

Configuring Gigabit EtherChannel Features

On a Cisco 10000 series router, a Gigabit EtherChannel (GEC) is a specialized interface type comprising aggregated Gigabit Ethernet links. A GEC bundle is synonymous with port channel and can have a minimum of one or a maximum of 8 active links. The bandwidth of the GEC interface is the aggregate of all the physical member links comprising the GEC bundle.

**Note**

Cisco IOS Release 12.2(31)SB supports a maximum of 4 member links per GEC bundle. In Cisco IOS Release 12.2(15)BX, the maximum number of links per GEC bundle has been increased from 4 to 8.

The Gigabit EtherChannel can be deployed in two ways on the Cisco 10000 series router:

- *Core facing* or network facing deployment is an uplink EtherChannel that connects the Cisco 10000 Series router to the service provider. This setup has multiple physicals links bundled per GEC interface and allows:
 - Load balancing across all the active interfaces.
 - Combination of different Gigabit Ethernet (GE) ports (both shared port adaptors and line cards)
- *Access facing* or subscriber facing deployment connects the Cisco 10000 series router to the subscriber edge. This setup typically has only one active member link on a GEC bundle interface. The remaining links in the GEC bundle serve as passive links. Traffic is sent only through the active member link, while the passive link is used as a backup when the active member link fails. This arrangement provides link redundancy with no loss of Point-to-Point Protocol over Ethernet (PPPoE) sessions during link failover.
 - Load balancing is not applicable when there is only one active link in a GEC bundle.
 - Queuing action is allowed only on the GEC bundle and not on member links.

**Note**

A GEC bundle can include a combination of active and passive links. In an M:N mode, 'M' denotes active links and 'N' denotes passive links. In a 1:N mode only one link is active per GEC bundle and 'N' denotes number of passive links. Passive links operate as backup links but do not transfer any network traffic.

This chapter describes Gigabit EtherChannel (GEC) enhancements implemented on the Cisco 10000 series routers and includes the following topics:

- [Feature History for Gigabit EtherChannel Enhancements, page 20-2](#)
- [Prerequisites for Gigabit EtherChannel Configuration, page 20-2](#)
- [Restrictions for Gigabit EtherChannel Configuration, page 20-3](#)

- [Configuring QoS Service Policies on GEC Interfaces](#), page 20-3
- [Configuring Policy Based Routing Support on a GEC Bundle](#), page 20-7
- [Configuring IEEE 802.1Q and QinQ Support on GEC Bundle](#), page 20-7
- [Configuring MVPN Support on GEC Bundle](#), page 20-9
- [Configuring PPPoX Support on a GEC Bundle](#), page 20-9
- [Configuring High Availability Support on GEC Bundle](#), page 20-11
- [Configuring 8 Member Links per GEC Bundle](#), page 20-11

For more information on Gigabit EtherChannels (GEC) see, the *Link Aggregation Control Protocol (LACP) (802.3ad) for Gigabit Interfaces* feature guide at:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios122sb/newft/122sb31/10gigeth.htm>

Feature History for Gigabit EtherChannel Enhancements

Cisco IOS Release	Description	Required PRE
12.2(31)SB	This feature was supported only on native line cards. <ul style="list-style-type: none"> • QoS policies supported only on GEC member links. 	PRE2 and PRE3
12.2(33)SB	This feature is supported on native line cards ¹ and the SPA Interface Processor (SIP) and Shared Port Adapters (SPA) ² on the Cisco 10000 series router.	PRE3 and PRE4
12.2(33)SB	The following Gigabit EtherChannel enhancements were added on the Cisco 10000 series router: <ul style="list-style-type: none"> • QoS Service Policies on GEC Bundle³ • PPPoE hitless⁴ switchover support with Link Aggregation Control Protocol (LACP) (802.3ad) port channel • PBR Support for GEC Bundle • IEEE 802.1Q and QinQ Support on GEC Bundle • Multicast VPN Support on GEC Bundle • PPPoX Support for GEC Bundle (includes PPPoEoE, PPPoEoQinQ, PPPoVLAN) • High availability for SSO, NSF, ISSU, and NSR • 8 Member Links per GEC bundle 	PRE2, PRE3, and PRE4

1. 1 Port GE – Half-height and 1 Port GE – Full-height.

2. 2 Port GE – Half-height and 5 Port GE – Half-height.

3. Queuing actions still require QoS application on each member link.

4. A hitless switchover implies that no PPPoX sessions are dropped when an active member link fails and the passive or backup link takes over as the active link.

Prerequisites for Gigabit EtherChannel Configuration

The following are the prerequisites for configuring GEC bundles:

- Create a GEC bundle interface before adding GE links to the GEC bundle using the **channel-group** command.
- Add GE links to the GEC bundle and configure all the links identically.

Restrictions for Gigabit EtherChannel Configuration

The following are general restrictions applicable to GEC bundles:

- Bidirectional Forwarding Detection Protocol (BFD) is not supported on GEC bundles.
- A dot1Q/QinQ subinterface created on a GEC bundle requires one VCCI on all the member links. The GEC bundle also uses one VCCI.
- Intelligent Service Gateway (ISG) IP sessions are not supported on GEC bundles.
- Gigabit EtherChannels are not supported on a 10 GE shared port adaptor (SPA).
- On core facing deployments, queuing actions are only supported when they are applied on each individual member link.
- In 1:N deployment mode:
 - Combination of any SPA based Gigabit Ethernet ports with either a full height GE line card or half height GE line card is not supported.
 - A maximum of 4 Gigabit Ethernet SPAs form a GEC bundle. Each SPA interface must have the same bay number and port number, assuming the representation is GigabitEthernetSlotNumber/BayNumber/Port-Number.

For example, in the case of SPAs, Gi1/2/1 can be bundled with Gi5/2/1, but Gi1/2/1 cannot be bundled with Gi1/0/1.
 - Member link counters are not updated.
- We do not recommend the deletion of the GEC bundle main interface before removing the member links, using the **no channel-group** command. Similarly, before you delete the GEC bundle main interface, remove the subinterfaces.

Configuring QoS Service Policies on GEC Interfaces

The QoS support feature on Gigabit EtherChannel allows service policies to be applied on GEC traffic. Support for QoS can be applied differently to GEC bundles or main interfaces of member links and GEC bundle subinterfaces.

- Input QoS can directly be applied on GEC bundle subinterfaces or main interfaces. Input QoS can be applied on member links using the vlan-group QoS feature. For details, see the [“Configuration Example for Using the VLAN Group Feature to Apply QoS on Member Links”](#) section on page 20-5 and the [“Configuration Example for Applying QoS on GEC Bundle Subinterfaces”](#) section on page 20-6.
- Output QoS can directly be applied on GEC bundle subinterfaces similar to the GEC main interfaces. Alternatively, output QoS can be applied on member links using the vlan-group QoS feature. The service policy with **match-vlan class-maps** is applied on the member link main interface.

The application of QoS depends on the deployment mode of the GEC bundle interface as described in the [Table 20-1](#):

Table 20-1 Service Policies Applied on GEC Bundles

QoS for GEC	M:N Deployment	1:N Deployment
Input QoS for GEC	<p>Service policy can be applied for both GEC bundle interface and member links. If applied on a:</p> <ul style="list-style-type: none"> GEC bundle, the aggregate ingress traffic on GEC bundle is subject to this service-policy. Member link, ingress traffic on a particular member link is subject to the service-policy applied on the member link. 	Service policy can be applied only on the GEC bundle interface.
Output QoS for GEC	<p>Service-policy <i>without</i> queuing actions can be applied either on GEC bundle interface or on the member links. If applied on a:</p> <ul style="list-style-type: none"> GEC bundle, the aggregate egress traffic on GEC bundle is subject to this service-policy. Member link, egress traffic on a particular member link is subject to the service-policy applied on the member link. <p>Service-policies <i>with</i> queuing actions can be applied only on member links.</p>	Service policies <i>with</i> or <i>without</i> queuing actions can be applied only on the GEC bundle interface.
Input QoS for GEC subinterface	<p>Input QoS applied on GEC bundle interface and on member main-interfaces. If the service-policy is applied on a:</p> <ul style="list-style-type: none"> GEC bundle subinterface, the aggregate ingress traffic on the GEC bundle subinterface is subject to this service-policy. GEC member main-interface using vlan-group feature, the ingress traffic on that member link with the vlan-ids specified in the vlan-group service-policy is subject to the corresponding actions as specified in the service-policy. 	Input QoS can only be applied on a bundle subinterface. The aggregate bundle subinterface traffic is subject to this service-policy.
Output QoS for GEC subinterface	<p>Service-policies <i>without</i> queuing actions can be applied either on the GEC bundle subinterface or on the member main-interface. If the service-policy is applied on a:</p> <ul style="list-style-type: none"> GEC bundle subinterface, the aggregate egress traffic on that GEC bundle subinterface is subject to this service-policy. GEC member main-interface using vlan-group feature, the egress traffic on that member link with the vlan-ids specified in the vlan-group service-policy is subject to the corresponding actions as specified in the service-policy. <p>Service policies <i>with</i> queuing actions can only be applied on member links. The egress traffic on that member link with the vlan-ids specified in the vlan-group service-policy is subject to the corresponding actions as specified in the service-policy.</p>	Output QoS <i>with</i> or <i>without</i> queuing actions can only be applied on a GEC bundle subinterface.

Restrictions for QoS Service Policies on GEC Bundles

The following restrictions are applicable to QoS service policies applied on GEC bundle interfaces and subinterfaces:

- Both ingress and egress service-policy without any queuing actions can only be applied on member links for M:N deployment, and are restricted for 1:N deployment.
- Egress service-policy with queuing action can only be applied on:
 - Member interfaces for an M:N GEC deployment
 - Bundle interface for a 1:N GEC deployment.
- Restriction for application of QoS on VLAN groups:
 - A VLAN group restricts the application of QoS to a maximum of 255 individual dot1Q (VLAN) subinterfaces. 255 denotes the number of user classes that can be used in VLAN group parent policy.
 - Matching a VLAN group user class on QinQ subinterfaces is not supported using VLAN group policy. Each VLAN group user class at parent hierarchy can only match a set of dot1Q subinterfaces.
 - VLAN group QoS policy at member link is used only when dot1Q subinterfaces are defined on the GEC bundles and not when QinQ subinterfaces are defined on the GEC bundle.
- Input Quality of Service (QoS) on member links is not supported for QinQ subinterfaces.
- The classification criteria of **match input-interface port-channel** is not supported. Instead, packets are classified by matching them with member-links.

Configuration Examples

This section provides the following configuration examples:

- [Configuration Example for Using the VLAN Group Feature to Apply QoS on Member Links, page 20-5](#)
- [Configuration Example for Applying QoS on GEC Bundle Subinterfaces, page 20-6](#)

Configuration Example for Using the VLAN Group Feature to Apply QoS on Member Links

Step 1 Consider a GEC bundle interface with two member links Gig3/0/0 and Gig4/0/0.

Step 2 Assume subinterfaces exist on the GEC bundle interface having the following configurations:

```
Port-channel 1.1
  Encapsulation dot1q 2
Port-channel 1.2
  Encapsulation dot1q 3
Port-channel 1.3
Encapsulation dot1q 4
```

Assume that the following configurations need to be performed on each member link

- Police ingress traffic for subinterface port-channel 1.1 at 100 mbps
- Police ingress traffic for subinterface port-channel 1.2 at 150 mbps
- Shape egress traffic for subinterface port-channel 1.2 at 50 mbps
- Shape egress traffic for subinterfaces port-channel 1.1 and port-channel 1.3 together at 150 mbps

Step 3 Create **match-vlan class-maps** as follows:

```
Class-map match-any vlan_2
  Match vlan 2
```

```

Class-map match-any vlan_3
  Match vlan 3
Class-map match-any vlan_4
  Match vlan 4
Class-map match-any vlan_2_4
  Match vlan 2 4

```

Step 4 Create **policy-maps** as follows:

```

Policy-map mega_ingress
  Class vlan_2
    Police 100 mbps
  Class vlan_3
    Police 150 mbps
Policy-map mega_egress
  Class vlan_3
    Shape 50 mpbs
  Class vlan_2_4
    Shape 150 mbps

```

Step 5 Apply this policy on the GEC member links.

```

Interface Gig3/0/0
  Service-policy input mega_ingress
  Service-policy output mega_egress
Interface Gig4/0/0
  Service-policy input mega_ingress
  Service-policy output mega_egress

```

Configuration Example for Applying QoS on GEC Bundle Subinterfaces

[Example 20-1](#) shows how QoS is applied on GEC bundle subinterfaces:

Example 20-1 *Applying QoS on GEC Bundle Subinterfaces*

```

Class-map match-any dscp_20_30
  Match dscp 20 30
Class-map match-any dscp_40
  Match dscp 40

Policy-map police_dscp
  Class dscp_20_30
    Police 50 3000 3000 conform-action transmit exceed-action drop
  Set ip dscp af22
  Class dscp_40
    Police 10 3000 3000 conform-action transmit exceed-action drop

Policy-map customer_A
  Class class-default
    Police 100 mpbs
  service-policy police_dscp

Policy-map customer_B
  Class class-default
    Police 150 mbps
  Service-policy police_dscp

Interface Port-channel 1.1
  Service-policy input customer_A

Interface Port-channel 1.2

```

```
Service-policy input customer_B
```

Configuring Policy Based Routing Support on a GEC Bundle

Cisco Policy Based Routing (PBR) provides a flexible mechanism for network administrators to customize the operation of the routing table and the flow of traffic within their networks.

Load balancing is performed on packets that pass through PBR. If a PBR clause is applied to outbound packets, and the clause results in the selection of an EtherChannel egress interface, then a new hash is generated based on the new address information. This hash is used to select an appropriate member link as the packet's final destination.

Policy based routing is supported on Gigabit EtherChannel. You can configure PBR directly on a GEC bundle interface.

Restriction for Configuring PBR Support on a GEC Bundle

- Use of the **set interface** command is restricted in the set clause for PBR, on GEC bundle interfaces. Only the IP address for the next hop can be specified.

Configuring IEEE 802.1Q and QinQ Support on GEC Bundle

Support for both dot1Q and QinQ subinterfaces is available for GEC bundle interfaces. Configuring subinterface on a GEC bundle interface is similar to a normal Gigabit Ethernet interface configuration. When a subinterface is configured on a GEC bundle interface, the GEC *Toaster* client creates subinterface instances in the Toaster for all the GEC member links. The subinterface instances created internally on GEC member links are hidden and not available to the user for applying configurations.

**Note**

The *toaster* is designed to process IP packets at very high rates using existing forwarding algorithms, though it may also be programmed to perform other tasks and protocols.

Prerequisites for Configuring IEEE 802.1Q and QinQ Support

- Create a GEC bundle main interface before creating subinterfaces.

Restrictions for Configuring IEEE 802.1Q and QinQ Support on GEC Bundle

- A dot1Q/QinQ subinterface created on GEC bundle requires a VCCI on all the member-links. For example, a GEC bundle interface with 8 member-links uses 9 (1+8) VCCIs for each dot1Q/QinQ subinterface created on the GEC bundle.
- Ingress packet accounting for QinQ subinterfaces is carried out at the bundle level. Accounting of these ingress packets per member link is not supported.

Configuration Tasks for IEEE 802.1Q and QinQ on Subinterfaces

To create a GEC bundle subinterface and configure a dot1Q/QinQ encapsulation, enter the following commands beginning from the global configuration mode in the following table:

	Command	Purpose
Step 1	<code>router(config)# interface port-channel <i>number</i></code>	Creates a GEC bundle.
Step 2	<code>router(config)# interface port-channel subinterface</code>	Creates a GEC bundle subinterface and enters the subinterface mode.
Step 3	<code>router(config-subif)# encapsulation dot1q vlan-id</code>	Enables IEEE 802.1Q encapsulation on a specified subinterface in a VLAN.
Step 4	<code>router(config-subif)# encapsulation dot1q vlan-id second-dot1q inner vlan-id</code>	Enables 802.1Q encapsulation on a specified subinterface in an inner VLAN.
Step 5	<code>router# show running-config interface port-channel subinterface</code>	Displays the current configuration for the GEC bundle subinterface.
Step 6	<code>router# show interface port-channel subinterface</code>	Displays status, traffic data, and configuration information about the subinterface you specify.

Configuration Examples

[Example 20-2](#) and [Example 20-3](#) show the encapsulation configuration details:

Example 20-2 show interface Command for the GEC Bundle Subinterface

```
router# show interface port-channel 1.1
Port-channell.1 is up, line protocol is up
  Hardware is GEChannel, address is 0004.9b3e.101a (bia 0004.9b3e.1000)
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation 802.1Q Virtual LAN, Vlan ID 20.
  ARP type: ARPA, ARP Timeout 04:00:00
  Last clearing of "show interface" counters never
```

Example 20-3 show running-config Command for the GEC Bundle Subinterface

```
router# show running-config interface port-channel 1.1
Building configuration...

Current configuration : 134 bytes
!
interface Port-channell.1
 encapsulation dot1q 20 second-dot1q 200
 ip address 3.0.0.1 255.255.255.0
end
```

Configuring MVPN Support on GEC Bundle

The Multicast VPN (MVPN) feature allows a service provider to configure and support multicast traffic within a Virtual Private Network (VPN) environment. MVPN also supports routing and forwarding of multicast packets for each individual VPN routing and forwarding (VRF) instance, and it also provides a mechanism to transport VPN multicast packets across the service provider backbone.

On the Cisco 10000 series router, when we use GEC as a core facing link (from the provider edge to the provider) the MVPN packet sent on the GEC interface has the IP header encapsulated inside a GRE Header or the Tunnel Header. The hash function is calculated based on the tunnel header's source and destination IP address and the original IP header's (Inner IP header) source and destination address. Load balancing is used on outbound GEC packets to find out the member link on which the packet is sent.

For more information on MVPN, see the “IP Multicast VPN” section in the *Multicast VPN—IP Multicast Support for MPLS VPN* guide at:

http://www.cisco.com/en/US/docs/ios/12_2sb/feature/guide/sbb_mvpn.html#wp1040907

Configuration Tasks and Examples

For configuration information and examples, see the “How to Configure Multicast VPN—IP Multicast Support for MPLS VPNs” section in the *How to Configure Multicast VPN—IP Multicast Support for MPLS VPNs* at:

http://www.cisco.com/en/US/docs/ios/12_2sb/feature/guide/sbb_mvpn.html#wp1041284

Configuring PPPoX Support on a GEC Bundle

PPPoE, PPPoEoQinQ, PPPoEoVLAN sessions are supported only in 1:N GEC mode and are provisioned on the GEC bundle interface. The complete session traffic is directed towards the active member link. Hence, when the active link goes down, the session traffic is directed towards the passive member link, which then becomes the active link.

PPPoX sessions on GEC work similar to that of a normal Gigabit Ethernet interface and QoS policy inheritance is similar to that of a normal Gigabit Ethernet interface.

Restrictions for Configuring PPPoX Support for GEC Bundle

- Support for PPPoX sessions is allowed only in a 1:N mode, where there is only one active GEC link.
- At any point of time the bandwidth of the 1:N GEC bundle will be 1 Gbps.



Note Multiple passive links can be added, but only one active link is supported for PPPoE.

For more information on PPPoEoQinQ support for subinterfaces, see PPPoE - QinQ Support feature guide at:

http://www.cisco.com/en/US/docs/ios/12_3t/12_3t7/feature/guide/gt_qinq.html

Configuration Tasks

To enable PPPoE session creation on a GEC bundle, enter the following commands:

	Command	Purpose
Step 1	<code>router(config)# interface port-channel <i>number</i></code>	Creates a GEC bundle.
Step 2	<code>router(config)# lacp max-bundle 1-8</code>	Sets the maximum number of active links per GEC bundle. For PPPoE sessions maximum number of active links is one.
Step 3	<code>router(config)# lacp fast-switchover</code>	Retains PPPoX sessions incase of member link switchover.
Step 4	<code>router(config)# interface port-channel <i>subinterface</i></code>	Creates a GEC bundle subinterface and enters the subinterface mode.
Step 5	<code>router(config-subif)# encapsulation dot1Q <i>vlan-id</i></code>	Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in a VLAN. Specify the VLAN identifier.
Step 6	<code>router(config-subif)# pppoe enable group <i>global</i></code>	Enables PPPoE session on the GEC bundle subinterface. global is the default group used when a group name is not specified.
Step 7	<code>router(config-subif)# end</code>	Exits to the global configuration mode.

For more information on PPPoE over Ethernet, see the *Cisco 10000 Series Router Software Configuration Guide* at:

<http://www.cisco.com/en/US/docs/routers/10000/10008/configuration/guides/broadband/vlan.html>

Configuration Examples

Example 20-4 shows how to enable a PPPoE session on a GEC bundle:

Example 20-4 Enabling a PPPoE Session

```
interface Port-channel32
no ip address
no negotiation auto
lacp max-bundle 1
lacp fast-switchover
!
interface Port-channel32.1
encapsulation dot1Q 10
pppoe enable group bba_group_1
!
interface Port-channel32.2
encapsulation dot1Q 20
pppoe enable group bba_group_1
!
```

Configuring High Availability Support on GEC Bundle

The following high availability features are supported on GEC bundle interfaces, on the Cisco 10000 series router.

- Stateful Switchover (SSO)
- In Service Software Upgrade (ISSU)
- Nonstop Forwarding (NSF)
- Nonstop Routing (NSR)

The EtherChannel and the IEEE 802.3ad LACP protocol are SSO and ISSU aware. This feature makes the GEC bundle interface available after a PRE switchover, in the event of a catastrophic failure.

For more information on NSF, see *Cisco Nonstop Forwarding* whitepaper at:

http://www.cisco.com/en/US/docs/ios/12_2s/feature/guide/fsnsf20s.html

For information on SSO see, *Stateful Switchover* feature guide at:

http://www.cisco.com/en/us/docs/ios/12_2s/feature/guide/fssso20s.html

For more information on ISSU, see *Cisco IOS In Service Software Upgrade and Enhanced Fast Software Upgrade Process* feature guide, at:

http://www.cisco.com/en/US/docs/ios/12_2sb/feature/guide/sb_issu.html

Configuring 8 Member Links per GEC Bundle

A maximum of 8 configured member links are supported per GEC bundle on the Cisco 10000 series router. The number of member links per GEC bundle has been increased from 4 to 8 in the Cisco IOS Release 12.2(33)SB.

Configuration Tasks

The following table lists the configuration commands used to configure the maximum and minimum links on a GEC bundle on a Cisco 10000 series router.

Command	Purpose
<code>router(config-if)# lacp max-bundle 1-8</code>	Assigns the maximum number of links per bundle. The default value is 8.
<code>router(config-if)# lacp min-link 1-8</code>	Sets the minimum number of active links required before declaring the port channel interface down. The default value is 1.
<code>router(config-if)# lacp fast-switchover</code>	Reduces the switchover time from 2 seconds to 10ms. By default lacp fast-switchover configuration is not enabled.

For more information on configuring member links, see the *Link Aggregation Control Protocol (LACP) (802.3ad) for Gigabit Interfaces* feature guide at:

<http://www.cisco.com/univercd/cc/td/doc/product/software/ios122sb/newft/122sb31/10gigeth.htm>

For more information on how to aggregate multiple Ethernet links into one logical channel, see *IEEE 802.3ad Link Bundling* feature guide at:
<http://www.cisco.com/univercd/cc/td/doc/product/software/ios122sb/newft/122sb31/sbcelacp.htm#wp1053782>