



Configuring Load Balancing and Dynamic Channel Change (DCC) on the Cisco CMTS

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The Load Balancing feature for the Cisco Cable Modem Termination System (CMTS) allows system operators to distribute cable modems across radio frequency (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 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 that entail multiple interfaces, multiple load balancing policies, and the option to configure multiple additional Load Balancing parameters.

Effective with Cisco IOS Release 12.3(17a)BC, and later 12.3 BC releases, load balancing is further 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 re-registration after the change.

Effective with Cisco IOS release 12.3(17b)BC4, and later releases, Load Balancing is further 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.

These 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.

Feature Specifications for Load Balancing on the Cisco CMTS

Feature History	
Release	Modification
Release 12.2(15)BC1	This feature was introduced for Cisco uBR7246VXR and Cisco uBR10012 routers.
Release 12.3(9a)BC	This feature was introduced for the Cisco uBR7100 Series universal broadband routers.



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Release 12.3(17a)BC	Dynamic Channel Change (DCC) for Load Balancing supported on the Cisco uBR10012 and Cisco uBR7246VXR routers.
Release 12.3(17b)BC4	Downstream load balancing further enhanced to equalize downstream load balancing with upstream load balancing group members. This feature introduces two new and supporting commands: <ul style="list-style-type: none"> • cable load-balance group <i>ds-lb-group-id</i> policy { pcmm ugs us-groups-across-ds } • show cable load all Refer to the “Downstream Load Balancing Distribution with Upstream Load Balancing” section on page 12 and the “Distributing Downstream Load Balancing with Upstream Load Balancing” section on page 23.
Supported Platforms	
Cisco uBR7100 Series, Cisco uBR7246VXR, Cisco uBR10012 universal broadband routers.	

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

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Prerequisites

Prerequisites for Load Balancing on the Cisco CMTS

The Load Balancing on the Cisco CMTS feature has the following prerequisites:

- The Cisco uBR7200 series and Cisco uBR10012 router must be running Cisco IOS Release 12.2(15)BC1 or later Cisco IOS Release 12.2 BC release.
- 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 informational-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.
- DOCSIS1.1 must be enabled for a modem to behave properly for the DCC operation. Note that not all DOCSIS1.1 certified modems are DCC capable as the CableLabs DCC ATP tests need enhancement for complete coverage.

Restrictions

Restrictions for Load Balancing on the Cisco CMTS

The Load Balancing on the Cisco CMTS feature has the following restrictions:

- For additional information about support of Load Balancing on the Cisco CMTS, refer to [Feature Specifications for Load Balancing on the Cisco CMTS](#).
- Load balancing can be done only on a per chassis basis—all interfaces in a load-balance group must be provided by the same chassis.
- A downstream or upstream can belong to only one load-balance group.
- All downstreams and upstreams in a load-balance group must share physical connectivity to the same group of cable modems. Downstreams can be in a separate load-balance group than upstreams, but all downstreams or all upstreams that have the same RF physical connectivity must be members of the same load-balance group.

- You can configure only one load-balance group per shared physical domain (upstream or interface). You cannot configure multiple load-balance groups to distribute downstreams or upstreams that share physical connectivity.
- In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis (the older limitation was 20). However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.
- 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 balance 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-balance group to contain the downstreams for both MAC domains.



Note A MAC domain is one downstream and its associated upstreams.

- 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.
- In Cisco IOS Release 12.2(15)BC1, the dynamic load balancing method uses the Downstream Frequency Override message to move cable modems between downstream channels, which results in cable modems going offline and having to reregister, resulting in a short, temporary loss of connectivity for the customer. This is because the DOCSIS 1.0 specification requires cable modems to reregister whenever the downstream is changed using the Downstream Frequency Override message. Cable modems should not go offline when they are moved between upstreams. This behavior is modified in Cisco IOS Release 12.3(17a)BC, with the introduction of four initialization techniques for Dynamic Channel Change (DCC). See the [“Configuring DCC for Load Balancing on the Cisco CMTS”](#) section on page 36.
- As required by cable interface bundling, all interfaces in a load-balance group must also be in the same 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 require 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.
- In Cisco IOS Release 12.2(15)BC1, 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 pre-configure the Protect interface with the appropriate load-balancing commands, but you must be certain that the downstreams and upstreams in each load-balance group after the switchover have the same physical connectivity.)

Restrictions for Dynamic Channel Change for Load Balancing

- DCC initialization 0 is the default technique for load balancing DCC. Legacy line cards can only use DCC initialization technique 0.
- 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 which are explicitly changed by the DCC-REQ messages encodings.
- 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, i.e. ± 0.25 usec plus $\pm \frac{1}{2}$ symbol time.

For example, for a symbol rate of 1.28Msps, 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 CMTS to change by more than 6dB.

- DCC initialization technique 3 must not be used if the conditions for using technique 2 is 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 only used for dynamic downstream load balancing on DOCSIS1.1 modems. UCC is used for dynamic upstream load balancing. DCC is not used for static load balancing.
- 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 CMTS receives an IGMP join message from the CPE as the result of the CMTS IGMP query, where the IGMP query interval is set to 1 minute. This is a IGMPv2 limitation.

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 switchover event, this prompts the load balancing feature to engage. 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 may increase the dynamic load balance threshold, in the case that the system has a given percentage of cable modems that reset during switchover. An alternate method is to use static load balancing with N+1 Redundancy. Refer to the [“Types of Load-Balancing Operations” section on page 7](#) for additional information.

Information on the Load Balancing on the Cisco CMTS Feature

This section describes the operation, concepts, and benefits of the Load Balancing on the Cisco CMTS feature.

- [Feature Overview, page 6](#)
- [Benefits of Load Balancing, page 14](#)

Feature Overview

This 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 rebalance 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.

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.
- **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.



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.

- **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.



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.

When using dynamic load balancing and an upstream channel is overloaded, the Cisco CMTS sends an Upstream Channel Change (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 reregister with the 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 reregister on the new downstream channel, so as to conform to the DOCSIS 1.0 specifications.



Note In Cisco IOS Release 12.2(15)BC1, the dynamic load balancing method results in cable modems going offline and having to reregister whenever the modems are moved between downstreams. This is because the DOCSIS 1.0 specification requires cable modems to reregister 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 reregister.

Methods to Determine When Interfaces are Balanced

In addition to selecting how interfaces should be balancing (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:

- **Modem Method**—Uses the number of active cable modems on an interface.
- **Service Flow Method**—Uses the number of active Service Flow IDs (SFIDs) on an interface.
- **Utilization Method**—Uses an interface's current percentage of utilization.

See the following sections for more information about each method.

Modem 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's 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 different 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**

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.

Service Flow Method

The service flow method of load balancing uses the number of active service flow IDs (SFIDs) on an interface to determine the current load. This is a form of distribution-based load balancing, in which 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**— For example, 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's channel width.
- **Modulation profiles**— For example, 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 different 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**

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.

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 utilization method does not go into effect until the absolute utilization of the interfaces is at least 25 percent or greater. If the utilization of an interface is less than 25 percent, the Cisco CMTS does not attempt to load balance the interfaces, regardless of the difference in usage levels between the interfaces.

**Note**

In Cisco IOS Release 12.2(15)BC2, the average utilization figures for an upstream were reset to zero whenever the upstream configuration was changed (such as changing the modulation profile or channel width). This reset of the average utilization could skew the load balancing algorithm and cause unnecessary moving of cable modems. This is no longer the case in Cisco IOS Release 12.3(9a)BC and later releases, because the average utilization figure is reset only when the upstream is shut down, allowing load balancing operation to be more accurate.

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-Balance Groups

To enable the Load Balancing on the Cisco CMTS feature, you first must create and configure a load-balance group, which specifies how load balancing should be performed. You then must assign cable interfaces to the load-balance group, at which point the Cisco CMTS begins performing load balancing on those cable interfaces.

You can use separate load-balance groups for upstreams or downstreams, or you can use the same load-balance group for both upstreams and downstreams. However, all cable interfaces in a load-balance group must share the same physical RF connectivity.

Note

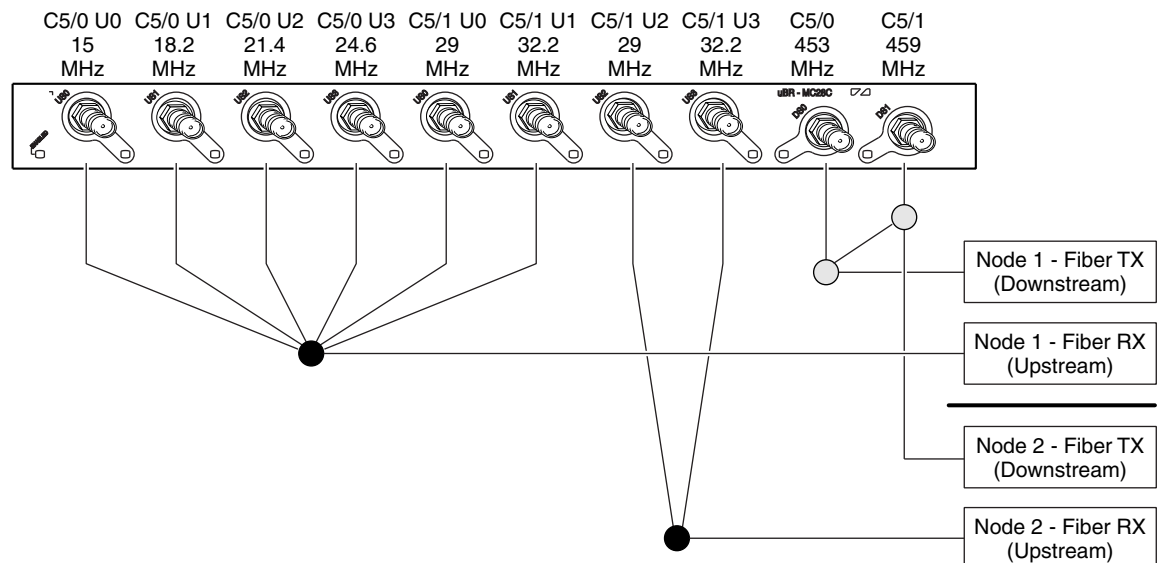
In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis (the older limitation was 20). However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces. If downstreams are not included in a load-balance group, then each downstream can be considered a separate domain.

Also, the same load-balance 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-balance groups.

If you assign downstreams and upstreams to different load-balance groups, the Cisco CMTS performs load balancing independently on the upstreams and downstreams. If both downstreams and upstreams are assigned to the same load-balance group, the Cisco CMTS attempts to balance both the downstream and upstream load.

Figure 1 shows a simple example of how load-balance groups can be created.

Figure 1 Example of Load -Balance Groups



As shown in this figure, three load-balance 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-balance group.
- The last two upstreams for downstream C5/1 (U1 and U2) are used for a different node and are therefore part of a separate load-balance group.
- The two downstreams, C5/0 and C5/1, are part of the same load-balance 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-balance groups.)

Note

To see a sample configuration for the configuration that is shown in Figure 1, see the “Sample Configuration for Upstreams and Downstreams” section on page 33.

Downstream Load Balancing Distribution with Upstream Load Balancing

Cisco IOS Release 12.3(17b)BC4 introduces further enhancements to downstream load balancing, resulting in 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.

- **cable load-balance group** *ds-lb-group-id* **policy** { **pcmm** | **ugs** | **us-groups-across-ds** }
- **show cable load all**

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.

This enhancement applies when downstream load balancing occurs on a headend system with separate upstream load balancing segments; the upstream segments are spread over multiple downstreams segments.

Cisco IOS Release 12.3(17b)BC4 enables the configuration and operation of making downstream load balancing decisions 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.



Note

When this feature is active, and one upstream channel only is overloaded, downstream load balancing distribution with upstream load balancing does not initiate until the two downstream channels are beyond 25% utilization rate.

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
- nowhere else, however

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 setting for configuring downstream load balancing groups with upstream resources.

For additional information, refer to the [“Distributing Downstream Load Balancing with Upstream Load Balancing”](#) section on page 23.

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 modulation, 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.

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).

How to Configure Load Balancing on the Cisco CMTS

The following sections describe how to create and configure load-balance groups, to enable load balancing on the Cisco CMTS. Each task is marked as required or optional, as appropriate.

- [Creating a Load-Balance Group \(required\), page 15](#)
- [Configuring a Load-Balance Group \(optional\), page 16](#)
- [Assigning Interfaces to a Load-Balance Group \(required\), page 19](#)
- [Excluding Cable Modems from a Load-Balance Group \(optional\), page 22](#)
- [Distributing Downstream Load Balancing with Upstream Load Balancing, page 23](#)
- [Verifying Load Balancing Operations \(optional\), page 27](#)

Creating a Load-Balance Group (required)

This section describes how to create a load-balance group. You must create at least one load-balance group before the Cisco CMTS will begin load balancing cable modems.

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `cable load-balance group n method [modem | service-flows | utilization]`
4. `exit`

DETAILED STEPS

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

Command or Action	Purpose
<p>Step 3</p> <pre>cable load-balance group n method [modem service-flows utilization]</pre> <p>Example:</p> <pre>Router(config)# cable load-balance group 10 method service-flows enforce Router(config)# cable load-balance group 11 method modem Router(config)# cable load-balance group 12 method utilization enforce Router(config)#</pre>	<p>Creates a load-balance group with the following parameters:</p> <ul style="list-style-type: none"> <i>n</i>—Number of the load-balance group. Valid range is 1 to 80, with no default. <p>Note In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis. The older limitation was 20. However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.</p> <ul style="list-style-type: none"> method modem—(Optional) Specifies that the load-balance group should use the number of active cable modems on an interface to determine the current load (default). method service-flows—(Optional) Specifies that the load-balance group should use the number of active service flow IDs (SFIDs) on an interface to determine the current load. method utilization—(Optional) Specifies that the load-balance group should use an interface's current percentage of utilization to determine the current load. (To avoid unnecessary movement of cable modems, the utilization method does not perform load balancing until the amount of utilization on an interface is at 25 percent or more.)
<p>Step 4</p> <pre>exit</pre> <p>Example:</p> <pre>Router(config)# exit Router#</pre>	<p>Exits global configuration mode.</p>

Configuring a Load-Balance Group (optional)

This section describes how to configure a load-balance group. All steps are optional, unless you want to change the default load-balance configuration.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cable load-balance group n [interval seconds]**

4. `cable load-balance group n threshold {load load-value [enforce threshold] | load minimum number | stability percent | ugs band-value}`
5. `cable load-balance group n policy ugs`
6. `exit`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><code>enable</code></p> <p>Example: Router> enable Router#</p>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<p><code>configure terminal</code></p> <p>Example: Router# configure terminal Router(config)#</p>	Enters global configuration mode.
Step 3	<p><code>cable load-balance group n [interval seconds]</code></p> <p>Example: Router(config)# cable load-balance group 10 interval 30 Router(config)#</p>	<p>Modifies the frequency by which the Cisco CMTS checks for exceeded thresholds in order to launch the load balancing feature.</p> <ul style="list-style-type: none"> • <i>n</i>—Number of the load-balance group. Valid range is 1 to 80, with no default. <p>Note In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis. The older limitation was 20. However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.</p> <ul style="list-style-type: none"> • <i>seconds</i>—Minimum time between when cable modems can be moved to load balance the interfaces. One cable modem at most is moved during each interval time period. The valid range is 0 to 3600 seconds, with a default value of 10 seconds.

Command or Action	Purpose
<p>Step 4</p> <pre>cable load-balance group n threshold {load load-value [enforce threshold] load minimum number stability percent ugs band-value}</pre> <p>Example:</p> <pre>Router(config)# cable load-balance group 10 threshold load 20 enforce 30 Router(config)# cable load-balance group 10 threshold ugs 60</pre>	<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"> • load load-value—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. <p>Note 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"> • enforce threshold—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. • load minimum number—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). • stability percent—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. • ugs band-value—Specifies that the Cisco CMTS should move cable modems with active 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.

	Command or Action	Purpose
Step 5	<pre>cable load-balance group n policy ugs</pre> <p>Example: Router(config)# cable load-balance group 10 policy ugs Router(config)#</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"> n —Number of the load-balance group. Valid range is 1 to 80, with no default. <p>Note In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis. The older limitation was 20. However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.</p>
Step 6	<pre>exit</pre> <p>Example: Router(config)# exit Router#</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.

Assigning Interfaces to a Load-Balance Group (required)

This section describes how to assign cable interfaces (both downstreams and upstreams) to a load-balance group. A cable interface does not participate in load-balancing operations until it is a member of a load-balance group.

Restrictions

When assigning cable interfaces to load balance groups, be aware of the following restrictions:

- A downstream or upstream can belong to only one load-balance group.
- All downstreams and upstreams in a load-balance group must share physical connectivity to the same group of cable modems. Downstreams can be in a separate load-balance group than upstreams, but all downstreams or all upstreams that have the same RF physical connectivity must be members of the same load-balance group. You cannot distribute downstreams or upstreams that share physical connectivity across multiple load-balance groups.
- All interfaces in a load-balance 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 (see the [“Excluding Cable Modems from a Load-Balance Group \(optional\)”](#) section on page 22).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface cable *x/y***
4. **cable load-balance group *n***
5. **cable downstream frequency *freq-hz***
6. **cable upstream *uport* load-balance group *n***
7. **exit**
8. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable Router#	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal Router(config)#	Enters global configuration mode.
Step 3	interface cable <i>x/y</i> Example: Router(config)# interface cable 5/1 Router(config-if)#	Enters interface configuration mode for the specified cable interface.
Step 4	cable load-balance group <i>n</i> Example: Router(config-if)# cable load-balance group 10 Router(config-if)#	Assigns the downstream interface to the specified load-balance group. <ul style="list-style-type: none"> • <i>n</i>—Number of the load-balance group. Valid range is 1 to 80, with no default. Note In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis. The older limitation was 20. However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.

Command or Action	Purpose
<p>Step 5</p> <pre>cable downstream frequency <i>freq-hz</i></pre> <p>Example: Router(config-if)# cable downstream frequency 453000000 Router(config-if)# </p>	<p>Specifies the known downstream center frequency to be used on this cable interface. This is an informational-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>
<p>Step 6</p> <pre>cable upstream <i>uport</i> load-balance group <i>n</i></pre> <p>Example: Router(config-if)# cable upstream 0 load-balance group 10 Router(config-if)# </p>	<p>Assigns an upstream port to the specified load-balance group.</p> <ul style="list-style-type: none"> <i>uport</i>—Upstream port number. Valid range starts with 0 and ends with a value that depends on the number of upstream ports on the cable interface line card. <i>n</i>—Number of the load-balance group. Valid range is 1 to 80, with no default. <p>Note In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis. The older limitation was 20. However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.</p>
<p>Note Repeat Step 3 through Step 6 as needed for each downstream cable interface and its upstream ports that should belong to this group.</p>	
<p>Step 7</p> <pre>exit</pre> <p>Example: Router(config-if)# exit Router(config)# </p>	<p>Exits interface configuration mode.</p>
<p>Step 8</p> <pre>exit</pre> <p>Example: Router(config)# exit Router# </p>	<p>Exits global configuration mode.</p>

Excluding Cable Modems from a Load-Balance Group (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 this 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.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cable load-balance exclude {modem *mac-address* | oui *oui-value*} [enforce | static | strict]**
4. **exit**

DETAILED STEPS

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

	Command or Action	Purpose
Step 3	<p>cable load-balance exclude {<i>modem mac-address</i> <i>oui oui-value</i>} [enforce static strict]</p> <p>Example: Router(config)# cable load-balance exclude mac 0102.0304.0506 Router(config)# cable load-balance exclude oui 00:00:0c Router(config)#</p>	<p>Specifies that one or more cable modems should be excluded from load-balancing operations.</p> <ul style="list-style-type: none"> • <i>mac-address</i> — Hardware (MAC) address of an individual cable modem to be excluded from load balancing. (You cannot specify a multicast MAC address.) • <i>oui-value</i> — Organization unique identifier (OUI) value for a vendor whose cable modems are to be excluded from load balancing. The OUI is composed of three hexadecimal bytes separated by colons or periods. <p>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:</p> <ul style="list-style-type: none"> • enforce — (Optional) Excludes the cable modems from dynamic load balancing, but they continue to participate in static load balancing. • static — (Optional) Excludes the cable modems from static load balancing, but they continue to participate in passive load balancing and dynamic load balancing. • strict — (Optional) Excludes the cable modems from all forms of load balancing. • static strict — (Optional) Excludes the cable modem from static and passive load balancing, but they continue to participate in dynamic load balancing.
Step 4	<p>exit</p> <p>Example: Router(config)# exit Router#</p>	<p>Exits global configuration mode.</p>

Distributing Downstream Load Balancing with Upstream Load Balancing

Cisco IOS Release 12.3(17b)BC4 introduces two commands that 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**

Cisco IOS Release 12.3(17b)BC4 enables the optional configuration of making downstream load balancing decisions 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.

For additional information, refer to the [“Downstream Load Balancing Distribution with Upstream Load Balancing”](#) section on page 12.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cable load-balance group *ds-lb-group-id* policy {pcmm | ugs | us-groups-across-ds }**
4. **exit**
5. **show cable load all**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable Router#	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal Router(config)#	Enters global configuration mode.
Step 3	cable load-balance group <i>ds-lb-group-id</i> policy <i>us-groups-across-ds</i> Example: Router(config)# cable load-balance group 1 policy us-groups-across-ds	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. <ul style="list-style-type: none"> • <i>ds-lb-group-id</i>—Specifies the load balancing group being configured. This downstream group includes the upstream segment in load balancing decisions. • us-groups-across-ds—Specifies the upstream group to be distributed in load balancing decisions for the downstream group specified. • ugs—Keyword applies this load balancing policy with DOCSIS Unsolicited Grant Service (UGS) service flow parameters. • pcmm—Keyword applies this load balancing policy configuration with PacketCable MultiMedia (PCMM) service flow parameters.

	Command or Action	Purpose
Step 4	exit Example: Router(config)# exit Router#	Exits global configuration mode.
Step 5	show cable load all Example: Router# show cable load all	Displays load balancing statistics and status of load balancing configurations on the Cisco CMTS, to include distributed upstream-to-downstream load balancing when configured.

Refer to the following resources for additional information:

- “Downstream Load Balancing Distribution with Upstream Load Balancing” section on page 12
- *Cisco Broadband Cable Command Reference Guide*
http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

Examples

The following example illustrates this command and one supported implementation:

```
Router(config)# cable load-balance group 1 policy us-groups-across-ds
Router(config)#
```

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
- nowhere else, however

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# config t
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		Threshold			
			Technique	Minimum	Static	Enforce	Ugs	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

Verifying Load Balancing Operations (optional)

This section describes how to use certain test and show commands to verify the configuration and operation of the Load Balancing or Dynamic Channel Change feature on the Cisco CMTS.

SUMMARY STEPS

1. **enable**
2. **test cable load-balance** *mac-address* [**ucc** | **upstream**] [*count*]
3. **show cable load-balance** [**group** *n*] [**all** | **load** | **pending** | **statistics** | **target**]
4. **test cable dcc** [*mac-addr* | *ip-addr* | *cable-if-src sid*] *cable-if-target uschan* {*ranging-tech*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable Router#	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	test cable load-balance <i>mac-address</i> [ucc upstream] [<i>count</i>] Example: Router# test cable load-balance 0000.394e.4e59 Router#	Tests the operation of the current load-balancing configuration by moving a cable modem to a new upstream. <ul style="list-style-type: none"> • <i>mac-address</i>—Hardware (MAC) address of the cable modem to be moved in the load-balancing test. (This cable modem must be online.) • ucc—(Optional) Moves the cable modem to a new upstream channel by sending an Upstream Channel Change (UCC) request message. • upstream—(Optional) Moves the cable modem to a new upstream channel by forcing the cable modem offline, and then instructing it to the new upstream channel when it reregisters. • <i>count</i>—(Optional) Number of times to perform the test. The valid range is 1 to 80, with a default of 1. <p>Note In later Cisco IOS Releases, such as release 12.3(17a)BC, you can create a maximum of 80 load-balance groups on each chassis. The older limitation was 20. However, in prior Cisco IOS releases, you can reuse those load-balance groups on different sets of cable interfaces, as long as they are in different domains. If downstream channels are not included in a load-balance group, then each downstream channel can be considered a separate domain.</p>

Command or Action	Purpose
<p>Step 3</p> <pre>show cable load-balance [group n] [all load pending statistics target]</pre> <p>Example: Router# show cable load-balance group 1 Router# show cable load-balance all Router#</p>	<p>Displays real-time statistical and operational information for load-balancing operations. If given without any options, this command displays information for the load-balance groups and each cable interface's current load and load-balancing status. You can also specify the following options:</p> <ul style="list-style-type: none"> • group n—Displays information for a single load-balance group. The valid range for <i>n</i> is 1 to 80. The default is to display information for all groups. • all—(Optional) Display information for all command options. • load—(Optional) Displays current interface load and load-balance group assignments. • pending—(Optional) Displays list of cable modems that are currently being moved between interfaces. • statistics—(Optional) Displays cumulative statistics for load-balancing operations. • target—(Optional) Displays the current and target interfaces being used for load balancing.
<p>Step 4</p> <pre>test cable dcc [mac-addr ip-addr cable-if-src sid] cable-if-target uschan {ranging-tech}</pre> <p>Example: Router# test cable dcc 0000.394e.4e59</p>	<p>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.</p> <ul style="list-style-type: none"> • <i>mac-addr</i>—The MAC address of the cable modem to be moved for DCC test. • <i>ip-addr</i>—The IP address of the cable modem to be moved for DCC test. • <i>cable-if-src</i>—The name of the source downstream interface for the DCC transaction. • <i>sid</i>—Primary sid value. • <i>cable-if-target</i>—The name of the target downstream interface for the DCC transaction. • <i>uschan</i>—The upstream channel id of the target upstream for the DCC transaction. • <i>ranging-tech</i>—The initialization technique to be used for the DCC transaction; 0 is the default if not specified. <p>Refer to the “Configuring DCC for Load Balancing on the Cisco CMTS” section on page 36 for additional information about initialization techniques applied to DCC.</p>

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 balance group.

```
Router# show cable load-balance target
```

```
Target assignments:
```

Interface	State	Group	Target
Cable5/0/0 (669 MHz)	up	1	
Cable5/0/0/U0	up	1	Cable5/0/0/U1 [enforce]
Cable5/0/0/U1	up	1	

```
Router# show cable load-balance statistics
```

```
Statistics:
```

Target interface	State	Transfers			
		Complete	Pending	Retries	Failures
Cable5/0/0 (669 MHz)	up	15	0	1	0
Cable5/0/0/U0	up	33	0	1	0
Cable5/0/0/U1	up	22	0	2	0

```
Router# test cable load-balance 0000.394e.4e59
```

```
Sending UCC request: Cable5/0/0/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: Cable5/0/0/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
Cable5/0/0 (669 MHz)	up	15	0	1	0
Cable5/0/0/U0	up	34	0	1	0
Cable5/0/0/U1	up	23	0	2	0

```
Router#
```

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 balance group:

```
Router# show cable load-balance statistics

Statistics:

Target interface      State      Transfers
                    Complete Pending  Retries  Failures
Cable5/0/0 (669 MHz) up          15       0         1         0
Cable5/0/0/U0        up          34       0         1         0
Cable5/0/0/U1        up          23       0         2         0

Router# test cable load-balance 0007.0e01.4129 ucc 1

Sending UCC request: Cable5/0/0/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
Cable5/0/0 (669 MHz) up          15       0         1         0
Cable5/0/0/U0        up          35       0         1         0
Cable5/0/0/U1        up          24       0         2         0
```

Router#

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          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          State          Sid  (dB)  Offset  CPE  Enb
0012.17ea.f563 12.0.0.2      C7/1/1/U0  online   3    0.00  2451    0    N
```

Configuration Examples for Load Balancing on the Cisco CMTS

This section provides the following configuration examples:

- [Load-Balance Group Example \(Static Load Balancing\)](#), page 31
- [Load-Balance Group Example \(Passive Load Balancing\)](#), page 31
- [Load-Balance Group Example \(Dynamic Load Balancing\)](#), page 32
- [Interface Configuration Example](#), page 32
- [Sample Configuration for Upstreams and Downstreams](#), page 33

Load-Balance Group Example (Static Load Balancing)

This sample configuration shows a number of load-balance 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
```

Load-Balance Group Example (Passive Load Balancing)

This sample configuration shows a number of load-balance 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
```

Load-Balance Group Example (Dynamic Load Balancing)

This sample configuration shows a number of load-balance 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
```

Interface Configuration Example

This sample configuration for a cable interface shows a downstream and its four upstreams being assigned to the same load-balance 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
```


Sample Configuration for Upstreams and Downstreams

The following example shows the configuration necessary to create the load-balance groups that are shown in [Figure 1 on page 11](#), with load-balance group 1 being used for the two downstreams, load-balance group 2 being used for six upstreams, and load-balance 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
```

How to Configure Dynamic Channel Change for Load Balancing

Cisco IOS Release 12.3(17a)BC introduces Dynamic Channel Change (DCC) and DCC for Load Balancing on the Cisco CMTS.

DCC in DOCSIS 1.1 dynamically changes cable modem upstream or downstream channels without forcing a cable modem to go offline, and without re-registration after the change. DCC supports five different initialization methods (0-4), instead of one, as in earlier DOCSIS support.

DCC and DCC for load balancing is supported on the Cisco uBR7246VXR router and the Cisco uBR10012 router with the following cable interface line cards, including the Cisco MC28U and the Cisco MC5X20S/U/H.

- 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) has to be switched to ATDMA-only mode.

Dynamic Channel Change for Load Balancing entails the following new or enhanced commands in Cisco IOS Release 12.3(17a)BC, and later releases:

Global Configuration Commands

- **cable load-balance group** *group-num* **dcc-init-technique** { 0-4 }
- **cable load-balance group** *group-num* **policy** { pcmm | ugs }
- **cable load-balance group** *group-num* **threshold** {load | pcmm | stability | ugs} { 1-100 }
- **cable load-balance group** *group-num* **threshold load** { 1-100 } {minimum}
- **cable load-balance group** *group-num* **threshold load** { 1-100 } {enforce}

Testing Commands

- **test cable** (*slot/port* | *slot/subslot/port*) **dcc**

Refer also to the [“Command Reference”](#) section on page 45.

Configuring DCC for Load Balancing on the Cisco CMTS

To configure the DCC feature for load balancing, use the following steps in global configuration mode. Values indicated are sample values that may differ from your own.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cable load-balance group *group-num* dcc-init-technique *number***
4. **cable load-balance group *group-num* policy { *pcmm* | *ugs* | *us-groups-across-ds* }**
5. **cable load-balance group *group-num* threshold { *load* | *pcmm* | *stability* | *ugs* } { **1-100** }**
6. **cable load-balance group *group-num* threshold load { **1-100** } { *minimum* }**
7. **cable load-balance group *group-num* threshold load { **1-100** } { *enforce* }**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# config t	Enters global configuration mode.
Step 3	cable load-balance group <i>group-num</i> dcc-init-technique <i>number</i> Example: Router(config)# cable load-balance group 1 dcc-init-technique 0	Sets the DCC initialization technique for the specified load balancing group. The initialization technique number can range from 0-4. <ul style="list-style-type: none"> • Initialization technique 0—reinitializes the MAC address. The cable modem needs to go offline and reregister itself on the new channel. • 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. • Initialization technique 2—performs periodic ranging. The cable modem is kept online and allowed to start on the new channel with periodic ranging. • Initialization technique 3—performs initial ranging or periodic ranging. This technique enables the cable modem to choose a ranging method between initial ranging and periodic ranging. • Initialization technique 4—uses the new channel directly. The cable modem may start to send data immediately on the new channel without any initial ranging or periodic ranging.

	Command or Action	Purpose
Step 4	<pre>cable load-balance group group-num policy { pcmm ugs us-groups-across-ds }</pre> <p>Example:</p> <pre>Router(config)# cable load-balance group 1 policy pcmm Router(config)# cable load-balance group 1 policy ugs</pre>	<p>Enables load balancing of cable modems with either 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.</p> <ul style="list-style-type: none"> • pcmm—Enables balancing of cable modems with active PCMM service flows. • ugs—Enables balancing of cable modems with active UGS service flows. • us-groups-across-ds—Keyword supported in Cisco IOS release 12.3(17b)BC4, and later releases, 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.
Step 5	<pre>cable load-balance group group-num threshold {load pcmm stability ugs} {1-100}</pre> <p>Example:</p> <pre>Router(config)# cable load-balance group 1 threshold ugs 75 Router(config)# cable load-balance group 1 threshold pcmm 75</pre>	<p>Selects the type of service flow threshold and sets the respective threshold in percentage for the load balancing group.</p> <ul style="list-style-type: none"> • load—Interface load threshold settings • pcmm—PCMM service flow threshold • stability—Threshold for stability detection • ugs—UGS service flow threshold • { 1-100}—Interface utilization threshold in percentage of interface capacity.
Step 6	<pre>cable load-balance group group-num threshold load {1-100} {minimum}</pre> <p>Example:</p> <pre>Router(config)# cable load-balance group 1 threshold load 75 minimum</pre>	<p>Sets the load threshold for the specified load balancing group.</p> <ul style="list-style-type: none"> • { 1-100}—Threshold value in percentage • minimum—Set minimum number of modems/flows difference before load balancing starts
Step 7	<pre>cable load-balance group group-num threshold load {1-100} {enforce}</pre> <p>Example:</p> <pre>Router(config)# cable load-balance group 1 threshold load 75 enforce</pre>	<p>Sets the enforce threshold for the specified load balancing group.</p> <ul style="list-style-type: none"> • { 1-100}—Threshold value in percentage • enforce—Keyword enables the enforce threshold, specified in a percentage.
Step 8	<pre>end</pre> <p>Example:</p> <pre>Router(config)# end Router#</pre>	<p>Returns to Privileged EXEC mode.</p>

Testing Dynamic Channel Change for Load Balancing

To test and verify DCC for load balancing, use the following two commands:

- [test cable dcc](#)
- [show controllers cable](#)

These commands, and usage guidelines, are described in the [“Command Reference” section on page 45](#).

Configuration Examples of Dynamic Channel Change (DCC) for Load Balancing

The following example of the running configuration illustrates DCC for load balancing implemented with the commands above. Refer also to the additional **show run** example further below.

```
Router# show run
*Nov 11 15:42:18.955: %SYS-5-CONFIG_I: Configured from console by conscable load all
Group Interval Method DCC Init Threshold
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		Retries	Failures
		Complete	Pending		
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 the DCC for load balancing implemented with the commands above.

```
Router# show run
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 the DCC for load balancing implemented with the commands above.

```

Router# show cable load all
*Nov 11 15:43:39.979: %SYS-5-CONFIG_I: Configured fromconf t
*Nov 11 15:43:40.255: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on
GigabitEthernet0/1 (not full duplex), with JAB023301VR(bxb-sit-sw1) 3/1 (full dushow cable
load all
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. The first command configures load balancing group 1:

```

Router# 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 immediately above 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 cable modems with active voice call or PCMM calls do participate in load balancing.

System Error Messages for Load Balancing

**Note**

Cable modems that are load balanced between cable interface line cards may require a long time to come online. This may result in cable modems being stuck in the **pending** state. This state appears in the output of the **show cable load-balance pending** command.

Affected cable modems have duplicate entries in the pending table and are in a state of being moved back and forth between different cable interface line cards.

This issue occurs when load balancing is configured between Cisco uBR-MC28U line cards, and a cable modem is directed by a line card to move to a second line card. However, by the time the cable modem is moved to the second line card, the second line card has enough cable modems online and directs the cable modem to either move back, or to move further to yet another cable interface line card.

A workaround for this scenario is to configure a large minimum-threshold for load balancing with the following command:

```
cable load-balance group group-number threshold load minimum minimum-threshold
```

To bring cable modems stuck in the pending state to come online, execute the **clear cable load-balance state** command in global configuration mode.

Cisco IOS Release 12.2(15)BC1 adds the following system error messages to support the Load Balancing on the Cisco CMTS feature.

```
%UBR7100-4-LB_MODEM_FAILED
%UBR7200-4-LB_MODEM_FAILED
%UBR10000-4-LB_MODEM_FAILED: Failed to move modem [enet] from [chars] to [chars].
```

Explanation The CMTS was trying to load-balance the two indicated interfaces, but was unable to move the specified cable modem from its current interface to the new interface after five attempts.

Recommended Action Verify that both interfaces are connected and passing traffic. Also look for any possible RF noise problems. Check the **cable load-balance group** configuration to ensure that the two downstreams or upstreams are combined in the same node and share the same physical connectivity (which is required when interfaces are part the same load-balance group).


```
%UBR7100-3-LB_IF_DISABLED  
%UBR7200-3-LB_IF_DISABLED  
%UBR10000-3-LB_IF_DISABLED: Disabled interface [chars]
```

Explanation The CMTS load-balancing subsystem disabled the indicated cable interface, because it could not move cable modems either to it or from it.

Recommended Action Verify that the interface is connected and passing traffic. Also look for any possible RF noise problems. Check the **cable load-balance group** configuration to ensure that the interface's load-balance group contains only those interfaces that are combined in the same node and share the same physical connectivity (which is required when interfaces are part the same load-balance group).

Additional References

For additional information related to Load Balancing on the Cisco CMTS, refer to the following references:

Related Documents

Related Topic	Document Title
CMTS Command Reference	<i>Cisco Broadband Cable Command Reference Guide</i> , at the following URL: http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html
Cisco IOS Release 12.2 Command Reference	Cisco IOS Release 12.2 Configuration Guides and Command References, at the following URL: http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html

Standards

Standards ¹	Title
SP-RFIV1.1-I09-020830	Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification, version 1.1

1. Not all supported standards are listed.

MIBs

MIBs ¹	MIBs Link
New MIBs are introduced in Cisco IOS Release 12.3(17a)BC in support of DCC for load balancing.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

1. Not all supported MIBs are listed.

The following MIB information is updated in Cisco IOS Release 12.3(17a)BC in support of DCC for load balancing:

docsQosDCCReqs OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION "The number of Dynamic Channel Change Request messages traversing an interface. This count is nonzero only on downstream direction rows."

::= { docsQosDynamicServiceStatsEntry 16 }

docsQosDCCRspS OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION "The number of Dynamic Channel Change Response messages traversing an interface. This count is nonzero only on upstream direction rows."

::= { docsQosDynamicServiceStatsEntry 17 }

docsQosDCCAcks OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION "The number of Dynamic Channel Change Acknowledgement messages traversing an interface. This count is nonzero only on downstream direction rows."

::= { docsQosDynamicServiceStatsEntry 18 }

docsQosDCCs OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION "The number of successful Dynamic Channel Change transactions. This count is nonzero only on downstream direction rows."

::= { docsQosDynamicServiceStatsEntry 19 }

docsQosDCCFails OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION "The number of failed Dynamic Channel Change transactions. This count is nonzero only on downstream direction rows."

::= { docsQosDynamicServiceStatsEntry 20 }

RFCs

RFCs ¹	Title
RFC 1163	Border Gateway Protocol
RFC 1164	Application of the Border Gateway Protocol in the Internet
RFC 1483	Multiprotocol Encapsulation over ATM Adaptation Layer 5
RFC 2233	DOCSIS OSSI Objects Support
RFC 2283	Multiprotocol Extensions for BGP-4
RFC 2665	DOCSIS Ethernet MIB Objects Support
RFC 2669	Cable Device MIB

1. Not all supported RFCs are listed.

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.	http://www.cisco.com/cisco/web/support/index.html

Command Reference

The following commands are needed to enable and configure the Load Balancing feature for the Cisco CMTS. This section includes commands for Dynamic Channel Change (DCC) for Load Balancing. Otherwise, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com and to procedures in this document for complete information.

Primary Load Balancing Commands

- **cable load-balance exclude**
- **cable load-balance group** (global configuration)
- **cable load-balance group** (interface configuration)
- **cable load-balance group interval**
- **cable load-balance group policy**
- **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**

Dynamic Channel Change Commands for Load Balancing

Dynamic Channel Change for Load Balancing entails the following new or enhanced commands in Cisco IOS Release 12.3(17a)BC, and later releases. This section describes commands supporting DCC for Load Balancing. Also refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com and to procedures in this document for additional command information.

Global Configuration Commands for DCC

- **cable load-balance group**
- **cable load-balance group dcc-init-technique**
- **cable load-balance group policy**
- **cable load-balance group threshold**

Show and Testing Commands for DCC

- **show controllers cable**
- **test cable dcc**

cable load-balance group

To set multiple parameters for Load Balancing with Dynamic Channel Change (DCC), use the following command in global configuration mode. To remove this configuration, use the **no** form of this command.

```
cable load-balance group group-num { dcc-init-technique | interval | method | policy | threshold }
no cable load-balance group group-num { dcc-init-technique | interval | method | policy | threshold }
```

Syntax Description

dcc-init-technique	Sets DCC initialization technique.
interval	Sets interface polling interval.
method	Sets upstream load balancing type/method.
policy	Sets load balancing policy.
threshold	Load balancing threshold in percentage.

Command Default

Load balancing is not configured by default on the Cisco CMTS.

Command Modes

Global configuration mode.

Command History

Release	Modification
12.3(17a)BC	This command was introduced on the Cisco uBR10012 router and the Cisco uBR7246VXR router, with supporting broadband processing engines (BPEs) or cable interface line cards on the respective routers.

Examples

The following example illustrates configuration of the initialization techniques specified for DCC:

```
Router(config)# cable load-balance group 1 dcc-init-technique 4
```

For further examples of this command, and related keywords, refer to related commands, and refer also to the “[Configuring DCC for Load Balancing on the Cisco CMTS](#)” section on page 36.

Usage Guidelines

This command is subject to the restrictions and prerequisites described in [Configuring Load Balancing and Dynamic Channel Change \(DCC\) on the Cisco CMTS](#).

Related Commands

Command	Description
cable load-balance group dcc-init-technique	Sets the initialization technique for Dynamic Channel Change (DCC) for Load Balancing.
cable load-balance group policy	Sets the type of service flow for use with Load Balancing and DCC, whether PacketCable MultiMedia (PCMM) or Unsolicited Grant Service (UGS).

Command	Description
cable load-balance group threshold	Sets the threshold levels for corresponding service flow types for the specified Load Balancing group, supporting Dynamic Channel Change (DCC)
show controllers cable	Displays statistics for Dynamic Channel Change (DCC) for load balancing.
test cable dcc	Performs testing functions for Load Balancing with DCC

Also refer to the following document on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*
http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

cable load-balance group dcc-init-technique

To set the initialization technique for Dynamic Channel Change (DCC), use the following command in global configuration mode. To remove this configuration, use the no form of this command.

```
cable load-balance group group-num dcc-init-technique {0-4}
```

Syntax Description

dcc-init-technique	Sets DCC initialization technique
<0-4>	DCC Initialization technique number

Command Default

By default, DCC uses the 0 initialization technique, unless otherwise specified.



Note

By default, UGS and PCMM policies are not turned on, so that cable modems with active voice call or PCMM calls do participate in load balancing.

Command Modes

Global configuration mode.

Command History

Release	Modification
12.3(17a)BC	This command was introduced on the Cisco uBR10012 router and the Cisco uBR7246VXR router, with supporting broadband processing engines (BPEs) or cable interface line cards on the respective routers.

Examples

The following example illustrates configuration of the initialization techniques specified for DCC:

```
Router(config)# cable load-balance group 1 dcc-init-technique 4
```

Usage Guidelines

This command is subject to the restrictions and prerequisites described in [Configuring Load Balancing and Dynamic Channel Change \(DCC\) on the Cisco CMTS](#).

DCC for Load Balancing supports the following types of initialization techniques:

- Initialization technique 0—reinitializes the MAC address. The cable modem needs to go offline and re-register on the new channel.
- Initialization technique 1—broadcasts the initial ranging. The cable modems are kept online and re-registration is avoided, but this technique requires completion of initial ranging.
- Initialization technique 2—performs periodic ranging. The cable modems are kept online and allowed to start on the new channel with periodic ranging.
- Initialization technique 3—performs initial ranging or periodic ranging. This technique enables the cable modem to choose a ranging method between initial ranging and periodic ranging.
- Initialization technique 4—uses the new channel directly. The cable modem may start to send data immediately on the new channel without any initial ranging or periodic ranging.

Related Commands	Command	Description
	cable load-balance group	Sets multiple parameters for Load Balancing with DCC.
	cable load-balance group policy	Sets the type of service flow for use with Load Balancing and DCC, whether PacketCable MultiMedia (PCMM) or Unsolicited Grant Service (UGS).
	cable load-balance group threshold	Sets the threshold levels for corresponding service flow types for the specified Load Balancing group, supporting Dynamic Channel Change (DCC)
	show controllers cable	Displays statistics for Dynamic Channel Change (DCC) for load balancing.
	test cable dcc	Performs testing functions for Load Balancing with DCC

Also refer to the following document on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*
http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

cable load-balance group policy

To set the type of service flow for use with Load Balancing and Dynamic Channel Change (DCC), use the following command in global configuration mode. This command supports PacketCable MultiMedia (PCMM), Unsolicited Grant Service (UGS), or distributed load balancing to the specified Load Balancing group.

In the case of PCMM, this command enables cable modems with active PCMM flows to participate in load balancing after a certain threshold is reached.



Note

Defining the UGS policy in load balancing is required, in addition to UGS that is used for PCMM calls.

To remove this configuration, use the **no** form of this command.

```
cable load-balance group group-num policy {pcmm | ugs | us-groups-across-ds }
```

```
no cable load-balance group group-num policy {pcmm | ugs | us-groups-across-ds }
```

Syntax Description

<i>group-num</i>	Specifies the load balancing group number being configured.
pcmm	Enables balancing of modems with active PCMM service flows.
ugs	Enables balancing of modems with active UGS service flows.
us-groups-across-ds	Keyword supported in Cisco IOS release 12.3(17b)BC4, and later releases, 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.

Command Default

By default, cable modems with active PCMM are not load balanced.

By default, cable modems with active UGS flows are not load balanced.

Command Modes

Global configuration mode.

Command History

Release	Modification
12.3(17a)BC	This command was introduced on the Cisco uBR10012 router and the Cisco uBR7246VXR router, with supporting broadband processing engines (BPEs) or cable interface line cards on the respective routers.

Examples

The following examples illustrate configuration commands for PacketCable MultiMedia (PCMM) and Unsolicited Grant Service (UGS) for DCC:

```
Router(config)# cable load-balance group 1 policy pcmm  
Router(config)# cable load-balance group 1 policy ugs
```

Usage Guidelines

This command is subject to the restrictions and prerequisites described in [Configuring Load Balancing and Dynamic Channel Change \(DCC\) on the Cisco CMTS](#).

Cisco IOS Release 12.3(17b)BC4 introduces further enhancements to downstream load balancing, resulting in 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.

- **cable load-balance group** *ds-lb-group-id* **policy** { **ugs** | **pcmm** | **us-groups-across-ds** }
- **show cable load all**

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.

This 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.

Cisco IOS Release 12.3(17b)BC4 enables the configuration and operation of making downstream load balancing decisions 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
- nowhere else, however

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 for configuring downstream load balancing groups.

Related Commands	Command	Description
	cable load-balance group	Sets multiple parameters for Load Balancing with DCC.
	cable load-balance group dcc-init-technique	Sets the initialization technique for Dynamic Channel Change (DCC) for Load Balancing.
	cable load-balance group threshold	Sets the threshold levels for corresponding service flow types for the specified Load Balancing group, supporting Dynamic Channel Change (DCC)
	show controllers cable	Displays statistics for Dynamic Channel Change (DCC) for load balancing.
	test cable dcc	Performs testing functions for Load Balancing with DCC

Also refer to the following document on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*
http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

cable load-balance group threshold

To set the threshold levels and corresponding service flow types for the specified Load Balancing group, supporting Dynamic Channel Change (DCC) on the Cisco router, use the following command in global configuration mode. To remove threshold settings, use the **no** form of this command.

```
cable load-balance group group-num threshold {load | pcmm | stability | ugs} {0-100}
```

```
cable load-balance group group-num threshold ugs {1-100}
```

```
cable load-balance group group-num threshold load {1-100} {minimum} {enforce}
```

Syntax Description

load	Interface load threshold settings
pcmm	PCMM service flow threshold
stability	Threshold for stability detection
ugs	UGS service flow threshold
0-100	Interface utilization threshold in percentage of interface capacity.
load	Interface load threshold settings
1-100	Threshold value in percentage
minimum	Sets minimum number of modems/flows difference before loadbalancing starts
enforce	Enters the enforce threshold

Command Default

Load balancing is not configured by default on the Cisco CMTS, commencing in Cisco IOS Release 12.3(17a)BC. The default load balancing threshold, when Load Balancing is enabled on the Cisco CMTS, is 70% for PCMM or UGS service flows.

In Cisco IOS releases prior to Cisco IOS Release 12.3(17a)BC, the load balancing default setting is UGS.

Command Modes

Global configuration mode.

Command History

Release	Modification
12.3(17a)BC	This command was introduced on the Cisco uBR10012 router and the Cisco uBR7246VXR router, with supporting broadband processing engines (BPEs) or cable interface line cards on the respective routers.

Examples

The following command specifies the reserved bandwidth threshold. Above this level, cable modems with active PCMM service flows participate in load balancing, and the default threshold is 70%. Note that if UGS is used for PCMM, the UGS threshold needs to be crossed as well. The default UGS threshold is 70%.

```
Router(config)# cable load-balance group 4 threshold pcmm pcmm-value
```

Usage Guidelines

In Cisco IOS releases prior to Cisco IOS Release 12.3(17a)BC, the load balancing default setting is UGS. This is not the case with Cisco IOS Release 12.3(17a)BC. In this latter release, and subsequent releases, configuration is required if the cable modems with active UGS flows are desired to participate in load balancing.

This command is subject to the restrictions and prerequisites described in *Configuring Load Balancing and Dynamic Channel Change (DCC) on the Cisco CMTS*.

Related Commands

Command	Description
cable load-balance group	Sets multiple parameters for Load Balancing with DCC.
cable load-balance group dcc-init-technique	Sets the initialization technique for Dynamic Channel Change (DCC) for Load Balancing.
cable load-balance group policy	Sets the type of service flow for use with Load Balancing and DCC, whether PacketCable MultiMedia (PCMM) or Unsolicited Grant Service (UGS).
show controllers cable	Displays statistics for Dynamic Channel Change (DCC) for load balancing.
test cable dcc	Performs testing functions for Load Balancing with DCC

Also refer to the following document on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*
http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

show controllers cable

To display statistics for Dynamic Channel Change (DCC) for load balancing, use the **show controllers cable** command in privileged EXEC mode.

```
show controllers cable {slot/port | slot/subslot/port} upstream | i DCC
```

```
show controllers cable {slot/port | slot/subslot/port} downstream | i DCC
```

Syntax Description		
<i>slot/port</i>	Identifies a cable interface on the Cisco uBR7246VXR router. The following are valid values:	<ul style="list-style-type: none"> <i>slot</i>—3 to 6 <i>port</i>—0 or 1, depending on the cable interface
<i>slot/subslot/port</i>	Identifies a cable interface on the Cisco uBR10012 router. The following are the valid values:	<ul style="list-style-type: none"> <i>slot</i>—5 to 8 <i>subslot</i>—0 or 1 <i>port</i>—0 to 4, depending on the cable interface

Command Default Test functions are disabled by default.

Command Modes Privileged EXEC mode.

Command History	Release	Modification
	12.3(17a)BC	This command was enhanced on the Cisco uBR10012 router and the Cisco uBR7246VXR router, to display DCC information.

Examples The following commands and fields illustrate the **show controllers** command used with DCC:

```
Router# show controllers cx/y upstream | i DCC
DCC: 0 REQs n2 RSPs 0 ACKs
Router# show controllers cx/y downstream | i DCC
DCC: n1 REQs 0 RSPs n3 ACKs
n4 Successful DCCs n5 DCC Failures
DCC end of transaction counts:
DCC unknown cause(e1) offline(e2) if down(e3) no cm(e4)
DCC no resource(e5) no retries(e6) reject(e7) unknown state (e8)
DCC rebuild err (e9) T15 timeout(e10) reinit MAC (e11) dcc succeeds(e12)
```

The fields in this example are as follows:

- n1—The number of DCC REQ messages traversing an interface, nonzero on downstream.
- n2—The number of DCC RSP messages traversing an interface, nonzero on upstream.
- n3—The number of DCC ACK messages traversing an interface, nonzero on downstream.
- n4—The number of successful DCC transactions, nonzero on downstream direction.
- n5—The number of failed DCC transactions, nonzero only on downstream direction

The above counters are DOCSIS specific DCC counters, which can also be collected via SNMP MIB.

The following summary illustrates classified DCC transaction end counts originated from the interface with the above **show controllers** command example.

- e1—The number of DCC transactions ended with unknown causes.
- e2—The number of DCC transactions ended due to modem's going offline.
- e3—The number of DCC transactions ended due to interface down.
- e4—The number of DCC transactions ended due to nonexistent cm.
- e5—The number of DCC transactions ended due to insufficient resource on target.
- e6—The number of DCC transactions ended due to exhausted DCC-REQ retries.
- e7—The number of DCC transactions ended due to rejected DCC-REQ.
- e8—The number of DCC transactions ended due to unknown DCC state.
- e9—The number of DCC transactions ended due to failure to assign cm on the target.
- e10—The number of DCC transactions ended due to T15 time out.
- e11—The number of DCC transactions ended due to CM MAC reinitialization.
- e12—The number of DCC transactions ended successfully.

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
```

Below are further verification examples of DCC for load balancing, using the **show controllers** command. In the following example, one DCC-RSP (depart) message is received on the source upstream.

```
Router# show controllers c7/1/0 upstream | i DCC
DCC: 0 REQs 1 RSPs 0 ACKs
0 Successful DCCs 0 DCC Failures
```

In the following example, one DCC-RSP (arrive) message is received on the target upstream.

```
Router# show controllers c7/1/1 upstream | i DCC
DCC: 0 REQs 1 RSPs 0 ACKs
0 Successful DCCs 0 DCC Failures
```

In the following example, one DCC-REQ message is transmitted on the source downstream. Further information follows:

```
Router# show controllers c7/1/0 downstream | i DCC
DCC: 1 REQs 0 RSPs 0 ACKs
1 Successful DCCs 0 DCC Failures
```

```
DCC end of transaction counts:
DCC unknown cause(0) offline(0) if down(0) no cm(0)
DCC no resource(0) no retries(0) reject(0) unknown state (0)
DCC rebuild err (0) T15 timeout(0) reinit MAC (0) dcc succeeds(1)
(1 DCC transaction originated ended successfully)
Router# show controllers c7/1/1 downstream | i DCC
DCC: 0 REQs 0 RSPs 1 ACKs
0 Successful DCCs 0 DCC Failures
(1 DCC-ACK message transmitted on the target downstream)
```


Usage Guidelines

This command is subject to the restrictions and prerequisites described in [Configuring Load Balancing and Dynamic Channel Change \(DCC\) on the Cisco CMTS](#).

Related Commands

Command	Description
test cable load-balance	Performs general testing for Load Balancing.
test cable dcc	Performs testing functions for Load Balancing with DCC.

test cable dcc

To test Dynamic Channel Change for Load Balancing on the Cisco CMTS, use the following command in global configuration mode.

```
test cable dcc [ mac-addr | ip-addr | cable-if-src sid ] cable-if-target uschan { ranging-tech }
```

Syntax	Description
<i>mac-addr</i>	The MAC address of the cable modem to be moved for DCC test.
<i>ip-addr</i>	The IP address of the cable modem to be moved for DCC test.
<i>cable-if-src</i>	The name of the source downstream interface for the DCC transaction.
<i>Sid</i>	Primary Service ID (sid) value.
<i>cable-if-target</i>	The name of the target downstream interface for the DCC transaction.
<i>uschan</i>	The upstream channel ID of the target upstream for the DCC transaction.
<i>ranging-tech</i>	The initialization technique to be used for the DCC transaction, 0 is the default if not specified. Valid range is 0-4.

Command Default Test functions are disabled by default.

Command Modes Global configuration mode.

Command History	Release	Modification
	12.3(17a)BC	This command was introduced on the Cisco uBR10012 router and the Cisco uBR7246VXR router, with supporting broadband processing engines (BPEs) or cable interface line cards on the respective routers.

Examples

The following examples illustrate DCC verification, using the **test cable dcc** command.

The following example moves a target cable modem, specified by MAC address, IP address or the primary sid value on the source interface to a target downstream with the specified frequency using DCC initialization technique 0:

```
Router# test cable dcc [<mac-addr>|<ip-addr>|<cable-if-src><sid>] frequency <freq-value>
Frequency-value: <55000000-858000000> New Downstream Frequency in HZ.
```

The following example moves a target cable modem, specified by MAC address, IP address or the primary sid value on the source interface to a upstream channel on a target downstream with the DCC-REQ TLV given in the specified HEX data.

```
Router# test cable dcc [<mac-addr>|<ip-addr>|<cable-if-src><sid>] TLV <Hex-data>
```

The following example moves all cable modems on a source interface to a target downstream with the specified frequency using DCC initialization technique 0.

```
Router# test cable dcc <cable-if-src> frequency <frequency-value>
Frequency-value: <55000000-858000000> New Downstream Frequency in HZ.
```

Usage Guidelines

This command is subject to the restrictions and prerequisites described in *Configuring Load Balancing and Dynamic Channel Change (DCC) on the Cisco CMTS*.

Related Commands

Command	Description
cable load-balance group	Sets multiple parameters for Load Balancing with DCC.
cable load-balance group dcc-init-technique	Sets the initialization technique for Dynamic Channel Change (DCC) for Load Balancing.
cable load-balance group policy	Sets the type of service flow for use with Load Balancing and DCC, whether PacketCable MultiMedia (PCMM) or Unsolicited Grant Service (UGS).
cable load-balance group threshold	Sets the threshold levels for corresponding service flow types for the specified Load Balancing group, supporting Dynamic Channel Change (DCC)
show controllers cable	Displays statistics for Dynamic Channel Change (DCC) for load balancing.

Also refer to the following document on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*
http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

Glossary

This section describes terms and acronyms that are used in this manual and not otherwise defined. See the *Internetworking Terms and Acronyms* for terms not included in this glossary.

active service flow—An admitted service flow that is available for packet transmissions between the cable modem and the CMTS in either the upstream or the downstream direction.

admitted service flow—A provisioned or dynamically signaled service flow that is authorized, and for which resources have been reserved, but that is not active.

amplifier—Used on coaxial segments of a CATV plant to restore signal levels lost due to attenuation through distance.

availability—The long term ratio of the actual radio frequency (RF) channel operation time to the scheduled RF channel operation time (expressed as a percentage) based on a bit error rate (BER) assumption.

ATM—Asynchronous Transfer Mode.

bandwidth allocation map—The MAC management message that the CMTS uses to allocate transmission opportunities to cable modems.

branch line—A coaxial cable that runs from a trunk line to a subscriber drop point. A branch line is also known as a feeder cable.

cable interface line card—The modem front-end card of the cable router headend device, plugged into the midplane. Each cable line card provides a number of radio frequency (RF) channels as external interfaces.

cable modem (CM)—A modulator/demodulator at subscriber locations that is used in conveying data communications on a cable television system.

cable modem termination system (CMTS)—A device that provides complementary functionality to cable modems to enable connectivity to a wide area network (WAN).

cable access router—A modular chassis-based router that is optimized for the data over CATV HFC application.

CATV—Refers to any cable-based system of television services (either coaxial or fiber cable).

CLI—command-line interface.

codec—coder-decoder. A device that typically uses pulse code modulation to transform analog signals into a digital bit stream and digital signals back into analog.

CPE—customer premises equipment. One or more PCs located at the customer site.

distribution hub—A smaller or remote headend distribution point for a CATV system. Video signals are received here from another site (headend) and are redistributed. Sometimes a small number of locally originated signals are added. These signals might be city of information channels, HFC cable modem signals, and so on.

DOCSIS—Data-over-Cable Service Interface Specifications. Defines technical specifications for equipment at both subscriber locations and cable operators' headends. Adoption of DOCSIS can accelerate deployment of data-over-cable services and ensure interoperability of equipment throughout system operators' infrastructures.

downstream—A set of frequencies used to send data from a headend to a subscriber.

drop—A subscriber access point; the actual coaxial connection in a subscriber's home.

dynamic load balancing—A form of traffic-based load balancing in which cable modems are balanced among upstreams and downstreams after they come online, while they are passing traffic. Dynamic load balancing must be enabled by using the **enforce** option of the **cable load-balance group threshold** command.

fiber node (node)—An optical node (located in the outside plant distribution system) that terminates the fiber-based downstream signal as an electrical signal onto a coaxial RF cable. Each fiber node is defined to support a designated service area, defined either by the number of homes or by total amplifier cascade (the total number of active amplifiers in the longest line from the node to the end of the line).

headend—The endpoint of a broadcast network and central distribution point for a CATV system. All stations transmit toward the headend; the headend then transmits toward the destination stations. Video signals are received from a satellite (either colocated or remote), and the frequency is converted to the appropriate channels where it is combined with locally originated signals and is rebroadcast onto the HFC plant. For a CATV data system, the headend is the typical place to link between the HFC system and any external data networks.

HFC—hybrid fiber-coaxial. Older CATV systems were provisioned using only coaxial cable. Modern systems use fiber transport from the headend to an optical node located in the neighborhood to reduce system noise. Coaxial runs from the node to the subscriber. The fiber plant is generally a star configuration with all optical node fibers terminating at a headend. The coaxial part of the system is generally a trunk and branch configuration.

MAC—media access control. Typically refers to the lower of the two sublayers of the data link layer that is defined by the IEEE. The MAC sublayer handles access to shared physical transmission media. In DOCSIS networks, MAC also refers to the management messages that are sent between the CMTS and CM to maintain connectivity over the cable network.

optical node—A device used to convert broadband RF to and from a fiber-optic signal. An optical node is usually located in the outside field.

passive load balancing—Load balancing that is done at the time a cable modem registers by ignoring a cable modem's ranging request (RNG-REQ) message until it uses the correct target channels. Passive load balancing is not performed for cable modems unless you exclude those modems from using static load balancing with the **cable load-balance exclude** command.

provisioning—The programming of allocatable resources, such as operating parameters, upstream and downstream frequencies, slot assignments, and logical identifiers, in headend and subscriber modems.

ranging—The adjustment of the subscriber modem upstream timing offset to ensure that an upstream packet inserted into a TDMA slot aligns correctly with the headend modem upstream frame.

registration—The process of a subscriber modem signing on to the cable network by identifying itself to the headend.

SAID—See security association identifier.

security association identifier—A Baseline Privacy security identifier between a CMTS and a cable modem.

service flow—A MAC-layer transport service that provides unidirectional transport of packets from the upper service layer entity to the RF device.

service identifier (SID)—A service flow identifier (14 bits) assigned by the CMTS to an active or admitted upstream service flow.

SFID—service flow identifier.

SGCP—Simple Gateway Control Protocol. Controls Voice-over-IP (VoIP) gateways by an external call control element (called a call agent).

SID— See service identifier.

SNMP—Simple Network Management Protocol.

static load balancing—Load balancing that is done at the time a cable modem registers by specifying the proper target channel in the Downstream Frequency Override or an Upstream Channel ID Override field in the ranging response (RNG-RSP) message that the CMTS sends to the cable modem. Static load balancing is done by default for cable modems in a load-balance group, unless you exclude those modems from static load balancing using the **cable load-balance exclude** command.

status request—The periodic querying of subscriber cable modems by the headend for alarm and service requests.

tap—A passive device that divides a signal between the trunk or feeder lines and splits the signal into ports for subscriber drop access.

TDM—time-division multiplexing. A technique in which information from multiple channels can be allocated bandwidth on a single wire, based on preassigned time slots. Bandwidth is allocated to each channel regardless of whether the station has data to transmit.

TDMA—time-division multiple access.

trunk line—A CATV backbone coaxial cable. This cable runs from an optical node through a specific neighborhood or service area.

UBR—universal broadband router. Refers to the family line of DOCSIS Cisco CMTS routers.

UGS—unsolicited grant service, which is an Upstream Flow Scheduling Service Type that provides constant bit rate (CBR) traffic onto service flows. UGS service flows support applications that require real-time traffic, such as Voice over IP and Video-on-Demand (VoD).

upstream—The set of frequencies used to send data from a subscriber to the headend.

VoIP—Voice over IP. The ability to carry normal telephone-style voice over an IP-based Internet with POTS-like functionality, reliability, and voice quality. VoIP is a blanket term that generally refers to the Cisco standards-based (for example, H.323 or SGCP) approach to IP voice traffic.

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