

Flow-Based per Port-Channel Load Balancing

The Flow-Based per Port-Channel Load Balancing feature allows different flows of traffic over a Gigabit EtherChannel (GEC) interface to be identified based on the packet header and then mapped to the different member links of the port channel. This feature enables you to apply flow-based load balancing and VLAN-manual load balancing to specific port channels.

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Restrictions for Flow-Based per Port-Channel Load Balancing

- Supports up to 64 GEC interfaces.
- Supports up to 14 member links per GEC interface.

Note This feature achieves load balancing of MPLS traffic only by using source IP address and destination IP address. The MPLS label is not considered for load balancing.

Information About Flow-Based per Port-Channel Load Balancing

Flow-Based Load Balancing

Flow-based load balancing identifies different flows of traffic based on the key fields in the data packet. For example, IPv4 source and destination IP addressees can be used to identify a flow. The various data traffic flows are then mapped to the different member links of a port channel. After the mapping is done, the data traffic for a flow is transmitted through the assigned member link. The flow mapping is dynamic and changes when there is any change in the state of a member link to which a flow is assigned. The flow mappings can

also change if member links are added to or removed from the GEC interface. Multiple flows can be mapped to each member link.

Buckets for Flow-Based Load Balancing

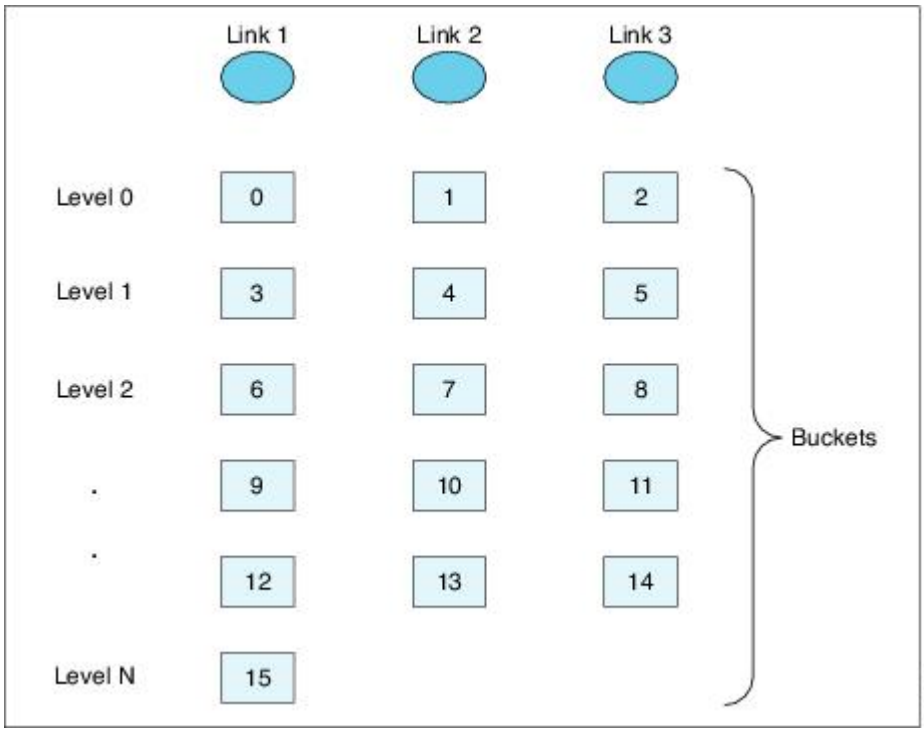
Load balancing dynamically maps traffic flows to the member links of a GEC interface through the concept of buckets. The various defined traffic flows are mapped to the buckets and the buckets are evenly distributed among the member links. Each port channel maintains 16 buckets, with one active member link associated with each bucket. All traffic flows mapped to a bucket use the member link to which the bucket is assigned.

The router creates the buckets-to-member links mappings when you apply flow-based load balancing to a port channel and the port channel has at least one active member link. The mappings are also created when the first member link is added, or comes up, and the load-balancing method is set to flow-based.

When a member link goes down or is removed from a port channel, the buckets associated with that member link are redistributed among the other active member links in a round-robin fashion. When a member link comes up or is added to a port channel, some of the buckets associated with other links are assigned to this link.

The figure below illustrates an example of 16 buckets distributed among three member links. The numbers shown in the buckets are the bucket IDs. Note that the first member link has an extra bucket.

Figure 1: Example of 16 Buckets Mapped to Three Member Links



If you change the load-balancing method, the bucket-to-member link mappings for flow-based load balancing are deleted. The mappings are also deleted if the port channel is deleted or the last member link in the port channel is deleted or goes down.

Load Balancing on Port Channels

GEC interfaces can use either dynamic flow-based load balancing or VLAN-manual load balancing. You can configure the load-balancing method globally for all port channels or directly on specific port channels. The global configuration applies only to those port channels for which you have not explicitly configured load balancing. The port-channel configuration overrides the global configuration.

Flow-based load balancing is enabled by default at the global level. You must explicitly configure VLAN load balancing or the load-balancing method is flow-based.

For more information about configuring VLAN load balancing, see the module VLAN Mapping to Gigabit EtherChannel (GEC) Member Links.

The table below lists the load-balancing method that is applied to port channels based on the configuration:

Table 1: Flow-Based Load Balancing Configuration Options

Global Configuration	Port-Channel Configuration	Load Balancing Applied
Not configured	Not configured	Flow-based
	Flow-based	Flow-based
	VLAN-manual	VLAN-manual
VLAN-manual	Not configured	VLAN-manual
	Flow-based	Flow-based
	VLAN-manual	VLAN-manual

The table below lists the configuration that results if you change the global load-balancing method.

Table 2: Results When Global Configuration Changes

Port-Channel Configuration	Global Configuration	Action Taken at Port Channel	
–	From	To	–
Not configured	Not configured	VLAN-manual	Changed from flow-based to VLAN-manual
	VLAN-manual	Not configured	Changed from VLAN-manual to flow-based
Configured	Any	Any	No change

The table below lists the configuration that results if you change the port-channel load-balancing method.

Table 3: Results When Port-Channel Configuration Changes

Global Configuration	Port-Channel Configuration	Action Taken at Port Channel	
–	From	To	–

Global Configuration	Port-Channel Configuration	Action Taken at Port Channel	
Not configured	Not configured	VLAN-manual	Changed from flow-based to VLAN-manual
	Not configured	Flow-based	No action taken
	VLAN-manual	Flow-based	Changed from VLAN-manual to flow-based
	VLAN-manual	Not configured	Changed from VLAN-manual to flow-based
	Flow-based	VLAN-manual	Changed from flow-based to VLAN-manual
	Flow-based	Not configured	No action taken
VLAN-manual	Not configured	VLAN-manual	No action taken
	Not configured	Flow-based	Changed from VLAN-manual to flow-based
	VLAN-manual	Flow-based	Changed from VLAN-manual to flow-based
	VLAN-manual	Not configured	No action taken
	Flow-based	VLAN-manual	Changed from flow-based to VLAN-manual
	Flow-based	Not configured	Changed from flow-based to VLAN-manual

How to Enable Flow-Based per Port-Channel Load Balancing

Configuring Load Balancing on a Port Channel

To configure load balancing on a port channel, perform the following steps. Repeat these steps for each GEC interface.

Before you begin

If you have already configured your desired load-balancing method globally and want to use that method for all port channels, you need not perform this task. To configure load balancing globally, use the **port-channel load-balancing vlan-manual** command. If you do not configure the global command, flow-based load balancing is applied to all port channels.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface port-channel** *channel-number*
4. **load-balancing** {**flow** | **vlan**}
5. **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	**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 4	**load-balancing** {**flow**	**vlan**} **Example:** `Router(config-if)# load-balancing flow`	Applies a load-balancing method to the specific port channel. • If you do not configure this command, the port channel uses the global load-balancing method configured with the **port-channel load-balancing vlan-manual** command. The global default is flow-based.
Step 5	**end** **Example:** `Router(config-if)# end`	Exits configuration mode.

Verifying Load-Balancing Configuration on a GEC Interface

Use these show commands to verify the load-balancing configuration and to display information about the bucket distribution on the port channel. You can use these commands in any order.

SUMMARY STEPS

1. **show running-config interface port-channel** *channel-number*
2. **show etherchannel load-balancing**
3. **show interfaces port-channel** *channel-number* **etherchannel**

DETAILED STEPS

Procedure

Step 1 **show running-config interface port-channel** *channel-number*

Use this command to verify the configuration of the port channel.

Example:

```
Router# show running-config interface port-channel 1
Building configuration...

Current configuration : 88 bytes
!
interface Port-channel1
 ip address 10.1.1.1 255.0.0.0
 no negotiation auto
 load-balancing flow
end
```

Step 2 **show etherchannel load-balancing**

Use this command to display the load-balancing method applied to each port channel. The following example shows output for a configuration with load balancing set globally to VLAN-manual and set to flow-based on port channel 1:

Example:

```
Router# show etherchannel load-balancing


EtherChannel Load-Balancing Method:
Global LB Method: vlan-manual

  Port-Channel:                      LB Method
    Port-channel1                  :  flow-based
```

Step 3 **show interfaces port-channel** *channel-number* **etherchannel**

Use this command to display the bucket distribution currently in use. The following example shows output for an interface with load balancing set to flow-based:

Example:

```
Router(config)# show interface port-channel 2 etherchannel

 All IDBs List contains 3 configured interfaces
  Port: GigabitEthernet2/1/6 (index: 0)
  Port: GigabitEthernet2/1/7 (index: 1)
  Port: GigabitEthernet2/1/0 (index: 2)
```

```
Active Member List contains 1 interfaces
 Port: GigabitEthernet2/1/0

Passive Member List contains 2 interfaces
 Port: GigabitEthernet2/1/6

 Port: GigabitEthernet2/1/7

Load-Balancing method applied: flow-based

Bucket Information for Flow-Based LB:
Interface:                                Buckets
   GigabitEthernet2/1/0:
                          Bucket 0 , Bucket 1 , Bucket 2 , Bucket 3
                          Bucket 4 , Bucket 5 , Bucket 6 , Bucket 7
                          Bucket 8 , Bucket 9 , Bucket 10, Bucket 11
                          Bucket 12, Bucket 13, Bucket 14, Bucket 15
```

Configuration Examples for Flow-Based per Port-Channel Load Balancing

Flow-Based Load Balancing Example

The following example shows a configuration where flow-based load balancing is configured on port-channel 2 while the VLAN-manual method is configured globally:

```
!
no aaa new-model
port-channel load-balancing vlan-manual
ip source-route
.
.
.
interface Port-channel2
 ip address 10.0.0.1 255.255.255.0
 no negotiation auto
 load-balancing flow
!
interface Port-channel2.10
 ip rsvp authentication key 11223344
 ip rsvp authentication
!
interface Port-channel2.50
 encapsulation dot1Q 50
!
interface GigabitEthernet2/1/0
 no ip address
 negotiation auto
 cdp enable
 channel-group 2
!
```

Information About Five-Tuple Hash Support for GEC Flow-based Load Balancing

The five-tuple hash support for gigabit etherchannel (GEC) flow-based load balancing feature decides which member link to use for routing traffic based on the following five parameters:

- Source IP address
- Destination IP address
- Source Port
- Destination Port
- Protocol ID (type of protocol: TCP/UDP)

Earlier, the GEC flow-based load balancing feature was applicable only for layer 3 (network layer). With the five-tuple hash support, it's applicable for layer 4 (TCP/IP layer) also. But it is supported only for the TCP and UDP, layer 4 protocols.

Restrictions for Five-Tuple Hash Support for GEC Flow-based Load Balancing

The five-tuple hash support for GEC flow-based load balancing feature is not supported for MPLS traffic.

Configuring Five-Tuple Hash Support for GEC Flow-based Load Balancing

Use the **port-channel load-balance-hash-algo** command to enable the five-tuple hash support for GEC flow-based load balancing feature.

The following example shows how to configure a five-tuple hash support for GEC flow-based load balancing feature:

```
Device (config)# port-channel load-balance-hash-algo ?

src-dst-ip Source XOR Destination IP Addr
src-dst-mixed-ip-port Source XOR Destination Port, IP addr
```

The **src-dst-mixed-ip-port** option specifies load distribution based on the hash value obtained from the calculation of five parameters: source ip address, destination ip address, source port, destination port, and L4 protocol.

Example

Additional References

The following sections provide references related to the Flow-Based per Port-Channel Load Balancing feature.

Related Documents

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

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 XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

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

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. 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. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Flow-Based per Port-Channel Load Balancing

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 4: Feature Information for Flow-Based per Port-Channel Load Balancing

Feature Name	Releases	Feature Information
Flow-Based per Port-Channel Load Balancing	Cisco IOS XE Release 2.5	This feature allows different flows of traffic over a GEC interface to be identified and mapped to the different member links. It also enables you to apply load balancing to specific port channels. The following commands were introduced or modified: **load-balancing**, **port-channel load-balancing vlan-manual**, **show etherchannel load-balancing, show interfaces port-channel etherchannel**.
IPv6 Loadbalancing on GEC	Cisco IOS XE Release 3.4S	The IPv6 Loadbalancing on GEC feature provides load balancing for IPv6 traffic on Gigabit EtherChannel.
Five-Tuple Hash Support for GEC Flow-based Load Balancing	Cisco IOS XE Everest 16.4.1	The five-tuple hash support for gigabit etherchannel (GEC) flow-based load balancing feature decides which member link to use for routing traffic based on the hash value obtained from the calculation of 5 parameters: source ip address, destination ip address, source port, destination port, and L4 protocol.