

Configuring Basic Cisco Express Forwarding

This module contains information about Cisco Express Forwarding and describes the required and optional tasks for verifying Cisco Express Forwarding operation.

Cisco Express Forwarding is an advanced Layer 3 IP switching technology. It optimizes network performance and scalability for all kinds of networks: those that carry small amounts of traffic and those that carry large amounts of traffic in complex patterns, such as the Internet, and networks characterized by intensive web-based applications or interactive sessions.

- Prerequisites for Cisco Express Forwarding, on page 1
- Restrictions for Cisco Express Forwarding, on page 1
- Information About Cisco Express Forwarding, on page 1
- How to Verify Basic Cisco Express Forwarding, on page 3
- Configuration Examples for Basic CEF, on page 18
- Where to Go Next, on page 18
- Glossary, on page 18

Prerequisites for Cisco Express Forwarding

Cisco Express Forwarding requires a software image that includes Cisco Express Forwarding and IP routing enabled on the device.

Restrictions for Cisco Express Forwarding

The Cisco ASR 1000 Series Aggregation Services Routers operate only in distributed Cisco Express Forwarding mode.

Information About Cisco Express Forwarding

If your network architecture requires that you disable or reenable Cisco Express Forwarding or distributed Cisco Express Forwarding switching and forwarding, change your load balancing scheme, refresh Cisco Express Forwarding tables, configure network accounting for Cisco Express Forwarding, or customize the display of Cisco Express Forwarding events, go to the "Related Documents" section for links to information on these tasks. Otherwise, you need do nothing more to configure Cisco Express Forwarding or distributed Cisco Express Forwarding operation in your network.

Note Cisco Express Forwarding is supported on interfaces on which IEEE 802.1Q encapsulation has been enabled at the subinterface level. You no longer need to disable Cisco Express Forwarding operation on interfaces that are using IEEE 802.1Q encapsulation on VLAN subinterfaces.

Cisco Platform Support for CEF and dCEF

Cisco Express Forwarding is enable by default on the Cisco ASR 1000 Series Aggregation Services Routers.

To find out if Cisco Express Forwarding is enabled by default on your platform, enter the **show ip cef**command. If Cisco Express Forwarding is enabled, you receive output that looks like the following:

```
Router# show ip cef
Prefix              Next Hop            Interface
[...]
10.2.61.8/24        192.168.100.1       FastEthernet1/0/0
                    192.168.101.1       FastEthernet2/1/0
[...]
```

If Cisco Express Forwarding is not enabled on your platform, the output for the **show ip cef**command looks like this:

```
Router# show ip cef
%CEF not running
```

If Cisco Express Forwarding is not enabled on your platform, use the **ip cef**command to enable Cisco Express Forwarding or the **ip cef distributed** command to enable distributed Cisco Express Forwarding.

Cisco Express Forwarding Benefits

- Improved performance--Cisco Express Forwarding is less CPU-intensive than fast switching route caching. As a result, more CPU processing power can be dedicated to Layer 3 services such as quality of service (QoS) and encryption.
- Scalability--Cisco Express Forwarding offers full switching capacity at each line card when distributed Cisco Express Forwarding mode is active. Distributed Cisco Express Forwarding is a distributed switching mechanism that scales linearly with the number of interface cards and the bandwidth installed in the router.
- Resiliency--Cisco Express Forwarding offers an unprecedented level of switching consistency and stability in large dynamic networks. In dynamic networks, fast-switched cache entries are frequently invalidated by routing changes. These changes can cause traffic to be process-switched through use of the routing table, rather than fast-switched through use of the route cache. Because the forwarding information base (FIB) lookup table contains all known routes that exist in the routing table, it eliminates the need for route cache maintenance and the steps involved with fast-switch or process-switch forwarding. Cisco Express Forwarding can switch traffic more efficiently than typical demand caching schemes.

Main Components for CEF Operation

Information conventionally stored in a route cache is stored in several data structures for Cisco Express Forwarding switching. The data structures provide optimized lookup for efficient packet forwarding. The two main components of Cisco Express Forwarding operation are the forwarding information base (FIB) and the adjacency tables.

The FIB is conceptually similar to a routing table or information base. A router uses this lookup table to make destination-based switching decisions during Cisco Express Forwarding operation. The FIB is updated as changes occur in the network and contains all routes known at the time. For more information on the FIB, see the "Cisco Express Forwarding Overview" module.

Adjacency tables maintain Layer 2 next-hop addresses for all FIB entries. For more information on adjacency tables, see the "Cisco Express Forwarding Overview" module.

This separation of the reachability information (in the Cisco Express Forwarding table) and the forwarding information (in the adjacency table), provides two main benefits:

- The adjacency table can be built separately from the Cisco Express Forwarding table, allowing both tables to build without the process switching of any packets.
- The MAC header rewrite used to forward a packet isn't stored in cache entries, so changes in a MAC header rewrite string do not require invalidation of cache entries.

How to Verify Basic Cisco Express Forwarding

There are no configuration tasks. Cisco Express Forwarding is enabled by default.

The following section contains instructions for verifying basic Cisco Express Forwarding or distributed Cisco Express Forwarding operation.

Before you perform the remaining tasks in this section you need to know which mode of Cisco Express Forwarding is running on your router. Distributed Cisco Express Forwarding is enabled by default on the Cisco ASR 1000 Series Routers. To determine if Cisco Express Forwarding or distributed Cisco Express Forwarding is enabled on your router, you can enter the **show ip interface** command and look for the entry "IP CEF switching enabled" or "IP Distributed CEF switching enabled." If Cisco Express Forwarding is not enabled, the entry in the command display would indicate that "IP CEF switching is disabled."

To verify basic Cisco Express Forwarding or distributed Cisco Express Forwarding operation, perform the following procedures and tasks:

Determining How the Router Is Configured

To determine if the router is configured for Cisco Express Forwarding or distributed Cisco Express Forwarding, perform the following task.

SUMMARY STEPS

1. **enable**
2. **show ip interface** [*type slot* / *subslot* / *port*[**.** *subinterface-number*]] [**brief**]
3. **disable**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip interface** [*type slot* / *subslot* / *port*[**.** *subinterface-number*]] [**brief**] **Example:** `Router# show ip interface`	Configures an interface type and enters interface configuration mode. • The *type* argument is the type of interface to be configured. • The *slot* argument is the chassis slot number. Refer to the appropriate hardware manual for slot information. For SIPs, refer to the platform-specific SPA hardware installation guide or the corresponding "Identifying Slots and Subslots for SIPs and SPAs" topic in the platform-specific SPA software configuration guide. • The / *subslot* keyword and argument pair is the secondary slot number on a SIP where a SPA is installed. The slash (/) is required. Refer to the platform-specific SPA hardware installation guide and the corresponding "Specifying the Interface Address on a SPA" topic in the platform-specific SPA software configuration guide for subslot information. • The / *port* keyword and argument pair is the port or interface number. The slash (/) is required. Refer to the appropriate hardware manual for port information. For SPAs, refer to the corresponding "Specifying the Interface Address on a SPA" topics in the platform-specific SPA software configuration guide. • The **.** *subinterface-number*keyword and argument pair is the subinterface number in the range 1 to 4294967293. The number that precedes the period (.) must match the number to which this subinterface belongs. • The **brief** keyword displays a summary of the usability status information. Look for the entry "IP CEF switching enabled" or "IP Distributed CEF switching enabled."
Step 3	**disable** **Example:**	Exits to user EXEC mode.

	Command or Action	Purpose
	`Router# disable`	

What to Do Next

Verifying Cisco Express Forwarding Operation

Perform the following tasks, in the order presented, to verify Cisco Express Forwarding operation on your router or to look for Cisco Express Forwarding operation information on your router:

See the Verifying Distributed Cisco Express Forwarding Operation, on page 12 for the tasks to perform for distributed Cisco Express Forwarding operation.

Verifying That Cisco Express Forwarding Switching Is Enabled

To verify that Cisco Express Forwarding switching is enabled on the input (ingress) interface on the router, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **show ip cef**
3. **show cef interface** *type slot / subslot / port* [**.** *subinterface-number*]
4. **show ip interface** *type slot / subslot / port* [**.** *subinterface-number*]
5. **disable**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip cef**

Use this command to verify that Cisco Express Forwarding is enabled globally. For example:

Example:

```
Router# show ip cef
%CEF not running
```

If Cisco Express Forwarding is not running, use the **ip cef**command to enable Cisco Express Forwarding or the **ip cef distributed** command to enable distributed Cisco Express Forwarding.

When Cisco Express Forwarding or distributed Cisco Express Forwarding is enabled, the **show ip cef**command shows a brief display of all FIB entries.

Step 3 **show cef interface** *type slot / subslot / port* [**.** *subinterface-number*]

Use this command to verify that Cisco Express Forwarding is enabled on a particular ingress interface. Look for the entry "IP CEF switching enabled." For example:

Example:

```
Router# show cef interface fastethernet 1/0/0
FastEthernet1/0/0 is up (if_number 6)
  Corresponding hwidb fast_if_number 6
  Corresponding hwidb firstsw->if_number 6
  Internet address is 10.1.1.1/24
  ICMP redirects are always sent
  Per packet load-sharing is disabled
  IP unicast RPF check is disabled
  Inbound access list is not set
  Outbound access list is not set
  IP policy routing is disabled
  BGP based policy accounting on input is enabled
  BGP based policy accounting on output is disabled
Hardware idb is FastEthernet1/0/0 (6)
  Software idb is FastEthernet1/0/0 (6)
  Fast switching type 1, interface type 18
  IP Distributed CEF switching enabled ! <==== Notice this entry
.
  IP Feature Fast switching turbo vector
  IP Feature CEF switching turbo vector
  Input fast flags 0x100, Output fast flags 0x0, Flags 0x0
  ifindex 7(7)
  Slot 1 Slot unit 0 VC -1
  Transmit limit accumulator 0xE8001A82 (0xE8001A82)
  IP MTU 1500
```

Step 4 **show ip interface** *type slot / subslot / port* [**.** *subinterface-number*]

Use this command to display the Cisco IOS switching methods enabled on an interface. For example:

Example:

```
Router# show ip interface fastethernet 1/0/0

 FastEthernet1/0/0 is up, line protocol is up

   IP fast switching is enabled
   IP fast switching on the same interface is enabled
   IP Flow switching is disabled
   IP CEF switching is enabled ! <--- Entry verifying Cisco Express Forwarding is enabled.
   IP Distributed switching is enabled
   IP Fast switching turbo vector
   IP Normal CEF switching turbo vector
   IP multicast fast switching is enabled
   IP multicast distributed fast switching is disabled
   IP route-cache flags are Fast, Distributed, No CEF         ! <--- HERE.
```

In the above output, the "IP CEF switching is enabled" entry indicates that Cisco Express Forwarding is enabled by default. The "No CEF" IP route-cache flag indicates that Cisco Express Forwarding is disabled because an administrator entered the **no ip route-cache cef**command on this interface.

To enable Cisco Express Forwarding on this interface, enter the **ip route-cache cef** command. Once you do that, the "CEF" flag indicates that Cisco Express Forwarding is running.

Step 5 **disable**

Use this command to exit privileged EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Locating the Prefix in a Forwarding Table on the RP

To locate the prefix in a forwarding table, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **show ip cef**
3. **show ip cef vrf** *vrf-name*
4. Repeat Step 2 as many times as required to locate the prefix.
5. **disable**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip cef**

Use this command to show entries in the FIB and confirm that prefixes are listed in the FIB. For example:

Example:

```
Router# show ip cef
Prefix              Next Hop            Interface
[...]
10.2.61.8/24        192.168.100.1       FastEthernet1/0/0
                    192.168.101.1       FastEthernet2/1/0
[...]
```

Step 3 **show ip cef vrf** *vrf-name*

Use this command to locate prefixes in forwarding tables associated with Virtual Private Network (VPN) routing/forwarding table instances (VRFs). For example, this command shows prefixes in the left-hand column for a VRF named vpn1:

Example:

```
Router# show ip cef vrf vpn1
Prefix              Next Hop            Interface
0.0.0.0/32          receive
10.1.0.0/8          10.0.0.1            FastEthernet1/0/3
10.2.0.0/8          10.0.0.2            POS2/0/0
10.0.0.0/8          attached            FastEthernet1/0/3
10.0.0.0/32         receive
10.0.0.1/32         10.0.0.1            FastEthernet1/0/3
10.0.0.2/32         receive
10.255.255.255/32   receive
10.3.0.0/8          10.0.0.2            POS2/0/0
10.50.0.0/24        receive
255.255.255.255/32  receive
```

Step 4 Repeat Step 2 as many times as required to locate the prefix.

If Cisco Express Forwarding is in a VPN, you might need to look at multiple VRFs.

Step 5 **disable**

Use this command to exit privileged EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Finding the Cisco Express Forwarding Output Information

To find the Cisco Express Forwarding output information associated with the prefix on the RP, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **show ip cef**
3. **show ip cef** *prefix*
4. **show ip cef** *prefix* **detail**
5. **disable**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip cef**

Use this command to confirm that the prefix is listed in the FIB. For example:

Example:

```
Router# show ip cef
Prefix              Next Hop            Interface
0.0.0.0/32          receive
192.168.0.0/30      attached            Serial2/0/0:1
192.168.0.0/32      receive
10.2.61.8/24        192.168.100.1       FastEthernet1/0/0
```

Step 3 **show ip cef** *prefix*

Use this command to display the prefix entry in the FIB for centralized Cisco Express Forwarding. For example:

Example:

```
Router# show ip cef 10.2.61.8 255.255.255.0
10.0.0.0/8, version 72, per-destination sharing
0 packets, 0 bytes
  via 192.168.100.1, 0 dependencies, recursive
    traffic share 1
    next hop 192.168.100.1, FastEthernet1/0/0 via 192.168.100.1/32
    valid adjacency
  via 192.168.101.1, 0 dependencies, recursive
    traffic share 1
    next hop 192.168.101.1, FastEthernet2/1/0 via 192.168.101.1/32
    valid adjacency
  0 packets, 0 bytes switched through the prefix
```

Step 4 **show ip cef** *prefix* **detail**

Use this command to show more detail for each of the active paths associated with a destination prefix. For example:

Example:

```
Router# show ip cef 10.0.0.0 detail
10.0.0.0/8, version 72, per-destination sharing
0 packets, 0 bytes
  via 192.168.100.1, 0 dependencies, recursive
    traffic share 1
    next hop 192.168.100.1, FastEthernet1/0/0 via 192.168.100.1/32
    valid adjacency
  via 192.168.101.1, 0 dependencies, recursive
    traffic share 1
    next hop 192.168.101.1, FastEthernet2/1/0 via 192.168.101.1/32
    valid adjacency
  0 packets, 0 bytes switched through the prefix
```

Step 5 **disable**

Use this command to exit privileged EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Verifying the Adjacency or Next-Hop Information

To verify the adjacency or next-hop information, perform the following steps.

Adjacencies are added to the adjacency table when the adjacency is

- Indirectly configured manually
- Dynamically discovered through ARP
- Created when a routing protocol, for example, Border Gateway Protocol (BGP) or Open Shortest Path First (OSPF), forms a neighbor relationship

For more information on adjacencies, see the "Cisco Express Forwarding Overview" module.

SUMMARY STEPS

1. **enable**
2. **show ip cef**
3. **show adjacency detail**
4. **show adjacency summary**
5. **show adjacency** *type slot / subslot / port* [**.** *subinterface-number*]
6. **show ip cef exact-route** *source-address destination-address*
7. **disable**

DETAILED STEPS

Step 1 enable

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 show ip cef

Use this command to find the output interface. For example:

Example:

```
Router# show ip cef
Prefix              Next Hop            Interface
0.0.0.0/32          receive
192.168.0.0/30      attached            Serial2/0/0:1
192.168.0.0/32      receive
10.2.61.8/24        192.168.100.1       FastEthernet1/0/0
```

In this example, the output interface for the prefix 10.2.61.8/24 is FastEthernet 1/0/0, and the next hop address is 192.168.100.1.

Step 3 show adjacency detail

Use this command to display adjacency information, including Layer 2 information. For example:

Example:

```
Router# show adjacency detail
Protocol Interface                 Address
IP       FastEthernet1/0/0         10.2.61.8(7)
                                   0 packets, 0 bytes
                                   00107BC30D5C
                                   00500B32D8200800
                                   ARP        02:01:49
```

The encapsulation string 00107BC30D5C00500B32D8200800 is that of an adjacency used for traffic switched out of a router on a FastEthernet link by means of Ethernet II encapsulation.

Step 4 **show adjacency summary**

Use this command to display Cisco Express Forwarding adjacency table summary information. For example:

Example:

```
Router# show adjacency summary
Adjacency Table has 1 adjacency
  Interface                Adjacency Count
  FastEthernet1/0/0        1
```

Step 5 **show adjacency** *type slot* / *subslot* / *port* [**.** *subinterface-number*]

Use this command to display adjacency information for a particular interface. For example:

Example:

```
Router# show adjacency fastethernet 2/0/3
Protocol  Interface                    Address
IP        FastEthernet2/0/3            172.20.52.1(3045)
IP        FastEthernet2/0/3            172.20.52.22(11)
```

Step 6 **show ip cef exact-route** *source-address destination-address*

Use this command to display the exact route for a source-destination IP address pair and verify the next-hop address. For example:

Example:

```
Router# show ip cef exact-route 10.1.1.1 10.2.61.8
10.1.1.1         -> 10.2.61.8 :FastEthernet1/0/0 (next hop 192.168.100.1)
```

In this example, the exact route from source address 10.1.1.1 to destination address 10.2.61.8 is through interface FastEthernet1/0/0 to next hop address 192.168.100.1.

Step 7 **disable**

Use this command to exit privileged EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Verifying Distributed Cisco Express Forwarding Operation

Perform the following tasks, in the order presented, to verify distributed Cisco Express Forwarding operation on your router:

Verifying That dCEF Switching Is Enabled

To verify that distributed Cisco Express Forwarding switching is enabled on the input (ingress) interface on the line card, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **show ip cef**
3. **show ip cef** *prefix type slot / subslot / port[. subinterface-number]*
4. **disable**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip cef**

Use this command to verify that Cisco Express Forwarding is enabled globally. For example:

Example:

```
Router# show ip cef
%CEF not running
```

If Cisco Express Forwarding is not running, use the **ip cef**command to enable (central) Cisco Express Forwarding or the **ip cef distributed** command to enable distributed Cisco Express Forwarding.

When Cisco Express Forwarding or distributed Cisco Express Forwarding is enabled, the **show ip cef**command shows a brief display of all FIB entries.

Step 3 **show ip cef** *prefix type slot / subslot / port[. subinterface-number]*

Use this command to verify information about interfaces on a line card. For example:

Example:

```
Router# show ip cef 192.68.0.0 255.255.255.0 fastethernet0/0/0
show ip cef 192.68.0.0 255.255.255.0 from slot 0:
192.68.0.0/24, version 19, epoch 0, attached, connected
0 packets, 0 bytes
  via FastEthernet0/0/0, 0 dependencies
    valid glean adjacency
```

Step 4 **disable**

Use this command to exit privileged EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Interpreting Cisco Express Forwarding Command Output

Perform the following tasks to interpret information in Cisco Express Forwarding command output:

Verifying That CEF Information Looks As Expected

Perform the following tasks to verify that the Cisco Express Forwarding information looks as you expected.

SUMMARY STEPS

1. **enable**
2. **show ip route**
3. **show ip cef**
4. Compare the command output in Steps 2 and 3.
5. (For distributed Cisco Express Forwarding operation only) **show ip cef** *type slot* / *subslot* / *port*[**.** *subinterface-number*
6. (For distributed Cisco Express Forwarding operation only) Compare the command output in Steps 2 and 4.
7. **disable**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip route**

Use this command to look at the forwarding information contained in the IP routing table. For example:

Example:

```
Router# show ip route
...
     10.1.0.0/32 is subnetted, 1 subnets
O       10.1.2.3 [110/3] via 10.5.5.5, 00:00:03, POS2/0/0
```

```
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.5.5.5/32 is directly connected, POS2/0/0
C       10.5.5.0/24 is directly connected, POS2/0/0
     10.7.0.0/24 is subnetted, 1 subnets
O       10.7.8.0 [110/3] via 10.5.5.5, 00:00:04, POS2/0/0
     10.0.0.0/24 is subnetted, 2 subnets
O       10.23.64.0 [110/12] via 10.5.5.5, 00:00:04, POS2/0/0
O       10.23.66.0 [110/12] via 10.5.5.5, 00:00:04, POS2/0/0
     10.47.0.0/32 is subnetted, 1 subnets
O       10.47.0.10 [110/3] via 10.5.5.5, 00:00:04, POS2/0/0
O    172.16.57.0/24 [110/3] via 10.5.5.5, 00:00:04, POS2/0/0
     10.150.0.0/24 is subnetted, 1 subnets
C       10.150.3.0 is directly connected, POS0/0/0
O    192.168.92.0/24 [110/2] via 10.5.5.5, 00:00:04, POS2/0/0 ! <---- Compare with entry !in show ip
 cef
 command that follows.
```

In the example, c indicates a directly connected route and o represents a route discovered by means of OSPF.

Step 3 **show ip cef**

Use this command to display entries in the FIB. For example:

Example:

```
Router# show ip cef
Prefix              Next Hop            Interface
0.0.0.0/0           10.5.5.5             POS2/0/0 (default route)
0.0.0.0/32          receive
10.1.2.3/32         10.5.5.5             POS2/0/0 (two paths)
                    10.150.3.9           POS0/0/0
10.5.5.0/24         attached             POS2/0/0
10.5.5.0/32         receive
10.5.5.5/32         attached             POS2/0/0 (glean adjacency)
10.5.5.6/32         receive    (our interface)
10.5.5.255/32       receive    (broadcast)
10.7.8.0/24         10.5.5.5             POS2/0/0
                    10.150.3.9           POS0/0/0
10.23.64.0/24       10.150.3.9           POS0/0/0
10.23.66.0/24       10.150.3.9           POS0/0/0 (normal route)
10.47.0.10/32       10.150.3.9           POS0/0/0
10.150.3.0/24       attached             POS0/0/0
10.150.3.0/32       receive
10.150.3.1/32       receive
10.150.3.255/32     receive
192.168.92.0/24     10.5.5.5             POS2/0/0 ! <--- Compare with entry in show
 ip
!route
command.
                    10.150.3.9           POS0/0/0
172.16.57.0/24      10.5.5.5             POS2/0/0
                    10.150.3.9           POS0/0/0
239.224.0.0/4       receive    (multicast)
255.255.255.255/32  receive    (all 1s broadcast)
```

Step 4 Compare the command output in Steps 2 and 3.

Cisco Express Forwarding maintains the information contained in the IP routing table structured in a way that optimizes forwarding. Check that there is a one-to-one correlation between FIB entries and routing table entries. For example, the following lines from the sample output in Step 2 and Step 2 show a one-to-one correlation. The destination prefix 192.92.92.0/24, the next hop IP address 10.5.5.5, and the next-hop interface POS2/0/0 are the same.

- From the **show ip route** command output in Step 2:

Example:

```
O    192.168.92.0/24 [110/2] via 10.5.5.5, 00:00:04, POS2/0/0
```

- From the **show ip cef** command output in Step 3:

Example:

```
192.168.92.0/24      10.5.5.5              POS2/0/0
```

If there is not a one-to-one correlation, you can recreate the central FIB table by clearing the IP routing table and allowing the routing table to be rebuilt, which in turn causes the central FIB table to be repopulated with up-to-date routing information.

Step 5 (For distributed Cisco Express Forwarding operation only) **show ip cef** *type slot* / *subslot* / *port*[**.** *subinterface-number*

Use this command to display FIB entries on all line cards. For example:

Example:

```
Router# show ip cef pos2/0/0
show ip cef from slot 2:
Prefix              Next Hop            Interface
0.0.0.0/0           10.5.5.5             POS2/0/0
0.0.0.0/32          receive
10.1.2.3/32         10.5.5.5             POS2/0/0
                    10.150.3.9           POS0/0/0
105.5.5.0/24        attached             POS2/0/0
10.5.5.0/32         receive
10.5.5.5/32         attached             POS2/0/0
10.5.5.6/32         receive
10.5.5.255/32       receive
10.7.8.0/24         10.5.5.5             POS2/0/0
                    10.150.3.9           POS0/0/0
10.7.54.0/24        attached             POS0/1/0
10,7.54.0/32        receive
10.7.54.3/32        receive
10.7.54.255/32      receive
10.23.64.0/24       10.150.3.9           POS0/0/0
10.23.66.0/24       10.150.3.9           POS0/0/0
10.47.0.10/32       10.150.3.9           POS0/0/0
10.150.3.0/24       attached             POS0/0/0
10.150.3.0/32       receive
10.150.3.1/32       receive
10.150.3.255/32     receive
192.168.92.0/24     10.5.5.5             POS2/0/0
                    10.150.3.9           POS0/0/0
172.16.57.0/24      10.5.5.5             POS2/0/0
                    10.150.3.9           POS0/0/0
239.224.0.0/4       receive
255.255.255.255/32  receive
```

Step 6 (For distributed Cisco Express Forwarding operation only) Compare the command output in Steps 2 and 4.

The output from the **show ip cef**command in Step 3 should be identical to the output from the **show ip cef**command in Step 5. If the outputs are not identical, see the " Configuring Cisco Express Forwarding Consistency Checkers for Route Processors and Line Cards " module for information on synchronizing FIB entries on the RP and the line card.

Step 7 **disable**

Use this command to exit privileged EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Interpreting MPLS Information in CEF Output

Perform the following steps to interpret Multiprotocol Label Switching (MPLS) information in Cisco Express Forwarding output.

Cisco Express Forwarding interacts with a label switched path (LSP) primarily at the beginning and end of the LSP--that is, on label imposition (IP packet to MPLS packet) and label disposition (MPLS packet to IP packet). Output from Cisco Express Forwarding commands should show these processes.

The Cisco implementation of MPLS leverages the advantages of Cisco Express Forwarding. When you use a router as an MPLS edge router, Cisco Express Forwarding identifies the route for incoming packets and finds the label to apply to the packet.

However, when you use a router as a label switch router (LSR), tables from the MPLS label forwarding information base (LFIB) are used to switch MPLS packets. These tables are distributed to the line cards in the same way that the FIB tables are distributed in Cisco Express Forwarding.

A customer-site VRF contains all the routes available to the site from the VPNs to which it belongs. VPN routing information is stored in the IP routing table and in the Cisco Express Forwarding table for each VRF. A separate set of tables is maintained for each VRF, which prevents information from being forwarded outside a VPN and prevents packets that are outside a VPN from being forwarded to a router within the VPN. Based on the routing information stored in the VRF IP routing table and the VRF Cisco Express Forwarding table, packets are forwarded to their destinations. Output from Cisco Express Forwarding commands shows details from the VRF Cisco Express Forwarding tables.

SUMMARY STEPS

1. **enable**
2. **show ip cef vrf** *vrf-name* **detail**
3. **disable**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. You can also enter this command in user EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip cef vrf** *vrf-name* **detail**

Use this command to display detailed information from the Cisco Express Forwarding forwarding table that is associated with a VRF. For example:

Example:

```
Router# show ip cef vrf vpn1 detail

IP CEF with switching (Table Version 10), flags=0x0
  8 routes, 0 reresolve, 0 unresolved (0 old, 0 new)
  46 leaves, 51 nodes, 54640 bytes, 361 inserts, 315 invalidations
  0 load sharing elements, 0 bytes, 0 references
  universal per-destination load sharing algorithm, id F968AD29
  5 CEF resets, 38 revisions of existing leaves
  refcounts:  1400 leaf, 1392 node
Adjacency Table has 2 adjacencies
0.0.0.0/32, version 0, receive
192.168.6.0/24, version 9, cached adjacency to Serial0/1.1
0 packets, 0 bytes
```

The following section of the Cisco Express Forwarding output provides MPLS information for the first adjacency. The "tag rewrite" is an equivalent of a Cisco Express Forwarding adjacency. Look at the tags imposed field. The first tag {20} is the tag used to reach the next hop, 10.1.1.13. The second tag {30} is the tag advertised to the local provider edge (PE) router by the remote PE router.

Example:

```
  tag information set
    local tag: VPN-route-head
    fast tag rewrite with Se0/1.1, point2point, tags imposed: {20 30}
  via 10.10.10.6, 0 dependencies, recursive
    next hop 10.1.1.13, Serial0/1.1 via 10.10.10.6
    valid cached adjacency
    tag rewrite with Se0/1.1, point2point, tags imposed: {20 30}
```

The following section of the output provides information about the second adjacency. For the second adjacency, no tag rewrite occurs as indicated by the entry "tag rewrite with , ," and MPLS tags are not imposed on the packet indicated by the entry "tags imposed : {}." The router also discards this packet indicated by the entry "valid discard adjacency."

Example:

```
192.168.4.0/24, version 6, attached, connected
0 packets, 0 bytes
  tag information set
    local tag: 28
  via Loopback102, 0 dependencies
    valid discard adjacency
    tag rewrite with , , tags imposed: {}
192.168.4.0/32, version 4, receive
192.168.4.1/32, version 3, receive
192.168.4.255/32, version 5, receive
192.168.0.0/24, version 2, receive
255.255.255.255/32, version 1, receive
```

Step 3 **disable**

Use this command to exit to user EXEC mode. For example:

Example:

```
Router# disable
Router>
```

Configuration Examples for Basic CEF

There are no configuration examples for Cisco Express Forwarding. Cisco Express Forwarding is enabled by default.

Where to Go Next

If you want to disable Cisco Express Forwarding or distributed Cisco Express Forwarding operation, refer to Enabling or Disabling Cisco Express Forwarding or distributed Cisco Express Forwarding to Customize Switching/Forwarding for Dynamic Networks.

Glossary

adjacency --A relationship formed between selected neighboring routers and end nodes for the purpose of exchanging routing information. Adjacency is based upon the use of a common media segment by the routers and nodes involved.

Cisco Express Forwarding --A Layer 3 switching technology. Cisco Express Forwarding can also refer to central Cisco Express Forwarding mode, one of two modes of Cisco Express Forwarding operation. Cisco Express Forwarding enables a Route Processor (RP) to perform express forwarding. Distributed Cisco Express Forwarding is the other mode of Cisco Express Forwarding operation.

distributed Cisco Express Forwarding --A type of Cisco Express Forwarding switching in which line cards maintain identical copies of the Forwarding Information Base (FIB) and adjacency tables. The line cards perform the express forwarding between port adapters; this relieves the Route Processor of involvement in the switching operation.

FIB --forwarding information base. A component of Cisco Express Forwarding. The router uses the FIB lookup table to make destination-based switching decisions during Cisco Express Forwarding operation. The router maintains a mirror image of the forwarding information in an IP routing table.

IPC --interprocess communication. The mechanism that enables the distribution of Cisco Express Forwarding tables from the Route Processor (RP) to the line card when the router is operating in distributed Cisco Express Forwarding mode.

label disposition --The removal of Multiprotocol Label Switching (MPLS) headers at the edge of a network. In MPLS label disposition, packets arrive on a router as MPLS packets and, with the headers removed, are transmitted as IP packets.

label imposition --The action of putting a label on a packet.

LER --label edge router. A router that performs label imposition.

LFIB --label forwarding information base. The data structure used by switching functions to switch labeled packets.

LIB --label information base. A database used by a label switch router (LSR) to store labels learned from other LSRs, as well as labels assigned by the local LSR.

line card --A general term for an interface processor that can be used in various Cisco products.

LSP --label switched path. A sequence of hops (Router 0...Router n). A packet travels from R0 to Rn by means of label switching mechanisms. An LSP can be chosen dynamically, based on normal routing mechanisms, or it can be configured manually.

LSR --label switch router. A Layer 3 router that forwards a packet based on the value of a label encapsulated in the packet.

MPLS --Multiprotocol Label Switching. An emerging industry standard for the forwarding of packets along the normal routing paths (sometimes called MPLS hop-by-hop forwarding).

prefix --The network address portion of an IP address. A prefix is specified by a network and mask and is generally represented in the format network/mask. The mask indicates which bits are the network bits. For example, 1.0.0.0/16 means that the first 16 bits of the IP address are masked, making them the network bits. The remaining bits are the host bits. In this example, the network number is 10.0.

RIB --Routing Information Base. A central repository of routes that contains Layer 3 reachability information and destination IP addresses or prefixes. The RIB is also known as the routing table.

RP --Route Processor. The processor module contains the CPU, system software, and most of the memory components that are used in the router. It is sometimes called a supervisory processor.

VPN --Virtual Private Network. The result of a router configuration that enables IP traffic to use tunneling to travel securely over a public TCP/IP network.

VRF --A Virtual Private Network (VPN) routing/forwarding instance. A VRF consists of an IP routing table, a derived forwarding table, a set of interfaces that use the forwarding table, and a set of rules and routing protocols that determine what goes into the forwarding table. In general, a VRF includes the routing information that defines a customer VPN site that is attached to a provider edge (PE) router.