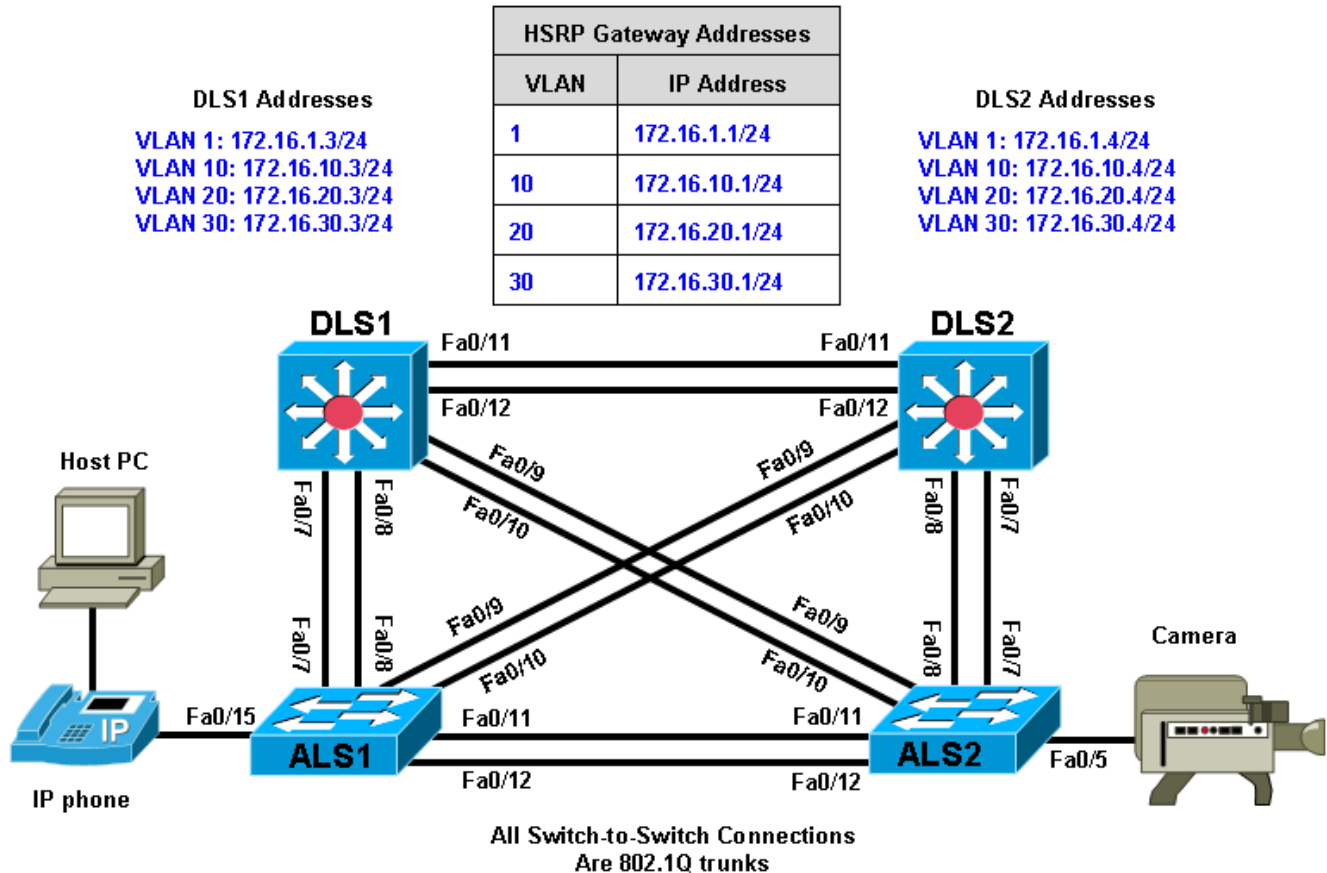Cisco | Networking Academy®
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Chapter 7 Lab 7-1, Configuring Switches for IP Telephony Support

Topology

Objectives

- Configure auto QoS to support IP phones.
- Configure CoS override for data frames.
- Configure the distribution layer to trust access layer QoS measures.
- Manually configure CoS for devices that cannot specify CoS (camera).
- Configure HSRP for voice and data VLANs to ensure redundancy.
- Configure 802.1Q trunks and EtherChannels for Layer 2 redundancy and load balancing.

Background

IP phones have been deployed throughout the network. Each phone is connected to an access port on a 2960 Cisco switch. Each user PC is connected to the network using the IP phone internal switch so that the phones can be deployed without additional wiring.

Note: The access layer switches depicted in the topology are assumed to support PoE for the IP phones. However, the switches used in this lab do not support PoE. This will not affect the commands used in this lab.

In this lab, you configure the quality of service (QoS) on the access and distribution layer switches so that they trust the class of service (CoS) mapping provided by the IP phone through Cisco Discovery Protocol (CDP). To ensure redundancy for the phones and user end stations, you will use Hot Standby Router Protocol (HSRP) on the distribution layer switches.

A camera for video is also deployed on the network, which requires that its access port on the 2960 be manually configured. It is not necessary to have an IP phone or camera to successfully complete the lab. The focus is on the configuration of access and distribution layer switches to support QoS for these devices.

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 a 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)
- 2 switches (Cisco 3560 with the Cisco IOS Release 12.2(46)SE C3560-ADVIPSERVICESK9-mz image or comparable)
- Host PC (optional)
- IP phone (optional)
- Camera (optional)
- 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.

Configure the management IP addresses in VLAN 1, and the hostname, password, and Telnet access on all four switches. Also configure a default gateway on the access layer switches. The distribution layer switches act as Layer 3 devices and do not need default gateways.

```
Switch(config)# hostname ALS1
ALS1(config)# enable secret class
ALS1(config)# line vty 0 15
ALS1(config-line)# password cisco
ALS1(config-line)# login
ALS1(config-line)# exit
ALS1(config)# interface vlan 1
ALS1(config-if)# ip address 172.16.1.101 255.255.255.0
ALS1(config-if)# no shutdown
ALS1(config-if)# exit
ALS1(config)# ip default-gateway 172.16.1.1

Switch(config)# hostname ALS2
ALS2(config)# enable secret class
```

```
ALS2(config)# line vty 0 15
ALS2(config-line)# password cisco
ALS2(config-line)# login
ALS2(config-line)# exit
ALS2(config)# interface vlan 1
ALS2(config-if)# ip address 172.16.1.102 255.255.255.0
ALS2(config-if)# no shutdown
ALS2(config-if)# exit
ALS2(config)# ip default-gateway 172.16.1.1

Switch(config)# hostname DLS1
DLS1(config)# enable secret class
DLS1(config)# line vty 0 15
DLS1(config-line)# password cisco
DLS1(config-line)# login
DLS1(config-line)# exit
DLS1(config)# interface vlan 1
DLS1(config-if)# ip address 172.16.1.3 255.255.255.0
DLS1(config-if)# no shutdown

Switch(config)# hostname DLS2
DLS2(config)# enable secret class
DLS2(config)# line vty 0 15
DLS2(config-line)# password cisco
DLS2(config-line)# login
DLS2(config-line)# exit
DLS2(config)# interface vlan 1
DLS2(config-if)# ip address 172.16.1.4 255.255.255.0
DLS2(config-if)# no shutdown
```

Step 3: Configure the trunks and EtherChannels.

Configure the trunks according to the diagram, and configure EtherChannels between the switches. Using EtherChannel for the trunks provides Layer 2 load balancing over redundant trunks.

a. The following is a sample configuration for the trunks and EtherChannel from DLS1 to the other three switches. Notice that the 3560 switch needs the **switchport trunk encapsulation** {**dot1q** | **isl**} command, 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 active

Creating a port-channel interface Port-channel 1

DLS1(config-if-range)# 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 active

Creating a port-channel interface Port-channel 2

DLS1(config-if-range)# interface range fastEthernet 0/11 - 12
DLS1(config-if-range)# switchport trunk encapsulation dot1q
DLS1(config-if-range)# switchport mode trunk
DLS1(config-if-range)# channel-group 3 mode active
```

```
Creating a port-channel interface Port-channel 3
```

b. The following is a sample configuration for the trunks and EtherChannels from DLS2 to the other three switches.

```
DLS2(config)# interface range fastEthernet 0/7 - 8
DLS2(config-if-range)# switchport trunk encapsulation dot1q
DLS2(config-if-range)# switchport mode trunk
DLS2(config-if-range)# channel-group 1 mode active
```

```
Creating a port-channel interface Port-channel 1
```

```
DLS2(config-if-range)# interface range fastEthernet 0/9 - 10
DLS2(config-if-range)# switchport trunk encapsulation dot1q
DLS2(config-if-range)# switchport mode trunk
DLS2(config-if-range)# channel-group 2 mode active
```

```
Creating a port-channel interface Port-channel 2
```

```
DLS2(config-if-range)# interface range fastEthernet 0/11 - 12
DLS2(config-if-range)# switchport trunk encapsulation dot1q
DLS2(config-if-range)# switchport mode trunk
DLS2(config-if-range)# channel-group 3 mode active
```

```
Creating a port-channel interface Port-channel 3
```

c. The following is a sample configuration for the trunks and EtherChannel from ALS1 and ALS2 to the other switches.

```
ALS1(config)# interface range fastEthernet 0/7 - 8
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# channel-group 1 mode active
```

```
Creating a port-channel interface Port-channel 1
```

```
ALS1(config-if-range)# interface range fastEthernet 0/9 - 10
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# channel-group 2 mode active
```

```
Creating a port-channel interface Port-channel 2
```

```
ALS1(config-if-range)# interface range fastEthernet 0/11 - 12
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# channel-group 3 mode active
```

```
Creating a port-channel interface Port-channel 3
```

```
ALS2(config)# interface range fastEthernet 0/7 - 8
ALS2(config-if-range)# switchport mode trunk
ALS2(config-if-range)# channel-group 1 mode active
```

```
Creating a port-channel interface Port-channel 1
```

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

```
Creating a port-channel interface Port-channel 2
```

```
ALS2(config-if-range)# interface range fastEthernet 0/11 - 12
ALS2(config-if-range)# switchport mode trunk
ALS2(config-if-range)# channel-group 3 mode active

Creating a port-channel interface Port-channel 3
```

d. Use the **show interfaces trunk** command on all switches to verify the trunks.

Which VLANs are currently allowed on the newly created trunks?

_____

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

Which EtherChannel negotiation protocol is in use here?

_____

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
```

b. Verify the VTP changes with the **show vtp status** command.

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

_____

Step 5: Configure VTP and the VLANs on DLS1.

a. Create the VTP domain on DLS1, and create VLANs 10, 20, and 30 for the computer data, voice, and video VLANs in the domain.

```
DLS1(config)# vtp domain SWPOD
DLS1(config)# vtp version 2
DLS1(config)# vlan 10
DLS1(config-vlan)# name CP-DATA
DLS1(config-vlan)# exit
DLS1(config)# vlan 20
DLS1(config-vlan)# name VOICE
DLS1(config-vlan)# exit
DLS1(config)# vlan 30
DLS1(config-vlan)# name VIDEO
```

b. Verify the 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 IP routing, VLAN SVIs, and HSRP on DLS1 and DLS2.

a. Configure HSRP between the VLANs to provide redundancy in the network. To achieve some load balancing, use the **standby** [*group*] **priority** command. Use the **ip routing** command on DLS1 and DLS2 to activate routing capabilities on the switch.

Each route processor will have its own IP address on each switched virtual interface (SVI) and also be assigned an HSRP virtual IP address for each VLAN. Devices connected to VLANs 10, 20, and 30 use the gateway IP address for the VLANs.

The **standby** command is also used to configure the IP address of the virtual gateway and configure the router for preemption. The **preempt** option allows for the active router with the higher priority to take over again after a network failure has been resolved.

Notice in the following configurations that the priority for VLANs 1 and 10 has been configured for 150 on DLS1, making DLS1 the active router for those VLANs. VLANs 20 and 30 have been configured for a priority of 100 on DLS1, making DLS1 the standby router for these VLANs. Reverse priorities have been configured on the VLANs on DLS2. DLS2 is the active router for VLANs 20 and 30, and the standby router for VLANs 1 and 10.

HSRP Configuration for DLS1

```
DLS1(config)# ip routing
DLS1(config)# interface vlan 1
DLS1(config-if)# standby 1 ip 172.16.1.1
DLS1(config-if)# standby 1 preempt
DLS1(config-if)# standby 1 priority 150
DLS1(config-if)# exit
DLS1(config)# interface vlan 10
DLS1(config-if)# ip address 172.16.10.3 255.255.255.0
DLS1(config-if)# standby 1 ip 172.16.10.1
DLS1(config-if)# standby 1 preempt
DLS1(config-if)# standby 1 priority 150
DLS1(config-if)# exit
DLS1(config)# interface vlan 20
DLS1(config-if)# ip address 172.16.20.3 255.255.255.0
DLS1(config-if)# standby 1 ip 172.16.20.1
DLS1(config-if)# standby 1 preempt
DLS1(config-if)# standby 1 priority 100
DLS1(config-if)# exit
DLS1(config)# interface vlan 30
DLS1(config-if)# ip address 172.16.30.3 255.255.255.0
DLS1(config-if)# standby 1 ip 172.16.30.1
DLS1(config-if)# standby 1 preempt
DLS1(config-if)# standby 1 priority 100
```

HSRP Configuration for DLS2

```
DLS2(config)# ip routing
DLS2(config)# interface vlan 1
DLS2(config-if)# standby 1 ip 172.16.1.1
DLS2(config-if)# standby 1 preempt
DLS2(config-if)# standby 1 priority 100
DLS2(config-if)# exit
DLS2(config)# interface vlan 10
DLS2(config-if)# ip address 172.16.10.4 255.255.255.0
DLS2(config-if)# standby 1 ip 172.16.10.1
DLS2(config-if)# standby 1 preempt
DLS2(config-if)# standby 1 priority 100
```

```
DLS2(config-if)# exit
DLS2(config)# interface vlan 20
DLS2(config-if)# ip address 172.16.20.4 255.255.255.0
DLS2(config-if)# standby 1 ip 172.16.20.1
DLS2(config-if)# standby 1 preempt
DLS2(config-if)# standby 1 priority 150
DLS2(config-if)# exit
DLS2(config)# interface vlan 30
DLS2(config-if)# ip address 172.16.30.4 255.255.255.0
DLS2(config-if)# standby 1 ip 172.16.30.1
DLS2(config-if)# standby 1 preempt
DLS2(config-if)# standby 1 priority 150
```

b. Enter the **show standby brief** command on both DLS1 and DLS2.

Which router is the active router for VLANs 1 and 10? Which is the active router for VLAN 20?

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How is the active HSRP router selected?

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c. Enter the **show standby** command on both DLS1 and DLS2.

What is the default hello time for each VLAN? What is the default hold time?

_____

d. Verify routing using the **show ip route** command. The following is sample output from 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, 4 subnets
C       172.16.20.0 is directly connected, Vlan20
C       172.16.30.0 is directly connected, Vlan30
C       172.16.1.0 is directly connected, Vlan1
C       172.16.10.0 is directly connected, Vlan10
```

Step 7: Configure access ports to trust IP phone CoS.

The access layer switches will be the QoS trust boundaries for the network. Data coming in on the switch ports will either have the CoS trusted or altered based on the information received on the ports.

Configure Fast Ethernet access ports 15 to 24 to trust the CoS for recognized IP phones on the network. The CoS of a Cisco IP phone is 5 by default. Any port that has a device other than a Cisco phone will not trust the CoS that is advertised. This configuration is accomplished by using the Cisco auto QoS features offered on these switches. Using a single command at the interface level, you can implement both trust boundaries and QoS features. Information obtained through CDP is used to determine when an IP phone is attached to the access port.

The following configuration also sets the voice VLAN on the interface with the **switchport voice vlan** *vlan-number* command.

Configure Fast Ethernet ports 15 through 24 on ALS1 and ALS2 using the **interface range** command.

```
ALS1(config)# interface range fastEthernet 0/15 - 24
ALS1(config-if-range)# switchport mode access
ALS1(config-if-range)# switchport access vlan 10
ALS1(config-if-range)# switchport voice vlan 20
ALS1(config-if-range)# auto qos voip cisco-phone

ALS2(config)# interface range fastEthernet 0/15 - 24
ALS2(config-if-range)# switchport mode access
ALS2(config-if-range)# switchport access vlan 10
ALS2(config-if-range)# switchport voice vlan 20
ALS2(config-if-range)# auto qos voip cisco-phone
```

Note: Configuring auto QoS on an interface automatically adds global **mls qos srr-queue**, **class-map** and **policy-map** commands to the running configuration. A number of interface-specific command are also added, including **spanning-tree portfast**.

Step 8: Verify the access layer auto QoS configuration.

Verify the auto QoS configuration at the access layer using the **show mls qos interface** *interface-type interface-number* and **show run** commands.

```
ALS1# show mls qos interface fastEthernet 0/15
FastEthernet0/15
Attached policy-map for Ingress: AutoQoS-Police-CiscoPhone
trust state: not trusted
trust mode: trust cos
trust enabled flag: dis
COS override: dis
default COS: 0
DSCP Mutation Map: Default DSCP Mutation Map
Trust device: cisco-phone
qos mode: port-based

ALS1# show run interface fastEthernet 0/15
interface FastEthernet0/15
 switchport access vlan 10
 switchport voice vlan 20
 srr-queue bandwidth share 10 10 60 20
 priority-queue out
 mls qos trust device cisco-phone
 mls qos trust cos
```

```
auto qos voip cisco-phone
spanning-tree portfast
service-policy input AutoQoS-Police-CiscoPhone
```

What is the default CoS for a PC connected to these interfaces?

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_____

Step 9: Configure the distribution layer switches to trust access layer CoS.

Configure the distribution layer switches to trust the CoS information in the Layer 2 frames being sent from the access layer. Because the trust boundary is at the access layer, frames being sent from this layer should be trusted into the distribution layer for optimal QoS.

```
DLS1(config)# mls qos
DLS1(config)# interface range fastEthernet 0/7 - 12
DLS1(config-if-range)# auto qos voip trust

DLS2(config)# mls qos
DLS2(config)# interface range fastEthernet 0/7 - 12
DLS2(config-if-range)# auto qos voip trust
```

Step 10: Verify the distribution layer auto QoS configuration.

a. Verify auto QoS at the distribution layer on DLS1 and DLS2 using the **show auto qos interface** command.

```
DLS1# show auto qos interface
FastEthernet0/7
auto qos voip trust

FastEthernet0/8
auto qos voip trust

FastEthernet0/9
auto qos voip trust

FastEthernet0/10
auto qos voip trust

FastEthernet0/11
auto qos voip trust

FastEthernet0/12
auto qos voip trust
```

b. Use the **show mls qos interface fastEthernet** *interface ID* command on DLS1 to verify QoS on the trunk interfaces.

```
DLS1# show mls qos interface fastEthernet 0/7
FastEthernet0/7
trust state: trust cos
trust mode: trust cos
trust enabled flag: ena
COS override: dis
default COS: 0
```

```
DSCP Mutation Map: Default DSCP Mutation Map
Trust device: none
qos mode: port-based
```

Step 11: Manually assign access layer CoS for the camera.

A camera needs to be moved from its current location in the network and connected to FastEthernet0/5 of ALS2.

Video traffic must have priority treatment within the network, because it has different requirements than data or voice traffic. The priority of the video traffic will be configured to be lower than the priority of the voice traffic.

a. Because the camera is not capable of setting its own CoS, assign a CoS of 3 to ensure that the video traffic is identified by other switches and routers within the network.

```
ALS2(config)# interface fastEthernet 0/5
ALS2(config-if)# switchport mode access
ALS2(config-if)# switchport access vlan 30
ALS2(config-if)# mls qos trust cos
ALS2(config-if)# mls qos cos 3
```

b. Verify the configuration using the **show mls qos interface** command on ALS2.

```
ALS2# show mls qos interface fastEthernet 0/5
FastEthernet0/5
trust state: trust cos
trust mode: trust cos
trust enabled flag: ena
COS override: dis
default COS: 3
DSCP Mutation Map: Default DSCP Mutation Map
Trust device: none
qos mode: port-based
```