CHEMBUR TROMABY EDUCATION SOCIETY

N. G. ACHARYA & D. K. MARATHE COLLEGE

OF ARTS, SCIENCE & COMMERCE

N. G. Acharya Marg, Chembur, Mumbai – 400 071.

NAAC ACCREDITED COLLEGE

M.Sc (Computer Science /Information Technology)

Certificate

Certified that the work entered in this journal was done in the Computer laboratory by the student Mr. / Miss Dalvi Siddhesh Dinesh Roll No. A1-5 Of Class M.Sc IT & A Semester II During the Year 2021-2022 in a Satisfactory manner.

Lecture Incharge | *External Examiner* | *Head of Dept*

MSc. I.T. Semester II

MODERN NETWORKING (**PSIT2P2**)

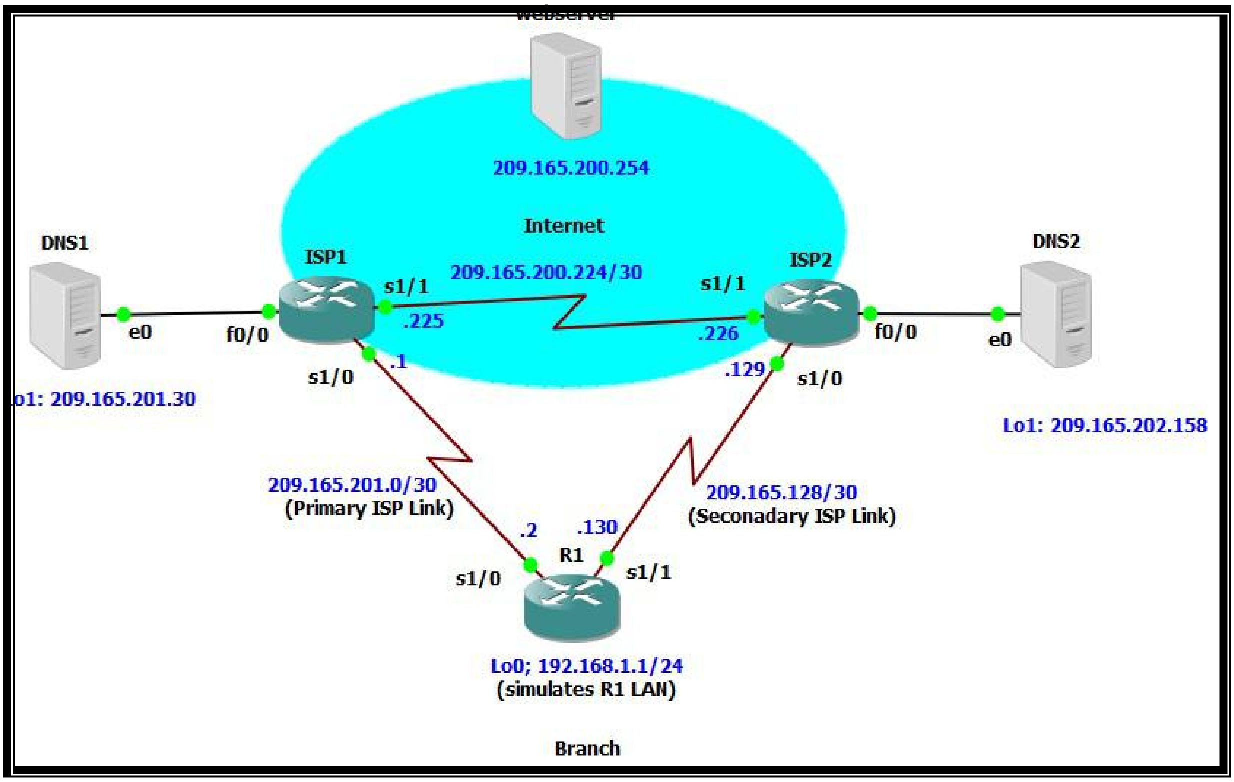
List of Practical

All practical’s are expected to be performed on GNS3/EVE-Ng networkEmulator/MININET

Practical No – 1

Aim: Configure IP SLA Tracking and Path ControlTopology .

Topolgy :



Objectives:

- Configure and verify the IP SLA feature.
- Test the IP SLA tracking feature.
- Verify the configuration and operation using **show** and **debug** commands.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 1: Prepare the routers and configure the router hostname and interface addresses.

a. Cable the network as shown in the topology diagram

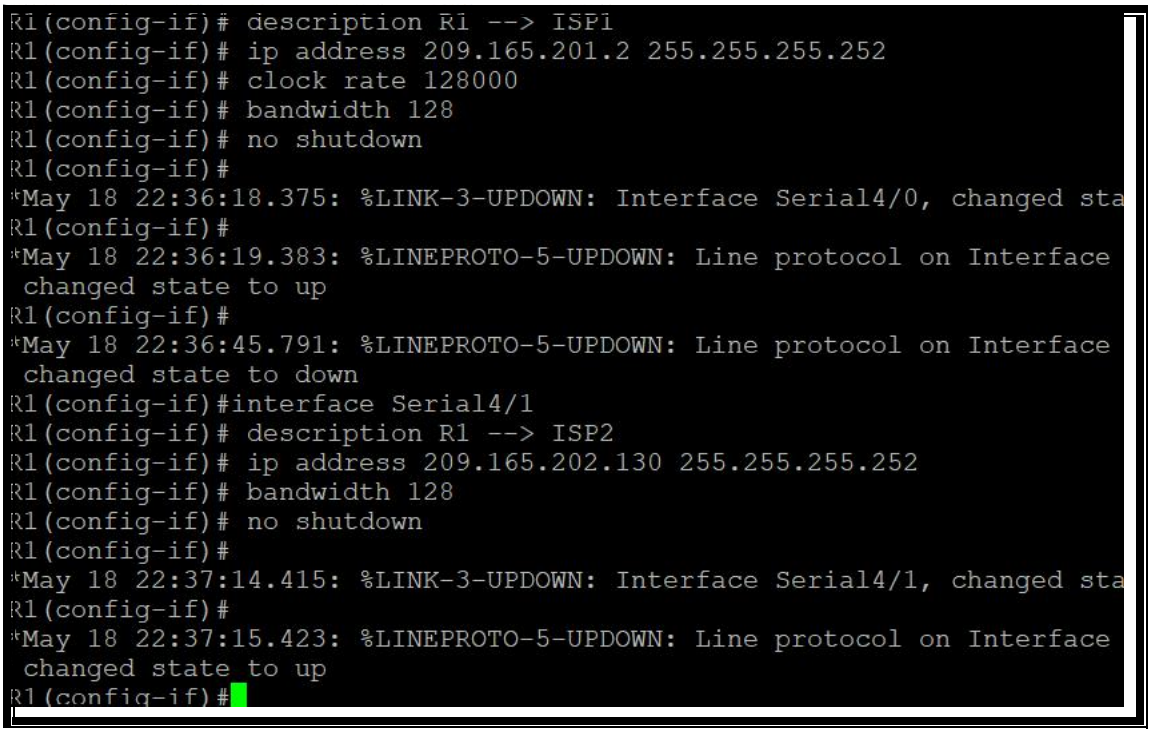
Router R1

hostname R1

interface Loopback 0
description R1 LAN
ip address 192.168.1.1 255.255.255.0
interface Serial0/0
description R1 --> ISP1
ip address 209.165.201.2 255.255.255.252

clock rate 128000
bandwidth 128
no shutdown

interface Serial0/1
description R1 --> ISP2
ip address 209.165.202.130 255.255.255.252
bandwidth 128
no shutdown

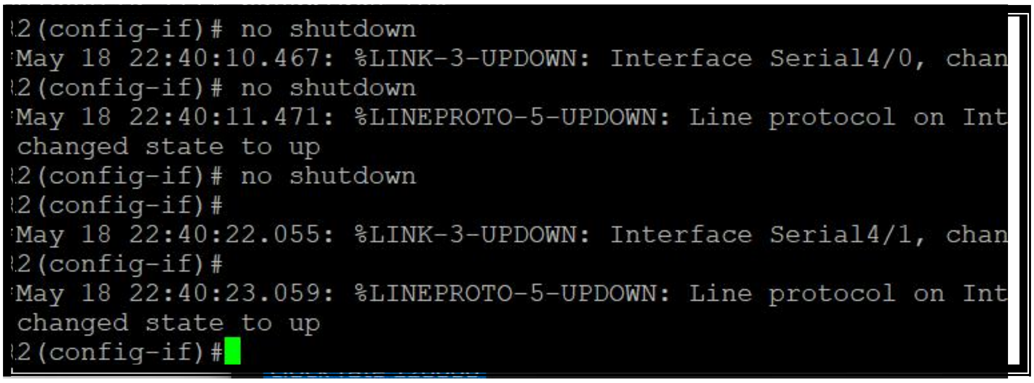


```
R1(config-if)# description R1 --> ISP1
R1(config-if)# ip address 209.165.201.2 255.255.255.252
R1(config-if)# clock rate 128000
R1(config-if)# bandwidth 128
R1(config-if)# no shutdown
R1(config-if)#
*May 18 22:36:18.375: %LINK-3-UPDOWN: Interface Serial4/0, changed sta
R1(config-if)#
*May 18 22:36:19.383: %LINEPROTO-5-UPDOWN: Line protocol on Interface
 changed state to up
R1(config-if)#
*May 18 22:36:45.791: %LINEPROTO-5-UPDOWN: Line protocol on Interface
 changed state to down
R1(config-if)#interface Serial4/1
R1(config-if)# description R1 --> ISP2
R1(config-if)# ip address 209.165.202.130 255.255.255.252
R1(config-if)# bandwidth 128
R1(config-if)# no shutdown
R1(config-if)#
*May 18 22:37:14.415: %LINK-3-UPDOWN: Interface Serial4/1, changed sta
R1(config-if)#
*May 18 22:37:15.423: %LINEPROTO-5-UPDOWN: Line protocol on Interface
 changed state to up
R1(config-if)#
```

Router ISP1 (R2)
hostname ISP1
interface Loopback0
description Simulated Internet Web Server
ip address 209.165.200.254 255.255.255.255

interface Loopback1
description ISP1 DNS Server
ip address 209.165.201.30 255.255.255.255
interface Serial0/0/0
description ISP1 --> R1
ip address 209.165.201.1 255.255.255.252
bandwidth 128
no shutdown

interface Serial0/0/1
description ISP1 --> ISP2
ip address 209.165.200.225 255.255.255.252
clock rate 128000
bandwidth 128
no shutdown



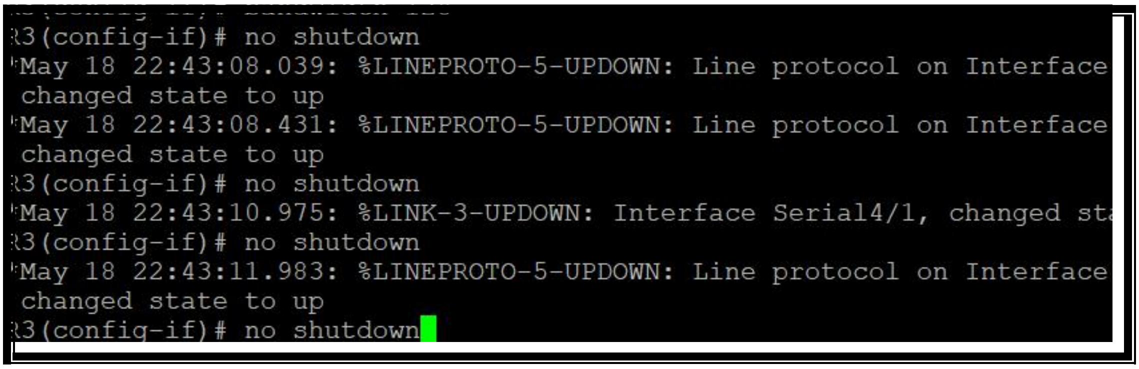
```
R2(config-if)# no shutdown
*May 18 22:40:10.467: %LINK-3-UPDOWN: Interface Serial4/0, chan
R2(config-if)# no shutdown
*May 18 22:40:11.471: %LINEPROTO-5-UPDOWN: Line protocol on Int
 changed state to up
R2(config-if)# no shutdown
R2(config-if)#
*May 18 22:40:22.055: %LINK-3-UPDOWN: Interface Serial4/1, chan
R2(config-if)#
*May 18 22:40:23.059: %LINEPROTO-5-UPDOWN: Line protocol on Int
 changed state to up
R2(config-if)#
```

Router ISP2 (R3)

hostname ISP2
interface Loopback0
description Simulated Internet Web Server
ip address 209.165.200.254 255.255.255.255

interface Loopback1
description ISP2 DNS Server
ip address 209.165.202.158 255.255.255.255
interface Serial0/0/0
description ISP2 --> R1
ip address 209.165.202.129 255.255.255.252
clock rate 128000
bandwidth 128
no shutdown

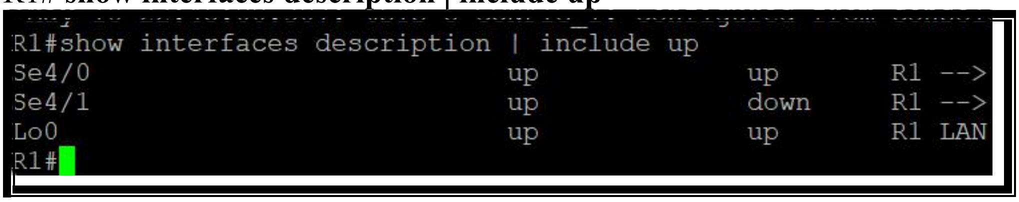
interface Serial0/0/1
description ISP2 --> ISP1
ip address 209.165.200.226 255.255.255.252
bandwidth 128
no shutdown



```
R3(config-if)# no shutdown
*May 18 22:43:08.039: %LINEPROTO-5-UPDOWN: Line protocol on Interface
 changed state to up
*May 18 22:43:08.431: %LINEPROTO-5-UPDOWN: Line protocol on Interface
 changed state to up
R3(config-if)# no shutdown
*May 18 22:43:10.975: %LINK-3-UPDOWN: Interface Serial4/1, changed sta
R3(config-if)# no shutdown
*May 18 22:43:11.983: %LINEPROTO-5-UPDOWN: Line protocol on Interface
 changed state to up
R3(config-if)# no shutdown
```

b.Verify the configuration by using the show interfaces descriptioncommand.

R1# **show interfaces description | include up**



```
R1#show interfaces description | include up
Se4/0                          up             up       R1 -->
Se4/1                          up             down     R1 -->
Lo0                            up             up       R1 LAN
R1#
```

Step 2: Configure static routing.

a. Implement the routing policies on the respective routers.

Router R1

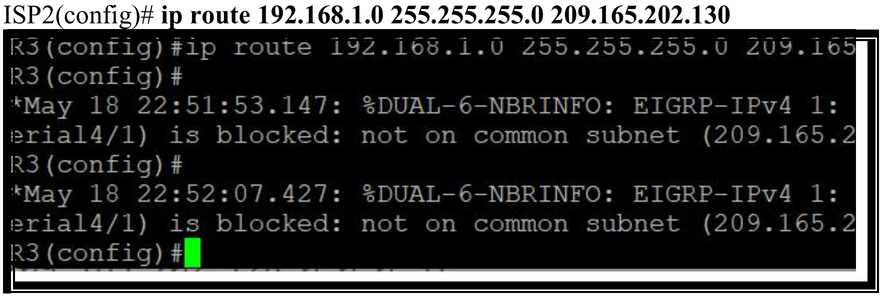
R1(config)# **ip route 0.0.0.0 0.0.0.0 209.165.201.1**
R1(config)#

Router ISP1 (R2)

ISP1(config)# **router eigrp 1**
ISP1(config-router)# **network 209.165.200.224 0.0.0.3**
ISP1(config-router)# **network 209.165.201.0 0.0.0.31**
ISP1(config-router)# **no auto-summary**
ISP1(config-router)# **exit**
ISP1(config)#
ISP1(config-router)# **ip route 192.168.1.0 255.255.255.0 209.165.201.2**
ISP1(config)#

Router ISP2 (R3)

ISP2(config)# **router eigrp 1**
ISP2(config-router)# **network 209.165.200.224 0.0.0.3**
ISP2(config-router)# **network 209.165.202.128 0.0.0.31**
ISP2(config-router)# **no auto-summary**
ISP2(config-router)# **exit**
ISP2(config)#
ISP2(config)# **ip route 192.168.1.0 255.255.255.0 209.165.202.130**



b. **The Cisco IOS IP SLA feature enables an administrator to monitor network performance between Cisco devices (switches or routers) or from a Cisco device to a remote IP device.**

```
foreach address {
209.165.200.254
209.165.201.30
209.165.202.158
} {
ping $address source 192.168.1.1
}
```

c. Trace the path taken to the web server, ISP1 DNS server, and ISP2 DNS server. You can copy the following Tcl script and paste it into R1.

```
foreach address {
209.165.200.254
209.165.201.30
209.165.202.158
} {
trace $address source 192.168.1.1
}
```

```
+>(tcl)#}
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.25
Packet sent with a source address of 192.168.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip mi
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.201.30
Packet sent with a source address of 192.168.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip mi
Type escape sequence to abort.
```

Step 3: Configure IP SLA probes.

a.Create an ICMP echo probe on R1 to the primary DNS server on ISP1 using the ip sla command.

R1(config)# ip sla 11
R1(config-ip-sla)# icmp-echo 209.165.201.30
R1(config-ip-sla-echo)# frequency 10
R1(config-ip-sla-echo)# exit
R1(config)#
R1(config)# ip sla schedule 11 life forever start-time now
R1(config)#

b.Verify the IP SLAs configuration of operation 11 using the show ip sla configuration 11command.

R1# **show ip sla configuration 11**

```
R1#show ip sla configuration
IP SLAs Infrastructure Engine-III
Entry number: 11
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 209.165.201.30/0.0.
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
```

c. Issue the show ip sla statisticscommand to display the number of successes, failures, and results of the latest operations.

R1# **show ip sla statistics**

```
R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 11
        Latest RTT: 28 milliseconds
Latest operation start time: 15:49:09 UTC Sat May 7 2022
Latest operation return code: OK
Number of successes: 49
Number of failures: 0
Operation time to live: Forever

R1#
```

d. Although not actually required because IP SLA session 11 alone could provide the desired fault tolerance, create a second probe, 22, to test connectivity to the second DNS server located on router ISP2.

R1(config)# **ip sla 22**
R1(config-ip-sla)# **icmp-echo 209.165.202.158**
R1(config-ip-sla-echo)# **frequency 10**
R1(config-ip-sla-echo)# **exit**
R1(config)#
R1(config)# **ip sla schedule 22 life forever start-time now**
R1(config)# **end**
R1#

e. Verify the new probe using the show ip sla configuration andshow ip sla statistics commands.

R1# **show ip sla configuration 22**

```
R1#show ip sla configuration 11
IP SLAs Infrastructure Engine-III
Entry number: 11
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 209.165.201.30/0.0.0.0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
```

R1# **show ip sla statistics 22**

```
R1#show ip sla statistics 22
IPSLAs Latest Operation Statistics

IPSLA operation id: 22
        Latest RTT: NoConnection/Busy/Timeout
Latest operation start time: 15:55:06 UTC Sat May 7 2022
Latest operation return code: Timeout
Number of successes: 0
Number of failures: 19
Operation time to live: Forever


R1#
```

Step 4: Configure tracking options.

a.On R1, remove the current default route and replace it with a floating static route having an administrative distance of 5.

R1(config)# **no ip route 0.0.0.0 0.0.0.0 209.165.201.1**
R1(config)# **ip route 0.0.0.0 0.0.0.0 209.165.201.1 5**
R1(config)# **exit**

```
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 5
R1(config)#exit
R1#
*May 18 23:17:05.843: %SYS-5-CONFIG_I: Configured from c
R1#
```

b.Verify the routing table.

R1# **show ip route | begin Gateway**

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#no ip route 0.0.0.0 0.0.0.0 209.165.201.1
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 5
R1(config)#exit
R1#
*May  7 15:57:11.527: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.201.1 to network 0.0.0.0

S*    0.0.0.0/0 [5/0] via 209.165.201.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/30 is directly connected, Serial4/0
L        209.165.201.2/32 is directly connected, Serial4/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.202.128/30 is directly connected, Serial4/2
L        209.165.202.130/32 is directly connected, Serial4/2
R1#
```

C .From global configuration mode on R1, use the track 1 ip sla 11 reachabilitycommand to enter the config-track subconfiguration mode.

R1(config)# **track 1 ip sla 11 reachability**
R1(config-track)#

d. Specify the level of sensitivity to changes of tracked objects to 10 seconds of down delay and 1 second of up delay using the delay down 10 u1 command.

R1(config-track)# **delay down 10 up 1**
R1(config-track)# **exit**
R1(config)#

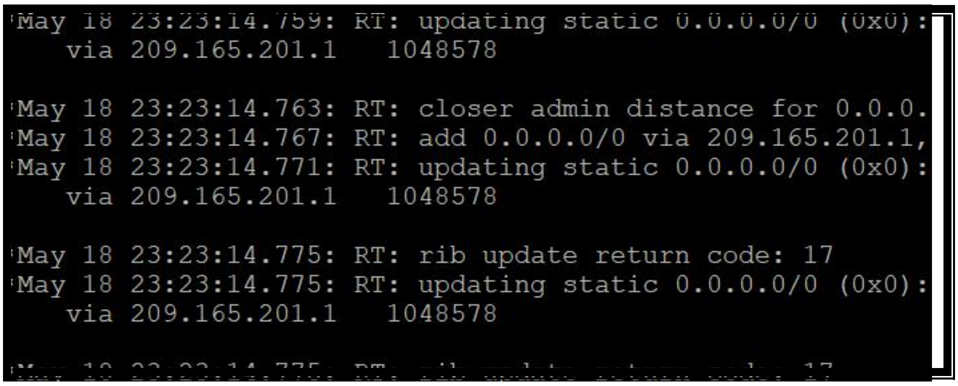
e. To view routing table changes as they happen, first enable the debug ip routing command.

R1# **debug ip routing**

```
R1(config)#exit
R1#debug ip routing
*May 18 23:19:44.487: %SYS-5-CONFIG_
R1#debug ip routing
IP routing debugging is on
R1#
```

f. Configure the floating static route that will be implemented when tracking object 1 is active.

R1(config)# **ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1**
R1(config)#

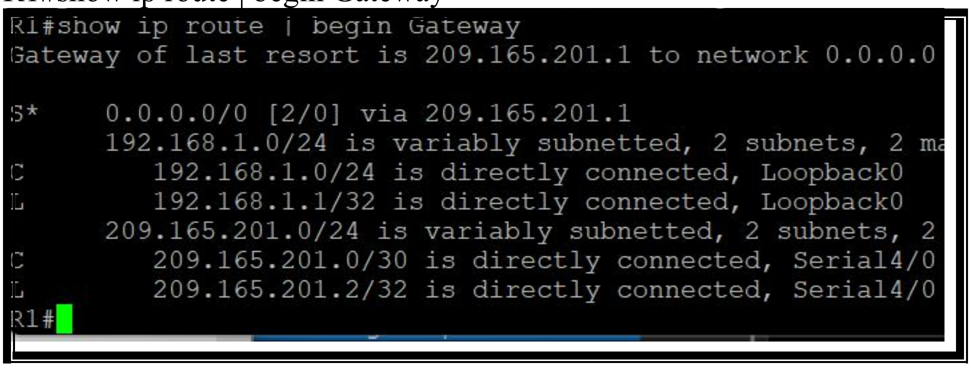


```
May 18 23:23:14.759: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1   1048578

May 18 23:23:14.763: RT: closer admin distance for 0.0.0.
May 18 23:23:14.767: RT: add 0.0.0.0/0 via 209.165.201.1,
May 18 23:23:14.771: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1   1048578

May 18 23:23:14.775: RT: rib update return code: 17
May 18 23:23:14.775: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1   1048578
```

g.Repeat the steps for operation 22, track number 2, and assign the static route an admin distance higher than track 1 and lower than 5.

R1(config)# **track 2 ip sla 22 reachability**
R1(config-track)# **delay down 10 up 1**
R1(config-track)# **exit**
R1(config)#
R1(config)# **ip route 0.0.0.0 0.0.0.0 209.165.202.129 3 track 2**
R1(config)#
h. Verify the routing table again.

R1#show ip route | begin Gateway

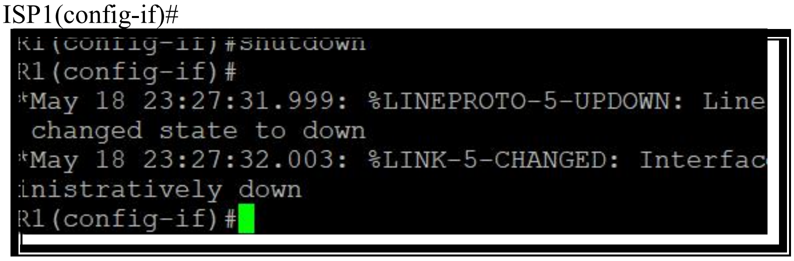


```
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.201.1 to network 0.0.0.0

S*    0.0.0.0/0 [2/0] via 209.165.201.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 ma
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2
C        209.165.201.0/30 is directly connected, Serial4/0
L        209.165.201.2/32 is directly connected, Serial4/0
R1#
```

Step 5: Verify ip sla operation.

a.On ISP1, disable the loopback interface 1.
ISP1(config-if)# **int lo1**

ISP1(config-if)# **shutdown**
ISP1(config-if)#



```
R1(config-if)#shutdown
R1(config-if)#
*May 18 23:27:31.999: %LINEPROTO-5-UPDOWN: Line
 changed state to down
*May 18 23:27:32.003: %LINK-5-CHANGED: Interfac
inistratively down
R1(config-if)#
```

b.On R1, observe the debug output being generated.

R1# **show ip route | begin Gateway**

```
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.201.1 to network 0.0.0.0

S*    0.0.0.0/0 [5/0] via 209.165.201.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/30 is directly connected, Serial4/0
L        209.165.201.2/32 is directly connected, Serial4/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.202.128/30 is directly connected, Serial4/2
L        209.165.202.130/32 is directly connected, Serial4/2
R1#show ip sla statistics
```

c.Verify the IP SLA statistics.

R1# **show ip sla statistics**

```
1#show ip sla statistics
PSLAs Latest Operation Statistics

PSLA operation id: 11
       Latest RTT: NoConnection/Busy/Timeout
atest operation start time: 16:12:49 UTC Sat May 7 2022
atest operation return code: Timeout
umber of successes: 167
umber of failures: 24
peration time to live: Forever



PSLA operation id: 22
       Latest RTT: NoConnection/Busy/Timeout
atest operation start time: 16:12:46 UTC Sat May 7 2022
```

d. On R1, initiate a trace to the web server from the internal LAN IP address.

R1# **trace 209.165.200.254 source 192.168.1.1**

e. On ISP1, re-enable the DNS address by issuing the no shutdowncommand on the loopback 1 interface

ISP1(config-if)# **no shutdown**

```
P routing debugging is on
1#conf t
nter configuration commands, one per line.  End with CNTL/
1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1
1(config)#
May  7 15:59:31.491: RT: updating static 0.0.0.0/0 (0x0):
   via 209.165.201.1   1048578

May  7 15:59:31.491: RT: closer admin distance for 0.0.0.0

May  7 15:59:31.491: RT: add 0.0.0.0/0 via 209.165.201.1,

May  7 15:59:31.491: RT: updating static 0.0.0.0/0 (0x0):
   via 209.165.201.1   1048578

May  7 15:59:31.491: RT: rib update return code: 17
May  7 15:59:31.491: RT: updating static 0.0.0.0/0 (0x0):
   via 209.165.201.1   1048578
```

f. Again examine the IP SLA statistics.
R1# **show ip sla statistics**

```
.1#show ip sla configuration 22
P SLAs Infrastructure Engine-III
ntry number: 22
wner:
ag:
peration timeout (milliseconds): 5000
ype of operation to perform: icmp-echo
arget address/Source address: 209.165.202.158/
ype Of Service parameter: 0x0
equest size (ARR data portion): 28
erify data: No
rf Name:
```

g.Verify the routing table.

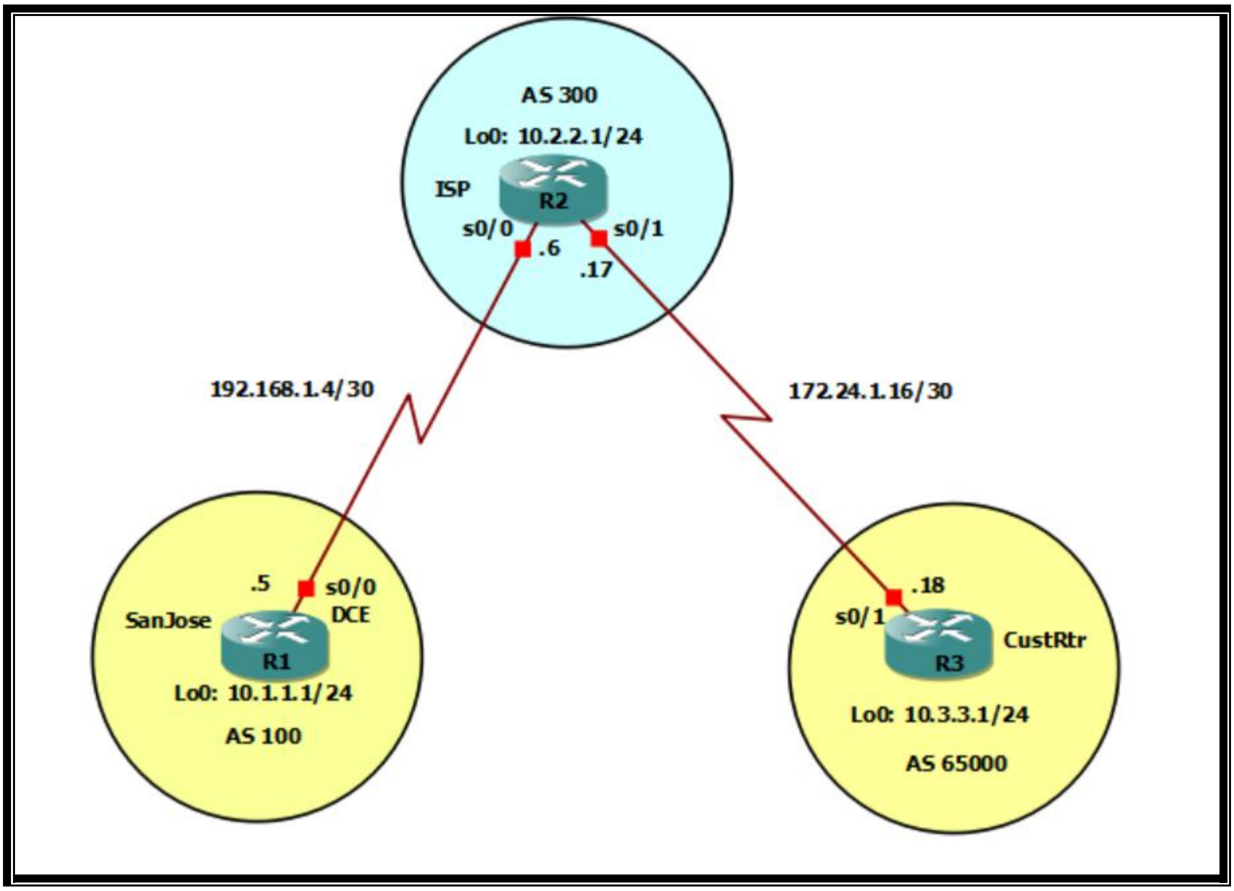
R1# **show ip route | begin Gateway**

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#no ip route 0.0.0.0 0.0.0.0 209.165.201.1
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 5
R1(config)#exit
R1#
*May  7 15:57:11.527: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.201.1 to network 0.0.0.0

S*    0.0.0.0/0 [5/0] via 209.165.201.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/30 is directly connected, Serial4/0
L        209.165.201.2/32 is directly connected, Serial4/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.202.128/30 is directly connected, Serial4/2
L        209.165.202.130/32 is directly connected, Serial4/2
R1#
```

Practical No – 2

Aim: Using the AS_PATH Attribute.

Topolgy :



Objectives:

- Use BGP commands to prevent private AS numbers from being advertised to the outside world.
- Use the AS_PATH attribute to filter BGP routes based on their source AS numbers.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 0: Prepare the routers for the lab.

a.Apply the following configuration to each router along with the appropriate hostname. **The** exec-timeout 0 0 **command should only be used in a lab environment**

Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0

Step 2 : Configure the hostname and interface addresses.

a.You can copy and paste the following configurations into your routers to begin.

SanJose(config)# interface Loopback0

SanJose(config-if)# ip address 10.1.1.1 255.255.255.0

SanJose(config-if)# exit

SanJose(config)# interface Serial0/0/0

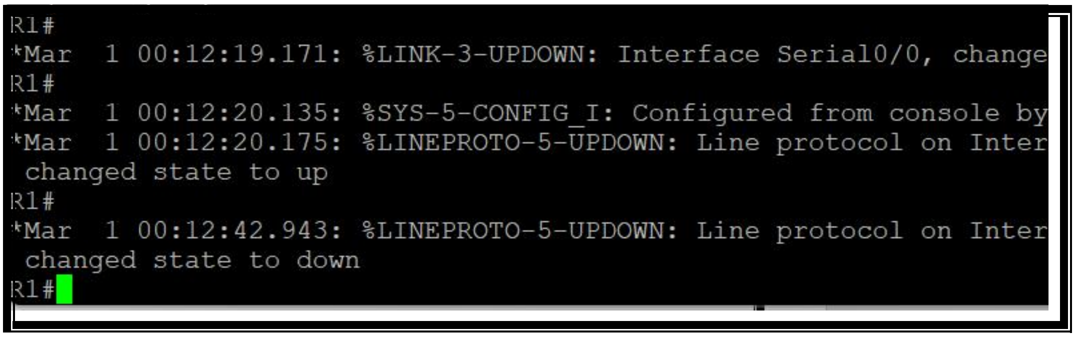
SanJose(config-if)# ip address 192.168.1.5 255.255.255.252

SanJose(config-if)# clock rate 128000

SanJose(config-if)# no shutdown

SanJose(config-if)# end

SanJose#



```
R1#
*Mar  1 00:12:19.171: %LINK-3-UPDOWN: Interface Serial0/0, change
R1#
*Mar  1 00:12:20.135: %SYS-5-CONFIG_I: Configured from console by
*Mar  1 00:12:20.175: %LINEPROTO-5-UPDOWN: Line protocol on Inter
 changed state to up
R1#
*Mar  1 00:12:42.943: %LINEPROTO-5-UPDOWN: Line protocol on Inter
 changed state to down
R1#
```

ISP(config)# interface Loopback0

ISP(config-if)# ip address 10.2.2.1 255.255.255.0

ISP(config-if)# interface Serial0/0/0

ISP(config-if)# ip address 192.168.1.6 255.255.255.252

ISP(config-if)# no shutdown

ISP(config-if)# exit

ISP(config)# interface Serial0/0/1

ISP(config-if)# ip address 172.24.1.17 255.255.255.252

ISP(config-if)# clock rate 128000

ISP(config-if)# no shutdown

ISP(config-if)# end

ISP#

```
R2(config-if)#no shutdown
R2(config-if)#
*Mar  1 00:16:27.391: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
R2(config-if)#
*Mar  1 00:16:28.395: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1
 changed state to up
R2(config-if)#end
R2#
*Mar  1 00:16:33.191: %SYS-5-CONFIG_I: Configured from console by console
R2#
```

CustRtr(config)# interface Loopback0

CustRtr(config-if)# ip address 10.3.3.1 255.255.255.0

CustRtr(config-if)# exit

CustRtr(config)# interface Serial0/0/1

CustRtr(config-if)# ip address 172.24.1.18 255.255.255.252

CustRtr(config-if)# no shutdown

CustRtr(config-if)# end

CustRtr#

```
R3#
*Mar  1 00:17:59.731: %LINK-3-UPDOWN: Interface Serial0/1, changed state
R3#
*Mar  1 00:18:00.735: %LINEPROTO-5-UPDOWN: Line protocol on Interface Se
 changed state to up
*Mar  1 00:18:00.959: %SYS-5-CONFIG_I: Configured from console by consol
R3#
```

b. Use ping to test the connectivity between the directly connected routers.

```
R2#ping 192.168.1.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.5, timeout is 2 seco
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/8/
R2#
```

Step 3 : Configure BGP.

a. Configure BGP for normal operation. Enter the appropriate BGP commands on each router so that they identify their BGP neighbors and advertise their loopback networks.

SanJose#show ip route

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS leve
       ia - IS-IS inter area, * - candidate default, U - per-user static
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Loopback0
     192.168.1.0/30 is subnetted, 1 subnets
C       192.168.1.4 is directly connected, Serial0/0
R1#
```

b. **Ping the 10.3.3.1 address from SanJose.**

```
R1#ping 10.3.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
R1#
```

c. **Ping again, this time as an extended ping, sourcing from the Loopback0 interface address.**

```
R1#ping
Protocol [ip]:
Target IP address: 10.3.3.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 10.1.1.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
.....
Success rate is 0 percent (0/5)
```

SanJose# ping 10.3.3.1 source 10.1.1.1

```
R1#ping 10.3.3.1 source 10.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
.....
Success rate is 0 percent (0/5)
R1#
```

d. Check the BGP table from SanJose by using the show ip bgp **command.**

SanJose# show ip bgp

```
R1#show ip bgp
BGP table version is 3, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*> 10.3.3.0/24      192.168.1.6                            0 300 65000 i
R1#
```

e. Configure ISP to strip the private AS numbers from BGP routes exchanged with SanJose using the following commands.

ISP(config)# router bgp 300

ISP(config-router)# neighbor 192.168.1.5 remove-private-as

```
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#router bgp 300
R2(config-router)#neighbor 192.168.1.5 remove-private-as
% Specify remote-as or peer-group commands first
R2(config-router)#
```

f. After issuing these commands, use the clear ip bgp * **command on ISP to reestablish the BGP relationship between the three routers.**

ISP# clear ip bgp *

```
R2#clear ip bgp *
R2#
*Mar  1 00:58:11.299: %BGP-5-ADJCHANGE: neighbor 172.24.1.18 Down User reset
*Mar  1 00:58:11.299: %BGP-5-ADJCHANGE: neighbor 192.168.1.5 Down User reset
*Mar  1 00:58:11.883: %BGP-5-ADJCHANGE: neighbor 172.24.1.18 Up
R2#
*Mar  1 00:58:12.407: %BGP-5-ADJCHANGE: neighbor 192.168.1.5 Up
R2#
```

SanJose# show ip route

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS lev
       ia - IS-IS inter area, * - candidate default, U - per-user static
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 1 subnets
C       10.1.1.0 is directly connected, Loopback0
     192.168.1.0/30 is subnetted, 1 subnets
C       192.168.1.4 is directly connected, Serial0/0
```

SanJose# ping 10.3.3.1 source lo0

```
R1#ping 10.3.3.1 source lo0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
Packet sent with a source address of 10.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/10/32 ms
```

g. Now check the BGP table on SanJose. The AS_ PATH to the 10.3.3.0 network should be AS 300. It no longer has the private AS in the path.

SanJose# show ip bgp

```
R1#show ip bgp
BGP table version is 6, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > be
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight P
*> 10.1.1.0/24      0.0.0.0                  0         32768 i
*> 10.3.3.0/24      192.168.1.6                            0 3
R1#
```

Step 4 : Remove the private AS.

a. Configure a special kind of access list to match BGP routes with an AS_PATH attribute that both begins and ends with the number 100.

ISP(config)# ip as-path access-list 1 deny ^100$

ISP(config)# ip as-path access-list 1 permit .*

ISP(config)# router bgp 300

ISP(config-router)# neighbor 172.24.1.18 filter-list 1 out

b. Use the clear ip bgp * **command to reset the routing information.**

ISP# clear ip bgp *

```
R2#clear ip bgp *
R2#
*Mar  1 01:20:12.331: %BGP-5-ADJCHANGE: neighbor 172.24.1.18 I
*Mar  1 01:20:12.331: %BGP-5-ADJCHANGE: neighbor 192.168.1.5 I
R2#
*Mar  1 01:20:13.439: %BGP-5-ADJCHANGE: neighbor 192.168.1.5 U
R2#
*Mar  1 01:20:14.875: %BGP-5-ADJCHANGE: neighbor 172.24.1.18 U
```

ISP# show ip route

```
R2#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS le
       ia - IS-IS inter area, * - candidate default, U - per-user stati
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.24.0.0/30 is subnetted, 1 subnets
C       172.24.1.16 is directly connected, Serial0/1
     10.0.0.0/24 is subnetted, 3 subnets
B       10.3.3.0 [20/0] via 172.24.1.18, 00:00:28
```

c. Check the routing table for CustRtr. It should not have a route to 10.1.1.0 in its routing table.

CustRtr# show ip route

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static rout
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.24.0.0/30 is subnetted, 1 subnets
C       172.24.1.16 is directly connected, Serial0/1
     10.0.0.0/24 is subnetted, 1 subnets
C       10.3.3.0 is directly connected, Loopback0
R3#
```

e. Return to ISP and verify that the filter is working as intended. Issue the show ip bgp regexp ^100$ **command.**

ISP# show ip bgp regexp ^100$

```
R2#Show ip bgp regexp ^100$
BGP table version is 3, local router ID is 10.2.2.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 10.1.1.0/24      192.168.1.5              0             0 100 i
R2#
```

f. Run the following Tcl script on all routers to verify whether there is connectivity.

ISP# tclsh

```
foreach address {
10.1.1.1
10.2.2.1
```

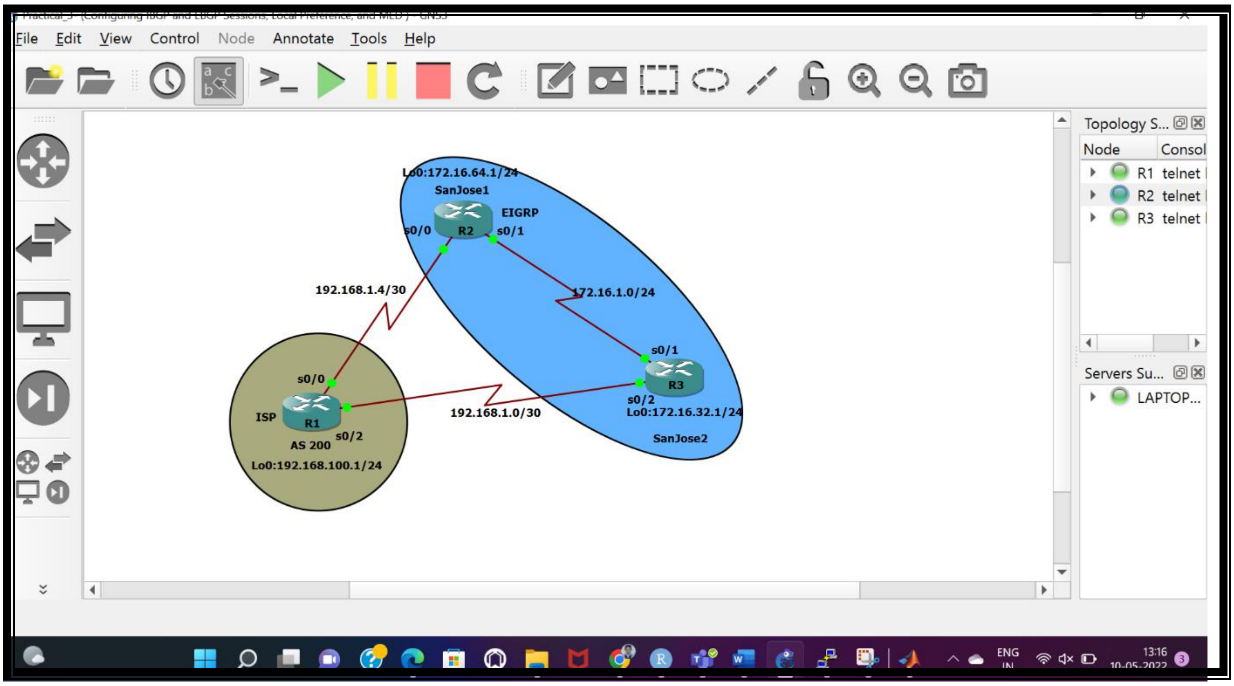
10.3.3.1
192.168.1.5
192.168.1.6
172.24.1.17
172.24.1.18
} {
ping $address }

```
R2#ping 10.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/12 ms
R2#ping 10.2.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
R2#ping 10.3.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/16 ms
R2#ping 192.168.1.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R2#ping 192.168.1.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/7/20 ms
R2#ping 172.24.1.17

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.24.1.17, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/10/28 ms
R2#ping 172.24.1.18

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.24.1.18, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/16 ms
R2#
```

Practical No – 3

Aim: Configuring IBGP and EBGP Sessions, Local Preference, and MED

Topolgy :



Objectives:

- For IBGP peers to correctly exchange routing information, use the **next-hop-self** command with the **Local-Preference** and **MED** attributes.
- Ensure that the flat-rate, unlimited-use T1 link is used for sending and receiving data to and fromthe AS 200 on ISP and that the metered T1 only be used in the event that the primary T1 link has failed.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

a. Apply the following configuration to each router along with the appropriate hostname.

Router(config)# no ip domain-lookup

Router(config)# line con 0

Router(config-line)# logging synchronous

Router(config-line)# exec-timeout 0 0

Step 1: Configure interface addresses.

a. Using the addressing scheme in the diagram, create the loopback interfaces and apply IPv4 addresses to these and the serial interfaces on ISP (R1), SanJose1 (R2), and SanJose2 (R3)

Router R1 (hostname ISP)

ISP(config)# interface Loopback0
ISP(config-if)# ip address 192.168.100.1 255.255.255.0
ISP(config-if)# exit
ISP(config)# interface Serial0/0/0
ISP(config-if)# ip address 192.168.1.5 255.255.255.252

ISP(config-if)# clock rate 128000
ISP(config-if)# no shutdown
ISP(config-if)# exit
ISP(config)# interface Serial0/0/1
ISP(config-if)# ip address 192.168.1.1 255.255.255.252
ISP(config-if)# no shutdown
ISP(config-if)# end
ISP#

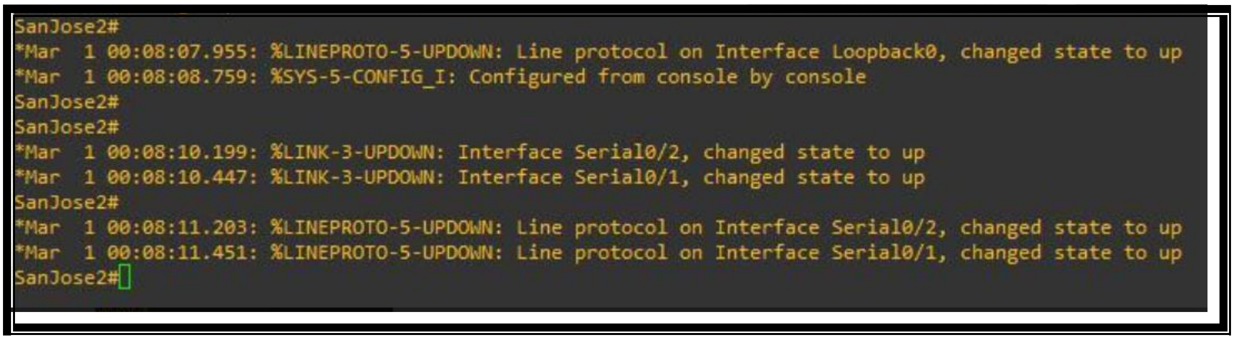
```
*Mar  1 00:03:44.479: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state
*Mar  1 00:03:45.087: %SYS-5-CONFIG_I: Configured from console by console
ISP#
*Mar  1 00:03:46.519: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar  1 00:03:46.783: %LINK-3-UPDOWN: Interface Serial0/2, changed state to up
ISP#
*Mar  1 00:03:47.523: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state
*Mar  1 00:03:47.787: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/2, changed state
ISP#
```

Router R2 (hostname SanJose1)
SanJose1(config)# interface Loopback0
SanJose1(config-if)# ip address 172.16.64.1 255.255.255.0
SanJose1(config-if)# exit
SanJose1(config)# interface Serial0/0/0
SanJose1(config-if)# ip address 192.168.1.6 255.255.255.252
SanJose1(config-if)# no shutdown
SanJose1(config-if)# exit
SanJose1(config)# interface Serial0/0/1
SanJose1(config-if)# ip address 172.16.1.1 255.255.255.0
SanJose1(config-if)# clock rate 128000
SanJose1(config-if)# no shutdown
SanJose1(config-if)# end
SanJose1#

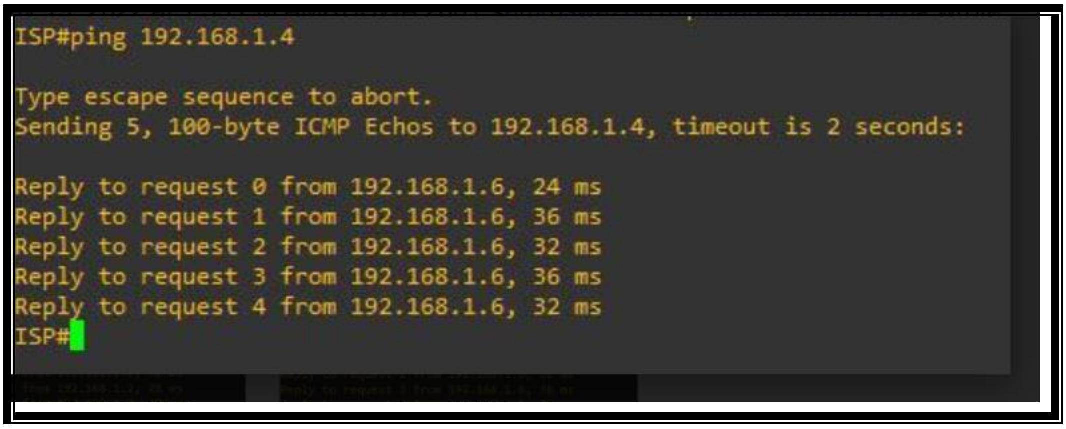
```
SanJose1#
*Mar  1 00:06:20.299: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
*Mar  1 00:06:21.063: %SYS-5-CONFIG_I: Configured from console by console
SanJose1#
*Mar  1 00:06:22.331: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar  1 00:06:22.759: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
SanJose1#
*Mar  1 00:06:23.335: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
*Mar  1 00:06:23.763: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
SanJose1#
```

Router R3 (hostname SanJose2)
SanJose2(config)# interface Loopback0
SanJose2(config-if)# ip address 172.16.32.1 255.255.255.0
SanJose2(config-if)# exit
SanJose2(config)# interface Serial0/0/0
SanJose2(config-if)# ip address 192.168.1.2 255.255.255.252
SanJose2(config-if)# clock rate 128000
SanJose2(config-if)# no shutdown
SanJose2(config-if)# exit
SanJose2(config)# interface Serial0/0/1
SanJose2(config-if)# ip address 172.16.1.2 255.255.255.0
SanJose2(config-if)# no shutdown

SanJose2(config-if)# end
SanJose2#



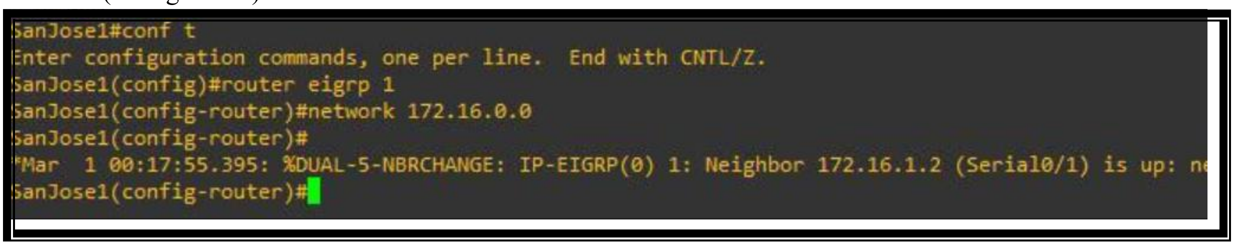
b. Use ping **to test the connectivity between the directly connected routers. Both SanJose routers should be able to ping each other and their local ISP serial link IP address.**



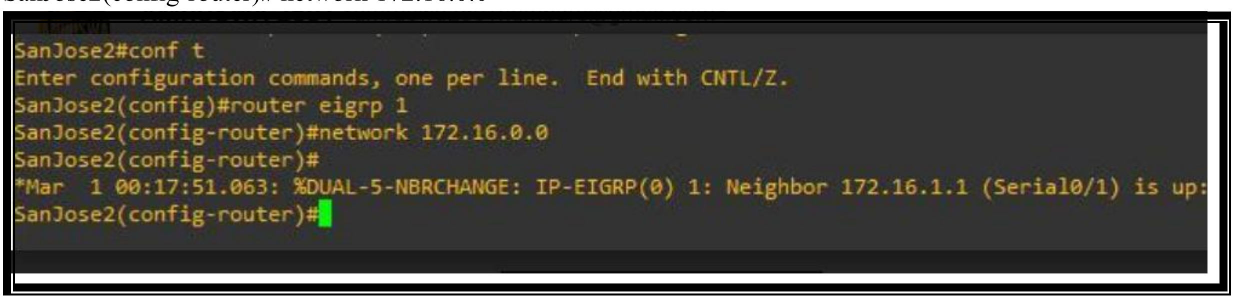
Step 2: Configure EIGRP.

Configure EIGRP between the SanJose1 and SanJose2 routers.

SanJose1(config)# router eigrp 1
SanJose1(config-router)# network 172.16.0.0



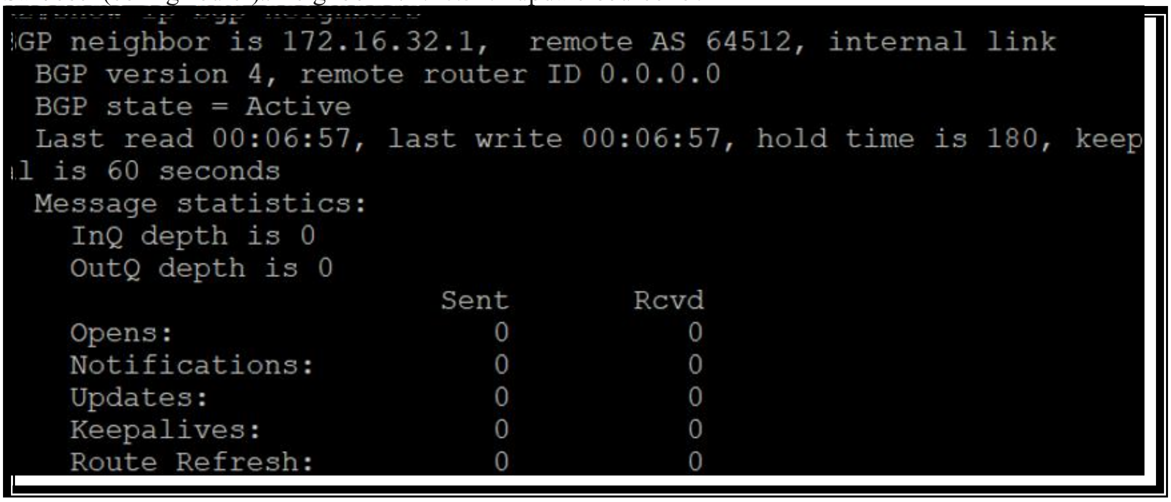
SanJose2(config)# router eigrp 1
SanJose2(config-router)# network 172.16.0.0



Step 3: Configure IBGP and verify BGP neighbors.

a. Configure IBGP between the SanJose1 and SanJose2 routers. On the SanJose1 router, enter the following configuration.

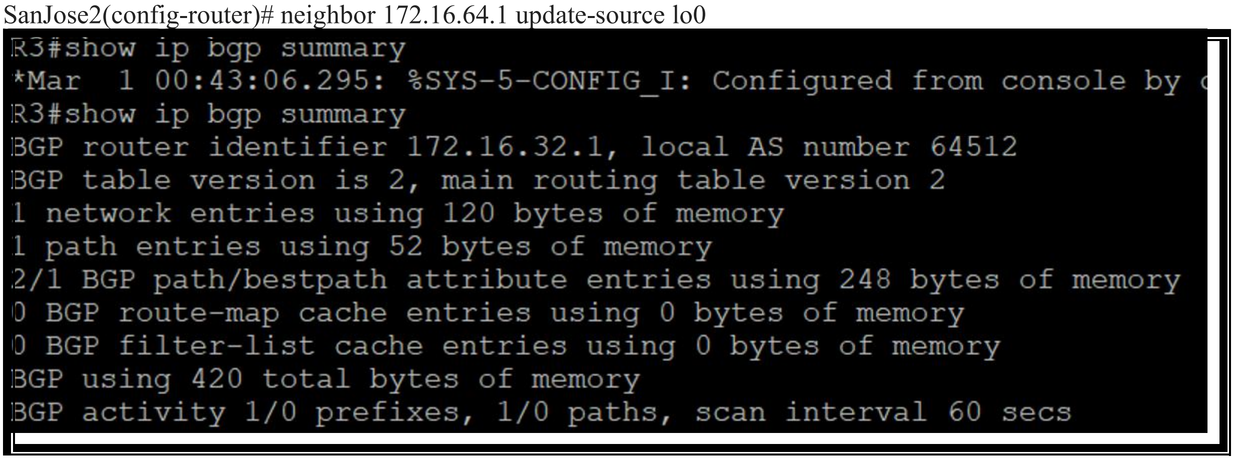
SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 172.16.32.1 remote-as 64512
SanJose1(config-router)# neighbor 172.16.32.1 update-source lo0



```
3GP neighbor is 172.16.32.1,  remote AS 64512, internal link
 BGP version 4, remote router ID 0.0.0.0
 BGP state = Active
 Last read 00:06:57, last write 00:06:57, hold time is 180, keep
al is 60 seconds
 Message statistics:
   InQ depth is 0
   OutQ depth is 0
                        Sent       Rcvd
   Opens:                  0          0
   Notifications:          0          0
   Updates:                0          0
   Keepalives:             0          0
   Route Refresh:          0          0
```

b. Complete the IBGP configuration on SanJose2 using the following commands.

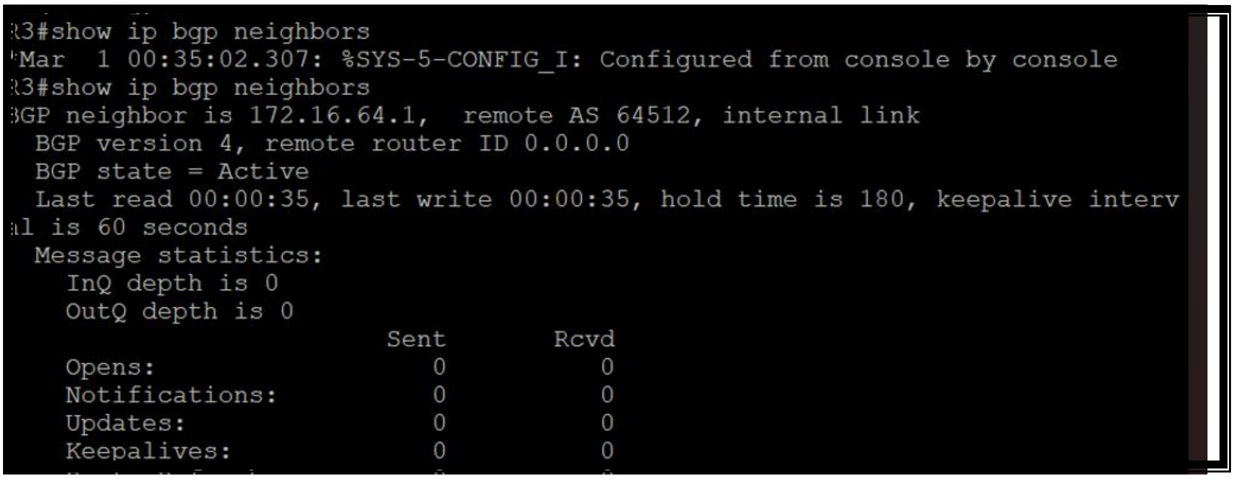
SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 172.16.64.1 remote-as 64512
SanJose2(config-router)# neighbor 172.16.64.1 update-source lo0



```
R3#show ip bgp summary
*Mar  1 00:43:06.295: %SYS-5-CONFIG_I: Configured from console by c
R3#show ip bgp summary
BGP router identifier 172.16.32.1, local AS number 64512
BGP table version is 2, main routing table version 2
1 network entries using 120 bytes of memory
1 path entries using 52 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 420 total bytes of memory
BGP activity 1/0 prefixes, 1/0 paths, scan interval 60 secs
```

c. Verify that SanJose1 and SanJose2 become BGP neighbors by issuing the show ip bgp neighbors **command on SanJose1.**

SanJose2# show ip bgp neighbors
BGP neighbor is 172.16.64.1, remote AS 64512, internal link
  BGP version 4, remote router ID 172.16.64.1
  BGP state = Established, up for 00:00:22
  Last read 00:00:22, last write 00:00:22, hold time is 180, keepalive interval is 60 seconds
<output omitted>

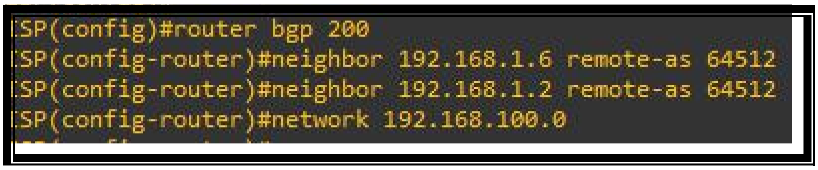


```
R3#show ip bgp neighbors
*Mar  1 00:35:02.307: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip bgp neighbors
BGP neighbor is 172.16.64.1,  remote AS 64512, internal link
  BGP version 4, remote router ID 0.0.0.0
  BGP state = Active
  Last read 00:00:35, last write 00:00:35, hold time is 180, keepalive interv
al is 60 seconds
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  0          0
    Notifications:          0          0
    Updates:                0          0
    Keepalives:             0          0
```

Step 4: Configure EBGP and verify BGP neighbors.

a. Configure ISP to run EBGP with SanJose1 and SanJose2. Enter the following commands on ISP.

ISP(config)# router bgp 200
ISP(config-router)# neighbor 192.168.1.6 remote-as 64512
ISP(config-router)# neighbor 192.168.1.2 remote-as 64512
ISP(config-router)# network 192.168.100.0



```
ISP(config)#router bgp 200
ISP(config-router)#neighbor 192.168.1.6 remote-as 64512
ISP(config-router)#neighbor 192.168.1.2 remote-as 64512
ISP(config-router)#network 192.168.100.0
```

SanJose1(config)# ip route 172.16.0.0 255.255.0.0 null0

c. Configure SanJose1 as an EBGP peer to ISP

SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 192.168.1.5 remote-as 200
SanJose1(config-router)# network 172.16.0.0

```
R2#show ip bgp neighbors
BGP neighbor is 172.16.32.1,  remote AS 64512, internal link
  BGP version 4, remote router ID 0.0.0.0
  BGP state = Active
  Last read 00:06:57, last write 00:06:57, hold time is 180,
al is 60 seconds
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  0          0
    Notifications:          0          0
    Updates:                0          0
    Keepalives:             0          0
    Route Refresh:          0          0
    Total:                  0          0
  Default minimum time between advertisement runs is 0 second

 For address family: IPv4 Unicast
  BGP table version 2, neighbor version 0/0
  Output queue size: 0
  Index 1, Offset 0, Mask 0x2
  1 update-group member
                                 Sent       Rcvd
  Prefix activity:               ----       ----
```

d. Use the show ip bgp neighbors **command to verify that SanJose1 and ISP have reached the established state.**

SanJose1# show ip bgp neighbors
BGP neighbor is 172.16.32.1, remote AS 64512, internal link
  BGP version 4, remote router ID 172.16.32.1
  BGP state = Established, up for 00:12:43
<output omitted>

BGP neighbor is 192.168.1.5, remote AS 200, external link
  BGP version 4, remote router ID 192.168.100.1
  BGP state = Established, up for 00:06:49
  Last read 00:00:42, last write 00:00:45, hold time is 180, keepalive interval is 60 seconds
<output omitted>

```
R2#show ip bgp neighbors
BGP neighbor is 172.16.32.1,  remote AS 64512, internal link
  BGP version 4, remote router ID 0.0.0.0
  BGP state = Active
  Last read 00:06:57, last write 00:06:57, hold time is 180, keepalive
al is 60 seconds
  Message statistics:
    InQ depth is 0
```

e. Configure a discard static route for 172.16.0.0/16 on SanJose2 and as an EBGP peer to ISP.

SanJose2(config)# ip route 172.16.0.0 255.255.0.0 null0
SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 192.168.1.1 remote-as 200
SanJose2(config-router)# network 172.16.0.0

```
R3(config-router)#neighbor 192.168.1.1 route-map SECONDARY_T1_IN in
R3(config-router)#exit
R3(config)#exit
R3#
*Mar  1 01:14:18.127: %SYS-5-CONFIG_I: Configured from console by console
R3#clear ip bgp * soft
R3#show ip bgp
BGP table version is 2, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - inte
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       0.0.0.0                  0         32768 i
R3#
```

Step 5: View BGP summary output.

SanJose2# show ip bgp summary

```
R3
R3#show ip bgp summary
*Mar  1 00:43:06.295: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip bgp summary
BGP router identifier 172.16.32.1, local AS number 64512
BGP table version is 2, main routing table version 2
1 network entries using 120 bytes of memory
1 path entries using 52 bytes of memory
2/1 BGP path/bestpath attribute entries using 248 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 420 total bytes of memory
BGP activity 1/0 prefixes, 1/0 paths, scan interval 60 secs
```

Step 6: Verify which path the traffic takes.

f. Clear the IP BGP conversation with the clear ip bgp * **command on ISP. Wait for the conversations to reestablish with each SanJose router.**

ISP# clear ip bgp *

```
R2#clear ip bgp * soft
*Mar  1 01:14:25.319: %SYS-5-CONFIG_I: Configured from console by console
R2#clear ip bgp * soft
R2#show ip bgp
BGP table version is 4, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       0.0.0.0                  0         32768 i
*> 192.168.100.0    192.168.1.5              0    150      0 200 i
R2#
```

g. Test whether ISP can ping the loopback 0 address of 172.16.64.1 on SanJose1 and the serial link between SanJose1 and SanJose2, 172.16.1.1.

ISP# ping 172.16.64.1

```
R1#ping 172.16.32.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.32.1, timeout is 2 seconds:
UUUUU
Success rate is 0 percent (0/5)
R1#ping 172.16.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.2, timeout is 2 seconds:
```

h. Now ping from ISP to the loopback 0 address of 172.16.32.1 on SanJose2 and the serial link between SanJose1 and SanJose2, 172.16.1.2.

ISP# ping 172.16.32.1

```
R1#ping 172.16.32.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.32.1,
UUUUU
Success rate is 0 percent (0/5)
R1#ping 172.16.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.2, t
.....
Success rate is 0 percent (0/5)
```

i. Issue the show ip bgp **command on ISP to verify BGP routes and metrics.**

ISP# show ip bgp

```
R1#show ip bgp
BGP table version is 4, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       192.168.1.6              0             0 64512 i
*> 192.168.1.4/30   0.0.0.0                  0         32768 i
*> 192.168.100.0    0.0.0.0                  0         32768 i
R1#
```

ISP# ping 172.16.1.1 source 192.168.100.1

```
R1#ping 172.16.1.1 source 192.168.100.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.100.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping 172.16.32.1 source 192.168.100.1
```

ISP# ping 172.16.64.1 source 192.168.100.1

```
R1#ping 172.16.64.1 source 192.168.100.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.100.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
R1#ping
Protocol [ip]:
```

ISP# ping

```
R1#ping
Protocol [ip]:
Target IP address: 172.16.64.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.100.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.100.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/5/12 ms
R1#
```

Step 7: Configure the BGP next-hop-self feature.

a. Issue the following commands on the ISP router.

ISP(config)# router bgp 200
ISP(config-router)# network 192.168.1.0 mask 255.255.255.252
ISP(config-router)# network 192.168.1.4 mask 255.255.255.252

b. Issue the show ip bgp **command to verify that the ISP is correctly injecting its own WAN links into BGP.**

```
ISP#show ip bgp
BGP table version is 5, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  172.16.0.0       192.168.1.6              0             0 64512 i
*>                  192.168.1.2              0             0 64512 i
*> 192.168.1.0/30   0.0.0.0                  0         32768 i
*> 192.168.1.4/30   0.0.0.0                  0         32768 i
*> 192.168.100.0    0.0.0.0                  0         32768 i
ISP#
```

c. Verify on SanJose1 and SanJose2 that the opposite WAN link is included in the routing table. The output from SanJose2 is as follows.

SanJose2# show ip route

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static rout
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
C       172.16.32.0/24 is directly connected, Loopback0
```

d. To better understand the next-hop-self **command we will remove ISP advertising its two WAN links and shutdown the WAN link between ISP and SanJose2.**

ISP(config)# router bgp 200
ISP(config-router)# no network 192.168.1.0 mask 255.255.255.252
ISP(config-router)# no network 192.168.1.4 mask 255.255.255.252
ISP(config-router)# exit
ISP(config)# interface serial 0/0/1
ISP(config-if)# shutdown
ISP(config-if)#

```
R1#show ip bgp
BGP table version is 7, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid,
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weig
```

e. Display SanJose2's BGP table using the show ip bgp **command and the IPv4 routing table with** show ip route**.**

SanJose2# show ip bgp

```
R3#show ip bgp
BGP table version is 1, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - i
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  172.16.0.0       0.0.0.0                  0         32768 i
```

SanJose2# show ip route

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
       ia - IS-IS inter area, * - candidate default, U - per-user static ro
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
```

f. Issue the next-hop-self **command on SanJose1 and SanJose2 to advertise themselves as the next hop to their IBGP peer.**

SanJose1(config)# router bgp 64512
SanJose1(config-router)# neighbor 172.16.32.1 next-hop-self

SanJose2(config)# router bgp 64512
SanJose2(config-router)# neighbor 172.16.64.1 next-hop-self

g. Reset BGP operation on either router with the clear ip bgp * **command**

SanJose1# clear ip bgp *
SanJose1#

SanJose2# clear ip bgp *
SanJose2#

```
R3#clear ip bgp *
*Mar  1 01:05:40.527: %SYS-5-CONFIG_I: Configured from console by
R3#clear ip bgp *
R3#show ip bgp
BGP table version is 1, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best,
l,
              r RIB-failure, S Stale
```

h. After the routers have returned to established BGP speakers, issue the show ip bgp **command on SanJose2 and notice that the next hop is now SanJose1 instead of ISP**

SanJose2# show ip bgp

```
R3#show ip bgp
BGP table version is 1, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - inte
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  172.16.0.0       0.0.0.0                  0         32768 i
```

i. The show ip route **command on SanJose2 now displays the 192.168.100.0/24 network because SanJose1 is the next hop, 172.16.64.1, which is reachable from SanJose2.**

SanJose2# show ip route

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
       ia - IS-IS inter area, * - candidate default, U - per-user static ro
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
```

j. Before configuring the next BGP attribute, restore the WAN link between ISP and SanJose3.

ISP(config)# interface serial 0/0/1
ISP(config-if)# no shutdown
ISP(config-if)#

SanJose2# show ip route

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
       ia - IS-IS inter area, * - candidate default, U - per-user static ro
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
```

Step 8: Set BGP local preference.

a. Use the clear ip bgp * soft **command after configuring this new policy.**

SanJose1# clear ip bgp * soft

```
R2#clear ip bgp * soft
*Mar  1 01:14:25.319: %SYS-5-CONFIG_I: Configured from console by console
R2#clear ip bgp * soft
R2#show ip bgp
BGP table version is 4, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       0.0.0.0                  0         32768 i
*> 192.168.100.0    192.168.1.5              0    150      0 200 i
R2#
```

SanJose2# clear ip bgp * soft

```
R3#clear ip bgp * soft
R3#show ip bgp
BGP table version is 2, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
```

SanJose1# show ip bgp

```
l1#show ip bgp
GP table version is 7, local router ID is 192.168.100.1
tatus codes: s suppressed, d damped, h history, * valid, > be
,
            r RIB-failure, S Stale
rigin codes: i - IGP, e - EGP, ? - incomplete

  Network          Next Hop            Metric LocPrf Weight
```

Step 9: Set BGP MED.

a. In the previous step we saw that SanJose1 and SanJose2 will route traffic for 192.168.100.0/24 using the link between SanJose1 and ISP.

ISP# show ip bgp
ISP# show ip route

```
R1#show ip bgp
BGP table version is 7, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best,
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       192.168.1.6              0             0 6451
*> 192.168.100.0    0.0.0.0                  0         32768 i
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter a
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external typ
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-
       ia - IS-IS inter area, * - candidate default, U - per-user
e
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
```

b. Use an extended ping **command to verify this situation.**

SanJose2# ping

```
Protocol [ip]:
Target IP address: 172.16.64.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.100.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.64.1, timeo
Packet sent with a source address of 192.168.100.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/av
```

c. Use the clear ip bgp * soft **command after issuing this new policy.**

SanJose1# clear ip bgp * soft

```
R2#clear ip bgp * soft
*Mar  1 01:14:25.319: %SYS-5-CONFIG_I: Configured from console by console
R2#clear ip bgp * soft
R2#show ip bgp
BGP table version is 4, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       0.0.0.0                  0         32768 i
*> 192.168.100.0    192.168.1.5              0    150      0 200 i
R2#
```

SanJose2# clear ip bgp * soft

```
R3#clear ip bgp * soft
R3#show ip bgp
BGP table version is 2, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * val
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf
*> 172.16.0.0       0.0.0.0                  0
R3#
```

d. Reissue an extended ping **command with the** record **command.**

SanJose2# ping

```
Target IP address: 172.16.64.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 192.168.100.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.64.1,
Packet sent with a source address of 192.168.10
!!!!!
Success rate is 100 percent (5/5), round-trip m
```

ISP# show ip bgp

```
R1#show ip bgp
BGP table version is 4, local router ID is 192.168.100.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - interna
l,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 172.16.0.0       192.168.1.6              0             0 64512 i
*> 192.168.1.4/30   0.0.0.0                  0         32768 i
*> 192.168.100.0    0.0.0.0                  0         32768 i
R1#
```

Step 10: Establish a default route.

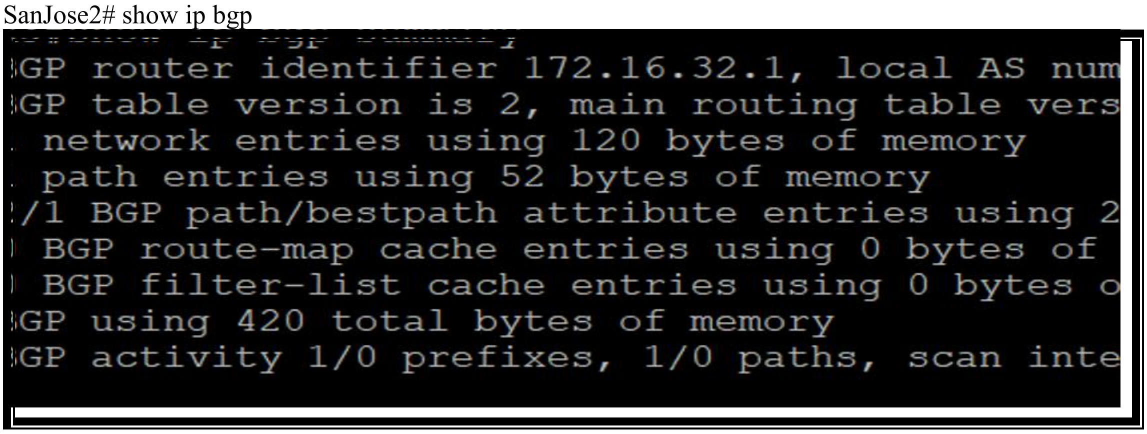
a. Configure ISP to inject a default route to both SanJose1 and SanJose2 using BGP using the default-originate **command**

ISP(config)# router bgp 200
ISP(config-router)# neighbor 192.168.1.6 default-originate
ISP(config-router)# neighbor 192.168.1.2 default-originate
ISP(config-router)# exit

ISP(config)# interface loopback 10
ISP(config-if)# ip address 10.0.0.1 255.255.255.0
ISP(config-if)#

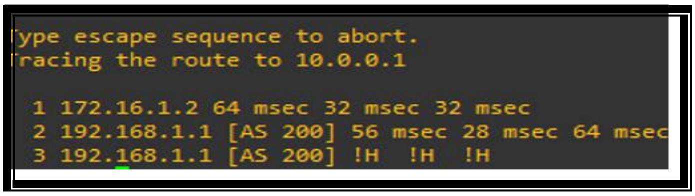
b. Verify that both routers have received the default route by examining the routing tables on SanJose1 and SanJose2.

SanJose1# show ip route
SanJose2# show ip bgp



```
GP router identifier 172.16.32.1, local AS num
GP table version is 2, main routing table vers
 network entries using 120 bytes of memory
 path entries using 52 bytes of memory
/1 BGP path/bestpath attribute entries using 2
 BGP route-map cache entries using 0 bytes of
 BGP filter-list cache entries using 0 bytes o
GP using 420 total bytes of memory
GP activity 1/0 prefixes, 1/0 paths, scan inte
```

SanJose2# traceroute 10.0.0.1
SanJose1# trace 10.0.0.1

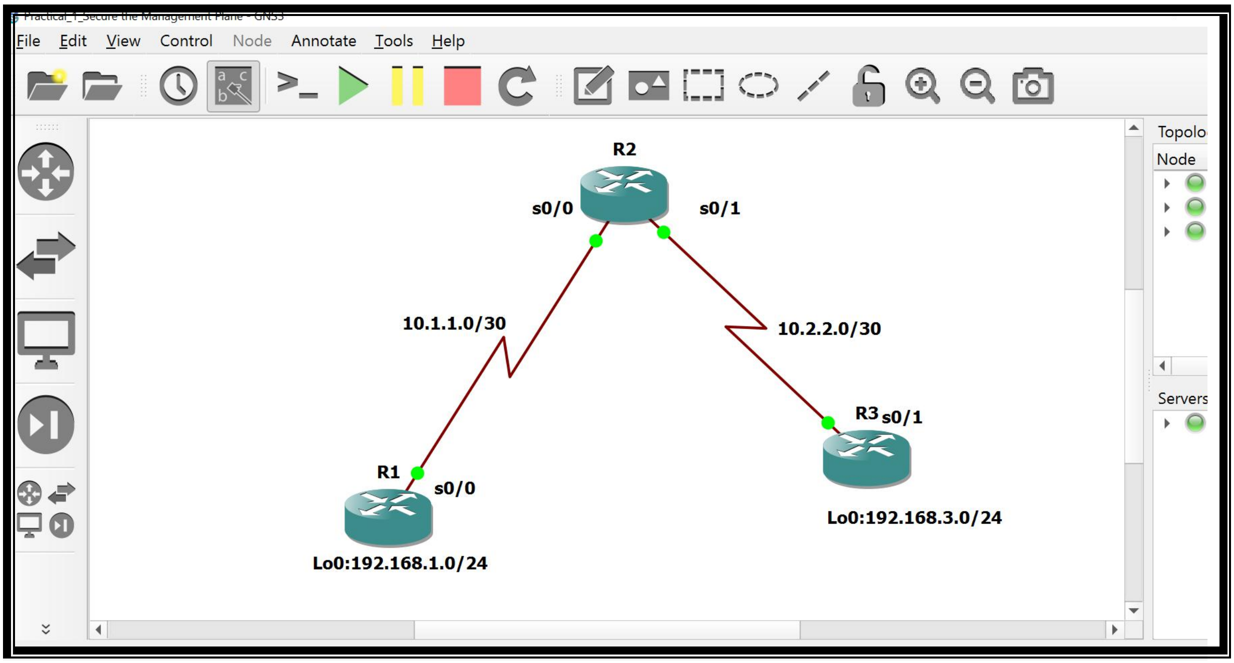


```
ype escape sequence to abort.
racing the route to 10.0.0.1

 1 172.16.1.2 64 msec 32 msec 32 msec
 2 192.168.1.1 [AS 200] 56 msec 28 msec 64 msec
 3 192.168.1.1 [AS 200] !H  !H  !H
```

Practical No – 4

Aim: Secure the Management Plane

Topolgy :



Objectives

- Secure management access.
- Configure enhanced username password security.
- Enable AAA RADIUS authentication.
- Enable secure remote management.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables
-

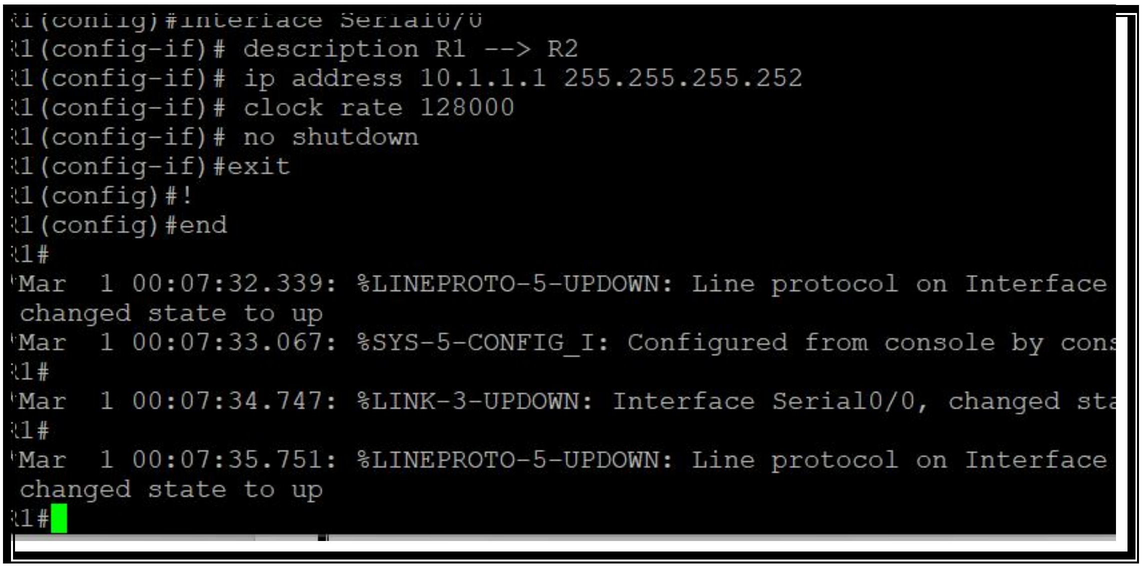
Step 1: Configure loopbacks and assign addresses.

a. Cable the network as shown in the topology diagram. Erase the startup configuration and reload each router to clear previous configurations. Using the addressing scheme in the diagram, apply the IP addresses to the interfaces on the R1, R2, and R3 routers. You can copy and paste the following configurations into your routers to begin.

R1

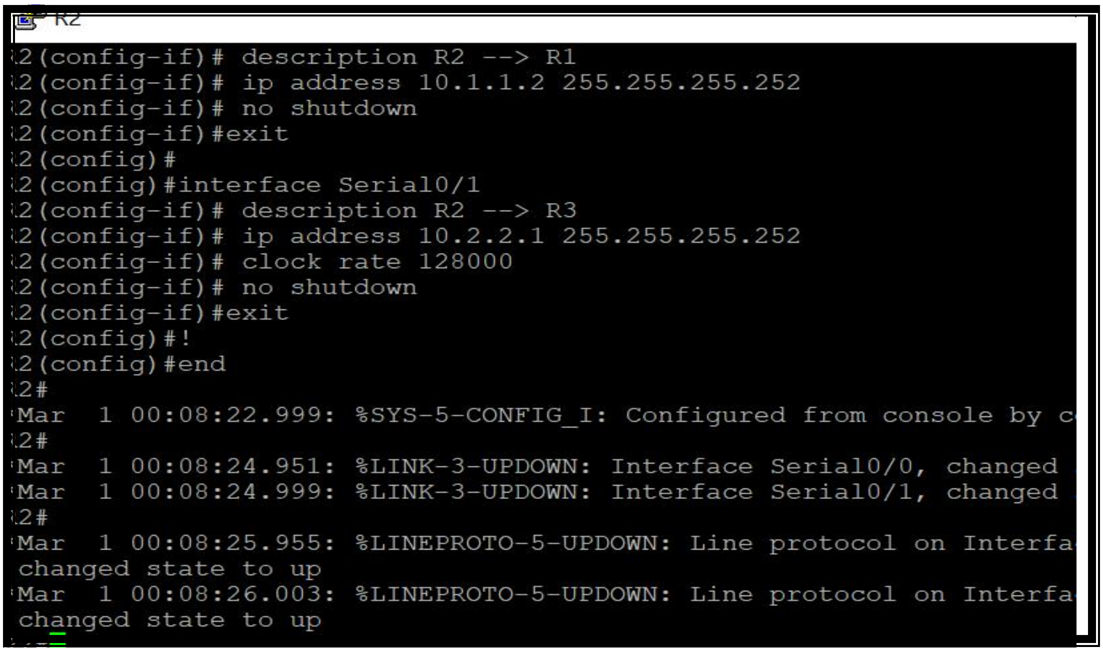
```
hostname R1

interface Loopback 0
 description R1 LAN
 ip address 192.168.1.1 255.255.255.0
exit
!
interface Serial0/0
 description R1 --> R2
 ip address 10.1.1.1 255.255.255.252
 clock rate 128000
 no shutdown
exit
```

!
End



R2
hostname R2
!
interface Serial0/0
 description R2 --> R1
 ip address 10.1.1.2 255.255.255.252
 no shutdown
exit

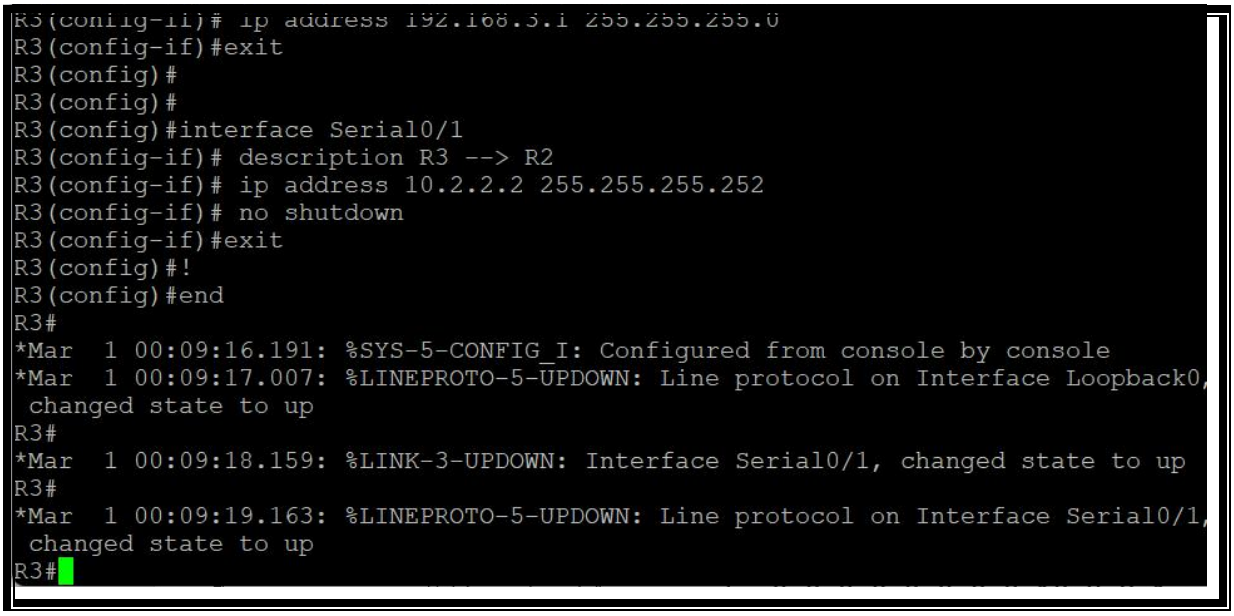
interface Serial0/1
 description R2 --> R3
 ip address 10.2.2.1 255.255.255.252
 clock rate 128000
 no shutdown
exit
!
End



```
R2
2(config-if)# description R2 --> R1
2(config-if)# ip address 10.1.1.2 255.255.255.252
2(config-if)# no shutdown
2(config-if)#exit
2(config)#
2(config)#interface Serial0/1
2(config-if)# description R2 --> R3
2(config-if)# ip address 10.2.2.1 255.255.255.252
2(config-if)# clock rate 128000
2(config-if)# no shutdown
2(config-if)#exit
2(config)#!
2(config)#end
2#
Mar  1 00:08:22.999: %SYS-5-CONFIG_I: Configured from console by c
2#
Mar  1 00:08:24.951: %LINK-3-UPDOWN: Interface Serial0/0, changed
Mar  1 00:08:24.999: %LINK-3-UPDOWN: Interface Serial0/1, changed
2#
Mar  1 00:08:25.955: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
 changed state to up
Mar  1 00:08:26.003: %LINEPROTO-5-UPDOWN: Line protocol on Interfa
 changed state to up
```

R3
hostname R3
!
interface Loopback0
 description R3 LAN
 ip address 192.168.3.1 255.255.255.0
exit

interface Serial0/1
 description R3 --> R2
 ip address 10.2.2.2 255.255.255.252
 no shutdown
exit
!
End



```
R3(config-if)# ip address 192.168.3.1 255.255.255.0
R3(config-if)#exit
R3(config)#
R3(config)#
R3(config)#interface Serial0/1
R3(config-if)# description R3 --> R2
R3(config-if)# ip address 10.2.2.2 255.255.255.252
R3(config-if)# no shutdown
R3(config-if)#exit
R3(config)#!
R3(config)#end
R3#
*Mar  1 00:09:16.191: %SYS-5-CONFIG_I: Configured from console by console
*Mar  1 00:09:17.007: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
 changed state to up
R3#
*Mar  1 00:09:18.159: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
R3#
*Mar  1 00:09:19.163: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
 changed state to up
R3#
```

Step 2: Configure static routes.

a. **On R1, configure a default static route to ISP.**

R1(config)# ip route 0.0.0.0 0.0.0.0 10.1.1.2

b. **On R3, configure a default static route to ISP.**

R3(config)# ip route 0.0.0.0 0.0.0.0 10.2.2.1

c. **On R2, configure two static routes.**

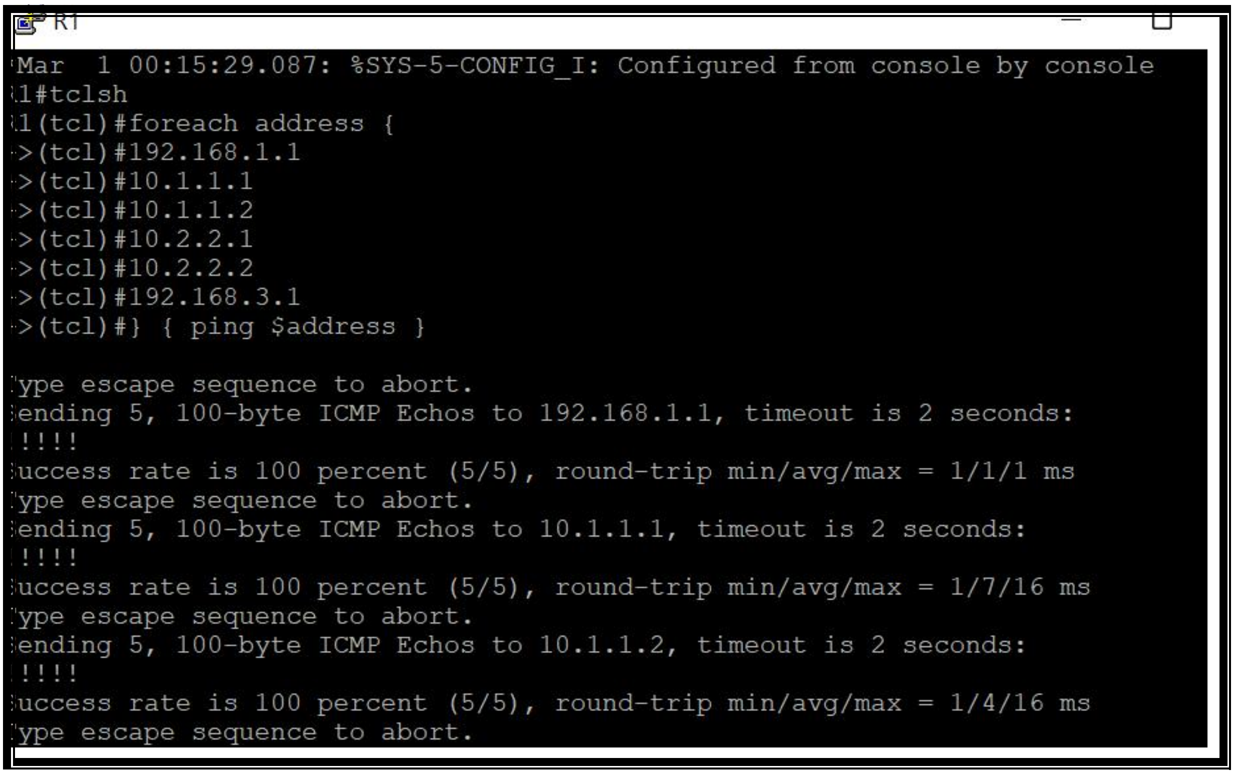
R2(config)# ip route 192.168.1.0 255.255.255.0 10.1.1.1

R2(config)# ip route 192.168.3.0 255.255.255.0 10.2.2.2

d. **From the R1 router, run the following Tcl script to verify connectivity.**

R1# tclsh

```
foreach address {
192.168.1.1
10.1.1.1
10.1.1.2
10.2.2.1
10.2.2.2
192.168.3.1
} { ping $address }
```



Step 3: Secure management access.

a. On R1, use the security passwords command to set a minimum password length of 10 characters.

R1(config)# security passwords min-length 10

b. Configure the enable secret encrypted password on both routers.

R1(config)# enable secret class12345

c. **Configure a console password and enable login for routers. For additional security, the exec-timeout command causes the line to log out after 5 minutes of inactivity.**

R1(config)# **line console 0**
R1(config-line)# **password ciscoconpass**
R1(config-line)# **exec-timeout 5 0**
R1(config-line)# **login**
R1(config-line)# **logging synchronous**
R1(config-line)# **exit**
R1(config)#

d. Configure the password on the vty lines for router R1.

R1(config)# line vty 0 4
R1(config-line)# password ciscovtypass
R1(config-line)# exec-timeout 5 0
R1(config-line)# login
R1(config-line)# exit
R1(config)#

e. The aux port is a legacy port used to manage a router remotely using a modem and is hardly ever used. Therefore, disable the aux port.

R1(config)# **line aux 0**
R1(config-line)# **no exec**
R1(config-line)# **end**
R1#

f. Enter privileged EXEC mode and issue the show run command**. Can you read the enable secret password? Why or why not?**

```
R1#showrun
Translating "showrun"

Translating "showrun"

% Unknown command or computer name, or unable to find computer address
R1#show run
Building configuration...

Current configuration : 1929 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
```

```
*Mar  1 00:58:10.063: %SYS-5-CONFIG_I: Configured from c
R3#show run
Building configuration...

Current configuration : 1908 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
```

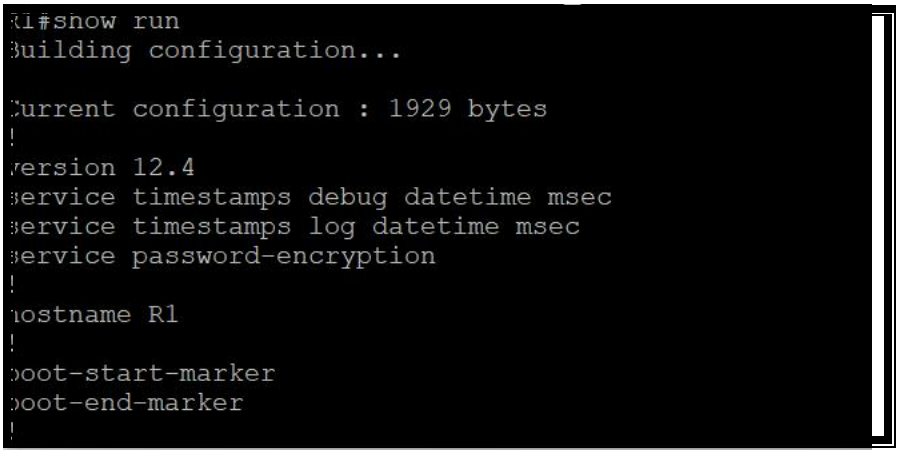
g. Use the service password-encryption command to encrypt the line console and vty passwords.

R1(config)# **service password-encryption**

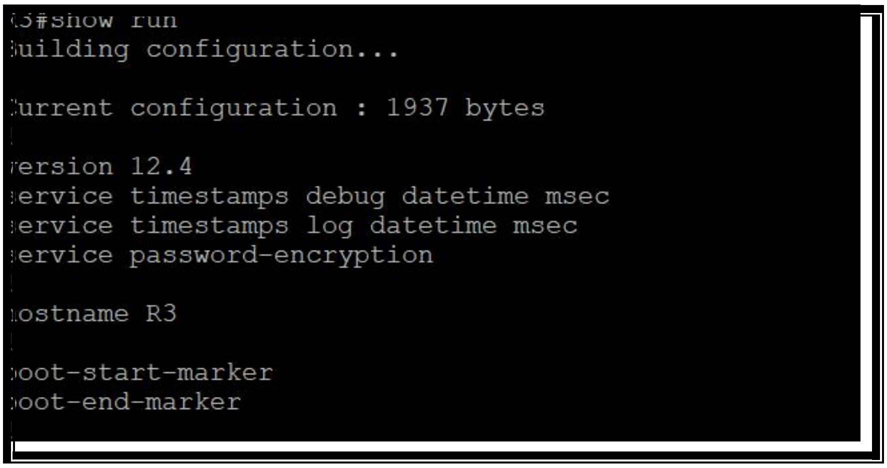
R1(config)#

```
nter configuration commands, one per line.  End with CNTL/Z.
1(config)#service password-encryption
1(config)#exit
1#
Mar  1 00:48:27.471: %SYS-5-CONFIG_I: Configured from console by console
```

h. Configure a warning to unauthorized users with a message-of-the-day (MOTD) banner using the banner motd command.



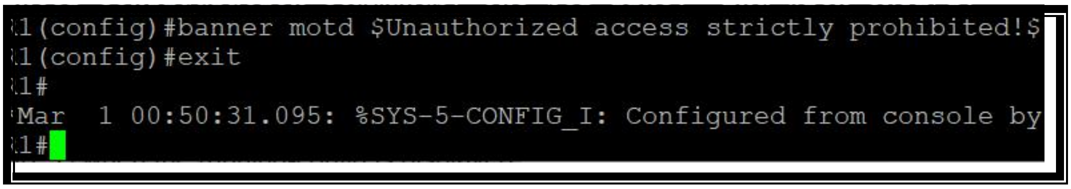
```
ℜ1#show run
Building configuration...

Current configuration : 1929 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
```



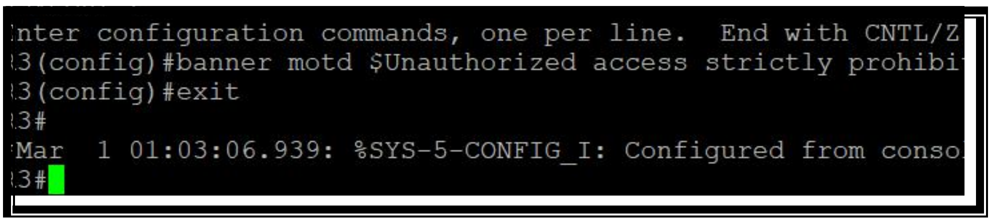
```
R3#show run
Building configuration...

Current configuration : 1937 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
```

i. Issue the show run command. Can you read the console, aux, and vty passwords.

R1(config)# banner motd $Unauthorized access strictly prohibited!$
R1(config)# exit

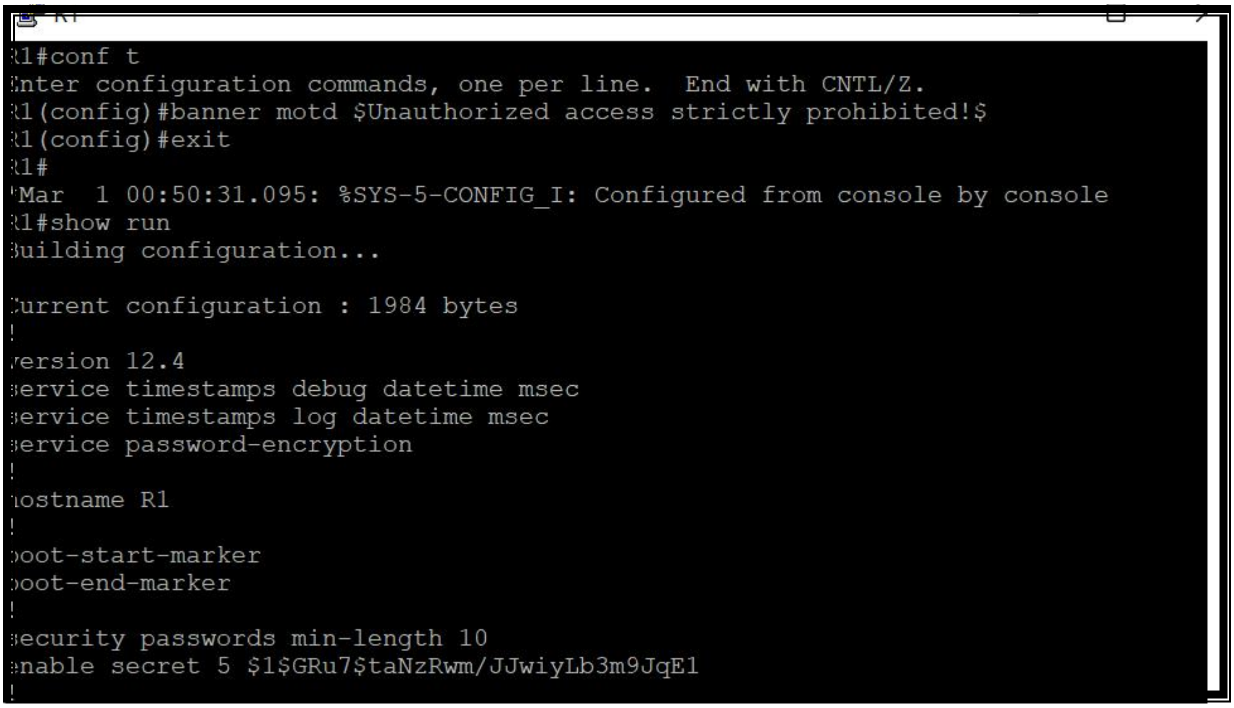


```
R1(config)#banner motd $Unauthorized access strictly prohibited!$
R1(config)#exit
R1#
*Mar  1 00:50:31.095: %SYS-5-CONFIG_I: Configured from console by
R1#
```

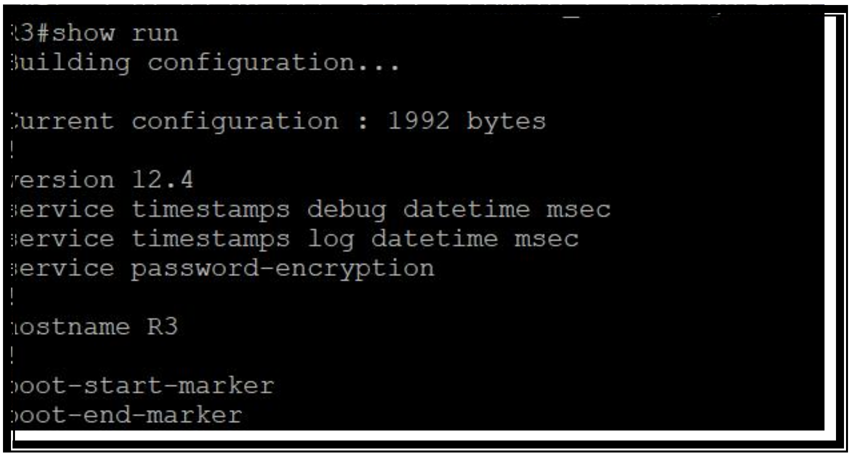


```
Enter configuration commands, one per line.  End with CNTL/Z
R3(config)#banner motd $Unauthorized access strictly prohibi
R3(config)#exit
R3#
*Mar  1 01:03:06.939: %SYS-5-CONFIG_I: Configured from conso
R3#
```

j.Issue the show run command.



```
1#conf t
nter configuration commands, one per line.  End with CNTL/Z.
1(config)#banner motd $Unauthorized access strictly prohibited!$
1(config)#exit
1#
Mar  1 00:50:31.095: %SYS-5-CONFIG_I: Configured from console by console
1#show run
uilding configuration...

urrent configuration : 1984 bytes
!
ersion 12.4
ervice timestamps debug datetime msec
ervice timestamps log datetime msec
ervice password-encryption
!
ostname R1
!
oot-start-marker
oot-end-marker
!
ecurity passwords min-length 10
nable secret 5 $1$GRu7$taNzRwm/JJwiyLb3m9JqE1
!
```



```
3#show run
uilding configuration...

urrent configuration : 1992 bytes
!
ersion 12.4
ervice timestamps debug datetime msec
ervice timestamps log datetime msec
ervice password-encryption
!
ostname R3
!
oot-start-marker
oot-end-marker
```

k.Exit privileged EXEC mode using the disable or exit command and press Enter to get started.
l. Repeat the configuration portion of steps 3a through 3k on router R3

Step 4: Configure enhanced username password security.

a. **To create local database entry encrypted to level 4 (SHA256), use the username *name* secret *password* global configuration command. In global configuration mode, enter the following command:**

R1(config)# **username JR-ADMIN secret class12345**

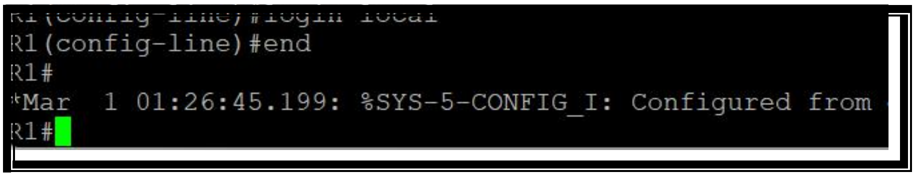
R1(config)# **username ADMIN secret class54321**

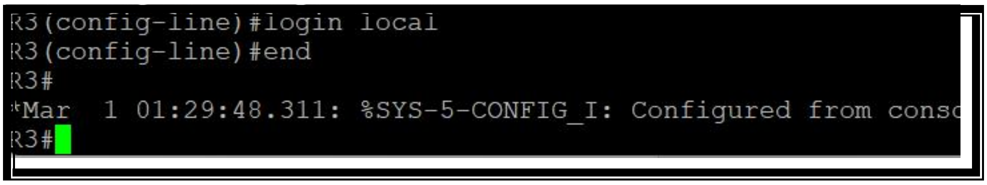
b. **Set the console line to use the locally defined login accounts**.

R1(config)# **line console 0**
R1(config-line)# **login local**
R1(config-line)# **exit**
R1(config)#

c. **Set the vty lines to use the locally defined login accounts.**

R1(config)# **line vty 0 4**
R1(config-line)# **login local**
R1(config-line)# **end**
R1(config)#

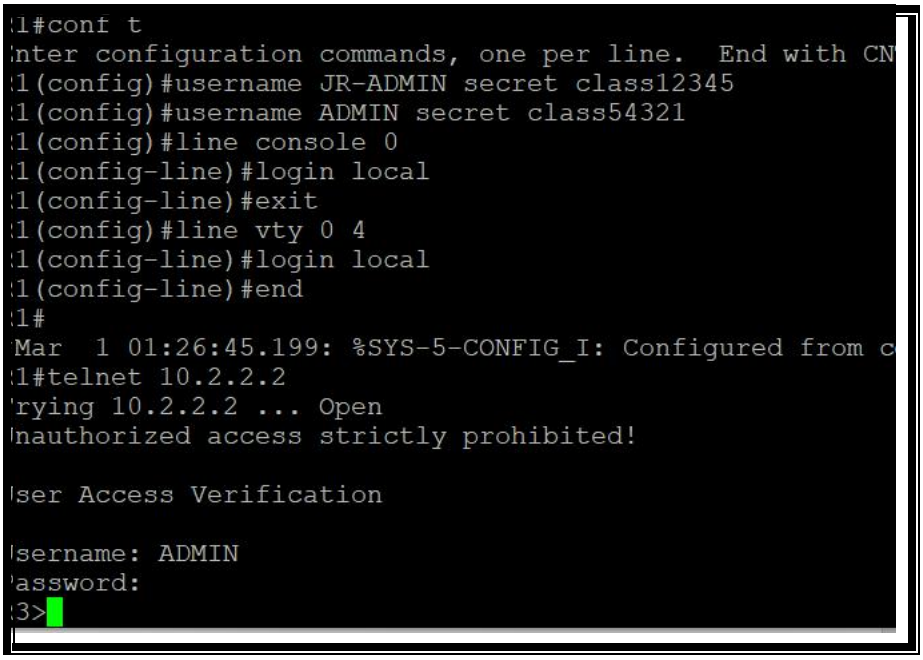




d. **Repeat the steps 4a to 4c on R3**.

e. **To verify the configuration, telnet to R3 from R1 and login using the ADMIN local database account.**

R1# **telnet 10.2.2.2**



Step 5: Enabling secure remote management using SSH.

a. **SSH requires that a device name and a domain name be configured. Since the router already has a name assigned, configure the domain name.**

R1(config)# **ip domain-name ccnasecurity.com**

b. **The router uses the RSA key pair for authentication and encryption of transmitted SSH data. Although optional it may be wise to erase any existing key pairs on the router.**

R1(config)# **crypto key zeroize rsa**

c. **Generate the RSA encryption key pair for the router. Configure the RSA keys with 1024 for the number of modulus bits**.

R1(config)# **crypto key generate rsa general-keys modulus 1024**

d. **Cisco routers support two versions of SSH:**

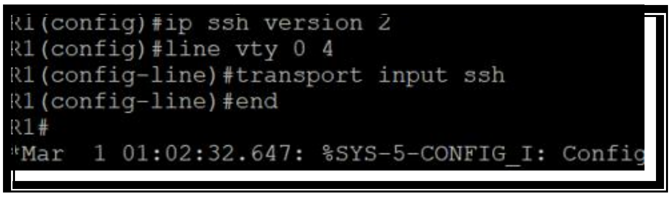
- **SSH version 1 (SSHv1)**: Original version but has known vulnerabilities.
- **SSH version 2 (SSHv2)**: Provides better security using the Diffie-Hellman key exchange and the strong integrity-checking message authentication code (MAC).

R1(config)# **ip ssh version 2**

R1(config)#

e. **Configure the vty lines to use only SSH connections.**

R1(config)# **line vty 0 4**
R1(config-line)# **transport input ssh**
R1(config-line)# **end**



```
R1(config)#ip ssh version 2
R1(config)#line vty 0 4
R1(config-line)#transport input ssh
R1(config-line)#end
R1#
*Mar  1 01:02:32.647: %SYS-5-CONFIG_I: Config
```

f. **Verify the SSH configuration using the show ip ssh command**.

R1# **show ip ssh**

```
R1#show ip ssh
SSH Enabled - version 2.0
Authentication timeout: 120 secs; Authentication retrie
R1#ssh -l ADMIN 10.2.2.2

Password:
% Password:  timeout expired!
Password:
% Password:  timeout expired!
% Authentication failed.

[Connection to 10.2.2.2 closed by foreign host]
R1#ssh -l ADMIN 10.2.2.2

Password:
Unauthorized access strictly prohibited!
R3>
```

g. **Repeat the steps 6a to 6f on R3**.

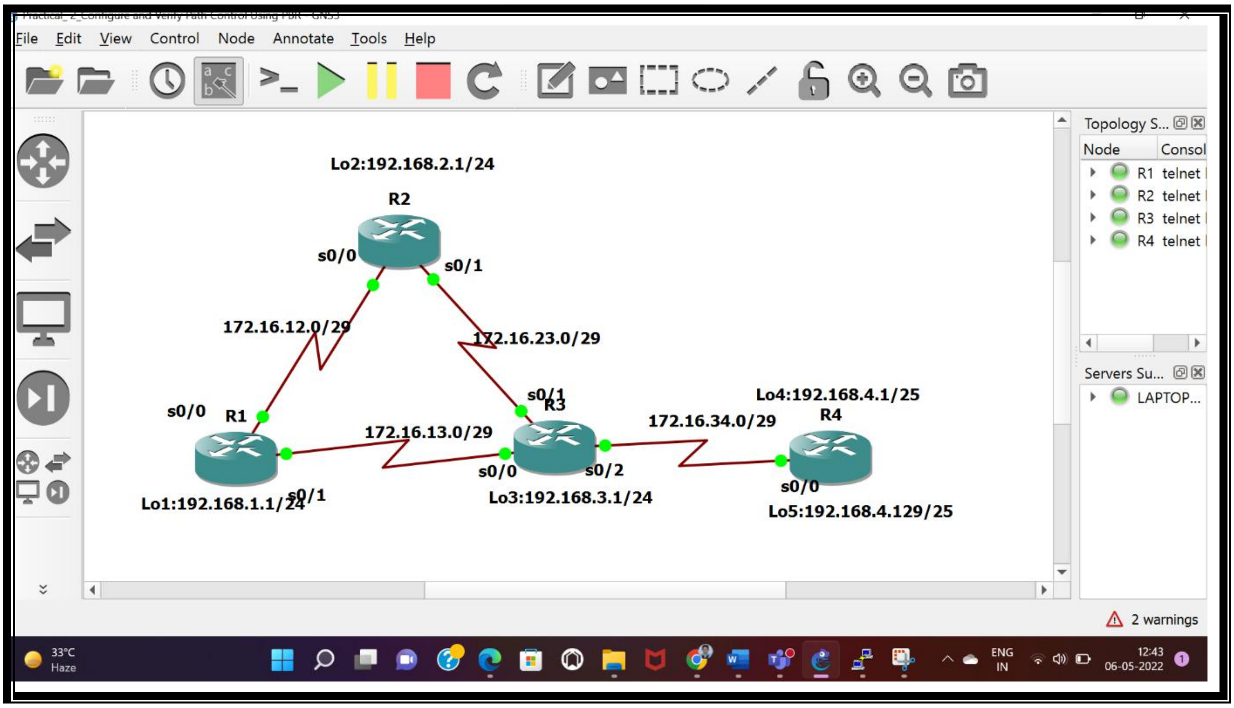
h. **Although a user can SSH from a host using the SSH option of TeraTerm of PuTTY, a router can also SSH to another SSH enabled device. SSH to R3 from R1.**

R1# **ssh -l ADMIN 10.2.2.2**

Practical No – 5

Aim: Configure and Verify Path Control Using PBR.

Topolgy :



Objectives

- Configure and verify policy-based routing.
- Select the required tools and commands to configure policy-based routing operations.
- Verify the configuration and operation by using the proper show and debug commands.

Required Resources

- 4 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 1: Configure loopbacks and assign addresses.

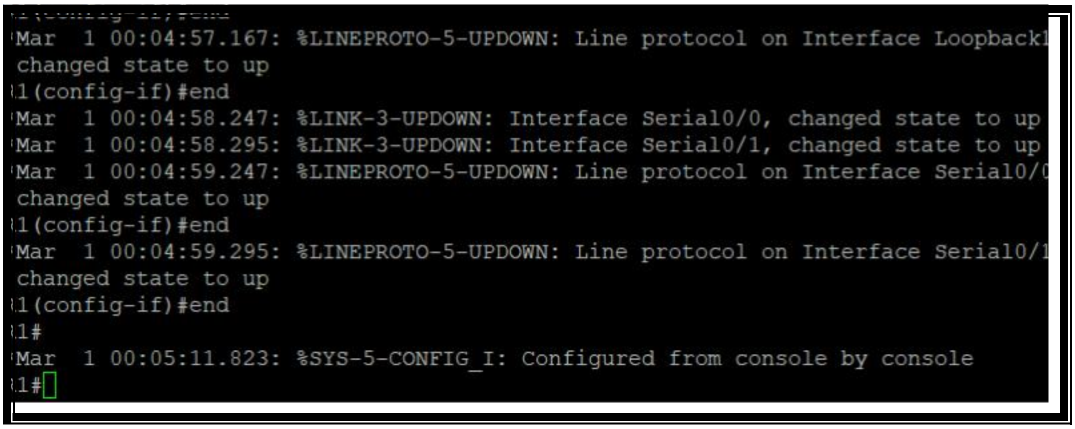
a. Cable the network as shown in the topology diagram. Erase the startup configuration, and reload each router to clear previous configurations.

b. Using the addressing scheme in the diagram, create the loopback interfaces and apply IP addresses to these and the serial interfaces on R1, R2, R3, and R4.

Router R1

```
hostname R1
!
interface Lo1
 description R1 LAN
 ip address 192.168.1.1 255.255.255.0
!
```

```
interface Serial0/0
 description R1 --> R2
 ip address 172.16.12.1 255.255.255.248
 clock rate 128000
 bandwidth 128
 no shutdown
!
interface Serial0/1
 description R1 --> R3
 ip address 172.16.13.1 255.255.255.248
 bandwidth 64
 no shutdown
!
End
```



```
Mar  1 00:04:57.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1
 changed state to up
1(config-if)#end
Mar  1 00:04:58.247: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
Mar  1 00:04:58.295: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
Mar  1 00:04:59.247: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0
 changed state to up
1(config-if)#end
Mar  1 00:04:59.295: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1
 changed state to up
1(config-if)#end
1#
Mar  1 00:05:11.823: %SYS-5-CONFIG_I: Configured from console by console
1#
```

Router R2

```
hostname R2
!
interface Lo2
 description R2 LAN
 ip address 192.168.2.1 255.255.255.0
!
interface Serial0/0
 description R2 --> R1
 ip address 172.16.12.2 255.255.255.248
 bandwidth 128
 no shutdown

interface Serial0/1
 description R2 --> R3
 ip address 172.16.23.2 255.255.255.248
 clock rate 128000
 bandwidth 128
 no shutdown
!
end
```

```
*Mar  1 00:12:25.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback2,
 changed state to up
R2(config-if)#end
*Mar  1 00:12:26.235: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar  1 00:12:26.287: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
R2(config-if)#end
*Mar  1 00:12:27.239: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
 changed state to up
*Mar  1 00:12:27.291: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
 changed state to up
R2(config-if)#end
*Mar  1 00:12:51.963: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
 changed state to down
```

Router R3

hostname R3
!
interface Lo3
 description R3 LAN
 ip address 192.168.3.1 255.255.255.0
!
interface Serial0/0
 description R3 --> R1
 ip address 172.16.13.3 255.255.255.248
 clock rate 64000
 bandwidth 64
 no shutdown
!
interface Serial0/1
 description R3 --> R2
 ip address 172.16.23.3 255.255.255.248
 bandwidth 128
 no shutdown
!
interface Serial0/0
 description R3 --> R4
 ip address 172.16.34.3 255.255.255.248
 clock rate 64000
 bandwidth 64
 no shutdown
!
End

```
R3(config-if)#end
*Mar  1 00:19:39.075: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback3,
changed state to up
R3(config-if)#end
*Mar  1 00:19:40.143: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar  1 00:19:40.203: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
*Mar  1 00:19:40.219: %LINK-3-UPDOWN: Interface Serial2/0, changed state to up
R3(config-if)#end
*Mar  1 00:19:41.147: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0,
changed state to up
*Mar  1 00:19:41.207: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1,
changed state to up
*Mar  1 00:19:41.223: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0,
changed state to up
R3(config-if)#end
*Mar  1 00:20:02.531: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to down
R3(config-if)#end
```

Router R4

hostname R4
!
interface Lo4
 description R4 LAN A
 ip address 192.168.4.1 255.255.255.128
!

interface Lo5
 description R4 LAN B
 ip address 192.168.4.129 255.255.255.128
!
interface Serial0/0
 description R4 --> R3
 ip address 172.16.34.4 255.255.255.248
 bandwidth 64
 no shutdown
!
End

```
R4(config-if)#end
R4#
*Mar  1 00:31:46.567: %SYS-5-CONFIG_I: Configured from console by console
*Mar  1 00:31:47.463: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback4,
 changed state to up
*Mar  1 00:31:47.519: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback5,
 changed state to up
R4#
*Mar  1 00:31:48.535: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R4#
*Mar  1 00:31:49.539: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state
R4#
```

c. **Verify the configuration with the show ip interface brief, show protocols, and show interfaces description commands. The output from router R3 is shown here as an example**.

```
R3#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES unset  administratively down down
Serial1/0                  172.16.13.3     YES manual up                    up
Serial1/1                  172.16.23.3     YES manual up                    up
Serial1/2                  172.16.34.3     YES manual up                    up
Serial1/3                  unassigned      YES unset  administratively down down
Loopback3                  192.168.3.1     YES manual up                    up
```

R3# **show ip interface brief | include up**

R3# **show protocols**

```
R3#show protocols
Global values:
  Internet Protocol routing is enabled
FastEthernet0/0 is administratively down, line protocol i
Serial1/0 is up, line protocol is up
  Internet address is 172.16.13.3/29
Serial1/1 is up, line protocol is up
  Internet address is 172.16.23.3/29
Serial1/2 is up, line protocol is up
  Internet address is 172.16.34.3/29
Serial1/3 is administratively down, line protocol is dowr
Loopback3 is up, line protocol is up
  Internet address is 192.168.3.1/24
```

```
R3#show interfaces description
Interface                      Status         Protocol Description
Fa0/0                          admin down     down
Se1/0                          up             up
Se1/1                          up             up
Se1/2                          up             up
Se1/3                          admin down     down
```

R3# **show interfaces description | include up**

Step 3: Configure basic EIGRP

a. **Implement EIGRP AS 1 over the serial and loopback interfaces as you have configured it for the other EIGRP labs.**

b. **Advertise networks 172.16.12.0/29, 172.16.13.0/29, 172.16.23.0/29, 172.16.34.0/29, 192.168.1.0/24, 192.168.2.0/24, 192.168.3.0/24, and 192.168.4.0/24 from their respective routers**.

Router R1

```
router eigrp 1
 network 192.168.1.0
 network 172.16.12.0 0.0.0.7
 network 172.16.13.0 0.0.0.7
 no auto-summary
```

```
R1(config)#router eigrp 1
R1(config-router)#network 192.168.1.0
R1(config-router)#network 172.16.12.0 0.0.0.7
R1(config-router)#network 172.16.13.0 0.0.0.7
R1(config-router)#no auto-summary
```

Router R2

```
router eigrp 1
 network 192.168.2.0
 network 172.16.12.0 0.0.0.7
 network 172.16.23.0 0.0.0.7
 no auto-summary
```

```
R2(config)#router eigrp 1
R2(config-router)#network 192.168.2.0
R2(config-router)#network 172.16.12.0 0.0.0.7
R2(config-router)#network 172.16.23.0 0.0.0.7
R2(config-router)#no auto-summary
```

Router R3

```
router eigrp 1
 network 192.168.3.0
 network 172.16.13.0 0.0.0.7
 network 172.16.23.0 0.0.0.7
 network 172.16.34.0 0.0.0.7
 no auto-summary
```

```
R3(config)#router eigrp 1
R3(config-router)#network 192.168.3.0
R3(config-router)#network 172.16.13.0 0.0.0.7
R3(config-router)#network 172.16.23.0 0.0.0.7
R3(config-router)#network 172.16.34.0 0.0.0.7
R3(config-router)#no auto-summary
```

Router R4
router eigrp 1
 network 192.168.4.0
 network 172.16.34.0 0.0.0.7
 no auto-summary

```
R4(config)#router eigrp 1
R4(config-router)#network 192.168.4.0
R4(config-router)#network 172.16.34.0 0.0.0.7
R4(config-router)#no auto-summary
```

Step 4: Verify EIGRP connectivity.

a. **Verify the configuration by using the show ip eigrp neighbors command to check which routers have EIGRP adjacencies.**

```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   172.16.13.3             Se1/1             11 00:00:31   26    200  0  18
0   172.16.12.2             Se1/0             12 00:00:44   37    222  0  13
```

R1# **show ip eigrp neighbors**

```
R2#show ip eigrp neighbors
*May 19 23:13:42.783: %SYS-5-CONFIG_I: Configured from console by console
R2#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   172.16.23.3             Se1/1             11 00:00:50   41    246  0  20
0   172.16.12.1             Se1/0             11 00:01:04   30    200  0  18
```

R2# **show ip eigrp neighbors**

R3# **show ip eigrp neighbors**

```
R3#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
2   172.16.34.4             Se1/2             12 00:00:44   48    288  0  6
1   172.16.23.2             Se1/1             11 00:00:58   26    200  0  19
0   172.16.13.1             Se1/0             12 00:00:58  281   1686  0  20
```

```
R4#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
0   172.16.34.3             Se1/0             10 00:00:55   23    200  0  26
```

R4# **show ip eigrp neighbors**

b. Run the following Tcl script on all routers to verify full connectivity.

R1# **tclsh**

```
foreach address {
172.16.12.1
172.16.12.2
172.16.13.1
172.16.13.3
172.16.23.2
172.16.23.3
172.16.34.3
172.16.34.4
192.168.1.1
192.168.2.1
192.168.3.1
192.168.4.1
192.168.4.129
} { ping $address }
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/61/76 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/27/40 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.13.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/58/80 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.13.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/31/44 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.23.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/28/32 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/40/48 ms
Type escape sequence to abort.
```

Step 5: Verify the current path.

a. **On R1, use the show ip route command. Notice the next-hop IP address for all networks discovered by EIGRP.**

R1# **show ip route | begin Gateway**

```
1#show ip route
odes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS le
      ia - IS-IS inter area, * - candidate default, U - per-user stati
      o - ODR, P - periodic downloaded static route

ateway of last resort is not set

     172.16.0.0/29 is subnetted, 4 subnets
        172.16.34.0 [90/2681856] via 172.16.13.3, 00:01:50, Serial1/1
        172.16.23.0 [90/2681856] via 172.16.13.3, 00:01:50, Serial1/1
                    [90/2681856] via 172.16.12.2, 00:01:50, Serial1/0
        172.16.12.0 is directly connected, Serial1/0
        172.16.13.0 is directly connected, Serial1/1
     192.168.4.0/24 [90/2809856] via 172.16.13.3, 00:01:38, Serial1/1
     192.168.1.0/24 is directly connected, Loopback1
     192.168.2.0/24 [90/2297856] via 172.16.12.2, 00:01:50, Serial1/0
     192.168.3.0/24 [90/2297856] via 172.16.13.3, 00:01:50, Serial1/1
```

b. **On R4, use the traceroute command to the R1 LAN address and source the ICMP packet from R4 LAN A and LAN B.**

```
R4#traceroute 192.168.1.1 source 192.168.4.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1

  1 172.16.34.3 36 msec 32 msec 32 msec
  2 172.16.13.1 28 msec 56 msec 84 msec
```

R4# **traceroute 192.168.1.1 source 192.168.4.1**

R4# **traceroute 192.168.1.1 source 192.168.4.129**

```
R4#traceroute 192.168.1.1 source 192.168.4.129

Type escape sequence to abort.
Tracing the route to 192.168.1.1

  1 172.16.34.3 44 msec 28 msec 28 msec
  2 172.16.13.1 64 msec 28 msec 64 msec
```

c. **On R3, use the show ip route command and note that the preferred route from R3 to R1 LAN 192.168.1.0/24 is via R2 using the R3 exit interface S0/0/1.**

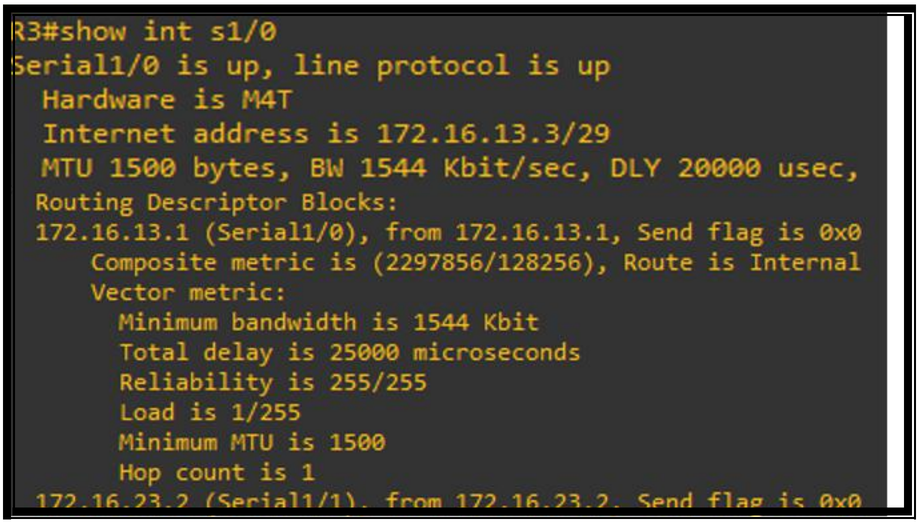
R3# **show ip route | begin Gateway**

```
3#show ip route
odes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS leve
      ia - IS-IS inter area, * - candidate default, U - per-user static
      o - ODR, P - periodic downloaded static route
```

```
     172.16.0.0/29 is subnetted, 4 subnets
        172.16.34.0 is directly connected, Serial1/2
        172.16.23.0 is directly connected, Serial1/1
        172.16.12.0 [90/2681856] via 172.16.23.2, 00:02:29, Serial1/1
                    [90/2681856] via 172.16.13.1, 00:02:29, Serial1/0
        172.16.13.0 is directly connected, Serial1/0
     192.168.4.0/24 [90/2297856] via 172.16.34.4, 00:02:17, Serial1/2
     192.168.1.0/24 [90/2297856] via 172.16.13.1, 00:02:29, Serial1/0
     192.168.2.0/24 [90/2297856] via 172.16.23.2, 00:02:29, Serial1/1
     192.168.3.0/24 is directly connected, Loopback3
```

d. **On R3, use the show interfaces serial 0/0/0 and show interfaces s0/0/1 commands.**

R3# **show interfaces serial0/0**



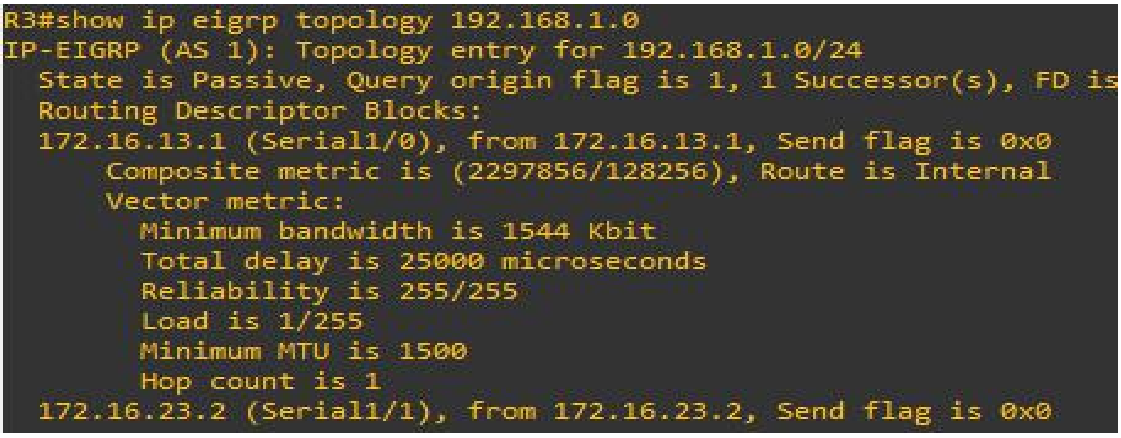
```
R3#show int s1/0
Serial1/0 is up, line protocol is up
  Hardware is M4T
  Internet address is 172.16.13.3/29
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
  Routing Descriptor Blocks:
  172.16.13.1 (Serial1/0), from 172.16.13.1, Send flag is 0x0
      Composite metric is (2297856/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  172.16.23.2 (Serial1/1), from 172.16.23.2, Send flag is 0x0
```

R3# **show interfaces serial0/0 | include BW**

R3# **show interfaces serial0/1 | include BW**

e. **Confirm that R3 has a valid route to reach R1 from its serial 0/0/0 interface using the show ip eigrp topology 192.168.1.0 command**.

R3# **show ip eigrp topology 192.168.1.0**



```
R3#show ip eigrp topology 192.168.1.0
IP-EIGRP (AS 1): Topology entry for 192.168.1.0/24
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is
  Routing Descriptor Blocks:
  172.16.13.1 (Serial1/0), from 172.16.13.1, Send flag is 0x0
      Composite metric is (2297856/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 1544 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  172.16.23.2 (Serial1/1), from 172.16.23.2, Send flag is 0x0
```

Step 6: Configure PBR to provide path control.

a. **On router R3, create a standard access list called PBR-ACL to identify the R4 LAN B network.**

R3(config)# **ip access-list standard PBR-ACL**
R3(config-std-nacl)# **remark ACL matches R4 LAN B traffic**
R3(config-std-nacl)# **permit 192.168.4.128 0.0.0.127**
R3(config-std-nacl)# **exit**
R3(config)#

b. **Create a route map called R3-to-R1 that matches PBR-ACL and sets the next-hop interface to the R1 serial 0/0/1 interface.**

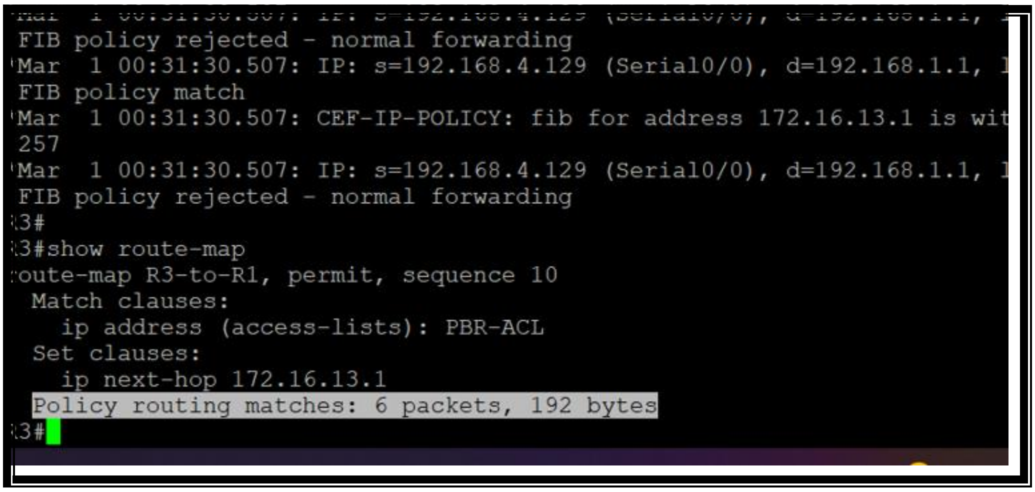
R3(config)# **route-map R3-to-R1 permit**
R3(config-route-map)# **description RM to forward LAN B traffic to R1**
R3(config-route-map)# **match ip address PBR-ACL**
R3(config-route-map)# **set ip next-hop 172.16.13.1**
R3(config-route-map)# **exit**
R3(config)#

c. Apply the R3-to-R1 route map to the serial interface on R3 that receives the traffic from R4. Use the ip policy route-map command on interface S0/1/0.

R3(config)# **interface s0/0**
R3(config-if)# **ip policy route-map R3-to-R1**
R3(config-if)# **end**
R3#

d. On R3, display the policy and matches using the show route-map command.

R3# show route-map



```
 FIB policy rejected - normal forwarding
'Mar  1 00:31:30.507: IP: s=192.168.4.129 (Serial0/0), d=192.168.1.1, l
 FIB policy match
'Mar  1 00:31:30.507: CEF-IP-POLICY: fib for address 172.16.13.1 is wit
 257
'Mar  1 00:31:30.507: IP: s=192.168.4.129 (Serial0/0), d=192.168.1.1, l
 FIB policy rejected - normal forwarding
:3#
:3#show route-map
:oute-map R3-to-R1, permit, sequence 10
  Match clauses:
    ip address (access-lists): PBR-ACL
  Set clauses:
    ip next-hop 172.16.13.1
  Policy routing matches: 6 packets, 192 bytes
:3#
```

Step 7: Test the policy.

a. **On R3, create a standard ACL which identifies all of the R4 LANs**.

R3# **conf t**
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)# **access-list 1 permit 192.168.4.0 0.0.0.255**
R3(config)# **exit**

b. **Enable PBR debugging only for traffic that matches the R4 LANs**.

R3# **debug ip policy ?**
R3# **debug ip policy 1**

c. Test the policy from R4 with the traceroute command, using R4 LAN A as the source network.

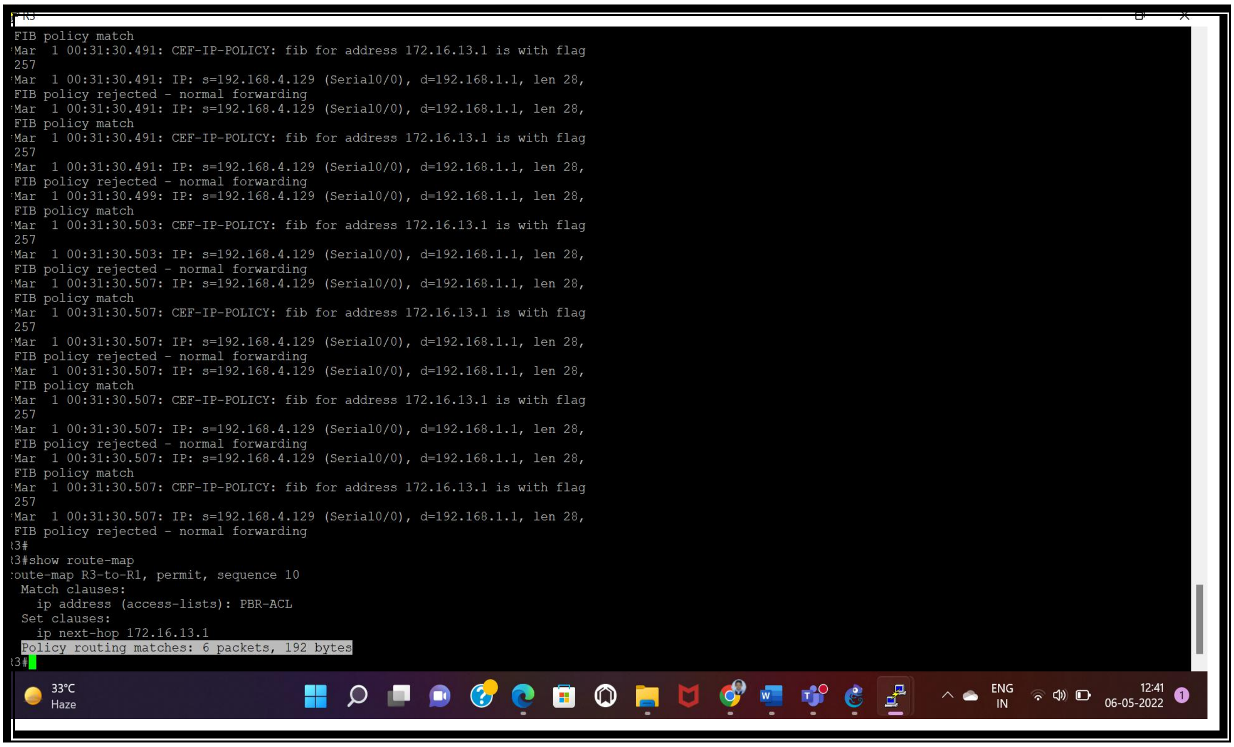
R4# **traceroute 192.168.1.1 source 192.168.4.1**

d. Test the policy from R4 with the traceroute command, using R4 LAN B as the source network.

R4# **traceroute 192.168.1.1 source 192.168.4.129**

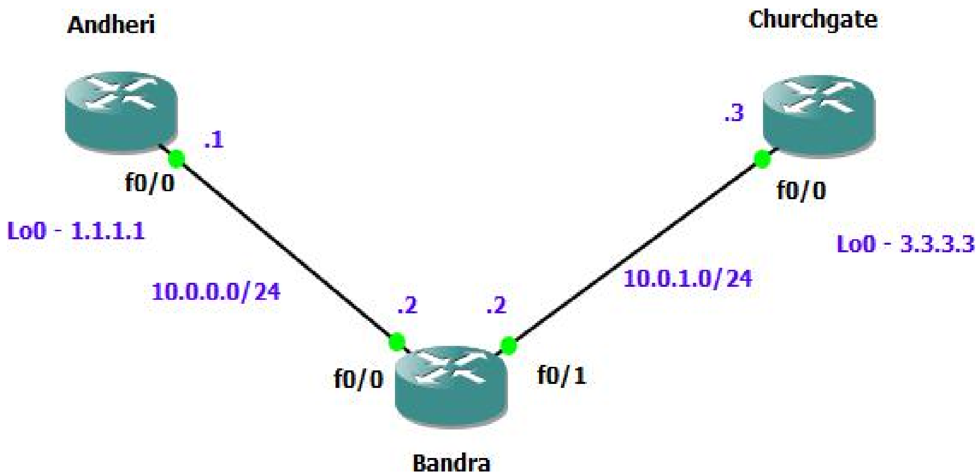
e. On R3, display the policy and matches using the show route-map command.

R3# **show route-map**



Practical 6

Aim: Cisco MPLS Configuration.
Topology:



Step 1 – IP addressing of MPLS Core and OSPF
First bring 3 routers into your **Topology** R1, R2, R3 position them as below. We are going to address the routers and configure ospf to ensure loopback to loopback connectivity between R1 and R3

```
Andheri(config)#int lo0
Andheri(config-if)#ip add 1.1.1.1 255.255.255.255
Andheri(config-if)#ip ospf 1 area 0
Andheri(config-if)#
Andheri(config-if)#int f0/0
Andheri(config-if)#ip add 10.0.0.1 255.255.255.0
Andheri(config-if)#no shut
Andheri(config-if)#ip ospf 1 area 0
```

```
Bandra(config)#int lo0
Bandra(config-if)#
Bandra(config-if)#ip add 2.2.2.2 255.255.255.255
Bandra(config-if)#ip ospf 1 are 0
Bandra(config-if)#
Bandra(config-if)#int f0/0
Bandra(config-if)#ip add 10.0.0.2 255.255.255.0
Bandra(config-if)#no shut
Bandra(config-if)#ip ospf 1 area 0
Bandra(config-if)#
Bandra(config-if)#int f0/1
Bandra(config-if)#ip add 10.0.1.2 255.255.255.0
Bandra(config-if)#no shut
Bandra(config-if)#ip ospf 1 area 0
```

```
Churchgate(config)#int lo0
Churchgate(config-if)#ip add 3.3.3.3 255.255.255.255
Churchgate(config-if)#ip ospf 1 are 0
Churchgate(config-if)#
Churchgate(config-if)#int f0/0
Churchgate(config-if)#ip add 10.0.1.3 255.255.255.0
Churchgate(config-if)#no shut
Churchgate(config-if)#ip ospf 1 area 0
```

You should now have full ip connectivity between R1, R2, R3 to verify this we need to see if we can ping between the loopbacks of R1 and R3

```
Andheri#ping 3.3.3.3 source lo0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/52/64 ms
```

Step 2 – Configure LDP on all the interfaces in the MPLS Core
In order to run MPLS you need to enable it, there are two ways to do this.
At each interface enter the mpls ip command
Under the ospf process use the mpls ldp autoconfig command

```
Andheri(config)#router ospf 1
Andheri(config-router)#mpls ldp autoconfig
```

```
Bandra(config)#router ospf 1
Bandra(config-router)#mpls ldp autoconfig
```

```
Churchgate(config)#router ospf 1
Churchgate(config-router)#mpls ldp autoconfig
```

You should see log messages coming up showing the LDP neighbors are up.

```
Bandra#
*May 29 17:03:09.559: %SYS-5-CONFIG_I: Configured from console by console
Bandra#
*May 29 17:03:28.631: %LDP-5-NBRCHG: LDP Neighbor 3.3.3.3:0 (2) is UP
```

To verify the mpls interfaces the command is very simple – sh mpls interface

This is done on R2 and you can see that both interfaces are running mpls and using LDP

```
Bandra#sh mpls int
Interface              IP            Tunnel   BGP Static Operational
FastEthernet0/0        Yes (ldp)     No       No  No     Yes
FastEthernet0/1        Yes (ldp)     No       No  No     Yes
Bandra#
```

You can also verify the LDP neighbors with the sh mpls ldp neighbors command.

```
Bandra#sh mpls ldp neigh
    Peer LDP Ident: 1.1.1.1:0; Local LDP Ident 2.2.2.2:0
        TCP connection: 1.1.1.1.646 - 2.2.2.2.25712
        State: Oper; Msgs sent/rcvd: 9/9; Downstream
        Up time: 00:01:23
        LDP discovery sources:
          FastEthernet0/0, Src IP addr: 10.0.0.1
        Addresses bound to peer LDP Ident:
          10.0.0.1        1.1.1.1
    Peer LDP Ident: 3.3.3.3:0; Local LDP Ident 2.2.2.2:0
        TCP connection: 3.3.3.3.50470 - 2.2.2.2.646
        State: Oper; Msgs sent/rcvd: 8/8; Downstream
        Up time: 00:00:54
        LDP discovery sources:
          FastEthernet0/1, Src IP addr: 10.0.1.3
        Addresses bound to peer LDP Ident:
          10.0.1.3        3.3.3.3
```

One more verification to confirm LDP is running ok is to do a trace between R1 and R3 and verify if you get MPLS Labels show up in the trace.

```
Andheri#trace 3.3.3.3

Type escape sequence to abort.
Tracing the route to 3.3.3.3

  1 10.0.0.2 [MPLS: Label 17 Exp 0] 20 msec 60 msec 60 msec
  2 10.0.1.3 60 msec 60 msec 60 msec
```

Step 3 – MPLS BGP Configuration between R1 and R3
We need to establish a Multi Protocol BGP session between R1 and R3 this is done by configuring the vpnv4 address family as below

```
Andheri(config)#router bgp 1
Andheri(config-router)#neighbor 3.3.3.3 remote-as 1
Andheri(config-router)#neighbor 3.3.3.3 update-source Loopback0
Andheri(config-router)#no auto-summary
Andheri(config-router)#!
Andheri(config-router)#address-family vpnv4
Andheri(config-router-af)#neighbor 3.3.3.3 activate
```

```
Churchgate(config)#router bgp 1
Churchgate(config-router)#neighbor 1.1.1.1 remote-as 1
Churchgate(config-router)#neighbor 1.1.1.1
*May 29 17:06:19.459: %BGP-5-ADJCHANGE: neighbor 1.1.1.1 Up
Churchgate(config-router)#neighbor 1.1.1.1 update-source loopback 0
Churchgate(config-router)#no auto-summary
Churchgate(config-router)#address-family vpnv4
Churchgate(config-router-af)#neighbor 1.1.1.1 activate
```

To verify the BGP session between R1 and R3 issue the command sh bgp vpnv4 unicast all summary

```
Andheri#sh bgp vpnv4 unicast all summary
BGP router identifier 1.1.1.1, local AS number 1
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4            1       5       6        1    0    0 00:00:30        0
```

Step 4 – Add two more routers, create VRFs

We will add two more routers into the **Topology** so it now looks like the final **Topology**

```
Borivali(config)#int lo0
Borivali(config-if)#ip ad
*May 29 17:13:47.223: %LINEPROTO-5-UPDOWN: Line protocol o
Borivali(config-if)#ip address 4.4.4.4 255.255.255.255
Borivali(config-if)#ip ospf 2 area 2
Borivali(config-if)#int f0/0
Borivali(config-if)#ip addresss 192.168.1.4 255.255.255.0
                                 ^
% Invalid input detected at '^' marker.

Borivali(config-if)#ip address 192.168.1.4 255.255.255.0
Borivali(config-if)#ip ospf 2 area 2
Borivali(config-if)#no shut
```

```
Andheri(config)#int f0/1
Andheri(config-if)#no shut
Andheri(config-if)#ip address
*May 29 17:14:16.199: %LINK-3-UPDOWN: Interface FastEther
*May 29 17:14:17.199: %LINEPROTO-5-UPDOWN: Line protocol
Andheri(config-if)#ip address 192.168.1.1 255.255.255.0
```

```
Andheri(config-if)#ip vrf RED
Andheri(config-vrf)#rd 4:4
Andheri(config-vrf)#route-target both 4:4
```

```
Andheri(config-vrf)#int f0/1
Andheri(config-if)#ip vrf forwarding RED
% Interface FastEthernet0/1 IP address 192.168.1.1 removed due to enabling VRF RED
```

```
Andheri#sh run int f0/1
Building configuration...

Current configuration : 119 bytes
!
interface FastEthernet0/1
 ip vrf forwarding RED
 ip address 192.168.1.1 255.255.255.0
 duplex auto
 speed auto
end
```

If you issue the command sh ip route this shows the routes in the global table and you willnotice that you do not see 192.168.1.0/24

```
Andheri#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter a
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external typ
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-
       ia - IS-IS inter area, * - candidate default, U - per-user
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.0.2, 00:19:39, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/3] via 10.0.0.2, 00:18:35, FastEthernet0/0
     10.0.0.0/24 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
O       10.0.1.0 [110/2] via 10.0.0.2, 00:18:45, FastEthernet0/0
```

```
Andheri#sh ip route vrf RED

Routing Table: RED
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external ty
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS
       ia - IS-IS inter area, * - candidate default, U - per-user
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/1
```

We just need to enable OSPF on this interface and get the loopback address for R4 in the VRF RED routing table before proceeding.

```
Andheri(config)#int f0/1
Andheri(config-if)#ip ospf 2 area 2
```

If we now check the routes in the VRF RED routing table you should see 4.4.4.4 in there as well.

```
Andheri#sh ip route vrf RED

Routing Table: RED
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter ar
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-I
       ia - IS-IS inter area, * - candidate default, U - per-user s
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 192.168.1.4, 00:00:11, FastEthernet0/1
C    192.168.1.0/24 is directly connected, FastEthernet0/1
```

```
Andheri#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external t
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - I
       ia - IS-IS inter area, * - candidate default, U - per-use
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.0.2, 00:28:18, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/3] via 10.0.0.2, 00:27:14, FastEthernet0/0
     10.0.0.0/24 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
O       10.0.1.0 [110/2] via 10.0.0.2, 00:27:24, FastEthernet0/
```

```
Andheri#sh ip route vrf RED

Routing Table: RED
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter are
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
       ia - IS-IS inter area, * - candidate default, U - per-user st
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 192.168.1.4, 00:07:42, FastEthernet0/1
C    192.168.1.0/24 is directly connected, FastEthernet0/1
```

We now need to repeat this process for R3 & R6 Router 6 will peer OSPF using process number2 to a VRF configured on R3. It will use the local site addressing to 192.168.2.0/24

```
Mahim(config)#INT LO0
Mahim(config-if)#
*May 29 17:18:58.903: %LINEPROTO-5-UPDOWN: Line pr
Mahim(config-if)#ip add 6.6.6.6 255.255.255.255
Mahim(config-if)#ip ospf 2 area 2
Mahim(config-if)#int f0/0
Mahim(config-if)#ip add 192.168.2.6 255.255.255.0
Mahim(config-if)#ip ospf 2 area 2
Mahim(config-if)#no shut
```

```
Churchgate(config)#int f0/1
Churchgate(config-if)#no shut
Churchgate(config-if)#ip add
*May 29 17:23:19.111: %LINK-3-UPDOWN: Interface FastEth
*May 29 17:23:20.111: %LINEPROTO-5-UPDOWN: Line protocol
Churchgate(config-if)#ip add 192.168.2.3 255.255.255.0
```

We also need to configure a VRF onto R3 as well.

```
Churchgate(config-if)#ip vrf RED
Churchgate(config-vrf)#rd 4:4
Churchgate(config-vrf)#route-target both 4:4
```

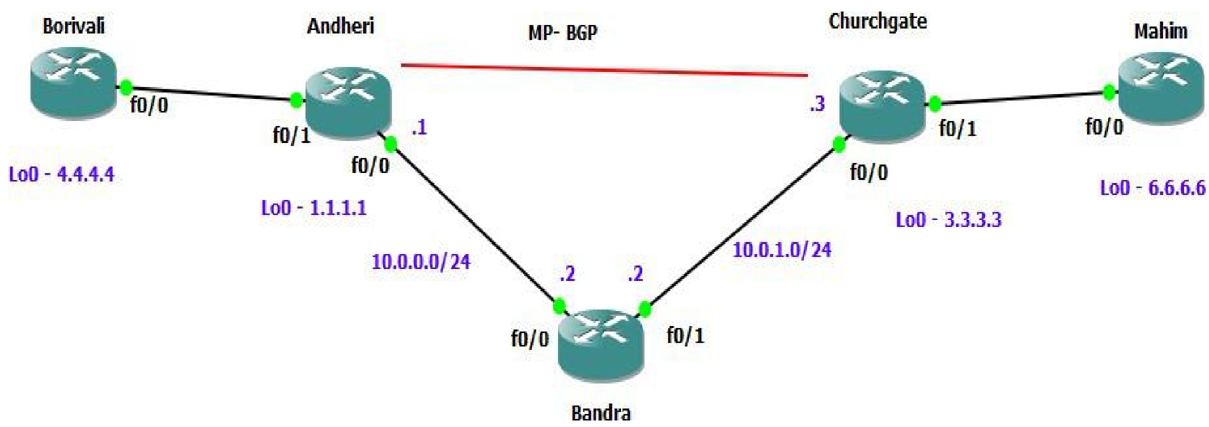
```
Churchgate(config-vrf)#int f0/1
Churchgate(config-if)#ip vrf forwarding RED
% Interface FastEthernet0/1 IP address 192.168.2.3 removed due to enabling VRF RED
Churchgate(config-if)#int f0/1
Churchgate(config-if)#ip add 192.168.2.1 255.255.255.0
```

```
Churchgate#sh run int f0/1
Building configuration...

Current configuration : 119 bytes
!
interface FastEthernet0/1
 ip vrf forwarding RED
 ip address 192.168.2.1 255.255.255.0
 duplex auto
 speed auto
end
```

Check the router in vrf RED

```
Churchgate#sh ip route vrf RED

Routing Table: RED
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter a
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-
       ia - IS-IS inter area, * - candidate default, U - per-user
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     6.0.0.0/32 is subnetted, 1 subnets
O       6.6.6.6 [110/2] via 192.168.2.6, 00:01:10, FastEthernet0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/1
```

Ok so we have come a long way now let’s review the current situation. We now have this setup




```
Borivali#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter a
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-
       ia - IS-IS inter area, * - candidate default, U - per-user
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     4.0.0.0/32 is subnetted, 1 subnets
C       4.4.4.4 is directly connected, Loopback0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
```

As expected we have the local interface and the loopback address. When we are done we wantto see 6.6.6.6 in there so we can ping across the MPLS Check the routes on R1

```
Andheri#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external ty
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS
       ia - IS-IS inter area, * - candidate default, U - per-user
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.0.2, 00:28:18, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/3] via 10.0.0.2, 00:27:14, FastEthernet0/0
     10.0.0.0/24 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
O       10.0.1.0 [110/2] via 10.0.0.2, 00:27:24, FastEthernet0/0
```

```
Andheri#sh ip route vrf RED

Routing Table: RED
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
       ia - IS-IS inter area, * - candidate default, U - per-user sta
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 192.168.1.4, 00:07:42, FastEthernet0/1
C    192.168.1.0/24 is directly connected, FastEthernet0/1
```

```
Churchgate(config)#router bgp 1
Churchgate(config-router)#address-family ipv4 vrf RED
Churchgate(config-router-af)#redistribute ospf 2
Churchgate(config-router-af)#end
```

```
Andheri(config)#router bgp 1
Andheri(config-router)#address-family ipv4 vrf RED
Andheri(config-router-af)#redistribute ospf 2
Andheri(config-router-af)#exit
Andheri(config-router)#end
```

```
Andheri#sh ip bgp vpnv4 vrf RED
BGP table version is 9, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 4:4 (default for vrf RED)
*> 4.4.4.4/32       192.168.1.4              2         32768 ?
*>i6.6.6.6/32       3.3.3.3                  2    100      0 ?
*> 192.168.1.0      0.0.0.0                  0         32768 ?
*>i192.168.2.0      3.3.3.3                  0    100      0 ?
```

```
Churchgate#sh ip bgp vpnv4 vrf RED
BGP table version is 9, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 4:4 (default for vrf RED)
*>i4.4.4.4/32       1.1.1.1                  2    100      0 ?
*> 6.6.6.6/32       192.168.2.6              2         32768 ?
*>i192.168.1.0      1.1.1.1                  0    100      0 ?
*> 192.168.2.0      0.0.0.0                  0         32768 ?
```

Which it is! 6.6.6.6 is now in the BGP table in VRF RED on R3 with a next hop of 192.168.2.6 (R6)and also 4.4.4 is in there as well with a next hop of 1.1.1.1 (which is the loopback of R1 – showing that it is going over the MPLS and R2 is not in the picture)

```
Andheri(config)#router ospf 2
Andheri(config-router)#redistribute bgp 1 subnets
```

```
Churchgate(config)#router ospf 2
Churchgate(config-router)#redistribute bgp 1 subnets
```

Before we do let's see what the routing table look like on R4

```
Borivali#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS l
       ia - IS-IS inter area, * - candidate default, U - per-user stat
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     4.0.0.0/32 is subnetted, 1 subnets
C       4.4.4.4 is directly connected, Loopback0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/3] via 192.168.1.1, 00:00:50, FastEthernet0/0
C    192.168.1.0/24 is directly connected, FastEthernet0/0
O IA 192.168.2.0/24 [110/2] via 192.168.1.1, 00:00:50, FastEthernet0/0
```

Do the same step of on R6

```
Mahim#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS lev
       ia - IS-IS inter area, * - candidate default, U - per-user static
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/3] via 192.168.2.1, 00:00:22, FastEthernet0/0
     6.0.0.0/32 is subnetted, 1 subnets
C       6.6.6.6 is directly connected, Loopback0
O IA 192.168.1.0/24 [110/2] via 192.168.2.1, 00:00:22, FastEthernet0/0
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```

Lets chevk ping command

```
Borivali#ping 6.6.6.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 6.6.6.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 112/120/128 ms
```

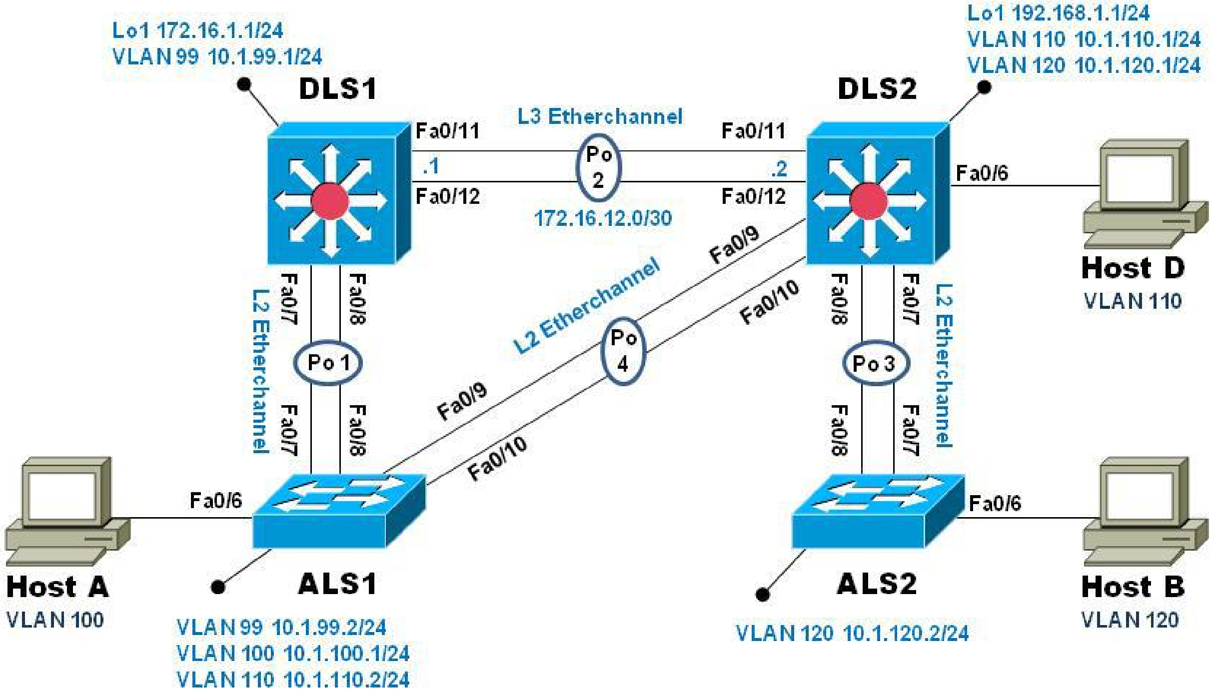
Which we can – to prove this is going over the mpls and be label switched and not routed, let do a trace

```
Borivali#trace 6.6.6.6

Type escape sequence to abort.
Tracing the route to 6.6.6.6

  1 192.168.1.1 20 msec 32 msec 24 msec
  2 10.0.0.2 [MPLS: Labels 17/19 Exp 0] 112 msec 136 msec 124 msec
  3 192.168.2.1 [MPLS: Label 19 Exp 0] 72 msec 92 msec 92 msec
  4 192.168.2.6 140 msec 124 msec 124 msec
```

Practical 7

Aim: Inter-VLAN Routing

Topology:



Objectives:

Implement a Layer 3 EtherChannel
Implement Static Routing
Implement Inter-VLAN Routing
Configure Multilayer Switching using Distribution Layer Switches
Load base config
Use the reset.tcl script you created in Lab 1 "Preparing the Switch" to set your switches up for this lab. Then load the file BASE.CFG into the running-config with the command **copy flash:BASE.CFG running-config**. An example from DLS1:

DLS1# **tclsh reset.tcl**
Erasing the nvram filesystem will remove all configuration files! Continue? [confirm]
[OK]
Erase of nvram: complete
Reloading the switch in 1 minute, type reload cancel to halt

Proceed with reload? [confirm]

*Mar 7 18:41:40.403: %SYS-7-NV_BLOCK_INIT: Initialized the geometry of nvram
*Mar 7 18:41:41.141: %SYS-5-RELOAD: Reload requested by console. Reload Reason: Reload command.
<switch reloads - output omitted>

Would you like to enter the initial configuration dialog? [yes/no]: n
Switch> **en**
*Mar 1 00:01:30.915: %LINK-5-CHANGED: Interface Vlan1, changed state to administratively down
Switch# **copy BASE.CFG running-config**

Destination filename [running-config]?
184 bytes copied in 0.310 secs (594 bytes/sec)
DLS1#
Verify switch management database configuration
At each switch, use the show sdm prefer command to verify the appropriate template is chosen. The DLS switches should be using the "dual ipv4-and-ipv6 routing" template and the ALS switches should be using the "lanbase-routing" template. If any of the switches are using the wrong template, make the necessary change and reboot the switch with the **reload** command. An example from ALS1 is below:

ALS1# **sho sdm pref**
 The current template is "default" template.
<output omitted>
ALS1# **conf t**
Enter configuration commands, one per line. End with CNTL/Z.
ALS1(config)# **sdm pref lanbase-routing**
Changes to the running SDM preferences have been stored, but cannot take effect
until the next reload.
Use 'show sdm prefer' to see what SDM preference is currently active.
ALS1(config)# **end**
ALS1# **reload**

System configuration has been modified. Save? [yes/no]: **y**
*Mar 1 02:12:00.699: %SYS-5-CONFIG_I: Configured from console by console
Building configuration...
[OK]
Proceed with reload? [confirm]

Configure layer 3 interfaces on the DLS switches
Enable IP Routing, create broadcast domains (VLANs), and configure the DLS switches with the layer 3 interfaces and addresses shown:

Switch	Interface	Address/Mask
DLS1	VLAN 99	10.1.99.1/24
DLS1	Loopback 1	172.16.1.1/24
DLS2	VLAN 110	10.1.110.1/24
DLS2	VLAN 120	10.1.120.1/24
DLS2	Loopback 1	192.168.2.1/24

 An example from DLS2:

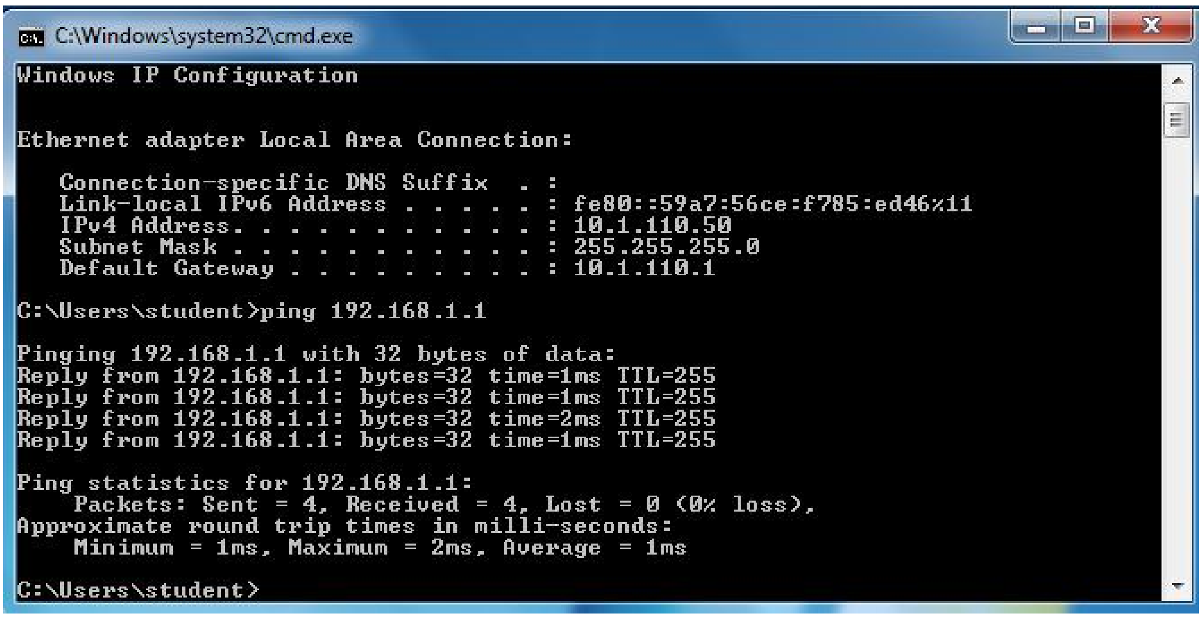
DLS2(config)# **ip routing**
DLS2(config)# **vlan 110**
DLS2(config-vlan)# **name Management**
DLS2(config-vlan)# **exit**
DLS2(config)# **vlan 120**
DLS2(config-vlan)# **name Local**
DLS2(config-vlan)# **exit**
DLS2(config)# **int vlan 110**
DLS2(config-if)# **ip address 10.1.110.1 255.255.255.0**

DLS2(config-if)# **no shut**
DLS2(config-if)# **exit**
DLS2(config)# **int vlan 120**
DLS2(config-if)# **ip address 10.1.120.1 255.255.255.0**
DLS2(config-if)# **no shut**
DLS2(config-if)# **exit**
DLS2(config)# **int loopback 1**
DLS2(config-if)# **ip address 192.168.1.1 255.255.255.0**
DLS2(config-if)# **no shut**
DLS2(config-if)# **exit**
DLS2(config)#

At this point, basic intervlan routing can be demonstrated using an attached host. Host D is attached to DLS2 via interface Fa0/6. On DLS2, assign interface Fa0/6 to VLAN 110 and configure the host with the address 10.1.110.50/24 and default gateway of 10.1.110.1. Once you have done that, try and ping Loopback 1's IP address (192.168.1.1). This should work just like a hardware router; the switch will provide connectivity between two directly connected interfaces. In the output below, the **switchport host** macro was used to quickly configure interface Fa0/6 with host-relative commands:

DLS2(config)# **int f0/6**
DLS2(config-if)# **switchport host**
switchport mode will be set to access
spanning-tree portfast will be enabled
channel group will be disabled

DLS2(config-if)# **switchport access vlan 110**
DLS2(config-if)# **no shut**
DLS2(config-if)# **exit**
DLS2(config)#



Configure a Layer 3 Etherchannel between DLS1 and DLS2
Now you will interconnect the multilayer switches in preparation to demonstrate other routing capabilities. Configure a layer 3 EtherChannel between the DLS switches. This will

provide the benefit of increased available bandwidth between the two multilayer switches. To convert the links from layer 2 to layer 3, issue the **no switchport** command. Then, combine interfaces F0/11 and F0/12 into a single PAgP EtherChannel and then assign an IP address as shown.

DLS1	172.16.12.1/30	DLS2	172.16.12.2/30

Example from DLS1:

DLS1(config)# **interface range f0/11-12**
DLS1(config-if-range)# **no switchport**
DLS1(config-if-range)# **channel-group 2 mode desirable**
Creating a port-channel interface Port-channel 2

DLS1(config-if-range)# **no shut**
DLS1(config-if-range)# **exit**
DLS1(config)# **interface port-channel 2**
DLS1(config-if)# **ip address 172.16.12.1 255.255.255.252**
DLS1(config-if)# **no shut**
DLS1(config-if)# **exit**
DLS1(config)#

Once you have configured both sides, verify that the EtherChannel link is up

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


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
2      Po2(RU)        PAgP      Fa0/11(P)   Fa0/12(P)
```

DLS2# **ping 172.16.12.1**
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.1, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/3/9 ms
DLS2#
Configure default routing between DLS switches

At this point, local routing is support at each distribution layer switch. Now to provide reachability across the layer 3 EtherChannel trunk, configure fully qualified static default routes at DLS1 and DLS2 that point to each other. From DLS1:

DLS1(config)# **ip route 0.0.0.0 0.0.0.0 port-channel 2**
%Default route without gateway, if not a point-to-point interface, may impact performance
DLS1(config)# **ip route 0.0.0.0 0.0.0.0 port-channel 2 172.16.12.2**
DLS1(config)#

Once done at both ends, verify connectivity by pinging from one switch to the other. In the example below, DLS2 pings the Loopback 1 interface at DLS1.

DLS2# **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
<output omitted>

Gateway of last resort is 172.16.12.1 to network 0.0.0.0

```
S*    0.0.0.0/0 [1/0] via 172.16.12.1, Port-channel2
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.1.110.0/24 is directly connected, Vlan110
L        10.1.110.1/32 is directly connected, Vlan110
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.12.0/30 is directly connected, Port-channel2
L        172.16.12.2/32 is directly connected, Port-channel2
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback1
L        192.168.1.1/32 is directly connected, Loopback1
```

DLS2# **ping 172.16.1.1**
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/9 ms
DLS2#

Configure the remaining EtherChannels for the topology
Configure the remaining EtherChannel links as layer 2 PagP trunks using VLAN 1 as the native VLAN.

Endpoint 1	Channel number	Endpoint 2	VLANs Allowed
ALS1 F0/7-8	1	DLS1 F0/7-8	All except 110
ALS1 F0/9-10	4	DLS2 F0/9-10	110 Only
ALS2 F0/7-8	3	DLS2 F0/7-8	All

Example from ALS1:

```
ALS1(config)# interface range f0/7-8
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# switchport trunk allowed vlan except 110
ALS1(config-if-range)# channel-group 1 mode desirable
Creating a port-channel interface Port-channel 1

ALS1(config-if-range)# no shut
ALS1(config-if-range)# exit
ALS1(config)# interface range f0/9-10
ALS1(config-if-range)# switchport mode trunk
ALS1(config-if-range)# switchport trunk allowed vlan 110
ALS1(config-if-range)# channel-group 4 mode desirable
Creating a port-channel interface Port-channel 4

ALS1(config-if-range)# no shut
ALS1(config-if-range)# exit
ALS1(config)#end
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)         PAgP      Fa0/7(P)    Fa0/8(P)
4      Po4(SU)         PAgP      Fa0/9(P)    Fa0/10(P)

ALS1# show interface 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         1-109,111-4094
Po4         110
<output omitted>
ALS1#
```

Enable and Verify Layer 3 connectivity across the network

In this step we will enable basic connectivity from the management VLANs on both sides of the network.
Create the management VLANs (99 at ALS1, 120 at ALS2)
Configure interface VLAN 99 at ALS1 and interface VLAN 120 at ALS2
Assign addresses (refer to the diagram) and default gateways (at DLS1/DLS2 respectively).

Once that is all done, pings across the network should work, flowing across the layer 3 EtherChannel. An example from ALS2:

ALS2(config)# **vlan 120**
ALS2(config-vlan)# **name Management**
ALS2(config-vlan)# **exit**
ALS2(config)# **int vlan 120**
ALS2(config-if)# **ip address 10.1.120.2 255.255.255.0**
ALS2(config-if)# **no shut**
ALS2(config-if)# **exit**
ALS2(config)# **ip default-gateway 10.1.120.1**
ALS2(config)# **end**

ALS2# **ping 10.1.99.2**
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.99.2, timeout is 2 seconds:
..!!!
Success rate is 60 percent (3/5), round-trip min/avg/max = 1/3/8 ms
ALS2#
ALS2# **traceroute 10.1.99.2**
Type escape sequence to abort.
Tracing the route to 10.1.99.2
VRF info: (vrf in name/id, vrf out name/id)
1 10.1.120.1 0 msec 0 msec 8 msec
2 172.16.12.1 0 msec 0 msec 8 msec
3 10.1.99.2 0 msec 0 msec *
ALS2#

Configure Multilayer Switching at ALS1
At this point all routing is going through the DLS switches, and the port channel between ALS1 and DLS2 is not passing anything but control traffic (BPDUs, etc).
The Cisco 2960 is able to support basic routing when it is using the LANBASE IOS. In this step you will configure ALS1 to support multiple SVIs and configure it for basic static routing. The objectives of this step are:
Enable intervlan routing between two VLANs locally at ALS1
Enable IP Routing
Configure a static route for DLS2's Lo1 network travel via Port-Channel 4.
Configure additional VLANs and VLAN interfaces
At ALS1, create VLAN 100 and VLAN 110 and then create SVIs for those VLANs:

ALS1(config)# **ip routing**
ALS1(config)# **vlan 100**
ALS1(config-vlan)# **name Local**
ALS1(config-vlan)# **exit**

ALS1(config)# **vlan 110**
ALS1(config-vlan)# **name InterNode**
ALS1(config-vlan)# **exit**
ALS1(config)# **int vlan 100**
ALS1(config-if)# **ip address 10.1.100.1 255.255.255.0**
ALS1(config-if)# **no shut**
ALS1(config-if)# **exit**
ALS1(config)# **int vlan 110**
ALS1(config-if)# **ip address 10.1.110.2 255.255.255.0**
ALS1(config-if)# **no shut**
ALS1(config-if)# **exit**
ALS1(config)#

Configure and test Host Access
Assign interface Fa0/6 to VLAN 100. On the attached host (Host A) configure the IP address 10.1.100.50/24 with a default gateway of 10.1.100.1. Once configured, try a traceroute from the host to 10.1.99.2 and observe the results.
In the output below, the **switchport host** macro was used to quickly configure interface Fa0/6 with host-relative commands.

ALS1(config)# **interface f0/6**
ALS1(config-if)# **switchport host**
switchport mode will be set to access
spanning-tree portfast will be enabled
channel group will be disabled

ALS1(config-if)# **switchport access vlan 100**
ALS1(config-if)# **no shut**
ALS1(config-if)# **exit**

```
Administrator: Command Prompt

C:\Windows\system32>ipconfig

Windows IP Configuration


Ethernet adapter Local Area Connection:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::d53b:d1d3:aabd:b3c4%11
   IPv4 Address. . . . . . . . . . . : 10.1.100.50
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.1.100.1

C:\Windows\system32>tracert 10.1.99.2

Tracing route to 10.1.99.2 over a maximum of 30 hops

  1     2 ms     1 ms     1 ms  10.1.99.2

Trace complete.

C:\Windows\system32>_
```

The output from the host shows that attempts to communicate with interface VLAN 99 at ALS1 were fulfilled locally, and not sent to DLS1 for routing.

Configure and verify static routing across the network
At this point, local routing (at ALS1) works, and off-net routing (outside of ALS1) will not work, because DLS1 doesn't have any knowledge of the 10.1.100.0 subnet. In this step you will configure routing on several different switches:
At DLS1, configure:
a static route to the 10.1.100.0/24 network via VLAN 99
At DLS2, configure
a static route to the 10.1.100.0/24 network via VLAN 110
At ALS1, configure
a static route to the 192.168.1.0/24 network via VLAN 110
a default static route to use 10.1.99.1

Here is an example from ALS1:

ALS1(config)# **ip route 192.168.1.0 255.255.255.0 vlan 110**
ALS1(config)# **ip route 0.0.0.0 0.0.0.0 10.1.99.1**
ALS1(config)# **end**
ALS1# **show ip route**
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
    D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
    N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
    E1 - OSPF external type 1, E2 - OSPF external type 2
    i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
    ia - IS-IS inter area, * - candidate default, U - per-user static route
    o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
    + - replicated route, % - next hop override

Gateway of last resort is 10.1.99.1 to network 0.0.0.0

S*   0.0.0.0/0 [1/0] via 10.1.99.1
   10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C   10.1.99.0/24 is directly connected, Vlan99
L   10.1.99.2/32 is directly connected, Vlan99
C   10.1.100.0/24 is directly connected, Vlan100
L   10.1.100.1/32 is directly connected, Vlan100
C   10.1.110.0/24 is directly connected, Vlan110
L   10.1.110.2/32 is directly connected, Vlan110
S   192.168.1.0/24 is directly connected, Vlan110
After configuring all of the required routes, test to see that the network behaves as expected.

From ALS1, a traceroute to 10.1.120.2 should take three hops:

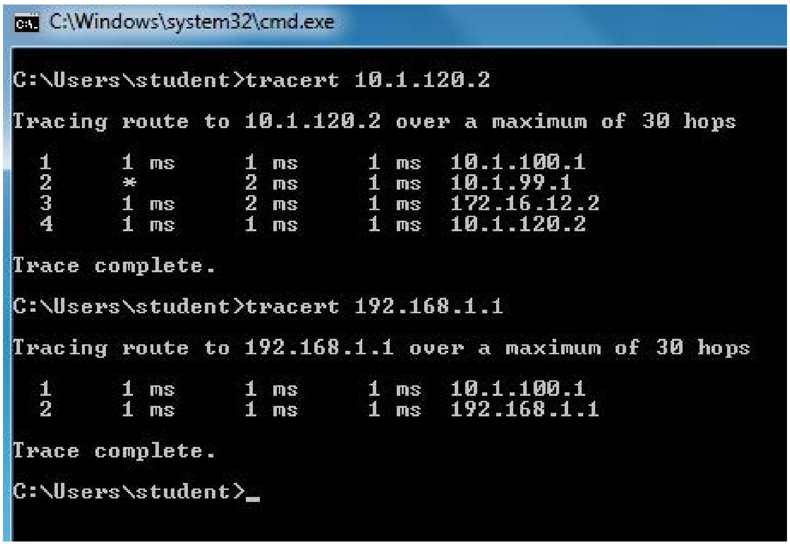
ALS1# **traceroute 10.1.120.2**
Type escape sequence to abort.
Tracing the route to 10.1.120.2

VRF info: (vrf in name/id, vrf out name/id)
 1 10.1.99.1 0 msec 0 msec 0 msec
 2 172.16.12.2 9 msec 0 msec 0 msec
 3 10.1.120.2 0 msec 8 msec *
ALS1#

From ALS1, a traceroute to 192.168.1.1 should take one hop:

ALS1# **traceroute 192.168.1.1**
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
 1 10.1.110.1 0 msec 0 msec *
ALS1#

Traces from Host A show an additional hop, but follow the appointed path:



End of Lab
Save your configurations. The switches will be used as configured now for lab 5-2, DHCP.