Bandwidth-Based Call Admission Control for IP Multicast

Last Updated: April 16, 2012

This module describes how to configure the Bandwidth-Based Call Admission Control for IP Multicast feature to create bandwidth-based multicast call admission control (CAC) policies for assigning costs to mroutes that are being limited by per interface mroute state limiters.

Finding Feature Information

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

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Broadwidth-Based CAC for IP Multicast

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Multicast Admission Control

As the popularity of network video applications grows among consumers, admission control functions--which govern transmission and reception of multicast traffic based on available network resources--are vital. Without admission control, some users may receive degraded multicast streams, rendering programs unwatchable, and others may receive a “Network Busy” message or nothing at all as network resources are overtaxed. Network admission control is important in maintaining a high quality of experience for digital video consumers.

The goals of multicast admission control features, therefore, are as follows:

- Protect the router from control plane overload to ensure that memory and CPU resources on multicast-enabled routers are not overrun by multicast route (mroute) states or denial-of-service (DoS) attacks from multicast packets.
- Enable proper resource allocation (on a global, per MVRF, or per interface basis) to ensure that multicast services are delivered to subscribers per their IP Service Level Agreements (SLAs) and to minimize the effects of DoS attacks on subscribers.
- Provide multicast CAC capabilities to prevent bandwidth resources (interfaces, subnetworks) from being congested and to enable service providers to offer more flexible and refined content and subscriber-based policies.

Bandwidth-Based CAC for IP Multicast

The Bandwidth-Based CAC for IP Multicast feature enhances the Per Interface Mroute State Limit feature by implementing a way to count per interface mroute state limiters using cost multipliers (referred to as *bandwidth-based multicast CAC policies*). This feature can be used to provide bandwidth-based multicast CAC on a per interface basis in network environments where the multicast flows utilize different amounts of bandwidth.

Mechanics of the Bandwidth-Based Multicast CAC Policies

The mechanics of bandwidth-based multicast CAC policies are as follows:

- Once an mroute matches an ACL configured for a per interface mroute state limiter, the Cisco IOS software performs a top-down search from the global or per MVRF list of configured bandwidth-based multicast CAC policies to determine if a cost should be applied to the mroute.
- A cost is applied to the first bandwidth-based CAC policy that matches the mroute. A match is found when the ACL applied to the bandwidth-based CAC policy permits the mroute state.
- The counter for the mroute state limiter either adds or subtracts the cost configured for the *cost-multiplier* argument. If no costs are configured or if the mroute does not match any of the configured bandwidth-based CAC polices, the default cost of 1 is used.

Tips for Configuring Bandwidth-Based CAC Policies for IP Multicast

- To ensure that a particular cost applies to all mroutes being limited, you can configure a bandwidth-based CAC policy whose ACL contains a **permit any** statement. Configuring a bandwidth-based CAC policy in this manner effectively ensures that the default cost is not applied to any mroutes being limited.

- Configuring a bandwidth-based CAC policy with a cost of 0 for the *cost-multiplier* argument can be used to skip the accounting of certain mroutes (for example, to prevent Auto-RP groups or a specific multicast channel from being accounted).
- An explicit deny statement for a specific mroute in an ACL can be used to specify the state that will not match the ACL (thus, preventing the ACL from being accounted). If an mroute matches a deny statement, the search immediately continues to the next configured bandwidth-based CAC policy. Configuring an explicit deny statement in an ACL can be more efficient than forcing the mroute to fall through an ACL (by means of the implicit **deny any** statement at the end of the ACL).

How to Configure Bandwidth-Based Call Admission Control (CAC) for IP Multicast

Configuring Bandwidth-Based Multicast CAC Policies

Perform this optional task to configure bandwidth-based multicast CAC policies. Bandwidth-based multicast CAC policies provide the capability to assign costs to mroutes that are being limited by per interface mroute state limiters. This task can be used to provide bandwidth-based multicast CAC on a per interface basis in network environments where the multicast flows utilize different amounts of bandwidth. Bandwidth-based multicast CAC policies can be applied globally.

Note You can omit Steps 3 to 7 if you have already configured the per interface mroute state limiters for which to apply costs.

- IP multicast is enabled and the Protocol Independent Multicast (PIM) interfaces are configured using the tasks described in the "Configuring Basic IP Multicast" module of the *IP Multicast: PIM Configuration Guide*.
- All ACLs to be applied to bandwidth-based multicast CAC policies must be configured prior to beginning this configuration task; otherwise, the limiters are ignored. For information about how to configure ACLs, see the “Creating an IP Access List and Applying It to an Interface” module of the *Security Configuration Guide: Access Control Lists* guide.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip multicast limit** [**connected** | **out** | **rpf**] *access-list max-entries*
5. Repeat Step 4 if you want to configure additional mroute state limiters on the interface. Repeat Step 3 and Step 4 if you want to configure mroute state limiters on additional interfaces.
6. **exit**
7. **ip multicast limit cost** *access-list cost-multiplier*
8. Repeat Step 7 if you want to apply additional costs to mroutes.
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 0/0/0`	Enters interface configuration mode for the specified interface type and number.
Step 4	**ip multicast limit** [**connected** | **out** | **rpf**] *access-list max-entries* **Example:** `Device(config-if)# ip multicast limit acl-test 100`	Configures mroute state limiters on an interface.
Step 5	Repeat Step 4 if you want to configure additional mroute state limiters on the interface. Repeat Step 3 and Step 4 if you want to configure mroute state limiters on additional interfaces.	

	Command or Action	Purpose
Step 6	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode, and returns to global configuration mode.
Step 7	**ip multicast limit cost** *access-list cost-multiplier* **Example:** `Device(config)# ip multicast limit cost acl-MP2SD-channels 4000`	Applies costs to per interface mroute state limiters. • Specify the ACL that defines the IP multicast traffic for which to apply a cost. ◦ Standard ACLs can be used to define the (*, G) state. ◦ Extended ACLs can be used to define the (S, G) state. Extended ACLs also can be used to define the (*, G) state, by specifying 0.0.0.0 for the source address and source wildcard--referred to as (0, G)--in the permit or deny statements that compose the extended access list. • Specify the cost value to be applied to mroutes that match the ACL associated with the bandwidth-based multicast CAC policy.
Step 8	Repeat Step 7 if you want to apply additional costs to mroutes.	
Step 9	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode, and enters privileged EXEC mode.

Monitoring Per Interface Mroute State Limiters and Bandwidth-Based Multicast CAC Policies

Perform this optional task to monitor per interface mroute state limiters and bandwidth-based multicast CAC policies.

SUMMARY STEPS

1. **enable**
2. **debug ip mrouting limits** [*group-address*]
3. **show ip multicast limit** *type number*
4. **clear ip multicast limit** [*type number*]

DETAILED STEPS

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **debug ip mrouting limits** [*group-address*]
Displays debugging information about configured per interface mroute state limiters and bandwidth-based multicast CAC policies.

The following output is from the **debug ip mrouting limits** command. The output displays the following events:

- An mroute state being created and the corresponding per interface mroute state limiter counter being increased by the default cost of 1 on incoming Ethernet interface 1/0.
- An mroute olist member being removed from the olist and the corresponding per interface mroute limiter being decreased by the default cost of 1 on outgoing Ethernet interface 1/0.
- An mroute being denied by the per interface mroute state limiter because the maximum number of mroute states has been reached.
- An mroute state being created and the corresponding per interface mroute state limiter counter being increased by the cost of 2 on incoming Ethernet interface 1/0.
- An mroute olist member being removed from the olist and the corresponding per interface mroute limiter being decreased by a cost of 2 on outgoing Ethernet interface 1/0.

Example:

```
device# debug ip mrouting limits

MRL(0): incr-ed acl ‘rpf-list’ to (13 < max 32), [n:0,p:0], (main) GigabitEthernet0/0,
(10.41.0.41, 225.30.200.60)
MRL(0): decr-ed acl ‘out-list’ to (10 < max 32), [n:0,p:0], (main) GigabitEthernet0/0, (*,
225.40.202.60)
MRL(0): Add mroute (10.43.0.43, 225.30.200.60) denied for GigabitEthernet0/2, acl std-list, (16 =
max 16)
MRL(0): incr-ed limit-acl `rpf-list' to (12 < max 32), cost-acl 'cost-list' cost 2, [n:0,p:0],
(main) GigabitEthernet0/0, (10.41.0.41, 225.30.200.60)
MRL(0): decr-ed limit-acl `out-list' to (8 < max 32), cost-acl 'cost-list'' cost 2, [n:0,p:0],
(main) GigabitEthernet0/0, (*, 225.40.202.60)
```

Step 3 **show ip multicast limit** *type number*
Displays counters related to mroute state limiters configured on the interfaces on the router.

For each per interface mroute state limiter shown in the output, the following information is displayed:

- The direction of traffic that the per mroute state limiter is limiting.
- The ACL referenced by the per interface mroute state limiter that defines the IP multicast traffic being limited.
- Statistics, enclosed in parenthesis, which track the current number of mroutes being limited less the configured limit. Each time the state for an mroute is created or deleted and each time an outgoing interface list (olist) member is added or removed, the counters for matching per interface mroute state limiters are increased or decreased accordingly.
- The exceeded counter, which tracks the total number of times that the limit configured for the per interface mroute state limiter has been exceeded. Each time an mroute is denied due to the configured limit being reached, the exceeded counter is increased by a value of 1.

The following is sample output from the **show ip multicast limit** command with the *type number* arguments. In this example, information about mroute state limiters configured on Gigabit Ethernet interface 0/0 is displayed.

Example:

```
Device# show ip multicast limit GigabitEthernet 0/0

Interface GigabitEthernet 0/0
 Multicast Access Limits
out acl out-list (1 < max 32) exceeded 0
rpf acl rpf-list (6 < max 32) exceeded 0
con acl conn-list (0 < max 32) exceeded 0
```

Step 4 **clear ip multicast limit** [*type number*]

Resets the exceeded counter for per interface mroute state limiters.

The following example shows how to reset exceeded counters for per interface mroute state limiters configured on Gigabit Ethernet interface 0/0:

Example:

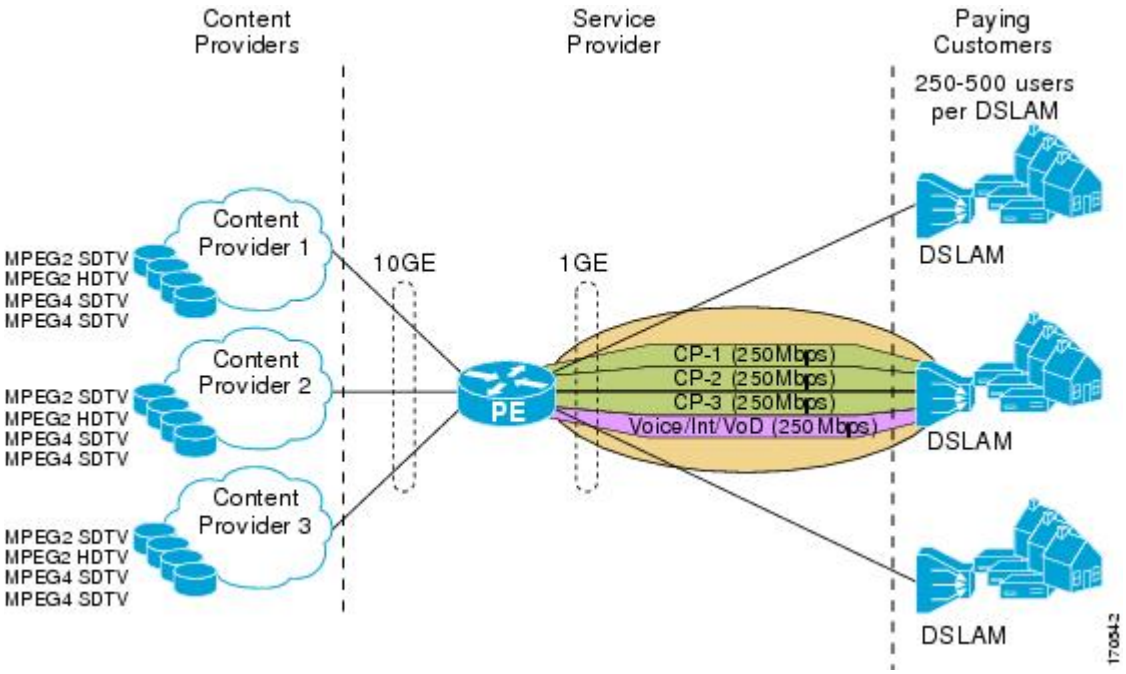
```
Device# clear ip multicast limit interface GigabitEthernet 0/0
```

Configuration Examples for Bandwidth-Based Call Admission Control for IP Multicast

Example: Configuring Bandwidth-Based Multicast CAC Policies

The following example shows how to configure bandwidth-based multicast CAC policies to provide multicast CAC in a network environment where the multicast flows utilize different amounts of bandwidth. This example uses the topology illustrated in the figure.

Figure 1 Bandwidth-Based CAC for IP Multicast Example Topology



In this example, three content providers are providing TV services across a service provider core. The content providers are broadcasting TV channels that utilize different amounts of bandwidth:

- MPEG-2 SDTV channels--4 Mbps per channel.
- MPEG-2 HDTV channels--18 Mbps per channel.
- MPEG-4 SDTV channels--1.6 Mbps per channel.
- MPEG-4 HDTV channels--6 Mbps per channel.

The service provider needs to provision the fair sharing of bandwidth between these three content providers to its subscribers across Gigabit Ethernet interfaces. The service provider, thus, determines that it needs to provision each Gigabit Ethernet interface on the PE device connected to the DSLAMs as follows:

- 250 Mbps per content provider.
- 250 Mbps for Internet, voice, and VoD services.

The service provider then configures three ACLs:

- acl-CP1-channels--The ACL that defines the channels being offered by the content provider CP1.
- acl-CP2-channels--The ACL that defines the channels being offered by the content provider CP2.
- acl-CP3-channels--The ACL that defines the channels being offered by the content provider CP3.

Because the content providers are broadcasting TV channels that utilize different amounts of bandwidth, the service provider needs to determine the values that need to be configured for the per interface mroute state limiters and bandwidth-based multicast CAC policies to provide the fair sharing of bandwidth required between the content providers.

Prior to the introduction of the Bandwidth-Based CAC for IP Multicast feature, per interface mroute state limiters were based strictly on the number of flows. The introduction of cost multipliers by the Bandwidth-Based CAC for IP Multicast feature expands how per interface mroute state limiters can be defined. Instead of defining the per interface mroute state limiters based on the number of multicast flows, the service provider looks for a common unit of measure and decides to represent the per interface mroute state limiters in kilobits per second (Kbps). The service provider then configures three per interface mroute state limiters, one per content provider. Because the link is a Gigabit, the service provider sets each limit to 250000 (because 250000 Kbps equals 250 Mbps, the number of bits that service provider needs to provision per content provider).

The service provider needs to further provision the fair sharing of bandwidth between the content providers, which can be achieved by configuring bandwidth-based multicast CAC policies. The service provider decides to create four bandwidth-based CAC policies, one policy per channel based on bandwidth. For these policies, the service provider configures the following ACLs:

- acl-MP2SD-channels--Defines all the MPEG-2 SD channels offered by the three content providers.
- acl-MP2HD-channels--Defines all the MPEG-2 HD channels offered by the three content providers.
- acl-MP4SD-channels--Defines all the MPEG-4 SD channels offered by the three content providers.
- acl-MP4HD-channels--Defines all the MPEG-4 HD channels offered by the three content providers.

For each policy, a cost multiplier (represented in Kbps) is defined for each ACL that is based on the bandwidth of the channels defined in the ACL:

- 4000--Represents the 4 Mbps MPEG-2 SD channels.
- 18000--Represents the 18 Mbps MPEG-2 HD channels.
- 1600--Represents the 1.6 Mbps MPEG-4 SD channels.
- 6000--Represents the 6 Mbps MPEG-4 HD channels.

The following configuration example shows how the service provider used per interface mroute state limiters with bandwidth-based multicast CAC policies to provision Gigabit Ethernet interface 0/0 for the fair sharing of bandwidth required between the three content providers:

```
!
ip multicast limit cost acl-MP2SD-channels 4000
ip multicast limit cost acl-MP2HD-channels 18000
ip multicast limit cost acl-MP4SD-channels 1600
ip multicast limit cost acl-MP4HD-channels 6000
!
.
.
.
!
interface GigabitEthernet0/0
 ip multicast limit out acl-CP1-channels 250000
 ip multicast limit out acl-CP2-channels 250000
 ip multicast limit out acl-CP3-channels 250000
!
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
IP multicast commands	*Cisco IOS IP Multicast Command Reference*

Standards and RFCs

Standard/RFC	Title
No new or modified standards or RFCs are supported by this feature.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

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

Feature Information for Bandwidth-Based CAC for IP Multicast

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1 Feature Information for Bandwidth-Based CAC for IP Multicast

Feature Name	Releases	Feature Information
Bandwidth-Based CAC for IP Multicast	12.2(33)SRB 12.4(15)T 12.2(33)SXI Cisco IOS XE Release 2.1 15.1(1)SG Cisco IOS XE Release 3.3SG	The Bandwidth-Based CAC for IP Multicast feature enhances the Per Interface Mroute State Limit feature by implementing a way to count per interface mroute state limiters using cost multipliers. This feature can be used to provide bandwidth-based CAC on a per interface basis in network environments where the multicast flows utilize different amounts of bandwidth. The following commands were introduced or modified: **ip multicast limit cost**.