MPLS

CCNP Lab 10

2018-2019

Nipun Chhajed

Cisco CCNP - Hoffman and Mason - Periods 6 and 7

MPLS Lab 10

Purpose

The main reason for accomplishing this lab was to learn how to configure Multiprotocol Label Switching (MPLS). It was also to demonstrate an understanding of how to capture and interpret packets using WireShark, specifically LDP packets, in this lab.

Background Information

Multiprotocol Label Switching, or MPLS, is a routing strategy that allows for networks to direct data from one device to another based on path labels, instead of network addresses, as path labels are much shorter. This allows for easy lookup in routing tables, and speeds up the flow of traffic. The reason for it being called “multiprotocol” is because MPLS combines the abilities of Layer 2 switching with the Layer 3 routing functions. Due to this combination, MPLS is called “layer 2.5 protocol”. In MPLS, certain routers have special terms that they go by. The first type of router is a Label Switch Router or LSR. This type of router does routing based on labels only. It is usually located in the middle of an MPLS based network and it is the router that performs switching of the labels to route packets. When it receives a packet, it uses the packet’s label to look up, in the table, where the packet is supposed to go next, which is called “the next hop” on the label-switched path (LSP). It also finds the new label, that the packet is supposed to contain, and before forwarding the packet, it replaces the current label with the new label, and then sends it off to its next destination. The other type of node router in an MPLS network is Label Edge Router also known as LER. These types of routers

reside on the edge of the network and are usually the “entries and exits” into the network. When a packet is entering an MPLS network, the LER uses the routing table and other information to figure out which label should be attached to the packet. It labels the packet, and then allows the packet to move forward into the network. If the packet is exiting the MPLS domain, then the LER removes the label and moves the packet into the rest of the network. For the MPLS backbone, many protocols can be used, however Label Distribution Protocol also known as LDP, is what we used in this lab. The protocol allows for routers that are configured with MPLS to share label mapping information. Routers, once connected by LDP, are called peers, and can share information back and forth. LDP builds and updates LSP databases for traffic forwarding through MPLS based networks. To find packets on WireShark, one must use Border Gateway Protocol or BGP. BGP does routing by looking at paths, network policies, or rules configured in a network. BGP allows for loop free routes, and it shares all the info among the routers in the same autonomous system.

Lab Summary

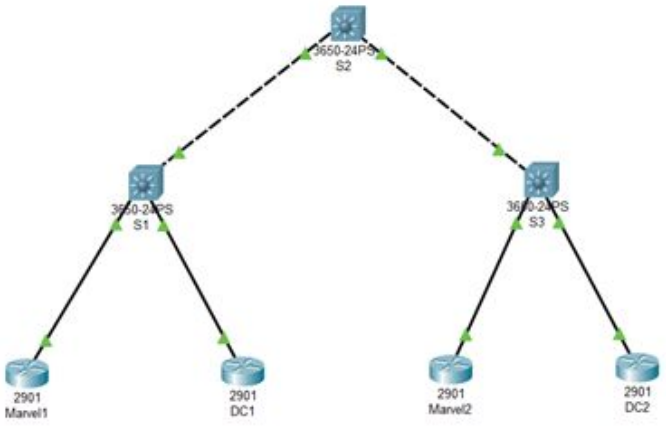
We set up a simple topology to learn about MPLS and configure it. We used OSPF as the adjacency protocol for each node in the network. On the switches specifically we used BGP, as it is crucial for MPLS operations. Finally, we showed successful completion by capturing the BGP packets containing MPLS labels and showing our MPLS labels on the devices.,

Lab Commands

interface [interface-id]	Navigates to the configuration of the specified interface on routers and switches

ip address [ip address] [subnet mask]	Sets the ip address for the specified interface
router ospf [process-id]	Enables the OSPF process for IPv4
network [network address] [wildcard mask] [area-id]	Adds the network specified to the OSPF table for routing
ip cef distributed	Enables the Cisco Express Forwarding process
mpls label protocol ldp	Changes the mpls backbone protocol to ldp
mpls ip	Enables MPLS on the interface
router bgp [AS number]	Enables the BGP process on the router
neighbor [loopback ip address] update-source [loopback interface id]	Sets the loopback as the update source for all MPLS operations
neighbor [loopback ip address] remote-as [AS number]	Connects mpls to the autonomous system

Network Diagram



Device/interface	IP Address
S1	
G1/1/2	192.168.1.2/24
F1/0/1	192.168.3.1/24
F1/0/2	192.168.4.1/24
Lo0	2.2.2.2/32
S2	
G1/1/1	192.168.1.1/24
G1/1/2	192.168.2.1/24
Lo0	1.1.1.1/32
S3	
G1/1/1	192.168.2.2/24
F1/0/1	192.168.5.1/24
F1/0/2	192.168.6.1/24
Lo0	4.4.4.4/32
Marvel1	
G0/1	192.168.3.2/24
Lo0	3.3.3.3/32
DC1	
G0/1	192.168.4.2/24
Lo0	5.5.5.5/32
Marvel2	
G0/1	192.168.5.2/24
Lo0	6.6.6.6/32
DC2	
G0/1	192.168.6.2/24
Lo0	7.7.7.7/32

Configurations

Switch 1 Configuration:

```
S1# show run
hostname S1
boot-start-marker
boot-end-marker
no aaa new-model
system mtu routing 1500
ip routing
vtp domain CCNP
vtp mode transparent
crypto pki trustpoint TP-self-signed-2132837760
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-2132837760
 revocation-check none
 rsakeypair TP-self-signed-2132837760
crypto pki certificate chain TP-self-signed-2132837760
spanning-tree mode pvst
spanning-tree extend system-id
vlan internal allocation policy ascending
vlan 2
 name Data
vlan 10
 name voice
vlan 20
 name data
vlan 100
vlan 996
 name CUSTOMER_NATIVE
interface Loopback0
 ip address 2.2.2.2 255.255.255.255
interface FastEthernet1/0/1
 no switchport
 ip address 192.168.3.1 255.255.255.0
interface FastEthernet1/0/2
 no switchport
```

```
 ip address 192.168.4.1 255.255.255.0
interface FastEthernet1/0/3
interface FastEthernet1/0/4
interface FastEthernet1/0/5
interface FastEthernet1/0/6
interface FastEthernet1/0/7
interface FastEthernet1/0/8
interface FastEthernet1/0/9
interface FastEthernet1/0/10
interface FastEthernet1/0/11
interface FastEthernet1/0/12
interface FastEthernet1/0/13
interface FastEthernet1/0/14
interface FastEthernet1/0/15
interface FastEthernet1/0/16
interface FastEthernet1/0/17
interface FastEthernet1/0/18
interface FastEthernet1/0/19
interface FastEthernet1/0/20
interface FastEthernet1/0/21
interface FastEthernet1/0/22
interface FastEthernet1/0/23
interface FastEthernet1/0/24
interface GigabitEthernet1/0/1
interface GigabitEthernet1/0/2
interface GigabitEthernet1/1/1
interface GigabitEthernet1/1/2
 no switchport
 ip address 192.168.1.2 255.255.255.0
 speed auto 1000
 mpls ip
interface Vlan1
 no ip address
 shutdown
router ospf 1
 network 2.2.2.2 0.0.0.0 area 0
 network 192.168.1.0 0.0.0.255 area 0
router bgp 14
 bgp log-neighbor-changes
```

```
 network 192.168.3.0
 network 192.168.4.0
 redistribute static
 neighbor 4.4.4.4 remote-as 14
 neighbor 4.4.4.4 update-source Loopback0
 no auto-summary
ip http server
ip http secure-server
ip route 3.3.3.3 255.255.255.255 192.168.3.2
ip route 5.5.5.5 255.255.255.255 192.168.4.2
logging esm config
mpls ldp router-id Loopback0 force
line con 0
line vty 0 4
 login
line vty 5 15
 login
monitor session 1 source interface Gi1/1/2
monitor session 1 destination interface Fa1/0/10
end
```

Switch 2 Configuration:

S2# show run

```
hostname S2
boot-start-marker
boot-end-marker
no aaa new-model
system mtu routing 1500
ip routing
ip cef load-sharing algorithm original
vtp mode transparent
mpls ldp session protection
crypto pki trustpoint TP-self-signed-1928519808
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-1928519808
 revocation-check none
 rsakeypair TP-self-signed-1928519808
crypto pki certificate chain TP-self-signed-1928519808
```

```
 spanning-tree mode pvst
spanning-tree extend system-id
vlan internal allocation policy ascending
vlan 996
 name CUSTOMER_NATIVE
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
interface FastEthernet1/0/1
interface FastEthernet1/0/2
interface FastEthernet1/0/3
interface FastEthernet1/0/4
interface FastEthernet1/0/5
interface FastEthernet1/0/6
interface FastEthernet1/0/7
interface FastEthernet1/0/8
interface FastEthernet1/0/9
interface FastEthernet1/0/10
interface FastEthernet1/0/11
interface FastEthernet1/0/12
interface FastEthernet1/0/13
interface FastEthernet1/0/14
interface FastEthernet1/0/15
interface FastEthernet1/0/16
interface FastEthernet1/0/17
interface FastEthernet1/0/18
interface FastEthernet1/0/19
interface FastEthernet1/0/20
interface FastEthernet1/0/21
interface FastEthernet1/0/22
interface FastEthernet1/0/23
interface FastEthernet1/0/24
interface GigabitEthernet1/0/1
interface GigabitEthernet1/0/2
interface GigabitEthernet1/1/1
 no switchport
 ip address 192.168.2.1 255.255.255.0
 speed auto 1000
 mpls label protocol ldp
 mpls ip
```

```
interface GigabitEthernet1/1/2
 no switchport
 ip address 192.168.1.1 255.255.255.0
 speed auto 1000
 mpls ip
interface Vlan1
 no ip address
 shutdown
router ospf 1
 network 1.1.1.1 0.0.0.0 area 0
 network 192.168.1.0 0.0.0.255 area 0
 network 192.168.2.0 0.0.0.255 area 0
ip http server
ip http secure-server
logging esm config
line con 0
line vty 0 4
 login
line vty 5 15
 login
monitor session 1 source interface Gi1/1/2
monitor session 1 destination interface Fa1/0/6
monitor session 2 source interface Gi1/1/1
monitor session 2 destination interface Fa1/0/14
end
```

Switch 3 Configuration:

S3# show run

```
hostname S3
boot-start-marker
boot-end-marker
no aaa new-model
system mtu routing 1500
ip routing
mpls ldp session protection
crypto pki trustpoint TP-self-signed-3180753792
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-3180753792
```

```
 revocation-check none
 rsakeypair TP-self-signed-3180753792
crypto pki certificate chain TP-self-signed-3180753792
spanning-tree mode pvst
spanning-tree extend system-id
vlan internal allocation policy ascending
interface Loopback0
 ip address 4.4.4.4 255.255.255.255
interface FastEthernet1/0/1
 no switchport
 ip address 192.168.5.1 255.255.255.0
interface FastEthernet1/0/2
 no switchport
 ip address 192.168.6.1 255.255.255.0
interface FastEthernet1/0/3
interface FastEthernet1/0/4
interface FastEthernet1/0/5
interface FastEthernet1/0/6
interface FastEthernet1/0/7
interface FastEthernet1/0/8
interface FastEthernet1/0/9
interface FastEthernet1/0/10
interface FastEthernet1/0/11
interface FastEthernet1/0/12
interface FastEthernet1/0/13
interface FastEthernet1/0/14
interface FastEthernet1/0/15
interface FastEthernet1/0/16
interface FastEthernet1/0/17
interface FastEthernet1/0/18
interface FastEthernet1/0/19
interface FastEthernet1/0/20
interface FastEthernet1/0/21
interface FastEthernet1/0/22
interface FastEthernet1/0/23
interface FastEthernet1/0/24
interface GigabitEthernet1/0/1
interface GigabitEthernet1/0/2
interface GigabitEthernet1/1/1
```

```
 no switchport
 ip address 192.168.2.2 255.255.255.0
 speed auto 1000
 mpls label protocol ldp
 mpls ip
interface GigabitEthernet1/1/2
interface Vlan1
 no ip address
 shutdown
router ospf 1
 network 4.4.4.4 0.0.0.0 area 0
 network 192.168.2.0 0.0.0.255 area 0
 network 192.168.5.0 0.0.0.255 area 0
 network 192.168.6.0 0.0.0.255 area 0
router bgp 14
 bgp log-neighbor-changes
 network 192.168.5.0
 network 192.168.6.0
 redistribute static
 neighbor 2.2.2.2 remote-as 14
 neighbor 2.2.2.2 update-source Loopback0
 no auto-summary
ip http server
ip http secure-server
ip route 6.6.6.6 255.255.255.255 192.168.5.2
ip route 7.7.7.7 255.255.255.255 192.168.6.2
logging esm config
line con 0
line vty 0 4
 login
line vty 5 15
 login
end
```

Marvel 1 Router Configuration:

Marvel1# show run

```
hostname Marvel1
boot-start-marker
```

```
boot-end-marker
no aaa new-model
memory-size iomem 25
ip cef
no ipv6 cef
multilink bundle-name authenticated
voice-card 0
license udi pid CISCO2901/K9 sn FTX180180M8
license accept end user agreement
license boot module c2900 technology-package securityk9
license boot module c2900 technology-package uck9
vtp domain CCNP
vtp mode transparent
redundancy
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
interface GigabitEthernet0/1
 ip address 192.168.3.2 255.255.255.0
 duplex auto
 speed auto
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
interface Serial0/0/1
 no ip address
 shutdown
 clock rate 2000000
ip forward-protocol nd
no ip http server
no ip http secure-server
```

```
ip route 0.0.0.0 0.0.0.0 192.168.3.1
control-plane
mgcp profile default
gatekeeper
 shutdown
line con 0
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 login
 transport input all
scheduler allocate 20000 1000
end
```

DC 1 Router Configuration:

DC1# show run

```
hostname DC1
boot-start-marker
boot-end-marker
no aaa new-model
memory-size iomem 10
ip cef
no ipv6 cef
multilink bundle-name authenticated
voice-card 0
license udi pid CISCO2901/K9 sn FTX180180M5
license accept end user agreement
license boot module c2900 technology-package securityk9
license boot module c2900 technology-package uck9
vtp domain cisco
vtp mode transparent
redundancy
interface Loopback0
```

```
 ip address 5.5.5.5 255.255.255.0
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
interface GigabitEthernet0/1
 ip address 192.168.4.2 255.255.255.0
 duplex auto
 speed auto
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
interface Serial0/0/1
 no ip address
 shutdown
 clock rate 2000000
interface GigabitEthernet0/1/0
 no ip address
 shutdown
 duplex auto
 speed auto
ip forward-protocol nd
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 192.168.4.1
control-plane
mgcp profile default
gatekeeper
 shutdown
line con 0
line aux 0
line 2
 no activation-character
 no exec
```

```
 transport preferred none
 transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 login
 transport input all
scheduler allocate 20000 1000
end
```

Marvel 2 Router Configuration:

Marvel2# show run

```
hostname Marvel2
boot-start-marker
boot-end-marker
no aaa new-model
memory-size iomem 10
ip cef
no ipv6 cef
multilink bundle-name authenticated
voice-card 0
license udi pid CISCO2901/K9 sn FTX15208074
license accept end user agreement
license boot module c2900 technology-package securityk9
license boot module c2900 technology-package uck9
vtp domain cisco
vtp mode transparent
redundancy
interface Loopback0
 ip address 6.6.6.6 255.255.255.255
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
interface GigabitEthernet0/1
```

```
 ip address 192.168.5.2 255.255.255.0
 duplex auto
 speed auto
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
interface Serial0/0/1
 no ip address
 shutdown
 clock rate 2000000
interface GigabitEthernet0/1/0
 no ip address
 shutdown
 duplex auto
 speed auto
ip forward-protocol nd
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 192.168.5.1
control-plane
mgcp profile default
gatekeeper
 shutdown
line con 0
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 login
 transport input all
scheduler allocate 20000 1000
end
```

DC 2 Router Configuration:

DC2# show run

```
hostname DC2
boot-start-marker
boot-end-marker
no aaa new-model
memory-size iomem 10
ip cef
no ipv6 cef
multilink bundle-name authenticated
voice-card 0
license udi pid CISCO2901/K9 sn FTX1520806E
license accept end user agreement
license boot module c2900 technology-package securityk9
license boot module c2900 technology-package uck9
vtp domain cisco
vtp mode transparent
redundancy
interface Loopback0
 ip address 7.7.7.7 255.255.255.255
interface Embedded-Service-Engine0/0
 no ip address
 shutdown
interface GigabitEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
interface GigabitEthernet0/1
 ip address 192.168.6.2 255.255.255.0
 duplex auto
 speed auto
interface Serial0/0/0
 no ip address
 shutdown
 clock rate 2000000
interface Serial0/0/1
 no ip address
```

```
 shutdown
 clock rate 2000000
interface GigabitEthernet0/1/0
 no ip address
 shutdown
 duplex auto
 speed auto
ip forward-protocol nd
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 192.168.6.1
control-plane
mgcp profile default
gatekeeper
 shutdown
line con 0
line aux 0
line 2
 no activation-character
 no exec
 transport preferred none
 transport output lat pad telnet rlogin lapb-ta mop udptn v120 ssh
 stopbits 1
line vty 0 4
 login
 transport input all
scheduler allocate 20000 1000
end
```

Configuration Steps

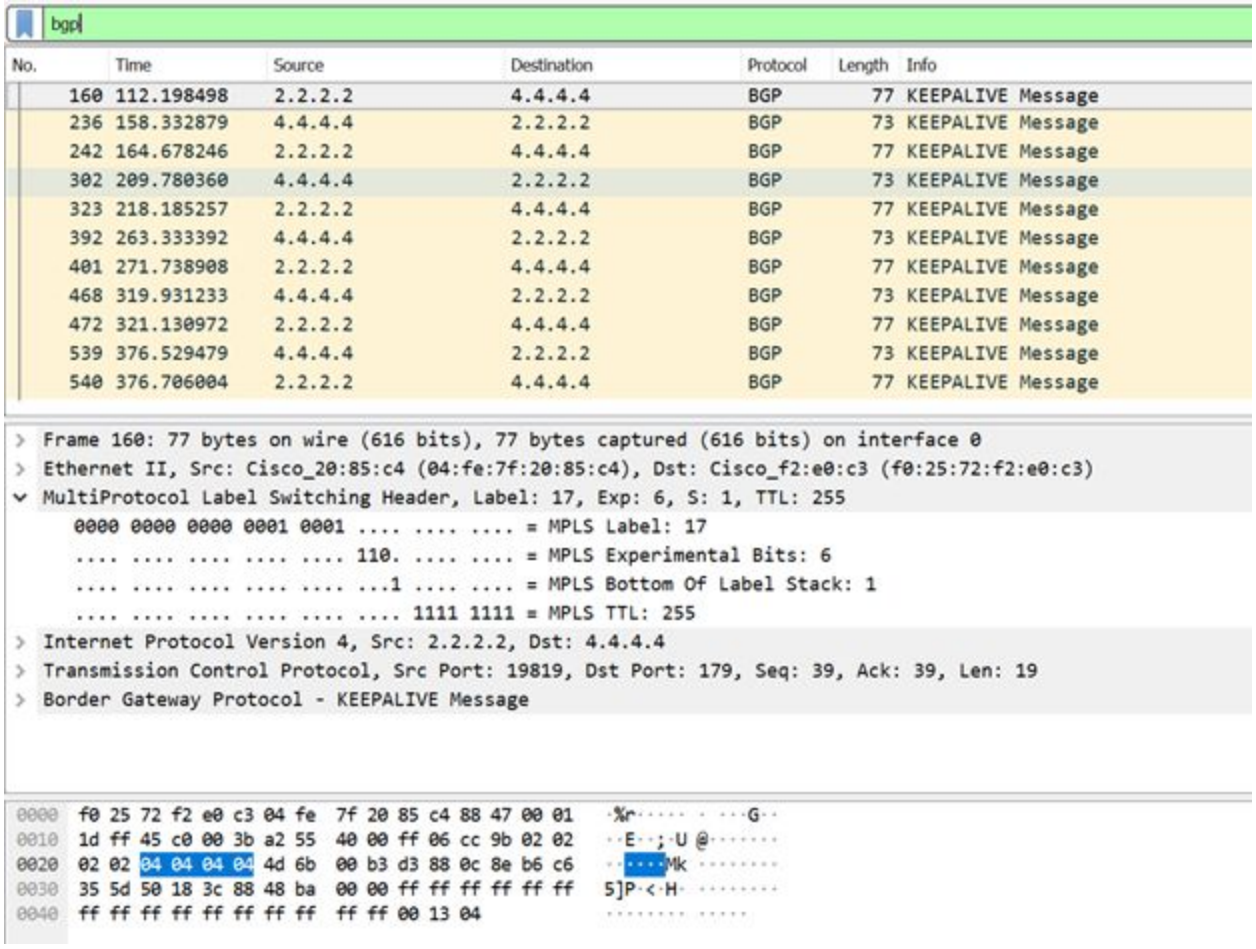
1. Set up all the routers and switches as shown in the topology, and set their interfaces' ip addresses as shown on the topology. Use this command to navigate to the interface: **interface [interface-id]**. Then use the **ip address [ip address]** command to set the ip address of the

interface. For switches specifically, you might have to use the **no switchport** command on the interfaces, to set up their ip addresses.

2. After the initial setup, it's time to configure OSPF on the routers. OSPF can just be configured using single area OSPF. Start the OSPF processes using the command: **router ospf [process-id]**. The process id should be the same for all the routers. Then, advertise all the directly connected networks into the OSPF of the routers using the **network [network ip address] [wildcard mask] area [area number]** command.
3. To start configuring MPLS, first use the **ip cef distributed** command to enable the Cisco Express Forwarding service on the switches, this is vital to MPLS.
4. Then, we have to set up MPLS to have a LDP backbone. The default backbone protocol is TDP, which we don't want. So using the command **mpls label protocol ldp** we change the MPLS backbone protocol.
5. This step is optional, but we can configure the LDP router ID. This will make it easier to troubleshoot any problems that arise, as it will allow us to differentiate which routers are still running TDP instead of LDP. The command used to achieve this is: **mpls ldp router-id Loopback0 force**.
6. After these last two steps, we can enable MPLS on the interface(s) on which we would like for it to run using the command: **mpls ip**.
7. Now that MPLS set up is done, we just have to configure BGP. This can be enabled by typing the command: **router bgp [AS number]**.
8. Now we have to advertise the networks to the LERs using the **network [network address]** command.
9. Finally, on the LERs, we must use a loopback interface as the update source for all of MPLS, and connect it to the autonomous system. This can be done with the following two commands: **neighbor [loopback ip**

address] update-source [loopback interface id] and **neighbor [loopback ip address] remote-as [AS number]**.

Results



In the end, we were able to successfully capture packets containing the MPLS label, which was our end goal. This is very hard to capture on wireshark, and it took us a long time to figure out how to capture it.

Problems

This lab was extremely picky in carrying out. Due to that fact, we encountered multitudes of problems. The first one was how to show MPLS labels on the router configurations, which after a bit of research, we figured out that the

command was **show mpls forwarding-table**. Before we did the research to find that BGP needed to be configured for wireshark to capture the correct data we were looking for, we tried to just look for the MPLS label without configuring BGP which didn't produce the expected result. However, after understanding the crucial role that BGP plays, we configured it, and were easily able to find the MPLS label.

Conclusion

In conclusion, we successfully completed this pretty tough MPLS lab. We learned about how MPLS works and how to configure it, as well as expanded upon our previous knowledge of OSPF and BGP set up. MPLS is growing in popularity as a networking strategy, and many ISPs are shifting towards using it.