



Configuring Modular QoS on Link Bundles

A link bundle is a group of one or more ports that are aggregated together and treated as a single link. This module describes QoS on link bundles.

Feature History for Configuring Modular QoS on Link Bundles on Cisco IOS XR Software

Release	Modification
Release 3.8.0	The QoS on Link Bundles feature was introduced.

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Link Bundling Overview

The Link Bundling feature allows you to group multiple point-to-point links together into one logical link and provide higher bidirectional bandwidth, redundancy, and load balancing between two routers. A virtual interface is assigned to the bundled link. The component links can be dynamically added and deleted from the virtual interface.

The virtual interface is treated as a single interface on which one can configure an IP address and other software features used by the link bundle. Packets sent to the link bundle are forwarded to one of the links in the bundle.

A link bundle is simply a group of ports that are bundled together and act as a single link. The advantages of link bundles are as follows:

- Multiple links can span several line cards and SPAs to form a single interface. Thus, the failure of a single link does not cause a loss of connectivity.
- Bundled interfaces increase bandwidth availability, because traffic is forwarded over all available members of the bundle. Therefore, traffic can move onto another link if one of the links within a bundle fails. You can add or remove bandwidth without interrupting packet flow. For example, you can upgrade from an OC-48c PLIM modular services card to an OC-192 PLIM modular services card without interrupting traffic.

All links within a bundle must be of the same type. For example, a bundle can contain all Ethernet interfaces, or it can contain all POS interfaces, but it cannot contain Ethernet and POS interfaces at the same time.

Cisco IOS XR software supports these methods of forming bundles of Ethernet and POS interfaces:

- IEEE 802.3ad—Standard technology that employs a Link Aggregation Control Protocol (LACP) to ensure that all the member links in a bundle are compatible. Links that are incompatible or have failed are automatically removed from a bundle.
- EtherChannel or POS Channel—Cisco proprietary technology that allows the user to configure links to join a bundle, but has no mechanisms to check whether the links in a bundle are compatible. (EtherChannel applies to Ethernet interfaces and POS Channel applies to POS interfaces.)

Load Balancing

Load balancing is supported on all links in the bundle. Load balancing function is a forwarding mechanism to distribute traffic over multiple links based on Layer 3 routing information in the router. There are two types of load balancing schemes:

- Per-Destination Load Balancing
- Per-Packet Load Balancing

When a traffic stream arrives at the router, per-packet load balancing allows the traffic to be evenly distributed among multiple equal cost links. Per-packet schemes make routing decision based on round-robin techniques, regardless of the individual source-destination hosts.

Only Per-Destination Load Balancing is supported.

Per-destination load balancing allows the router to distribute packets over one of the links in the bundle to achieve load sharing. The scheme is realized through a hash calculating based on the source-destination address and user sessions.

When the per-destination load balancing is enabled, all packets for a certain source-destination pair will go through the same link, though there are multiple links available. In other words, per-destination load balancing can ensure that packets for a certain source-destination pair could arrive in order.

QoS and Link Bundling

All Quality of Service (QoS) features, currently supported on Layer 3 physical interfaces, are also supported on all Link Bundle interfaces. All QoS features currently supported on Layer 3 physical sub interfaces are also supported on bundle VLANs.

QoS is configured on Link Bundles in primarily the same way that it is configured on individual interfaces. However, there are some important restrictions that should be noted:

- Parameters for QoS actions can only be specified as percentages.
- WRED and queue limit parameters can only be configured in time units.
- A policer rate limit greater than 16 GB per class cannot be configured.
- Layer 2 QoS is not supported for bundles.

These guidelines describe the characteristics of QoS behavior on bundle interfaces:

- QoS features are configured only on the Link Bundle interfaces, never on individual members.
- For egress QoS policies, a unique set of queues defined by the policy are assigned to each physical interface on each linecard hosting a member link. As a result, for queuing actions (e.g. shaping), egress QoS policy acts on the bandwidth provided by the individual member interfaces. This means that the actual shape rate experienced by a traffic class may be less than the configured value (as a percentage of the bundle bandwidth), if its traffic is not load-balanced evenly across all member links. For policer actions, egress QoS policy acts on the aggregate bandwidth provided by the interfaces on that linecard.
- For ingress QoS policies, a single set of queues defined by the policy are assigned on each linecard hosting a member link. As a result, ingress QoS policy acts on the aggregate bandwidth provided by the interfaces on that linecard.

QoS for POS link bundling

For POS link bundles, percentage-based bandwidth is supported for policers and output queues. Time-based queue limit is supported for output queues.

Input QoS Policy setup

For input QoS, queuing is not supported and thus bandwidth is used for policer only. As a member link is added or removed from a bundle with input QoS configured, the aggregate bundle bandwidth for that affected line card will change. One input QoS policy instance is assigned for each SIP 700 line card that is part of the POS link bundle.

Output QoS Policy setup

When a member link is added to a bundle with output QoS configured, the policy-map of the bundle is applied to the member link.

Example 2 shows the output QoS policy supported on POS link bundles.

Example 2 : Output QoS policy supported on POS link bundles

```
policy-map out-sample
  class voice
    priority level 1
    police rate percent 10
  class premium
    bandwidth percent 30
    queue-limit 100 ms
  class class-default
    queue-limit 100 ms
```

Aggregate Bundle QoS Mode

Aggregated Bundle QoS allows the shape, bandwidth, police rates, and burst values to be distributed between the active members of a bundle where a QoS policy-map is applied. For instance, consider that the traffic is

load-balanced among the members of the bundle. In aggregate mode, the bundle ethernet traffic is shaped to 10 Mbps to match the configuration of QoS policy.

When the policy is applied on a member of the bundle, a ratio can be calculated based on the total bandwidth of the bundle to that of the bandwidth of a member in the bundle. For example, if the bandwidth of the bundle is 20 Gbps, and the bandwidth of a member in the bundle is 10 Gbps, then the ratio will be 2:1.

A change in the bundle (with a member down, added, removed or activated) or mode results in the automatic recalculation of QoS rate.

The user QoS policy is invalid when applied to the bundle interface under the following scenarios:

- A 10 Gbps interface and 40 Gbps interface are part of a bundle, and the 40 Gbps interface is inactive. Currently, QoS policy is also programmed on non-active members. When programming the 40Gbps bundle member, the bundle bandwidth is 10 Gbps, but the member bandwidth is 40 Gbps. The ratio of bundle bandwidth to member bandwidth does not work for this member.
- Consider a shape of 15 Gbps. This action is valid on bundles with multiple 10G active members, but invalid when only one member is active and that member is in QoS inconsistent state. To view inconsistency details for the QoS policy, run the **show qos inconsistency** command in EXEC mode. This scenario is also applicable during the reload of a router where only few interfaces in line cards (LC) becomes available before the rest of the interfaces in all LCs.
- A failure in the hardware when programming a rate change during the bundle bandwidth change or when a new member is added to the bundle.
- If an interface has the QoS policy configured to an absolute value, you cannot change the aggregated bundle mode from enabled to disabled. You must modify the policy or remove it before attempting to disable the aggregate bundle mode.
- An invalid policy combination, with the absolute values of port shaper less than the policy shape rate is accepted without an error in console or log file.
- You apply QoS policy on bundle interfaces for BNG subscribers. In this case, there is no aggregation across bundle members, and the policy is applied individually. For the policy to work correctly, modify the rate according to the number of members in the bundle.
- You apply QoS policy on PWHE and BVI interfaces. Both these interfaces don't support bundle aggregate mode.

Load Balancing in Aggregate Bundle QoS

Load balancing requires a large number of flows in order to distribute the traffic among the members of the bundle. Ensure that load is balanced evenly among the members of the bundle before using the aggregate bundle QoS mode. If the under-lying traffic is only a few tunnels (GRE, TE-TUNNELS), it may be possible that the load balancing is not distributing the traffic evenly and may cause problems.

For example, consider bandwidth of a bundle is 20 Gbps, and the bandwidth of a member in the bundle is 10 Gbps. If the traffic is not load balanced, the aggregate traffic output may not reach 10 Mbps even when more than 10 Mbps is sent to the bundle-ether interface.

QoS Policy in Aggregate bundle mode

The following table shows the behavior of aggregate QoS policy mode to various actions:

Action	Behavior
Policing and Shaping / Bandwidth	<p>Percentage: No change. The percentage is calculated based on parent max-rate / interface bandwidth</p> <p>PPS / Absolute rate: Divide the rate based on bandwidth ratio</p> <p>Burst-size: If <code>time-units</code>, no change. Convert <code>time-units</code> to bytes based on <code>service-rate</code></p> <p>If configured in absolute value, divide the absolute value based on bandwidth ratio</p>
Wred / Queue-Limit Threshold	<p>Time-Units: No Change. Use the <code>service-rate</code> to convert to bytes</p> <p>Absolute value: Divide the absolute value based on bandwidth ratio</p>

Enabling Aggregate Bundle QoS

To enable the aggregate bundle QoS, perform these steps:

SUMMARY STEPS

1. **configure**
2. **hw-module all qos-modeaggregate-bundle-mode**
3. **class class-name**
4. **end or commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: <pre>RP/0/RSP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	hw-module all qos-modeaggregate-bundle-mode Example: <pre>RP/0/RSP0/CPU0:router(config)# hw-module all qos-mode aggregate-bundle-mode</pre>	<p>Enters policy map configuration mode.</p> <p>When aggregated bundle mode changes, QoS polices on bundle interfaces and sub-interfaces are modified automatically. A reload of the line card is not required.</p>
Step 3	class class-name Example: <pre>RP/0/RSP0/CPU0:router(config-pmap)# class class-default</pre>	<p>Enters policy map class configuration mode.</p> <p>Specifies the name of the class whose policy you want to create or change.</p>

	Command or Action	Purpose
Step 4	end or commit Example: RP/0/RSP0/CPU0:router(config-pmap-c-police)# end or RP/0/RSP0/CPU0:router(config-pmap-c-police)# commit	

Policing using Aggregate Bundle QoS

```

policy-map grand-parent
class class-default
  service-policy parent
  police rate 200 mbps burst 1 kbytes
end-policy-map

policy-map parent
class class-default
  service-policy child
  police rate 300 mbps
end-policy-map

policy-map child
class 3play-voip
  police rate 10 mbps burst 10 kbytes peak-rate 20 mbps peak-burst 20 kbytes
  conform-color red-cos
  conform-action set precedence 1
  exceed-action set precedence 2
  violate-action drop

class 3play-video
  police rate 15 mbps burst 10 kbytes peak-rate 30 mbps peak-burst 20 kbytes
  conform-color yellow-cos
  conform-action set precedence 1
  exceed-action set precedence 2
  violate-action drop
!
!
class 3play-premium
  police rate 25 mbps burst 10 kbytes peak-rate 35 mbps peak-burst 20 kbytes
  conform-color green-cos
  conform-action set precedence 1
  exceed-action set precedence 2
  violate-action drop
!
!
class class-default
  police rate 6 mbps
!
!
end-policy-map
!

```

Additional References

These sections provide references related to implementing QoS on Link Bundles.

Related Documents

Related Topic	Document Title
Initial system bootup and configuration	<i>Cisco IOS XR Getting Started Guide for the Cisco CRS Router</i>
Link Bundling	“Configuring Link Bundling on Cisco IOS XR Software” module of <i>Cisco IOS XR Interface and Hardware Component Configuration Guide for the Cisco CRS Router</i>
QoS commands	Cisco IOS XR Modular Quality of Service Command Reference for the Cisco CRS Router
User groups and task IDs	“Configuring AAA Services on Cisco IOS XR Software” module of <i>Cisco IOS XR System Security Configuration Guide</i>

Standards

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

MIBs

MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

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

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of 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