Configuring IP Unicast Layer 3 Switching

This chapter describes how to configure IP unicast Layer 3 switching on the Cisco 7600 series routers.

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

- The *Cisco 7600 Series Router Cisco IOS Command Reference* at this URL:
  http://www.cisco.com/en/US/docs/ios/mcl/122sxmcl/12_2sx_mcl_book.html
- The Release 12.2 publications at this URL:
  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/index.htm

This chapter consists of these sections:

Note

- IPX traffic is fast switched on the MSFC. For more information, refer to this URL:
  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fatipx_c/index.htm
- For information about IP multicast Layer 3 switching, see Chapter 28, "Configuring IPv4 Multicast Layer 3 Switching."

Understanding How Layer 3 Switching Works

These sections describe Layer 3 switching:

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 PF3 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 Cisco 7600 series router.

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 Cisco 7600 series router 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 router recognizes that the packet was sent to the Layer 2 (MAC) address of the MSFC.

To perform Layer 3 switching, the router 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 router decrements the Layer 3 TTL value by 1 and recomputes the Layer 3 packet checksum. The router 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		
MSFC MAC	*Source A MAC*	*Destination B IP*	*Source A IP*	*n*	*calculation1*		

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

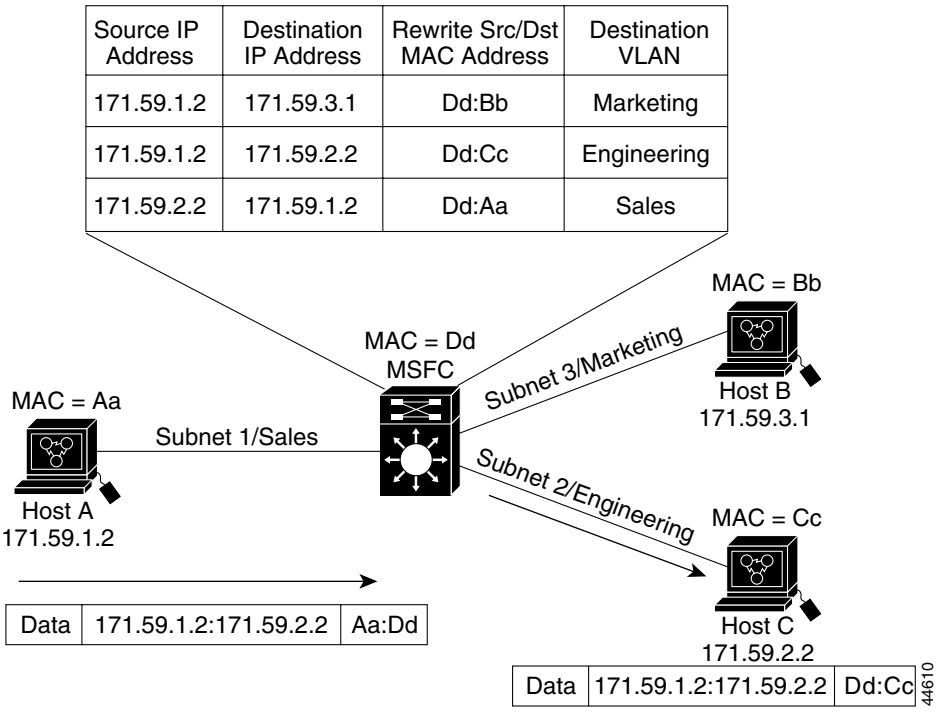
Layer 2 Frame Header		Layer 3 IP Header				Data	FCS
Destination	Source	Destination	Source	TTL	Checksum		
Destination B MAC	*MSFC MAC*	*Destination B IP*	*Source A IP*	*n-1*	*calculation2*		

Hardware Layer 3 Switching Examples

Figure 26-1 on page 26-3 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[1] 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)
  - 802.3 with 802.2 and SNAP

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# show interface {{`*type*[1] *slot/port*`} | {port-channel` *number*`}} | begin L3`	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/univercd/cc/td/doc/product/software/ios122/122cgcr/fswtch_c/swprt1/index.htm

- The *Cisco IOS Switching Services Command Reference* publication at this URL:

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fswtch_r/index.htm

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# **show interfaces** {{*type*[1] *slot/port*} | {**port-channel** *number*}}	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# **show adjacency** [{{*type*[1] *slot/port*} | {**port-channel** *number*}} | **detail** | **internal** | **summary**]	Displays adjacency table information. The optional **detail** 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.