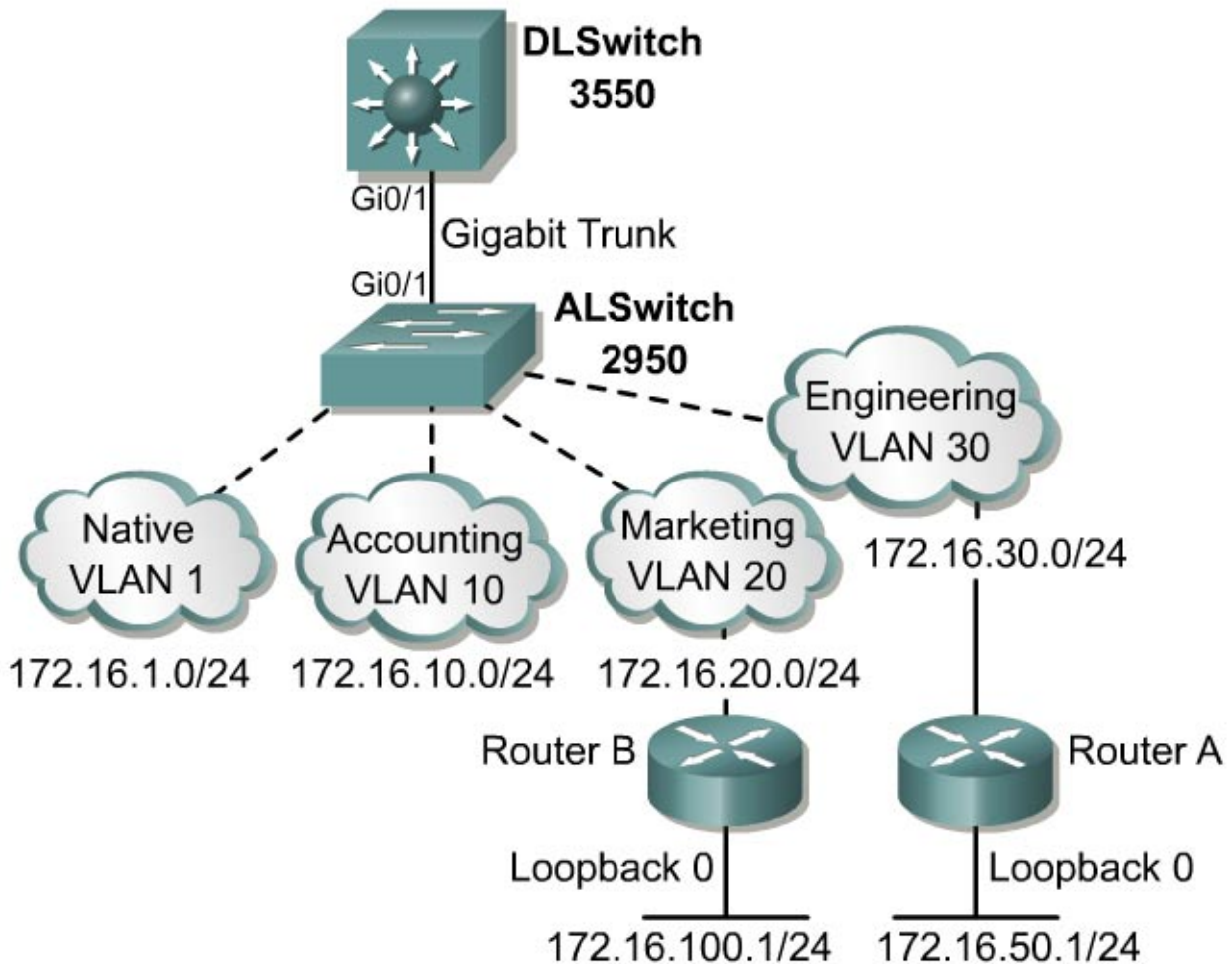


## Lab 5.4.1 Monitoring Cisco Express Forwarding



### Objective

The objective of this lab is to monitor the default behavior of Cisco Express Forwarding (CEF).

### Scenario

In this lab the network switching equipment currently includes a 3550 distribution layer switch and a 2950 access switch. The network is segmented into four functional VLANs for better network management. VLANs include Accounting, Engineering, and Marketing for the users. VLAN 1 is used for the native VLAN. Currently the 3550 provides inter-VLAN routing. The switch by default uses CEF. The network administrator wants to monitor CEF and verify proper operation of CEF.

## Design

Switch	VTP Domain	VTP Mode
DLSwitch	CORP	Server
ALSwitch	CORP	Client

## VLAN configuration information

VLAN ID	VLAN Name	VLAN Subnet	DLSwitch	ALSwitch Ports
1	Native	172.16.1.0	Gi0/1-2 Fa0/1-24	Gi0/1-2 Fa0/1-3 Fa0/13-24
10	Accounting	172.16.10.0		Fa0/4-6
20	Marketing	172.16.20.0		FA0/7-9
30	Engineering	172.16.30.0		FA0/10-12
Trunk				802.1Q

## Internal Router Processor Interface Configuration Information

Interface	IP Address	VLAN
VLAN1	172.16.1.1	1 Native
VLAN10	172.16.10.1	10
VLAN20	172.16.20.1	20
VLAN30	172.16.30.1	30

## Step 1

Build the network according to the diagram. Before beginning a lab the configurations on all the devices should be cleared.

**Note:** For permanently rack-mounted labs the router can be attached to different VLANs. Make sure to change the routing configuration to match the topology.

```
DLSwitch#delete flash
Delete filename [flash]?
Enter vlan.dat at the Delete prompt.
DLSwitch#erase start
Switch#reload
```

Configure both switches with the proper hostname and enable Telnet access on both switches.

## Step 2

On the DLSwitch, configure the VTP Domain name and create and name the VLANs as shown below. The DLSwitch will be the VTP server and should already be in the default server mode.

```

DLSwitch#vlan database
DLSwitch(vlan)#vtp domain CORP
DLSwitch(vlan)#vlan 10 name Accounting
DLSwitch(vlan)#vlan 20 name Marketing
DLSwitch(vlan)#vlan 30 name Engineering
DLSwitch(vlan)#exit

```

Now verify the VLAN configuration with the `show vlan brief` command. Verify the VTP configuration with the `show vtp status` command. The DLSwitch should be in the server mode and the VTP Domain name should be CORP.

```
DLSwitch#show vlan brief
```

VLAN	Name	Status	Ports
1	default	active	Fa0/2, Fa0/3, Fa0/4, Fa0/5 Fa0/6, Fa0/7, Fa0/8, Fa0/9 Fa0/10, Fa0/11, Fa0/12, Fa0/13 Fa0/14, Fa0/15, Fa0/16, Fa0/17 Fa0/18, Fa0/19, Fa0/20, Fa0/21 Fa0/22, Fa0/23, Fa0/24, Gi0/1 Gi0/2
10	Accounting	active	
20	marketing	active	
30	Engineering	active	
1002	fddi-default	active	
1003	token-ring-default	active	
1004	fddinet-default	active	
1005	trnet-default	active	

### Step 3

Configure the ALSwitch as a VTP client. The ALSwitch should pick up the VTP Domain name from the sever DLSwitch, but it may be entered again.

```

ALSwitch(vlan)#vtp client
ALSwitch(vlan)#vtp domain CORP
ALSwitch(vlan)#exit

```

Verify the VTP and VLAN configurations with the `show vtp status` and `show vlan brief` command.

1. Can the VLAN 10, VLAN 20, and VLAN 30 be seen? \_\_\_\_\_
2. Why or why not? \_\_\_\_\_

### Step 4

Create a trunk link between the DLSwitch and ALSwitch.

On the DLSwitch set the port to trunking with the 802.1Q encapsulation.

**Note:** An error might be received because the port is trunking and set to auto encapsulation. If this occurs skip the `switchport mode trunk` command.

```

DLSwitch(config)# interface gigabitEthernet 0/1
DLSwitch(config-if)#switchport mode trunk
DLSwitch(config-if)#switchport trunk encapsulation dot1q
DLSwitch(config-if)#exit

```

Follow the same procedure for the ALSwitch.

```
ALSwitch(config)# interface gigabitEthernet 0/1
ALSwitch(config-if)#switchport mode trunk
ALSwitch(config-if)#exit
```

Now move the ports into the appropriate VLANs.

```
ALSwitch(config)#interface range fastEthernet 0/4-6
ALSwitch(config-if-range)#switchport access vlan 10
ALSwitch(config-if-range)#exit

ALSwitch(config)#interface range fastEthernet 0/7-9
ALSwitch(config-if-range)#switchport access vlan 20
ALSwitch(config-if-range)#exit

ALSwitch(config)#interface range fastEthernet 0/10-12
ALSwitch(config-if-range)#switchport access vlan 30
ALSwitch(config-if-range)#exit
```

Verify the port trunking.

```
ALSwitch#show interfaces trunk
Port      Mode      Encapsulation  Status        Native vlan
Gi0/1     on        802.1q         trunking      1
Port      Vlans allowed on trunk
Gi0/1     1-4094
Port      Vlans allowed and active in management domain
Gi0/1     1,10,20,30
Port      Vlans in spanning tree forwarding state and not pruned
Gi0/1     1,10,20,30
```

## Step 5

Verify the VLAN trunking at Layer 3.

If possible connect one workstation to VLAN 10 on the ALSwitch. Connect a second workstation to VLAN 10 on the ALSwitch. Use **ping** to test the connection.

**Note:** If the lab is permanently rack mounted then the routers must be used as the end devices.

**Note:** Remember to change the workstation IP address when connecting to different VLANs.

1. Does the ping work? \_\_\_\_\_

Now move both workstations to VLAN 20 on the ALSwitch. Use **ping** to test the connection.

2. Does the ping work? \_\_\_\_\_

Test the connections between VLANs. Connect one workstation to VLAN 10 and the other to VLAN 20. Can the ping be used between these workstations? \_\_\_\_\_

## Step 6

In the 3550 the IOS consists of a single image, rather than a separate CatOS image for the switching engine. The 3550 also has an IOS image for the route processor. Inter-VLAN routing is configured from a single command-line interface (CLI). There is no need to configure internal trunks or internal EtherChannels. There are no longer internal Layer 2 ports and internal Layer 3 interfaces connecting through the switch backplane. To route between VLANs create the Layer 3 VLAN interfaces. Use the command **interface vlan vlan-id** to create the interface.

```

DLSwitch(config)#interface vlan 1
DLSwitch(config-if)#ip address 172.16.1.1 255.255.255.0
DLSwitch(config-if)#no shutdown
DLSwitch(config)#interface vlan 10
DLSwitch(config-if)#ip address 172.16.10.1 255.255.255.0
DLSwitch(config)#interface vlan 20
DLSwitch(config-if)#ip address 172.16.20.1 255.255.255.0
DLSwitch(config)#interface vlan 30
DLSwitch(config-if)#ip address 172.16.30.1 255.255.255.0
DLSwitch(config-if)^Z

```

Verify the interfaces with the **show ip interface brief** command.

```
DLSwitch#show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
Vlan1	172.16.1.1	YES	manual	up	up
Vlan10	172.16.10.1	YES	manual	up	up
Vlan20	172.16.20.1	YES	manual	up	up
Vlan30	172.16.30.1	YES	manual	up	up
FastEthernet0/1	unassigned	YES	unset	administratively down	down
FastEthernet0/2	unassigned	YES	unset	administratively down	down

Output Omitted-----

Use the **show ip route** command to see if the switch is routing.

```
DLSwitch#show ip route
```

Default gateway is not set

Host	Gateway	Last Use	Total Uses	Interface
ICMP redirect cache is empty				

Notice that the switch is still behaving as a Layer 2 device. After creating the VLANs, routing will still need to be enabled.

Enable routing with the **ip routing** global configuration command.

```

DLSwitch(config)#ip routing
DLSwitch(config)#router rip
DLSwitch(config-router)#network 172.16.0.0
DLSwitch(config-router)#exit

```

Now check the routing table again with the **show ip route** command.

```
DLSwitch#show ip route
```

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP  
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2  
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP  
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter  
area  
\* - candidate default, U - per-user static route, o - ODR  
P - periodic downloaded static route

Gateway of last resort is not set

172.16.0.0/24 is subnetted, 4 subnets

C 172.16.30.0 is directly connected, Vlan30

```

C      172.16.20.0 is directly connected, Vlan20
C      172.16.10.0 is directly connected, Vlan10
C      172.16.1.0 is directly connected, Vlan1

```

The DLSwitch is now providing Layer 2 and Layer 3 functions.

## Step 7

Configure RouterA and RouterB. Set the hostname and the IP address of the interface. Run the Routing Information Protocol (RIP) as the routing protocol.

```

Router(config)#hostname RouterA
RouterA(config)#interface loopback 0
RouterA(config-if)#ip address 172.16.50.1 255.255.255.0
RouterA(config)#interface fastethernet 0/0
RouterA(config-if)#ip address 172.16.30.5 255.255.255.0
RouterA(config-if)#no shutdown
RouterA(config)#router rip
RouterA(config-router)#network 172.16.0.0
RouterA(config-router)#exit

Router(config)#hostname RouterB
RouterB(config)#interface loopback 0
RouterB(config-if)#ip address 172.16.100.1 255.255.255.0
RouterB(config)#interface fastethernet0/0
RouterB(config-if)#ip address 172.16.20.5 255.255.255.0
RouterB(config-if)#no shutdown
RouterB(config)#router rip
RouterB(config-router)#network 172.16.0.0
RouterB(config-router)#exit

```

Verify the routing between with the **show ip route** command.

```

DLSwitch#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter
       area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

```

Gateway of last resort is not set

```

      172.16.0.0/24 is subnetted, 6 subnets
R      172.16.50.0 [120/1] via 172.16.30.5, 00:00:15, Vlan30
C      172.16.30.0 is directly connected, Vlan30
C      172.16.20.0 is directly connected, Vlan20
C      172.16.10.0 is directly connected, Vlan10
C      172.16.1.0 is directly connected, Vlan1
R      172.16.100.0 [120/1] via 172.16.20.5, 00:00:01, Vlan20

```

Check the routing table on RouterA and RouterB.

Now test the connectivity by using the **ping** command. Ping from RouterA to loopback 0 interface on RouterB.

3. Does the ping work? \_\_\_\_\_

## Step 8

Cisco Express Forwarding (CEF) is a Layer 3 IP switching technology used to optimize network performance. CEF implements an advanced IP lookup and forwarding algorithm to deliver maximum Layer 3 switching performance. CEF is less CPU-intensive than fast switching route caching. This allows for more CPU processing power to be dedicated to packet forwarding. In the Catalyst 3550 switch, the hardware uses CEF to achieve Gigabit speed line rate IP traffic. In dynamic networks, fast switching cache entries are frequently invalidated because of routing changes. This can cause traffic to be process switched using the routing table, instead of fast switched using the route cache. CEF uses the Forwarding Information Base (FIB) lookup table to perform destination-based switching of IP packets.

CEF is enabled globally by default. If for some reason it is disabled, re-enable it by using the `ip cef` global configuration command.

To display CEF status use the `show ip cef` command.

```
DLSwitch#show ip cef
Prefix          Next Hop          Interface
0.0.0.0/32      receive
172.16.1.0/24    attached          Vlan1
172.16.1.0/32    receive
172.16.1.1/32    receive
172.16.1.2/32    172.16.1.2        Vlan1
172.16.1.255/32  receive
172.16.10.0/24   attached          Vlan10
172.16.10.0/32   receive
172.16.10.1/32   receive
172.16.10.255/32 receive
172.16.20.0/24   attached          Vlan20
172.16.20.0/32   receive
172.16.20.1/32   receive
172.16.20.5/32   172.16.20.5        Vlan20
172.16.20.255/32 receive
172.16.30.0/24   attached          Vlan30
172.16.30.0/32   receive
172.16.30.1/32   receive
172.16.30.5/32   172.16.30.5        Vlan30
172.16.30.255/32 receive
172.16.50.0/24   172.16.30.5        Vlan30
172.16.100.0/24  172.16.20.5        Vlan20
224.0.0.0/4      drop
224.0.0.0/24     receive
255.255.255.255/32 receive
```

To verify if CEF is enabled on an interface use the `show ip interface` command.

```
DLSwitch#show ip interface vlan10
Vlan10 is up, line protocol is up
 Internet address is 172.16.10.1/24
 Broadcast address is 255.255.255.255
 Address determined by setup command
 MTU is 1500 bytes
 Helper address is not set
 Directed broadcast forwarding is disabled
 Outgoing access list is not set
 Inbound access list is not set
 Proxy ARP is enabled
 Local Proxy ARP is disabled
 Security level is default
 Split horizon is enabled
 ICMP redirects are always sent
 ICMP unreachable are always sent
```

```

ICMP mask replies are never sent
IP fast switching is enabled
IP fast switching on the same interface is disabled
IP Flow switching is disabled
IP CEF switching is enabled
IP CEF Fast switching turbo vector
IP multicast fast switching is enabled
IP multicast distributed fast switching is disabled
TCP/IP header compression is disabled
RTP/IP header compression is disabled
Probe proxy name replies are disabled
Policy routing is disabled
Network address translation is enabled, interface in domain outside
WCCP Redirect outbound is disabled
WCCP Redirect inbound is disabled
WCCP Redirect exclude is disabled
BGP Policy Mapping is disabled

```

Now check if any packets were dropped with the **show cef drop** command.

```

DLSwitch#show cef drop
CEF Drop Statistics
Slot  Encap_fail  Unresolved  Unsupported  No_route  No_adj  ChkSum_Err
RP           36487           0           0           0           6           0

```

Use the **show ip cef summary** command to display the CEF table summary.

```

DLSwitch#show ip cef summary
IP CEF with switching (Table Version 23), flags=0x0
 23 routes, 0 reresolve, 0 unresolved (0 old, 0 new), peak 0
 23 leaves, 14 nodes, 17504 bytes, 48 inserts, 25 invalidations
 0 load sharing elements, 0 bytes, 0 references
 universal per-destination load sharing algorithm, id D19B2C80
 3(1) CEF resets, 0 revisions of existing leaves
 Resolution Timer: Exponential (currently 1s, peak 1s)
 0 in-place/0 aborted modifications
 refcounts: 1591 leaf, 1566 node

```

Table epoch: 0 (23 entries at this epoch)

Adjacency Table has 3 adjacencies

```

DLSwitch#show ip cef detail
IP CEF with switching (Table Version 25), flags=0x0
 25 routes, 0 reresolve, 0 unresolved (0 old, 0 new), peak 0
 25 leaves, 14 nodes, 17760 bytes, 73 inserts, 48 invalidations
 0 load sharing elements, 0 bytes, 0 references
 universal per-destination load sharing algorithm, id D19B2C80
 4(2) CEF resets, 0 revisions of existing leaves
 Resolution Timer: Exponential (currently 1s, peak 1s)
 0 in-place/0 aborted modifications
 refcounts: 1595 leaf, 1568 node

```

Table epoch: 0 (25 entries at this epoch)

```

Adjacency Table has 3 adjacencies
0.0.0.0/32, version 0, epoch 0, receive
172.16.1.0/24, version 18, epoch 0, attached, connected
0 packets, 0 bytes
  via Vlan1, 0 dependencies
    valid glean adjacency
172.16.1.0/32, version 4, epoch 0, receive
172.16.1.1/32, version 3, epoch 0, receive
172.16.1.2/32, version 22, epoch 0, connected, cached adjacency 172.16.1.2

```



```

0 packets, 0 bytes
  via 172.16.1.2, Vlan1, 0 dependencies
    next hop 172.16.1.2, Vlan1
    valid cached adjacency
172.16.1.255/32, version 5, epoch 0, receive
172.16.10.0/24, version 17, epoch 0, attached, connected
0 packets, 0 bytes
  via Vlan10, 0 dependencies
    valid glean adjacency
172.16.10.0/32, version 7, epoch 0, receive
172.16.10.1/32, version 6, epoch 0, receive
172.16.10.255/32, version 8, epoch 0, receive
172.16.20.0/24, version 16, epoch 0, attached, connected
0 packets, 0 bytes
  via Vlan20, 0 dependencies
    valid glean adjacency
172.16.20.0/32, version 10, epoch 0, receive
172.16.20.1/32, version 9, epoch 0, receive
172.16.20.5/32, version 23, epoch 0, connected, cached adjacency
    172.16.20.5
0 packets, 0 bytes
  via 172.16.20.5, Vlan20, 0 dependencies
    next hop 172.16.20.5, Vlan20
    valid cached adjacency
172.16.20.255/32, version 11, epoch 0, receive
172.16.30.0/24, version 15, epoch 0, attached, connected
0 packets, 0 bytes
  via Vlan30, 0 dependencies
    valid glean adjacency
172.16.30.0/32, version 13, epoch 0, receive
172.16.30.1/32, version 12, epoch 0, receive
172.16.30.5/32, version 20, epoch 0, connected, cached adjacency
    172.16.30.5
0 packets, 0 bytes
  via 172.16.30.5, Vlan30, 0 dependencies
    next hop 172.16.30.5, Vlan30
    valid cached adjacency
172.16.30.255/32, version 14, epoch 0, receive
172.16.50.0/24, version 21, epoch 0, cached adjacency 172.16.30.5
0 packets, 0 bytes
  via 172.16.30.5, Vlan30, 0 dependencies
    next hop 172.16.30.5, Vlan30
    valid cached adjacency
172.16.100.0/24, version 24, epoch 0, cached adjacency 172.16.20.5
0 packets, 0 bytes
  via 172.16.20.5, Vlan20, 0 dependencies
    next hop 172.16.20.5, Vlan20
    valid cached adjacency
224.0.0.0/4, version 19, epoch 0
0 packets, 0 bytes, Precedence routine (0)
224.0.0.0/24, version 2, epoch 0, receive
255.255.255.255/32, version 1, epoch 0, receive

```

There are several other commands to monitor and troubleshoot CEF. If time permits use the help option to check the output of all of commands.