

VLAN Mapping to Gigabit EtherChannel Member Links

The VLAN Mapping to Gigabit EtherChannel (GEC) Member Links feature allows you to configure static assignment of user traffic, as identified by a VLAN ID, to a given member link of a GEC bundle. You can manually assign virtual LAN (VLAN) subinterfaces to a primary and secondary link. This feature allows load balancing to downstream equipment regardless of vendor equipment capabilities, and provides failover protection by redirecting traffic to the secondary member link if the primary link fails. Member links are supported with up to 64 GEC interfaces and 14 member links per GEC interface.

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Prerequisites for VLAN Mapping to GEC Member Links

- Each VLAN must have IEEE 802.1Q encapsulation configured.
- One primary and one secondary link must be associated with each VLAN.
- Configure per VLAN load balancing either on the main port-channel interface or enable it globally.

Restrictions for VLAN Mapping to GEC Member Links

The following restrictions are applicable for IPv6 load balancing on Gigabit EtherChannel (GEC) links:

- IPv6 traffic distribution is enabled only on port channels with flow load balancing.
- Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) is not supported on port channels.
- For Cisco ASR 1000 Series Aggregation Services Routers, the minimum number of member links per GEC interface is 1 and the maximum number is 14.

- 10 Gigabit, 40 Gigabit, 100 Gigabit Ethernet supported as a member link in VLAN mapping.
- The port-channel QinQ subinterface is not supported.
- The quality of service (QoS) policy can be applied to a port-channel subinterface when the following conditions are met:
  - Manual virtual LAN (VLAN) load balancing is supported.
  - A policy map has the appropriate service-fragment policy configured on a physical member link.

Information About VLAN Mapping of GEC Member Links

VLAN-Manual Load Balancing

When load balancing is configured for GEC links, traffic flows are mapped to different buckets as dictated by the load balancing algorithm. For each EtherChannel, a set of 16 buckets are created. The EtherChannel module decides how the buckets are distributed across member links. Each bucket has an active link associated with it that represents the interface to be used for all flows that are mapped to the same bucket.

All packets to be forwarded over the same VLAN subinterface are considered to be part of the same flow that is mapped to one bucket. Each bucket is associated with a primary and secondary pair, and the buckets point to the active interface in the pair. Only one pair is active at a time. Multiple VLAN flows can be mapped to the same bucket if their (primary and secondary) mapping is the same.

The buckets are created when VLAN manual load balancing is enabled. When VLAN load balancing is removed, the buckets are deleted. All port channels use either VLAN manual load balancing or dynamic flow-based load balancing. For information about flow-based load balancing, see the “Flow-Based Per Port-Channel Load Balancing” module.

One primary and one secondary link must be associated with a given VLAN. The primary and secondary options are available only if VLAN manual load balancing is enabled. If the following conditions are met, the load balancing information is downloaded in the forwarding plane. If any of these conditions are not met , the load balancing information is removed from the forwarding plane.

- VLAN load balancing must be enabled globally.
- IEEE 802.1Q encapsulation must be configured on each VLAN.
- One primary and one secondary member link must be enabled to manually map the VLAN traffic to the EtherChannel links.
- The primary and secondary links must be part of the port channel for traffic to use these links.

If only a primary link is specified, a secondary link is selected as the default. If neither a primary nor a secondary link is explicitly configured, the primary and secondary links are selected by default. There is no attempt to perform equal VLAN distribution across links when default links are chosen.

If the interfaces specified as primary or secondary links are not configured as part of the port channel, or if the global VLAN load balancing is not enabled, warning messages are displayed.

Warning

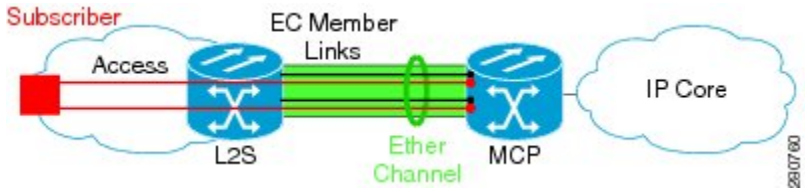
VLAN 500's main interface is not the channel group of primary=GigabitEthernet 4/0/1 Per-VLAN manual load-balancing will not take effect until channel-group is configured under the primary interface.

VLAN 500's main interface is not the channel group of secondary=GigabitEthernet 1/0/0 Per-VLAN manual load-balancing will not take effect until channel-group is configured under the primary interface.

VLAN-to-Port Channel Member Link Mapping

The figure below illustrates the traffic flow for the VLAN-to-port channel mapping.

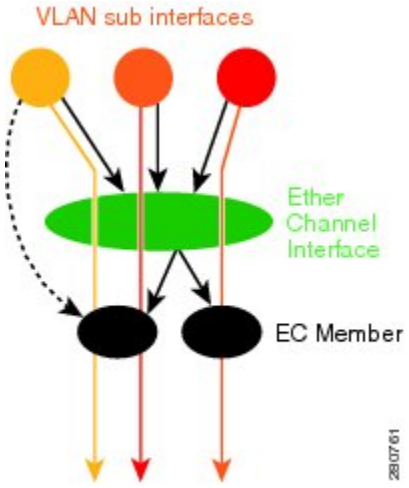
Figure 1: VLAN-to-Port Channel Member Link Mapping



The black lines represent the physical 1 Gigabit Ethernet interfaces connecting the MCP router with the Layer 2 (L2) switch. These interfaces are bundled together in port-channels, shown in green.

In the figure below, subscriber VLAN subinterfaces, shown in shades of orange and red, are configured as Layer 3 (L3) interfaces on top of EtherChannel interfaces. Mapping of the VLAN to the member link (shown with the dotted black arrow) is done through configuration and downloaded in the dataplane so that the outgoing VLA traffic (shown with orange and red arrows) is sent over the associated active primary or secondary member link. The QoS configuration in this model is applied at the VLAN subinterface and member link interface level, implying that QoS queues are created at both levels.

Figure 2: Mapping of VLAN to Member Links



VLAN Primary and Secondary Link Association

In a port-channel traffic distribution, a member link can have either a configured primary state or a secondary state, and an operational active or standby state. When the interface is up, the primary link is active. If the

primary link is down, the interface is in primary standby state while the secondary interface is in secondary active state. If the primary link is up, the secondary link is in secondary standby even if the interface is operationally up.

The primary and secondary member links are each associated with a routed VLAN configured on a port-channel main interface. When forwarding traffic for this VLAN, the primary interface is used as the outgoing interface when this interface is up; the secondary interface, if operational, is used when the primary interface is down.

If all the conditions for per-VLAN traffic distribution are not met, the mapping is not downloaded in the forwarding plane. If all the conditions are met, the dataplane is updated with this mapping.

The table below describes the primary and secondary link configuration status and the resulting function of each configuration.

Table 1: VLAN Primary and Secondary Link Mapping Status

Primary Status	Secondary Status	Description
Configured	Configured	Both primary and secondary links are specified with the **encapsulation dot1q** command. `encapsulation dot1Q vlan-id primary`
Defaulted	Defaulted	Neither a primary nor a secondary link is specified. `encapsulation dot1Q vlan-id` In a stable system, defaults for both primary and secondary links are selected in the same manner for all VLANs. The first link up that is added to the EC is selected as primary, and the second link up as secondary. If there are no links up, the primary and secondary links are selected from the down links.
Configured	Defaulted	Only the primary link is specified. `encapsulation dot1Q vlan-id primary` A secondary link that is different than the primary link is internally selected.
Configured	–	Only a primary link is specified and only one link is defined. `encapsulation dot1Q vlan-id primary` No secondary link can be selected as default when only one link is defined in the EC.
Defaulted	–	Neither a primary nor secondary link is specified, and only one link is defined. `encapsulation dot1Q vlan-id` A default for a primary link is selected. However, no default link can be selected for a secondary link if only one link is defined in the EC.

Primary Status	Secondary Status	Description
–	–	Neither a primary nor secondary link is specified, and no links are defined. `encapsulation dot1Q vlan-id` Defaults cannot be selected and no links are defined in the EC.



Note Default mappings do not override user-configured mappings even if the user-configured mappings are defined incorrectly. Once the (VLAN, primary, and secondary) association is performed (either through the CLI, default or a combination of both), the system validates the mapping and downloads it to the dataplane. If there are no VLANs configured, all traffic forwarded over the port channel is dropped.

Adding Channel Member Links

When a new member link is added, new buckets are created and downloaded in the dataplane. For all VLANs that have the interface as either primary or secondary, new VLAN-to-bucket mappings are downloaded in the dataplane. For all VLANs that need a default for primary and secondary, the default selection algorithm is triggered, and if QoS validation passes, the VLAN-to-bucket mappings are downloaded. QoS policies create VLAN queues on the newly added link.

Deleting Member Links

When a member link is removed, a warning message is displayed. All VLAN queues from the member link, VLAN-to-bucket mappings, and all affected buckets are removed.

Port Channel Link Down Notification

When a link goes down, all traffic for VLANs that have the Port Channel link assigned as primary link must be switched to secondary link if the secondary is up. The traffic for the VLANs with the Port Channel link assigned as secondary, is not affected. The Port Channel Link Down notification causes all buckets associated with a primary-secondary pair (where the primary link is down and the secondary link is up) to be updated with the secondary link. This change is communicated to the dataplane.

All buckets associated with a primary-secondary pair (and the secondary link is the down link and where primary link is up) are updated so that the primary link is now the active link. This change is communicated to the dataplane.

Port Channel Link Up Notification

When a link goes up, all traffic for VLANs that have this link assigned as primary is switched to this link. The traffic for VLANs that have this link assigned as secondary is not affected. The Port Channel Link Up notification causes all buckets associated with a primary-secondary pair, where the primary link is the link that came up, and the secondary link is up, to be notified that the primary link is up. The change is communicated to the dataplane.

All buckets associated with a primary-secondary pair, where the secondary link is the link that came up and the primary link is down are notified that the secondary link is now the primary link. The change is communicated to the dataplane.

Disabling Load Balancing on the EtherChannel

To disable load balancing on the EtherChannel, use the **no port-channel load-balancing vlan-manual** command. The following warning message is displayed if any VLAN subinterfaces exist:

```
Warning: Removing the Global VLAN LB command will affect traffic
c for all dot1Q VLANs
```

Removing a Member Link from the EtherChannel

To remove a member link from the EtherChannel (EC), use the **no channel-group** command

When a member link is removed from the EC is included in a VLAN mapping, the following warning message is displayed:

```
Warning: Removing GigabitEthernet 4/0/0 from the port-channel will affect traffic for the
dot1Q VLANs that include this link in their mapping.
```

How to Configure VLAN Mapping to GEC Links

Configuring VLAN-Based Manual Load Balancing

Perform this task to link VLAN port-channel and to enable VLAN load balancing on port channels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **port-channel load-balancing vlan-manual**
4. **interface port-channel** *channel-number*
5. **ip address** *ip-address address-mask*
6. **exit**
7. **interface** *type subinterface-number*
8. **channel-group** *channel-number*
9. **exit**
10. **interface port-channel** *interface-number.subinterface-number*
11. **encapsulation dot1Q** *vlan-id* **primary** *interface-type slot/port* **secondary** *interface-type slot/port*
12. **ip address** *ip-address address-mask*
13. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**port-channel load-balancing vlan-manual** **Example:** `Router(config)# port-channel load-balancing vlan-manual`	Enables port-channel load balancing on the router.
Step 4	**interface port-channel** *channel-number* **Example:** `Router(config)# interface port-channel 1`	Enters interface configuration mode and defines the interface as a port channel.
Step 5	**ip address** *ip-address address-mask* **Example:** `Router(config-if)# ip address 172.16.2.3 255.255.0.0`	Specifies the IP address and mask.
Step 6	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.
Step 7	**interface** *type subinterface-number* **Example:** `Router(config)# interface gigbabitethernet 1/1/0`	Enters interface configuration mode on the Gigabit Ethernet interface.
Step 8	**channel-group** *channel-number* **Example:** `Router(config-if)# channel-group 1`	Assigns the Gigabit Ethernet interface to the specified channel group. • The channel number is the same channel number that you specified when you created the port-channel interface.
Step 9	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.

	Command or Action	Purpose
Step 10	**interface port-channel** *interface-number.subinterface-number* **Example:** `Device(config)# interface port-channel 1.100`	Specifies the interface type, interface number, and subinterface number.
Step 11	**encapsulation dot1Q** *vlan-id* **primary** *interface-type slot/port* **secondary** *interface-type slot/port* **Example:** `Device(config-if)# encapsulation dot1Q 100 primary GigabitEthernet 1/1/1 secondary GigabitEthernet 1/2/1`	Enables IEEE 802.1Q encapsulation on the interface.
Step 12	**ip address** *ip-address address-mask* **Example:** `Device(config-if)# ip address 172.16.2.100 255.255.255.0`	Specifies the port channel IP address and mask.
Step 13	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode, and returns to privileged EXEC mode.

Troubleshooting Tips

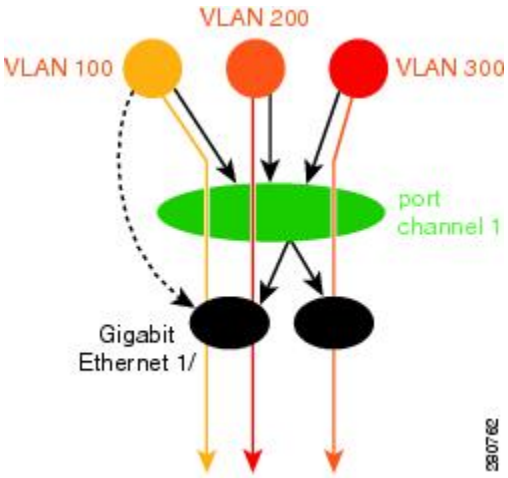
- Use the **show etherchannel load-balancing** command to display the current port channel load balancing method.
- Use the **show interfaces port-channel etherchannel** command to display the current traffic distribution.

Configuration Examples for VLAN Mapping to GEC Member Links

Example: Configuring VLAN Manual Load Balancing

This example shows how the load balancing configuration can be globally applied to define policies for handling traffic by using the **port-channel load-balancing** command. Note that IEEE 802.1Q encapsulation is configured on each port-channel interface. The figure below illustrates the port channel bundle with three VLANs used in the following configuration example:

Figure 3: Port Channel Bundle




```
port-channel load-balancing vlan-manual
!
class-map match-all BestEffort
!
class-map match-all video
!
class-map match-all voice
!
policy-map subscriber
  class voice
    priority level 1
  class video
    priority level 2
  class class-default service-fragment BE
    shape average 10000
    bandwidth remaining percent 80
policy-map aggregate-member-link
    class BestEffort service-fragment BE
    shape average 100000
!
interface Port-channel1
 ip address 172.16.2.3 255.255.0.0
!
interface Port-channel1.100
 encapsulation dot1Q 100 primary GigabitEthernet 1/1/1
              secondary GigabitEthernet 1/2/1
 ip address 172.16.2.100 255.255.255.0
 service-policy output subscriber
!
interface Port-channel1.200
 encapsulation dot1Q 200 primary GigabitEthernet 1/2/1
 ip address 172.16.2.200 255.255.255.0
 service-policy output subscriber
!
interface Port-channel1.300
 encapsulation dot1Q 300
 ip address 172.16.2.300 255.255.255.0
 service-policy output subscriber
!
interface GigabitEthernet 1/1/1
 no ip address
 channel-group 1 mode on
```

```
 service-policy output aggregate-member-link
!
interface GigabitEthernet 1/2/1
 no ip address
 channel-group 1 mode on
 service-policy output aggregate-member-link
```

Example: Troubleshooting

Example 1:

```
Device# show etherchannel load-balancing

EtherChannel Load-Balancing Configuration: vlan-manual
```

Example 2:

```
Device# show etherchannel load-balancing

EtherChannel Load-Balancing Configuration: not configured
```

Use the **show interfaces port-channel** command to display the traffic distribution currently in use.

```
Device# show interfaces port-channel 1 etherchannel

Active Member List contains 0 interfaces
 Passive Member List contains 2 interfaces
  Port: GigabitEthernet 4/0/0
    VLAN 1 (Pri, Ac, D, P)    VLAN 100 (Pri, Ac, C, P)    VLAN 200 (Sec, St, C, P)
  Port: GigabitEthernet 1/0/0
    VLAN 1 (Sec, St, D, P)    VLAN 100 (Sec, St, C, P)    VLAN 200 (Pri, Ac, C, P)
 Bucket Information for VLAN Manual LB:
    Bucket 0   (p=GigabitEthernet 4/0/0, s=GigabitEthernet 4/0/0) active GigabitEthernet
4/0/0
    Bucket 1   (p=Gigabitthernet 4/0/0, s=GigabitEthernet 1/0/0) active GigabitEthernet
4/0/0
    Bucket 4   (p=GigabitEthernet 1/0/0, s=GigabitEthernet 4/0/0) active GigabitEthernet
1/0/0
    Bucket 5   (p=GigabitEthernet 1/0/0, s=GigabitEthernet 1/0/0) active GigabitEthernet
1/0/0
```

To see the mapping of a VLAN to primary and secondary links, use the **show vlans** command.

```
Device# show vlans 100
VLAN ID: 100 (IEEE 802.1Q Encapsulation)
   Protocols Configured:          Received:        Transmitted:
VLAN trunk interfaces for VLAN ID 100:
Port-channel1.1 (100)
      Mapping for traffic load-balancing using bucket 1:
          primary   = GigabitEthernet 4/0/0 (active, C, P)
          secondary = GigabitEthernet 1/0/0 (standby, C, P)
      Total 0 packets, 0 bytes input
      Total 0 packets, 0 bytes output
No subinterface configured with ISL VLAN ID 100
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
LAN Switching commands	*Cisco IOS LAN Switching Command Reference*

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 VLAN Mapping to GEC Member Links

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 https://cfnng.cisco.com/. An account on Cisco.com is not required.

Table 2: Feature Information for VLAN Mapping to Gigabit EtherChannel Member Links

Feature Name	Releases	Feature Information
VLAN Mapping to Gigabit EtherChannel Member Links	Cisco IOS XE Release 2.1	The VLAN Mapping to Gigabit EtherChannel Member Links feature allows you to configure static assignment of user traffic as identified by a VLAN ID to a given member link of a GEC bundle. You can manually assign VLAN subinterfaces to a primary and secondary link. This feature allows load balancing to downstream equipment, regardless of vendor equipment capabilities, and provides failover protection by redirecting traffic to the secondary member link if the primary link fails. Member links are supported with up to 16 bundles per chassis. The following commands were modified by this feature: **encapsulation dot1q**, **port-channel load-balancing vlan-manual**, **show etherchannel load-balancing**, and **show interfaces port-channel vlan mapping**.