



## Configuring IP Unicast Layer 3 Switching

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This chapter describes how to configure IP unicast Layer 3 switching on the Catalyst 6500 series switches.



### Note

For complete syntax and usage information for the commands used in this chapter, refer to these publications:

- The *Cisco IOS Master Command List*, Release 12.2SX at this URL:  
[http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all\\_book.html](http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html)
- The Release 12.2 publications at this URL:  
[http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products\\_installation\\_and\\_configuration\\_guides\\_list.html](http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html)
- IPX traffic is fast switched on the MSFC. For more information, refer to this URL:  
[http://www.cisco.com/en/US/docs/ios/12\\_2/atipx/configuration/guide/fatipx\\_c.html](http://www.cisco.com/en/US/docs/ios/12_2/atipx/configuration/guide/fatipx_c.html)
- For information about IP multicast Layer 3 switching, see [Chapter 28, “Configuring IPv4 Multicast Layer 3 Switching.”](#)

This chapter consists of these sections:

- [Understanding How Layer 3 Switching Works, page 26-2](#)
- [Default Hardware Layer 3 Switching Configuration, page 26-4](#)
- [Configuration Guidelines and Restrictions, page 26-4](#)
- [Configuring Hardware Layer 3 Switching, page 26-5](#)
- [Displaying Hardware Layer 3 Switching Statistics, page 26-6](#)



### Tip

For additional information about Cisco Catalyst 6500 Series Switches (including configuration examples and troubleshooting information), see the documents listed on this page:

[http://www.cisco.com/en/US/products/hw/switches/ps708/tsd\\_products\\_support\\_series\\_home.html](http://www.cisco.com/en/US/products/hw/switches/ps708/tsd_products_support_series_home.html)

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# Understanding How Layer 3 Switching Works

These sections describe Layer 3 switching:

- [Understanding Hardware Layer 3 Switching, page 26-2](#)
- [Understanding Layer 3-Switched Packet Rewrite, page 26-2](#)

## Understanding Hardware Layer 3 Switching

Hardware Layer 3 switching allows the PFC and DFCs, instead of the MSFC, to forward IP unicast traffic between subnets. Hardware Layer 3 switching provides wire-speed forwarding on the PFC and DFCs, instead of in software on the MSFC. Hardware Layer 3 switching requires minimal support from the MSFC. The MSFC routes any traffic that cannot be hardware Layer 3 switched.

Hardware Layer 3 switching supports the routing protocols configured on the MSFC. Hardware Layer 3 switching does not replace the routing protocols configured on the MSFC.

Hardware Layer 3 switching runs equally on the PFC and DFCs to provide IP unicast Layer 3 switching locally on each module. Hardware Layer 3 switching provides the following functions:

- Hardware access control list (ACL) switching for policy-based routing (PBR)
- Hardware NetFlow switching for TCP intercept, reflexive ACL forwarding decisions
- Hardware Cisco Express Forwarding (CEF) switching for all other IP unicast traffic

Hardware Layer 3 switching on the PFC supports modules that do not have a DFC. The MSFC forwards traffic that cannot be Layer 3 switched.

Traffic is hardware Layer 3 switched after being processed by access lists and quality of service (QoS).

Hardware Layer 3 switching makes a forwarding decision locally on the ingress-port module for each packet and sends the rewrite information for each packet to the egress port, where the rewrite occurs when the packet is transmitted from the Catalyst 6500 series switch.

Hardware Layer 3 switching generates flow statistics for Layer 3-switched traffic. Hardware Layer 3 flow statistics can be used for NetFlow Data Export (NDE). (See [Chapter 51, “Configuring NDE”](#).)

## Understanding Layer 3-Switched Packet Rewrite

When a packet is Layer 3 switched from a source in one subnet to a destination in another subnet, the Catalyst 6500 series switch performs a packet rewrite at the egress port based on information learned from the MSFC so that the packets appear to have been routed by the MSFC.

Packet rewrite alters five fields:

- Layer 2 (MAC) destination address
- Layer 2 (MAC) source address
- Layer 3 IP Time to Live (TTL)
- Layer 3 checksum
- Layer 2 (MAC) checksum (also called the frame checksum or FCS)

**Note**

Packets are rewritten with the encapsulation appropriate for the next-hop subnet.

If Source A and Destination B are in different subnets and Source A sends a packet to the MSFC to be routed to Destination B, the switch recognizes that the packet was sent to the Layer 2 (MAC) address of the MSFC.

To perform Layer 3 switching, the switch rewrites the Layer 2 frame header, changing the Layer 2 destination address to the Layer 2 address of Destination B and the Layer 2 source address to the Layer 2 address of the MSFC. The Layer 3 addresses remain the same.

In IP unicast and IP multicast traffic, the switch decrements the Layer 3 TTL value by 1 and recomputes the Layer 3 packet checksum. The switch recomputes the Layer 2 frame checksum and forwards (or, for multicast packets, replicates as necessary) the rewritten packet to Destination B's subnet.

A received IP unicast packet is formatted (conceptually) as follows:

Layer 2 Frame Header		Layer 3 IP Header				Data	FCS
Destination	Source	Destination	Source	TTL	Checksum		
<i>MSFC MAC</i>	<i>Source A MAC</i>	<i>Destination B IP</i>	<i>Source A IP</i>	<i>n</i>	<i>calculation1</i>		

After the switch rewrites an IP unicast packet, it is formatted (conceptually) as follows:

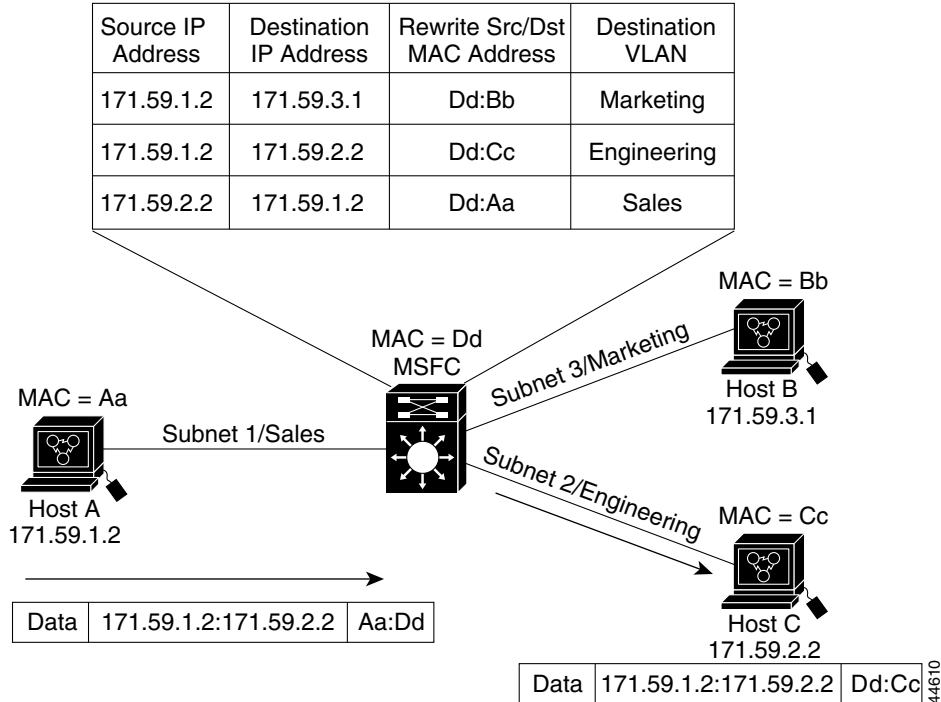
Layer 2 Frame Header		Layer 3 IP Header				Data	FCS
Destination	Source	Destination	Source	TTL	Checksum		
<i>Destination B MAC</i>	<i>MSFC MAC</i>	<i>Destination B IP</i>	<i>Source A IP</i>	<i>n-1</i>	<i>calculation2</i>		

## Hardware Layer 3 Switching Examples

Figure 26-1 on page 26-4 shows a simple network topology. In this example, Host A is on the Sales VLAN (IP subnet 171.59.1.0), Host B is on the Marketing VLAN (IP subnet 171.59.3.0), and Host C is on the Engineering VLAN (IP subnet 171.59.2.0).

When Host A initiates an HTTP file transfer to Host C, Hardware Layer 3 switching uses the information in the local forwarding information base (FIB) and adjacency table to forward packets from Host A to Host C.

Figure 26-1 Hardware Layer 3 Switching Example Topology



## Default Hardware Layer 3 Switching Configuration

Table 26-1 shows the default hardware Layer 3 switching configuration.

Table 26-1 Default Hardware Layer 3 Switching Configuration

Feature	Default Value
Hardware Layer 3 switching enable state	Enabled (cannot be disabled)
Cisco IOS CEF enable state on MSFC	Enabled (cannot be disabled)
Cisco IOS dCEF <sup>1</sup> enable state on MSFC	Enabled (cannot be disabled)

1. dCEF = Distributed Cisco Express Forwarding

## Configuration Guidelines and Restrictions

Follow these guidelines and restrictions when configuring hardware Layer 3 switching:

- Hardware Layer 3 switching supports the following ingress and egress encapsulations:
  - Ethernet V2.0 (ARPA)
  - 802.3 with 802.2 with 1 byte control (SAP1)

# Configuring Hardware Layer 3 Switching



## Note

For information on configuring unicast routing on the MSFC, see [Chapter 22, “Configuring Layer 3 Interfaces.”](#)

Hardware Layer 3 switching is permanently enabled. No configuration is required.

To display information about Layer 3-switched traffic, perform this task:

Command	Purpose
Router# <b>show interface</b> <i>{{type<sup>1</sup> slot/port}</i>   <i>{port-channel number}</i>   <b>begin L3</b>	Displays a summary of Layer 3-switched traffic.

1. *type* = **ethernet**, **fastethernet**, **gigabitethernet**, or **tengigabitethernet**

This example shows how to display information about hardware Layer 3-switched traffic on Fast Ethernet port 3/3:

```
Router# show interface fastethernet 3/3 | begin L3
  L3 in Switched: ucast: 0 pkt, 0 bytes - mcast: 12 pkt, 778 bytes mcast
  L3 out Switched: ucast: 0 pkt, 0 bytes - mcast: 0 pkt, 0 bytes
    4046399 packets input, 349370039 bytes, 0 no buffer
    Received 3795255 broadcasts, 2 runts, 0 giants, 0 throttles
<...output truncated...>
Router#
```



## Note

The Layer 3 switching packet count is updated approximately every five seconds.

Cisco IOS CEF and dCEF are permanently enabled. No configuration is required to support hardware Layer 3 switching.

With a PFC (and DFCs, if present), hardware Layer 3 switching uses per-flow load balancing based on IP source and destination addresses. Per-flow load balancing avoids the packet reordering that can be necessary with per-packet load balancing. For any given flow, all PFC- and DFC-equipped switches make exactly the same load-balancing decision, which can result in nonrandom load balancing.

The Cisco IOS CEF **ip load-sharing per-packet**, **ip cef accounting per-prefix**, and **ip cef accounting non-recursive** commands on the MSFC apply only to traffic that is CEF-switched in software on the MSFC. The commands do not affect traffic that is hardware Layer 3 switched on the PFC or on DFC-equipped switching modules.

For information about Cisco IOS CEF and dCEF on the MSFC, refer to these publications:

- The “Cisco Express Forwarding” sections at this URL:  
[http://www.cisco.com/en/US/docs/ios/12\\_2/switch/configuration/guide/xcfccef.html](http://www.cisco.com/en/US/docs/ios/12_2/switch/configuration/guide/xcfccef.html)
- The *Cisco IOS Switching Services Command Reference* publication at this URL:  
[http://www.cisco.com/en/US/docs/ios/12\\_2/switch/command/reference/fswtch\\_r.html](http://www.cisco.com/en/US/docs/ios/12_2/switch/command/reference/fswtch_r.html)

# Displaying Hardware Layer 3 Switching Statistics

Hardware Layer 3 switching statistics are obtained on a per-VLAN basis.

To display hardware Layer 3 switching statistics, perform this task:

Command	Purpose
Router# <b>show interfaces</b> <i>{{type<sup>1</sup> slot/port}</i>   <i>{port-channel number}</i>	Displays hardware Layer 3 switching statistics.

1. *type* = ethernet, fastethernet, gigabitethernet, or tengigabitethernet

This example shows how to display hardware Layer 3 switching statistics:

```
Router# show interfaces gigabitethernet 9/5 | include Switched
L2 Switched: ucast: 8199 pkt, 1362060 bytes - mcast: 6980 pkt, 371952 bytes
L3 in Switched: ucast: 0 pkt, 0 bytes - mcast: 0 pkt, 0 bytes mcast
L3 out Switched: ucast: 0 pkt, 0 bytes - mcast: 0 pkt, 0 bytes
```

To display adjacency table information, perform this task:

Command	Purpose
Router# <b>show adjacency</b> <i>[{{type<sup>1</sup> slot/port}</i>   <i>{port-channel number}</i> ]   <b>detail</b>   <b>internal</b>   <b>summary</b>	Displays adjacency table information. The optional <b>detail</b> keyword displays detailed adjacency information, including Layer 2 information.

1. *type* = ethernet, fastethernet, gigabitethernet, or tengigabitethernet

This example shows how to display adjacency statistics:

```
Router# show adjacency gigabitethernet 9/5 detail
Protocol Interface Address
IP GigabitEthernet9/5 172.20.53.206(11)
504 packets, 6110 bytes
00605C865B82
000164F83FA50800
ARP 03:49:31
```



## Note

Adjacency statistics are updated approximately every 60 seconds.



## Tip

For additional information about Cisco Catalyst 6500 Series Switches (including configuration examples and troubleshooting information), see the documents listed on this page:

[http://www.cisco.com/en/US/products/hw/switches/ps708/tsd\\_products\\_support\\_series\\_home.html](http://www.cisco.com/en/US/products/hw/switches/ps708/tsd_products_support_series_home.html)

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