

MPLS L1

991451344

Professor: Felix Carapaica

Timothy Pang

Introduction

In this lab, we are learning the functioning mechanics of an MPLS core, how it works. We learn how to set up the topology and configure in GNS3.

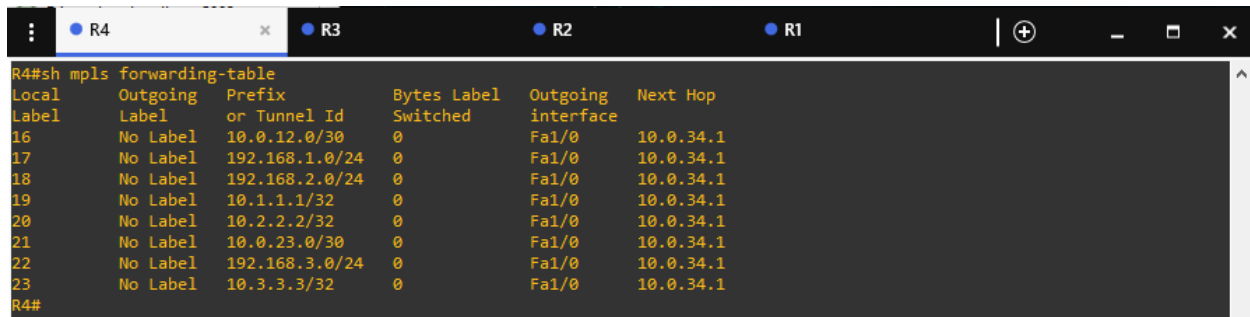
Objectives

- Discover how MPLS labels are generated
- Discover how the MPLS labels are exchanged
- Discover how the labels are installed by routers
- View the structure of the MPLS forwarding table
- View the encapsulation of IPv4 packets into MPLS packets

Part 1

Mechanics of MPLS and LDP

R4 mpls forwarding table after enabling on interface f1/0



The screenshot shows the output of the 'show mpls forwarding-table' command on router R4. The table lists 8 entries for various IP prefixes, all with 'No Label' and '0' bytes switched, pointing to Fa1/0 with next hop 10.0.34.1. The local labels are 16 through 23.

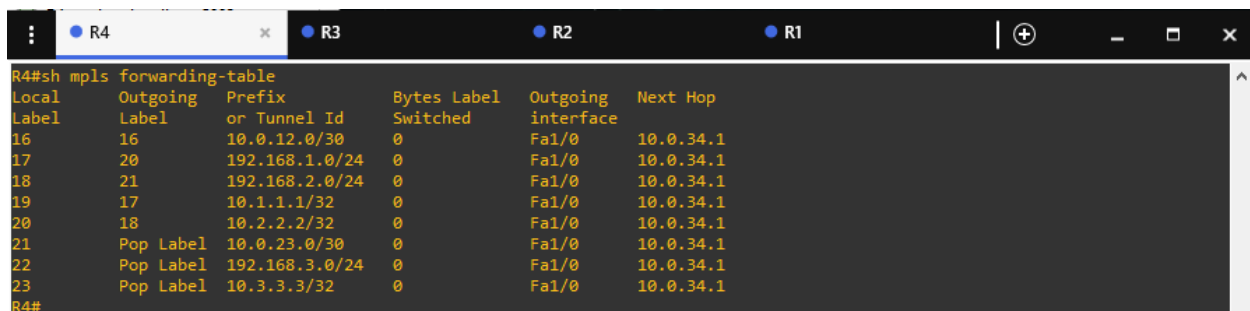
Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	No Label	10.0.12.0/30	0	Fa1/0	10.0.34.1
17	No Label	192.168.1.0/24	0	Fa1/0	10.0.34.1
18	No Label	192.168.2.0/24	0	Fa1/0	10.0.34.1
19	No Label	10.1.1.1/32	0	Fa1/0	10.0.34.1
20	No Label	10.2.2.2/32	0	Fa1/0	10.0.34.1
21	No Label	10.0.23.0/30	0	Fa1/0	10.0.34.1
22	No Label	192.168.3.0/24	0	Fa1/0	10.0.34.1
23	No Label	10.3.3.3/32	0	Fa1/0	10.0.34.1

Figure 1.

Explanation

When enabling mpls ip in interface f1/0, there are no outgoing labels or bytes switching because mpls ip is only enabled on one interface and the other router does not have mpls ip enabled. Looking at the data/snippets that was accumulated mpls ip does not give labels to directly connected devices rather the devices the other connections are connected to. Looking at the local labels, because MPLS has designated 1 to 14 in a cisco router as special cases, the number skips one and starts at 16, each time the router has a path the number increases by 1. Every connection has a local label that is in someway directly connected to each other.

R4 mpls forwarding table after adding R3 interface f1/0

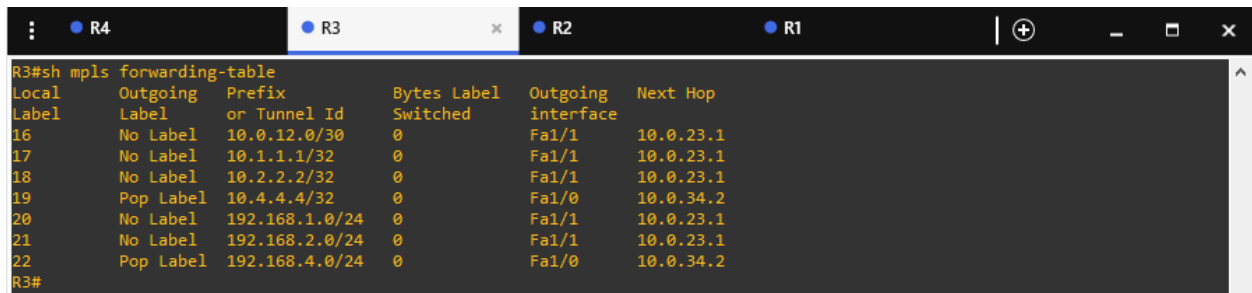


The screenshot shows the output of the 'show mpls forwarding-table' command on router R4 after adding R3. The table now shows 8 entries with outgoing labels (16, 20, 21, 17, 18, 21, 22, 23) and 'Pop Label' for the last three entries. The local labels are 16 through 23.

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	16	10.0.12.0/30	0	Fa1/0	10.0.34.1
17	20	192.168.1.0/24	0	Fa1/0	10.0.34.1
18	21	192.168.2.0/24	0	Fa1/0	10.0.34.1
19	17	10.1.1.1/32	0	Fa1/0	10.0.34.1
20	18	10.2.2.2/32	0	Fa1/0	10.0.34.1
21	Pop Label	10.0.23.0/30	0	Fa1/0	10.0.34.1
22	Pop Label	192.168.3.0/24	0	Fa1/0	10.0.34.1
23	Pop Label	10.3.3.3/32	0	Fa1/0	10.0.34.1

Figure 2.

R3 mpls forwarding table after enabling interface f1/0



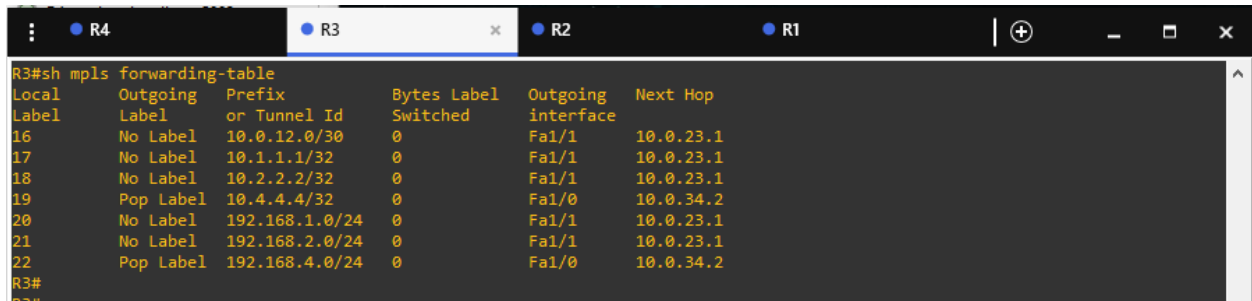
Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	No Label	10.0.12.0/30	0	Fa1/1	10.0.23.1
17	No Label	10.1.1.1/32	0	Fa1/1	10.0.23.1
18	No Label	10.2.2.2/32	0	Fa1/1	10.0.23.1
19	Pop Label	10.4.4.4/32	0	Fa1/0	10.0.34.2
20	No Label	192.168.1.0/24	0	Fa1/1	10.0.23.1
21	No Label	192.168.2.0/24	0	Fa1/1	10.0.23.1
22	Pop Label	192.168.4.0/24	0	Fa1/0	10.0.34.2

Figure 3.

Explanation

After adding mpls ip to R3 interface f1/0, which is directly connected to R4, the table on R4 gets filled with the Pop labels and the outgoing interfaces. Within the forwarding table of R4, the label called pop label is added to the connections going out of R3. As well as when viewing within the forwarding table of R3, the pop label is added to the outgoing interfaces of R4.

R3 mpls forwarding table after adding interface f1/1



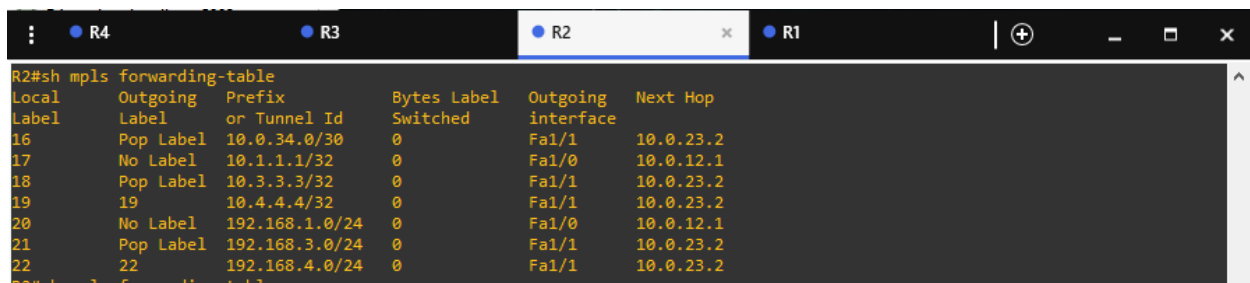
Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	No Label	10.0.12.0/30	0	Fa1/1	10.0.23.1
17	No Label	10.1.1.1/32	0	Fa1/1	10.0.23.1
18	No Label	10.2.2.2/32	0	Fa1/1	10.0.23.1
19	Pop Label	10.4.4.4/32	0	Fa1/0	10.0.34.2
20	No Label	192.168.1.0/24	0	Fa1/1	10.0.23.1
21	No Label	192.168.2.0/24	0	Fa1/1	10.0.23.1
22	Pop Label	192.168.4.0/24	0	Fa1/0	10.0.34.2

Figure 4.

Explanation

After adding mpls ip on interface f1/1 of R3, there is no change in the labels due to the fact that mpls ip is not enabled in the interface connecting from R2, so it does not recognize any outgoing labels.

R2 mpls forwarding table after adding R3



The screenshot shows a terminal window with tabs for R4, R3, R2, and R1. The R2 tab is active, displaying the output of the command 'R2#sh mpls forwarding-table'. The output is a table with columns: Local Label, Outgoing Label, Prefix or Tunnel Id, Bytes Switched, Outgoing interface, and Next Hop. The table contains 7 entries, all with '0' in the 'Bytes Switched' column. The 'Outgoing interface' for entries 16-19 is Fa1/1, and for entries 17, 20-22 it is Fa1/0. The 'Next Hop' for entries 16-19 is 10.0.23.2, and for entries 17, 20-22 it is 10.0.12.1.

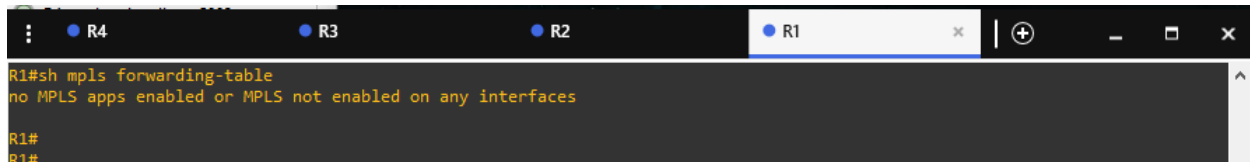
Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	Pop Label	10.0.34.0/30	0	Fa1/1	10.0.23.2
17	No Label	10.1.1.1/32	0	Fa1/0	10.0.12.1
18	Pop Label	10.3.3.3/32	0	Fa1/1	10.0.23.2
19	19	10.4.4.4/32	0	Fa1/1	10.0.23.2
20	No Label	192.168.1.0/24	0	Fa1/0	10.0.12.1
21	Pop Label	192.168.3.0/24	0	Fa1/1	10.0.23.2
22	22	192.168.4.0/24	0	Fa1/1	10.0.23.2

Figure 5.

Explanation

After enabling mpls ip on the interface f1/1 in R2, the forwarding table gets populated with the updated labels. The pop labels get added to the connections that are connected from R3 instead of from R2. There is no outgoing label for R1, and the network connected to R1 because mpls ip is not enabled on any of the interfaces of R1, however they are still statically connected so that is why they show up on the forwarding-table. In R2, compared to R3 and R4, the local labels are labeled to different addresses.

R1 mpls forwarding table after adding R2 interface f1/0



The screenshot shows a terminal window with tabs for R4, R3, R2, and R1. The R1 tab is active, displaying the output of the command 'R1#sh mpls forwarding-table'. The output is a single line: 'no MPLS apps enabled or MPLS not enabled on any interfaces'.

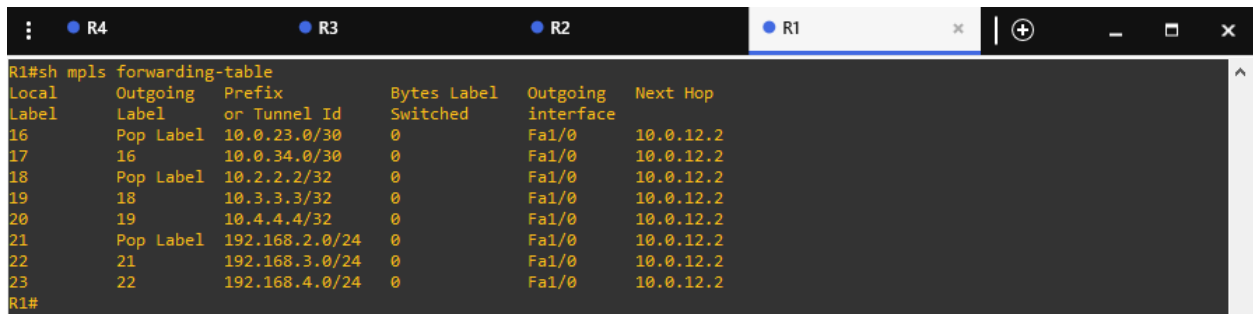
Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
no MPLS apps enabled or MPLS not enabled on any interfaces					

Figure 6.

Explanation

Looking inside R1's mpls forwarding-table, there is no data after adding mpls ip in R2's interface f1/0 because mpls ip is not activated/enabled on the connection coming out from R1 to R2.

R1 mpls forwarding table after adding R1 int f1/0



```
R1#sh mpls forwarding-table
```

Local Label	Outgoing Label	Prefix or Tunnel Id	Bytes Switched	Outgoing interface	Next Hop
16	Pop Label	10.0.23.0/30	0	Fa1/0	10.0.12.2
17	16	10.0.34.0/30	0	Fa1/0	10.0.12.2
18	Pop Label	10.2.2.2/32	0	Fa1/0	10.0.12.2
19	18	10.3.3.3/32	0	Fa1/0	10.0.12.2
20	19	10.4.4.4/32	0	Fa1/0	10.0.12.2
21	Pop Label	192.168.2.0/24	0	Fa1/0	10.0.12.2
22	21	192.168.3.0/24	0	Fa1/0	10.0.12.2
23	22	192.168.4.0/24	0	Fa1/0	10.0.12.2

Figure 7.

Explanation

With adding mpls ip to the connection from R1 to R2 the forwarding-table in R1 gets populated with the updated local labels for the outgoing interfaces. R2 which is the neighbor to R1 gets all of its routes designated as pop labels, the other labels depend on the route and how long it would take the packets to travel. The labels that have numbers on the outgoing labels coincide with the designated local interfaces depending on where they are connected, and which interface is the next hop. The local labels are updated to whichever route the router is directly connected to.

Diagrams

R1

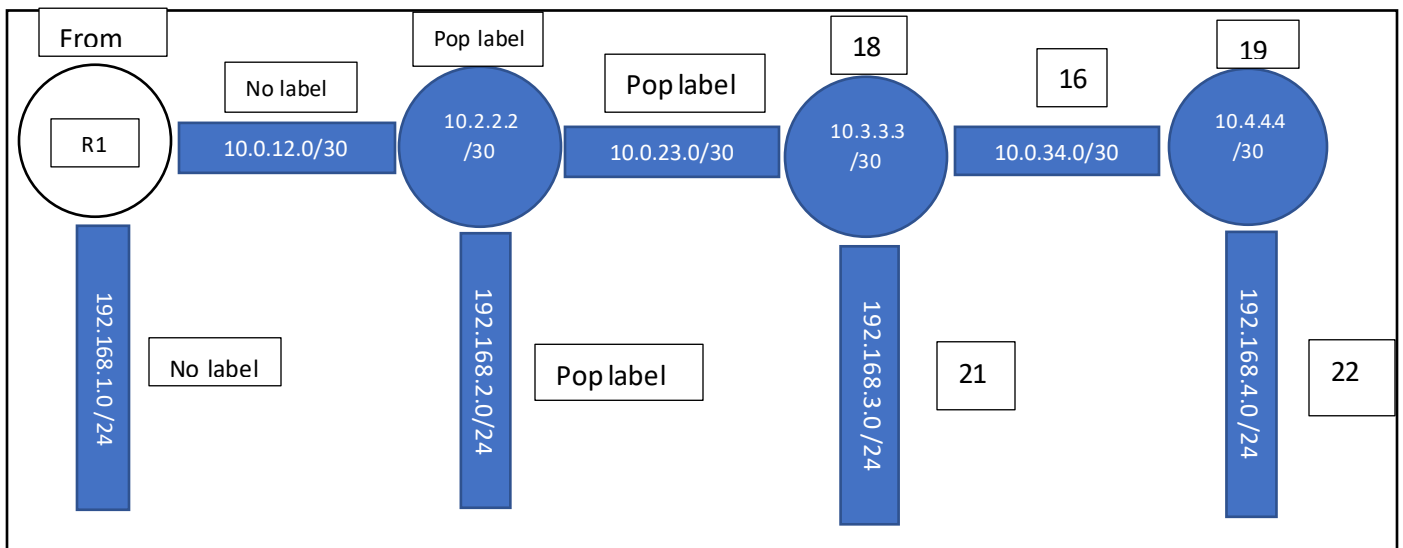


Figure 8.

R2

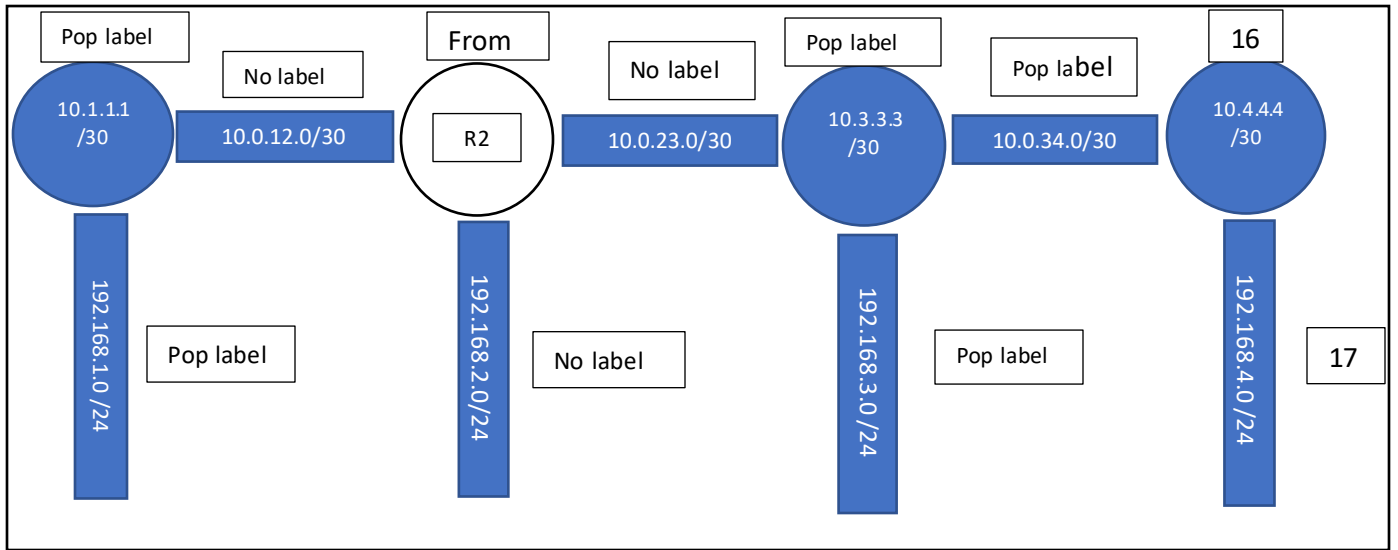


Figure 9.

R3

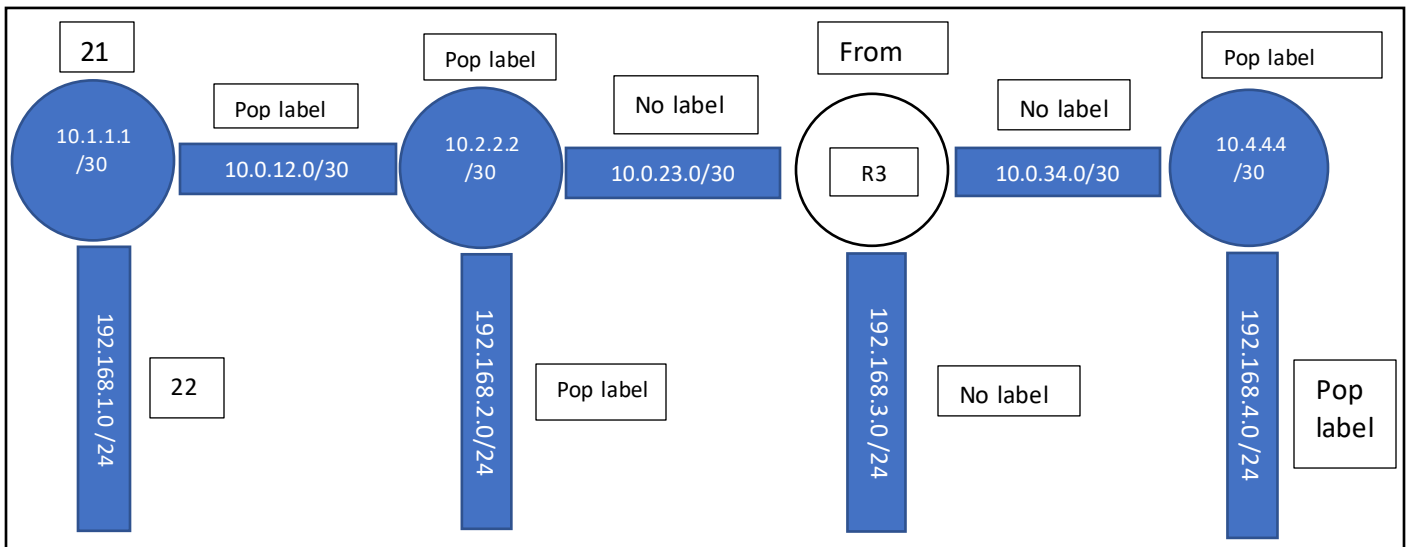


Figure 10.

R4

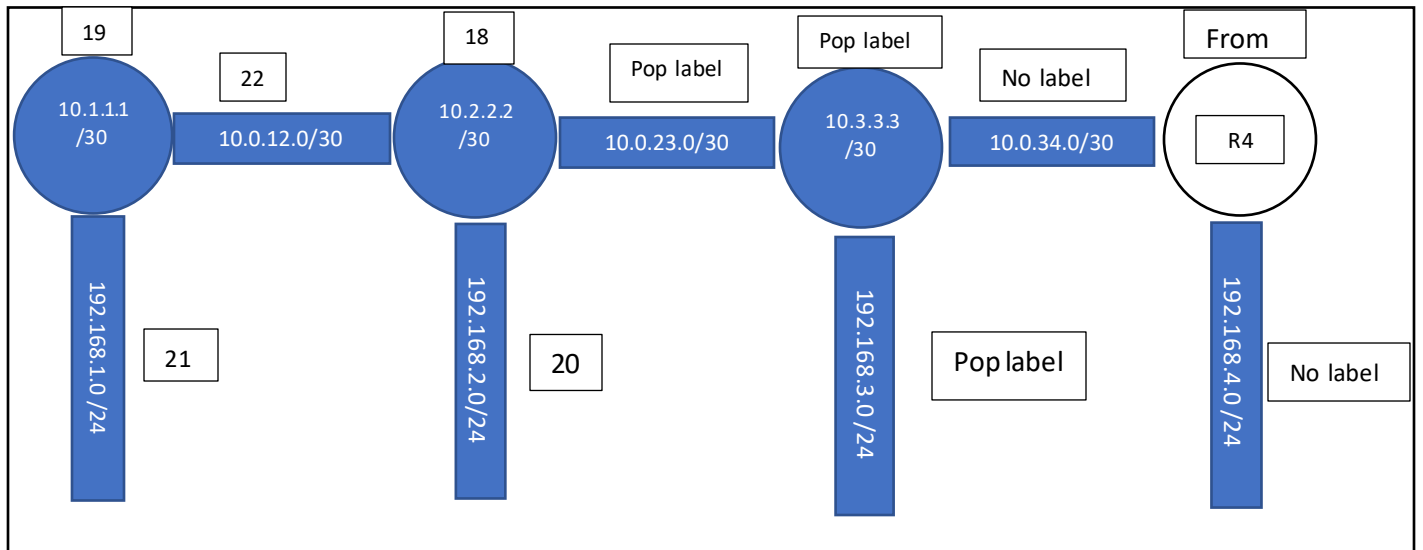
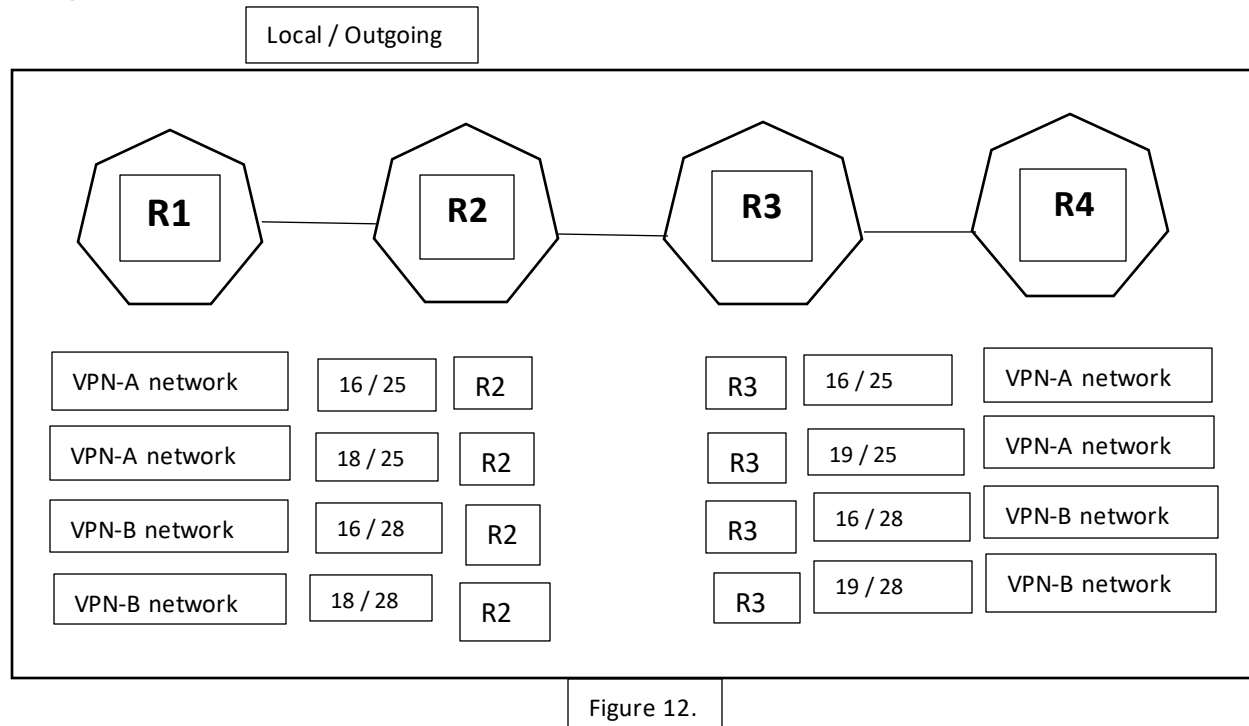


Figure 11.

Part 2

MPLS Layer 3 VPVn4, PE-CE static

Diagram



R1 mpls forwarding-table 10.4.4.4

```
R1#sh mpls forwarding-table 10.4.4.4
Local   Outgoing  Prefix      Bytes Label  Outgoing  Next Hop
Label   Label     or Tunnel Id  Switched     interface
16      16        10.4.4.4/32   0            Fa1/0     10.0.12.2
R1#
```

Figure 13.

R2 mpls forwarding-table 10.4.4.4

```
R2#sh mpls forwarding-table 10.4.4.4
Local   Outgoing  Prefix      Bytes Label  Outgoing  Next Hop
Label   Label     or Tunnel Id Switched      interface
16      16        10.4.4.4/32 5164         Fa1/1       10.0.23.2
R2#
```

Figure 14.

R3 mpls forwarding-table 10.4.4.4

```
R3#sh mpls forwarding-table 10.4.4.4
Local   Outgoing  Prefix      Bytes Label  Outgoing  Next Hop
Label   Label     or Tunnel Id Switched      interface
16      Pop Label  10.4.4.4/32 4888         Fa1/0       10.0.34.2
R3#
```

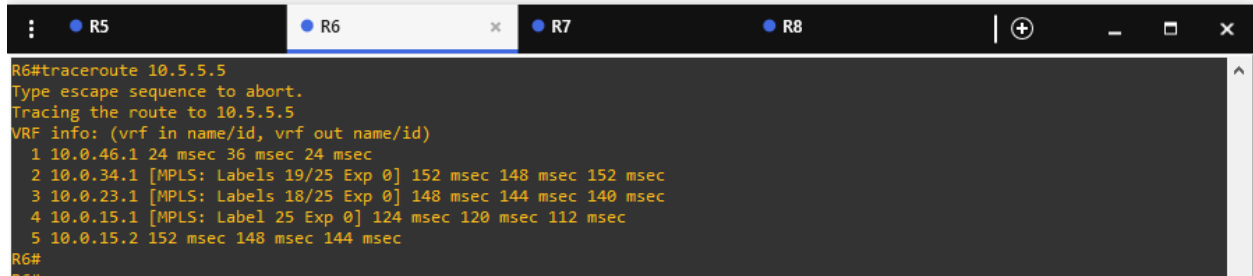
Figure 15.

Traceroute from R5 to 10.6.6.6

```
R5#traceroute 10.6.6.6
Type escape sequence to abort.
Tracing the route to 10.6.6.6
VRF info: (vrf in name/id, vrf out name/id)
 1 10.0.15.1 24 msec 28 msec 24 msec
 2 10.0.12.2 [MPLS: Labels 16/25 Exp 0] 152 msec 148 msec 156 msec
 3 10.0.23.2 [MPLS: Labels 16/25 Exp 0] 148 msec 144 msec 148 msec
 4 10.0.46.1 [MPLS: Label 25 Exp 0] 120 msec 116 msec 108 msec
 5 10.0.46.2 152 msec 136 msec 156 msec
R5#
```

Figure 16.

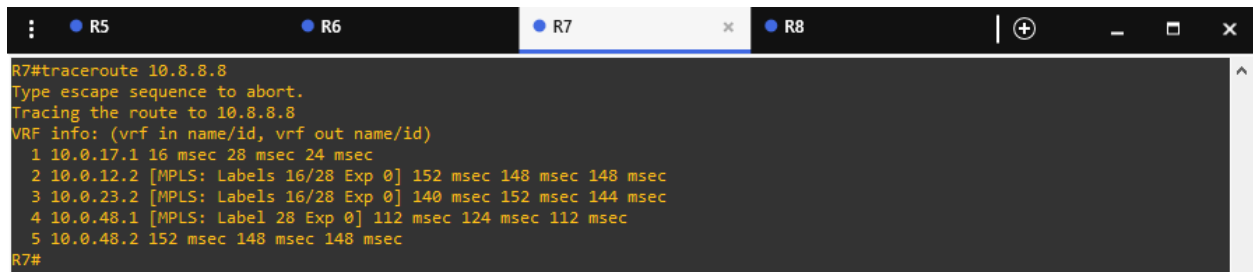
Traceroute from R6 to 10.5.5.5



```
R6#traceroute 10.5.5.5
Type escape sequence to abort.
Tracing the route to 10.5.5.5
VRF info: (vrf in name/id, vrf out name/id)
 1 10.0.46.1 24 msec 36 msec 24 msec
 2 10.0.34.1 [MPLS: Labels 19/25 Exp 0] 152 msec 148 msec 152 msec
 3 10.0.23.1 [MPLS: Labels 18/25 Exp 0] 148 msec 144 msec 140 msec
 4 10.0.15.1 [MPLS: Label 25 Exp 0] 124 msec 120 msec 112 msec
 5 10.0.15.2 152 msec 148 msec 144 msec
R6#
```

Figure 17.

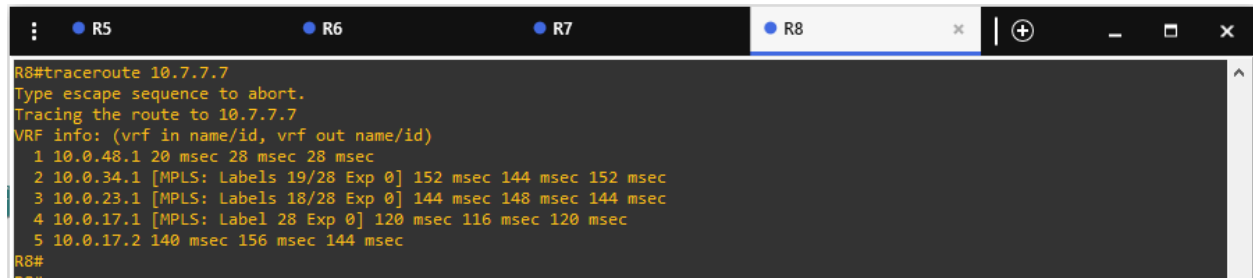
Trace route from R7 to 10.8.8.8



```
R7#traceroute 10.8.8.8
Type escape sequence to abort.
Tracing the route to 10.8.8.8
VRF info: (vrf in name/id, vrf out name/id)
 1 10.0.17.1 16 msec 28 msec 24 msec
 2 10.0.12.2 [MPLS: Labels 16/28 Exp 0] 152 msec 148 msec 148 msec
 3 10.0.23.2 [MPLS: Labels 16/28 Exp 0] 140 msec 152 msec 144 msec
 4 10.0.48.1 [MPLS: Label 28 Exp 0] 112 msec 124 msec 112 msec
 5 10.0.48.2 152 msec 148 msec 148 msec
R7#
```

Figure 18.

Traceroute from R8 to 10.7.7.7



```
R8#traceroute 10.7.7.7
Type escape sequence to abort.
Tracing the route to 10.7.7.7
VRF info: (vrf in name/id, vrf out name/id)
 1 10.0.48.1 20 msec 28 msec 28 msec
 2 10.0.34.1 [MPLS: Labels 19/28 Exp 0] 152 msec 144 msec 152 msec
 3 10.0.23.1 [MPLS: Labels 18/28 Exp 0] 144 msec 148 msec 144 msec
 4 10.0.17.1 [MPLS: Label 28 Exp 0] 120 msec 116 msec 120 msec
 5 10.0.17.2 140 msec 156 msec 144 msec
R8#
```

Figure 18.

MPLS

Looking at the function of MPLS Layer 3 VPNv4 model, based on the information collected from the trace route, the MPLS core acts as an intermediary to transfer information quick between two vpn's over an area larger than the current network allows. Looking at the trace route from R1,2, the outgoing labels are equal paths and the one from R3 to R4 is a pop label. The MPLS core is a way for networks over long distances to communicate with each other easily. The protocol used within the mpls core is OSPF and BGP is used for communicating between the VPN's that are in different areas.

Configurations

R1

```
ip vrf VPN-A
rd 65144:11
route-target export 65144:11
route-target import 65144:21
!
ip vrf VPN-B
rd 65144:12
route-target export 65144:12
route-target import 65144:22
!
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
!
!
!
!
!
ip tcp synwait-time 5
!
!
!
!
!
interface Loopback0
ip address 10.1.1.1 255.255.255.255
!
interface FastEthernet0/0
ip address 192.168.1.1 255.255.255.0
duplex full
!
interface FastEthernet1/0
ip address 10.0.12.1 255.255.255.252
speed auto
duplex auto
mpls ip
!
interface FastEthernet1/1
ip vrf forwarding VPN-A
ip address 10.0.15.1 255.255.255.252
speed auto
--More-- █
```

```
ip route vrf VPN-A 10.5.5 255.255.255.255 10.0.15.2
ip route vrf VPN-A 192.168.1.0 255.255.255.0 10.0.15.2
ip route vrf VPN-B 10.7.7.7 255.255.255.255 10.0.17.2
ip route vrf VPN-B 192.168.3.0 255.255.255.0 10.0.17.2

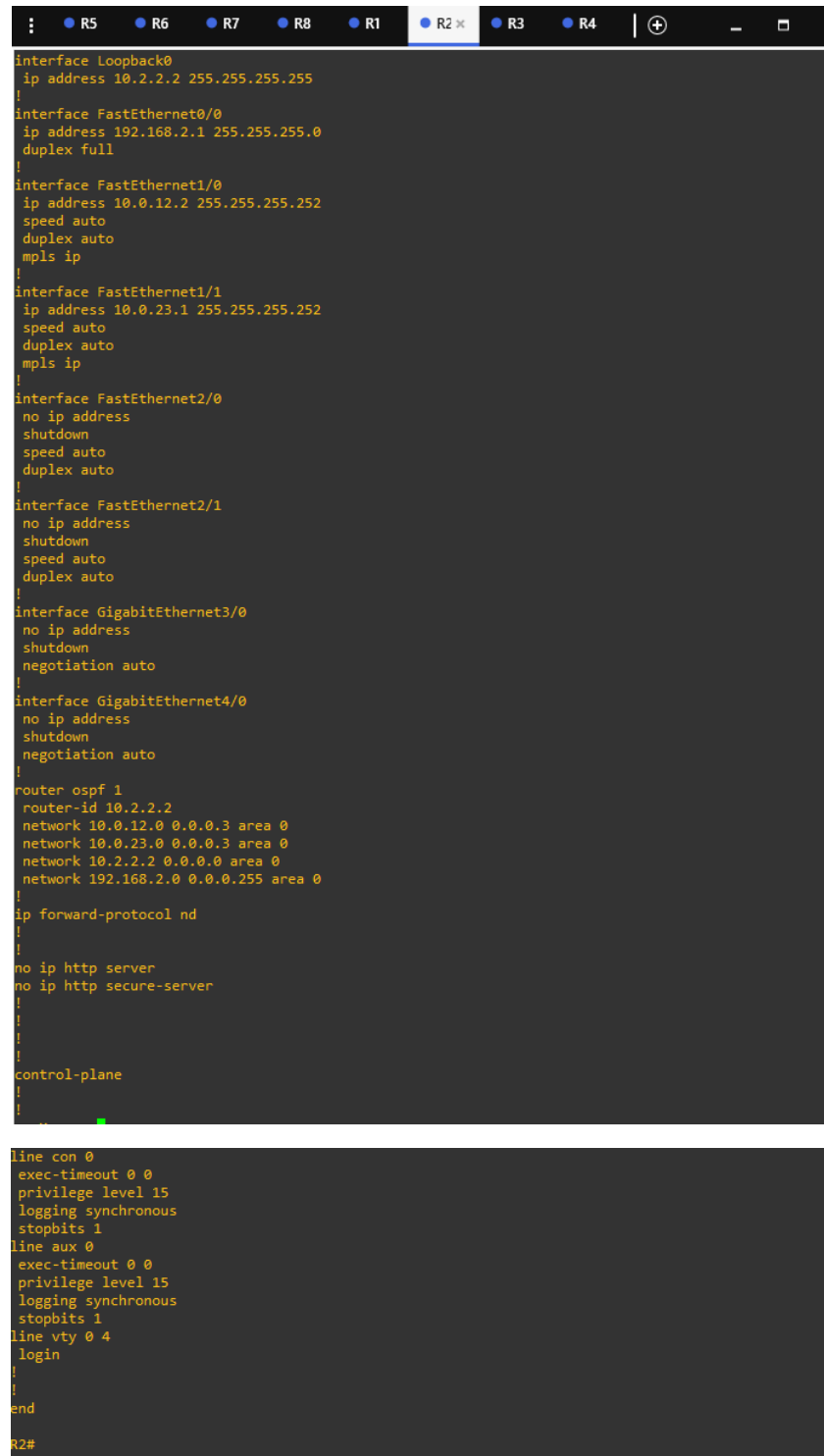
control-plane

line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
end

R1#
```

Figure 19.

R2



```
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
!
interface FastEthernet0/0
 ip address 192.168.2.1 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 10.0.12.2 255.255.255.252
 speed auto
 duplex auto
 mpls ip
!
interface FastEthernet1/1
 ip address 10.0.23.1 255.255.255.252
 speed auto
 duplex auto
 mpls ip
!
interface FastEthernet2/0
 no ip address
 shutdown
 speed auto
 duplex auto
!
interface FastEthernet2/1
 no ip address
 shutdown
 speed auto
 duplex auto
!
interface GigabitEthernet3/0
 no ip address
 shutdown
 negotiation auto
!
interface GigabitEthernet4/0
 no ip address
 shutdown
 negotiation auto
!
router ospf 1
 router-id 10.2.2.2
 network 10.0.12.0 0.0.0.3 area 0
 network 10.0.23.0 0.0.0.3 area 0
 network 10.2.2.2 0.0.0.0 area 0
 network 192.168.2.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
!
!
control-plane
!
!

line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
!
!
end

R2#
```

Figure 20.

R3

```

:  R5  R6  R7  R8  R1  R2  R3 x R4  +  -  □  x
interface Loopback0
 ip address 10.3.3.3 255.255.255.255
!
interface FastEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 duplex full
!
interface FastEthernet1/0
 ip address 10.0.34.1 255.255.255.252
 speed auto
 duplex auto
 mpls ip
!
interface FastEthernet1/1
 ip address 10.0.23.2 255.255.255.252
 speed auto
 duplex auto
 mpls ip
!
interface FastEthernet2/0
 no ip address
 shutdown
 speed auto
 duplex auto
!
interface FastEthernet2/1
 no ip address
 shutdown
 speed auto
 duplex auto
!
interface GigabitEthernet3/0
 no ip address
 shutdown
 negotiation auto
!
interface GigabitEthernet4/0
 no ip address
 shutdown
 negotiation auto
!
router ospf 1
 router-id 10.3.3.3
 network 10.0.23.0 0.0.0.3 area 0
 network 10.0.34.0 0.0.0.3 area 0
 network 10.3.3.3 0.0.0.0 area 0
 network 192.168.3.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
!
!
control-plane
!
!

line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
!
!
end
R3#
```

Figure 21.

R4

[illegible]

```

duplex auto
!
interface FastEthernet2/0
 ip vrf forwarding VPN-B
 ip address 10.0.48.1 255.255.255.252
 speed auto
 duplex auto
!
interface FastEthernet2/1
 no ip address
 shutdown
 speed auto
 duplex auto
!
interface GigabitEthernet3/0
 no ip address
 shutdown
 negotiation auto
!
interface GigabitEthernet4/0
 no ip address
 shutdown
 negotiation auto
!
router ospf 1
 router-id 10.4.4.4
 network 10.0.34.0 0.0.0.3 area 0
 network 10.4.4.4 0.0.0.0 area 0
 network 192.168.4.0 0.0.0.255 area 0
!
router bgp 65144
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 10.1.1.1 remote-as 65144
 neighbor 10.1.1.1 update-source Loopback0
!
 address-family ipv4
  neighbor 10.1.1.1 activate
 exit-address-family
!
 address-family vpnv4
  neighbor 10.1.1.1 activate
  neighbor 10.1.1.1 send-community both
 exit-address-family
!
 address-family ipv4 vrf VPN-A
  redistribute connected
  redistribute static
 exit-address-family
!
 address-family ipv4 vrf VPN-B
  redistribute connected
  redistribute static
 exit-address-family
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server

ip route vrf VPN-A 10.6.6.6 255.255.255.255 10.0.46.2
ip route vrf VPN-A 192.168.2.0 255.255.255.0 10.0.46.2
ip route vrf VPN-B 10.8.8.8 255.255.255.255 10.0.48.2
ip route vrf VPN-B 192.168.4.0 255.255.255.0 10.0.48.2
!
!
!
!
!
control-plane
!
!
!
line con 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line aux 0
 exec-timeout 0 0
 privilege level 15
 logging synchronous
 stopbits 1
line vty 0 4
 login
!
!
end

R4#

```

Figure 22.

R5

```
ip dhcp excluded-address 192.168.1.1 192.168.1.9
ip dhcp pool pcl
network 192.168.1.0 255.255.255.0
default-router 192.168.1.1

no ip domain lookup
ip cef
no ipv6 cef

multilink bundle-name authenticated

ip tcp synwait-time 5

Interface Loopback0
ip address 10.5.5.5 255.255.255.255

Interface FastEthernet0/0
ip address 192.168.1.1 255.255.255.0
duplex full

Interface FastEthernet1/0
no ip address
shutdown
speed auto
duplex auto

Interface FastEthernet1/1
ip address 10.0.15.2 255.255.255.252
speed auto
duplex auto

Interface FastEthernet2/0
no ip address
shutdown
speed auto
duplex auto

Interface FastEthernet2/1
no ip address
shutdown
speed auto
duplex auto
!
Interface GigabitEthernet3/0
no ip address
shutdown
negotiation auto
!
Interface GigabitEthernet4/0
no ip address
shutdown
negotiation auto
!
router ospf 1
router-id 10.5.5.5
network 10.5.5.5 0.0.0.0 area 0
network 192.168.1.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 10.0.15.1
!
!
control-plane
!
line con 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line aux 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line vty 0 4
login
!
end
R5#
```

Figure 23.

R6

```
ip dhcp excluded-address 192.168.2.1 192.168.2.9

ip dhcp pool pc2
network 192.168.2.0 255.255.255.0
default-router 192.168.2.1

no ip domain lookup
ip cef
no ipv6 cef

multilink bundle-name authenticated

ip tcp synwait-time 5

interface Loopback0
ip address 10.6.6.6 255.255.255.255
!
interface FastEthernet0/0
ip address 192.168.2.1 255.255.255.0
duplex full
!
interface FastEthernet1/0
no ip address
shutdown
speed auto
duplex auto
!
interface FastEthernet1/1
ip address 10.0.46.2 255.255.255.252
speed auto
duplex auto
!
interface FastEthernet2/0
no ip address
shutdown
speed auto
duplex auto
!
interface FastEthernet2/1
no ip address
shutdown
speed auto
duplex auto
!
interface GigabitEthernet3/0
no ip address
shutdown
negotiation auto
!
interface GigabitEthernet4/0
no ip address
shutdown
negotiation auto
!
router ospf 1
router-id 10.6.6.6
network 10.6.6.6 0.0.0.0 area 0
network 192.168.2.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 10.0.46.1
!
!
!
control-plane
!
line con 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line aux 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line vty 0 4
login
!
end

R6#
```

Figure 24.

R7

```
ip dhcp excluded-address 192.168.3.1 192.168.3.9
ip dhcp pool pc3
network 192.168.3.0 255.255.255.0
default-router 192.168.3.1
}
}
no ip domain lookup
ip cef
no ipv6 cef
}
multilink bundle-name authenticated
}
}
}
ip tcp synwait-time 5
}
}
}
Interface Loopback0
ip address 10.7.7.7 255.255.255.255
}
Interface FastEthernet0/0
ip address 192.168.3.1 255.255.255.0
duplex full
}
Interface FastEthernet1/0
no ip address
shutdown
speed auto
duplex auto
}
Interface FastEthernet1/1
no ip address
shutdown
speed auto
duplex auto
}
Interface FastEthernet2/0
ip address 10.0.17.2 255.255.255.252
speed auto
duplex auto
}
Interface FastEthernet2/1
no ip address
shutdown
speed auto
duplex auto
}
Interface GigabitEthernet3/0
no ip address
shutdown
negotiation auto
}
Interface GigabitEthernet4/0
no ip address
shutdown
negotiation auto
}
router ospf 1
router-id 10.7.7.7
network 10.7.7.7 0.0.0.0 area 0
network 192.168.3.0 0.0.0.255 area 0
}
ip forward-protocol nd
}
}
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 10.0.17.1
}
}
}
control-plane
}
}
line con 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line aux 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line vty 0 4
login
}
}
end
c7#
```

Figure 25.

R8

```
ip dhcp excluded-address 192.168.4.1 192.168.4.9
!
ip dhcp pool pc4
network 192.168.4.0 255.255.255.0
default-router 192.168.4.1
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
!
multilink bundle-name authenticated
!
!
!
!
!
!
!
!
!
!
ip tcp synwait-time 5
!
!
!
!
!
!
!
!
!
!
interface Loopback0
ip address 10.8.8.8 255.255.255.255
!
interface FastEthernet0/0
ip address 192.168.4.1 255.255.255.0
duplex full
!
interface FastEthernet1/0
no ip address
shutdown
speed auto
duplex auto
!
interface FastEthernet1/1
no ip address
shutdown
speed auto
duplex auto
!
interface FastEthernet2/0
ip address 10.0.48.2 255.255.255.252
speed auto
duplex auto
!
!
interface FastEthernet2/1
no ip address
shutdown
speed auto
duplex auto
!
interface GigabitEthernet3/0
no ip address
shutdown
negotiation auto
!
interface GigabitEthernet4/0
no ip address
shutdown
negotiation auto
!
router ospf 1
router-id 10.8.8.8
network 10.8.8.8 0.0.0.0 area 0
network 192.168.4.0 0.0.0.255 area 0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 10.0.48.1
!
!
!
!
!
!
control-plane
!
!
line con 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line aux 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line vty 0 4
login
!
!
end
R8#
```

Figure 26.