Advanced Networking II Case Study

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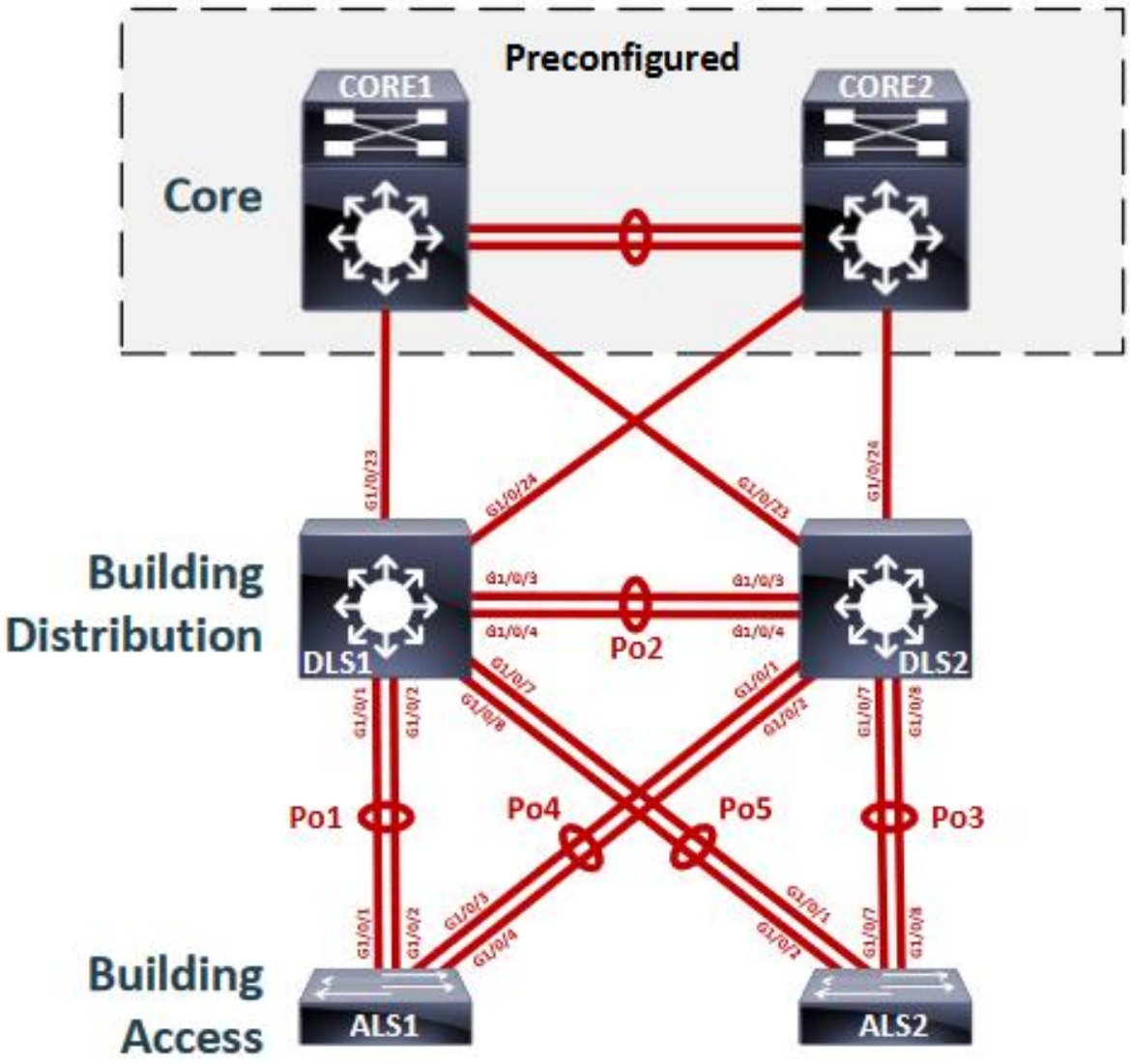
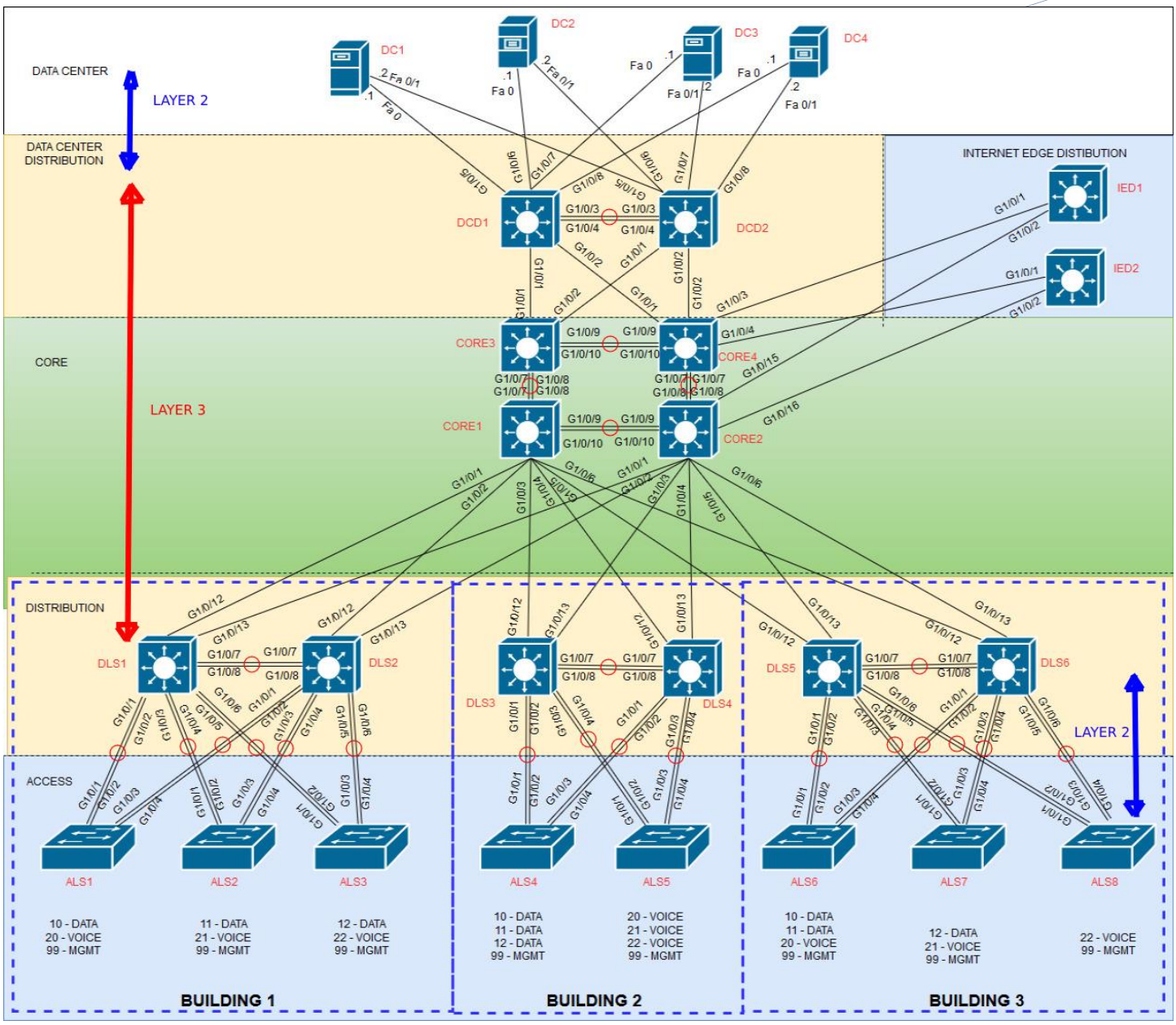
TOPOLOGY



UOIT STUDENT HELP DESK SWITCH NETWORK



EXPANDED ENTERPRISE NETWORK DESIGN

ABSTRACT

UOIT has required us to configure the help desk by using our cumulative knowledge of routing and switching. The networking students are faced with a task to help UOIT improve and construct their network. We configured the switches with the domain of HELPDESK and set the VTP mode to transparent. Next, we configured all switches for Rapid PVST+ and assigned the distribution switches as the root bridge. We then configured our access and distribution links as trunk and formed etherchannels using LACP and Cisco proprietary PAgP which provides redundancy. In addition, we configured the distribution to use HSRP for faultless links to provide for endless connectivity. For security reasons we enabled PortFast, BPDU guard and allow limited MAC addresses to be learned. We added access to our two laptops since we were the ones who configured the switches. On the distribution switches, we enabled EIGRP and this will be a necessity since this will allow communication and exchanging of information via the switches. As a favour for letting UOIT design and configure their network, we have decided to configure their HSRP with MD5 encryption preventing the attacker from using HSRP spoofing software. Lastly, UOIT has given us a final project to design the rest of the network. In our design we are using 8 layer 2 access switches, 8 layer 3 distribution switches, 4 layer 3 core switches, 2 layer 3 internet edge distribution switches and finally 4 data center servers. As our layer 3 protocols, we configured EIGRP on the core to distribution layers as well as the core to core layer for fast convergence and optimal routing and rerouting of traffic. For out layer 2 protocol, we implemented multiple spanning tree because this protocol will allow for multiple VLANs to be mapped to a single instance as well as load balancing and scalability. For STP enhancements we enabled UplinkFast on every root port in the access layer and loop guard on every non designated port in the Access Layer. We think these are needed since UplinkFast will help with link failures and loop guard will help prevent loops happening in our access layer. We used HSRP for our network because it provides the network with uninterrupted service and allows for default gateway redundancy. We used two security features, IP source guard and added VLAN hopping attacks. Enabling IP source guard will help with attackers from identifying themselves as their victim. We prevented VLAN hopping attacks by tagging all frames on the trunk ports and native VLAN trunks, as well as we configured the native VLANs to an unused VLAN and prevented traffic from going out of the native VLAN.

CONFIGURATIONS

1. Disable all unused links between the switches –use your own methods of discovery to learn which ports these are.

DLS1

- show ip int br
- int range g1/0/5-6
- shut
- int range g1/0/9-22
- shut
- int range g1/0/25-28
- shut

DLS2

- show ip int br
- int range g1/0/5-6
- shut
- int range g1/0/9-22
- shut
- int range g1/0/25-28
- Shut

ALS2

- show ip int br
- int range g1/0/9-28
- shut
- int range g1/0/3-4
- Shut

ALS1

- show ip int br
- int range g1/0/5-28
- Shut

```
DLS1#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
Vlan1                  unassigned      YES unset  administratively down down
Vlan140                10.14.0.1       YES manual up                    up
Vlan141                10.14.1.1       YES manual up                    up
Vlan142                10.14.2.1       YES manual up                    up
Vlan143                10.14.3.1       YES manual up                    up
Vlan149                10.14.9.1       YES manual up                    up
GigabitEthernet1/0/1   unassigned      YES unset  up                    up
GigabitEthernet1/0/2   unassigned      YES unset  up                    up
GigabitEthernet1/0/3   unassigned      YES manual up                    up
GigabitEthernet1/0/4   unassigned      YES manual up                    up
GigabitEthernet1/0/5   unassigned      YES unset  down                  down
GigabitEthernet1/0/6   unassigned      YES unset  down                  down
GigabitEthernet1/0/7   unassigned      YES unset  up                    up
GigabitEthernet1/0/8   unassigned      YES unset  up                    up
GigabitEthernet1/0/9   unassigned      YES unset  down                  down
GigabitEthernet1/0/10  unassigned      YES unset  down                  down
GigabitEthernet1/0/11  unassigned      YES unset  down                  down
GigabitEthernet1/0/12  unassigned      YES unset  down                  down
GigabitEthernet1/0/13  unassigned      YES unset  down                  down
GigabitEthernet1/0/14  unassigned      YES unset  down                  down
GigabitEthernet1/0/15  unassigned      YES unset  down                  down
GigabitEthernet1/0/16  unassigned      YES unset  down                  down
GigabitEthernet1/0/17  unassigned      YES unset  down                  down
GigabitEthernet1/0/18  unassigned      YES unset  up                    up
GigabitEthernet1/0/19  unassigned      YES unset  down                  down
GigabitEthernet1/0/20  unassigned      YES unset  down                  down
GigabitEthernet1/0/21  unassigned      YES unset  down                  down
GigabitEthernet1/0/22  unassigned      YES unset  down                  down
GigabitEthernet1/0/23  10.100.14.1     YES manual up                    up
GigabitEthernet1/0/24  10.200.14.1     YES manual up                    up
GigabitEthernet1/1/1   unassigned      YES unset  down                  down
GigabitEthernet1/1/2   unassigned      YES unset  down                  down
GigabitEthernet1/1/3   unassigned      YES unset  down                  down
GigabitEthernet1/1/4   unassigned      YES unset  down                  down
Port-channel1          unassigned      YES unset  up                    up
Port-channel2          10.99.14.1      YES manual up                    up
Port-channel5          unassigned      YES unset  up                    up
DLS1#
```

```
DLS2#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
Vlan1                  unassigned      YES unset  administratively down down
Vlan140                10.14.0.2       YES manual up                    up
Vlan141                10.14.1.2       YES manual up                    up
Vlan142                10.14.2.2       YES manual up                    up
Vlan143                10.14.3.2       YES manual up                    up
Vlan149                10.14.9.2       YES manual up                    up
GigabitEthernet1/0/1   unassigned      YES unset  up                    up
GigabitEthernet1/0/2   unassigned      YES unset  up                    up
GigabitEthernet1/0/3   unassigned      YES manual up                    up
GigabitEthernet1/0/4   unassigned      YES manual up                    up
GigabitEthernet1/0/5   unassigned      YES unset  administratively down down
GigabitEthernet1/0/6   unassigned      YES unset  administratively down down
GigabitEthernet1/0/7   unassigned      YES unset  up                    up
GigabitEthernet1/0/8   unassigned      YES unset  up                    up
GigabitEthernet1/0/9   unassigned      YES unset  administratively down down
GigabitEthernet1/0/10  unassigned      YES unset  administratively down down
GigabitEthernet1/0/11  unassigned      YES unset  administratively down down
GigabitEthernet1/0/12  unassigned      YES unset  administratively down down
GigabitEthernet1/0/13  unassigned      YES unset  administratively down down
GigabitEthernet1/0/14  unassigned      YES unset  administratively down down
GigabitEthernet1/0/15  unassigned      YES unset  administratively down down
GigabitEthernet1/0/16  unassigned      YES unset  administratively down down
GigabitEthernet1/0/17  unassigned      YES unset  administratively down down
GigabitEthernet1/0/18  unassigned      YES unset  administratively down down
GigabitEthernet1/0/19  unassigned      YES unset  administratively down down
GigabitEthernet1/0/20  unassigned      YES unset  administratively down down
GigabitEthernet1/0/21  unassigned      YES unset  administratively down down
GigabitEthernet1/0/22  unassigned      YES unset  administratively down down
GigabitEthernet1/0/23  10.100.14.2     YES manual up                    up
GigabitEthernet1/0/24  10.200.14.2     YES manual up                    up
GigabitEthernet1/1/1   unassigned      YES unset  down                  down
GigabitEthernet1/1/2   unassigned      YES unset  down                  down
GigabitEthernet1/1/3   unassigned      YES unset  down                  down
GigabitEthernet1/1/4   unassigned      YES unset  down                  down
Port-channel2          10.99.14.2      YES manual up                    up
Port-channel3          unassigned      YES unset  up                    up
Port-channel4          unassigned      YES unset  up                    up
DLS2#
```

```
ALS1#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
Vlan1                  unassigned      YES unset  up                    up
Vlan140                10.14.0.12      YES manual up                    up
Vlan141                10.14.1.12      YES manual up                    up
Vlan149                10.14.9.12      YES manual up                    up
FastEthernet0          unassigned      YES unset  administratively down down
GigabitEthernet1/0/1   unassigned      YES unset  up                    up
GigabitEthernet1/0/2   unassigned      YES unset  up                    up
GigabitEthernet1/0/3   unassigned      YES unset  up                    up
GigabitEthernet1/0/4   unassigned      YES unset  up                    up
GigabitEthernet1/0/5   unassigned      YES unset  down                  down
GigabitEthernet1/0/6   unassigned      YES unset  down                  down
GigabitEthernet1/0/7   unassigned      YES unset  administratively down down
GigabitEthernet1/0/8   unassigned      YES unset  administratively down down
GigabitEthernet1/0/9   unassigned      YES unset  administratively down down
GigabitEthernet1/0/10  unassigned      YES unset  administratively down down
GigabitEthernet1/0/11  unassigned      YES unset  administratively down down
GigabitEthernet1/0/12  unassigned      YES unset  up                    up
GigabitEthernet1/0/13  unassigned      YES unset  down                  down
GigabitEthernet1/0/14  unassigned      YES unset  down                  down
GigabitEthernet1/0/15  unassigned      YES unset  down                  down
GigabitEthernet1/0/16  unassigned      YES unset  down                  down
GigabitEthernet1/0/17  unassigned      YES unset  down                  down
GigabitEthernet1/0/18  unassigned      YES unset  down                  down
GigabitEthernet1/0/19  unassigned      YES unset  down                  down
GigabitEthernet1/0/20  unassigned      YES unset  down                  down
GigabitEthernet1/0/21  unassigned      YES unset  down                  down
GigabitEthernet1/0/22  unassigned      YES unset  down                  down
GigabitEthernet1/0/23  unassigned      YES unset  down                  down
GigabitEthernet1/0/24  unassigned      YES unset  down                  down
GigabitEthernet1/0/25  unassigned      YES unset  administratively down down
GigabitEthernet1/0/26  unassigned      YES unset  administratively down down
GigabitEthernet1/0/27  unassigned      YES unset  administratively down down
GigabitEthernet1/0/28  unassigned      YES unset  administratively down down
Port-channel1          unassigned      YES unset  up                    up
Port-channel4          unassigned      YES unset  up                    up
```

```
ALS2#show ip int br
Interface              IP-Address      OK? Method Status                Protoco
Vlan1                  unassigned      YES unset  administratively down down
Vlan142                10.14.2.12      YES manual up                    up
Vlan143                10.14.3.12      YES manual up                    up
Vlan149                10.14.9.13      YES manual up                    up
FastEthernet0          unassigned      YES DHCP   administratively down down
GigabitEthernet1/0/1   unassigned      YES unset  up                    up
GigabitEthernet1/0/2   unassigned      YES unset  up                    up
GigabitEthernet1/0/3   unassigned      YES unset  administratively down down
GigabitEthernet1/0/4   unassigned      YES unset  administratively down down
GigabitEthernet1/0/5   unassigned      YES unset  down                  down
GigabitEthernet1/0/6   unassigned      YES unset  down                  down
GigabitEthernet1/0/7   unassigned      YES unset  up                    up
GigabitEthernet1/0/8   unassigned      YES unset  up                    up
GigabitEthernet1/0/9   unassigned      YES unset  administratively down down
GigabitEthernet1/0/10  unassigned      YES unset  administratively down down
GigabitEthernet1/0/11  unassigned      YES unset  administratively down down
GigabitEthernet1/0/12  unassigned      YES unset  down                  down
GigabitEthernet1/0/13  unassigned      YES unset  down                  down
GigabitEthernet1/0/14  unassigned      YES unset  down                  down
GigabitEthernet1/0/15  unassigned      YES unset  down                  down
GigabitEthernet1/0/16  unassigned      YES unset  down                  down
GigabitEthernet1/0/17  unassigned      YES unset  down                  down
GigabitEthernet1/0/18  unassigned      YES unset  down                  down
GigabitEthernet1/0/19  unassigned      YES unset  down                  down
GigabitEthernet1/0/20  unassigned      YES unset  down                  down
GigabitEthernet1/0/21  unassigned      YES unset  down                  down
GigabitEthernet1/0/22  unassigned      YES unset  down                  down
GigabitEthernet1/0/23  unassigned      YES unset  down                  down
GigabitEthernet1/0/24  unassigned      YES unset  down                  down
GigabitEthernet1/0/25  unassigned      YES unset  administratively down down
GigabitEthernet1/0/26  unassigned      YES unset  administratively down down
GigabitEthernet1/0/27  unassigned      YES unset  administratively down down
GigabitEthernet1/0/28  unassigned      YES unset  administratively down down
Port-channel3          unassigned      YES unset  up                    up
Port-channel5          unassigned      YES unset  up                    up
```

Looking at the diagrams given, we issued the commands above and shut down all the unused ports that these switches were not using.

2. Place all switches in the VTP domain HELPDESK and set them to VTP mode transparent.

DLS1

- vtp domain HELPDESK
- vtp mode transparent

DLS2

- vtp domain HELPDESK
- vtp mode transparent

ALS1

- vtp domain HELPDESK
- vtp mode transparent

ALS2

- vtp domain HELPDESK
- vtp mode transparent

```
DLS1#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : HELPDESK
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : d8b1.9092.9700
Configuration last modified by 10.99.14.1 at 0-0-00 00:00:00

Feature VLAN:
--------------
VTP Operating Mode                : Transparent
Maximum VLANs supported locally   : 1005
Number of existing VLANs          : 10
Configuration Revision            : 0
MD5 digest                        : 0x75 0xBF 0x26 0xE0 0xF9 0x9E 0xD8 0x44
                                    0x0B 0x99 0x18 0x2E 0x86 0x81 0x83 0x3A
DLS1#
```

```
DLS2#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : HELPDESK
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : d8b1.9004.0080
Configuration last modified by 10.99.14.2 at 0-0-00 00:00:00

Feature VLAN:
--------------
VTP Operating Mode                : Transparent
Maximum VLANs supported locally   : 1005
Number of existing VLANs          : 10
Configuration Revision            : 0
MD5 digest                        : 0xB7 0xC1 0xC2 0x9F 0x56 0xC1 0xA0 0x17
                                    0x4F 0x5E 0xE8 0xEF 0x14 0xB9 0x06 0x02
```

```
ALS1#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : HELPDESK
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : 84b5.177b.3c80
Configuration last modified by 0.0.0.0 at 0-0-00 00:00:00

Feature VLAN:
--------------
VTP Operating Mode                : Transparent
```

```
ALS2#show vtp status
VTP Version capable             : 1 to 3
VTP version running             : 1
VTP Domain Name                 : HELPDESK
VTP Pruning Mode                : Disabled
VTP Traps Generation            : Disabled
Device ID                       : 84b5.17fc.0b80
Configuration last modified by 10.41.30.79 at 0-0-00 00:00:00

Feature VLAN:
--------------
VTP Operating Mode                : Transparent
```

We setup a domain sharing between all switches to carry over vlan information. We used transparent mode to create, modify and delete VLANs locally by issuing the commands above.

3. Configure all switches for Rapid PVST+. Make DLS1 the root bridge for VLANs x0and x1, and make DSL2 the root bridge for VLANs x2, x3, and x9. Manipulate the spanning tree port costs so that Po5on DLS1 will always become the root port for VLAN x2.

DLS1

- spanning-tree mode rapid-pvst
- spanning-tree vlan 140 root primary
- spanning-tree vlan 141 root primary
- int port number 5
- spanning-tree vlan 142 cost 1

DLS2

- spanning-tree mode rapid-pvst
- spanning-tree vlan 142 root primary
- spanning-tree vlan 143 root primary
- spanning-tree vlan 149 root primary

ALS1

- spanning-tree mode rapid-pvst

ALS2

- spanning-tree mode rapid-pvst

```
DLS1#show spanning-tree summary
Switch is in rapid-pvst mode
```

```
DLS1#show spanning-tree root port
VLAN0001         Port-channel1
VLAN0140         This bridge is root
VLAN0141         This bridge is root
VLAN0142         Port-channel5
VLAN0143         Port-channel5
VLAN0149         Port-channel1
```

```
DLS2#show spanning-tree root port
VLAN0001         Port-channel4
VLAN0140         Port-channel4
VLAN0141         Port-channel4
VLAN0142         This bridge is root
VLAN0143         This bridge is root
VLAN0149         This bridge is root
DLS2#
```

```
DLS1#show spanning-tree int po5 cost
VLAN0001             3
VLAN0140             3
VLAN0141             3
VLAN0142             1
VLAN0143             3
VLAN0149             3
DLS1#
```

```
DLS2#show spanning-tree root cost
VLAN0001         3
VLAN0140         6
VLAN0141         6
VLAN0142         0
VLAN0143         0
VLAN0149         0
```

Using rapid pvst+ allows for fast convergence along with the ability to create one spanning tree for every VLAN. Using root primary allows us to manually set the switch to become the root bridge for the specified VLANs. Modifying the cost ensured that our desired port will became a root port.

4. Configure all Access-to-Distribution links statically as 802.1q trunk links and disable DTP negotiation. Enable LACP Etherchannels along links between the Access Layer switches and DLS1. Enable PAgP Etherchannel between the Access Layer switches and DLS2. Configure the Etherchannel between the Distribution Layer switches to be statically defined and Layer 3, using the subnet specified in the table above. It's your decision on how the dynamic channel groups are formed.

DLS1
- int range g1/0/1-2, g1/0/7-8
- switchport trunk encapsulation dot1q
- switchport mode trunk
- switchport nonegotiate
- int range g1/0/1-2
- channel-group 1 mode active
- int range g1/0/7-8
- channel-group 5 mode active
- int range g1/0/3-4
- no switchport
- channel-group 2 mode on
- int port-channel 2
- no switchport
- ip address 10.99.14.1 255.255.255.0

DLS2
- int range g1/0/1-2, g1/0/7-8
- switchport trunk encapsulation dot1q
- switchport mode trunk
- switchport nonegotiate
- int range g1/0/1-2
- channel-group 4 mode desirable
- int range g1/0/7-8
- channel-group 3 mode desirable
- int range g1/0/3-4
- no switchport
- channel-group 2 mode on
- int port-channel 2
- no switchport
- ip address 10.99.14.2 255.255.255.0

ALS1
- int range g1/0/1-2, g1/0/7-8
- switchport trunk encapsulation dot1q
- switchport mode trunk
- switchport nonegotiate
- int range g1/0/1-2
- channel-group 1 mode active
- int range g1/0/3-4
- channel-group 4 mode desirable

ALS2
- int range g1/0/1-2, g1/0/7-8
- switchport trunk encapsulation dot1q
- switchport mode trunk

- switchport nonegotiate
- int range g1/0/1-2
- channel-group 5 mode active
- int range g1/0/7-8
- channel-group 3 mode desirable

```
DLS1#show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Po1         on               802.1q         trunking      1
Po5         on               802.1q         trunking      1

Port        Vlans allowed on trunk
Po1         1-4094
Po5         1-4094

Port        Vlans allowed and active in management domain
Po1         1,140-143,149
Po5         1,140-143,149

Port        Vlans in spanning tree forwarding state and not pruned
Po1         1,140-143,149
Po5         1,140-143
DLS1#
DLS1#
DLS1#
DLS1#
DLS1#
DLS1#
DLS1#show eth
DLS1#show etherchannel sum
DLS1#show etherchannel summary
Flags:  D - down        P - bundled 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

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG


Number of channel-groups in use: 3
Number of aggregators:           3

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Gi1/0/1(P)  Gi1/0/2(P)
2      Po2(RU)          -        Gi1/0/3(P)  Gi1/0/4(P)
5      Po5(SU)         LACP      Gi1/0/7(P)  Gi1/0/8(P)
```

```
DLS2#show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Po3         on               802.1q         trunking      1
Po4         on               802.1q         trunking      1

Port        Vlans allowed on trunk
Po3         1-4094
Po4         1-4094

Port        Vlans allowed and active in management domain
Po3         1,140-143,149
Po4         1,140-143,149

Port        Vlans in spanning tree forwarding state and not pruned
Po3         1,140-143,149
Po4         1,140-143,149
DLS2#show ether
DLS2#show etherchannel sum
DLS2#show etherchannel summary
Flags:  D - down        P - bundled 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

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG


Number of channel-groups in use: 3
Number of aggregators:           3

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
2      Po2(RU)          -        Gi1/0/3(P)  Gi1/0/4(P)
3      Po3(SU)         PAgP      Gi1/0/7(P)  Gi1/0/8(P)
4      Po4(SU)         PAgP      Gi1/0/1(P)  Gi1/0/2(P)
```

```
ALS1#show etherchannel summary
Flags:  D - down        P - bundled 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

        M - not in use, minimum links not met
        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)         LACP      Gi1/0/1(P)  Gi1/0/2(P)
4      Po4(SU)         PAgP      Gi1/0/3(P)  Gi1/0/4(P)

ALS1#show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Po1         on               802.1q         trunking      1
Po4         on               802.1q         trunking      1

Port        Vlans allowed on trunk
Po1         1-4094
Po4         1-4094

Port        Vlans allowed and active in management domain
Po1         1,140-141,149
Po4         1,140-141,149

Port        Vlans in spanning tree forwarding state and not pruned
Po1         1,140-141,149
Po4         1,140-141,149
```

```
ALS2#show int trunk

Port        Mode             Encapsulation  Status        Native vlan
Po3         on               802.1q         trunking      1
Po5         on               802.1q         trunking      1

Port        Vlans allowed on trunk
Po3         1-4094
Po5         1-4094

Port        Vlans allowed and active in management domain
Po3         1,142-143,149
Po5         1,142-143,149

Port        Vlans in spanning tree forwarding state and not pruned
Po3         1,142-143,149
Po5         142-143,149
ALS2#
ALS2#
ALS2#show ether
ALS2#show etherch
ALS2#show etherchannel summary
Flags:  D - down        P - bundled 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

        M - not in use, minimum links not met
        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
------+-------------+-----------+-----------------------------------------------
3      Po3(SU)         PAgP      Gi1/0/7(P)  Gi1/0/8(P)
5      Po5(SU)         LACP      Gi1/0/1(P)  Gi1/0/2(P)
```

Configuring links as trunk links will allow for multiple VLAN traffic to be carried over a link. Disabling DTP will prevent the switches from bonding between each other and disable frames from exchanging. Configuring etherchannels as desirable will allow for the cisco proprietary PAgP to form and bundle multiple links into one channel while using active will enable LACP to initiate and negotiate to form etherchannels. Using layer 3 links is very beneficial since there is a time to live on packets to ensure loops will not happen.

5. Create the required VLANs on each switch as specified in the table above. Configure DLS1 and DLS2 SVIs for each VLAN and assign addresses in the appropriate subnets as specified in the table above.

ALS1

- vlan 140

- name Data1
- vlan 141
- name Voice1
- vlan 149
- name Management

ALS2

- vlan 142
- name Data2
- vlan 143
- name Voice2
- vlan 149

DLS1

- vlan 140
- name Data1
- vlan 141
- name Voice1
- vlan 142
- name Data2
- vlan 143
- name Voice2
- vlan 149
- name Management
- interface vlan 140
- ip address 10.14.0.1 255.255.255.0
- interface vlan 141
- ip address 10.14.1.1 255.255.255.0
- interface vlan 149
- ip address 10.14.9.1 255.255.255.0
- interface vlan 142
- ip address 10.14.2.1 255.255.255.0
- interface vlan 143
- ip address 10.14.3.1 255.255.255.0

DLS2

- vlan 140
- name Data1
- vlan 141
- name Voice1
- vlan 142
- name Data2
- vlan 143
- name Voice2
- vlan 149
- name Management
- interface vlan 140
- ip address 10.14.0.2 255.255.255.0
- interface vlan 141
- ip address 10.14.1.2 255.255.255.0
- interface vlan 149
- ip address 10.14.9.2 255.255.255.0

- interface vlan 142
- ip address 10.14.2.2 255.255.255.0
- interface vlan 143
- ip address 10.14.3.2 255.255.255.0

```
DLS1#show vlan br

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/5, Gi1/0/6, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/1/1, Gi1/1/2
                                                Gi1/1/3, Gi1/1/4
140  Data1                            active
141  Voice1                           active
142  Data2                            active
143  Voice2                           active
149  Management                       active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
DLS1#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
Vlan1                  unassigned      YES unset  administratively down down
Vlan140                10.14.0.1       YES manual up                    up
Vlan141                10.14.1.1       YES manual up                    up
Vlan142                10.14.2.1       YES manual up                    up
Vlan143                10.14.3.1       YES manual up                    up
Vlan149                10.14.9.1       YES manual up                    up
```

```
DLS2#show vlan br

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/5, Gi1/0/6, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/1/1, Gi1/1/2
                                                Gi1/1/3, Gi1/1/4
140  Data1                            active
141  Voice1                           active
142  Data2                            active
143  Voice2                           active
149  Management                       active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
DLS2#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
Vlan1                  unassigned      YES unset  administratively down down
Vlan140                10.14.0.2       YES manual up                    up
Vlan141                10.14.1.2       YES manual up                    up
Vlan142                10.14.2.2       YES manual up                    up
Vlan143                10.14.3.2       YES manual up                    up
Vlan149                10.14.9.2       YES manual up                    up
```

```
ALS1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/7, Gi1/0/8, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/25
                                                Gi1/0/26, Gi1/0/27, Gi1/0/28
140  Data1                            active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
141  Voice1                           active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
149  Management                       active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
ALS1#show ip int br | begin vlan
ALS1#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
Vlan1                  unassigned      YES unset  up                    up
Vlan140                10.14.0.12      YES manual up                    up
Vlan141                10.14.1.12      YES manual up                    up
Vlan149                10.14.9.12      YES manual up                    up
ALS2#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/3, Gi1/0/4, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/25
                                                Gi1/0/26, Gi1/0/27, Gi1/0/28
142  Data2                            active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
143  Voice2                           active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
149  Management                       active
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
ALS2#show ip int br
Interface              IP-Address      OK? Method Status                Protocol
Vlan1                  unassigned      YES unset  administratively down down
Vlan142                10.14.2.12      YES manual up                    up
Vlan143                10.14.3.12      YES manual up                    up
Vlan149                10.14.9.13      YES manual up                    up
```

Creating VLANs will help with communication within the same domain and provide organization for your ports. We will use SVI's to route traffic and communicate to other VLANs.

6. Configure DLS1 and DLS2 to use HSRP for VLANS x0, x1, x2, x3and x9. Make DLS1 the primary gateway for VLAN x0and x1and DLS2 the primary gateway for VLAN x2, x3, and x9. Enable preemption on both switches.

DLS1

- ip routing
- interface vlan 140
- standby 140 ip 10.14.0.5
- standby 140 preempt
- standby 140 priority 110
- interface vlan 141
- standby 141 ip 10.14.1.5
- standby 141 preempt
- standby 141 priority 110
- interface vlan 142
- standby 142 ip 10.14.2.5
- standby 142 preempt
- interface vlan 143
- standby 143 ip 10.14.3.5
- standby 143 preempt
- interface vlan 149
- standby 149 ip 10.14.9.5
- standby 149 preempt

DLS2

- ip routing
- interface vlan 140
- standby 140 ip 10.14.0.5
- standby 140 preempt
- interface vlan 141
- standby 141 ip 10.14.1.5
- standby 141 preempt
- interface vlan 142
- standby 142 ip 10.14.2.5
- standby 142 preempt
- standby 142 priority 110
- interface vlan 143
- standby 143 ip 10.14.3.5
- standby 143 preempt
- standby 143 priority 110
- interface vlan 149
- standby 149 ip 10.14.9.5
- standby 149 preempt
- standby 149 priority 110

```
DLS1# show standby br
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Vl140       140  110 P Active  local           10.14.0.2       10.14.0.5
Vl141       141  110 P Active  local           10.14.1.2       10.14.1.5
Vl142       142  100 P Standby 10.14.2.2       local           10.14.2.5
Vl143       143  100 P Standby 10.14.3.2       local           10.14.3.5
Vl149_      149  100 P Standby 10.14.9.2       local           10.14.9.5
```

```
DLS2#   show stand br
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State   Active          Standby         Virtual IP
Vl140       140  100 P Standby 10.14.0.1       local           10.14.0.5
Vl141       141  100 P Standby 10.14.1.1       local           10.14.1.5
Vl142       142  110 P Active  local           10.14.2.1       10.14.2.5
Vl143       143  110 P Active  local           10.14.3.1       10.14.3.5
Vl149_      149  110 P Active  local           10.14.9.1       10.14.9.5
```

Configuring HSRP will create an illusion of a single Router/Switch that allow for link redundancy and acts as a single gateway. When a link fails, access to the primary gateway will still be available.

7. Using the table provided, assign ALS1 and ALS2 ports G1/0/5, G1/0/6, and G1/0/12-24 as access ports in the Data VLANs

ALS1

- int range g1/0/5-6, g1/0/12-24
- switchport mode access
- switchport access vlan 142

ALS2

- int range g1/0/5-6,g1/0/12-24
- switchport mode access
- switchport access vlan 142

```
Name: Gi1/0/17
Switchport: Enabled
Administrative Mode: static access
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: Off
Access Mode VLAN: 140 (Data1)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: 141 (Voice1)
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk associations: none
Administrative private-vlan trunk mappings: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL
```

```
Name: Gi1/0/14
Switchport: Enabled
Administrative Mode: static access
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: Off
Access Mode VLAN: 142 (Data2)
Trunking Native Mode VLAN: 1 (default)
Administrative Native VLAN tagging: enabled
Voice VLAN: 143 (Voice2)
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk Native VLAN tagging: enabled
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk associations: none
Administrative private-vlan trunk mappings: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled
Capture VLANs Allowed: ALL
```

```
ALS1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/7, Gi1/0/8, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/25
                                                Gi1/0/26, Gi1/0/27, Gi1/0/28
140  Data1                            active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
141  Voice1                           active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
```

```
ALS2#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/3, Gi1/0/4, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/25
                                                Gi1/0/26, Gi1/0/27, Gi1/0/28
142  Data2                            active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
143  Voice2                           active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
```

Here we are setting our ports to access specific VLANS, forcing the port to be an access port.

8. Enable PortFast and BPDU guard on all access ports. Shutdown any unused ports at the Distribution layer.

ALS1

- int range g1/0/5-6,g1/0/12-24
- spanning-tree bpduguard enable
- switchport portfast

ALS2

- int range g1/0/5-6,g1/0/12-24
- spanning-tree bpduguard enable

```
interface GigabitEthernet1/0/22
 switchport access vlan 140
 switchport mode access
 switchport voice vlan 141
 spanning-tree portfast
 spanning-tree bpduguard enable
```

```
interface GigabitEthernet1/0/6
 switchport access vlan 142
 switchport mode access
 switchport voice vlan 143
 switchport port-security maximum 3
 switchport port-security
 switchport port-security violation restrict
 spanning-tree portfast
 spanning-tree bpduguard enable
```

Enabling PortFast will affect our access ports. Using this will transition our blocking ports to a forwarding state. BPDU guard will help prevent loops and put the portFast port into an err-disabled if a BPDU is received.

9. Configure ALS1 and ALS2 ports G1/0/5, G1/0/6, and G1/0/12-24 for use with Cisco IP phones using the corresponding voice VLANs.

ALS1

- int range g1/0/5-6,g1/0/12-24
- switchport voice vlan 143

ALS2

- int range g1/0/5-6,g1/0/12-24
- switchport voice vlan 143

```
ALS1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/7, Gi1/0/8, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/25
                                                Gi1/0/26, Gi1/0/27, Gi1/0/28
140  Data1                            active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
141  Voice1                           active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
```

```
ALS2#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gi1/0/3, Gi1/0/4, Gi1/0/9
                                                Gi1/0/10, Gi1/0/11, Gi1/0/25
                                                Gi1/0/26, Gi1/0/27, Gi1/0/28
142  Data2                            active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
143  Voice2                           active    Gi1/0/5, Gi1/0/6, Gi1/0/12
                                                Gi1/0/13, Gi1/0/14, Gi1/0/15
                                                Gi1/0/16, Gi1/0/17, Gi1/0/18
                                                Gi1/0/19, Gi1/0/20, Gi1/0/21
                                                Gi1/0/22, Gi1/0/23, Gi1/0/24
```

Voice vlan are assigned to specific vlans that carry over IP voice traffic over the cisco IP phones.

10. Configure ALS2G1/0/5 and G1/0/6 for port security. Allow only up to three MAC addresses to be learned on each port and then drop any traffic from other MAC addresses and set the violate mode to restrict.

ALS2

- int range g1/0/5-6
- switchport port-security
- switchport port-security maximum 3
- switchport port-security violation restrict

```
ALS2#show port-security interface g1/0/5
Port Security              : Enabled
Port Status                : Secure-down
Violation Mode             : Restrict
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 3
Total MAC Addresses        : 0
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 0
Last Source Address:Vlan   : 0000.0000.0000:0
Security Violation Count   : 0

ALS2#show port-security interface g1/0/6
Port Security              : Enabled
Port Status                : Secure-down
Violation Mode             : Restrict
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 3
Total MAC Addresses        : 0
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 0
Last Source Address:Vlan   : 0000.0000.0000:0
Security Violation Count   : 0
```

Dropping traffic from unknown mac addresses using restrict allows for a great security practice.

11. Configure ALS1G1/0/5 and G1/0/6 to only allow the MAC addresses of the two supervisor laptops (i.e. the two team members completing this case study). Assign only one MAC address per port and shutdown if a violation occurs

ALS1

- int range g1/0/5-6
- switchport port-security maximum 1 vlan access
- switchport port-security maximum 1 vlan voice
- switchport port-security mac-address "mac"
- switchport port-security violation shutdown

```
ALS1#show port-security interface g1/0/5
Port Security              : Enabled
Port Status                : Secure-down
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 1
Total MAC Addresses        : 1
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 1
Last Source Address:Vlan   : 0000.0000.0000:0
Security Violation Count   : 0

ALS1#show port-security interface g1/0/6
Port Security              : Enabled
Port Status                : Secure-down
Violation Mode             : Shutdown
Aging Time                 : 0 mins
Aging Type                 : Absolute
SecureStatic Address Aging : Disabled
Maximum MAC Addresses      : 1
Total MAC Addresses        : 1
Configured MAC Addresses   : 0
Sticky MAC Addresses       : 1
Last Source Address:Vlan   : 0000.0000.0000:0
Security Violation Count   : 0
```

Learning up to 2 mac addresses on each end device is acceptable because it limits authority to admins who will be configuring these switches.

12. Create routed ports on DLS1 and DLS2 ports G1/0/23 and G1/0/24 that lead to CORE1 and CORE2. Configure addresses using the subnets specified in the table above.

DLS1

- int g1/0/23
- no switchport
- ip address 10.100.14.1 255.255.0.0
- int g1/0/24
- no switchport
- ip address 10.200.14.1 255.255.0.0

DLS2

- int g1/0/23
- no switchport
- ip address 10.100.14.2 255.255.0.0
- int g1/0/24
- no switchport,
- ip address 10.200.14.2 255.255.0.0

```
GigabitEthernet1/0/23  10.100.14.1     YES manual up                    up
GigabitEthernet1/0/24  10.200.14.1     YES manual up                    up
GigabitEthernet1/0/23  10.100.14.2     YES manual up                    up
GigabitEthernet1/0/24  10.200.14.2     YES manual up                    up
```

Routed ports are a layer 3 interface that will act as a port on a router. This configuration will allow these ports to be configured with IP addresses.

13. Enable EIGRP AS100on DLS1, DLS2, and advertise all connected networks.Ensure that neighbor relationships form with both CORE1 and CORE2 on both DLS switches.

DLS1

- router eigrp 100
- network 10.14.0.0 0.0.15.255
- network 10.99.14.0 0.0.0.255
- network 10.100.0.0 0.0.255.255
- network 10.200.0.0 0.0.255.255

DLS2

- router eigrp 100
- network 10.14.0.0 0.0.15.255
- network 10.99.14.0 0.0.0.255
- network 10.100.0.0 0.0.255.255
- network 10.200.0.0 0.0.255.255

```
DLS1#show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num
7   10.200.0.1              Gi1/0/24                 14 00:16:56 1592  5000  0  150
6   10.100.0.1              Gi1/0/23                 12 00:16:57 1594  5000  0  149
5   10.99.14.2              Po2                      12 00:16:57 1594  5000  0  18
4   10.14.9.2               Vl149                    11 00:16:57 1594  5000  0  17
3   10.14.3.2               Vl143                    14 00:16:57 1594  5000  0  16
2   10.14.2.2               Vl142                    11 00:16:57 1594  5000  0  15
1   10.14.1.2               Vl141                    13 00:16:57 1594  5000  0  14
0   10.14.0.2               Vl140                    11 00:16:57 1594  5000  0  13
DLS1#
DLS2#show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num
7   10.99.14.1              Po2                      14 00:16:26   10   100  0  22
6   10.14.9.1               Vl149                    14 00:16:26   10   100  0  21
5   10.14.3.1               Vl143                    13 00:16:26   10   100  0  20
4   10.14.2.1               Vl142                    12 00:16:26   10   100  0  19
3   10.14.1.1               Vl141                    13 00:16:26   10   100  0  18
2   10.14.0.1               Vl140                    14 00:16:26   10   100  0  17
1   10.200.0.1              Gi1/0/24                 13 00:16:32 1594  5000  0  142
0   10.100.0.1              Gi1/0/23                 10 00:16:33 1588  5000  0  141
```

Enabling eigrp will allow for our routed ports and SVI's to exchange routing information.

14. Implement one additional upgrade that you have learned in this course. Suggestions include monitoring (IP SLAs), private VLANs, security, etc.

DLS1

- int vlan 140
- standby 140 authentication md5 key-string letmein
- int vlan 141
- standby 141 authentication md5 key-string letmein
- int vlan 142
- standby 142 authentication md5 key-string letmein
- int vlan 143
- standby 143 authentication md5 key-string letmein
- int vlan 149
- standby 149 authentication md5 key-string letmein

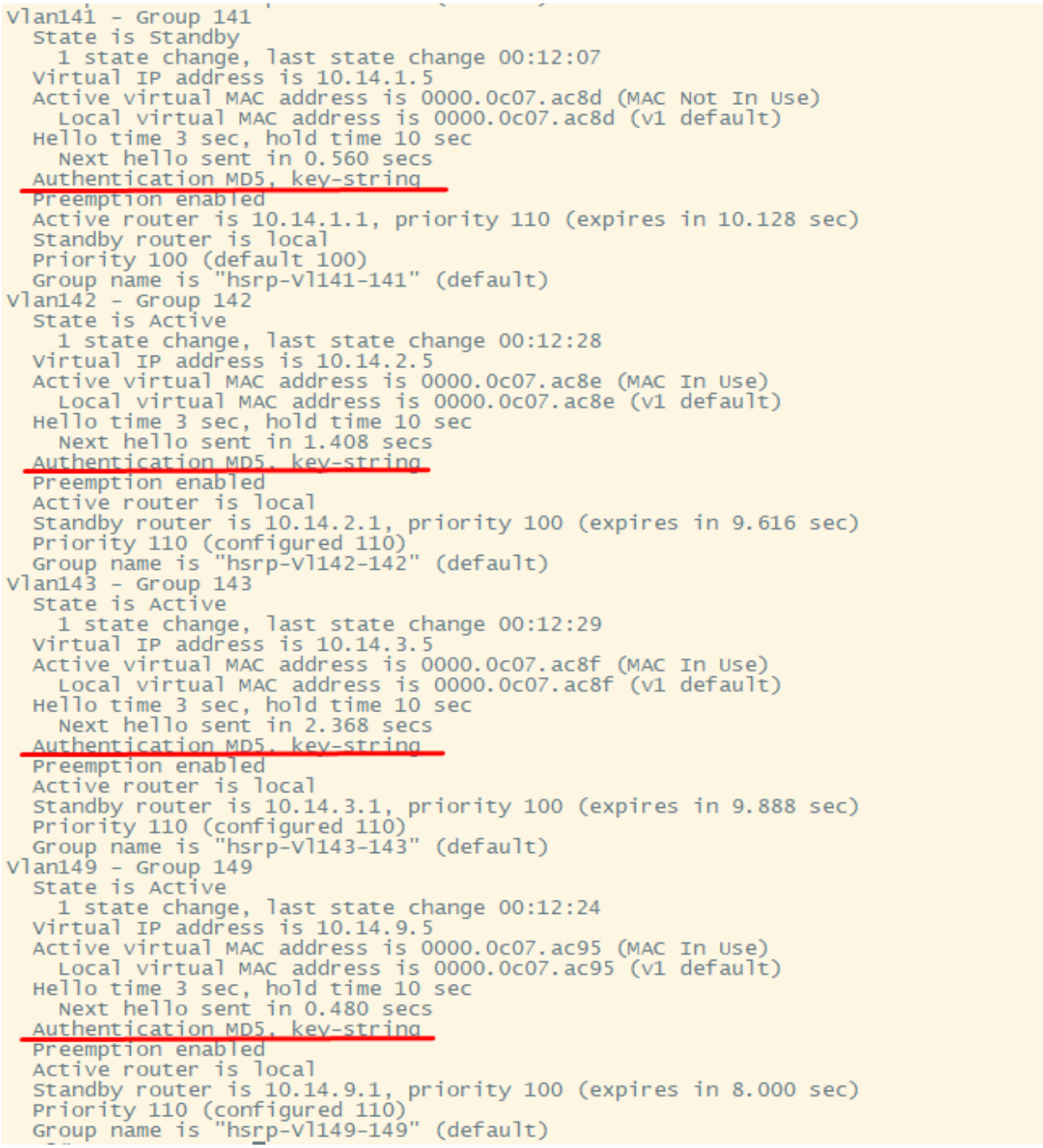
DLS2

- int vlan 140
- standby 140 authentication md5 key-string letmein
- int vlan 141
- standby 141 authentication md5 key-string letmein
- int vlan 142

- standby 142 authentication md5 key-string letmein
- int vlan 143
- standby 143 authentication md5 key-string letmein
- int vlan 149
- standby 149 authentication md5 key-string letmein

Additional Upgrade Discussion

We chose to implement HSRP md5 authentication because by default our packets are in plaintext string. This security feature will encrypt out plaintext string using a MD5 hash. “This functionality provides added security and protects against the threat from HSRP-spoofing software. [1]”



Additional Deliverables:

1. A ping issued from any host in any VLAN will reach the CORE switches(use address 1.1.1.1).

```
C:\Users\Quint Mata>ping 1.1.1.1

Pinging 1.1.1.1 with 32 bytes of data:
Reply from 1.1.1.1: bytes=32 time<1ms TTL=254
Reply from 1.1.1.1: bytes=32 time=1ms TTL=254
Reply from 1.1.1.1: bytes=32 time<1ms TTL=254
Reply from 1.1.1.1: bytes=32 time<1ms TTL=254

Ping statistics for 1.1.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

2. A trace issued from any host in any VLAN will reach the CORE switches(1.1.1.1)using the active HSRP router.

```
C:\Users\Quint Mata>tracert 1.1.1.1

Tracing route to 1.1.1.1 over a maximum of 30 hops

  1     7 ms     3 ms     3 ms  10.14.0.1
  2     5 ms    10 ms     3 ms  1.1.1.1

Trace complete.
```

3. When the active HSRP router fails, the standby router will switchover. Further, when the active HSRP router comes back up, preemption takes place and the original active router regains the active role.

```
DLS1(config-if)#int range g1/0/1-24
*Mar 21 10:47:18.470: %HSRP-5-STATECHANGE: Vlan140 Grp 140 state Listen -> Active
DLS1(config-if-range)#shut
DLS1(config-if-range)#
*Mar 21 10:47:29.118: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.100.0.1 (GigabitEthernet1/0/23) is down: interface down
*Mar 21 10:47:29.120: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.200.0.1 (GigabitEthernet1/0/24) is down: interface down
*Mar 21 10:47:29.999: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to down
*Mar 21 10:47:30.020: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to down
*Mar 21 10:47:30.029: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel5, changed state to down
*Mar 21 10:47:30.999: %LINK-5-CHANGED: Interface GigabitEthernet1/0/1, changed state to administratively down
*Mar 21 10:47:30.999: %LINK-5-CHANGED: Interface GigabitEthernet1/0/2, changed state to administratively down
*Mar 21 10:47:30.999: %LINK-3-UPDOWN: Interface Vlan149, changed state to down
*Mar 21 10:47:31.002: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.9.2 (Vlan149) is down: interface down
*Mar 21 10:47:31.007: %LINK-3-UPDOWN: Interface Port-channel1, changed state to down
*Mar 21 10:47:31.008: %LINK-5-CHANGED: Interface GigabitEthernet1/0/3, changed state to administratively down
*Mar 21 10:47:31.018: %LINK-5-CHANGED: Interface GigabitEthernet1/0/4, changed state to administratively down
*Mar 21 10:47:31.018: %LINK-3-UPDOWN: Interface Port-channel2, changed state to down
*Mar 21 10:47:31.025: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.99.14.2 (Port-channel2) is down: interface down
*Mar 21 10:47:31.028: %LINK-5-CHANGED: Interface GigabitEthernet1/0/7, changed state to administratively down
*Mar 21 10:47:31.028: %LINK-5-CHANGED: Interface GigabitEthernet1/0/8, changed state to administratively down
*Mar 21 10:47:31.029: %LINK-3-UPDOWN: Interface Vlan140, changed state to down
*Mar 21 10:47:31.029: %LINK-3-UPDOWN: Interface Vlan141, changed state to down
*Mar 21 10:47:31.030: %LINK-3-UPDOWN: Interface Vlan142, changed state to down
*Mar 21 10:47:31.031: %LINK-3-UPDOWN: Interface Vlan143, changed state to down
*Mar 21 10:47:31.034: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.0.2 (Vlan140) is down: interface down
*Mar 21 10:47:31.037: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.1.2 (Vlan141) is down: interface down
*Mar 21 10:47:31.054: %LINK-3-UPDOWN: Interface Port-channel5, changed state to down
*Mar 21 10:47:32.000: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to down
*Mar 21 10:47:32.001: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/2, changed state to down
*Mar 21 10:47:32.001: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan149, changed state to down
*Mar 21 10:47:32.001: %HSRP-5-STATECHANGE: Vlan149 Grp 149 state Standby -> Init
*Mar 21 10:47:32.007: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/3, changed state to down
*Mar 21 10:47:32.020: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/4, changed state to down
*Mar 21 10:47:32.029: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/7, changed state to down
*Mar 21 10:47:32.029: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/8, changed state to down
*Mar 21 10:47:32.029: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan140, changed state to down
*Mar 21 10:47:32.030: %HSRP-5-STATECHANGE: Vlan140 Grp 140 state Active -> Init
```

```
DLS1(config-if-range)#no shut
DLS1(config-if-range)#
*Mar 21 10:48:30.009: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/1, changed state to down
*Mar 21 10:48:30.009: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/2, changed state to down
*Mar 21 10:48:30.010: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/3, changed state to down
*Mar 21 10:48:30.010: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/4, changed state to down
*Mar 21 10:48:30.017: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/5, changed state to down
*Mar 21 10:48:30.017: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/6, changed state to down
*Mar 21 10:48:30.017: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/7, changed state to down
*Mar 21 10:48:30.018: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/8, changed state to down
*Mar 21 10:48:30.027: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/9, changed state to down
*Mar 21 10:48:30.028: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/10, changed state to down
*Mar 21 10:48:30.028: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/11, changed state to down
*Mar 21 10:48:30.028: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/12, changed state to down
*Mar 21 10:48:30.028: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/13, changed state to down
*Mar 21 10:48:30.038: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/14, changed state to down
*Mar 21 10:48:30.038: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/15, changed state to down
*Mar 21 10:48:30.038: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/16, changed state to down
*Mar 21 10:48:30.038: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/17, changed state to down
*Mar 21 10:48:30.048: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/18, changed state to down
*Mar 21 10:48:30.048: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/19, changed state to down
*Mar 21 10:48:30.048: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/20, changed state to down
*Mar 21 10:48:30.048: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/21, changed state to down
*Mar 21 10:48:30.049: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/22, changed state to down
*Mar 21 10:48:30.088: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/23, changed state to down
*Mar 21 10:48:30.099: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/24, changed state to down
*Mar 21 10:48:33.938: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/3, changed state to up
*Mar 21 10:48:33.939: %LINK-3-UPDOWN: Interface Port-channel2, changed state to up
*Mar 21 10:48:34.110: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/4, changed state to up
*Mar 21 10:48:34.367: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/18, changed state to up
*Mar 21 10:48:34.937: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/3, changed state to up
*Mar 21 10:48:34.937: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel2, changed state to up
*Mar 21 10:48:35.108: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/4, changed state to up
*Mar 21 10:48:35.120: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/23, changed state to up
*Mar 21 10:48:35.278: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/24, changed state to up
*Mar 21 10:48:35.369: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/18, changed state to up
*Mar 21 10:48:36.120: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/23, changed state to up
*Mar 21 10:48:36.278: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/24, changed state to up
*Mar 21 10:48:36.689: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.99.14.2 (Port-channel2) is up: new adjacency
*Mar 21 10:48:36.948: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/1, changed state to up
*Mar 21 10:48:37.259: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/2, changed state to up
*Mar 21 10:48:37.417: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/7, changed state to up
*Mar 21 10:48:37.608: %LINK-3-UPDOWN: Interface GigabitEthernet1/0/8, changed state to up
*Mar 21 10:48:38.811: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/7, changed state to up
*Mar 21 10:48:39.811: %LINK-3-UPDOWN: Interface Port-channel5, changed state to up
*Mar 21 10:48:39.829: %LINK-3-UPDOWN: Interface Vlan142, changed state to up
*Mar 21 10:48:39.829: %LINK-3-UPDOWN: Interface Vlan143, changed state to up
*Mar 21 10:48:39.830: %LINK-3-UPDOWN: Interface Vlan149, changed state to up
*Mar 21 10:48:40.161: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.9.2 (Vlan149) is up: new adjacency
*Mar 21 10:48:40.319: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/1, changed state to up
*Mar 21 10:48:40.590: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/8, changed state to up
*Mar 21 10:48:40.837: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel5, changed state to up
*Mar 21 10:48:40.837: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan142, changed state to up
*Mar 21 10:48:40.837: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan143, changed state to up
*Mar 21 10:48:40.838: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan149, changed state to up
*Mar 21 10:48:40.838: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet1/0/2, changed state to up
*Mar 21 10:48:41.309: %LINK-3-UPDOWN: Interface Port-channel1, changed state to up
*Mar 21 10:48:41.339: %LINK-3-UPDOWN: Interface Vlan140, changed state to up
*Mar 21 10:48:41.340: %LINK-3-UPDOWN: Interface Vlan141, changed state to up
*Mar 21 10:48:41.351: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.2.2 (Vlan142) is up: new adjacency
*Mar 21 10:48:41.669: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.3.2 (Vlan143) is up: new adjacency
*Mar 21 10:48:42.310: %LINEPROTO-5-UPDOWN: Line protocol on Interface Port-channel1, changed state to up
*Mar 21 10:48:42.338: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan140, changed state to up
*Mar 21 10:48:42.339: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan141, changed state to up
*Mar 21 10:48:42.370: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.0.2 (Vlan140) is up: new adjacency
*Mar 21 10:48:44.289: %HSRP-5-STATECHANGE: Vlan140 Grp 140 state Listen -> Active
*Mar 21 10:48:44.772: %HSRP-5-STATECHANGE: Vlan141 Grp 141 state Listen -> Active
*Mar 21 10:48:46.018: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.14.1.2 (Vlan141) is up: new adjacency
*Mar 21 10:49:02.808: %HSRP-5-STATECHANGE: Vlan149 Grp 149 state Speak -> Standby
*Mar 21 10:49:02.948: %HSRP-5-STATECHANGE: Vlan143 Grp 143 state Speak -> Standby
*Mar 21 10:49:03.105: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.100.0.1 (GigabitEthernet1/0/23) is up: new adjacency
*Mar 21 10:49:03.549: %HSRP-5-STATECHANGE: Vlan142 Grp 142 state Speak -> Standby
*Mar 21 10:49:05.269: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 10.200.0.1 (GigabitEthernet1/0/24) is up: new adjacency
```

4. Port security violations will act as anticipated. i.e. The ports will shut down or transition to restrict when a violation occurs as described above.

```
ALS1#show int g1/0/5 status

Port      Name               Status       Vlan       Duplex  Speed Type
Gi1/0/5                      err-disabled 140          auto   auto 10/100/1000BaseTX
ALS1#
```

NETWORK DESIGN REPORT

Vlan and subnet information

VLANS			VLANS			VLANS		
Building 1			Building 2			Building 3		
ALS1			ALS4			ALS6		
NAME	VLAN	SUBNET	NAME	VLAN	SUBNET	NAME	VLAN	SUBNET
DATA1	10	10.14.0.0/24	DATA4	13	10.15.0.0/24	DATA7	16	10.16.0.0/24
VOICE1	20	10.14.1.0/24	DATA5	14	10.15.1.0/24	DATA8	17	10.16.1.0/24
MGMT	99	10.14.9.0/24	DATA6	15	10.15.2.0/24	VOICE7	26	10.16.2.0/24
			MGMT	49	10.15.9.0/24	MGMT	99	10.16.9.0/24
ALS2			ALS5			ALS7		
NAME	VLAN	SUBNET	NAME	VLAN	SUBNET	NAME	VLAN	SUBNET
DATA2	11	10.14.2.0/24	VOICE4	23	10.15.3.0/24	DATA9	18	10.16.3.0/24
VOICE2	21	10.14.3.0/24	VOICE5	24	10.15.4.0/24	VOICE8	27	10.16.4.0/24
MGMT	99	10.14.9.0/24	VOICE6	25	10.15.5.0/24	MGMT	99	10.16.9.0/24
			MGMT	49	10.15.9.0/24			
ALS3						ALS8		
NAME	VLAN	SUBNET				NAME	VLAN	SUBNET
DATA3	12	10.14.4.0/24				VOICE9	28	10.16.5.0/24
VOICE3	22	10.14.5.0/24				MGMT	99	10.16.9.0/24
MGMT	99	10.14.9.0/24						

DLS1-to-DLS2 subnet:	10.99.14.0/24	DLS3-to-DLS4 subnet:	10.89.14.0/24	DLS5-to-DLS6 subnet:	10.79.14.0/24
DLS1-to-Core1 subnet:	10.100.14.0/16	DLS3-to-Core1 subnet:	10.101.14.0/16	DLS5-to-Core1 subnet:	10.102.14.0/16
DLS1-to-Core2 subnet:	10.200.14.0/16	DLS3-to-Core2 subnet:	10.201.14.0/16	DLS5-to-Core2 subnet:	10.202.14.0/16
DLS2-to-Core1 subnet:	10.100.14.0/16	DLS4-to-Core1 subnet:	10.101.14.0/16	DLS6-to-Core1 subnet:	10.102.14.0/16
DLS2-to-Core2 subnet:	10.200.14.0/16	DLS4-to-Core2 subnet:	10.201.14.0/16	DLS6-to-Core2 subnet:	10.202.14.0/16
Core1-to-Core2 subnet:	10.29.14.0/24	DCD1-to-Core3 subnet:	10.103.14.0/16	IED1-to-Core2 subnet:	10.104.14.0/16
Core1-to-Core3 subnet:	10.39.14.0/24	DCD1-to-Core4 subnet:	10.203.14.0/16	IED1-to-Core4 subnet:	10.204.14.0/16
Core2-to-Core4 subnet:	10.49.14.0/24	DCD2-to-Core3 subnet:	10.103.14.0/16	IED2-to-Core2 subnet:	10.104.14.0/16
Core3-to-Core4 subnet:	10.59.14.0/24	DCD2-to-Core4 subnet:	10.203.14.0/16	IED2-to-Core4 subnet:	10.204.14.0/16

Layer 3 Routing Protocols

i. **Which ones would you implement and where**

ii. **Any special design notes regarding the implementation of the routing protocols**

Based on our network design, we would implement EIGRP or OSPF as our Layer 3 Routing Protocols. To enhance the network, we would place these protocols in the core to distribution layers as well as the core to core layer. These protocols are used with other features such as summarization at these layers for fast convergence and optimal routing and rerouting of traffic.

To ensure optimal use of these routing protocols, it's important to follow a few special design notes. One special design note is the use of Triangle Topologies when building the topology to complement the use of these protocols. This special design can enhance performance if "equal-cost paths are configured to all redundant nodes to avoid the need for timer-base, non-deterministic convergence [2]" according to Campus Network for High Availability Design Guide. One other special design which would enhance the network would be to configure summarization of routing information as it travels from the distribution to the core layer. This design reduces the amount of interaction needed by the protocols to converge and restore connectivity.

Layer 2 Redundancy.

i. **What type(s) of spanning tree would you use? Where? Why? Where would you put the root bridges?**
ii. **What STP enhancements would you implement? Where? Why?**

We would implement multiple spanning tree because this protocol will allow for multiple VLANs to be mapped to a single instance as well as load balancing and scalability. A campus enterprise will have thousands of the users connected, clustered traffic that we can control through multiple links providing efficient packet flow.

We are going to implement multiple spanning tree on all layer 2 switches. Unlike layer 3, layer 2 does not have a time to live. Without a time to live, redundant links can cause loops. In addition, broadcast storms can occur causing a slow and congested network.

The root bridge is elected by bridge ID, if all bridge ID's are the same, we elect the root bridge by MAC address. In our enterprise, we ordered out switches from the lowest Mac address to greatest Mac address. In building one, ALS1 is elected as the root bridge. In building two, ALS3 is elected as the root bridge. In building three, ALS6 is elected as the root bridge.

UplinkFast – we would enable UplinkFast on every root port in the access layer: ALS1's exit interface, ALS3's exit interface and ALS6's exit interface. Enabling it on these interfaces are important because if the root port fails, UplinkFast will immediately recalculate and assign the blocking link to a forwarding state.

Loop Guard - we decided to implement the STP enhancement, loop guard. Loop guard would be enabled on every non designated port in the Access Layer. We think this feature is important to our campus design due to the fact that this feature prevents loops. Loop Guard, prevents a blocking state transitioning into a forwarding state when BPDUs are being received on a port.

FHRP
Which one(s) would you implement? Where? Why?
Where would the active switch(es) be in the topology? Why?

We intend to implement HSRP because it provides the network with uninterrupted service and allows for default gateway redundancy. Redundancy and traffic flow is important to a campus network considering when students have to upload assignments, write online tests and download work. Configuring HSRP on the distribution switches would be the most appropriate since HSRP routers need to be layer 2 adjacent. In addition, we could implement MHSRP to provide load sharing to the core network which will enhance performance speeds and avoid congested links.

Theses active switches would be placed in the distribution layers connecting to the access layers in the topology. These switches would be placed in this layer as these act as the default gateway for the hosts in the access layer by sharing a virtual IP address. In addition, these switches can provide load sharing to the core by configuring MHSRP as well as provide redundancy by ensuring there is a "backup default gateway" in the event of link failure.

Link Aggregation and Oversubscription

i. **Describe the oversubscription ratios present in your network (based on the link bandwidths). Acceptable ratio 20:1 to calculate osub, 24 ports in switch, Present this as a ratio reduced as much as possible 6:1a (e.g. 8:1 rather than 16:2). Explain why this oversubscription exists in your network design and whether it will be problematic for your users.**

ii. **Where would you implement link aggregation (Etherchannel) to help reduce oversubscription? How many links would you need to include in each bundle to meet your target ratio, and what would be the total bandwidth?**

We analyzed and determined the oversubscription ratios present in our network and adjusted connections which led to acceptable oversubscription rates. Note that all links are 1 GBPS throughout our network except for the Data Center Links which are 10GBPS.

Building 1 Distribution Layer to Core Layer- For one device in this layer, there are 6 downlinks and 2 uplinks. This presents the ratio of 6:2 which reduces to 3:1. Since there are two devices, oversubscription doubles to 6:1.

Building 2 Distribution Layer to Core Layer- For one device in this layer, there are 4 downlinks and 2 uplinks. This presents the ratio of 4:2 which reduces to 2:1. Since there are two devices, oversubscription doubles to 4:1.

Building 3 Distribution Layer to Core Layer- For one device in this layer, there are 6 downlinks and 2 uplinks. This presents the ratio of 6:2 which reduces to 3:1. Since there are two devices, oversubscription doubles to 6:1.

Building 1 Access Layer to Distribution Layer- For one device in this layer, there are 20 downlinks and 4 uplinks. This presents a ratio of 5:1. Since there are three devices, oversubscription triples to 15:1.

Building 2 Access Layer to Distribution Layer- For one device in this layer, there are 20 downlinks and 4 uplinks. This presents a ratio of 5:1. Since there are two devices, oversubscription doubles to 10:1.

Building 3 Access Layer to Distribution Layer- For one device in this layer, there are 20 downlinks and 4 uplinks. This presents a ratio of 5:1. Since there are three devices, oversubscription triples to 15:1.

Explain why this oversubscription exists in your network design and whether it will be problematic for your users.

Oversubscription exists due to the hierarchical design of our network. Oversubscription is defined as “the result of the aggregating the connectivity from the access layer switches to the distribution layer, or from the distribution layer to the core. [3]” In addition, there are multiple points where the amount of bandwidth entering

a layer is greater than the amount leaving. Since this situation is clear from our network, it is evident that only a fraction of the number of ports can run at full rates at the same time but not all at once without being oversubscribed. There's a very slim chance of oversubscription affecting our users by causing network congestion. This problem will only ever occur if there's a bottleneck and all users maximize the potential bandwidth on their dedicated link at the same time.

It would be feasible to implement link aggregation between the access layer and distribution layer in order to help reduce oversubscription. In order to meet our goal to achieve acceptable oversubscription ratios, we would need to include two links in each bundle. For building 1 and 3 we would need to have a total of 2 etherchannels each. Total bandwidth would be equal to 8 GBPS for building 1 and 3.

Security

i. **What Layer 2 security measures would you implement? Where? Why?**

IP Source Guard - In the event we use DHCP servers we would enable IP source guard on all layer 2 access switches. We think this is an important necessity to implement in our campus enterprise because this security measure prevents attackers from identifying themselves as their victim. In addition, IP source guard will help prevent man in the middle attacks and any attempt for a denial of service attack. IP source guard blocks all IP traffic except for the DHCP packets, if the destination hosts find the DHCP packet to be valid, this will be added to the access list, otherwise, the packet will be dropped.

Preventing VLAN hopping Attacks - A series of basic security measures can be configured to improve our Layer 2 security. To prevent attacks such as VLAN hopping, it is important we tag all frames on the trunk ports and native VLAN trunks, configure native VLANs to an unused VLAN and lastly, prevent traffic from going out of the native VLAN.

CONCLUSION

As a group, we think that this case study has tested our 2nd year switching knowledge to the fullest. We have learned how to implement many new protocols such an STP, FHRP, and advanced features to help improve on network security as well as how to combine these operations to enhance network design and performance. We observed that it is important we design a network with the best practices which account for high availability. Overall, it is very important that each layer is configured to the fullest capacity, many new features and protocols implemented to achieve to optimal performance, scalability and stability in the hierarchical design. Completing this case study gives us the confidence and capability of applying these techniques studied to prepare for real-world careers and apply this knowledge for the remaining of the course.

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