner group E
Cable4/0
DS +-----+ Upconverter +----- laser group 2
U0 +-----combiner group E
U1 +----- combiner group F
U2 +----- combiner group G
U3 +----- combiner group H
U4 +----- combiner group I
U5 +----- combiner group J
```

The *laser group* term refers to the set of fiber nodes that share the same downstream signal. An optical splitter is often used to create individual feeds per node.

In the downstream direction, two 6-MHz channel slots are assigned. All fiber nodes in combiner groups A through E should have a channel slot containing the downstream signal from Cable3/0. Combiner groups A through E are said to belong to laser group 1.

All fiber nodes in combiner groups E through J should have a channel slot containing the downstream signal from Cable4/0. Combiner groups E through J are said to belong to laser group 2.

Because combiner group E belongs to two laser groups, there should be two different downstream channel slots for Cable3/0 and Cable4/0.

## Example: Combiner Group

The following example enables spectrum management for all upstream ports, where all combiner groups use the frequency band from 20 to 26 MHz:

```
CMTS01(config)# cable spectrum-group 1 band 20000000 26000000
CMTS01(config)# cable spectrum-group 2 shared
CMTS01(config)# cable spectrum-group 2 band 20000000 26000000
CMTS01(config)# cable spectrum-group 3 shared
CMTS01(config)# cable spectrum-group 3 band 20000000 26000000
CMTS01(config)# interface Cable3/0
CMTS01(config-if)# cable spectrum-group 1
CMTS01(config-if)# cable upstream 2 spectrum-group 2
CMTS01(config-if)# cable upstream 3 spectrum-group 2
CMTS01(config-if)# cable upstream 5 spectrum-group 3
CMTS01(config-if)# exit
CMTS01(config)# interface Cable4/0
CMTS01(config-if)# cable spectrum-group 1
CMTS01(config-if)# cable upstream 0 spectrum-group 3
```

A description of the spectrum groups 1 through 3 follows:

- Spectrum group 1—This group is nonshared. Upstream RF domains exist for each member upstream port.

Upstream Port	RF Domain
Cable3/0 U0	combiner group A
Cable3/0 U1	combiner group B
Cable3/0 U4	combiner group D
Cable4/0 U1	combiner group F
Cable4/0 U2	combiner group G
Cable4/0 U3	combiner group H
Cable4/0 U4	combiner group I
Cable4/0 U5	combiner group J

- Spectrum group 2—This group is shared. A single upstream RF domain exists.

Upstream Port	RF Domain
Cable3/0 U2	combiner group C
Cable3/0 U3	combiner group C

- Spectrum group 3—This group is shared. A single upstream RF domain exists.

Upstream Port	RF Domain
Cable3/0 U5	combiner group E
Cable4/0 U0	combiner group E

For the 20- to 26-MHz band of each RF domain, the spectrum is channelized according to the channel width settings of each member port. For example, if the ports U2 and U3 of Cable3/0 are set to 3.2 MHz and 1.6 MHz channel widths, respectively, then spectrum group 2 uses the following channelization:

```
> Channel Width Start Stop Center
>          (Mhz) (Mhz) (Mhz) (Mhz)
> 1         3.2   20.0 23.2 21.6
> 2*        1.6   20.0 21.6 20.8
> 3*        1.6   21.6 23.2 22.4
> 4         1.6   23.2 24.8 24.0
```



### Note

Channels 2 and 3 are not available when channel 1 is in use.



Because the group is shared, ports U2 and U3 will be assigned channels 1 and 4, respectively, to prevent overlap.

**Note**

There are no alternate frequency assignments for either port, and bandwidth is wasted from 24.8 to 26.0 MHz. To create alternate channels, increase the upper boundary from 26.0 to 28.0 MHz.

---

```
> Channel  Width  Start Stop  Center
>          (Mhz)  (Mhz) (Mhz) (Mhz)
>  1       3.2    20.0 23.2  21.6
>  2       3.2    23.2 26.4  24.8
>  3       1.6    20.0 21.6  20.8
>  4       1.6    21.6 23.2  22.4
>  5       1.6    23.2 24.8  24.0
>  6       1.6    24.8 26.4  25.6
>  7       1.6    26.4 28.0  27.4
```

Try to reduce the spectrum allocation when it is used with small channel widths. Otherwise, there will be a large number of upstream channel slots, and the frequency hopping may require several minutes to find a clean slot.

## Example: Other Spectrum Management Configurations

To configure differing spectrum groups, refer to the following examples:

- Use the following example to add a time-scheduled spectrum. You can add a spectrum on a weekly schedule by including an optional weekday and time:

```
Router(config)# cable spectrum-group 1 time Mon 08:00:00 frequency 21600000
```

- Use the **delete** keyword to delete the frequency:

```
Router(config)# cable spectrum-group 1 time Mon 18:00:00 delete frequency 21600000
```

- Use the following example to configure spectrum group 1 with an upstream frequency of 6,500,000 Hz and a default power level of 0 dBmV:

```
Router(config)# cable spectrum-group 1 frequency 6500000
```

- Use the following example to add the upstream frequency 7,000,000 Hz to the list of valid frequencies with a default power level of 0 dBmV for spectrum group 1:

```
Router(config)# cable spectrum-group 1 frequency 7000000
```

- Use the following example to configure spectrum group 2 with an upstream frequency 7,500,000 Hz and change the power level to 5 dBmV:

```
Router(config)# cable spectrum-group 2 frequency 7500000 5
```

- Use the following example to configure spectrum group 3 with an upstream band of 12,000,000 to 18,000,000 Hz and default power level of 0 dBmV:

```
Router(config)# cable spectrum-group 3 band 12000000 18000000
```

- Use the following example to add the upstream band 20,000,000 to 24,000,000 Hz to the list of valid bands with a change in the power level of 13 dBmV for spectrum group 3:

```
Router(config)# cable spectrum-group 3 band 20000000 24000000 13
```

- Use the following example to configure a continuous band between 5,000,004 and 40,000,000 Hz for scheduled spectrum group 4 with a default power level of 0 dBmV. The band is available to the spectrum group starting at 12:00 p.m. local time each Monday:

```
Router(config)# cable spectrum-group 4 time Monday 12:00:00 band 5000004 40000000
```

- Use the following example to add the upstream frequency 9,500,000 Hz to the list of valid frequencies and change the nominal power level to 5 dBmV. The spectrum manager adjusts frequencies and power levels on this group at 2:00 a.m. local time each day:

```
Router(config)# cable spectrum-group 3 time 02:00:00 frequency 9500000 5
```

- Use the following example to configure the minimum period before which a frequency hop can occur in seconds:

```
Router(config)# cable spectrum-group 3 hop period 800
```

- Use the following example to configure the threshold value (expressed as a percentage) of the number of “offline” modems identified before the router initiates an automatic frequency hop:

```
Router(config)# cable spectrum-group 3 hop threshold 40
```

- Use the following example to configure a particular spectrum group as a shared RF spectrum group. Specifying a given spectrum group as “shared” tells the router that you want to be sure that upstream frequencies assigned to upstream ports are not assigned to additional upstream ports:

```
Router(config)# cable spectrum-group 3 shared
```

- Use the following example to remove a specified spectrum group from your configuration:

```
Router(config)# no cable spectrum-group 3
```

- The following is an example of a spectrum group configuration that is designed to perform minor equalization as a function of frequency.

```
Router(config)# cable spectrum-group 1 frequency 21600000
Router(config)# cable spectrum-group 1 frequency 24800000 1
Router(config)# cable spectrum-group 1 frequency 28000000 2
```

In this example, the upstream port receives power at 21.6 MHz with a default power level of 0 dBmV, at 24.8 MHz with a power level of 1 dBmV, and at 28.0 MHz with a power level of 2 dBmV. At any time, the power level set in the interface configuration overrides the spectrum group power level.

## Dynamic Upstream Modulation Examples

The following examples describe how to display modulation profile information with the **show cable modulation-profile** command and to define a modulation profile with the **cable modulation-profile** command.

## Verifying Your Settings

---

**Step 1** To check the value of the settings you have entered, enter the **show running-config** command in privileged EXEC mode:

**Example:**

```
Router# show running-config
```

To review changes you make to the configuration, use the **show startup-config** command in privileged EXEC mode to display the information stored in NVRAM.

**Step 2** To display modulation profile group information, use the **show cable modulation-profile** command in privileged EXEC mode:

**Example:**

```
Router# show cable modulation-profile [profile] [iuc-code]
```

This command uses the following syntax:

- *profile*—(Optional) Profile number. Valid values are from 1 to 8.
- *iuc-code*—(Optional) Internal usage code.

Valid options are:

- **initial**—Initial ranging burst
  - **long**—Long grant burst
  - **request**—Request burst
  - **short**—Short grant burst
  - **station**—Station ranging burst
- 

## Example: Modulation Profiles

In Cisco IOS Release 12.1(3a)EC1 and later, the Cisco CMTS has one preconfigured modulation profile resident in memory, which defines a typical profile for QPSK modulation. To use the Dynamic Upstream Modulation feature, a second profile must be created that is unique from the first profile, and typically provides a higher, more robust modulation scheme.

The following example is a modulation profile for QAM-16, in which the initial, request, and station maintenance messages are sent as QPSK, and the short and long data packets are sent as QAM-16. The QAM-16 modulation is more bandwidth-efficient than QPSK, but QPSK is more robust than QAM-16.

**Note**

The upstream request and station maintenance messages use less time on the cable network when configured in QPSK for symbol rates of 640K, 1280K, and 2560K symbols/sec. Thus, these messages are actually more efficient when used in QPSK mode and they ensure a more reliable modem connection. The upstream initial maintenance message takes exactly the same amount of time on the cable network, no matter how it is configured. Modems connect more quickly and experience fewer cycles of power adjustment during initial maintenance if the system is set for QPSK.

```
Router# configure terminal
Router(config)# cable modulation-profile 2 request 0 16 1 8 qpsk scrambler 152 no-diff 64
fixed uw16
Router(config)# cable modulation-profile 2 initial 5 34 0 48 qpsk scrambler 152 no-diff 128
fixed uw16
Router(config)# cable modulation-profile 2 station 5 34 0 48 qpsk scrambler 152 no-diff 128
fixed uw16
Router(config)# cable modulation-profile 2 short 6 75 6 8 16qam scrambler 152 no-diff 72
fixed uw16
Router(config)# cable modulation-profile 2 long 8 220 0 8 16qam scrambler 152 no-diff 160
fixed uw16
```

In the following example, all message types are carried with QAM-16 modulation. Although QAM-16 modulation offers a consistent modulation scheme for all five types of messages, the added length of the QAM-16 preamble offsets the increased bandwidth efficiency of the MAC data message for the station maintenance messages and bandwidth request messages.

```
Router# configure terminal
Router(config)# cable modulation-profile 2 request 0 16 1 8 16qam scrambler 152 no-diff 128
fixed uw16
Router(config)# cable modulation-profile 2 initial 5 34 0 48 16qam scrambler 152 no-diff
256 fixed uw16
Router(config)# cable modulation-profile 2 station 5 34 0 48 16qam scrambler 152 no-diff
256 fixed uw16
Router(config)# cable modulation-profile 2 short 5 75 6 8 16qam scrambler 152 no-diff 144
fixed uw16
Router(config)# cable modulation-profile 2 long 8 220 0 8 16qam scrambler 152 no-diff 160
fixed uw16
```

**Note**

When using DOCSIS concatenation with a 16-QAM or mixed symbol rate, configure the CMTS for Unique Word 16 ("uw16") in the preamble for both short and long data burst profiles.

Add the **cable upstream *port-number modulation-profile primary profile-number secondary profile-number*** command to the appropriate interfaces. In this example, modulation profile 2 is for QAM-16 modulation and profile 1 is for QPSK modulation.

```
Router# configure terminal
Router(config)# interface Cable6/0
Router(config-if)# cable upstream 0 modulation-profile 2 1
```

## Example: Input Power Level

In the following example, the modem transmit power at 24.8 MHz is adjusted upstream by 1 dBmV and the modem transmit power at 28.0 MHz is adjusted upstream by 2 dBmV.

```
CMTS01(config)# cable spectrum-group 1 frequency 21600000
CMTS01(config)# cable spectrum-group 1 frequency 24800000 1
CMTS01(config)# cable spectrum-group 1 frequency 28000000 2
```

## Advanced Spectrum Management Configuration Examples

This section provides the following typical configurations:

### Example: Advanced Spectrum Management for the Cisco uBR7200 Series Router

This section provides a typical configuration example for a Cisco uBR7200 series router using the Cisco uBR-MC16U cable interface line card. This configuration does the following:

- Creates three spectrum groups with different frequency bands, hop periods, and hop thresholds.
- Creates two upstream modulation profiles, one for QPSK operation and one for QAM-16 operation, by specifying the parameters for each burst type.
- Creates two upstream modulation profiles, one for QPSK operation and one for mixed QPSK/QAM-16 operation, using the default profile options (**qpsk** and **mix**).
- Configures one upstream (port 5) on cable interface 3/0 to use spectrum group 3.
- Configures the upstreams with the primary modulation profile set to mixed QPSK/QAM-16 operation and the secondary modulation profile set for QPSK operation.
- Configures the upstream so that when its noise threshold is reached, it first attempts to change the frequency, then the channel-width, and finally to switch the modulation profile (using the Dynamic Upstream Modulation feature).

```

!
version 12.3
no service pad
no service password-encryption
service udp-small-servers
service tcp-small-servers
!
hostname ubr7200
!
!
! Define a frequency band for a 1.6 MHz channel around center frequency of 20.800 MHz
cable spectrum-group 1 band 19750000 21850000 0
! Define a frequency band for a 1.6 MHz channel around center frequency of 23.200 MHz
cable spectrum-group 1 band 22150000 24250000 0
! Hop period set to 30 sec to avoid modems going offline before initiating a hop priority
cable spectrum-group 1 hop period 30
! Percentage of missed station maintenance from modems
cable spectrum-group 1 hop threshold 20
!
cable modulation-profile 1 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 1 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
! Create second modulation profile numbered 4
cable modulation-profile 4 request 0 16 0 8 qpsk scrambler 152 no-diff 64 fixed uw16
cable modulation-profile 4 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 4 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 4 short 6 75 6 8 16qam scrambler 152 no-diff 144 shortened uw16
cable modulation-profile 4 long 8 220 0 8 16qam scrambler 152 no-diff 160 shortened uw16
! Create two modulation profiles using the default QPSK and QPSK/16-QAM profiles
cable modulation-profile 3 qpsk
cable modulation-profile 5 mix
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable time-server
clock calendar-valid

```

```

no ip subnet-zero
no ip domain-lookup
!
!
!
interface FastEthernet0/0
no ip address
no ip mroute-cache
shutdown
media-type MII
full-duplex
!
interface Ethernet1/0
ip address 10.11.10.1 255.0.0.0
no ip mroute-cache
half-duplex
!
interface Cable3/0
ip address 255.255.255.0 secondary
ip address 255.255.255.0
no keepalive
cable map-advance static
cable bundle 1 master
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 687000000
! Assign upstream to spectrum group
cable upstream 0 spectrum-group 1
! Set channel-width to be fixed at 1.6 MHz
cable upstream 0 channel-width 1600000 1600000
! Set priority of corrective actions
cable upstream 0 hop-priority frequency channel-width modulation
! Set the thresholds for corrective action
cable upstream 0 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
! Assign modulation profiles to upstream port in order of preference
cable upstream 0 modulation-profile 5 1
no cable upstream 0 concatenation
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 1
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 hop-priority frequency channel-width modulation
cable upstream 1 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
cable upstream 1 modulation-profile 5 1
no cable upstream 1 concatenation
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 1
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 hop-priority frequency channel-width modulation
cable upstream 2 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
cable upstream 2 modulation-profile 5 1
no cable upstream 2 concatenation
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 1
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 hop-priority frequency channel-width modulation
cable upstream 3 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
cable upstream 3 modulation-profile 5 1
no cable upstream 3 concatenation
no cable upstream 3 shutdown
cable upstream 4 spectrum-group 1
cable upstream 4 channel-width 1600000 1600000
cable upstream 4 hop-priority frequency channel-width modulation
cable upstream 4 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5

```

```

cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 4 modulation-profile 5 1
  no cable upstream 4 concatenation
  no cable upstream 4 shutdown
  cable upstream 5 spectrum-group 1
  cable upstream 5 channel-width 1600000 1600000
  cable upstream 5 hop-priority frequency channel-width modulation
cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 5 modulation-profile 5 1
  no cable upstream 5 concatenation
  no cable upstream 5 shutdown
  no cable dci-response
  cable dhcp-giaddr policy
!
interface Cable4/0
  no ip address
  no keepalive
  cable map-advance static
  cable bundle 1
  cable downstream annex B
  cable downstream modulation 64qam
  cable downstream interleave-depth 32
  cable downstream frequency 687000000
  cable upstream 0 spectrum-group 1
  cable upstream 0 channel-width 1600000 1600000
  cable upstream 0 hop-priority frequency channel-width modulation
cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 0 modulation-profile 5 1
  no cable upstream 0 concatenation
  no cable upstream 0 shutdown
  cable upstream 1 spectrum-group 1
  cable upstream 1 channel-width 1600000 1600000
  cable upstream 1 hop-priority frequency channel-width modulation
cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 1 modulation-profile 5 1
  no cable upstream 1 concatenation
  no cable upstream 1 shutdown
  cable upstream 2 spectrum-group 1
  cable upstream 2 channel-width 1600000 1600000
  cable upstream 2 hop-priority frequency channel-width modulation
cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 2 modulation-profile 5 1
  no cable upstream 2 concatenation
  no cable upstream 2 shutdown
  cable upstream 3 spectrum-group 1
  cable upstream 3 channel-width 1600000 1600000
  cable upstream 3 hop-priority frequency channel-width modulation
cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 3 modulation-profile 5 1
  no cable upstream 3 concatenation
  no cable upstream 3 shutdown
  cable upstream 4 spectrum-group 1
  cable upstream 4 channel-width 1600000 1600000
  cable upstream 4 hop-priority frequency channel-width modulation
cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 4 threshold Uncorr-Fec 2
  cable upstream 4 modulation-profile 5 1
  no cable upstream 4 concatenation
  no cable upstream 4 shutdown
  cable upstream 5 spectrum-group 1
  cable upstream 5 channel-width 1600000 1600000
  cable upstream 5 hop-priority frequency channel-width modulation

```

```

cable upstream 5 threshold cnr-profiles 23 15
cable upstream 0 threshold Corr-Fec 5
cable upstream 0 threshold Uncorr-Fec 2
  cable upstream 5 modulation-profile 5 1
  no cable upstream 5 concatenation
  no cable upstream 5 shutdown
  no cable dci-response
  cable dhcp-giaddr primary
!
ip default-gateway 10.11.0.1
ip classless
ip route 10.11.254.254 255.255.255.255 10.11.0.1
no ip http server
!!
snmp-server engineID local 00000009020000D0CAA7BB00
snmp-server community private RW
snmp-server trap-source FastEthernet0/0
snmp-server packetsize 2048
snmp-server system-shutdown
snmp-server enable traps cable hopping
snmp-server manager
!
line con 0
  exec-timeout 0 0
  transport input none
line aux 0
line vty 0 4
  no login
!
end

```

## Example: Advanced Spectrum Management for the Cisco uBR10012 Router

This section provides an excerpt from a typical configuration example for a Cisco uBR10012 router using the Cisco uBR10-MC5X20S/U/H cable interface line card. This configuration does the following:

- Configures four spectrum groups with a hop period of 30 seconds.
- Creates a QPSK modulation profile and assigns it to four upstreams on the Cisco uBR-MC5X20S/U/H cable interface line card in slot 6/1/0.
- Assigns a spectrum group to each of the four upstreams.
- Configures each upstream for the default CNR (CNiR) and FEC thresholds.

```

cable modulation-profile 21 qpsk
interface Cable6/1/0
cable bundle 1
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
! upstream 0
cable upstream 0 spectrum-group 1
cable upstream 0 modulation-profile 21
cable upstream 0 threshold cnr-profiles 16 0
cable upstream 0 threshold Corr-Fec 3
cable upstream 0 threshold Uncorr-Fec 1
no cable upstream 0 shutdown ! upstream 1
cable upstream 1 spectrum-group 2
cable upstream 1 modulation-profile 21
cable upstream 1 threshold cnr-profiles 16 0
cable upstream 1 threshold Corr-Fec 3
cable upstream 1 threshold Uncorr-Fec 1
no cable upstream 1 shutdown ! upstream 2
cable upstream 2 spectrum-group 3
cable upstream 2 modulation-profile 21
cable upstream 2 threshold cnr-profiles 16 0
cable upstream 2 threshold Corr-Fec 3

```



```

cable upstream 2 threshold Uncorr-Fec 1
no cable upstream 2 shutdown ! upstream 3
cable upstream 3 spectrum-group 4
cable upstream 3 modulation-profile 21
cable upstream 3 threshold cnr-profiles 16 0
cable upstream 3 threshold Corr-Fec 3
cable upstream 3 threshold Uncorr-Fec 1
no cable upstream 3 shutdown

```

## Additional References

The following sections provide references related to Spectrum Management and Advanced Spectrum Management for the Cisco CMTS routers.

### Related Documents

Related Topic	Document Title
CMTS Command Reference	<a href="https://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">https://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a> Cisco Broadband Cable Command Reference Guide.
Cisco IOS Release 12.2 Command Reference	Cisco IOS Release 12.2 Configuration Guides and Command References, at the following URL: <a href="https://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html">https://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html</a> <a href="https://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html">https://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html</a>
Cable Features Configuration Guide	<a href="#">Cisco CMTS Feature Guide</a>
Installing Cisco uBR7100 Series Universal Broadband Routers	<a href="#">Cisco uBR7100 Series Universal Broadband Router Hardware Installation Guide</a>
Configuring Cisco uBR7100 Series Universal Broadband Routers	<a href="#">Cisco uBR7100 Series Universal Broadband Router Software Configuration Guide</a>

Related Topic	Document Title
Installing Cisco uBR7200 Series Universal Broadband Routers	<a href="#">Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide</a> <a href="#">Cisco uBR7200 Series Universal Broadband Router Cable Modem Card Installation and Configuration</a> <a href="#">Cisco uBR7200 Series Universal Broadband Router Port Adapter Installation and Configuration</a> <a href="#">Cisco uBR7200 Series Universal Broadband Router 550-Watt DC-Input Power Supply Replacement Instructions</a> <a href="#">Cisco uBR7200 Series Universal Broadband Router Subchassis and Midplane Replacement Instructions</a> <a href="#">Cisco uBR7200 Series Rack-Mount and Cable-Management Kit Installation Instructions</a> <a href="#">Cisco uBR7200 Series Universal Broadband Router Fan Tray Replacement Instructions</a>
Configuring Cisco uBR7200 Series Universal Broadband Routers	<a href="#">Cisco uBR7200 Series Universal Broadband Router Software Configuration Guide</a> <a href="#">Cisco uBR7200 Series Universal Broadband Router Feature Roadmap</a>
Installing Cisco uBR10012 Universal Broadband Routers	<a href="#">Cisco uBR10012 Series Universal Broadband Router Hardware Installation Guide</a> <a href="#">2400W AC-Input Power Shelf for the Cisco uBR10012 Series Universal Broadband Router</a> <a href="#">Cable Interface Line Card Processor Hardware Installation for the Cisco uBR10012 Series Universal Broadband Router</a> <a href="#">Fan Assembly Module for the Cisco uBR10012 Series Universal Broadband Router</a> <a href="#">DC Power Entry Module for the Cisco uBR10012 Series Universal Broadband Router</a> <a href="#">Performance Routing Engine Card Hardware Installation for the Cisco uBR10012 Series Universal Broadband Router</a> <a href="#">TCC+ Card for the Cisco uBR10012 Series Universal Broadband Router</a>
Configuring the Cisco uBR10012 Universal Broadband Routers	<a href="#">Cisco uBR10012 Universal Broadband Router Software Configuration Guide</a>

**Standards and RFCs**

Standards	Title
SP-RFIV1.1-I09-020830	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 1.1
SP-RFIV2.0-I03-021218	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 2.0
SP-OSSIV2.0-I03-021218	Data-over-Cable Service Interface Specifications Operations Support System Interface Specification, version 2.0
SP-BPI+-I09-020830	Data-over-Cable Service Interface Specifications Baseline Privacy Plus Interface Specification, version 2.0

**MIBs**

MIBs	MIBs Link
CISCO-CABLE-SPECTRUM-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:  <a href="https://www.cisco.com/go/mibs">https://www.cisco.com/go/mibs</a>

**Technical Assistance**

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="https://www.cisco.com/cisco/web/support/index.html">https://www.cisco.com/cisco/web/support/index.html</a>

## Feature Information for Spectrum Management and Advanced Spectrum Management on CMTS

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

The table below 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 61: Feature Information for Spectrum Management**

Feature Name	Releases	Feature Information
Spectrum Management	11.3(9)NA, 12.0(6)SC, and 12.1(2)EC	Guided and scheduled spectrum management was introduced on Cisco uBR7200 series universal broadband routers.
Spectrum Management	12.1(5)EC	Support was added for guided and scheduled spectrum management on Cisco uBR7100 series universal broadband routers.
Spectrum Management	12.1(10)EC1 and 12.2(4)BC1	The MER (SNR) algorithm was corrected to display a more accurate value for upstreams.
Spectrum Management	12.2(4)BC1	Support was added for guided and scheduled spectrum management on Cisco uBR10012 routers.
Spectrum Management	12.2(15)BC1	Support was added for guided and scheduled spectrum management on the Cisco uBR10-MC5X20S/U/H cable interface line card.

Feature Name	Releases	Feature Information
Spectrum Management	12.2(15)BC2	<p>This release added the following support:</p> <ul style="list-style-type: none"> <li>• Support was added for intelligent and advanced spectrum management on the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cable interface line cards.</li> <li>• Support was added for guided and scheduled spectrum management on the Cisco uBR10-MC5X20S/U/H line card.</li> <li>• The maximum number of spectrum groups was increased from 32 to 40 groups per router.</li> <li>• The number of predefined modulation profiles was increased.</li> </ul>
Cisco Broadband Troubleshooter (CBT)	12.3(9)BC	<p>This release added the following support:</p> <ul style="list-style-type: none"> <li>• Spectrum management support with the Cisco Broadband Troubleshooter (CBT) 3.2 for the Cisco MC5X20S/U/H Broadband Processing Engine (BPE).</li> </ul>
Advanced Spectrum Management	12.3(13a)BC	<p>This release added the following support:</p> <ul style="list-style-type: none"> <li>• Advanced spectrum management support for the Cisco MC5X20S/U/H BPE in the Cisco uBR10012 Universal Broadband Router.</li> </ul>

Feature Name	Releases	Feature Information
Spectrum Management	12.3(21)BC	<p>This release added the following support:</p> <ul style="list-style-type: none"> <li>• Shared spectrum groups for DOCSIS 3.0, otherwise referred to as Fiber Node Groups, supporting inter-line card or intra-line card group combining. Refer to the <a href="#">Configuring Shared Spectrum Groups (Fiber Node Groups) for DOCSIS 3.0</a>, on page 414.</li> <li>• The <b>show controllers cable upstream spectrum</b> command is obsolete.</li> </ul>
Dynamic Upstream Modulation	12.3(23)BC7	<p>The Dynamic Upstream Modulation feature was enhanced to support a configuration of up to three modulation profiles. 64-QAM-based modulation profile is used to increase the upstream throughput and to satisfy the demand for new spectrum management.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream modulation</b></li> <li>• <b>cable upstream threshold hysteresis</b></li> <li>• <b>show cable hop history</b></li> </ul>
Three Step Dynamic Modulation	12.2(33)SCB3	<p>This release added support for the Three Step Dynamic Modulation feature.</p>
DOCSIS3.0 CNiR Measurement	12.2(33)SCF	<p>This feature was added to support CNiR (CNR) measurement for all US channels irrespective of whether spectrum management feature is enabled or not on the US channels.</p> <p>The <b>show cable modem cnr</b> command was modified.</p>









# Support for Extended Upstream Frequency Ranges

**First Published:** February 14, 2008

Cisco IOS Release 12.2(15)BC2 adds support for the extended upstream frequency range that is used in cable networks in Japan and other areas. This feature also clarifies the configuration of DOCSIS and EuroDOCSIS networks, so that the router shows only those upstream and downstream frequencies that are valid for each mode of operation.



**Note**

Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

## 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 Extended Upstream Frequency Ranges, page 460](#)
- [Restrictions for Extended Upstream Frequency Ranges, page 460](#)
- [Information About Extended Upstream Frequency Ranges, page 460](#)
- [How to Configure the Upstream Frequency Range, page 462](#)
- [Configuration Examples for Extended Upstream Frequency Ranges, page 467](#)
- [Additional References, page 475](#)

## Prerequisites for Extended Upstream Frequency Ranges

- The Cisco CMTS router must be running Cisco IOS Release 12.2(15)BC2 or later releases.
- The North American upstream frequency range (DOCSIS, 5 MHz to 42 MHz) is supported on all Cisco CMTS routers and all cable interfaces.
- The European upstream frequency range (EuroDOCSIS, 5 MHz to 65 MHz) is supported on the following platforms and cable interfaces:
  - Cisco uBR7111E and Cisco uBR7114E routers
  - Cisco uBR7246VXR router with the Cisco uBR-MC16E, Cisco uBR-MC16U/X, or Cisco uBR-MC28U/X cable interface line cards.
  - Cisco uBR10012 router with the Cisco uBR-LCP2-MC16E or Cisco uBR-MC5X20U cable interface line cards.
- The Japanese extended upstream frequency range (5 MHz to 55 MHz) is supported on the following platforms and cable interfaces:
  - Cisco uBR7111E and Cisco uBR7114E routers
  - Cisco uBR7246VXR router with the Cisco uBR-MC16E, Cisco uBR-MC16U/X, or Cisco uBR-MC28U/X cable interface line cards.
  - Cisco uBR10012 router with the Cisco uBR-LCP2-MC16E or Cisco uBR-MC5X20U cable interface line cards.
- The cable physical plant must be configured with upconverters, filters, and other equipment that supports the desired frequency range and DOCSIS modes of operation.

## Restrictions for Extended Upstream Frequency Ranges

- The RF modulation format should be configured for ITU J.112 Annex A for EuroDOCSIS operations, and for ITU J.83 Annex B for DOCSIS and Japanese operations. While it is possible to configure the modulation format differently, we do not recommend this because it violates the DOCSIS and EuroDOCSIS specifications.
- The ITU J.83 Annex C specification is not supported.
- You cannot configure the router for a particular frequency range if an upstream or spectrum group on the router is currently configured for a frequency that is invalid for the new range. If you try to do so, the command is ignored and a warning message is printed prompting you to reconfigure the upstream or spectrum group before retrying the command.

## Information About Extended Upstream Frequency Ranges

The original Data-over-Cable Service Interface Specifications (DOCSIS) specified a range of downstream and upstream frequencies that were compatible only with the North American National Television Systems

Committee (NTSC) channel plans. Those specifications have been enhanced to provide support for other cable systems.

## Frequency Ranges Currently in Use

The table below lists the specifications that are commonly used in cable plants at the current time:

**Table 62: Frequency Specifications**

Region	Channel Plan	Radio Frequency (RF) <sup>35</sup> Modulation Format	Downstream Frequency Range	Upstream Frequency Range
North American (DOCSIS)	6 MHz NTSC <sup>36</sup>	ITU J.83 Annex B	85 MHz to 860 MHz	5 MHz to 42 MHz
European (EuroDOCSIS)	8 MHz PAL <sup>37</sup> /SECAM <sup>38</sup>	ITU J.112 Annex A	85 MHz to 860 MHz	5 MHz to 65 MHz
Japan <sup>39</sup>	6 MHz NTSC	ITU J.83 Annex B	70 MHz to 860 MHz	5 MHz to 55 MHz

<sup>35</sup> The RF Modulation Format column shows the configuration that is required for operation in normal DOCSIS and EuroDOCSIS networks. While it is possible to configure the Modulation Format differently than what is shown in this table, we do not recommend doing so.

<sup>36</sup> NTSC = North American National Television Systems Committee

<sup>37</sup> PAL = Phase Alternating Line

<sup>38</sup> SECAM= Systeme Electronique Couleur Avec Memoire

<sup>39</sup> CableLabs has not released an official version of the DOCSIS specification to support the extended Japanese upstream and downstream frequency ranges.

## Extended Frequency Support for Downstreams

All current Cisco cable interface line cards support downstream frequencies between 54 MHz and 860 MHz, which is a superset of the DOCSIS and EuroDOCSIS downstream frequency range. This allows those cards to automatically support the extended downstream frequency range of Japanese networks, assuming that the appropriate upconverters, filters, and other supporting equipment is also installed in the cable plant.

## Extended Frequency Support for Upstreams

To support the different upstream frequency ranges, Cisco IOS Release 12.2(15)BC2 introduces a new command, **cable freq-range**, which configures the Cisco CMTS router for the maximum allowable range of frequencies that can be used on the router. This command makes these frequencies available only for those cable interfaces that support them.



### Tip

The **cable freq-range** command is not normally needed except to enable EuroDOCSIS operations on the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cards. However, it can be used in other situations to ensure that the other **cable upstream** commands do not allow frequencies outside of the desired range.

Support for the different frequency ranges depends on the cable interfaces being used:

- Cisco uBR-MC16E cable interface line card and the Cisco uBR7111E/7114E routers—Support the EuroDOCSIS frequency range, which is the default mode of operation.
- Cisco uBR-MC16U/X, Cisco uBR-MC28U/X, and Cisco uBR-MC5X20U cable interface line cards—Support the Japanese extended frequency range and the EuroDOCSIS frequency range, and the Japanese range is the default mode of operation.
- All other cable interfaces—Support the DOCSIS frequency range, which is the default mode of operation.

If a cable interface card does not support the frequency range that is configured with the **cable freq-range** command, a warning message is displayed. The card interface card, however, can continue to be used with its normal set of frequencies.

For example, consider the case where a Cisco uBR7246VXR router has a Cisco uBR-MC16C card and a Cisco uBR-MC28U card installed. By default, the Cisco uBR-MC16C card supports the DOCSIS frequency range, and the Cisco uBR-MC28U supports the Japanese frequency range. If you configure the router to support the EuroDOCSIS frequency range, only the Cisco uBR-MC28U card supports the extra downstream and upstream frequencies. The Cisco uBR-MC16C card, however, can continue to be used with the regular DOCSIS frequencies.

## How to Configure the Upstream Frequency Range

To configure a Cisco CMTS router to use a particular range of upstream frequencies, use the following procedures:



### Note

You do not need any special configuration to be able to use the extended range of downstream frequencies that is used in Japanese networks, because all currently-supported Cisco cable interface line cards support a superset (54 MHz to 860 Mhz) of the DOCSIS frequencies that include the Japanese range.

## Configuring DOCSIS Upstream Frequencies

To configure one or more upstreams with a frequency in the valid DOCSIS range of 5 MHz to 42 MHz, use the following procedure.



### Tip

This procedure typically is not needed, because by default all cable interfaces support the DOCSIS frequency range. However, you might want to use this procedure for the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cable interface line cards to specify that these cards use a narrower DOCSIS frequency filter that would filter out any noise in the frequencies above 42 MHz, which might improve RF performance on some cable plants.

### Before You Begin

All Cisco CMTS platforms and cable interfaces support the North American range of upstream frequencies.

**Restriction**

All cable interfaces in the router must be using the North American upstream frequency range.

Any upstreams that are currently configured for frequencies greater than 42 MHz must be reconfigured to use a lower frequency, using the **cable upstream frequency** interface command, before beginning this procedure.

**DETAILED STEPS**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
<b>Step 3</b>	<b>cable freq-range north-american</b>  <b>Example:</b> Router(config)# <b>cable freq-range north-american</b>	Configures the Cisco CMTS router for the DOCSIS upstream frequency range (5 MHz to 42 MHz).  <b>Note</b> This command will fail if any upstreams are currently configured with frequencies greater than 42 MHz. Use the <b>cable upstream frequency</b> command to reconfigure these upstreams for a lower frequency and then re-enter this command.
<b>Step 4</b>	<b>interface cable {x/y   x/y/z }</b>  <b>Example:</b> Router(config)# <b>interface cable 3/0</b>	Enters interface cable configuration mode for the specified cable interface.
<b>Step 5</b>	<b>cable downstream annex b</b>  <b>Example:</b> Router(config-if)# <b>cable downstream annex b</b>	Configures the downstream for the Annex B (ITU J.83) RF mode, which is used in DOCSIS networks.
<b>Step 6</b>	<b>cable upstream n frequency frequency</b>  <b>Example:</b> Router(config-if)# <b>cable upstream 0 frequency 32000000</b>	Configures the upstream for the desired frequency in Hertz. The valid range for <i>n</i> starts with 0 and depends on the number of upstream ports for this downstream. The valid range for <i>frequency</i> is 5000000 to 42000000.  <b>Note</b> Repeat this command for each upstream port for this downstream.
<b>Step 7</b>	<b>exit</b>  <b>Example:</b> Router(config-if)# <b>exit</b>	Exits interface configuration mode.

	Command or Action	Purpose
Step 8	<b>exit</b>  <b>Example:</b> Router (config) # <b>exit</b>	Exits global configuration mode.

## Configuring Extended DOCSIS Upstream Frequencies for Japan

To configure one or more upstreams with a frequency in the extended Japanese frequency range of 5 MHz to 55 MHz, use the following procedure.



### Note

This procedure is not typically needed, because all of the cable interfaces listed in the [Before You Begin](#) section support the extended upstream frequency ranges in their default configuration. However, if you have configured a Cisco uBR-MC16U/X or Cisco uBR-MC28U/X card as described in the [Configuring DOCSIS Upstream Frequencies, on page 462](#), you must use this procedure to re-enable the extended frequency range.

### Before You Begin

The Japanese upstream frequency range (5 MHz to 55 MHz) is supported on the following platforms and cable interfaces:

- Cisco uBR7111E and Cisco uBR7114E routers
- Cisco uBR7246VXR router with the Cisco uBR-MC16E, Cisco uBR-MC16U/X, or Cisco uBR-MC28U/X cable interface line cards.
- Cisco uBR10012 router with the Cisco uBR-LCP2-MC16E or Cisco uBR-MC5X20U cable interface line cards.



### Restriction

All cable interfaces in the router must be using either the North American or the Japanese upstream frequency range.

Any upstream that is currently configured for EuroDOCSIS, using frequencies greater than 55 MHz must be reconfigured for a lower frequency, using the **cable upstream frequency** interface command, before beginning this procedure.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable freq-range japanese</b>  <b>Example:</b> Router(config)# <b>cable freq-range japanese</b>	Configures the Cisco CMTS router for the extended upstream frequency range (5 MHz to 55 MHz) that is used in Japanese cable networks.  <b>Note</b> This command will fail if any upstreams are currently configured with frequencies greater than 55 MHz. Use the <b>cable upstream frequency</b> command to reconfigure these upstreams for a lower frequency and then re-enter this command.
Step 4	<b>interface cable</b> {x/y   x/y/z }  <b>Example:</b> Router(config)# <b>interface cable 3/0</b>	Enters interface cable configuration mode for the specified cable interface.
Step 5	<b>cable downstream annex b</b>  <b>Example:</b> Router(config-if)# <b>cable downstream annex b</b>	Configures the downstream for the Annex B (ITU J.83) RF mode, which is used in DOCSIS networks.
Step 6	<b>cable upstream n frequency frequency</b>  <b>Example:</b> Router(config-if)# <b>cable upstream 0 frequency 3200000</b>	Configures the upstream for the desired frequency in Hertz. The valid range for <i>n</i> starts with 0 and depends on the number of upstream ports for this downstream. The valid range for <i>frequency</i> is 5000000 to 55000000.  <b>Note</b> Repeat this command for each upstream port for this downstream.
Step 7	<b>exit</b>  <b>Example:</b> Router(config-if)# <b>exit</b>	Exits interface configuration mode.
Step 8	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Configuring EuroDOCSIS Upstream Frequencies

To configure one or more upstreams with a frequency in the valid EuroDOCSIS range of 5 MHz to 65 MHz, use the following procedure.



### Tip

This command is not normally needed with the Cisco UBR-MC5X20U cable interface line card, because by default it supports upstream frequencies up to 65 MHz. However, if you have used one of the previous procedures, [Configuring DOCSIS Upstream Frequencies, on page 462](#) or [Configuring Extended DOCSIS Upstream Frequencies for Japan, on page 464](#), to limit the frequency range, you must use this procedure to re-enable the EuroDOCSIS frequency range.

### Before You Begin

The European upstream frequency range (EuroDOCSIS, 5 MHz to 65 MHz) is supported on the following platforms and cable interfaces:

- Cisco uBR7111E and Cisco uBR7114E routers
- Cisco uBR7246VXR router with the Cisco uBR-MC16E, Cisco uBR-MC16U/X, or Cisco uBR-MC28U/X cable interface line cards.
- Cisco uBR10012 router with the Cisco uBR-LCP2-MC16E or Cisco uBR-MC5X20U cable interface line cards.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable freq-range european</b>  <b>Example:</b> Router (config)# <b>cable freq-range european</b>	Configures the Cisco CMTS router for the EuroDOCSIS upstream frequency range (5 MHz to 65 MHz).
Step 4	<b>interface cable</b> {x/y   x/y/z }  <b>Example:</b> Router (config)# <b>interface cable</b> 3/0	Enters interface cable configuration mode for the specified cable interface.



	Command or Action	Purpose
Step 5	<b>cable downstream annex a</b>  <b>Example:</b> <pre>Router(config-if)# cable downstream annex a</pre>	Configures the downstream for the Annex A (ITU J.112) RF mode, which is used in EuroDOCSIS networks.  <b>Note</b> You must configure the downstream for Annex A for EuroDOCSIS operations. You can configure certain cable interface cards (such as the Cisco uBR-MC28U) for both Annex B (DOCSIS) and the EuroDOCSIS frequency range, but this violates the DOCSIS specifications and should not be used on standard DOCSIS networks.
Step 6	<b>cable upstream n frequency frequency</b>  <b>Example:</b> <pre>Router(config-if)# cable upstream 0 frequency 32000000</pre>	Configures the upstream for the desired frequency in Hertz. The valid range for <i>n</i> starts with 0 and depends on the number of upstream ports for this downstream. The valid range for <i>frequency</i> is 5000000 to 65000000.  <b>Note</b> Repeat this command for each upstream port for this downstream.
Step 7	<b>exit</b>  <b>Example:</b> <pre>Router(config-if)# exit</pre>	Exits interface configuration mode.
Step 8	<b>exit</b>  <b>Example:</b> <pre>Router(config)# exit</pre>	Exits global configuration mode.

## Configuration Examples for Extended Upstream Frequency Ranges

This section provides the following examples of sample configurations for the cable interface:

### Example: Configuring North American (DOCSIS) Frequency Range

The following excerpt from a configuration file for the Cisco uBR7246VXR router shows a Cisco uBR-MC28U card and a Cisco uBR-MC16U card being configured for the default DOCSIS upstream frequency range of 5 MHz to 42 MHz. This frequency spectrum is allocated across two spectrum groups. Also, each downstream is configured for the DOCSIS Annex B mode.



**Note** The **cable freq-range north-american** command is not needed for this configuration, but using the command filters out the upstream frequencies above 42 MHz, which could be useful if noise is occurring in those frequencies.

...

## Example: Configuring North American (DOCSIS) Frequency Range

```

cable freq-range north-american
cable spectrum-group 1 shared
cable spectrum-group 1 band 5000000 23500000
cable spectrum-group 2 shared
cable spectrum-group 2 band 23500000 42000000
...
!
interface Cable3/0
description Cisco uBR-MC28U cable interface DS0
ip address 10.2.4.1 255.255.255.0 secondary
ip address 10.2.3.1 255.255.255.0
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 195000000
cable downstream channel-id 0
cable upstream 0 frequency 29008000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 1
no cable upstream 0 shutdown
cable upstream 1 frequency 25808000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot-size 2
cable upstream 1 modulation-profile 1
no cable upstream 1 shutdown
cable upstream 2 frequency 9808000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislot-size 2
cable upstream 2 modulation-profile 1
no cable upstream 2 shutdown
cable upstream 3 frequency 19408000
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislot-size 2
cable upstream 3 modulation-profile 1
no cable upstream 3 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
interface Cable3/1
description Cisco uBR-MC28U cable interface DS1
ip address 10.2.5.1 255.255.255.0 secondary
ip address 10.2.4.1 255.255.255.0
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 789000000
cable downstream channel-id 1
cable upstream 0 spectrum-group 1
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 1
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 1
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot-size 2
cable upstream 1 modulation-profile 1
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 2
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislot-size 2
cable upstream 2 modulation-profile 1
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 2
cable upstream 3 power-level 0
cable upstream 3 channel-width 1600000

```

```

cable upstream 3 minislot-size 4
cable upstream 3 modulation-profile 1
no cable upstream 3 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
interface Cable4/0
description Cisco uBR-MC16U cable interface
ip address 10.2.0.1 255.255.255.0 secondary
ip address 10.2.0.1 255.255.255.0
cable bundle 10 master
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 195000000
cable downstream channel-id 2
cable upstream 0 frequency 29008000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 1
cable upstream 0 shutdown
cable upstream 1 frequency 25808000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot-size 2
cable upstream 1 modulation-profile 1
cable upstream 1 shutdown
cable upstream 2 frequency 9808000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislot-size 2
cable upstream 2 modulation-profile 1
cable upstream 2 shutdown
cable upstream 3 frequency 19408000
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislot-size 2
cable upstream 3 modulation-profile 1
cable upstream 3 shutdown
cable upstream 4 frequency 35408000
cable upstream 4 power-level 0
cable upstream 4 channel-width 3200000
cable upstream 4 minislot-size 2
cable upstream 4 modulation-profile 1
cable upstream 4 shutdown
cable upstream 5 frequency 16208000
cable upstream 5 power-level 0
cable upstream 5 channel-width 3200000
cable upstream 5 minislot-size 2
cable upstream 5 modulation-profile 1
cable upstream 5 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
...

```

## Example: Configuring Japanese Frequency Range

The following excerpt from a configuration file for the Cisco uBR7246VXR router shows a Cisco uBR-MC28U card and two Cisco uBR-MC16U cards being configured for the Japanese extended upstream frequency range of 5 MHz to 55 MHz. This frequency spectrum is allocated across three spectrum groups. Also, each downstream is configured for the DOCSIS Annex B mode.

```

...
cable freq-range japanese
cable spectrum-group 1 shared
cable spectrum-group 1 band 5000000 23500000

```

## Example: Configuring Japanese Frequency Range

```

cable spectrum-group 2 shared
cable spectrum-group 2 band 23500000 42000000
cable spectrum-group 3 shared
cable spectrum-group 3 band 42000000 55000000
...
!
interface Cable3/0
description Cisco uBR-MC28U cable interface DS0
ip address 10.2.4.1 255.255.255.0 secondary
ip address 10.2.3.1 255.255.255.0
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 195000000
cable downstream channel-id 0
cable upstream 0 frequency 29008000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislots-size 2
cable upstream 0 modulation-profile 1
no cable upstream 0 shutdown
cable upstream 1 frequency 25808000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislots-size 2
cable upstream 1 modulation-profile 1
no cable upstream 1 shutdown
cable upstream 2 frequency 44808000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislots-size 2
cable upstream 2 modulation-profile 1
no cable upstream 2 shutdown
cable upstream 3 frequency 19408000
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislots-size 2
cable upstream 3 modulation-profile 1
no cable upstream 3 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
interface Cable3/1
description Cisco uBR-MC28U cable interface DS1
ip address 10.2.5.1 255.255.255.0 secondary
ip address 10.2.4.1 255.255.255.0
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 789000000
cable downstream channel-id 1
cable upstream 0 frequency 45408000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislots-size 2
cable upstream 0 modulation-profile 1
no cable upstream 0 shutdown
cable upstream 1 frequency 16208000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislots-size 2
cable upstream 1 modulation-profile 1
no cable upstream 1 shutdown
cable upstream 2 frequency 6608000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislots-size 2
cable upstream 2 modulation-profile 1
no cable upstream 2 shutdown
cable upstream 3 frequency 41008000
cable upstream 3 power-level 0
cable upstream 3 channel-width 1600000
cable upstream 3 minislots-size 4

```

```

cable upstream 3 modulation-profile 1
no cable upstream 3 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
interface Cable4/0
description Cisco uBR-MC16U cable interface
ip address 10.2.0.1 255.255.255.0 secondary
ip address 10.2.0.1 255.255.255.0
cable bundle 10 master
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 195000000
cable downstream channel-id 2
cable upstream 0 frequency 29008000
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislots-size 2
cable upstream 0 modulation-profile 1
cable upstream 0 shutdown
cable upstream 1 frequency 25808000
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislots-size 2
cable upstream 1 modulation-profile 1
cable upstream 1 shutdown
cable upstream 2 frequency 9808000
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislots-size 2
cable upstream 2 modulation-profile 1
cable upstream 2 shutdown
cable upstream 3 frequency 19408000
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislots-size 2
cable upstream 3 modulation-profile 1
cable upstream 3 shutdown
cable upstream 4 frequency 35408000
cable upstream 4 power-level 0
cable upstream 4 channel-width 3200000
cable upstream 4 minislots-size 2
cable upstream 4 modulation-profile 1
cable upstream 4 shutdown
cable upstream 5 frequency 16208000
cable upstream 5 power-level 0
cable upstream 5 channel-width 3200000
cable upstream 5 minislots-size 2
cable upstream 5 modulation-profile 1
cable upstream 5 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
interface Cable5/0
description Cisco uBR-MC16U cable interface
no ip address
load-interval 30
cable bundle 10
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 453000000
cable downstream channel-id 4
no cable downstream rf-shutdown
cable upstream 0 spectrum-group 3
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 power-level 0
cable upstream 0 channel-width 200000 200000
cable upstream 0 minislots-size 32
cable upstream 0 modulation-profile 41
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 1

```

**Example: Configuring European (EuroDOCSIS) Frequency Range**

```

cable upstream 1 ingress-noise-cancellation 200
cable upstream 1 power-level 0
cable upstream 1 channel-width 1600000 1600000
cable upstream 1 minislot-size 4
cable upstream 1 modulation-profile 42
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 3
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 power-level 0
cable upstream 2 channel-width 1600000 1600000
cable upstream 2 minislot-size 4
cable upstream 2 modulation-profile 42
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 3
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 power-level 0
cable upstream 3 channel-width 1600000 1600000
cable upstream 3 minislot-size 4
cable upstream 3 modulation-profile 42
no cable upstream 3 shutdown
cable upstream 4 spectrum-group 3
cable upstream 4 ingress-noise-cancellation 200
cable upstream 4 power-level 0
cable upstream 4 channel-width 1600000 1600000
cable upstream 4 minislot-size 4
cable upstream 4 modulation-profile 42
no cable upstream 4 shutdown
cable upstream 5 spectrum-group 3
cable upstream 5 ingress-noise-cancellation 200
cable upstream 5 power-level 0
cable upstream 5 channel-width 1600000 1600000
cable upstream 5 minislot-size 4
cable upstream 5 modulation-profile 42
no cable upstream 5 shutdown
cable dhcp-giaddr policy
cable helper-address 10.2.0.2
!
...

```

**Example: Configuring European (EuroDOCSIS) Frequency Range**

The following excerpt from a configuration file for the Cisco uBR10012 router shows a Cisco uBRMC5X20U card being configured for the EuroDOCSIS frequency range of 5 MHz to 65 MHz. This frequency spectrum is allocated across a number of spectrum groups. Also, each downstream is configured for the EuroDOCSIS Annex A mode.

```

...
card 5/0 5cable-mc520u-d
...
cable freq-range european
cable spectrum-group 1 shared
cable spectrum-group 1 band 5000000 42000000
cable spectrum-group 2 shared
cable spectrum-group 2 band 5000000 30000000
cable spectrum-group 3 shared
cable spectrum-group 3 band 30000000 42000000
cable spectrum-group 4 band 5000000 10000000
cable spectrum-group 5 band 10000000 15000000
cable spectrum-group 6 band 15000000 20000000
cable spectrum-group 7 band 20000000 25000000
cable spectrum-group 8 band 25000000 30000000
cable spectrum-group 9 band 30000000 35000000
cable spectrum-group 10 band 35000000 42000000
cable spectrum-group 12 band 42000000 50000000
cable spectrum-group 13 band 50000000 55000000
cable spectrum-group 14 band 55000000 65000000
!
interface Cable5/0/0

```

```

no ip address
cable enable-trap cmonoff-notification
cable bundle 1 master
cable downstream annex A
cable downstream modulation 256qam
cable downstream interleave-depth 64
cable downstream frequency 471000000
cable downstream channel-id 0
no cable downstream rf-shutdown
cable upstream 0 spectrum-group 6
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 21 22
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 7
cable upstream 1 power-level 0
cable upstream 1 channel-width 1600000
cable upstream 1 minislot-size 4
cable upstream 1 modulation-profile 121 122
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 8
cable upstream 2 power-level 0
cable upstream 2 channel-width 800000
cable upstream 2 minislot-size 8
cable upstream 2 modulation-profile 123 124
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 14
cable upstream 3 power-level 0
cable upstream 3 channel-width 400000
cable upstream 3 minislot-size 16
cable upstream 3 modulation-profile 22 23
no cable upstream 3 shutdown
!
interface Cable5/0/1
no ip address
load-interval 30
cable bundle 1
cable downstream annex A
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 471000000
cable downstream channel-id 0
no cable downstream rf-shutdown
cable upstream 0 spectrum-group 10
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 122 123
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 2
cable upstream 1 power-level 0
cable upstream 1 channel-width 1600000
cable upstream 1 minislot-size 4
cable upstream 1 modulation-profile 124 125
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 3
cable upstream 2 power-level 0
cable upstream 2 channel-width 400000
cable upstream 2 minislot-size 16
cable upstream 2 modulation-profile 126 127
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 1
cable upstream 3 power-level 0
cable upstream 3 channel-width 200000
cable upstream 3 minislot-size 32
cable upstream 3 modulation-profile 125 128
no cable upstream 3 shutdown
!
interface Cable5/0/2
no ip address
load-interval 30
cable bundle 2

```

## Example: Configuring European (EuroDOCSIS) Frequency Range

```

cable downstream annex A
cable downstream modulation 256qam
cable downstream interleave-depth 16
cable downstream frequency 453000000
cable downstream channel-id 0
no cable downstream rf-shutdown
cable upstream 0 spectrum-group 1
cable upstream 0 power-level 0
cable upstream 0 channel-width 1600000
cable upstream 0 minislot-size 4
cable upstream 0 modulation-profile 21 22
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 2
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot-size 2
cable upstream 1 modulation-profile 122 129
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 3
cable upstream 2 power-level 0
cable upstream 2 channel-width 800000
cable upstream 2 minislot-size 8
cable upstream 2 modulation-profile 123 126
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 1
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislot-size 2
cable upstream 3 modulation-profile 22 23
no cable upstream 3 shutdown
!
interface Cable5/0/3
no ip address
cable bundle 3
cable downstream annex A
cable downstream modulation 256qam
cable downstream interleave-depth 16
cable downstream frequency 471000000
cable downstream channel-id 0
no cable downstream rf-shutdown
cable upstream 0 spectrum-group 6
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 21 22
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 6
cable upstream 1 power-level 0
cable upstream 1 channel-width 1600000
cable upstream 1 minislot-size 4
cable upstream 1 modulation-profile 121 122
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 7
cable upstream 2 power-level 0
cable upstream 2 channel-width 800000
cable upstream 2 minislot-size 8
cable upstream 2 modulation-profile 123 124
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 7
cable upstream 3 power-level 0
cable upstream 3 channel-width 400000
cable upstream 3 minislot-size 16
cable upstream 3 modulation-profile 22 23
no cable upstream 3 shutdown
!
interface Cable5/0/4
no ip address
cable bundle 4
cable downstream annex A
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 471000000
cable downstream channel-id 0

```



```

no cable downstream rf-shutdown
cable upstream 0 spectrum-group 10
cable upstream 0 power-level 0
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 modulation-profile 22 24
no cable upstream 0 shutdown
cable upstream 1 spectrum-group 10
cable upstream 1 power-level 0
cable upstream 1 channel-width 3200000
cable upstream 1 minislot-size 2
cable upstream 1 modulation-profile 122 129
no cable upstream 1 shutdown
cable upstream 2 spectrum-group 15
cable upstream 2 power-level 0
cable upstream 2 channel-width 3200000
cable upstream 2 minislot-size 2
cable upstream 2 modulation-profile 125 124
no cable upstream 2 shutdown
cable upstream 3 spectrum-group 15
cable upstream 3 power-level 0
cable upstream 3 channel-width 3200000
cable upstream 3 minislot-size 2
cable upstream 3 modulation-profile 22 23
no cable upstream 3 shutdown
no keepalive
!
```

## Additional References

The following sections provide references related to the Extended Upstream Frequency Ranges.

### Related Documents

Related Topic	Document Title
CMTS Command Reference	<p><i>Cisco Broadband Cable Command Reference Guide</i>, at the following URL:</p> <p><a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a></p>
Software Configuration Information	<p><i>Cisco uBR7100 Series Software Configuration Guide</i>, at the following URL:</p> <p><a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/configuration/guide/scg7100.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/configuration/guide/scg7100.html</a></p> <p><i>Cisco uBR7200 Series Software Configuration Guide</i>, at the following URL:</p> <p><a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr7200/configuration/guide/cr72scg.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr7200/configuration/guide/cr72scg.html</a></p> <p><i>Cisco uBR10012 Universal Broadband Router Software Configuration Guide</i>, at the following URL:</p> <p><a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/configuration/guide/scg.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/configuration/guide/scg.html</a></p>

Related Topic	Document Title
Cable Features Configuration Guide	<i>Cisco CMTS Feature Guide</i> , at the following URL: <a href="http://www.cisco.com/en/US/docs/cable/cmts/feature/guide/cmtsfg.html">http://www.cisco.com/en/US/docs/cable/cmts/feature/guide/cmtsfg.html</a>
Cisco IOS Release 12.2 Command Reference	<i>Cisco IOS Release 12.2 Configuration Guides and Command References</i> , at the following URL: <a href="http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html">http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html</a>

### Standards and RFCs

Standards	Title
<a href="#">SP-RF1v1.1-I09-020830</a>	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 1.1
<a href="#">SP-RF1v2.0-I03-021218</a>	Data-Over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 2.0

### MIBs

MIBs	MIBs Link
<ul style="list-style-type: none"> <li>CISCO-CABLE-SPECTRUM-MIB</li> </ul>	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

### Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>



# CHAPTER 18

## Upstream Bonding Support for D-PON on the Cisco CMTS Routers

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**First Published:** November 29, 2010

Cisco IOS Release 12.2(33)SCE provides support for the DOCSIS Passive Optical Network (D-PON). This architecture, also known as RF over glass (RFOG), helps the cable operators to effectively utilize the DOCSIS infrastructure and enter fiber-to-the-home market space.

### 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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## Prerequisites for Upstream Bonding Support for D-PON

The table below shows the hardware compatibility prerequisites for this feature.

**Table 63: Upstream Bonding Support for D-PON Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 universal broadband router	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• PRE4</li> <li>• PRE2</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20H</li> <li>• Cisco UBR-MC20X20V<sup>40</sup></li> <li>• Cisco uBR-MC3GX60V<sup>41</sup></li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>40</sup> The Cisco UBR-MC20X20V cable interface line card has three variants—Cisco UBR-MC20X20V-0D, Cisco UBR-MC20X20V-5D, and Cisco UBR-MC20X20V-20D. The Cisco UBR-MC20X20V-0D line card supports 20 upstreams and zero (no) downstreams. The Cisco UBR-MC20X20V-5D line card supports 20 upstreams and 5 downstreams, and the Cisco UBR-MC20X20V-20D line card supports 20 upstreams and 20 downstreams.

<sup>41</sup> The Cisco uBR-MC3GX60V line card is not compatible with PRE2.

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

**Note**

The hardware components introduced in a given Cisco IOS Release are supported in all subsequent releases unless otherwise specified.

## Restrictions for Upstream Bonding Support for D-PON

- Multiple CMs cannot work at the same time. Each CM must get a separate time slot for upstream data transmission. Configuring D-PON ensures that the upstream scheduler allows only a single CM to transmit at a particular time.
- Configuring D-PON in a MAC domain enables D-PON for all MAC domains in the line card. Similarly, disabling D-PON on a MAC domain disables all the MAC domains in the line card.
- When D-PON is enabled in a MAC domain, you must manually shut down and enable the MAC domain using **shutdown** and **no shutdown** command.
- All frequencies in a MAC domain must have the same configuration for:

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

## Information About Upstream Bonding Support for D-PON

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

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

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

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

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

- **Internal Control Configuration**—In this configuration, the internal CM of the ONT controls the laser. Upstream signals go to the Ethernet interface of the CM allowing the ONT to control upstream timing. The device that uses this type of configuration is the Digital Audio Visual Council (DAVIC) set top terminal (STT).
- **External Control Configuration**—In this configuration, the presence of the RF at the ONT upstream input activates the laser. The device that uses this type of configuration is the DOCSIS Set-top Gateway (DSG) device.
- **Dual Control Configuration**—In this configuration, the home that contains an ONT with an internal CM and other DOCSIS upstream sources, like DSG devices. The RF presence detector or the internal CM control line detects the upstream signal and activates the upstream laser.

## D-PON on Upstream Scheduling

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

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

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

The D-PON feature supports the following service types:

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

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

This section describes how to enable D-PON for a MAC domain on the Cisco CMTS routers:

### DETAILED STEPS

	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/port</i>   <i>slot/subslot/cable-interface-index</i> }  <b>Example:</b> Router(config)# <b>interface cable</b> 7/0/1	Enters interface configuration mode for the specified cable interface.  The valid values are:  • <i>slot</i> —5 to 8

	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>• <i>port</i>—0 to 4 (depending on the cable interface)</li> <li>• <i>subslot</i>—0 or 1</li> <li>• <i>cable-interface-index</i>—0 to 14 (depending on the cable interface)</li> </ul>
<b>Step 4</b>	<b>cable upstream dpon</b>  <b>Example:</b> Router(config-if)# <b>cable upstream dpon</b>	Enables D-PON for a MAC domain.
<b>Step 5</b>	<b>shutdown</b>  <b>Example:</b> Router(config-if)# <b>shutdown</b>	Shuts down the interface.
<b>Step 6</b>	<b>no shutdown</b>  <b>Example:</b> Router(config-if)# <b>no shutdown</b>	Enables the interface.
<b>Step 7</b>	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to the privileged EXEC mode.

## DOCSIS 3.0 Cable Modems Upstream Bonding Enters Partial Bonding

Sometimes, upstream bonding enters partial bonding while reverting to the original CLC after switchover. In the following example, the switchover is performed between CLC in slot 1 and 0. After reverting to CLC in slot 1, C1/0/3/UB turns to C1/0/3/p. The following output highlights the change:

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

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

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

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

## Verifying the Upstream Bonding Support for D-PON

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



### Note

The D-PON reference channel US0 (US channel-id 1) MAP serves as a template for producing other MAPs within the MAC domain. Therefore, some of the statistics related to upstream scheduling is not relevant for other channels, except for the D-PON reference channel.

```
Router# show interface cable 7/0/2 mac-scheduler 0
DOCSIS 1.1 MAC scheduler for Cable7/0/2/U0: rate 15360000
wfq:None
Req Slots 124, Req/Data Slots 13
Init Mtn Slots 2243, Stn Mtn Slots 5
Short Grant Slots 0, Long Grant Slots 0
Adv Phy Short Grant Slots 1, 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 13, init_retries 0
          late_initial_maps 0, late_ucd_maps 0
          mac-phy tss errors 0
! Only the D-PON reference channel will display the following
Queue[Rng Polls] 0/128, 0 drops, flows 0 max 3
Queue[CIR Grants] 0/256, 0 drops, flows 0 max 1
Queue[BE(7) Grants] 0/64, 0 drops, flows 0 max 0
Queue[BE(6) Grants] 0/64, 0 drops, flows 0 max 0
Queue[BE(5) Grants] 0/64, 0 drops, flows 0 max 0
Queue[BE(4) Grants] 0/64, 0 drops, flows 0 max 0
Queue[BE(3) Grants] 0/64, 0 drops, flows 0 max 0
Queue[BE(2) Grants] 0/64, 0 drops, flows 0 max 2
Queue[BE(1) Grants] 0/64, 0 drops, flows 0 max 0
Queue[BE(0) Grants] 0/64, 0 drops, flows 0 max 1
BG pending grant list entries: 0
BG delay list entries: 0
Router# sh interfaces cable 1/0/0 mac-scheduler 0

DOCSIS 1.1 MAC scheduler for Cable1/0/0/U0 : rate 15360000
wfq:None
us_balance:OFF
dpon_mode:OFF
fairness:OFF
Queue[Rng Polls] flows 0
Queue[CIR Grants] flows 0
Queue[BE(07) Grants] flows 0
Queue[BE(06) Grants] flows 0
Queue[BE(05) Grants] flows 0
Queue[BE(04) Grants] flows 0
Queue[BE(03) Grants] flows 0
Queue[BE(02) Grants] flows 0
Queue[BE(01) Grants] flows 0
Queue[BE(00) Grants] flows 0
Req Slots 3075489702, Req/Data Slots 277062737
```



```

Init Mtn Slots 1236108257, Stn Mtn Slots 4010630
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
Avg upstream channel utilization : 0%
Avg percent contention slots : 97%
Avg percent initial ranging slots : 1%
Avg percent minislots lost on late MAPs : 0%

MAP TSS: lch_state 10, init_retries 0
         late_initial_maps 0, late_ucd_maps 0
         mac-phy tss errors 0, missed_ccc 0

```

## Additional References

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

### Related Documents

Related Topic	Document Title
CMTS commands	<a href="#">Cisco IOS CMTS Cable Command Reference</a>
Prisma D-PON	<a href="#">Cisco Prisma D-PON</a>

### Standards

Standards	Title
SCTE IPS SP 910	IPS SP 910 RFoG System <a href="http://www.ieee802.org/3/minutes/nov08/1108_SCTE_IPS_WG5_to_802_3.pdf">http://www.ieee802.org/3/minutes/nov08/1108_SCTE_IPS_WG5_to_802_3.pdf</a>

### Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>

# Feature Information for Upstream Bonding Support for D-PON on the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.


**Note**

The table below 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 64: Feature Information for Upstream Bonding Support for D-PON on the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
Upstream Bonding Support for D-PON	12.2(33)SCE	<p>This feature was introduced for the Cisco uBR10012 and Cisco uBR7200 series Universal Broadband Routers.</p> <p>The following commands are new or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream dpon</b></li> <li>• <b>show interface cable mac-scheduler</b></li> </ul>



## Upstream Channel Bonding

---

**First Published:** November 16, 2009

**Last Updated:** June 16, 2014

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.

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- [Configuration Example for Upstream Channel Bonding](#) , page 512
- [Verifying the Upstream Channel Bonding Configuration](#), page 514
- [Additional References](#), page 519
- [Feature Information for Upstream Channel Bonding](#) , page 521

## 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 65: 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"> <li>• PRE2</li> <li>• PRE4</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20H</li> <li>• Cisco uBR-MC20X20V</li> </ul>
	Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>42</sup></li> </ul>
Cisco uBR7246VXR router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>
Cisco uBR7225VXR router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>42</sup> 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.
- 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 66: 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"> <li>• Annex A (EuroDOCSIS)—5 to 65 MHz</li> <li>• Annex B (DOCSIS, North American)—5 to 42 MHz</li> <li>• Annex B (J-DOCSIS)—5 to 55 MHz</li> </ul>
Cisco uBR10-MC20X20V	55-999 MHz	
Cisco uBR-MC88V	69-999 MHz	
Cisco uBR-MC3GX60V	55-999 MHz <sup>43</sup>	The upstream frequency range for the Cisco uBR-MC3GX60V line card is from 5 to 85 MHz irrespective of the region and Annexure configuration.

<sup>43</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 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 497.
- 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 67: 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 511.



**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](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 68: 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 66: Downstream and Upstream Frequencies, on page 488](#)). 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 66: Downstream and Upstream Frequencies, on page 488](#)).

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 69: 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)

## 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 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 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](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 514.

#### Enabling MTC Mode for All CMs



- Note**
- For DOCSIS 3.1 cable modems, the CMTS router must be configured to use MTC mode.
  - 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	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	<b>Example:</b> Router> <code>enable</code>	Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b>  <b>Example:</b> Router# <code>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> Router(config)# <code>interface cable 7/1/0</code>	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)# <code>cable mtc-mode</code>	Enables MTC mode at the MAC interface for all CMs.
<b>Step 5</b>	<b>end</b>  <b>Example:</b> 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
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> Router> <code>enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b>  <b>Example:</b> Router# <code>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> }	Specifies the cable interface line card on a Cisco CMTS router.



	Command or Action	Purpose
	<b>Example:</b> Router(config)# <b>interface cable</b> 7/1/0	
<b>Step 4</b>	<b>cable upstream bonding-group</b> <i>id</i>  <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> Router(config-if)# <b>end</b>	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
<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> 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.

	Command or Action	Purpose
Step 4	<b>cable upstream bonding-group</b> <i>id</i>  <b>Example:</b> Router(config-if)# <b>cable upstream bonding-group</b> <b>200</b>	Creates the bonding group on the specified interface.
Step 5	<b>upstream</b> <i>number</i>  <b>Example:</b> Router(config-upstream-bonding)# <b>upstream 1</b>	Enters upstream bonding configuration submode and adds an upstream channel to the upstream bonding group.
Step 6	<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 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](http://www.cisco.com/en/US/tech/tk86/tk804/technologies_tech_note09186a00807f32fd.shtml)

## DETAILED STEPS

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

	Command or Action	Purpose
	<b>Example:</b> Router> <b>enable</b>	<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.
<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 cable</b> <i>slot/subslot connector grouplist</i>  <b>Example:</b> Router(config-fiber-node)# <b>upstream cable 5/0 connector 2</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.

### DETAILED STEPS

	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> }	Specifies the cable interface line card on a Cisco CMTS router.

	Command or Action	Purpose
	<b>Example:</b> Router(config)# <b>interface cable 7/1/0</b>	
<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.

### DETAILED STEPS

	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 7/1/0</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.

	Command or Action	Purpose
Step 5	<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.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<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 7/1/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	<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.
Step 5	<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.

### DETAILED STEPS

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

	Command or Action	Purpose
	<p><b>Example:</b>  Router(config-if)# <b>cable sid-cluster-switching max-outstanding-byte 4444</b></p> <p>Router(config-if)# <b>cable sid-cluster-switching max-request 222</b></p> <p>Router(config-if)# <b>cable sid-cluster-switching max-time 444</b></p> <p>Router(config-if)# <b>cable sid-cluster-switching max-total-byte 67890</b></p>	
<b>Step 6</b>	<p><b>end</b></p> <p><b>Example:</b>  Router(config-if)# <b>end</b></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
<b>Step 1</b>	<p><b>enable</b></p> <p><b>Example:</b>  Router&gt; <b>enable</b></p>	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<p><b>configure terminal</b></p> <p><b>Example:</b>  Router# <b>configure terminal</b></p>	Enters global configuration mode.

	Command or Action	Purpose
<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 7/1/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable init-channel-timeout</b> <i>value</i>  <b>Example:</b> Router(config-if)# <b>cable init-channel-timeout 160</b>	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.

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
<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
Step 3	<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 7/1/0</b>	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	<b>cable upstream resiliency</b> { <b>channel-down-detect</b> <i>number</i>   <b>modem-offline-detect</b> <i>number</i>   <b>on-failure</b> { <b>disable-channel</b>   <b>extended-ranging</b>   <b>reset-modem</b> }   <b>sf-move</b> { <b>NRTPS</b>   <b>RTPS</b>   <b>UGS</b>   <b>UGS-AD</b> } }  <b>Example:</b> Router(config-if)# <b>cable upstream resiliency channel-down-detect 30</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> Router(config-if)# <b>cable upstream resiliency sf-move UGS</b> Router(config-if)# <b>cable upstream resiliency sf-move UGS-AD</b>	Configures upstream resiliency for bonded upstream service flows.
Step 5	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	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	<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>

	Command or Action	Purpose
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <code>configure terminal</code>	Enters global configuration mode.
Step 3	<b>cable upstream rate-limit-ccf [aggregated-burst value   aggregated-throughput value   cpu-burst value   cpu-threshold value]</b>  <b>Example:</b> 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"> <li>• <b>aggregated-burst value</b>—(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.</li> <li>• <b>aggregated-throughput value</b>—(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.</li> <li>• <b>cpu-burst value</b>—(Optional) Specifies the CPU burst for CCF in percentage. The valid range is from 0 to 100. The default value is 10.</li> <li>• <b>cpu-threshold value</b>—(Optional) Specifies the CPU threshold for CCF in percentage. The valid range is from 0 to 100. The default value is 50.</li> </ul>
Step 4	<b>end</b>  <b>Example:</b> 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](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	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<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> 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
Step 4	<b>cable upstream bonding-group</b> <i>id</i>  <b>Example:</b> Router(config-if)# <b>cable upstream bonding-group</b> 200	Creates the bonding group on the specified cable interface and enters the upstream bonding configuration mode.
Step 5	<b>attributes</b> <i>value</i>  <b>Example:</b> Router(config-upstream-bonding)# <b>attributes</b> eeeeeeee	Modifies the attribute value for the specified bonding group.
Step 6	<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 491 .



**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
<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> 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream ranging-poll</b> [interval value   t4-multiplier timeout_value]  <b>Example:</b> Router(config-if)# <b>cable upstream ranging-poll</b> interval 24000 t4-multiplier 4	Specifies the ranging poll interval for upstream channels.  <b>Note</b> If <b>t4-multiplier timeout_value</b> 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.
<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 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**

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

	<b>Command or Action</b>	<b>Purpose</b>
<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</b> 7/1/0	Specifies the cable interface line card on a Cisco CMTS router.
<b>Step 4</b>	<b>cable upstream ext-power</b>  <b>Example:</b> Router(config-if)# <b>cable upstream ext-power</b>	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> Router(config-if)# <b>end</b>	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.6bfb.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.6bfb.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> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
DOCSIS 3.0 Downstream Channel Bonding	<i>Cisco Cable Wideband Solution Design and Implementation Guide</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html">http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html</a>

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><a href="http://www.cisco.com/en/US/docs/interfaces_modules/cable/broadband_processing_engines/ubr10_mc5x20s_u_h/installation/guide/ubrmc520.html">http://www.cisco.com/en/US/docs/interfaces_modules/cable/broadband_processing_engines/ubr10_mc5x20s_u_h/installation/guide/ubrmc520.html</a></p>
Dynamic Bandwidth Sharing	<p><i>Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC</i></p> <p><a href="http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_dyn_bw_sharing_ps2209_TSD_Products_Configuration_Guide_Chapter.html">http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_dyn_bw_sharing_ps2209_TSD_Products_Configuration_Guide_Chapter.html</a></p>
Upstream Scheduler Mode	<p><i>Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC</i></p> <p><a href="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</a></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"> <li>• DOCS-IF3-MIB</li> <li>• DOCS-SUBMGT3-MIB</li> <li>• CLAB-TOPO-MIB</li> </ul>	<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><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></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><a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a></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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**


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The table below 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 70: 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"> <li>• <a href="#">Information About Upstream Channel Bonding</a>, on page 487</li> <li>• <a href="#">How to Configure Upstream Channel Bonding</a>, on page 497</li> <li>• <a href="#">Configuration Example for Upstream Channel Bonding</a>, on page 512</li> </ul> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable mtc-mode</b></li> <li>• <b>cable mrc-mode</b></li> <li>• <b>cable upstream bonding-group</b></li> <li>• <b>cable upstream resiliency</b></li> <li>• <b>cable upstream ranging-poll</b></li> <li>• <b>clear cable modem cm-status</b></li> <li>• <b>debug cable cm-ctrl</b></li> <li>• <b>debug cable cm-status</b></li> <li>• <b>debug cable mdd</b></li> <li>• <b>debug cable md-sg</b></li> <li>• <b>debug cable ubg</b></li> <li>• <b>show cable fiber-node</b></li> <li>• <b>show cable flap-list</b></li> <li>• <b>show cable mac-domain upstream-service-group</b></li> </ul>

Feature Name	Releases	Feature Information
		<ul style="list-style-type: none"> <li>• <b>show cable modem cnr</b></li> <li>• <b>show cable signal-quality</b></li> <li>• <b>show interface cable service-flow</b></li> <li>• <b>show interface cable upstream</b></li> <li>• <b>upstream</b></li> <li>• <b>upstream cable connector</b></li> </ul>
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"> <li>• <b>cable upstream rate-limit-ccf</b></li> <li>• <b>show cable rate-limit-ccf</b></li> </ul>
SID Tracking	12.2(33)SCC	<p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>debug cable interface sid</b></li> <li>• <b>show interface cable upstream debug</b></li> </ul>
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"> <li>• <b>cable upstream qos wfq</b></li> <li>• <b>show interface cable mac-scheduler</b></li> </ul>

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"> <li>• <b>interface cable</b></li> <li>• <b>show interface cable</b></li> <li>• <b>show running-config interface cable</b></li> </ul>
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"> <li>• <b>cable tx-power-headroom</b></li> <li>• <b>cable upstream max-channel-power-offset</b></li> </ul>
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"> <li>• <b>cable upstream ext-power</b></li> <li>• <b>show cable modem extended-power</b></li> </ul>

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"> <li>• <b>cable upstream resiliency sf-move</b></li> </ul>
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"> <li>• <b>cable upstream resiliency data-burst polling-interval</b></li> </ul>



## CHAPTER 20

# Upstream Scheduler Mode for the Cisco CMTS Routers

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**First Published:** December 18, 2008

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### Note

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Cisco IOS Release 12.2(33)SCA integrates support for the Upstream Scheduler Mode feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

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This document describes how to configure optional upstream (US) scheduler modes.

With this feature, you can select Unsolicited Grant Services (UGS), Real Time Polling Service (rtPS) or Non-Real Time Polling Service (nrtPS) scheduling types, as well as packet-based or Time Division Multiplex (TDM) based scheduling. Low latency queueing (LLQ) emulates a packet-mode-like operation over the TDM infrastructure of DOCSIS. As such, the feature provides the typical trade-off between packets and TDM. With LLQ, you have more flexibility in defining service parameters for UGS, rtPS or nrtPS, but with no guarantee (other than statistical distribution) regarding parameters such as delay and jitter.

### 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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- [Information About Upstream Scheduler Mode for the Cisco CMTS Routers](#), page 529

- [How to Configure Upstream Scheduler Modes, page 531](#)
- [How to Configure Exempted Priority for BRRL feature, page 532](#)
- [Additional References, page 533](#)
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## Prerequisites for the Upstream Scheduler Mode for the Cisco CMTS Routers

The table below shows the hardware compatibility prerequisites for this feature.

**Table 71: Upstream Scheduler Mode for the Cisco CMTS Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• PRE2</li> </ul>	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul>
	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE4</li> </ul>	Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• CiscoUBR-MC20X20V</li> </ul>
	Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCE and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC3GX60V<sup>44</sup></li> </ul>
Cisco uBR7246VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCA and later releases <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCA <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>
		Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V<sup>45</sup></li> </ul>

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	<p>Cisco IOS Release 12.2(33)SCA and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> <p>Cisco IOS Release 12.2(33)SCB and later releases</p> <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	<p>Cisco IOS Release 12.2(33)SCA releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul> <p>Cisco IOS Release 12.2(33)SCD and later releases</p> <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

<sup>44</sup> Cisco uBR-MC3GX60V cable interface line card is not compatible with PRE2.

<sup>45</sup> Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2.

## Restrictions for Upstream Scheduler Mode for the Cisco CMTS Routers

- To ensure proper operation, Call Admission Control (CAC) must be enabled. When the LLQ option is enabled, it is possible for the upstream path to be filled with so many calls that it becomes unusable, making voice quality unacceptable. CAC must be used to limit the number of calls to ensure acceptable voice quality, as well as to ensure traffic other than voice traffic.
- Even if CAC is not enabled, the default (DOCSIS) scheduling mode blocks traffic after a certain number of calls.
- UGS with Activity Detection (UGS-AD) is not supported by the LLQ scheduler mode but remains supported by the default DOCSIS scheduler mode.
- Upstream bandwidth request rate limiting feature is supported only on the Cisco UBR-MC20X20V, Cisco uBR-MC3GX60V, Cisco uBR-MC88V, and Cisco uBR-MC5X20H cable interface line cards.

## Information About Upstream Scheduler Mode for the Cisco CMTS Routers

With UGS, a service flow is created that enables a cable modem to transmit fixed-size bursts of data at a guaranteed rate and with a guaranteed level of jitter by providing periodic transmission opportunities to the cable modem for fixed-sized frames. This kind of service flow is particularly suitable for VoIP applications.

With rtPS, a service flow is created that provides a periodic opportunity for a cable modem to request permission to transmit data by polling a single cable modem for a bandwidth request, rather than all the cable modems. This satisfies applications that have a requirement for real-time data transmission, and enables the cable

modem to transmit data bursts of varying length. This kind of service flow is particularly suitable for MPEG VoIP.

Starting with Cisco IOS Release 12.2(33)SCG, rtPS requests, by default, are internally treated as priority 7—the highest priority for all Best Effort traffic. This high priority reduces the latency of rtPS traffic under congestion.

With nrtPS, a service flow is created that provides a periodic opportunity for a cable modem to request permission to transmit data by polling a single cable modem for a bandwidth request, rather than all the cable modems. The data bursts may be of varying length. This kind of service flow is particularly suitable for non-interactive services such as file transfers.

## Upstream Peak Traffic Rate

The Cisco uBR10012 universal broadband routers support upstream traffic peak rates (DOCSIS 3.0 TLV 24.27). This feature is supported on the Cisco uBR10012 universal broadband routers with the Cisco uBR10-MC5X20H and Cisco UBR-MC20X20V cable interface line cards and supports DOCSIS 2.0 and DOCSIS 3.0 cable modems. The upstream peak traffic rate is configured using the cable service class command. To view the peak traffic rate value for a specific service flow, use the **show cable modem qos verbose** and **show cable service-class verbose** commands.

Some of the DOCSIS 1.x and DOCSIS 2.0 cable modems, which are not fully DOCSIS 1.x or DOCSIS 2.0 compliant, may fail to come online when they receive upstream peak rate TLV 24.27 from the Cisco CMTS. To overcome this, you can configure the **cable service attribute withhold-TLVs** command with **peak-rate** keyword to restrict sending of this type, length, value (TLV) to non-DOCSIS 3.0 cable modems.

## Upstream Bandwidth Request Rate Limiting

The Cisco CMTS US scheduler may report high CPU consumption because of extensive incoming bandwidth request processing. The Cisco IOS Release 12.2(33)SCF introduces the upstream Bandwidth Request Rate Limiting (BRRL) feature, which controls the CPU consumption of the US scheduler by monitoring the number of incoming bandwidth requests, and dropping excessive bandwidth requests.



### Note

Only the best effort (BE) service flows are subjected to bandwidth request rate limiting.

By default, the BRRL feature is enabled for the Cisco uBR-MC3GX60V line card.

By default, all the bandwidth requests with service flow priority from 0 to 7 are processed by the BRRL feature. However, the BRRL feature also enables you to configure a service flow priority that is exempted from BRRL. Any bandwidth request received with this configured priority or above, is exempted from BRRL processing and is therefore not dropped even if the CPU consumption by the US scheduler is high. For example, if the configured exempted priority is 5, any bandwidth request with priority 5, 6, or 7 is not dropped even if the CPU consumption is high.

Use the **cable upstream rate-limit-bwreq exempted-priority** command to configure the exempted service flow priority. If the **exempted-priority** is set to value zero, all the bandwidth requests are exempted from rate limiting, or in other words BRRL feature is disabled.



# How to Configure Upstream Scheduler Modes

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	Use one the following commands:  <ul style="list-style-type: none"> <li>• <b>interface cable</b> <i>slot/subslot/port</i></li> <li>• <b>interface cable</b> <i>slot/port</i></li> </ul> <b>Example:</b> Router(config)# <b>interface cable</b> 5/1	Enters interface configuration mode for the specified cable interface.
Step 4	<b>cable upstream</b> <i>n</i> <b>scheduling type</b> <i>ugs mode</i> [ <b>llq</b>   <b>docsis</b> ]  <b>Example:</b> Router(config-if)# <b>cable upstream</b> 4 <b>scheduling type</b> <i>ugs mode llq</i>	Enables LLQ-type (packet-based) scheduling for UGS services.  <b>Note</b> Any combination of <b>ugs</b> , <b>rtps</b> , <b>nrtps</b> , <b>llq</b> , and <b>docsis</b> is allowed. The only default value is <b>docsis</b> .
Step 5	<b>cable upstream</b> <i>n</i> <b>scheduling type</b> <i>rtps mode</i> [ <b>llq</b>   <b>docsis</b> ]  <b>Example:</b> Router(config-if)# <b>cable upstream</b> 4 <b>scheduling type</b> <i>rtps mode docsis</i>	Enables standard DOCSIS (TDM-based) scheduling for rtPS services.  <b>Note</b> Any combination of <b>ugs</b> , <b>rtps</b> , <b>nrtps</b> , <b>llq</b> , and <b>docsis</b> is allowed. The only default value is <b>docsis</b> .
Step 6	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Exits interface configuration mode and returns to privileged EXEC mode.

### What to Do Next

To confirm whether the scheduler is operating in LLQ or DOCSIS mode, use the **show interface cable mac-scheduler** command. A new queue is added when LLQ mode is enabled, as shown in the following example:

```
Router# show interface cable 4/0 mac-scheduler 0
DOCSIS 1.1 MAC scheduler for Cable4/0/U0
```

```

Queue[Rng Polls] 0/128, 0 drops, max 1
Queue[CIR Grants] 0/64, 0 drops, max 0
Queue[BE(7) Grants] 0/64, 0 drops, max 0
Queue[BE(6) Grants] 0/64, 0 drops, max 0
Queue[BE(5) Grants] 0/64, 0 drops, max 0
Queue[BE(4) Grants] 0/64, 0 drops, max 0
Queue[BE(3) Grants] 0/64, 0 drops, max 0
Queue[BE(2) Grants] 0/64, 0 drops, max 0
Queue[BE(1) Grants] 0/64, 0 drops, max 0
Queue[BE(0) Grants] 0/64, 0 drops, max 0

!This queue is added in LLQ Mode
Queue[LLQ Grants] 0/64, 0 drops, max 0
  Req Slots 153607143, Req/Data Slots 0
  Init Mtn Slots 1305584, Stn Mtn Slots 145897
  Short Grant Slots 47, Long Grant Slots 2939
  ATDMA Short Grant Slots 0, ATDMA Long Grant Slots 0
  ATDMA UGS Grant Slots 0
  Awacs Slots 0
  Fragmentation count 3
  Fragmentation test disabled
  Avg upstream channel utilization : 0%
  Avg percent contention slots : 98%
  Avg percent initial ranging slots : 1%
  Avg percent minislots lost on late MAPs : 0%
  Sched Table Adm-State: Grants 0, Reqpolls 0, Util 1%
  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       : 2 SIDs, Reservation-level in bps 0
  r4k ticks in lms 131000
  Total scheduling events 0
  No search was needed 0
  Previous entry free 0
  Next entry free0
  Could not schedule 0
  Recovery failed 0
  Curr time 8282 entry 90

```

## How to Configure Exempted Priority for BRRL feature

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable upstream rate-limit-bwreq exempted-priority <i>priority</i></b>	Configures the exempted priority: <ul style="list-style-type: none"> <li>• <i>priority</i>—Service flow priority. Bandwidth requests with this service flow priority value (and above) are exempted from BRRL. The valid range is from 0 to 7.</li> </ul>

	Command or Action	Purpose
	<b>Example:</b> <pre>Router(config)# cable upstream rate-limit-bwreq exempted-priority 5</pre>	
<b>Step 4</b>	<b>end</b>  <b>Example:</b> <pre>Router(config)# end</pre>	Exits configuration mode and returns to privileged EXEC mode.

## Additional References

The following sections provide references related to the Cisco CMTS routers.

### Related Documents

Related Topic	Document Title
Cisco CMTS command reference	<i>Cisco CMTS Cable Command Reference</i> <a href="http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html">http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html</a>

### Standards

Standard	Title
DOCSIS	Data-Over-Cable Service Interface Specifications, DOCSIS 2.0, Radio Frequency Interface Specification, CM-SP-RFIV2.0-I08-050408

### Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

# Feature Information for Upstream Scheduler Mode for the Cisco CMTS Routers

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.



## Note

The table below 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 72: Feature Information for Upstream Scheduler Mode for the Cisco CMTS Routers**

Feature Name	Releases	Feature Information
Upstream Scheduler Mode for the Cisco CMTS Routers	12.3(13)BC	This feature was introduced for all Cisco CMTS routers. The <b>cable upstream scheduling type</b> command was introduced.
Upstream Scheduler Mode for the Cisco CMTS Routers	12.2(33)SCA	This feature was integrated into Cisco IOS Release 12.2(33)SCA. Support for the Cisco uBR7225VXR universal broadband router was added.
Upstream Peak Traffic Rate	12.2(33)SCC	The upstream peak rate traffic (DOCSIS 3.0 TLV 24.27) is supported on Cisco uBR10012 universal broadband routers.  The following command outputs display the upstream peak traffic rate: <ul style="list-style-type: none"> <li>• <b>show cable modem qos verbose</b></li> <li>• <b>show cable service-class verbose</b></li> </ul>

Feature Name	Releases	Feature Information
Suppressing Downstream and Upstream Peak Rate TLVs for pre DOCSIS 3.0 Cable Modems	12.2(33)SCB10	This feature restricts sending of the DOCSIS 3.0 TLVs to DOCSIS 1.x and DOCSIS 2.0 cable modems.  The <b>cable service attribute withhold-TLVs</b> command was introduced.
Upstream Bandwidth Request Rate Limiting	12.2(33)SCF	In the Cisco IOS Release 12.2(33)SCF, this feature was introduced for all Cisco CMTS routers.  The <b>cable upstream rate-limit-bwreq exempted-priority</b> command was introduced.





# Upstream Utilization Optimization on the Cisco CMTS Routers

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**First Published:** May 12, 2008

**Last Updated:** December 17, 2009

The Upstream Utilization Optimization feature on the Cisco Cable Modem Termination System (CMTS) provides higher upstream throughput.



**Note**

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Cisco IOS Release 12.2(33)SCB integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

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## 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 Utilization Optimization, page 538](#)
- [Information about Upstream Utilization Optimization, page 539](#)
- [How to Configure Upstream Utilization Optimization, page 539](#)
- [Additional References, page 542](#)
- [Feature Information for Upstream Utilization Optimization, page 543](#)

## Prerequisites for Upstream Utilization Optimization

You must have Advanced Time Division Multiple Access (A-TDMA)-capable line cards.

For optimum performance, do the following:

- Set the maximum upstream burst on the cable modem to a large number; for example, 28,000 bytes.
- Set the maximum concatenation burst on the cable modem to a large number; for example, 28,000 bytes.
- Set the cable modem upstream maximum traffic burst parameter to a large number (for example, zero means no limit) using the **cable default-phy-burst** command.

The Upstream Utilization Optimization feature is supported on the Cisco CMTS routers in Cisco IOS Release 12.3BC and 12.2SC. The table below shows the hardware compatibility prerequisites for this feature.

**Table 73: Upstream Utilization Optimization Hardware Compatibility Matrix**

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.3(23)BC2 <ul style="list-style-type: none"> <li>• PRE-1</li> <li>• PRE-2</li> </ul> Cisco IOS Release 12.2(33)SCB <ul style="list-style-type: none"> <li>• PRE-2</li> <li>• PRE-4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.3(23)BC2 <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul> Cisco IOS Release 12.2(33)SCB <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul>
Cisco uBR7200 Series Universal Broadband Routers	Cisco IOS Release 12.3(23)BC2 <ul style="list-style-type: none"> <li>• NPE-G1</li> </ul> Cisco IOS Release 12.2(33)SCB <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.3(23)BC 2 <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul> Cisco IOS Release 12.2(33)SCB <ul style="list-style-type: none"> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>



CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCB <ul style="list-style-type: none"> <li>• NPE-G1</li> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCB <ul style="list-style-type: none"> <li>• Cisco uBR-E-28U</li> <li>• Cisco uBR-E-16U</li> <li>• Cisco uBR-MC28U/X</li> <li>• Cisco uBR-MC16U/X</li> </ul>

## Information about Upstream Utilization Optimization

Upstream utilization optimization provides the following benefits and functions on a Cisco CMTS router:

- Group configuration mode enables upstream utilization optimization eligibility on all cable modem upstream flows.
- Local configuration mode enables upstream utilization optimization eligibility on a specific upstream, provides configuration of selective parameters, and provides that local configuration overrides any global configuration.

## How to Configure Upstream Utilization Optimization

The following tasks describe how to configure the Upstream Utilization Optimization feature:

### Configuring Upstream Utilization Optimization Globally

By default, the Upstream Utilization Optimization feature is turned off. To globally enable upstream utilization optimization, use the **cable upstream rate-adapt** command in global configuration mode. All upstream flows created after this feature is enabled globally are eligible to rate-adapt. Using the **priority** or **rate** option allows you to restrict upstream utilization optimization to service flows that meet or exceed specified levels for priority or rate.

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<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 upstream rate-adapt</b> [ <b>local</b>   <b>priority value</b>   <b>rate number</b> ]  <b>Example:</b> <pre>Router(config)# cable upstream rate-adapt priority 6</pre>	Enables upstream utilization optimization globally on all upstream flows. <ul style="list-style-type: none"> <li>• <b>local</b>—(Optional) Enables upstream utilization optimization eligibility and configuration for a specific upstream flow.</li> <li>• <b>priority</b>—(Optional) Enables upstream utilization optimization on flows that meet or exceed a configured priority. The valid range is 0–7.</li> <li>• <b>rate</b>—(Optional) Enables upstream utilization optimization on flows that meet or exceed a specified minimum max-rate. The valid range is 0–30000000.</li> </ul>

## Configuring Upstream Utilization Optimization Locally Per Upstream

To configure a specific local upstream for upstream utilization optimization, use the **cable upstream rate-adapt** command in cable interface configuration mode for a specified upstream flow. You can configure several parameters for specific local upstream utilization optimization. By default, upstream utilization optimization uses the global configuration. However, when rate-adapt is configured on a local upstream, the local configuration parameters override the global configuration parameters.

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b>  <b>Example:</b> <pre>Router&gt; enable</pre>	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> <pre>Router# configure terminal</pre>	Enters global configuration mode.
<b>Step 3</b>	<b>interface cable</b>  <b>Example:</b> <pre>Router(config)#: interface cable 4/0/0</pre>	Enters cable interface configuration mode.
<b>Step 4</b>	<b>cable upstream port rate-adapt</b> [ <b>bcs slots</b>   <b>duration millisecs</b>   <b>fcms-off</b>   <b>priority value</b>   <b>rate number</b> ]	Enables upstream utilization optimization configuration on specific upstream flows. <ul style="list-style-type: none"> <li>• <b>bcs</b>—(Optional) Specifies the number of broadcast contention minislots (BCS). MAPs that have gaps are filled with BCS. By default, 10 BCS slots</li> </ul>

	Command or Action	Purpose
	<p><b>Example:</b></p> <pre>Router(config-if)# cable upstream 0 rate-adapt priority 6</pre>	<p>are saved. You can override the default of 10 with a larger or smaller number. The valid range is 0–80. The default is 10.</p> <ul style="list-style-type: none"> <li>• <b>duration</b>—(Optional) Enables configuration of the duration of a flow rate-adapt in milliseconds. You can override the default of one second for rate-adapt grants to a flow. A larger or smaller duration can be chosen. The valid range is 0–2000.</li> <li>• <b>fcms-off</b>—(Optional) Enables an override to the default forced broadcast contention minislot that follows each filled MAP. By default, fcms is turned on.</li> <li>• <b>priority</b>—(Optional) Enables upstream utilization optimization on flows that meet or exceed a configured priority. This overrides a globally configured rate-adapt priority. The valid range is 0–7.</li> <li>• <b>rate</b>—(Optional) Enables upstream utilization optimization on flows that meet or exceed a specified minimum max-rate. This overrides a globally configured rate-adapt rate. The valid range is 0–30000000.</li> </ul>

## Verifying Upstream Utilization Optimization Configuration

To verify the cable upstream utilization optimization configuration for cable modem upstream, use the **show** commands described below.

- To display upstream utilization optimization parameters, use the **show cable rate-adapt** command as shown in the following example. Global upstream utilization optimization is enabled, local upstream utilization optimization is disabled. The duration is 500 and there is no rate or priority configured.

```
router# show cable rate-adapt
show_cable_rate-adapt_command: Global:Enabled Local-Only:Disabled
:maps 500 Flags 0x1 priority -1, rate -1 bcs 10 fcms On
```

- To display the upstream utilization optimization settings and the parameters for a specific upstream, use the **show interface cable upstream** command as shown in the following example. On upstream 0, global and local upstream utilization optimization are enabled, the duration is 250, priority is 255, bcs is set to 0, rate is not configured, and the fcms feature is turned off.

```
router# show interface cable 8/0/0 upstream 0 rate-adapt
cmts_rate-adapt_show: Global:Enabled US[0]:Enabled
local:maps 250 pri 255, rate -1 bcs 0 (0) fcms Off
```

- To display service identifier (SID) and upstream utilization optimization information for a service flow, use the **show interface cable sid** command with the **counter** and **verbose** options as shown in the following example. On 8/0/0, upstream utilization optimization is enabled, 35542 rate-adapt requests were received, and there was one piggy-back request received from the upstream.

```
router# show interface cable 8/0/0 sid counters verbose
Sid : 1
Request polls issued : 0
BWReqs {Cont,Pigg,RPoll,Other} : 7, 146975, 0, 0
No grant buf BW request drops : 0
```

```

Rate exceeded BW request drops : 0
Grants issued : 1264300
Packets received : 2199040
Bytes received : 3241369899
rate-adapt : Enabled
rate-adapt {rcvd, Consec-PB} : 35542, 1
Fragment reassembly completed : N/A
Fragment reassembly incomplete : N/A
Concatenated packets received : N/A
Queue-indicator bit statistics : 0 set, 0 granted
Good Codewords rx : 14615740
Corrected Codewords rx : 1
Uncorrectable Codewords rx : 0
Concatenated headers received : 146807
Fragmentation headers received : 1296069
Fragmentation headers discarded: 240

```

## Additional References

The following sections provide references related to the Upstream Utilization Optimization feature on the Cisco CMTS routers.

### Related Documents

Related Topic	Document Title
Cable commands	<i>Cisco IOS CMTS Cable Command Reference</i> , <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
Line card configuration information	<ul style="list-style-type: none"> <li>• <i>Configuring the Cisco uBR10-MC5X20U/H Broadband Processing Engine</i> <a href="http://www.cisco.com/en/US/docs/interfaces_modules/cable/broadband_processing_engines/ubr10_mc5x20s_u_h/feature/guide/mc5x20u.html">http://www.cisco.com/en/US/docs/interfaces_modules/cable/broadband_processing_engines/ubr10_mc5x20s_u_h/feature/guide/mc5x20u.html</a></li> </ul>

Related Topic	Document Title
Software configuration information	<ul style="list-style-type: none"> <li>• <i>Cisco IOS CMTS Cable Software Configuration Guide, Release 12.2SC</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/12_2sc/cbl_12_2sc_book.html">http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/12_2sc/cbl_12_2sc_book.html</a></li> <li>• <i>Cisco uBR10012 Universal Broadband Router Software Configuration Guide</i> (for Cisco IOS Release 12.3BC) <a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/configuration/guide/scg.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/configuration/guide/scg.html</a></li> <li>• <i>Cisco uBR7200 Series Software Configuration Guide</i> (for Cisco IOS Release 12.3BC) <a href="http://www.cisco.com/en/US/docs/cable/cmts/ubr7200/configuration/guide/cr72scg.html">http://www.cisco.com/en/US/docs/cable/cmts/ubr7200/configuration/guide/cr72scg.html</a></li> </ul>

### 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/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

## Feature Information for Upstream Utilization Optimization

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**

The table below 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 74: Feature Information for Upstream Utilization Optimization**

Feature Name	Releases	Feature Information
Upstream Utilization Optimization	12.3(23)BC2	<p>This feature was introduced and provides increased upstream CM throughput.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable upstream rate-adapt (global)</b></li> <li>• <b>cable upstream rate-adapt (interface)</b></li> <li>• <b>show cable rate-adapt</b></li> <li>• <b>show interface cable sid</b></li> <li>• <b>show interface cable upstream</b></li> </ul>
Upstream Utilization Optimization	12.2(33)SCB	This feature was integrated into Cisco IOS Release 12.2(33)SCB.



## Wideband Modem Resiliency

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The Wideband Modem Resiliency feature provides reliable service in the event of non-primary RF channel disruptions to ensure that a cable modem remains operational. With the implementation of this feature, the Cable Modem Termination System (CMTS) does not force a cable modem to perform a MAC reset if the cable modem loses connectivity to the CMTS on one or all of its non-primary RF channels.

### 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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## Prerequisites for Wideband Modem Resiliency

The table below shows the hardware compatibility prerequisites for the Wideband Modem Resiliency feature.

**Table 75: Cable Hardware Compatibility Matrix for Wideband Modem Resiliency**

CMTS Platform	Processor Engine	Cable Interface Line Cards
Cisco uBR10012 Universal Broadband Router	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• PRE2</li> <li>• PRE4</li> </ul> Cisco IOS Release 12.2(33)SCH and later releases <ul style="list-style-type: none"> <li>• PRE5</li> </ul>	Cisco IOS Release 12.2(33)SCB and later releases <ul style="list-style-type: none"> <li>• Cisco uBR10-MC5X20S/U/H</li> </ul> Cisco IOS Release 12.2(33)SCC and later releases <ul style="list-style-type: none"> <li>• Cisco UBR-MC20X20V</li> </ul>
Cisco uBR7225VXR Universal Broadband Router	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>
Cisco uBR7246VXR Universal Broadband Routers	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• NPE-G2</li> </ul>	Cisco IOS Release 12.2(33)SCD and later releases <ul style="list-style-type: none"> <li>• Cisco uBR-MC88V</li> </ul>

## Restrictions for Wideband Modem Resiliency

- This feature provides resiliency support only for downstream RF channel disruptions in Cisco IOS Release 12.2(33)SCB and later releases. This feature does not support any upstream-related resiliency.
- The CMTS cannot move a w-online cable modem to a bonding group that contains an RF channel that is not a member of the original Receive Channel Configuration (RCC) for the wideband cable modem.

## Information About Wideband Modem Resiliency

The Wideband Modem Resiliency feature enables the Cisco uBR10012 or Cisco uBR7200 series router to interact with DOCSIS 3.0-compliant cable modems. This interaction helps provide reliable service in the event of non-primary channel disruptions of layer 1 and/or layer 2 connections, and loss of quadrature amplitude modulation (QAM) lock and/or MAC Domain Descriptor (MDD) timeout. If a cable modem loses connectivity with the CMTS on one or all of its non-primary RF channels, the CMTS does not force the cable modem to perform a MAC reset and enables the cable modem to remain operational.

A DOCSIS 3.0-qualified CMTS transmits data to one or more DOCSIS 3.0-compliant cable modems using multiple RF channels. For a cable modem, one of the RF channels is used as the primary RF channel, and the rest of the channels are considered non-primary channels. The primary RF channel is defined as the downstream (DS) RF channel on which the cable modem receives DOCSIS MAC messages needed for upstream timing and synchronization.



This feature enables the CMTS to collect and analyze data related to RF channel disruptions per cable modem to assist in identifying the impairment.

## CM-STATUS Messages

Cable modems use CM-STATUS messages to report events to the CMTS. A DOCSIS 3.0-compliant cable modem does not perform a MAC reset when reporting DS RF channel failures through CM-STATUS messages. The CMTS does not send an acknowledgement to the cable modem when it receives a CM-STATUS message. The CMTS might not receive a CM-STATUS message, if the message gets corrupted during transmission. To prevent this occurrence, the CMTS sends the following two parameters to the cable modem using the primary MDD message for each event type:

- Maximum reports
- Maximum hold-off time

The maximum reports parameter specifies how many reports should be sent each time a particular event occurs. The maximum hold-off time parameter defines the amount of time (in units of 20 milliseconds) a cable modem should wait between transmissions of the CM-STATUS messages when the maximum reports parameter is greater than one.

## RF Channel Event Dampening Time

The Wideband Modem Resiliency feature enables the CMTS to reduce the occurrence of a particular RF channel event by using the **cable rf-change-dampen-time** command. This command can also be used to prevent premature cable modem reconfiguration in the event of a prolonged outage. For example, the failover time of a remote edge-QAM device (EQAM) may be 10 seconds. Using the **cable rf-change-dampen-time** command, you can specify the dampening time such that an EQAM failover does not inadvertently trigger a mass reconfiguration of wideband cable modems.

## Response of CMTS to RF Impairment Recovery

When cable modems report the recovery from downstream RF channel failures and their default downstream service flow has been moved to their primary downstream channel, the response of the CMTS is different between the following two Cisco IOS releases:

- Cisco IOS Release 12.2(33)SCB and later releases—If a cable modem reports that full service has been restored after downstream RF channel failures, the CMTS forces the cable modem to perform a MAC reset.
- Cisco IOS Release 12.2(33)SCC and later releases—If a cable modem reports that full service has been restored, the CMTS does not force the cable modem to perform a MAC reset, and the cable modem is kept w-online (the wideband downstream service is restored by the original wideband interface without a MAC reset).

## Trigger Thresholds for Downstream Events

When a cable modem reports a downstream channel impairment via a CM-STATUS message, the cable modem can no longer reliably receive data on that channel. The Cisco CMTS must not use that channel to transmit data to the cable modem. The Cisco CMTS uses the following three options to prevent the use of the impaired channel(s):

- Option 1—Suspend the RF channel(s) from the wideband interface used by that cable modem.
- Option 2—Move the default downstream service flow from its wideband interface to its primary channel interface (modular or cable).
- Option 3—Move all the downstream service flows (primary and unicast secondary service flows) from its wideband interface to its primary channel interface (modular or cable).

Choosing option 1 retains all the remaining operational DS channels active, option 2 retains only a single DS channel, and option 3 retains all DS channels. Option 1 affects all cable modems that are receiving service via the affected wideband interface, while options 2 and 3 only affect the cable modem reporting the impairment.

To control which option the Cisco CMTS uses when an RF impairment is reported, use the **cable rf-change-trigger** command. This command enables you to configure thresholds (percent and count) for an event before the event triggers an action for the cable modem. This command also enables you to configure a secondary keyword to move all the secondary downstream service flows of a cable modem to the primary channel interface.

Because the CM-STATUS messages are received sequentially, the decision to use options 1, 2, or 3 is made based on whether the trigger threshold is reached or not, and if the secondary keyword is configured. The table below lists the **cable rf-change-trigger** command conditions and the corresponding options selected by the Cisco CMTS.

**Table 76: Conditions for Selecting RF Impairment Handling Options**

<b>rf-change-trigger Threshold Reached</b>	<b>secondary Keyword Configured</b>	<b>RF Impairment Handling Option Selected by the Cisco CMTS</b>
YES	NA	Option 1
NO	NO	Option 2
NO	YES	Option 3



### Note

Before the rf-change-trigger count has reached, FrwdIF moves to the NB primary interface and only after the rf-change-trigger count has reached, FrwdIF moves to the WB interface. Do not move the previous FrwdIF from NB primary interface to WB Interface.

If the trigger thresholds for an event are not configured, the state of the non-primary RF channels always remains up, and the cable modems that report RF failures are reset after the dampening time specified in the **cable rf-change-dampen-time** command expires. If both thresholds are configured, then both the thresholds must be reached before changing the RF channel state to down.

In addition to not meeting the configured `rf-change-trigger`, a cable modem that reports impairments has its downstream service flows modified in option 2 or option 3, to provide reliable service in the following conditions:

- If the count exceeds the specified number of cable modems but the percent threshold is not reached.
- If the percent threshold is reached but the count does not reach the specified number of cable modems.
- If all non-primary channels of the cable modem are reported down.

Additionally with option 3, only those unicast secondary service flows (static or dynamic) which share the same wideband interface as the primary service flow, are moved to the primary channel interface (modular or cable). Any new dynamic service flows are created on the primary channel interface.

A suspended RF channel is restored for all affected wideband interfaces when a specified number of cable modems report (via `CM-STATUS`) that the channel connectivity is restored. The Wideband Modem Resiliency feature defines the specified number of cable modems as half of the configured count or percentage of `rf-change-trigger`, or both. For example, if the count is 20 and the percent is 10, then the number of cable modems reporting recovery should reduce the count to 10 and the percent to 5 for the suspended RF channel to be restored.

When either option 2 or option 3 is chosen by the Cisco CMTS, the service flows are not moved back to the original wideband interface until all the impaired RF channels are restored. However, with option 3 the *existing* dynamic secondary service flows, which are transitory in nature, are not moved back to the wideband interface even when all RF channels are restored.

The table below lists the various RF channel impairment handling options that the cable modem chooses and their applicable Cisco IOS releases.

**Table 77: Release Specific Behavior for RF Impairment Handling options**

RF Impairment Handling Options	Applicable Cisco IOS Releases
Option 1	Cisco IOS Release 12.2(33)SCB and later releases.
Option 2	Cisco IOS Release 12.2(33)SCC and later releases.
Option 3	<p>Default behavior in Cisco IOS Release 12.2(33)SCB and SCB-based releases. All downstream service flows (primary or secondary) are moved to primary channel interface.</p> <p>Configurable behavior in Cisco IOS Release 12.2(33)SCE4 and later releases. The decision to move all secondary service flows can be configured using the <b>cable rf-change-trigger</b> command. For more information, see the <i>Cisco IOS CMTS Cable Command Reference</i> guide.</p>

# How to Configure Wideband Modem Resiliency

The following tasks describe how to configure the Wideband Modem Resiliency feature on a Cisco uBR10012 or Cisco uBR7200 series router:

## Specifying Trigger Thresholds for Downstream Events

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable rf-change-trigger [percent value] [count number] [secondary]</b>  <b>Example:</b> Router(config)# <b>cable            rf-change-trigger percent 50            count 1 secondary</b>	Specifies the amount of time an event must persist before it triggers an action for the reporting cable modem. <ul style="list-style-type: none"> <li>• <b>percent value</b>—(Optional) Indicates the percentage of cable modems that must report that a particular non-primary RF channel is down before that channel is removed from the bonding group with that NP RF channel configured. The valid range is from 1 to 100. The default value is 0.</li> <li>• <b>count number</b>—(Optional) Specifies the number of cable modems reporting an impairment for a non-primary downstream channel. The default value is 0.</li> <li>• <b>secondary</b>—(Optional) Configures the Cisco CMTS to move the unicast secondary service flows to primary interface, when the number of cable modems reporting RF channel impairment is less than the configured (percent or count) threshold.</li> </ul> <p><b>Note</b> Only those unicast secondary service flows, which share the same wideband interface as the primary interface, are moved to the primary channel interface.</p>

## Specifying Persistence Time for RF Channels

To configure the amount of time a non-primary RF channel must remain in its current state (either up or down), use the **cable rf-change-dampen-time** command.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable rf-change-dampen-time <i>seconds</i></b>  <b>Example:</b> Router(config)# <b>cable rf-change-dampen-time 10</b>	Specifies the amount of time in seconds for a non-primary RF channel to remain in its new state. The default value is 30.

## Changing Default CM-STATUS Configuration

To change the default configuration values of “Event Holdoff Timer” and “Number of Reports per Event” for any or all events, use the **cable cm-status** command.

## DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable cm-status {all   event} [holdoff {timer   default}   reports {reportvalue   default}]</b>  <b>Example:</b> Router(config-if)# <b>cable cm-status 1 holdoff 1</b>	Sets the holdoff timer (in units of 20 milliseconds) and the number of reports per event value. <ul style="list-style-type: none"> <li>• <i>event</i>—CM-STATUS event. The valid range is from 1 to 10.</li> <li>• <i>timer</i>—Holdoff timer value. The valid range is from 1 to 65535. The default value is 50.</li> <li>• <i>reportvalue</i>—Report value. The valid range is from 0 to 255. The default value is 2.</li> </ul>

## Verifying Wideband Modem Resiliency

Use the following **show** commands to verify the state of RF channels and the other configuration details:

- **show interface rf-status**
- **show cable rf-status**
- **show cable modem wideband rcs-status**
- **show cable modem**

To verify the logical up and down state for each of the configured RF channels for a wideband interface, use the **show interface rf-status** command as shown in the following example:

### Cisco uBR10012 Universal Broadband Router:

```
Router# show interface wideband-cable 1/0/0:3 rf-status
Logical
RF  Status
--  -----
17  UP
18  UP
19  UP
```

### Cisco uBR7200 Series Universal Broadband Router:

```
Router# show interface wideband-cable 5/1:0 rf-status
Logical
Resource  RF  Status
-----
5/1       0  UP
          1  UP
          2  UP
```

To verify the logical up and down state of the specified channel number, or the logical state of all RF channels, use the **show cable rf-status** command as shown in the following example:

```
Router# show cable rf-status
Logical  Flap  Flap
RF       Status Counts  Time
-----
1/0/0 0  UP    0
      1  UP    0
      2  UP    0
      3  UP    0
      5  UP    0
      6  UP    0
      7  UP    0
      8  UP    0
      9  UP    0
     10  UP    0
     11  UP    0
     12  UP    0
     13  UP    0
     14  UP    0
     15  UP    0
     16  UP    0
```

To verify details of events for each RF channel in the cable modem's Receive Channel Configuration (RCC), use the **show cable modem wideband rcs-status** command as shown in the following example:

```
Router# show cable modem 0019.474a.c0ba wideband rcs-status
CM : 0019.474a.c0ba
RF : 1/0/0 10
  Status                : UP
  FEC/QAM Failure       : 0
  Dup FEC/QAM Failure   : 0
  FEC/QAM Recovery      : 0
  Dup FEC/QAM Recovery  : 0
  MDD Failure           : 0
  Dup MDD Failure       : 0
  MDD Recovery          : 0
  Dup MDD Recovery      : 0
  Flaps                 : 0
  Flap Duration         : 00:00
RF : 1/0/0 11
  Status                : UP
  FEC/QAM Failure       : 0
  Dup FEC/QAM Failure   : 0
  FEC/QAM Recovery      : 0
  Dup FEC/QAM Recovery  : 0
  MDD Failure           : 0
  Dup MDD Failure       : 0
  MDD Recovery          : 0
  Dup MDD Recovery      : 0
  Flaps                 : 0
  Flap Duration         : 00:00
```

To verify the basic receive statistics for all possible event code types for the specified cable modem, use the **show cable modem** command as shown in the following example:

```
Router# show cable modem cm-status
I/F  MAC Address  Event                TID  Count  Error  Dups  Time
C7/0  001c.ea2b.79b2 MDD timeout          0    0      1     0    Jan 11 11:29:22
      001c.ea2b.79b2 QAM failure          0    0      1     0    Jan 11 11:29:02
      001c.ea2b.79b2 MDD recovery         0    0      1     0    Jan 11 11:30:20
      001c.ea2b.79b2 QAM recovery         0    0      1     0    Jan 11 11:30:13
C7/0  001c.ea2b.78b0 MDD timeout          0    0      1     0    Jan 11 11:29:16
      001c.ea2b.78b0 QAM failure          0    0      1     0    Jan 11 11:28:53
      001c.ea2b.78b0 MDD recovery         0    0      1     0    Jan 11 11:29:59
      001c.ea2b.78b0 QAM recovery         0    0      1     0    Jan 11 11:29:46

Router# show cable modem 001c.ea2b.79b2 cm-status
I/F  MAC Address  Event                TID  Count  Error  Dups  Time
C7/0  001c.ea2b.79b2 MDD timeout          0    0      1     0    Jan 11 11:29:22
      001c.ea2b.79b2 QAM failure          0    0      1     0    Jan 11 11:29:02
      001c.ea2b.79b2 MDD recovery         0    0      1     0    Jan 11 11:30:20
      001c.ea2b.79b2 QAM recovery         0    0      1     0    Jan 11 11:30:13

Router# show cable modem cable 7/0 cm-status
I/F  MAC Address  Event                TID  Count  Error  Dups  Time
C7/0  001c.ea2b.79b2 MDD timeout          0    0      1     0    Jan 11 11:29:22
      001c.ea2b.79b2 QAM failure          0    0      1     0    Jan 11 11:29:02
      001c.ea2b.79b2 MDD recovery         0    0      1     0    Jan 11 11:30:20
      001c.ea2b.79b2 QAM recovery         0    0      1     0    Jan 11 11:30:13
C7/0  001c.ea2b.78b0 MDD timeout          0    0      1     0    Jan 11 11:29:16
      001c.ea2b.78b0 QAM failure          0    0      1     0    Jan 11 11:28:53
      001c.ea2b.78b0 MDD recovery         0    0      1     0    Jan 11 11:29:59
      001c.ea2b.78b0 QAM recovery         0    0      1     0    Jan 11 11:29:46
```

## What to Do Next

To modify the default configuration of events for CM-STATUS reports, proceed to the [Modifying CM-STATUS Reports for Events](#), on page 554.

## Modifying CM-STATUS Reports for Events

You can enable or modify the following ten CM-STATUS events per interface using the **cable cm-status enable** command:

- Secondary channel MDD time-out
- QAM/FEC lock failure
- Sequence out of range
- MDD recovery
- QAM/FEC lock recovery
- T4 time-out
- T3 re-tries exceeded
- Successful ranging after T3 re-tries exceeded
- CM operating on battery backup
- CM returned to A/C power

### DETAILED STEPS

	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.
<b>Step 3</b>	<b>interface cable {slot/port   slot/subslot/port}</b>  <b>Example:</b> Router(config)# <b>interface cable8/0/0</b>	Specifies the cable interface line card on a Cisco CMTS router: <ul style="list-style-type: none"> <li>• <i>slot</i>—Chassis slot number of the cable interface line card.               <ul style="list-style-type: none"> <li>◦ Cisco uBR7246VXR router: The valid range is from 3 to 6.</li> <li>◦ Cisco uBR7225VXR router: The valid range is from 1 to 2.</li> <li>◦ Cisco uBR10012 router: The valid range is from 5 to 8.</li> </ul> </li> <li>• <i>subslot</i>—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. Valid subslots are 0 or 1.</li> <li>• <i>port</i>—Downstream port number.               <ul style="list-style-type: none"> <li>◦ Cisco uBR7246VXR and Cisco uBR7225VXR routers: The valid port value is 0 or 1.</li> </ul> </li> </ul>



	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>◦ Cisco uBR10012 router: The valid range is from 0 to 4 (depending on the cable interface).</li> </ul>
<b>Step 4</b>	<b>cable cm-status enable</b> <i>range</i>  <b>Example:</b> Router(config-if) # <b>cable cm-status enable 6-9</b>	Enables a particular CM-STATUS event on a primary cable interface. The valid range is from 1 to 10.  The following events are enabled by default on cable and modular cable interfaces: <ul style="list-style-type: none"> <li>• Secondary channel MDD time-out</li> <li>• QAM/FEC lock failure</li> <li>• Sequence out of range</li> <li>• MDD recovery</li> <li>• QAM/FEC lock recovery</li> </ul> To disable a CM-STATUS event, use the <b>no</b> form of the <b>cable cm-status enable</b> command.

## Enabling SNMP Traps for Wideband Resiliency Events

You can enable Simple Network Management Protocol (SNMP) traps for Wideband Resiliency specific events using the **snmp-server enable traps docsis-resil** command.

### DETAILED STEPS

	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.
<b>Step 3</b>	<b>snmp-server enable traps docsis-resil</b> [ <i>resil-events</i> ]  <b>Example:</b> Router(config)# <b>snmp-server enable traps docsis-resil rf-up</b>	Enables SNMP traps for wideband resiliency specific events. Traps can be sent for specific events using the <i>resil-events</i> option: <ul style="list-style-type: none"> <li>• <b>cm-pmode</b>—Enables the wideband resiliency cable modem partial service trap.</li> <li>• <b>cm-recover</b>—Enables the wideband resiliency cable modem full service trap.</li> </ul>

	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>• <b>event</b>—Enables the wideband resiliency event trap.</li> <li>• <b>rf-down</b>—Enables the wideband resiliency RF channel down status trap.</li> <li>• <b>rf-up</b>—Enables the wideband resiliency RF channel up status trap.</li> </ul> <p>To disable sending of the trap, use the <b>no</b> form of this command.</p>
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Enabling Wideband Resiliency Trap Notifications

You can enable Wideband Resiliency trap notifications to a specific SNMP host using the **snmp-server host traps docsis-resil** command.

### DETAILED STEPS

	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.
<b>Step 3</b>	<b>snmp-server host <i>ipaddr</i> traps <i>string</i> docsis-resil</b>  <b>Example:</b> Router(config)# <b>snmp-server host 172.17.2.0 traps snmhost01 docsis-resil</b>	Enables wideband resiliency traps for a specific SNMP host. <ul style="list-style-type: none"> <li>• <i>ipaddr</i>—IPv4 or IPv6 address of the SNMP notification host.</li> <li>• <i>string</i>—SNMPv1 community string, SNMPv2c community string, or SNMPv3 username.</li> </ul> <p>To disable, use the <b>no</b> form of this command.</p>
<b>Step 4</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Setting the Trap Interval

You can set the interval at which traps must be sent for Wideband Resiliency related events for each cable modem using the **cable resiliency traps-interval** command.

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>enable</b>  <b>Example:</b> Router> <b>enable</b>	Enables privileged EXEC mode.  • Enter your password if prompted.
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable resiliency traps-interval</b> <i>count</i>  <b>Example:</b> Router(config)# <b>cable resiliency traps-interval 0</b>	Sets the time interval at which traps must be sent for each cable modem.  • <i>count</i> —Time interval (in seconds) at which the traps must be sent for each cable modem. The valid range is from 0 to 86400. The default value is 1.  To disable, use the <b>no</b> form of this command.
Step 4	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Exits global configuration mode.

## Configuration Example for Wideband Modem Resiliency

The following example shows how to configure the Wideband Modem Resiliency feature by specifying the dampening time and persistence thresholds for non-primary RF channels:

```
Router# configure terminal
Router(config)# cable rf-change-dampen-time 40
Router(config)# cable rf-change-trigger percent 50 count 1
Router(config)# cable cm-status 1 holdoff 1
```

## Additional References

The following sections provide references related to the Wideband Modem Resiliency feature.

### Related Documents

Related Topic	Document Title
Commands on the Cisco CMTS (universal broadband) routers	<i>Cisco IOS CMTS Cable Command Reference</i> <a href="http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html">http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html</a>
Cisco DOCSIS 3.0 Downstream Solution	<i>Cisco DOCSIS 3.0 Downstream Solution Design and Implementation Guide</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_2.0/ds_solu.html">http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_2.0/ds_solu.html</a>
Cisco Cable Wideband Solution Design	<i>Cisco Cable Wideband Solution Design and Implementation Guide</i> <a href="http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html">http://www.cisco.com/en/US/docs/cable/cmts/wideband/solution/guide/release_1.0/wb_solu.html</a>

### Standards

Standard	Title
CM-SP-MULPIv3.0-I08-080522	DOCSIS 3.0 MAC and Upper Layer Protocol Interface Specification

### MIBs

MIB	MIBs Link
CISCO-DOCS-EXT-MIB	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://tools.cisco.com/ITDIT/MIBS/servlet/index">http://tools.cisco.com/ITDIT/MIBS/servlet/index</a>

**Technical Assistance**

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></p>

## Feature Information for Wideband Modem Resiliency

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://www.cisco.com/go/cfn>. An account on [Cisco.com](http://www.cisco.com) is not required.

**Note**


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The table below 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.

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**Table 78: Feature Information for Wideband Modem Resiliency**

Feature Name	Releases	Feature Information
Wideband Modem Resiliency	12.2(33)SCB	<p>The Wideband Modem Resiliency feature provides the best possible service in the event of non-primary RF channel disruptions.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> <li>• <a href="#">How to Configure Wideband Modem Resiliency</a>, on page 550</li> <li>• <a href="#">Configuration Example for Wideband Modem Resiliency</a>, on page 557</li> </ul> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable rf-change-dampen-time</b></li> <li>• <b>cable rf-change-trigger</b></li> <li>• <b>cable cm-status enable</b></li> <li>• <b>show interface rf-status</b></li> <li>• <b>show cable rf-status</b></li> <li>• <b>show cable modem wideband rcs-status</b></li> <li>• <b>show cable modem summary wb-rf</b></li> <li>• <b>clear cable modem cm-status</b></li> <li>• <b>clear cable modem rcs-counts</b></li> <li>• <b>clear cable rf-status</b></li> <li>• <b>debug cable wbcmts resiliency</b></li> <li>• <b>show cable flap-list wb-rf</b></li> </ul>

Feature Name	Releases	Feature Information
Bypass the 24 Hour Timer for Wideband Cable Modems	12.2(33)SCB	<p>This feature removes the 24-hour timer required to clear these channels. Once the cable modem successfully completes registration, the list of failed RF channels for that cable modem is cleared. If the RF impairment has been eliminated when the cable modem re-registers, that channel can be reused immediately.</p> <p>There are no new or modified commands for this feature.</p>
Wideband Modem Resiliency	12.2(33)SCD	<p>In Cisco IOS Release 12.2(33)SCD, this feature was introduced on the Cisco uBR7225VXR and Cisco uBR7246VXR routers.</p> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>interface cable</b></li> <li>• <b>show interface rf-status</b></li> <li>• <b>show cable modem</b></li> <li>• <b>clear cable modem cm-status</b></li> <li>• <b>cable cm-status</b></li> </ul>
Move Secondary Service Flows to Primary Channel Interface.	12.2(33)SCE4	<p>This feature enables the Cisco CMTS to move all the unicast secondary service flows to the primary channel interface, when the number of cable modems reporting the RF-channel impairment is less than the configured trigger threshold.</p> <p>For more information on this feature, see section <a href="#">Specifying Trigger Thresholds for Downstream Events</a>, on page 550.</p> <p>The <b>cable rf-change-trigger</b> command was modified.</p>

Feature Name	Releases	Feature Information
Downstream Wideband Resiliency Trap	12.2(33)SCG2	<p>This feature enables SNMP traps for Wideband Resiliency related events and setting of the trap interval.</p> <p>For more information, see:</p> <ul style="list-style-type: none"> <li>• <a href="#">Enabling SNMP Traps for Wideband Resiliency Events, on page 555</a></li> <li>• <a href="#">Enabling Wideband Resiliency Trap Notifications, on page 556</a></li> <li>• <a href="#">Setting the Trap Interval, on page 557</a></li> </ul> <p>The following commands were introduced or modified:</p> <ul style="list-style-type: none"> <li>• <b>cable resiliency traps-interval</b></li> <li>• <b>snmp-server enable traps docsis-resil</b></li> <li>• <b>snmp-server host traps docsis-resil</b></li> </ul>





## Downgrading Channel Bonding in Battery Backup Mode

Cisco CMTS supports downgrading the channel bonding for cable modems and media terminal adapters (MTAs) in battery backup mode.

### 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 Downgrading Channel Bonding in Battery Backup Mode, page 563](#)
- [Restrictions for Downgrading Channel Bonding in Battery Backup Mode, page 564](#)
- [Information About Downgrading Channel Bonding in Battery Backup Mode, page 564](#)
- [How to Configure Downgrading Channel Bonding in Battery Backup Mode, page 565](#)
- [Verifying the Configuration for Channel Bonding Downgrade in Battery Backup Mode, page 567](#)
- [Additional References, page 570](#)
- [Feature Information for Downgrading Channel Bonding in Battery Backup Mode, page 571](#)

## Prerequisites for Downgrading Channel Bonding in Battery Backup Mode

- The cable modem must be DOCSIS3.0-compliant with battery backup capability.

- Downstream channel bonding group with at least one downstream channel must be available.
- Upstream channel bonding group with at least one upstream channel must be available.

## Restrictions for Downgrading Channel Bonding in Battery Backup Mode

- If the cable modem does not support the CM-STATUS events 9 and 10, channel bonding is not downgraded for the cable modem in battery backup mode.



**Note** We recommend that you configure separate dynamic bonding groups for each primary channel in a MAC domain.

- If the cable modem has an active voice call, channel bonding is not downgraded for the cable modem in battery backup mode.
- If the cable modem is working on the protect line card, channel bonding is not downgraded if its primary channel is not included in the dynamic bonding group.
- If the line card switches over when the cable modem is entering or exiting the battery backup mode, the cable modem may go offline.
- The Cisco CMTS does not support In-Service Software Upgrade (ISSU) for the cable modems when this feature is enabled.
- If the cable modem joins an IGMP group and the Cisco CMTS receives the CM-STATUS event 9, the Cisco CMTS removes the cable modem from the IGMP group. If the cable modem is in battery backup mode and channel bonding is downgraded, the Cisco CMTS rejects the IGMP join request from the cable modem.
- If the cable modem is in battery backup mode and channel bonding is downgraded, it does not support dynamic channel change and dynamic bonding change.
- If the cable modem is in battery backup mode and channel bonding is downgraded, the committed information rate (CIR) of the cable modem is zero. The CIR of the cable modem is restored when it exits the battery backup mode.
- If BPI is enabled for the cable modem under Cisco Wideband SPA, channel bonding is not downgraded for the cable modem in battery backup mode.
- When the cable modem exits the battery backup mode and rejects the DBC request, the cable modem goes offline.

## Information About Downgrading Channel Bonding in Battery Backup Mode

When this feature is enabled and the cable modem enters the battery backup mode, channel bonding is downgraded to one downstream and one upstream channels (battery backup 1x1 mode). This feature reduces

the power usage when the cable modem is running on battery backup. When the cable modem returns to the AC power mode, the channel bonding is returned to its original configuration. You can configure this feature globally and for each MAC domain.



**Note** We recommend that you enable this feature globally and for each MAC domain.

The cable modem uses the following CM-STATUS events to indicate its power status to the Cisco CMTS:

- 9—Indicates that the cable modem is operating in battery backup mode.
- 10—Indicates that the cable modem has returned to AC power mode.

When this feature is disabled, cable modem cannot downgrade the channel bonding even if it is running on battery backup.

## How to Configure Downgrading Channel Bonding in Battery Backup Mode

This section contains the following:

### Configuring Channel Bonding Downgrade in Battery Backup Mode Globally

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<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>
Step 2	<b>configure terminal</b>  <b>Example:</b> Router# <b>configure terminal</b>	Enters global configuration mode.
Step 3	<b>cable reduction-mode mta-battery enable</b>  <b>Example:</b> Router(config)# <b>cable reduction-mode mta-battery enable</b>	Enables the channel bonding downgrade for cable modems in battery backup mode.
Step 4	<b>cable reduction-mode mta-battery dampen-time seconds</b>  <b>Example:</b> Router(config)# <b>cable reduction-mode mta-battery dampen-time 40</b>	(Optional) Configures the dampen time, in seconds, to defer the cable modems from entering or exiting the channel bonding downgrade 1x1 mode.

	Command or Action	Purpose
<b>Step 5</b>	<b>cable reduction-mode mta-battery ranging-init-technique</b> <i>us-ranging-init-technique</i>  <b>Example:</b> Router(config)# <b>cable reduction-mode mta-battery ranging-init-technique 3</b>	(Optional) Configures the init-ranging technique.
<b>Step 6</b>	<b>cable reduction-mode mta-battery dynamic-channel-percent</b> <i>percent</i>  <b>Example:</b> Router(config)# <b>cable reduction-mode mta-battery dynamic-channel-percent 10</b>	(Optional) Configures the maximum and first try percentage of dynamic channel bandwidth in battery backup mode.  <b>Note</b> Ensure to leave enough bandwidth for primary channel so that it can allocate dynamic channel bandwidth when it joins a newly created dynamic bonding group.
<b>Step 7</b>	<b>exit</b>  <b>Example:</b> Router(config)# <b>exit</b>	Returns to the privileged EXEC mode.

## Configuring Channel Bonding Downgrade in Battery Backup Mode for MAC Domain

### DETAILED STEPS

	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.
<b>Step 3</b>	<b>interface wideband-cable</b> <i>slot/subslot/port:wideband-channel</i>  <b>Example:</b> Router(config)# <b>interface wideband-cable 1/0/0:7</b>	Configures a wideband cable interface.

	Command or Action	Purpose
Step 4	<b>cable ds-resiliency</b>  <b>Example:</b> Router(config-if)# <b>cable ds-resiliency</b>	Reserves a resiliency bonding group or WB interface for usage on a line card, on a per controller basis.
Step 5	<b>exit</b>  <b>Example:</b> Router(config-if)# <b>exit</b>	Returns to the global configuration mode.
Step 6	<b>interface cable slot/subslot/port</b>  <b>Example:</b> Router(config)# <b>interface cable 9/0/0</b>	Specifies the cable interface on the router and enters the interface configuration mode.
Step 7	<b>cable reduction-mode mta-battery enable</b>  <b>Example:</b> Router(config-if)# <b>cable reduction-mode mta-battery enable</b>	Enables the channel bonding downgrade for cable modems in battery backup mode for each MAC domain.
Step 8	<b>cable cm-status enable 9</b>  <b>Example:</b> Router(config-if)# <b>cable cm-status enable 9</b>	Enables the CM-STATUS event 9 for the MAC domain. The value 9 indicates that the cable modem is operating in battery backup mode.
Step 9	<b>cable cm-status enable 10</b>  <b>Example:</b> Router(config-if)# <b>cable cm-status enable 10</b>	Enables the CM-STATUS event 10 for the MAC domain. The value 10 indicates that the cable modem has returned to AC power mode.
Step 10	<b>end</b>  <b>Example:</b> Router(config-if)# <b>end</b>	Returns to the privileged EXEC mode.

## Verifying the Configuration for Channel Bonding Downgrade in Battery Backup Mode

- **show cable modem**—Displays information if the cable modem is running in battery backup mode.

Following is a sample output of the command:

```
Router# show cable modem

      D
MAC Address      IP Address      I/F          MAC          Prim  RxPwr  Timing Num
      I
                               State          Sid    (dBmV)  Offset CPE
      P
f45f.d4a1.b75a ---          C6/1/0/UB    p-online(pt)  846    !-3.50  1475    0
```

```

N
c427.9551.3489 30.154.1.12 C6/1/0/UB w-online (pt) 930 -0.50 1579 2
Y
f45f.d4a1.b762 30.55.223.253 C6/1/0/UB w-online 1770 0.00 1503 0
Y
0016.925e.661a 30.55.230.136 C6/1/0/U0 online (pt) 825 -0.50 1467 1
N
4458.2945.458a 30.0.7.72 C6/1/0/UB w-online 3916 0.00 1511 2
Y
4458.2945.401e --- C6/1/0/UB w-online (pt) 847 -0.50 1473 1
N
4458.2945.20c6 --- C6/1/0/UB w-online (pt) (bm) 895 0.00 1481 0
N

```

- **show cable modem reduction-mode mta-battery**—Displays the channel bonding downgrade information for cable modems in battery backup mode.

Following is a sample output of the command:

```
Router# show cable modem reduction-mode mta-battery
```

I/F	MAC Address	ID	Orig BG I/F	RFs	ID	Curr BG I/F	Upstream
C7/0/0	0025.2eaf.843e	897	Wi7/0/0:0	4	252	Wi7/0/0:1	US0
C7/0/0	0025.2eaf.8356	897	Wi7/0/0:0	4	252	Wi7/0/0:1	US0
C7/0/0	0015.d176.5199	897	Wi7/0/0:0	4	252	Wi7/0/0:1	US0

Following is a sample output of the command for a cable modem when the MAC address is specified:

```
Router# show cable modem 0025.2eaf.843e reduction-mode mta-battery
```

I/F	MAC Address	ID	Orig BG I/F	RFs	ID	Curr BG I/F	Upstream
C7/0/0	0025.2eaf.843e	897	Wi7/0/0:0	4	252	Wi7/0/0:1	US0

Following is a sample output of the command for a cable modem when the IP address is specified:

```
Router# show cable modem 90.18.0.9 reduction-mode mta-battery
```

I/F	MAC Address	ID	Orig BG I/F	RFs	ID	Curr BG I/F	Upstream
C7/0/0	0025.2eaf.843e	897	Wi7/0/0:0	4	252	Wi7/0/0:1	US0

Following is a sample output of the command for a cable modem when the IPv6 address is specified:

```
Router# show cable modem 2001:18::9 reduction-mode mta-battery
```

I/F	MAC Address	ID	Orig BG I/F	RFs	ID	Curr BG I/F	Upstream
C7/0/0	0025.2eaf.843e	897	Wi7/0/0:0	4	252	Wi7/0/0:1	US0

- **show cable modem verbose**—Displays the detailed information for the cable modem.

Following is a sample output of the command:

```
Router# show cable modem 54d4.6ffb.30fd verbose
```

```

MAC Address           : 54d4.6ffb.30fd
IP Address            : 40.4.58.14
IPv6 Address         : 2001:40:4:58:741A:408D:7E4B:D7C8
Dual IP              : Y
Prim Sid             : 9
Host Interface       : C7/0/0/UB
MD-DS-SG / MD-US-SG : 1 / 1
MD-CM-SG            : 0x3C0101
Primary Wideband Channel ID : 897 (Wi7/0/0:0)

```

```

Primary Downstream           : In7/0/0:2 (RfId : 722)
Wideband Capable            : Y
RCP Index                   : 3
RCP ID                      : 00 10 00 00 08
Downstream Channel DCID RF Channel : 99 7/0/0:2
Downstream Channel DCID RF Channel : 97 7/0/0:0
Downstream Channel DCID RF Channel : 98 7/0/0:1
Downstream Channel DCID RF Channel : 100 7/0/0:3
Multi-Transmit Channel Mode  : Y
Extended Upstream Transmit Power : 0dB
Upstream Channel            : US0 US1
Ranging Status              : sta sta
Upstream SNR (dB)           : 36.12 32.55
Upstream Data SNR (dB)      : -- --
Received Power (dBmV)       : 0.00 0.00
Reported Transmit Power (dBmV) : 25.25 26.00
Peak Transmit Power (dBmV)   : 54.00 54.00
Phy Max Power (dBmV)        : 54.00 54.00
Minimum Transmit Power (dBmV) : 24.00 24.00
Timing Offset (97.6 ns)     : 1226 1226
Initial Timing Offset       : 1229 973
Rng Timing Adj Moving Avg(0.381 ns) : -1 0
Rng Timing Adj Lt Moving Avg : -7 0
Rng Timing Adj Minimum      : -768 0
Rng Timing Adj Maximum      : 0 64768
Pre-EQ Good                  : 0 0
Pre-EQ Scaled                : 0 0
Pre-EQ Impulse               : 0 0
Pre-EQ Direct Loads          : 0 0
Good Codewords rx            : 515 472
Corrected Codewords rx       : 0 0
Uncorrectable Codewords rx   : 0 0
Phy Operating Mode           : atdma* atdma*
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=16, Max DS Sids=15}
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                   : 200
Flaps                          : 0()
Errors                         : 0 CRCs, 0 HCSeS
Stn Mtn Failures              : 0 aborts, 0 exhausted
Total US Flows                 : 1(1 active)
Total DS Flows                 : 1(1 active)
Total US Data                  : 7 packets, 2006 bytes
Total US Throughput            : 0 bits/sec, 0 packets/sec
Total DS Data                  : 5 packets, 1202 bytes
Total DS Throughput            : 0 bits/sec, 0 packets/sec
LB group ID assigned (index)   : 2151416065 (48131)
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              : 2 (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
CM Energy Management Capable : Y
CM Enable Energy Management : Y
CM Enter Energy Management  : No
Battery Mode              : Yes
Battery Mode Status      : BATTERY_MODE / AC_POWER_MODE
DS Change Times            : 0
Boolean Services           : 2
Number of Multicast DSIDs Support : 16
MDF Capability Mode        : 2
IGMP/MLD Version           : MLDv2
FCType10 Forwarding Support : Y
Features Bitmask           : 0x0
Total Time Online          : 2h12m (2h12m since last counter reset)
CM Initialization Reason   : NO_PRIM_SF_USCHAN
CFG Max IPv6 CPE Prefix    : 16 (-1 used)

```



**Note** *Battery Mode* indicates if the cable modem is in battery backup mode or AC power mode.

*Battery Mode Status* indicates the status of the cable modem:

- When the cable modem is in AC\_POWER\_MODE/BATTERY\_MODE status, it is in stable state.
- When the cable modem is in AC\_POWER\_PENDING/BATTERY\_PENDING status, it is in transfer state.
- When the cable modem is in AC\_POWER\_HOLD/BATTERY\_HOLD status, it is updating status of the last event received until the dampen time expires.

- **show cable modem cm-status**—Displays the cable modem CM-STATUS event information.

Following is a sample output of the command:

```
Router# show cable modem e448.c70c.9d80 cm-status
```

I/F	MAC Address	Event	TID	Count	Error	Dups	Time
C6/0/3/UB	e448.c70c.9d80	Battery backup	14	1	0	0	Apr 2 22:17:29
	e448.c70c.9d80	A/C power	1	1	0	0	Apr 2 22:43:52

## Additional References

### Related Documents

Related Topic	Document Title
CMTS commands	<a href="#">Cisco CMTS Cable Command Reference</a>



**Standards and RFCs**

Standard/RFC	Title
CM-SP- MULPIv3.1-I01-131029	Data-Over-Cable Service Interface Specifications, DOCSIS 3.1, MAC and Upper Layer Protocols Interface Specification

**Technical Assistance**

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>

## Feature Information for Downgrading Channel Bonding in Battery Backup Mode

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**Note**

The table below 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 79: Feature Information for Downgrading Channel Bonding in Battery Backup Mode**

Feature Name	Releases	Feature Information
Battery Backup 1x1 Mode	Cisco IOS Release 12.2(33)SCI2	This feature was introduced on the Cisco uBR10012 routers.

