



# Multicast VPN and DOCSIS 3.0 Multicast QoS Support

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The CMTS enhanced multicast new features are consistent with DOCSIS 3.0 specifications and include:

- Enhanced multicast echo in which the Layer 3 multicast switching path uses a Cisco Packet Processor (CPP) parallel express forwarding multicast routing table.
- Enhanced multicast quality of service (MQoS) framework that specifies a group configuration (GC) to define a session range of multicast addresses and rule priorities and its associated multicast VPN (MVPN).
- Intelligent multicast admission control to include multicast service flows.
- Enhanced multicast VPN feature to configure and support multicast traffic in a multiprotocol label switching (MPLS)-VPN environment.
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## Finding Feature Information

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to <http://tools.cisco.com/ITDIT/CFN/>. An account on <http://www.cisco.com/> is not required.

# Hardware Compatibility Matrix for the Cisco cBR Series Routers



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

**Table 1: Hardware Compatibility Matrix for the Cisco cBR Series Routers**

| Cisco CMTS Platform                    | Processor Engine  | Interface Cards   |
|--|---|---|
| Cisco cBR-8 Converged Broadband Router | <p><b>Cisco IOS-XE Release 16.5.1 and Later Releases</b></p> <p>Cisco cBR-8 Supervisor:</p> <ul style="list-style-type: none"> <li>• PID—CBR-SUP-250G</li> <li>• PID—CBR-CCAP-SUP-160G</li> </ul> | <p><b>Cisco IOS-XE Release 16.5.1 and Later Releases</b></p> <p>Cisco cBR-8 CCAP Line Cards:</p> <ul style="list-style-type: none"> <li>• PID—CBR-LC-8D30-16U30</li> <li>• PID—CBR-LC-8D31-16U30</li> <li>• PID—CBR-RF-PIC</li> <li>• PID—CBR-RF-PROT-PIC</li> <li>• PID—CBR-CCAP-LC-40G</li> <li>• PID—CBR-CCAP-LC-40G-R</li> <li>• PID—CBR-CCAP-LC-G2-R</li> <li>• PID—CBR-SUP-8X10G-PIC</li> <li>• PID—CBR-2X100G-PIC</li> </ul> <p>Digital PICs:</p> <ul style="list-style-type: none"> <li>• PID—CBR-DPIC-8X10G</li> <li>• PID—CBR-DPIC-2X100G</li> </ul> <p>Cisco cBR-8 Downstream PHY Module:</p> <ul style="list-style-type: none"> <li>• PID—CBR-D31-DS-MOD</li> </ul> <p>Cisco cBR-8 Upstream PHY Modules:</p> <ul style="list-style-type: none"> <li>• PID—CBR-D31-US-MOD</li> </ul> |

# Restrictions for the Multicast VPN and DOCSIS 3.0 Multicast QoS Support

The type of service (ToS) parameter is not recognized by the Cisco cBR series routers.

To avail 40000 multicast sessions, a minimum of one bundle should be present for each LC.

## Information About the Multicast VPN and DOCSIS 3.0 Multicast QoS Support

IP multicast—transmission of the same information to multiple cable network recipients—improves bandwidth efficiency and allows service providers to offer differentiated quality of service for different types of traffic. Enhanced multicast introduces multicast improvements as mandated by the introduction of DOCSIS 3.0 specifications.



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**Note** DOCSIS 3.0 standards retain backwards compatibility with the DOCSIS 2.0 multicast mode of operation.

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The Cisco cBR routers support 40000 DSG multicast sessions per chassis.

The following are the benefits of CMTS enhanced multicast are:

## Enhanced Quality of Service

In the new multicast QoS (MQoS) framework, you can specify a group configuration (GC) that defines a session range of multicast addresses and rule priorities and its associated multicast VPN (MVPN). For every GC, there is attached a group QoS configuration (GQC) and a group encryption rule.

Based on the session range, rule priority, and MVPN, a multicast service flow is admitted into a GC and the associated GQC and group encryption rule are applied to the flow. In MQoS implementation, the source address of the multicast session is not checked because the current implementation for cable-specific multicast supports IGMP Version 2 but not IGMP Version 3. The downstream service flow, service identifier (SID), and MAC-rewrite string are created at the time of a new IGMP join (or static multicast group CLI on the interface) and MQoS is applied to the new multicast group join.

The benefits of enhanced QoS are the following:

- Group classifiers can be applied at cable interface level and also at bundle interface level.
- Group service flow (GSF) definition is based on service class names. The GSF is similar to individual service flows and commonly includes the minimum rate and maximum rate parameters for the service class. GSF is shared by all cable modems on a particular downstream channel set (DCS) that is matched to the same group classifier rule (GCR). A default service flow is used for multicast flows that do not match to any GCR. A GSF is always in the active state.
- CMTS replicates multicast packets and then classifies them.
- Single-stage replication and two-stage replication are supported.
- Enhanced QoS is compatible and integrated with DOCSIS Set-Top Gateway (DSG).

## Intelligent Multicast Admission Control

Admission control allows you to categorize service flows into buckets. Examples of categories are the service class name used to create the service flow, service flow priority, or the service flow type such as unsolicited grant service (UGS). Bandwidth limits for each bucket can also be defined. For example, you can define bucket 1 for high priority packet cable service flows and specify that bucket 1 is allowed a minimum of 30 percent and a maximum of 50 percent of the link bandwidth.

Intelligent multicast admission control includes additional features such as the inclusion of multicast service flows using the GSF concept. GSFs are created based on the rules as defined in the GQC table. The rules link the multicast streams to a GSF through the session range. The service class name in the rule defines the QoS for that GSF. Additionally, another attribute is added to the rules and the group configuration table to specify the application type to which each GSF belongs. In this way, the QoS associated with each GSF is independent of the bucket category for the GSF.

The benefits of intelligent multicast admission control are the following:

- There is explicit acknowledgment of the establishment of each multicast session.
- Admission control does not consume additional bandwidth for multicast flows once the first flow is established.
- Service flows are cleaned up as the multicast session is torn down.

## Multicast Session Limit Support

In a multicast video environment, you can limit the number of multicast sessions admitted onto a particular service flow. The multicast session limit feature—which adds functionality on top of the multicast QoS infrastructure—enables you to specify the number of multicast sessions to be admitted on a particular service flow. If the current number of sessions has reached the defined limit, new sessions will be forwarded but they will make use of the default multicast service flow until a session ends to free up a slot for new sessions.

## Multicast Virtual Private Network

The new multicast VPN (MVPN) feature allows you to configure and support multicast traffic in a multiprotocol label switching (MPLS)-VPN environment. This feature supports routing and forwarding of multicast packets for each individual VPN virtual routing and forwarding (VRF) instance, and also provides a mechanism to transport VPN multicast packets across the service provider backbone.

MVPN allows you to connect multiple remote sites or devices over either a Layer 3 or Layer 2 VPN. A Layer 3 VPN enables the routing of traffic inside the VPN. A Layer 2 VPN provides a bridging transport mechanism for traffic between remote sites belonging to a customer. To support multicast over Layer 3 VPNs, each VPN receives a separate multicast domain with an associated MVPN routing and forwarding (mVRF) table maintained by the provider edge (PE) router. In a cable environment, the PE router is a routing CMTS. The provider network builds a default multicast distribution tree (default-MDT) for each VPN between all the associated mVRF-enabled PE routers. This tree is used to distribute multicast traffic to all PE routers.

To enable maximum security and data privacy in a VPN environment, the CMTS distinguishes between multicast sessions on the same downstream interface that belong to different VPNs. To differentiate multicast traffic between different VPNs, the CMTS implements a per-VRF subinterface multicast security association identifier (MSAID) allocation feature that is BPI+ enabled. The MSAID is allocated for each cable bundle group for each subinterface. A multicast group has a specific MSAID for each VRF instance.

# How to Configure the Multicast VPN and DOCSIS 3.0 Multicast QoS Support

This section contains the following procedures:

## Configuring a QoS Profile for a Multicast Group

To configure a QoS profile that can be applied to a QoS group configuration, use the **cable multicast group-qos** command. You must configure a QoS profile before you can add a QoS profile to a QoS multicast group.

### Procedure

|        | Command or Action  | Purpose  |
|--------|--|--|
| Step 1 | <b>enable</b><br><b>Example:</b><br><pre>Router&gt; enable</pre>   | Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>   |
| Step 2 | <b>configure terminal</b><br><b>Example:</b><br><pre>Router# configure terminal</pre>  | Enters global configuration mode.  |
| Step 3 | <b>cable multicast group-qos</b> <i>number scn service-class-name</i><br><b>control</b> { <b>single</b>   <b>aggregate</b> [ <b>limit</b> <i>max-sessions</i> ] }<br><b>Example:</b><br><pre>Router(config)#: cable multicast group-qos 2 scn<br/>name1 control single</pre> | Configures a QoS profile that can be applied to a multicast QoS group.<br><b>Note</b> If a number is not specified, a default QoS profile is applied. The default group qos configuration creates a default multicast service flow for each cable interface that is used when a multicast session does not match any classifiers of a GC on the interface. |

## Configuring a Multicast QoS Group

You can specify a group configuration (GC) that defines a session range of multicast addresses and rule priorities and its associated multicast VPN (MVPN). For every GC, there is attached a group QoS configuration and a group encryption rule.

### Procedure

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

|               | Command or Action   | Purpose  |
|---------------|---|--|
|               | Router> enable  |  |
| <b>Step 2</b> | <b>configureterminal</b><br><b>Example:</b><br>Router# configure terminal   | Enters global configuration mode.  |
| <b>Step 3</b> | <b>cable multicast group-qos</b> <i>number scn service-class-name control {single   aggregate [limit max-sessions]}</i><br><b>Example:</b><br>Router(config-mqos)# cable multicast group-qos 5 scn name1 control single | (Optional) Configures a QoS profile that can be applied to a multicast QoS group.<br><b>Note</b> If a number is not specified, a default QoS profile is applied. The default group qos configuration creates a default multicast service flow for each cable interface that is used when a multicast session does not match any classifiers of a GC on the interface.  |
| <b>Step 4</b> | <b>cable multicast qos group</b> <i>id priority value [global]</i><br><b>Example:</b><br>Router(config)# cable multicast qos group 2 priority 6   | Configures a multicast QoS group and enters multicast QoS configuration mode.  |
| <b>Step 5</b> | <b>session-range</b> <i>ip-address ip-mask</i><br><b>Example:</b><br>Router(config-mqos)# session-range 224.10.10.10 255.255.255.224  | Specifies the session range IP address and IP mask of the multicast QoS group. You can configure multiple session ranges.  |
| <b>Step 6</b> | <b>tos</b> <i>low-byte high-byte mask</i><br><b>Example:</b><br>Router(config-mqos)# tos 1 6 15   | (Optional) Specifies the minimum type of service (ToS) data bytes, maximum ToS data bytes, and mask for a multicast QoS group.   |
| <b>Step 7</b> | <b>vrfname</b><br><b>Example:</b><br>Router(config-mqos)# vrf name1   | (Optional) Specifies the name for the virtual routing and forwarding (VRF) instance.<br><b>Note</b> If a multicast QoS (MQoS) group is not defined for this VRF, you will see an error message. You must either define a specific MQoS group for each VRF, or define a default MQoS group that can be assigned in those situations where no matching MQoS group is found. See the <a href="#">Configuring a Default Multicast QoS Group for VRF</a> , on page 7. |
| <b>Step 8</b> | <b>application-id</b> <i>number</i><br><b>Example:</b><br>Router(config-mqos)# application-id 25  | (Optional) Specifies the application identification number of the multicast QoS group. This value is configured to enable admission control to the multicast QoS group.  |

## Configuring a Default Multicast QoS Group for VRF

Each virtual routing and forwarding (VRF) instance that is defined must match a defined MQoS group to avoid multicast stream crosstalk between VRFs. To avoid potential crosstalk, define a default MQoS group that is assigned to the VRF whenever the multicast traffic in the VRF does not match an existing MQoS group.

### Procedure

|        | Command or Action   | Purpose  |
|--------|---|--|
| Step 1 | <b>enable</b><br><b>Example:</b><br>Router> enable  | Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>   |
| Step 2 | <b>configure terminal</b><br><b>Example:</b><br>Router# configure terminal  | Enters global configuration mode.  |
| Step 3 | <b>cable multicastgroup-qosnumber scnservice-class-name control {single   aggregate [limit max-sessions]}</b><br><b>Example:</b><br>Router(config-mqos)# cable multicast group-qos 5 scn name1 control single | (Optional) Configures a QoS profile that can be applied to a multicast QoS group.  |
| Step 4 | <b>cable multicast qos group id priority 255 global</b><br><b>Example:</b><br>Router(config)# cable multicast qos group 2 priority 255 global   | Configures a default multicast QoS group and enters multicast QoS configuration mode.  |
| Step 5 | <b>session-range 224.0.0.0 224.0.0.0</b><br><b>Example:</b><br>Router(config-mqos)# session-range 224.0.0.0 224.0.0.0   | Specifies the session-range IP address and IP mask of the default multicast QoS group. By entering 224.0.0.0 for the IP address and the IP mask you cover all possible multicast sessions. |
| Step 6 | <b>vrfname</b><br><b>Example:</b><br>Router(config-mqos)# vrf name1   | Specifies the name of the virtual routing and forwarding (VRF) instance.   |
| Step 7 | <b>application-idnumber</b><br><b>Example:</b><br>Router(config-mqos)# application-id 5   | (Optional) Specifies the application identification number of the multicast QoS group. This value is configured to enable admission control to the multicast QoS group.                    |

## Verifying Configuration of the Multicast VPN and DOCSIS 3.0 Multicast QoS Support

To verify the configuration of the Multicast VPN and DOCSIS 3.0 Multicast QoS Support feature, use the **show** commands described below.

- To show the configuration parameters for multicast sessions on a specific bundle, use the **show interface bundle *number* multicast-sessions** command as shown in the following example:

```
Router# show interface bundle 1 multicast-sessions
Multicast Sessions on Bundle1
Group          Interface    GC  SAID  SFID  GQC  GEn  RefCount  GC-Interface  State
234.1.1.45     Bundle1.1   1   8193  ---   1    5    1          Bundle1       ACTIVE
234.1.1.46     Bundle1.1   1   8193  ---   1    5    1          Bundle1       ACTIVE
234.1.1.47     Bundle1.1   1   8193  ---   1    5    1          Bundle1       ACTIVE
Aggregate Multicast Sessions on Bundle1
Aggregate Sessions for SAID 8193 GQC 1 CurrSess 3
Group          Interface    GC  SAID  SFID  AggGQC  GEn  RefCount  GC-Interface
234.1.1.45     Bundle1.1   1   8193  ---   1        5    1          Bundle1
234.1.1.46     Bundle1.1   1   8193  ---   1        5    1          Bundle1
234.1.1.47     Bundle1.1   1   8193  ---   1        5    1          Bundle1
```

- To show the configuration parameters for multicast sessions on a specific cable, use the **show interface cable *ip-addr* multicast-sessions** command as shown in the following example:

```
Router# show interface cable 7/0/0 multicast-sessions
Default Multicast Service Flow 3 on Cable7/0/0
Multicast Sessions on Cable7/0/0
Group          Interface    GC  SAID  SFID  GQC  GEn  RefCount  GC-Interface  State
234.1.1.45     Bundle1.1   1   8193  24    1    5    1          Bundle1       ACTIVE
234.1.1.46     Bundle1.1   1   8193  24    1    5    1          Bundle1       ACTIVE
234.1.1.47     Bundle1.1   1   8193  24    1    5    1          Bundle1       ACTIVE
Aggregate Multicast Sessions on Cable7/0/0
Aggregate Sessions for SAID 8193 SFID 24 GQC 1 CurrSess 3
Group          Interface    GC  SAID  SFID  AggGQC  GEn  RefCount  GC-Interface
234.1.1.45     Bundle1.1   1   8193  24    1        5    1          Bundle1
234.1.1.46     Bundle1.1   1   8193  24    1        5    1          Bundle1
234.1.1.47     Bundle1.1   1   8193  24    1        5    1          Bundle1
```

- To show the MSAID multicast group subinterface mapping, use the **show interface cable *address* modem** command as shown in the following example:

```
Router# show interface cable 6/1/0 modem
SID  Priv Type      State      IP address      method  MAC address      Dual
bits
9    11  modem  online(pt)  101.1.0.6      dhcp    0006.28f9.8c79  N
9    11  host   unknown     111.1.1.45     dhcp    0018.1952.a859  N
10   10  modem  online(pt)  101.1.0.5      dhcp    0006.5305.ac19  N
10   10  host   unknown     111.1.0.3      dhcp    0018.1952.a85a  N
13   10  modem  online(pt)  101.1.0.3      dhcp    0014.f8c1.fd1c  N
8195 10  multicast unknown    224.1.1.51     static  0000.0000.0000  N
8195 10  multicast unknown    224.1.1.49     static  0000.0000.0000  N
8195 10  multicast unknown    224.1.1.50     static  0000.0000.0000  N
```



# Configuration Examples for the Multicast VPN and DOCSIS 3.0 Multicast QoS Support

This section provides the following configuration examples:

## Example: Configuring Group QoS and Group Encryption Profiles



**Note** To add group QoS and group encryption profiles to a QoS group, you must configure each profile first before configuring the QoS group.

In the following example, QoS profile 3 and encryption profile 35 are configured.

```
configure terminal
cable multicast group-qos 3 scn name1 control single
cable multicast group-encryption 35 algorithm 56bit-des
```

## Example: Configuring a QoS Group

In the following example, QoS group 2 is configured with a priority of 6 and global application. To QoS group 2, QoS profile 3 and encryption profile 35 are applied. Other parameters are configured for QoS group 2 including application type, session range, ToS, and VRF.

```
cable multicast qos group 2 priority 6 global
group-encryption 35
group-qos 3
session-range 224.10.10.01 255.255.255.254
tos 1 6 15
vrf vrf-name1
application-id 44
```

## Additional References

The following sections provide references related to the Multicast VPN and DOCSIS 3.0 Multicast QoS Support.

### Related Documents

| Related Topic       | Document Title   |
|---------------------|--|
| CMTS cable commands | <i>Cisco CMTS Cable Command Reference</i><br><a href="http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html">http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html</a> |

**Standards**

| Standard  | Title |
|---|-------|
| No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature. | —     |

**MIBs**

| MIB   | MIBs Link  |
|---|--|
| No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature. | To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:<br><br><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a> |

**RFCs**

| RFC      | Title  |
|----------|--|
| RFC 2236 | <i>Internet Group Management Protocol, Version 2</i> |

**Technical Assistance**

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

## Feature Information for Multicast VPN and DOCSIS3.0 Multicast QoS Support

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the <https://cfng.cisco.com/> link. An account on the Cisco.com page is not required.



**Note** The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

**Table 2: Feature Information for Multicast VPN and DOCSIS3.0 Multicast QoS Support**

| Feature Name                                      | Releases                    | Feature Information   |
|---|-----------------------------|---|
| Multicast VPN and DOCSIS3.0 multicast QoS support | Cisco IOS XE Everest 16.6.1 | This feature was integrated into Cisco IOS XE Everest 16.5.1 on the Cisco cBR Series Converged Broadband Routers. |

