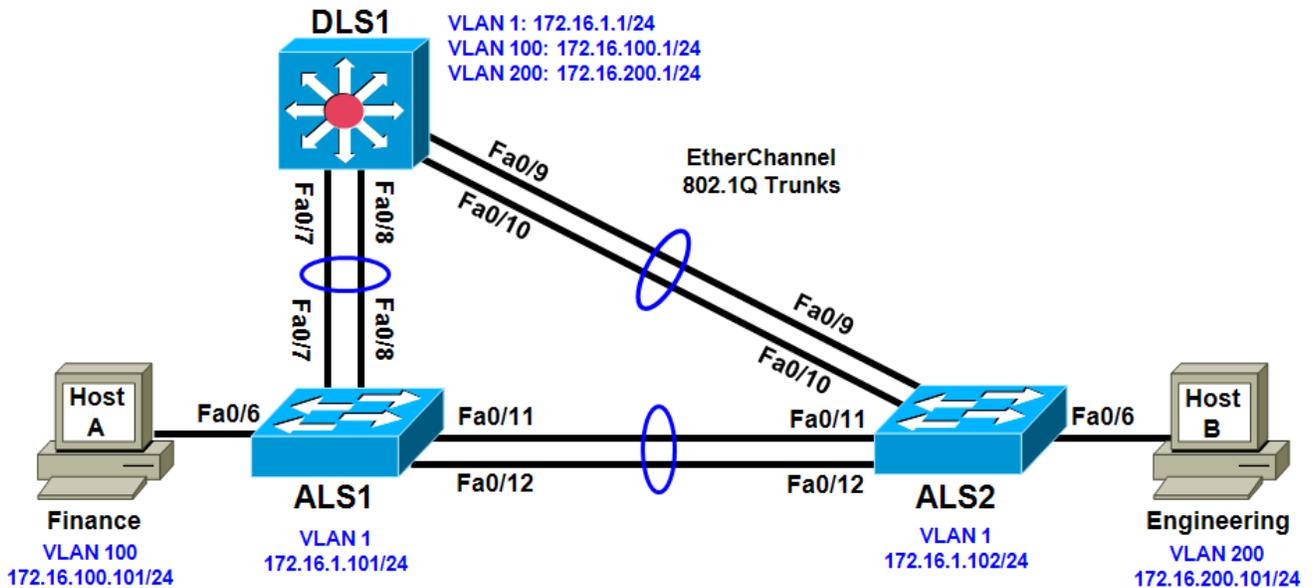


## Chapter 4 Lab 4-2, Inter-VLAN Routing with an Internal Route Processor and Monitoring CEF Functions

### Topology



### Objective

- Route between VLANs using a 3560 switch with an internal route processor using Cisco Express Forwarding (CEF).

### Background

The current network equipment includes a 3560 distribution layer switch and two 2960 access layer switches. The network is segmented into three functional subnets using VLANs for better network management. The VLANs include Finance, Engineering, and a subnet for equipment management, which is the default management VLAN, VLAN 1. After VTP and trunking have been configured for the switches, switched virtual interfaces (SVI) are configured on the distribution layer switch to route between these VLANs, providing full connectivity to the internal network.

**Note:** This lab uses Cisco WS-C2960-24TT-L switches with the Cisco IOS image c2960-lanbasek9-mz.122-46.SE.bin and Catalyst 3560-24PS with the Cisco IOS image c3560-advipservicesk9-mz.122-46.SE.bin. You can use other switches (such as 2950 or 3550) and Cisco IOS Software versions if they have comparable capabilities and features. Depending on the switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

### Required Resources

- 2 switches (Cisco 2960 with the Cisco IOS Release 12.2(46)SE C2960-LANBASEK9-M image or comparable)

- 1 switch (Cisco 3560 with the Cisco IOS Release 12.2(46)SE C3560-ADVIPSERVICESK9-mz image or comparable)
- Ethernet and console cables

### Step 1: Prepare the switches for the lab.

Erase the startup configuration, delete the vlan.dat file, and reload the switches. Refer to Lab 1-1, “Clearing a Switch” and Lab 1-2, “Clearing a Switch Connected to a Larger Network” to prepare the switches for this lab. Cable the equipment as shown.

### Step 2: Configure basic switch parameters.

- a. Configure the hostname, password, and optionally, Telnet access on each switch.

```
Switch(config)# hostname ALS1
ALS1(config)# enable secret cisco
ALS1(config)# line vty 0 15
ALS1(config-line)# password cisco
ALS1(config-line)# login
```

```
Switch(config)# hostname ALS2
ALS2(config)# enable secret cisco
ALS2(config)# line vty 0 15
ALS2(config-line)# password cisco
ALS2(config-line)# login
```

```
Switch(config)# hostname DLS1
DLS1(config)# enable secret cisco
DLS1(config)# line vty 0 15
DLS1(config-line)#password cisco
DLS1(config-line)# login
```

- b. Configure management IP addresses on VLAN 1 for all three switches according to the diagram.

```
ALS1(config)# interface vlan 1
ALS1(config-if)# ip address 172.16.1.101 255.255.255.0
ALS1(config-if)# no shutdown
```

```
ALS2(config)# interface vlan 1
ALS2(config-if)# ip address 172.16.1.102 255.255.255.0
ALS2(config-if)# no shutdown
```

```
DLS1(config)# interface vlan 1
DLS1(config-if)# ip address 172.16.1.1 255.255.255.0
DLS1(config-if)# no shutdown
```

- c. Configure default gateways on the access layer switches. The distribution layer switch will not use a default gateway, because it acts as a Layer 3 device. The access layer switches act as Layer 2 devices and need a default gateway to send management VLAN traffic off of the local subnet.

```
ALS1(config)# ip default-gateway 172.16.1.1
```

```
ALS2(config)# ip default-gateway 172.16.1.1
```

### Step 3: Configure trunks and EtherChannels between switches.

To distribute VLAN and VTP information between the switches, trunks are needed between the three switches. Configure these trunks according to the diagram. EtherChannel is used for these trunks.

EtherChannel allows you to utilize both Fast Ethernet interfaces that are available between each device, thereby doubling the bandwidth.

- a. Configure the trunks and EtherChannel from DLS1 to ALS1. The **switchport trunk encapsulation [isl | dot1q]** command is used because this switch also supports ISL encapsulation.

```
DLS1(config)# interface range fastEthernet 0/7 - 8
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-group 1 mode desirable
```

Creating a port-channel interface Port-channel 1

- b. Configure the trunks and EtherChannel from DLS1 to ALS2.

```
DLS1(config)# interface range fastEthernet 0/9 - 10
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-group 2 mode desirable
```

Creating a port-channel interface Port-channel 2

- c. Configure the trunks and EtherChannel between ALS1 and DLS1, and for the trunks and EtherChannel between ALS1 and ALS2.

```
ALS1(config)# interface range fastEthernet 0/11 - 12
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# channel-group 1 mode desirable
```

Creating a port-channel interface Port-channel 1

```
ALS1(config-if-range)# exit
ALS1(config)# interface range fastEthernet 0/7 - 8
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# channel-group 2 mode desirable
```

Creating a port-channel interface Port-channel 2

- d. Configure the trunks and EtherChannel between ALS2 and DLS1, and for the trunks and EtherChannel between ALS2 and ALS1.

```
ALS2(config)# interface range fastEthernet 0/11 - 12
ALS2(config-if-range)# switchport mode trunk
ALS2(config-if-range)# channel-group 1 mode desirable
```

Creating a port-channel interface Port-channel 1

```
ALS2(config-if-range)# exit
ALS2(config)# interface range fastEthernet 0/9 - 10
ALS2(config-if-range)# switchport mode trunk
ALS2(config-if-range)# channel-group 2 mode desirable
```

Creating a port-channel interface Port-channel 2

- e. Verify trunking between DLS1, ALS1, and ALS2 using the **show interface trunk** command on all switches.

```
DLS1# show interface trunk
```

| Port | Mode | Encapsulation | Status   | Native vlan |
|------|------|---------------|----------|-------------|
| Po1  | on   | 802.1q        | trunking | 1           |

```

Po2          on          802.1q          trunking      1

Port         Vlans allowed on trunk
Po1          1-4094
Po2          1-4094

Port         Vlans allowed and active in management domain
Po1          1
Po2          1

Port         Vlans in spanning tree forwarding state and not pruned
Po1          1
Po2          1

```

- f. Use the **show etherchannel summary** command on each switch to verify the EtherChannels.

The following is sample output from ALS1. Notice the two EtherChannels on the access layer switches.

```

ALS1# show etherchannel summary
Flags:  D - down          P - in port-channel
        I - stand-alone  s - suspended
        H - Hot-standby (LACP only)
        R - Layer3       S - Layer2
        U - in use       f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

```

```

Number of channel-groups in use: 2
Number of aggregators:          2

```

| Group | Port-channel | Protocol | Ports               |
|-------|--------------|----------|---------------------|
| 1     | Po1(SU)      | PAGP     | Fa0/11(P) Fa0/12(P) |
| 2     | Po2(SU)      | PAGP     | Fa0/7(P) Fa0/8(P)   |

On ALS1, which ports are used for channel group 2?

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#### Step 4: Configure VTP on ALS1 and ALS2.

- a. Change the VTP mode of ALS1 and ALS2 to client.

```

ALS1(config)# vtp mode client
Setting device to VTP CLIENT mode.

```

```

ALS2(config)# vtp mode client
Setting device to VTP CLIENT mode.

```

- b. Verify the VTP changes with the **show vtp status** command. The output on ALS2 is similar to that of ALS1.

```

ALS2# show vtp status
VTP Version                : running VTP1 (VTP2 capable)
Configuration Revision      : 0
Maximum VLANs supported locally : 255

```

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```
Number of existing VLANs      : 5
VTP Operating Mode           : Client
VTP Domain Name              :
VTP Pruning Mode             : Disabled
VTP V2 Mode                  : Disabled
VTP Traps Generation         : Disabled
MD5 digest                   : 0xC8 0xAB 0x3C 0x3B 0xAB 0xDD 0x34 0xCF
Configuration last modified by 0.0.0.0 at 3-1-93 15:47:34
```

How many VLANs can be supported locally on the 2960 switch?

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### Step 5: Configure VTP on DLS1.

- a. Create the VTP domain on DLS1 and create VLANs 100 and 200 for the domain.

```
DLS1(config)# vtp domain SWPOD
DLS1(config)# vtp version 2

DLS1(config)# vlan 100
DLS1(config-vlan)# name Finance
DLS1(config-vlan)# vlan 200
DLS1(config-vlan)# name Engineering
```

- b. Verify VTP information throughout the domain using the **show vlan** and **show vtp status** commands.

How many existing VLANs are in the VTP domain?

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### Step 6: Configure ports.

Configure the host ports for the appropriate VLANs according to the diagram.

```
ALS1(config)# interface fastEthernet 0/6
ALS1(config-if)# switchport mode access
ALS1(config-if)# switchport access vlan 100

ALS2(config)# interface fastEthernet 0/6
ALS2(config-if)# switchport mode access
ALS2(config-if)# switchport access vlan 200
```

Ping from the host on VLAN 100 to the host on VLAN 200. Was the ping successful? Why do you think this is the case?

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Ping from a host to the VLAN 1 management IP address of DLS1. Was the ping successful? Why do you think this is the case?

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**Step 7: Configure VLAN interfaces and enable routing.**

- a. On DLS1, create the Layer 3 VLAN interfaces to route between VLANs using the **interface vlan** *vlan-id* command. These are known as SVIs. You do not need to set up VLAN 1, because this was done in Step 2.

```
DLS1(config)# interface vlan 100
DLS1(config-if)# ip add 172.16.100.1 255.255.255.0
DLS1(config-if)# no shut
DLS1(config-if)# interface vlan 200
DLS1(config-if)# ip address 172.16.200.1 255.255.255.0
DLS1(config-if)# no shutdown
```

- b. The **ip routing** command is also needed to allow the switch to act as a Layer 3 device to route between these VLANs. Because the VLANs are all considered directly connected, a routing protocol is not needed at this time.

```
DLS1(config)# ip routing
```

- c. Verify the configuration using the **show ip route** command on DLS1.

```
DLS1# show ip route
Codes: C - connected, S - static, 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, su - IS-IS summary, 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, 3 subnets
C       172.16.200.0 is directly connected, Vlan200
C       172.16.1.0 is directly connected, Vlan1
C       172.16.100.0 is directly connected, Vlan100
```

**Step 8: Verify inter-VLAN routing by the internal route processor.**

- a. Ping from the Engineering host to the Finance host. Was the ping successful this time?
- 
- b. Telnet from one of the hosts to the VLAN 1 IP address of DLS1. Can this switch be remotely accessed from this host?
- 

**Step 9: Examine the CEF configuration.**

CEF implements an advanced IP lookup and forwarding algorithm to deliver maximum Layer 3 switching performance. CEF is less CPU-intensive than route caching.

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 by default on the 3560 switch.

- a. Use the **show ip cef** command to display the CEF FIB.

```
DLS1# 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
172.16.1.101/32 attached     Vlan1
172.16.1.102/32 attached     Vlan1
172.16.1.255/32 receive
172.16.100.0/24 attached     Vlan100
172.16.100.0/32 receive
172.16.100.1/32 receive
172.16.100.255/32 receive
172.16.200.0/24 attached     Vlan200
172.16.200.0/32 receive
172.16.200.1/32 receive
172.16.200.255/32 receive
224.0.0.0/4     drop
224.0.0.0/24   receive
255.255.255.255/32 receive
```

- b. Use the **show ip interface** command to verify that CEF is enabled on an interface. The following output shows that CEF is enabled on VLAN 100.

```
DLS1# show ip interface vlan 100
Vlan100 is up, line protocol is up
  Internet address is 172.16.100.1/24
  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 CEF switching is enabled
  IP CEF switching turbo vector
  IP multicast fast switching is disabled
  IP multicast distributed fast switching is disabled
  IP route-cache flags are Fast, CEF
  Router Discovery is disabled
  IP output packet accounting is disabled
  IP access violation accounting 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 disabled
  WCCP Redirect outbound is disabled
  WCCP Redirect inbound is disabled
```

```
WCCP Redirect exclude is disabled
BGP Policy Mapping is disabled
```

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

```
DLS1# show ip cef summary
IPv4 CEF is enabled for distributed and running
VRF Default:
 18 prefixes (18/0 fwd/non-fwd)
Table id 0, 0 resets
Database epoch: 1 (18 entries at this epoch)
```

- d. The **show ip cef detail** command shows CEF operation in detail for the switch.

```
DLS1# show ip cef detail
IPv4 CEF is enabled for distributed and running
VRF Default:
 18 prefixes (18/0 fwd/non-fwd)
Table id 0, 0 resets
Database epoch: 1 (18 entries at this epoch)

0.0.0.0/32, epoch 1, flags receive
  Special source: receive
  receive
172.16.1.0/24, epoch 1, flags attached, connected
  attached to Vlan1
172.16.1.0/32, epoch 1, flags receive
  receive
172.16.1.1/32, epoch 1, flags receive
  receive
172.16.1.101/32, epoch 1
  Adj source: IP adj out of Vlan1, addr 172.16.1.101
  attached to Vlan1
172.16.1.102/32, epoch 1
  Adj source: IP adj out of Vlan1, addr 172.16.1.102
  attached to Vlan1
172.16.1.255/32, epoch 1, flags receive
  receive
172.16.100.0/24, epoch 1, flags attached, connected
  attached to Vlan100
172.16.100.0/32, epoch 1, flags receive
  receive
172.16.100.1/32, epoch 1, flags receive
  receive
172.16.100.255/32, epoch 1, flags receive
  receive
172.16.200.0/24, epoch 1, flags attached, connected
  attached to Vlan200
172.16.200.0/32, epoch 1, flags receive
  receive
172.16.200.1/32, epoch 1, flags receive
  receive
172.16.200.255/32, epoch 1, flags receive
  receive
224.0.0.0/4, epoch 1
  Special source: drop
  drop
224.0.0.0/24, epoch 1, flags receive
  Special source: receive
  receive
```

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```
255.255.255.255/32, epoch 1, flags receive  
  Special source: receive  
  Receive
```