

Institute of Distance & Open Learning
M.Sc.I.T



UNIVERSITY OF MUMBAI

Certificate

This is to certify that **Rajpurohit Harsh Hargopalsingh** Seat no **600257** has successfully completed all the practical of paper titled **“Modern Networking”** for M.Sc. (Information Technology) Part 1 Sem 2 in the year 2022-2023

Signature
Faculty In-Charge

Head of the Department

Examiner

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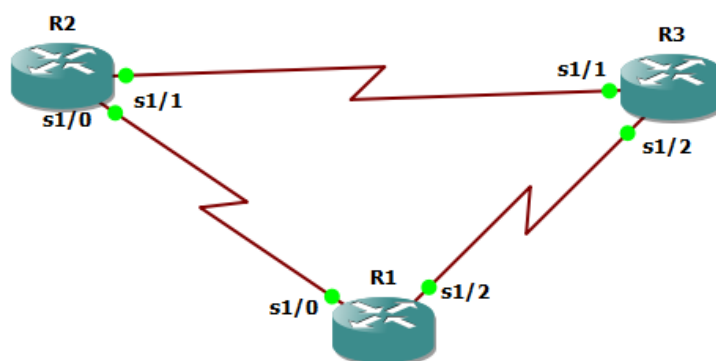
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Practical 1


Configure IP SLA Tracking & Path Control Topology

Aim: Configure IP SLA Tracking & Path Control Topology

Step 1: Consider the following Topology



IP SLA means Service Level Agreement

1. Start GNS3 Application → New Project → Name as: IPSLA → set path → ok.
2. Click on Router Tool → select c7200.R-15-2. Drag & place all three routers on workplace.
3. Click on Wire connection → connect from R1 Router → select serial 1/0 → connect to R2 router & select serial 1/0.
4. Click on Wire connection → connect from R2 Router → select serial 1/1 → connect to R3 router & select serial 1/1.
5. Click on Wire connection → connect from R3 Router → select serial 1/2 → connect to R1 router & select serial 1/2.
6. Click on Start option  to start all the nodes.
7. Click on console option → All console. It will open all consoles.
8. Type commands in R1 console .

```
R1#en
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#hostname R1
R1(config)#interface loopback 0
R1(config-if)#
*Mar 17 13:02:24.359: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#interface serial 1/0
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)#
*Mar 17 13:04:18.803: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#i
*Mar 17 13:04:19.811: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config-if)#interface serial 1/2
R1(config-if)#ip address 209.165.202.130 255.2
*Mar 17 13:04:49.295: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
R1(config-if)#ip address 209.165.202.130 255.255.255.252
R1(config-if)#bandwidth 128
R1(config-if)#no shutdown
```

9. Type commands in R2 console.

```
R2#en
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface loopback 0
R2(config-if)#
*Mar 17 13:21:54.015: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R2(config-if)#ip address 209.165.200.254 255.255.255.255
R2(config-if)#interface loopback 1
R2(config-if)#ip address 209.165.200.254 255.255.255.255
*Mar 17 13:22:27.539: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R2(config-if)#ip address 209.165.201.30 255.255.255.255
R2(config-if)#interface serial 1/0
R2(config-if)#ip address 209.165.201.1 255.255.255.252
R2(config-if)#bandwidth 128
R2(config-if)#no shutdown
R2(config-if)#in
*Mar 17 13:24:06.427: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R2(config-if)#inte
*Mar 17 13:24:07.435: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R2(config-if)#interface serial 1/1
R2(config-if)#ip address 209.165.200.225 255.255.255.252
R2(config-if)#clock rate 128000
R2(config-if)#bandwidth 128
R2(config-if)#no shutdown
```

10. Type commands in R3 console.

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#hostname ISP2
ISP2(config)#interface loopback 0
ISP2(config-if)#
*Mar 19 08:07:55.395: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP2(config-if)#ip address 209.165.200.254 255.255.255.255
ISP2(config-if)#interface loopback 1
ISP2(config-if)#
*Mar 19 08:08:32.003: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
ISP2(config-if)#ip address 209.165.202.158 255.255.255.255
ISP2(config-if)#interface serial 1/2
ISP2(config-if)#ip address 209.165.202.129 255.255.255.252
ISP2(config-if)#clock rate 128000
ISP2(config-if)#bandwidth 128
ISP2(config-if)#no shutdown
ISP2(config-if)#
*Mar 19 08:10:09.391: %LINK-3-UPDOWN: Interface Serial1/2, changed state to up
ISP2(config-if)#
*Mar 19 08:10:10.395: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/2, changed state to up
ISP2(config-if)#interface serial 1/1
ISP2(config-if)#ip address 209.165.200.226 255.255.255.252
ISP2(config-if)#bandwidth 128
ISP2(config-if)#no shutdown
ISP2(config-if)#
*Mar 19 08:11:03.347: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
ISP2(config-if)#
*Mar 19 08:11:04.351: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
ISP2(config-if)#
```

11. To check on how many interfaces are get connected successfully or not:- Type command in all three console

R1:-

```
R1(config-if)#^Z
R1#
*Mar 19 08:14:22.091: %SYS-5-CONFIG_I: Configured from console by console
R1#sh ip int br
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES unset administratively down down
Serial1/0 209.165.201.2 YES manual up up
Serial1/1 unassigned YES unset administratively down down
Serial1/2 209.165.202.130 YES manual up up
Serial1/3 unassigned YES unset administratively down down
Loopback0 192.168.1.1 YES manual up up
R1#
```

R2:-

```
R2(config-if)#^Z
R2#
*Mar 19 08:15:19.955: %SYS-5-CONFIG_I: Configured from console by console
R2#sh ip int br
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES unset administratively down down
Serial1/0 209.165.201.1 YES manual up up
Serial1/1 209.165.200.225 YES manual up up
Serial1/2 unassigned YES unset administratively down down
Serial1/3 unassigned YES unset administratively down down
Loopback0 209.165.200.254 YES manual up up
Loopback1 209.165.201.30 YES manual up up
R2#
```

R3:-

```
ISP2(config-if)#^Z
ISP2#
*Mar 19 08:16:10.963: %SYS-5-CONFIG_I: Configured from console by console
ISP2#sh ip int br
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES unset administratively down down
Serial1/0 unassigned YES unset administratively down down
Serial1/1 209.165.200.226 YES manual up up
Serial1/2 209.165.202.129 YES manual up up
Serial1/3 unassigned YES unset administratively down down
Loopback0 209.165.200.254 YES manual up up
Loopback1 209.165.202.158 YES manual up up
ISP2#
```

12. To assign specific route to R1 type command

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1
R1(config)#
```

13. Go to R2 console & type command

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#router eigrp 1
R2(config-router)#network 209.165.200.224 0.0.0.3
R2(config-router)#network 209.165.201.0 0.0.0.3
R2(config-router)#no auto-summary
R2(config-router)#exit
R2(config)#ip route 192.168.1.0 255.255.255.0 209.165.201.2
R2(config)#
```

14. Go to R3 console & type commands

```
ISP2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP2(config)#router eigrp 1
ISP2(config-router)#network 209.165.200.224 0.0.0.3
ISP2(config-router)#
*Mar 20 11:57:32.447: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 209.165.200.225 (Serial1/1) is up: new adjacency
ISP2(config-router)#network 209.165.202.128 0.0.0.3
ISP2(config-router)#no auto-summary
ISP2(config-router)#exit
ISP2(config)#ip route 192.168.1.0 255.255.255.0 209.165.202.130
ISP2(config)#
```

15. Now, by using ping command, we can check proper connection between routers. To start directly by using ping command we can first start with script command. For that

16. Go to R1 console type command

```
R1(config)#^Z
R1#
*Mar 20 11:59:44.075: %SYS-5-CONFIG_I: Configured from console by console
R1#telnet
R1(tel)#4 209.165.201.30 209.165.202.158 {ping $address source 192.168.1.1}
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.254, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
!!!!
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 209.165.201.30, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
!!!!
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 209.165.202.158, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
UUUU
Success rate is 0 percent (0/5)
R1(tel)#

R1(tel)#4 209.165.201.30 209.165.202.158 {trace $address source 192.168.1.1}
Type escape sequence to abort.
Tracing the route to 209.165.200.254
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 20 msec 24 msec 32 msec
Type escape sequence to abort.
Tracing the route to 209.165.201.30
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 20 msec 28 msec 28 msec
Type escape sequence to abort.
Tracing the route to 209.165.202.158
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 12 msec 44 msec 12 msec
  2 209.165.201.1 !H !H !H
R1(tel)#
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip sla monitor 1
% Invalid input detected at '^' marker.
R1(config)#ip sla 1
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)#^Z
R1#
*Mar 20 12:05:58.127: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip sla configuration 1
IP SLAs Infrastructure Engine-III
Entry number: 1
Name:
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:
  Operation frequency (seconds): 10 (not considered if randomly scheduled)
  Next Scheduled Start Time: Pending trigger
  Group Scheduled : FALSE
  Randomly Scheduled : FALSE
  Life (seconds): 3600
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): notInService
  Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
```

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

```
IPSLA operation id: 1
Number of successes: Unknown
Number of failures: Unknown
Operation time to live: 0
```

17. Now, commands for ISP2 Provider:-

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip sla 2
```

```
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)#ip sla schedule 2 life forever start-time now
R1(config)#end
R1
Mar 20 12:22:52.635: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip sla configuration 2
IP SLAs Infrastructure Engine-III
Entry number: 2
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 209.165.202.158/0.0.0.0
Type of Service parameter: 0x0
Request size (ADB data portion): 28
Verify data: No
Vrf Name:
Schedule:
  Operation frequency (seconds): 10 (not considered if randomly scheduled)
  Next Scheduled Start Time: Start Time already passed
  Group Scheduled: FALSE
  Randomly Scheduled: FALSE
  Life (seconds): Forever
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): Active
  Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
  Number of statistic distribution buckets kept: 1
  Statistic distribution interval (milliseconds): 20
Enhanced History:
History Statistics:
  Number of history Lives kept: 0
  Number of history Buckets kept: 15
```

History Filter Type: None

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

IPSLA operation id: 1
Number of successes: Unknown
Number of failures: Unknown
Operation time to live: 0

IPSLA operation id: 2
Latest RTT: NoConnection/Busy/Timeout
Latest operation start time: 12:23:26 UTC Mon Mar 20 2023
Latest operation return code: Timeout
Number of successes: 0
Number of failures: 5
Operation time to live: Forever
```

```
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 [1/0] 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
C   209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C   209.165.201.0/30 is directly connected, Serial1/0
L   209.165.201.2/32 is directly connected, Serial1/0
C   209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C   209.165.202.128/30 is directly connected, Serial1/2
L   209.165.202.130/32 is directly connected, Serial1/2
```

```
R1#
Mar 20 12:32:41.967: %SYS-5-CONFIG_I: Configured from console by console
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#track 1 ip sla 1 reachability
R1(config-track)#DELAY DOWN 10 UP 1
R1(config-track)#EXIT
R1(config)#track 1 ip sla 1 reachability
R1(config-track)#DELAY DOWN 10 UP 1
R1(config-track)#EXIT
R1(config)#Z
R1#
```

18. For Debugging mode

```
R1#debug ip routing
IP routing debugging is on
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1
R1(config)#track 2 ip sla 2 reachability
R1(config-track)#delay down 10 up 1
R1(config-track)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.202.28 3 track 2
R1(config)#end
R1
Mar 20 12:37:23.159: %SYS-5-CONFIG_I: Configured from console by console
R1#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 209.165.201.1 to network 0.0.0.0

S* 0.0.0.0/0 [1/0] 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
C   209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C   209.165.201.0/30 is directly connected, Serial1/0
L   209.165.201.2/32 is directly connected, Serial1/0
C   209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C   209.165.202.128/30 is directly connected, Serial1/2
L   209.165.202.130/32 is directly connected, Serial1/2
```

```
ip tcp synwait-time 5
```

```
track 1 ip sla 1 reachability
delay down 10 up 1
!
```

```
track 2 ip sla 2 reachability
delay down 10 up 1
!
```

```
interface Loopback0
ip address 192.168.1.1 255.255.255.0
!
interface FastEthernet0/0
no ip address
shutdown
duplex full
!
interface Serial1/0
bandwidth 128
ip address 209.165.201.2 255.255.255.252
serial restart-delay 0
clock rate 128000
!
interface Serial1/1
no ip address
shutdown
serial restart-delay 0
```

```
interface Serial1/2
bandwidth 128
ip address 209.165.202.130 255.255.255.252
serial restart-delay 0
!
interface Serial1/3
no ip address
shutdown
serial restart-delay 0
!
ip forward-protocol nd
!
no ip http server
no ip http secure-server
ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1
ip route 0.0.0.0 0.0.0.0 209.165.202.28 3 track 2
ip route 0.0.0.0 0.0.0.0 209.165.201.1
!
ip sla 1
icmp-echo 209.165.201.30
frequency 10
ip sla 2
icmp-echo 209.165.202.158
frequency 10
ip sla schedule 2 life forever start-time now
!
!
control-plane
!
line con 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
```

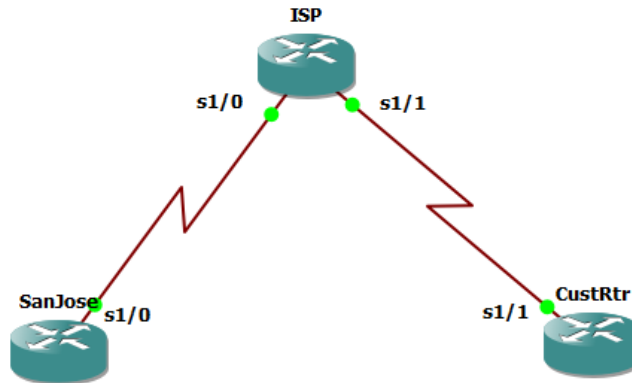
```
line aux 0
exec-timeout 0 0
privilege level 15
logging synchronous
stopbits 1
line vty 0 4
login
!
!
```

Practical 2


Using th AS_PATH Attribute

Aim: Using th AS_PATH Attribute

Step 1: Consider the following Topology



AS(Autonomous System)

1. To configure this topology let's start GNS3 software.
2. Place 3 routers one by one on worksheet(Take cisco 3640124-25d)
3. To change name of routers →Right click →change hostname →type name one by one as ISP, SanJose & CustRtr.
4. To configure router right click on 1st router →configure option →slots tab →slot 0:PA-4T+ →Ok. Do the same procedure for other two routers.
5. Choose wire connection connect from SanJose →select S1/0 → connect to ISP → select S1/0.
6. Choose wire connection connect from ISP →select S1/1 → connect toCustRtr → select S1/1.
7. Click om Start All Node option  → Yes
8. Right click on SanJose Router →console →Type commands.

```
SanJose#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose(config)#interface loopback 0
SanJose(config-if)#i
*Mar 20 13:22:44.023: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
SanJose(config-if)#ip address 10.1.1.1 255.255.255.0
SanJose(config-if)#exit
SanJose(config)#interface serial 1/0
SanJose(config-if)#ip address 192.168.1.1 255.255.255.0
SanJose(config-if)#no shutdown
SanJose(config-if)#exit
```

9. Right click on ISP Router →console →Type commands.

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#interface loopback 0
ISP(config-if)#ip
*Mar 20 13:24:16.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP(config-if)#ip address 10.2.2.1 255.255.255.0
ISP(config-if)#interface serial 1/0
ISP(config-if)#ip address 192.
% Incomplete command.

ISP(config-if)#ip address 192.168.1.2 255.255.255.0
ISP(config-if)#no shutdown
ISP(config-if)#exit
ISP(config)#
*Mar 20 13:25:32.823: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
*Mar 20 13:25:33.823: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
ISP(config)#interface serial 1/1
ISP(config-if)#ip address 192.168.2.1 255.255.255.0
ISP(config-if)#no shutdown
ISP(config-if)#exit
```

10. Right click on CustRtr Router →console →Type commands.

```
CustRtr#conf t
Enter configuration commands, one per line. End with CNTL/Z.
CustRtr(config)#interface loopback 0
CustRtr(config-if)#ip
*Mar 20 13:26:46.395: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
CustRtr(config-if)#ip address 10.3.3.1 255.255.255.0
CustRtr(config-if)#interface serial 1/1
CustRtr(config-if)#ip address 192.168.2.2 255.255.255.0
CustRtr(config-if)#no shutdown
CustRtr(config-if)#exit
```

11. To configure BGP Protocol on every Router

12. Go to SanJose Router console → type commands

```
SanJose#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose(config)#router bgp 100
SanJose(config-router)#neighbor 192.168.1.2 remote-as 300
SanJose(config-router)#network 10.1.1.0 mask 255.255.255.0
SanJose(config-router)#exit
SanJose(config)#
```

13. Go to ISP Router console → type commands

```
ISP(config)#router bgp 300
ISP(config-router)#neighbor 192.168.1.1 remote-as 100
ISP(config-router)#neighbor 192.168.2.2
*Mar 20 13:33:48.919: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Up
ISP(config-router)#neighbor 192.168.2.2 remote-as 65000
ISP(config-router)#network 10.2.2.0 mask 255.255.255.0
ISP(config-router)#exit
ISP(config)#
```

14. Go to CustRtr Router console → type commands

```
CustRtr(config)#router bgp 65000
CustRtr(config-router)#neighbor 192.168.2.1 remote-as 300
CustRtr(config-router)#network 10.3.3.0 mask
*Mar 20 13:35:31.491: %BGP-5-ADJCHANGE: neighbor 192.168.2.1 Up
CustRtr(config-router)#network 10.3.3.0 mask 255.255.255.0
CustRtr(config-router)#exit
```

15. To verify the establishment of the neighborhood

16. Go to ISP Router console → type commands

```
ISP#show ip bgp neighbors
BGP neighbor is 192.168.1.1, remote AS 100, external link
BGP version 4, remote router ID 10.1.1.1
BGP state = Established, up for 00:04:17
Last read 00:00:27, last write 00:00:00, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets ASN Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
  Stateful switchover support enabled: NO for session 1
Message statistics:
  InQ depth is 0
  OutQ depth is 0

Opens:          Sent      Rcvd
Notifications:  0          0
Updates:        3          2
Keepalives:     5          6
Route Refresh:  0          0
Total:          9          9
Default minimum time between advertisement runs is 30 seconds

For address family: IPv4 Unicast
Session: 192.168.1.1
BGP table version 4, neighbor version 4/0
Output queue size : 0
Index 1, Advertise bit 0
1 update-group member
Slow-peer detection is disabled
Slow-peer split-update-group dynamic is disabled
Prefix activity:
  Prefixes Current:      Sent      Rcvd
                        ----      ----
                        3          1 (Consumes 80 bytes)
```

17. To remove the Private As (Autonomous System)

18. Go to SanJose Router console → type commands

```
SanJose#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C    10.1.1.0/24 is directly connected, Loopback0
L    10.1.1.1/32 is directly connected, Loopback0
B    10.2.2.0/24 [20/0] via 192.168.1.2, 00:07:25
B    10.3.3.0/24 [20/0] via 192.168.1.2, 00:05:44
B    192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.1.0/24 is directly connected, Serial1/0
```

```
SanJose#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 100 percent (5/5), round-trip min/avg/max = 48/58/68 ms
SanJose#show ip bgp
BGP table version is 4, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               * best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop        Metric LocPrf Weight Path
*> 10.1.1.0/24       0.0.0.0          0           32768 i
*> 10.2.2.0/24       192.168.1.2      0           0 300 i
*> 10.3.3.0/24       192.168.1.2      0           0 300 65000 i
SanJose#
```


19. Go to ISP Router console → type commands

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#router bgp 300
ISP(config-router)#neighbor 192.168.1.1 remove-private-as
ISP(config-router)#exit
ISP(config)#exit
ISP#
*Mar 20 13:44:24.011: %SYS-5-CONFIG_I: Configured from console by console
ISP#clear ip bgp
% Incomplete command.

ISP#clear ip bgp *
ISP#
```

20. Again go to SanJose Router console → Type commands

```
SanJose#show ip bgp
BGP table version is 4, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
MPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop        Metric LocPrf Weight Path
*> 10.1.1.0/24      0.0.0.0          0         32768 i
*> 10.2.2.0/24      192.168.1.2       0         0 300 i
*> 10.3.3.0/24      192.168.1.2       0 300 65000 i
SanJose#
*Mar 20 13:44:44.603: %BGP-5-NBR_RESET: Neighbor 192.168.1.2 reset (Peer closed the session)
*Mar 20 13:44:44.611: %BGP-5-ADJCHANGE: neighbor 192.168.1.2 Down Peer closed the session
*Mar 20 13:44:44.615: %BGP_SESSION-5-ADJCHANGE: neighbor 192.168.1.2 IPv4 Unicast topology base removed from session
SanJose#
*Mar 20 13:44:45.591: %BGP-5-ADJCHANGE: neighbor 192.168.1.2 Up
SanJose#show ip bgp
BGP table version is 8, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
MPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop        Metric LocPrf Weight Path
*> 10.1.1.0/24      0.0.0.0          0         32768 i
*> 10.2.2.0/24      192.168.1.2       0         0 300 i
*> 10.3.3.0/24      192.168.1.2       0 300 i
SanJose#
```

21. To configure a special kind of access list to match BGP routers with an AS_PATH attribute that both begins & ends with the number 100.

22. Go to ISP Router console → type commands

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
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 192.168.2.2 filter-list 1 out
ISP(config-router)#exit
ISP(config)#exit
ISP#
*Mar 20 13:48:12.171: %SYS-5-CONFIG_I: Configured from console by console
ISP#clear ip bgp
% Incomplete command.

ISP#clear ip bgp *
ISP#
*Mar 20 13:48:26.207: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Down User reset
*Mar 20 13:48:26.207: %BGP_SESSION-5-ADJCHANGE: neighbor 192.168.1.1 IPv4 Unicast topology base removed from session
reset
*Mar 20 13:48:26.215: %BGP-5-ADJCHANGE: neighbor 192.168.2.2 Down User reset
*Mar 20 13:48:26.215: %BGP_SESSION-5-ADJCHANGE: neighbor 192.168.2.2 IPv4 Unicast topology base removed from session
reset
*Mar 20 13:48:26.659: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Up
*Mar 20 13:48:26.663: %BGP-5-ADJCHANGE: neighbor 192.168.2.2 Up
ISP#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
B       10.1.1.0/24 [20/0] via 192.168.1.1, 00:00:08
C       10.2.2.0/24 is directly connected, Loopback0
```

23. To check the routing table for CustRtr it should not have a route to 10.1.1.0 in its running table.

24. Go to CustRtr console → type command

```
CustRtr(config)#exit
CustRtr#
*Mar 20 13:49:52.227: %SYS-5-CONFIG_I: Configured from console by console
CustRtr#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
B       10.2.2.0/24 [20/0] via 192.168.2.1, 00:00:37
C       10.3.3.0/24 is directly connected, Loopback0
L       10.3.3.1/32 is directly connected, Loopback0
C       192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, Serial1/1
L       192.168.2.2/32 is directly connected, Serial1/1
CustRtr#
```

25. To verify that the filter is working on ISP, go to ISP router console →type command.

```
ISP#show ip bgp regex ^100$
BGP table version is 4, local router ID is 10.2.2.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop          Metric LocPrf Weight Path
  *> 10.1.1.0/24      192.168.1.1              0         0 100 i
ISP#
```

26. Pinging all the address from ISP it will successful for all, go to ISP router console again

```
ISP#tclsh
ISP(tcl)#$.1.1 10.2.2.1 10.3.3.1 192.168.1.1 192.168.2.2 {ping $address}
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 = 16/24/32 ms
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 = 1/1/1 ms
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 = 16/26/40 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/27/40 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/32/60 ms
ISP(tcl)#
```

27. Pinging all the addresses from CustRtr It will be failure for SanJose but successful for ISP. Go to CustRtr console →type command.

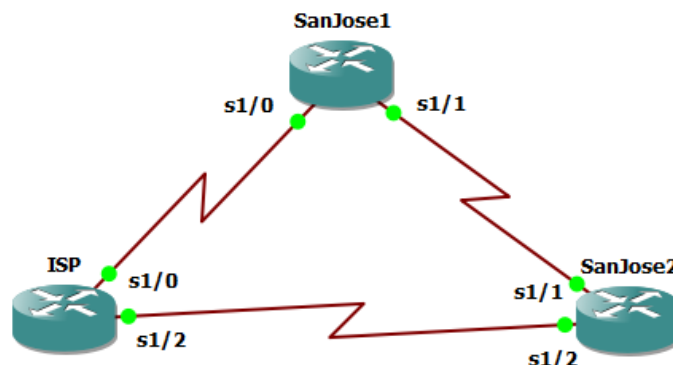
```
CustRtr#tclsh
CustRtr(tcl)#$.1 192.168.1.1 192.168.1.2 192.168.2.1 {ping $address}
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/27/32 ms
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 = 1/1/1 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/29/36 ms
CustRtr(tcl)#
```


Practical 3

Configuring IBGP & EBGp sessions, local preference & MED.

Aim: Configuring IBGP & EBGp sessions, local preference & MED.

Step 1: Consider the following Topology



1. Start GNS 3 software → file →new project →Name: Pract3_IBGP_EBGp_MED →change location → ok.
2. Click on router tool → select it & place it on screen →take three routers R1, R2 & R3 →arrange them as per topology.
3. Now click on wire connection, connect R1 → select serial 1/0 → to R2 →select serial 1/0. Connect R2 → select serial 1/1 → to R3→select serial 1/1. Connect R3→select serial 1/2 → to R1→select serial 1/2.
4. Click on Start All Node option  → Yes
5. To change the name of the router →right click →change hostname →type name one by one as R1(ISP), R2(SanJose1) & R3(SanJose2).
6. Right click on ISP (R1) Router → console →type commands.

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#line console 0
ISP(config-line)#logging synchronous
ISP(config-line)#exit
ISP(config)#int loopback 0
ISP(config-if)#
*Mar 20 20:20:57.803: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP(config-if)#ip address 192.168.100.1 255.255.255.0
ISP(config-if)#int serial 1/0
ISP(config-if)#ip address 192.168.1.5 255.255.255.252
ISP(config-if)#clock rate 120000
ISP(config-if)#no shutdown
ISP(config-if)#in
*Mar 20 20:22:21.459: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
ISP(config-if)#int
*Mar 20 20:22:22.467: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
ISP(config-if)#int serial 1/2
ISP(config-if)#ip address 192.168.1.1 255.255.255.0
*Mar 20 20:22:50.311: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
ISP(config-if)#ip address 192.168.1.1 255.255.255.252
ISP(config-if)#no shutdown
ISP(config-if)#end
```

7. Right click on SanJose 1(R2) Router →console →type commands

```
SanJose1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose1(config)#line console 0
SanJose1(config-line)#logging synchronous
SanJose1(config-line)#exit
SanJose1(config)#interface loopback 0
SanJose1(config-if)#
*Mar 20 20:31:28.087: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
SanJose1(config-if)#ip address 172.16.64.1 255.255.255.0
SanJose1(config-if)#int serial 1/0
SanJose1(config-if)#ip address 192.168.1.6 255.255.255.252
SanJose1(config-if)#no shutdown
SanJose1(config-if)#
*Mar 20 20:33:56.347: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
SanJose1(config-if)#int
*Mar 20 20:33:57.355: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
SanJose1(config-if)#int serial 1/1
SanJose1(config-if)#ip address 172.16.1.1 255.255.255.0
SanJose1(config-if)#clock rate 120000
SanJose1(config-if)#no shutdown
SanJose1(config-if)#exit
```

8. Right click on SanJose 2(R3) Router →console →type commands

```
SanJose2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose2(config)#line console 0
SanJose2(config-line)#logging synchronous
SanJose2(config-line)#exit
SanJose2(config)#interface loopback 0
SanJose2(config-if)#
*Mar 20 20:36:10.615: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
SanJose2(config-if)#ip address 172.16.32.1 255.255.255.0
SanJose2(config-if)#int serial 1/2
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)#int ser
*Mar 20 20:38:23.791: %LINK-3-UPDOWN: Interface Serial1/2, changed state to up
SanJose2(config-if)#int serial
*Mar 20 20:38:24.799: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/2, changed state to up
SanJose2(config-if)#int serial 1/1
SanJose2(config-if)#ip address 172.16.1.2 255.255.255.0
SanJose2(config-if)#no shutdown
SanJose2(config-if)#exit
```

9. To configure EIGRP (Enhanced Interior Gateway Routing Protocol) go to SanJose1 (R2) Router console

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

10. Now go to SanJose2 (R3) Router console

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

11. Next is to configure IBGP & verify BGP neighbors. IBGP (Internal Border Gateway Router). Go to SanJose1 (R2) Router console

```
SanJose1(config-router)#exit
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 loopback 0
SanJose1(config-router)#end
SanJose1#
*Mar 20 20:43:25.179: %SYS-5-CONFIG_I: Configured from console by console
SanJose1#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 = Idle
  Neighbor sessions:
    0 active, is not multisession capable (disabled)
  Stateful switchover support enabled: NO
  Default minimum time between advertisement runs is 0 seconds

For address family: IPv4 Unicast
  BGP table version 1, neighbor version 1/0
  Output queue size : 0
  Index 0, Advertise bit 0
  Slow-peer detection is disabled
  Slow-peer split-update-group dynamic is disabled

Prefix activity:
  Sent      Rcvd
  ----      -
  Prefixes Current:      0      0
  Prefixes Total:        0      0
  Implicit Withdraw:     0      0
  Explicit Withdraw:     0      0
  Used as bestpath:      n/a     0
  Used as multipath:      n/a     0
```

12. Go to SanJose2 (R3) Router console

```
SanJose2(config-router)#exit
SanJose2(config)#router bgp 64512
SanJose2(config-router)#neighbor 172.16.64.1 remote-as 64512
SanJose2(config-router)#neighbor 172.16.64.1
*Mar 20 20:45:07.151: %BGP-5-ADJCHANGE: neighbor 172.16.64.1 Up
SanJose2(config-router)#neighbor 172.16.64.1 update-source loopback 0
SanJose2(config-router)#end
SanJose2#
*Mar 20 20:45:22.795: %SYS-5-CONFIG_I: Configured from console by console
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 00:00:30
  Last read 00:00:30, last write 00:00:30, hold time is 180, keepalive interval is 60 seconds
  Neighbor sessions:
    1 active, is not multisession capable (disabled)
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Four-octets ASN Capability: advertised and received
    Address family IPv4 Unicast: advertised and received
    Enhanced Refresh Capability: advertised and received
    Multisession Capability:
      Stateful switchover support enabled: NO for session 1
  Message statistics:
    InQ depth is 0
    OutQ depth is 0

      Sent      Rcvd
      ----      -
  Opens:          1          1
  Notifications:  0          0
  Updates:        1          1
  Keepalives:     2          2
  --More--
```

13. Next is to configure EBGP & verify BGP neighbors. EBGP (External Border Gateway Router). Go to ISP (R1) Router console

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
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)#
```

14. Go to SanJose1 (R2) Router console

```

SanJose1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose1(config)#ip route 172.16.0.0 255.255.0.0 null 0
SanJose1(config)#router bgp 64512
SanJose1(config-router)#neighbor 192.168.1.5 remote-as 200
SanJose1(config-router)#network 172.16.0.0
*Mar 20 20:18:12.851: %BGP-5-ADJCHANGE: neighbor 192.168.1.5 Up
SanJose1(config-router)#network 172.16.0.0
SanJose1(config-router)#end
SanJose1#
*Mar 20 20:18:13.203: %SYS-5-CONFIG_I: Configured from console by console
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 00:05:40
Last read 00:00:14, last write 00:00:18, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets AS4 Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
  Stateful switchover support enabled: NO for session 1
Message statistics:
  InQ depth is 0
  OutQ depth is 0

      Sent          Rcvd
  -----
Opens:             1          1
Notifications:    0          0
Updates:           3          1
Keepalives:       7          8
--More--

```

15. Go to SanJose2 (R3) Router console

```

SanJose2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose2(config)#ip route 172.16.0.0 255.255.0.0 null 0
SanJose2(config)#router bgp 64512
SanJose2(config-router)#neighbor 192.168.1.1 remote-as 200
SanJose2(config-router)#network
*Mar 20 20:13:22.907: %BGP-5-ADJCHANGE: neighbor 192.168.1.1 Up
SanJose2(config-router)#network 172.16.0.0
SanJose2(config-router)#end
SanJose2#
*Mar 20 20:13:23.123: %SYS-5-CONFIG_I: Configured from console by console
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 00:05:24
Last read 00:00:35, last write 00:00:12, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
  1 active, is not multisession capable (disabled)
Neighbor capabilities:
  Route refresh: advertised and received(new)
  Four-octets AS4 Capability: advertised and received
  Address family IPv4 Unicast: advertised and received
  Enhanced Refresh Capability: advertised and received
  Multisession Capability:
  Stateful switchover support enabled: NO for session 1
Message statistics:
  InQ depth is 0
  OutQ depth is 0

      Sent          Rcvd
  -----
Opens:             1          1
Notifications:    0          0
Updates:           3          3
Keepalives:      11         10
--More--

```

16. To view BGP summary output go to SanJose2 (R3) Router console

```

SanJose2#show ip bgp summary
BGP router identifier 172.16.32.1, local AS number 64512
BGP table version is 4, main routing table version 4
2 network entries using 288 bytes of memory
4 path entries using 320 bytes of memory
4/2 BGP path/bestpath attribute entries using 544 bytes of memory
1 BGP AS-PATH entries using 24 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 1176 total bytes of memory
BGP activity 2/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down  State/PfxRcd
172.16.64.1      4    64512   15    16      4    0  0:00:35      2
192.168.1.1      4    200      8      7      4    0  0:00:19      1
SanJose2#

```

17. To verify which path traffic takes Go to ISP (R1) Router console →#end

```

ISP#clear ip bgp *
ISP#
*Mar 20 20:55:28.275: %BGP-5-ADJCHANGE: neighbor 192.168.1.2 Down User reset
*Mar 20 20:55:28.275: %BGP_SESSION-5-ADJCHANGE: neighbor 192.168.1.2 IPv4 Unicast topology base removed from session
reset

ISP#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 0 percent (0/5)
ISP#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:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/25/32 ms
ISP#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:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/24/36 ms
ISP#show ip bgp
BGP table version is 3, 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, m multipath, b backup-path, f RT-filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
  -----
*> 172.16.0.0      192.168.1.6          0           0 64512 i
*> 192.168.100.0  0.0.0.0              0           0 32768 i
ISP#

ISP#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 = 32/42/48 ms
ISP#ping 172.16.32.1 source 192.168.100.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.32.1, 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 = 16/28/44 ms
ISP#ping 172.16.1.2 source 192.168.100.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.2, 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 = 16/28/36 ms
ISP#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 = 32/44/56 ms
ISP#

```

18. Configure BGP next-hop-self feature.

```

ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
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
ISP(config-router)#next-hop-self
ISP#
*Mar 20 21:00:47.223: %SYS-5-CONFIG_I: Configured from console by console
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, m multipath, b backup-path, f RT-filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

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

```

19. Go to SanJose2 (R3) Router

```
SanJose2#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, I - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S    172.16.0.0/16 is directly connected, Null0
C    172.16.1.0/24 is directly connected, Serial1/1
L    172.16.1.2/32 is directly connected, Serial1/1
C    172.16.32.0/24 is directly connected, Loopback0
L    172.16.32.1/32 is directly connected, Loopback0
D    172.16.64.0/24 [90/2297856] via 172.16.1.1, 00:21:30, Serial1/1
C    192.168.1.0/24 is variably subnetted, 3 subnets, 2 masks
L    192.168.1.0/30 is directly connected, Serial1/2
L    192.168.1.2/32 is directly connected, Serial1/2
B    192.168.1.4/30 [20/0] via 192.168.1.1, 00:01:32
--More--
```

20. Go to SanJose1 (R2) Router

```
SanJose1#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, I - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S    172.16.0.0/16 is directly connected, Null0
C    172.16.1.0/24 is directly connected, Serial1/1
L    172.16.1.1/32 is directly connected, Serial1/1
D    172.16.32.0/24 [90/2297856] via 172.16.1.2, 00:22:36, Serial1/1
C    172.16.64.0/24 is directly connected, Loopback0
L    172.16.64.1/32 is directly connected, Loopback0
B    192.168.1.0/24 is variably subnetted, 3 subnets, 2 masks
L    192.168.1.0/30 [20/0] via 192.168.1.5, 00:03:09
L    192.168.1.4/30 is directly connected, Serial1/0
L    192.168.1.6/32 is directly connected, Serial1/0
B    192.168.100.0/24 [20/0] via 192.168.1.5, 00:07:21
SanJose1#
```

21. Go to ISP Router

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
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)#int serial 1/2
ISP(config-if)#shutdown
ISP(config-if)#
```

```
ISP(config-if)#end
ISP#
*Mar 20 21:08:17.947: %SYS-5-CONFIG_I: Configured from console by console
ISP#show ip bgp
BGP table version is 8, 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, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop          Metric LocPrf Weight Path
   *> 172.16.0.0      192.168.1.6            0         100      0 i
   *> 192.168.100.0   0.0.0.0                0         32768   i
ISP#
```

22. Go to SanJose1 Router

```
SanJose1#show ip bgp
BGP table version is 10, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop          Metric LocPrf Weight Path
   * i 172.16.0.0      172.16.32.1            0         100      0 i
   *> 192.168.100.0    0.0.0.0                0         32768   i
   *> 192.168.100.0    192.168.1.5            0         200   i
SanJose1#

SanJose1#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, I - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S    172.16.0.0/16 is directly connected, Null0
C    172.16.1.0/24 is directly connected, Serial1/1
L    172.16.1.1/32 is directly connected, Serial1/1
D    172.16.32.0/24 [90/2297856] via 172.16.1.2, 00:29:02, Serial1/1
C    172.16.64.0/24 is directly connected, Loopback0
L    172.16.64.1/32 is directly connected, Loopback0
C    192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
L    192.168.1.4/30 is directly connected, Serial1/0
L    192.168.1.6/32 is directly connected, Serial1/0
B    192.168.100.0/24 [20/0] via 192.168.1.5, 00:13:47
SanJose1#
```

23. Go to SanJose2 Router

```
SanJose2#show ip bgp
BGP table version is 13, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop          Metric LocPrf Weight Path
   *> 172.16.0.0      0.0.0.0                0         32768   i
   * i 172.16.64.1      172.16.64.1            0         100      0 i
   * i 192.168.100.0    192.168.1.5            0         100      0 200 i
SanJose2#
```

```
SanJose2#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S       172.16.0.0/16 is directly connected, Null0
C       172.16.1.0/24 is directly connected, Serial1/1
L       172.16.1.2/32 is directly connected, Serial1/1
C       172.16.32.0/24 is directly connected, Loopback0
L       172.16.32.1/32 is directly connected, Loopback0
D       172.16.64.0/24 [90/2297856] via 172.16.1.1, 00:31:16, Serial1/1
SanJose2#
```

24. Go to SanJose1 Router

```
SanJose1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose1(config)#router bgp 64512
SanJose1(config-router)#neighbor 172.16.32.1 next-hop-self
SanJose1(config-router)#end
SanJose1#cle
*Mar 20 21:13:54.215: %SYS-5-CONFIG_I: Configured from console by console
SanJose1#clear ip bgp *
SanJose1#
```

25. Go to SanJose2 Router

```
SanJose2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose2(config)#router bgp 64512
SanJose2(config-router)#neighbor 172.16.64.1 next-hop-self
SanJose2(config-router)#end
SanJose2#
*Mar 20 21:18:26.103: %SYS-5-CONFIG_I: Configured from console by console
SanJose2#clear ip bgp *
SanJose2#sh
*Mar 20 21:18:37.027: %BGP-5-ADJCHANGE: neighbor 172.16.64.1 Down User reset
*Mar 20 21:18:37.027: %BGP-5-ADJCHANGE: neighbor 172.16.64.1 IPv4 Unicast reset
SanJose2#show
*Mar 20 21:18:38.099: %BGP-5-ADJCHANGE: neighbor 172.16.64.1 Up
SanJose2#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 - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               * best-external, a additional-path, c RIB-compressed.
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
  * 172.16.0.0      0.0.0.0              0         32768 i
  * 1 172.16.64.1    172.16.64.1         0         100   0 i
  * 1 192.168.100.0  172.16.64.1         0         100   0 200 i
SanJose2#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    172.16.0.0/16 [28/0] via 192.168.1.6, 00:06:34
S       192.168.1.0/24 is variably subnetted, 4 subnets, 2 masks
C       192.168.1.0/30 is directly connected, Serial1/2
L       192.168.1.1/32 is directly connected, Serial1/2
C       192.168.1.4/30 is directly connected, Serial1/0
L       192.168.1.5/32 is directly connected, Serial1/0
C       192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.100.0/24 is directly connected, Loopback0
L       192.168.100.1/32 is directly connected, Loopback0
ISP#
```

26. Go to ISP Router

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#interface serial 1/2
ISP(config-if)#no shutdown
ISP(config-if)#
ISP#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, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    172.16.0.0/16 [28/0] via 192.168.1.6, 00:06:34
S       192.168.1.0/24 is variably subnetted, 4 subnets, 2 masks
C       192.168.1.0/30 is directly connected, Serial1/2
L       192.168.1.1/32 is directly connected, Serial1/2
C       192.168.1.4/30 is directly connected, Serial1/0
L       192.168.1.5/32 is directly connected, Serial1/0
C       192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.100.0/24 is directly connected, Loopback0
L       192.168.100.1/32 is directly connected, Loopback0
ISP#
```

27. To set BGP local preference go to SanJose1 Router

```
SanJose1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose1(config)#route-map PRIMARY_T1_IN permit 10
^
% Invalid input detected at '^' marker.

SanJose1(config)#route-map PRIMARY_T1_IN permit 10
SanJose1(config-route-map)#set local-preference 150
SanJose1(config-route-map)#exit
SanJose1(config)#router bgp 64512
SanJose1(config-router)#neighbor 192.168.1.5 route-map PRIMARY_T1_IN in
SanJose1(config-router)#end
SanJose1#
*Mar 20 21:24:16.967: %SYS-5-CONFIG_I: Configured from console by console
SanJose1#clear ip bgp * soft
SanJose1#show ip bgp
BGP table version is 5, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               * best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
  * i 172.16.0.0      172.16.32.1         0         100   0 i
  * > 172.16.64.1     0.0.0.0             0         32768 i
  * > 192.168.100.0  192.168.1.5         0         150   0 200 i
SanJose1#
```


28. Go to SanJose2 Router

```
SanJose2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose2(config)#route-map SECONDARY_T1_IN permit 10
SanJose2(config-route-map)#set local-preference 125
SanJose2(config-route-map)#exit
SanJose2(config)#router bgp 64512
SanJose2(config-router)#neighbor 192.168.1.1 route-map
% Incomplete command.
SanJose2(config-router)#neighbor 192.168.1.1 route-map SECONDARY_T1_IN in
SanJose2(config-router)#end
SanJose2#
*Mar 20 21:37:30.787: %SYS-5-CONFIG-I: Configured from console by console
SanJose2#clear ip bgp *soft
% Invalid input detected at '^' marker.
SanJose2#clear ip bgp * soft
SanJose2#show ip bgp
BGP table version is 5, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
*> 172.16.0.0      0.0.0.0              0         32768 i
*> 172.16.64.1     172.16.64.1          0         100   0 i
*> 192.168.100.0   192.168.1.1          0        125   0 200 i
*> 192.168.100.1   172.16.64.1          0        150   0 200 i
SanJose2#
```

29. To set BGP MED go to ISP router

```
ISP#show ip bgp
BGP table version is 11, 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, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
*> 172.16.0.0      192.168.1.2          0         64512 i
*> 192.168.100.0   192.168.1.6          0         64512 i
*> 192.168.100.0   0.0.0.0              0        32768 i
ISP#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
       I1 - OSPF external type 1, I2 - OSPF external type 2
       1 - 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, I - IISP
       * - replicated route, % - next hop override
Gateway of last resort is not set

R    172.16.0.0/16 [20/0] via 192.168.1.6, 00:14:29
R    192.168.1.0/30 is variably subnetted, 4 subnets, 2 masks
C    192.168.1.0/30 is directly connected, Serial1/2
C    192.168.1.4/30 is directly connected, Serial1/2
C    192.168.1.4/30 is directly connected, Serial1/0
C    192.168.100.0/24 is directly connected, Serial1/0
C    192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.100.24 is directly connected, Loopback0
C    192.168.100.1/32 is directly connected, Loopback0
ISP#
```

30. Go to SanJose1 Router

```
SanJose1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose1(config)#route-map PRIMARY_T1_MED_OUT permit 10
SanJose1(config-route-map)#set metric 50
SanJose1(config-route-map)#exit
SanJose1(config)#router bgp 64512
SanJose1(config-router)#neighbor 192.168.1.3 route-map PRIMARY_T1_MED_OUT out
SanJose1(config-router)#end
SanJose1#
*Mar 20 21:31:46.103: %SYS-5-CONFIG-I: Configured from console by console
SanJose1#clear ip bgp * soft
SanJose1#show ip bgp
% Invalid input detected at '^' marker.
SanJose1#show ip bgp
BGP table version is 5, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
*> 172.16.0.0      172.16.32.1          0         100   0 i
*> 192.168.100.0   192.168.1.5          0        150   0 200 i
SanJose1#
```

31. Go to SanJose2 Router

```
SanJose2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SanJose2(config)#route-map SECONDARY_T1_MED_OUT permit 10
SanJose2(config-route-map)#set metric 75
SanJose2(config-route-map)#exit
SanJose2(config)#router bgp 64512
SanJose2(config-router)#neighbor 192.168.1.1 route-map SECONDARY_T1_MED_OUT out
SanJose2(config-router)#end
SanJose2#cl
*Mar 20 21:34:48.979: %SYS-5-CONFIG-I: Configured from console by console
SanJose2#clear ip bgp * soft
SanJose2#show ip bgp
BGP table version is 5, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
*> 172.16.0.0      0.0.0.0              0        32768 i
*> 172.16.64.1     172.16.64.1          0         100   0 i
*> 192.168.100.0   192.168.1.1          0        125   0 200 i
*> 192.168.100.1   172.16.64.1          0        150   0 200 i
SanJose2#
```

32. Go to ISP router

```
ISP#show ip bgp
BGP table version is 13, 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, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop        Metric LocPrf Weight Path
*> 172.16.0.0      192.168.1.2          75        64512 i
*> 192.168.100.0   192.168.1.6          50        64512 i
*> 192.168.100.0   0.0.0.0              0        32768 i
ISP#
```

33. To establish a default route go to ISP Router

```
ISP#conf t
Enter configuration commands, one per line. End with CNTL/Z.
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)#
*Apr  4 21:20:36.855: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback10, changed state to up
ISP(config-if)#ip address 10.0.0.1 255.255.255.0
ISP(config-if)#exit
```


34. Go to SanJose1 Router

```
SanJose1#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, I - ISIS
       + - replicated route, % - next hop override

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S   172.16.0.0/16 is directly connected, Null0
C   172.16.1.0/24 is directly connected, Serial1/1
C   172.16.1.1/32 is directly connected, Serial1/1
C   172.16.32.0/24 [90/2297856] via 172.16.1.2, 00:57:19, Serial1/1
C   172.16.64.0/24 is directly connected, Loopback0
C   172.16.32.1/32 is directly connected, Loopback0
L   192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
L   192.168.1.0/30 is directly connected, Serial1/0
L   192.168.1.0/32 is directly connected, Serial1/0
B   192.168.100.0/24 [200/0] via 192.168.1.5, 00:13:45

SanJose1#show ip bgp
BGP table version is 5, local router ID is 172.16.64.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  * 172.16.0.0      172.16.32.1             0    100      0 1
  * 192.168.100.0   192.168.1.5            150    200 1
SanJose1#
```

35. Go to SanJose2 Router

```
SanJose2#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, I - ISIS
       + - replicated route, % - next hop override

Gateway of last resort is not set

172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S   172.16.0.0/16 is directly connected, Null0
C   172.16.1.0/24 is directly connected, Serial1/1
C   172.16.1.2/32 is directly connected, Serial1/1
C   172.16.32.0/24 is directly connected, Loopback0
C   172.16.32.1/32 is directly connected, Loopback0
D   172.16.64.0/24 [90/2297856] via 172.16.1.1, 00:58:00, Serial1/1
L   192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
L   192.168.1.0/30 is directly connected, Serial1/2
L   192.168.1.2/32 is directly connected, Serial1/2
SanJose2#show ip bgp
BGP table version is 5, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  * 0.0.0.0         192.168.1.1            125      0 200 1
  * 172.16.0.0      0.0.0.0                 0    100      0 1
  * 192.168.100.0   192.168.1.1            125    200 1
  * 172.16.64.0     172.16.64.1            0    100      0 1
  * 192.168.100.0   192.168.1.1            0    125    200 1
SanJose2#

SanJose2#show ip bgp
BGP table version is 5, local router ID is 172.16.32.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  * 0.0.0.0         192.168.1.1            125      0 200 1
  * 172.16.0.0      0.0.0.0                 0    100    32768 i
  * 192.168.100.0   192.168.1.1            0    100      0 1
  * 192.168.100.0   192.168.1.1            0    125    200 1
SanJose2#tracroute 10.0.0.1
Type escape sequence to abort.
Tracing the route to 10.0.0.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.1.2 52 msec 40 msec 24 msec
  2 192.168.1.1 [AS 200] 72 msec 52 msec 76 msec
SanJose1#
```

36. Go to ISP Router

```
ISP(config)#int serial 1/0
ISP(config-if)#shutdown
ISP(config-if)#
```

37. Go to SanJose1 Router

```
SanJose1#tracroute 10.0.0.1
Type escape sequence to abort.
Tracing the route to 10.0.0.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.1.2 52 msec 40 msec 24 msec
  2 192.168.1.1 [AS 200] 72 msec 52 msec 76 msec
SanJose1#
```

38. Go to SanJose2 Router

```
SanJose2#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, I - ISIS
       + - replicated route, % - next hop override

Gateway of last resort is not set

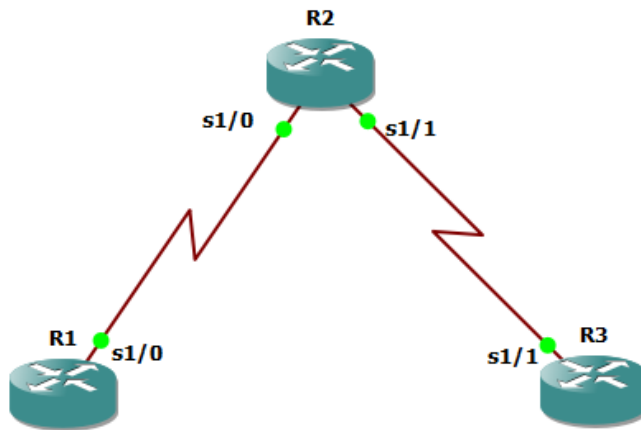
172.16.0.0/16 is variably subnetted, 6 subnets, 3 masks
S   172.16.0.0/16 is directly connected, Null0
C   172.16.1.0/24 is directly connected, Serial1/1
C   172.16.1.2/32 is directly connected, Serial1/1
C   172.16.32.0/24 is directly connected, Loopback0
L   172.16.32.1/32 is directly connected, Loopback0
D   172.16.64.0/24 [90/2297856] via 172.16.1.1, 01:04:14, Serial1/1
L   192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.1.0/30 is directly connected, Serial1/2
L   192.168.1.2/32 is directly connected, Serial1/2
B   192.168.100.0/24 [200/0] via 172.16.64.1, 00:20:43
SanJose2#
```


Practical 4

Secure the Management Plane.

Aim: Secure the Management Plane.

Soln: Consider the following topology



1. Start GNS 3 software → file → new project → Name: Secure_Management → change location → ok.
2. Click on router tool → select it & place it on screen → take three routers R1, R2 & R3 → arrange them as per topology.
3. Now click on Configure → slots → select PA-4T+ → Apply → ok. Do same procedure for all routers.
4. Now click on wire connection, connect R1 → select serial 1/0 → to R2 → select serial 1/0. Connect R2 → select serial 1/1 → to R3 → select serial 1/1.
5. Click on Start All Node option  → Yes
6. To configure loopbacks & assign address.

☆ Go to R1 console, type commands

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int loopback 0
R1(config-if)#
*May 25 15:48:41.027: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#int serial 1/0
R1(config-if)#ip address 10.1.1.1 255.255.255.0
R1(config-if)#clockrate 128000
R1(config-if)#no sh
R1(config-if)#exi
*May 25 15:50:13.963: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#exit
```

☆ Go to R2 console, type commands

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int serial 1/0
R2(config-if)#ip address 10.1.1.2 255.255.255.0
R2(config-if)#no sh
R2(config-if)#
*May 25 15:51:37.383: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R2(config-if)#
*May 25 15:51:38.387: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R2(config-if)#int serial 1/1
R2(config-if)#ip address 10.2.2.1 255.255.255.0
R2(config-if)#clockrate 128000
R2(config-if)#no sh
R2(config-if)#exit
```

☆ Go to R3 console, type commands

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int loopback 0
R3(config-if)#
*May 25 15:52:53.199: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip address 192.168.3.1 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int serial 1/1
R3(config-if)#ip address 10.2.2.2 255.255.255.0
R3(config-if)#no sh
R3(config-if)#
*May 25 15:54:16.971: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
R3(config-if)#
*May 25 15:54:17.979: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
R3(config-if)#do sh ip int br
Interface          IP-Address      OK? Method Status          Protocol
FastEthernet0/0    unassigned      YES unset  administratively down down
Serial1/0          unassigned      YES unset  administratively down down
Serial1/1          10.2.2.2        YES manual up             up
Serial1/2          unassigned      YES unset  administratively down down
Serial1/3          unassigned      YES unset  administratively down down
Loopback0          192.168.3.1     YES manual up             up
R3(config-if)#exit
R3(config)#

```

7. To configure static Routes

☆ Go to R1 Console

```

R1(config)#ip route 0.0.0.0 0.0.0.0 10.1.1.2
R1(config)#

```

☆ Go to R3 Console

```

R3(config)#ip route 0.0.0.0 0.0.0.0 10.2.2.1
R3(config)#

```

☆ Go to R2 Console

```

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
R2(config)#

```

☆ From R1 router run the following TCL script to verify connectivity.

```

R1#tclsh
R1(tcl)#$.1.1.1 10.1.1.2 10.2.2.1 10.2.2.2 198.168.3.1 {ping $address}
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/8 ms
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 = 52/58/64 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/33/44 ms
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 = 16/27/32 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.2.2.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/58/64 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 198.168.3.1, timeout is 2 seconds:
UUUUU
Success rate is 0 percent (0/5)
R1(tcl)#

```

8. To Secure Management Access

☆ Go to R1 Console

```

R1(config)#security passwords min-length 10
R1(config)#enable secret class12345
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)#

```

☆ Configure the password on the vty lines for 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)#line aux 0
R1(config-line)#no exec
R1(config-line)#end
R1#
```

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

Current configuration : 1339 bytes
!
! Last configuration change at 16:34:52 UTC Thu May 25 2023
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
security passwords min-length 10
enable secret 5 $1$0Uh0$H.UhWmbnmSqkv656oq0Ap0
!
no aaa new-model
no ip icmp rate-limit unreachable
ip cef
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#service password-encryption
R1(config)#end
```

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

Current configuration : 1400 bytes
!
! Last configuration change at 16:37:02 UTC Thu May 25 2023
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
security passwords min-length 10
enable secret 5 $1$0Uh0$H.UhWmbnmSqkv656oq0Ap0
!
no aaa new-model
no ip icmp rate-limit unreachable
ip cef
```

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#banner motd $unauthorized access strictly prohibited ! $
R1(config)#exit
```

☆ Go to R3 Console

```
R3(config)#security passwords min-length 10
R3(config)#enable secret class12345
R3(config)#
```

☆ Configure the password on the vty lines for R3

```
R3(config)#security passwords min-length 10
R3(config)#enable secret class12345
R3(config)#line console 0
R3(config-line)#password ciscoconpass
R3(config-line)#exec-timeout 5 0
R3(config-line)#login
R3(config-line)#logging synchronous
R3(config-line)#exit
R3(config)#
```

```
R3(config)#line vty 0 4
R3(config-line)#password ciscovtypass
R3(config-line)#exec-timeout 5 0
R3(config-line)#login
R3(config-line)#exit
R3(config)#
```

```
R3(config)#line aux 0
R3(config-line)#no exec
R3(config-line)#end
R3#
```

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

Current configuration : 1319 bytes
!
! Last configuration change at 17:02:35 UTC Thu May 25 2023
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
security passwords min-length 10
enable secret 5 $1$.BNn$2wi5zyAekU18KN1F9w1ih/
!
no aaa new-model
no ip icmp rate-limit unreachable
ip cef
```

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#service password-encryption
R3(config)#end
```

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

Current configuration : 1379 bytes
!
! Last configuration change at 17:06:19 UTC Thu May 25 2023
!
version 15.2
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
security passwords min-length 10
enable secret 5 $1$.BNn$2wi5zyAekU18KN1F9w1ih/
!
no aaa new-model
no ip icmp rate-limit unreachable
ip cef
```

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#banner motd $unauthorized access strictly prohibited ! $
R3(config)#exit
```

9. Go to R1 console to configure enhanced password security

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#username JR_ADMIN secret class12345
R1(config)#username ADMIN secret class54321
R1(config)#line console 0
R1(config-line)#login local
R1(config-line)#exit
R1(config)#line vty 0 4
R1(config-line)#login local
R1(config-line)#end
R1#
```

☆ Repeat above steps on Router 3

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#banner $unauthorized access strictly prohibited ! $
R3(config)#exit
R3#
*Jun 1 21:58:28.927: %SYS-5-CONFIG_I: Configured from console by console
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#username JR_ADMIN secret class12345
R3(config)#username ADMIN secret class54321
R3(config)#line console 0
R3(config-line)#login local
R3(config-line)#exit
R3(config)#line vty 0 4
R3(config-line)#login local
R3(config-line)#end
R3#
```

☆ To verify the configuration telnet to R3 from R1 & login using JR_ADMIN local database account

```
Username: JR_ADMIN
Password:
R3>enable
Password:
```

10. Enabling AAA Radius Authentication with Local User for Backup

```
R3>enable
Password:
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#aaa new-model
R3(config)#radius server RADIUS-1
R3(config-radius-server)#address ipv4 192.168.1.101
R3(config-radius-server)#key RADIUS-1-password
R3(config-radius-server)#exit
```

```
R3(config)#radius server RADIUS-2
R3(config-radius-server)#address ipv4 192.168.1.102
R3(config-radius-server)#key RADIUS-2-password
R3(config-radius-server)#exit
R3(config)#
```

```
R3(config)#aaa group server radius RADIUS-GROUP
R3(config-sg-radius)#server name RADIUS-1
R3(config-sg-radius)#server name RADIUS-2
R3(config-sg-radius)#exit
```

```
R3(config)#aaa authentication login default group RADIUS-GROUP local
R3(config)#$ication login TELNET-LOGIN group RADIUS-GROUP local-case
R3(config)#line vty 0 4
R3(config-line)#login authentication TELNET-LOGIN
R3(config-line)#exit
```

☆ Repeat above steps on R3. To verify configuration telnet to R3 from R1.

```
R3#telnet 10.2.2.2
Trying 10.2.2.2 ... Open
unauthorized access strictly prohibited !

User Access Verification

Username: JR_ADMIN
Password:

R3>
R3>enable
Password:
```

☆ Enabling AAA Radius Authentication with Local User for Backup

```
R3(config)#aaa new-model
R3(config)#radius server RADIUS-1
R3(config-radius-server)#address ipv4 192.168.1.101
R3(config-radius-server)#key RADIUS-1-password
R3(config-radius-server)#exit
```

```
R3(config)#radius server RADIUS-2
R3(config-radius-server)#address ipv4 192.168.1.102
R3(config-radius-server)#key RADIUS-2-password
R3(config-radius-server)#exit
```

```
R3(config)#aaa group server radius RADIUS-GROUP
R3(config-sg-radius)#server name RADIUS-1
R3(config-sg-radius)#server name RADIUS-2
R3(config-sg-radius)#exit
```

```
R3(config)#aaa authentication login default group RADIUS-GROUP local
R3(config)#location login TELNET-LOGIN group RADIUS-GROUP local-case
R3(config)#line vty 0 4
R3(config-line)#login authentication TELNET-LOGIN
R3(config-line)#exit
```

11. Enabling secure remote management using ssh.

☆ In this step you will enable R1 & R3 to support SSh instead of Telnet.

```
R1(config)#ip domain-name ccnasecurity.com
R1(config)#crypto key zeroize rsa
% No Signature Keys found in configuration.

R1(config)#crypto key generate rsa general-keys modulus 1024
The name for the keys will be: R1.ccnasecurity.com

% The key modulus size is 1024 bits
% Generating 1024 bit RSA keys, keys will be non-exportable...
[OK] (elapsed time was 1 seconds)
```

☆ Now configure SSh version 2 on R1. Configure the vty lines to use only SSH connections.

```
R1(config)#ip ssh version 2
R1(config)#line vty 0 4
R1(config-line)#transport input ssh
R1(config-line)#end
R1#
*Jun  1 22:30:40.703: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip ssh
SSH Enabled - version 2.0
Authentication timeout: 120 secs; Authentication retries: 3
Minimum expected Diffie Hellman key size : 1024 bits
IOS Keys in SECSH format(ssh-rsa, base64 encoded):
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQgQCkPbgZLdewr8Hxw0rLoztXZMVisSXZY0x/WjH55nOU
T9pSpKERzVh6FFFjIiykESKuGRFvQtFwRcHlx1Gm96qEWPvvmcjkE9fQl1LvwkI0uGgk5VmQ56RfySV
Q9r7jK41Mw2QkH2OInZjQeNtNI0oNBzZoM6qTiHJwqa+AtvSRw==
```

☆ Repeat above steps on R3

```
R3(config)#ip domain-name ccnasecurity.com
R3(config)#crypto key zeroize rsa
% No Signature Keys found in configuration.

R3(config)#crypto key generate rsa general-keys modulus 1024
The name for the keys will be: R3.ccnasecurity.com

% The key modulus size is 1024 bits
% Generating 1024 bit RSA keys, keys will be non-exportable...
[OK] (elapsed time was 0 seconds)
```

```
R3#show ip ssh
SSH Enabled - version 2.0
Authentication timeout: 120 secs; Authentication retries: 3
Minimum expected Diffie Hellman key size : 1024 bits
IOS Keys in SECSH format(ssh-rsa, base64 encoded):
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQgQDjSYNZ7wQ7I/Oa6Ux8TY10JaVM9ab9fG4mQkPXelWoS
wktGqg6L6DtIfzw1FdEzC27AKRv1q/fItUoB4pJ7abkMRthZemGzlr5o/Qa/3jt2M/kAQH0n9syGmpF
+H2WRT4bk0qtmnNSN3Gjj7v2mQ80mlznEjS7HC0wmDn67jXs9w==
```

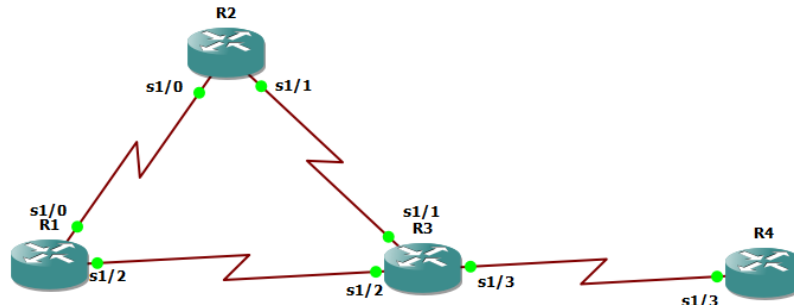
```
Unknown command or computer name
R1#ssh -l ADMIN 10.2.2.2
Password:
```

Practical 5

Configure and Verify Path Control Using PBR

Aim: Configure & verify the path control using PBR.

Soln: Consider the following topology



1. Start GNS 3 software → file → new project → Name: Configure & verify the path control using PBR → change location → ok.
2. Click on router tool → select it & place it on screen → take three routers R1, R2, R3 & R4 → arrange them as per topology.
3. Now click on Configure → slots → select PA-4T+ → Apply → ok. Do same procedure for all routers.
4. Now click on wire connection, connect R1 → select serial 1/0 → to R2 → select serial 1/0. Connect R1 → select serial 1/2 → to R3 → select serial 1/2. Connect R2 → select serial 1/1 → to R3 → select serial 1/1. Connect R3 → select serial 1/3 → to R4 → select serial 1/3.
5. Click on Start All Node option → Yes
6. To configure loopbacks & assign address.

☆ Go to R1 console, type commands

```
R1#conf t
Enter configuration commands, one per line. End with
R1(config)#int lo1
R1(config-if)#ip
*Jun 15 19:52:21.935: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R1(config-if)#ip add 192.168.1.1 255.255.255.0
R1(config-if)#int s1/0
R1(config-if)#ip add 172.16.12.1 255.255.255.0
R1(config-if)#no sh
R1(config-if)#int s
*Jun 15 19:53:17.259: %LINK-3-UPDOWN: Interface Serial
R1(config-if)#int s1/
*Jun 15 19:53:18.267: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R1(config-if)#int s1/2
R1(config-if)#ip add 172.16.13.1 25
*Jun 15 19:53:39.383: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R1(config-if)#ip add 172.16.13.1 255.255.255.0
R1(config-if)#no sh
```

```
R1(config-if)#int s1/0
R1(config-if)#bandwidth 128
R1(config-if)#int s1/2
R1(config-if)#bandwidth 64
R1(config-if)#
```

☆ Go to R2 console, type commands

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int lo1
R2(config-if)#
*Jun 15 19:56:04.211: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R2(config-if)#ip add 192.168.2.1 255.255.255.0
R2(config-if)#int s1/0
R2(config-if)#ip add 172.16.12.2 255.255.255.0
R2(config-if)#int s1/1
R2(config-if)#ip add 172.16.23.2 255.255.255.0
R2(config-if)#no sh
```

```
R2(config-if)#int s1/0
R2(config-if)#bandwidth 128
R2(config-if)#int s1/1
R2(config-if)#bandwidth 128
R2(config-if)#
```


☆ Go to R3 console, type commands

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int lo1
R3(config-if)#
*Jun 15 19:58:15.955: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R3(config-if)#ip add 192.168.3.1 255.255.255.0
R3(config-if)#int s1/1
R3(config-if)#ip add 172.16.23.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#int s
*Jun 15 19:59:08.179: %LINK-3-UPDOWN: Interface Serial1/1, changed st
R3(config-if)#int s1/
*Jun 15 19:59:09.187: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R3(config-if)#int s1/2
R3(config-if)#ip add 172.16.13.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#
*Jun 15 19:59:59.247: %LINK-3-UPDOWN: Interface Serial1/2, changed st
R3(config-if)#
*Jun 15 20:00:00.251: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R3(config-if)#int s1/3
R3(config-if)#ip add 172.16.34.3 255.255.255.0
R3(config-if)#no sh
R3(config-if)#
```

```
R3(config-if)#int s1/1
R3(config-if)#bandwidth 128
R3(config-if)#int s1/2
R3(config-if)#bandwidth 64
R3(config-if)#int s1/3
R3(config-if)#bandwidth 64
R3(config-if)#
```

☆ Go to R4 console, type commands

```
R4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R4(config)#int lo4
R4(config-if)#
*Jun 15 20:09:53.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R4(config-if)#ip add 192.168.4.1 255.255.255.128
R4(config-if)#int lo5
R4(config-if)#int lo5
*Jun 15 20:10:27.823: %LINEPROTO-5-UPDOWN: Line protocol on Interface
R4(config-if)#ip add 192.168.4.129 255.255.255.128
R4(config-if)#int s1/3
R4(config-if)#ip add 172.16.34.4 255.255.255.0
R4(config-if)#no sh
```

```
R4(config-if)#int s1/3
R4(config-if)#bandwidth 64
R4(config-if)#
```

☆ Verify the configuration in each console using show ip interface brief, show protocols, and show interfaces description commands.

```
R3(config-if)#do sh ip int br
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0 unassigned      YES unset   administratively down down
Serial1/0      unassigned      YES unset   administratively down down
Serial1/1      172.16.23.3     YES manual  up          up
Serial1/2      172.16.13.3     YES manual  up          up
Serial1/3      172.16.34.3     YES manual  up          down
Loopback1      192.168.3.1     YES manual  up          up
R3(config-if)#
```

```
R1(config-if)#do sh ip int br
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0 unassigned      YES unset   administratively down down
Serial1/0      172.16.12.1     YES manual  up          down
Serial1/1      unassigned      YES unset   administratively down down
Serial1/2      172.16.13.1     YES manual  up          up
Serial1/3      unassigned      YES unset   administratively down down
Loopback1      192.168.1.1     YES manual  up          up
R1(config-if)#
```

```
R2(config-if)#do sh ip int br
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0 unassigned      YES unset   administratively down down
Serial1/0      172.16.12.2     YES manual  administratively down down
Serial1/1      172.16.23.2     YES manual  up          up
Serial1/2      unassigned      YES unset   administratively down down
Serial1/3      unassigned      YES unset   administratively down down
Loopback1      192.168.2.1     YES manual  up          up
R2(config-if)#
```

```
R4(config-if)#do sh ip int br
Interface      IP-Address      OK? Method Status        Protocol
FastEthernet0/0 unassigned      YES unset  administratively down down
Serial1/0       unassigned      YES unset  administratively down down
Serial1/1       unassigned      YES unset  administratively down down
Serial1/2       unassigned      YES unset  administratively down down
Serial1/3       172.16.34.4     YES manual up           up
Loopback4       192.168.4.1     YES manual up           up
Loopback5       192.168.4.129   YES manual up           up
R4(config-if)#
```

```
R1(config-if)#do sh protocols
Global values:
  Internet Protocol routing is enabled
FastEthernet0/0 is administratively down, line protocol is down
Serial1/0 is up, line protocol is down
  Internet address is 172.16.12.1/24
Serial1/1 is administratively down, line protocol is down
Serial1/2 is up, line protocol is up
  Internet address is 172.16.13.1/24
Serial1/3 is administratively down, line protocol is down
Loopback1 is up, line protocol is up
  Internet address is 192.168.1.1/24
R1(config-if)#
```

```
R1(config-if)#do sh interfaces description
Interface      Status        Protocol Description
Fa0/0          admin down    down
Se1/0          up            down
Se1/1          admin down    down
Se1/2          up            up
Se1/3          admin down    down
Lo1            up            up
R1(config-if)#
```

☆ Configure basic EIGRP of each console

```
R1(config-if)#router eigrp 1
R1(config-router)#network 172.16.12.0 0.0.0.255
R1(config-router)#network 172.16.13.0 0.0.0.255
R1(config-router)#network 192.168.1.0
R1(config-router)#no auto-summary
R1(config-router)#
```

```
R2(config-if)#router eigrp 1
R2(config-router)#network 172.16.23.0 0.0.0.255
R2(config-router)#network 192.168.2.0
R2(config-router)#no auto-summary
R2(config-router)#
```

```
R3(config-if)#router eigrp 1
R3(config-router)#network 172.16.13.0 0.0.0.255
R3(config-router)#network 172.16.13.0 0.0.0.255
*Jun 15 20:28:04.331: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1:
R3(config-router)#network 172.16.23.0 0.0.0.255
R3(config-router)#network 172.16.23.0 0.0.0.255
*Jun 15 20:28:28.751: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1:
R3(config-router)#network 172.16.34.0 0.0.0.255
R3(config-router)#network 192.168.3.0
R3(config-router)#no auto-summary
R3(config-router)#
```

```
R4(config-if)#router eigrp 1
R4(config-router)#network 172.16.34.0 0.0.0.255
R4(config-router)#
*Jun 15 20:30:05.663: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1
R4(config-router)#network 192.168.4.0
R4(config-router)#no auto-summary
R4(config-router)#
```

```
R4(config-router)#do sh 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 not set

172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
D 172.16.13.0/24 [90/41024000] via 172.16.34.3, 00:01:31, Serial1/3
D 172.16.23.0/24 [90/41024000] via 172.16.34.3, 00:01:31, Serial1/3
C 172.16.34.0/24 is directly connected, Serial1/3
L 172.16.34.4/32 is directly connected, Serial1/3
D 192.168.1.0/24 [90/41152000] via 172.16.34.3, 00:01:31, Serial1/3
D 192.168.2.0/24 [90/41152000] via 172.16.34.3, 00:01:31, Serial1/3
D 192.168.3.0/24 [90/40640000] via 172.16.34.3, 00:01:31, Serial1/3
D 192.168.4.0/24 is variably subnetted, 4 subnets, 2 masks
C 192.168.4.0/25 is directly connected, Loopback4
L 192.168.4.1/32 is directly connected, Loopback4
--More--
```

★ Verify EIGRP connectivity.

```
R1(config-router)#do sh ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 172.16.13.3 Se1/2 11 00:06:09 57 2340 0 16
R1(config-router)#
```

```
R2(config-router)#do sh ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 172.16.23.3 Se1/1 12 00:07:04 54 1170 0 17
R2(config-router)#
```

```
R3(config-router)#do sh ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
2 172.16.34.4 Se1/3 12 00:06:17 88 2340 0 4
1 172.16.23.2 Se1/1 11 00:07:53 49 1170 0 6
0 172.16.13.1 Se1/2 14 00:08:17 49 2340 0 7
R3(config-router)#
```

```
R4(config-router)#do sh ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 172.16.34.3 Se1/3 14 00:06:58 67 2340 0 15
R4(config-router)#
```

☆ Verify the current path.

```
R1(config-router)#do sh 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 not set

172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.16.13.0/24 is directly connected, Serial1/2
L       172.16.13.1/32 is directly connected, Serial1/2
O       172.16.23.0/24 [90/41024000] via 172.16.13.3, 00:09:27, Serial1/2
O       172.16.34.0/24 [90/41024000] via 172.16.13.3, 00:09:21, Serial1/2
C       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
O       192.168.2.0/24 [90/41152000] via 172.16.13.3, 00:09:26, Serial1/2
O       192.168.3.0/24 [90/40640000] via 172.16.13.3, 00:09:02, Serial1/2
O       192.168.4.0/25 is subnetted, 2 subnets
O       192.168.4.0 [90/41152000] via 172.16.13.3, 00:07:36, Serial1/2
O       192.168.4.128 [90/41152000] via 172.16.13.3, 00:07:36, Serial1/2
```

☆ Use the traceroute command

```
R4(config-router)#do traceroute 192.168.1.1 source 192.168.4.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.34.3 52 msec 68 msec 68 msec
  2 172.16.13.1 112 msec 160 msec 108 msec
R4(config-router)#
```

```
R4(config-router)#do traceroute 192.168.1.1 source 192.168.4.129
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.34.3 52 msec 72 msec 44 msec
  2 172.16.13.1 132 msec 152 msec 120 msec
R4(config-router)#
```

```
R1(config-router)#do traceroute 192.168.4.129 source 192.168.1.1
Type escape sequence to abort.
Tracing the route to 192.168.4.129
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.13.3 64 msec 44 msec 64 msec
  2 172.16.34.4 136 msec 96 msec 140 msec
R1(config-router)#
```

```
R3(config-router)#do traceroute 192.168.1.1 source 192.168.3.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.13.1 40 msec 92 msec 56 msec
R3(config-router)#
```

☆ Configure PBR to provide path control.

```
R3(config-router)#exit
R3(config)#ip access-list standard pbr-acl
R3(config-std-nacl)#remark ACL matches R4 LAN129 traffic
R3(config-std-nacl)#set ip next-hop 172.16.13.1
      ^
% Invalid input detected at '^' marker.

R3(config-std-nacl)#permit 192.168.4.128 0.0.0.127
R3(config-std-nacl)#exit
R3(config)#
```

```
R3(config-std-nacl)#exit
R3(config)#route-map r3-to-r1permit
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)#int s1/3
R3(config-if)#ip policy route-map r3-to-r1
R3(config-if)#end
R3#
*Jun 15 20:59:10.859: %SYS-5-CONFIG_I: Configured from console by console
R3#sh route-map
route-map r3-to-r1permit, permit, sequence 10
  Match clauses:
    ip address (access-lists): pbr-acl
  Set clauses:
    ip next-hop 172.16.13.1
  Policy routing matches: 0 packets, 0 bytes
R3#
```

```
R4(config-router)#do traceroute 192.168.1.1 source 192.168.4.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.34.3 52 msec 68 msec 68 msec
  2 172.16.13.1 112 msec 160 msec 108 msec
R4(config-router)#do traceroute 192.168.1.1 source 192.168.4.129
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.34.3 52 msec 72 msec 44 msec
  2 172.16.13.1 132 msec 152 msec 120 msec
R4(config-router)#do traceroute 192.168.1.1 source 192.168.4.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.34.3 52 msec 72 msec 44 msec
  2 172.16.13.1 124 msec 104 msec 96 msec
R4(config-router)#
```

```
R4(config-router)#do traceroute 192.168.1.1 source 192.168.4.129
Type escape sequence to abort.
Tracing the route to 192.168.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.34.3 72 msec 60 msec 64 msec
  2 172.16.13.1 136 msec 160 msec 124 msec
R4(config-router)#
```

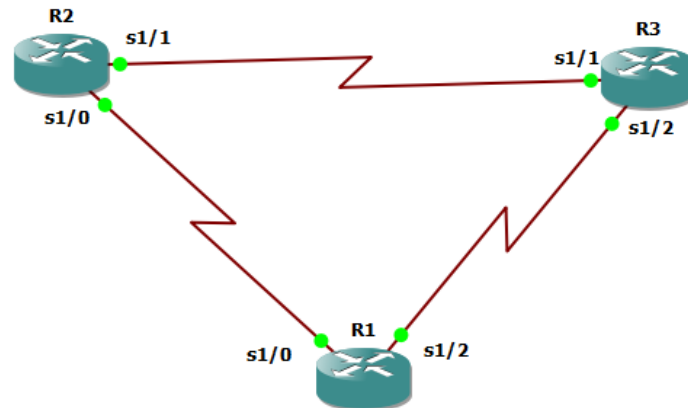
```
R1(config-router)#do traceroute 192.168.4.129 source 192.168.1.1
Type escape sequence to abort.
Tracing the route to 192.168.4.129
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.13.3 56 msec 52 msec 64 msec
  2 172.16.34.4 140 msec 152 msec 116 msec
R1(config-router)#
```


Practical 6

Configure IP SLA Tracking and Path Control

Aim: Configure IP SLA Tracking and Path Control

Solution: Consider the following topology



1. Start GNS 3 software → file → new project → Name: Configure IP SLA Tracking and Path Control → change location → ok.
2. Click on router tool → select it & place it on screen → take three routers R1, R2 & R3 → arrange them as per topology.
3. Now click on Configure → slots → select PA-4T+ → Apply → ok. Do same procedure for all routers.
4. Now click on wire connection, connect R1 → select serial 1/0 → to R2 → select serial 1/0. Connect R1 → select serial 1/2 → to R3 → select serial 1/2. Connect R2 → select serial 1/1 → to R3 → select serial 1/1. .
5. Click on Start All Node option  → Yes
6. To configure loopbacks & assign address.

☆ Go to R1 Console

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#hostname R1
R1(config)#int lo0
R1(config-if)#
*Jun 17 21:40:36.719: %LINEPROTO-5-UPDOWN: Line protocol on I
R1(config-if)#ip add 192.168.1.1 255.255.255.0
R1(config-if)#int s1/0
R1(config-if)#ip add 209.165.201.2 255.255.255.252
R1(config-if)#clock rate 128000
R1(config-if)#bandwidth 128
R1(config-if)#no sh
R1(config-if)#
*Jun 17 21:42:31.211: %LINK-3-UPDOWN: Interface Serial1/0, ch
R1(config-if)#
*Jun 17 21:42:32.219: %LINEPROTO-5-UPDOWN: Line protocol on I
R1(config-if)#int s1/2
R1(config-if)#ip add 209.165.202.13
*Jun 17 21:42:56.315: %LINEPROTO-5-UPDOWN: Line protocol on I
R1(config-if)#ip add 209.165.202.130 255.255.255.252
R1(config-if)#bandwidth 128
R1(config-if)#no sh
R1(config-if)#
```

☆ Go to R2 Console

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#hostname ISP1
ISP1(config)#int lo0
ISP1(config-if)#ip
*Jun 17 21:45:43.043: %LINEPROTO-5-UPDOWN: Line protocol on I
ISP1(config-if)#ip add 209.165.201.30 255.255.255.255
ISP1(config-if)#int s1/0
ISP1(config-if)#ip add 209.165.201.1 255.255.255.252
ISP1(config-if)#bandwidth 128
ISP1(config-if)#no sh
ISP1(config-if)#
*Jun 17 21:46:57.307: %LINK-3-UPDOWN: Interface Serial1/0, ch
ISP1(config-if)#
*Jun 17 21:46:58.315: %LINEPROTO-5-UPDOWN: Line protocol on I
ISP1(config-if)#int s1/1
ISP1(config-if)#ip add 209.165.200.225 255.255.255.252
ISP1(config-if)#clock rate 128000
ISP1(config-if)#bandwidth 128
ISP1(config-if)#no sh
ISP1(config-if)#

```

☆ Go to R3 Console

```

R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#hostname ISP2
ISP2(config)#int lo0
ISP2(config-if)#
*Jun 17 22:02:20.003: %LINEPROTO-5-UPDOWN: Line protocol on I
ISP2(config-if)#ip add 209.165.200.254 255.255.255.255
ISP2(config-if)#int lo1
ISP2(config-if)#ip
*Jun 17 22:02:54.847: %LINEPROTO-5-UPDOWN: Line protocol on I
ISP2(config-if)#ip add 209.165.202.158 255.255.255.255
ISP2(config-if)#int s1/2
ISP2(config-if)#ip add 209.165.202.129 255.255.255.252
ISP2(config-if)#clock rate 128000
ISP2(config-if)#bandwidth 128
ISP2(config-if)#no sh
ISP2(config-if)#
*Jun 17 22:04:44.855: %LINK-3-UPDOWN: Interface Serial1/2, ch
ISP2(config-if)#
*Jun 17 22:04:45.863: %LINEPROTO-5-UPDOWN: Line protocol on I
ISP2(config-if)#int s1/1
ISP2(config-if)#ip add 209.165.200.226 255.255.255.252
ISP2(config-if)#bandwidth 128
ISP2(config-if)#no sh
ISP2(config-if)#

```

☆ Verify the configuration by using the show interfaces description command.

```

R1#show interfaces description

```

Interface	Status	Protocol Description
Fa0/0	admin down	down
Se1/0	up	up
Se1/1	admin down	down
Se1/2	up	up
Se1/3	admin down	down
Lo0	up	up

☆ Configure static routing.

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1
R1(config)#exit

```

```

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)#ip route 192.168.1.0 255.255.255.0 209.165.201.2
ISP1(config)#

```



```
ISP2(config)#router eigrp 1
ISP2(config-router)#network 209.165.200.224 0.0.0.3
ISP2(config-router)#
*Jun 17 22:10:12.179: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1:
ISP2(config-router)#network 209.165.202.128 0.0.0.31
ISP2(config-router)#no auto-summary
ISP2(config-router)#exit
```

☆ verify reachability to the Internet servers to verify connectivity.

```
R1#tclsh
R1(tcl)#$4 209.165.201.30 209.165.202.158} {ping $address source 192.168.1.1}
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.200.254, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
UUUUU
Success rate is 0 percent (0/5)
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.201.30, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/26/32 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 209.165.202.158, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/47/56 ms
```

☆ Trace the path to the web server.

```
R1(tcl)#$201.30 209.165.202.158} {trace $address source 192.168.1.1}
Type escape sequence to abort.
Tracing the route to 209.165.200.254
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 20 msec 28 msec 24 msec
  2 209.165.201.1 !H !H !H
Type escape sequence to abort.
Tracing the route to 209.165.201.30
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 16 msec 24 msec 24 msec
Type escape sequence to abort.
Tracing the route to 209.165.202.158
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 12 msec 36 msec 16 msec
  2 209.165.200.226 48 msec 40 msec 40 msec
R1(tcl)#exit
```

☆ Configure IP SLA probes.

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip sla 11
R1(config-ip-sla)#icmp-echi 209.165.201.30
      ^
% Invalid input detected at '^' marker.

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)#ip sla schedule 11 life forever start-time now
R1(config)#exit
R1#
```

☆ Verify the IP SLAs configuration

```
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:
  Operation frequency (seconds): 10 (not considered if randomly scheduled)
  Next Scheduled Start Time: Start Time already passed
  Group Scheduled : FALSE
  Randomly Scheduled : FALSE
  Life (seconds): Forever
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
  Number of statistic distribution buckets kept: 1
  Statistic distribution interval (milliseconds): 20
Enhanced History:
```


☆ Use the show ip sla statistics command

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

IPSLA operation id: 11
  Latest RTT: 32 milliseconds
Latest operation start time: 22:17:25 UTC Sat Jun 17 2023
Latest operation return code: OK
Number of successes: 6
Number of failures: 0
Operation time to live: Forever
```

☆ Create a second probe to test connectivity to the second DNS server

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
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)#ip sla schedule 22 life forever start-time now
R1(config)#end
R1#
```

☆ Verify the new probe using the show ip sla configuration and show ip sla statistics commands.

```
R1#show ip sla configuration 22
IP SLAs Infrastructure Engine-III
Entry number: 22
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 209.165.202.158/0.0.0.0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
  Operation frequency (seconds): 10 (not considered if randomly scheduled)
  Next Scheduled Start Time: Start Time already passed
  Group Scheduled : FALSE
  Randomly Scheduled : FALSE
  Life (seconds): Forever
  Entry Ageout (seconds): never
  Recurring (Starting Everyday): FALSE
  Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
  Number of statistic hours kept: 2
  Number of statistic distribution buckets kept: 1
```

☆ Use the show ip sla statistics command

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

IPSLA operation id: 22
  Latest RTT: 52 milliseconds
Latest operation start time: 22:19:29 UTC Sat Jun 17 2023
Latest operation return code: OK
Number of successes: 6
Number of failures: 0
Operation time to live: Forever
```

```
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
```

☆ Configure tracking options.

```
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, Serial1/0
L     209.165.201.2/32 is directly connected, Serial1/0
     209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C     209.165.202.128/30 is directly connected, Serial1/2
L     209.165.202.130/32 is directly connected, Serial1/2
```

☆ From global configuration mode use the track 1 ip sla 11 reachability command

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#track 1 ip sla 11 reachability
R1(config-track)#delay down 10 up 1
R1(config-track)#exit
R1(config)#exit
R1#
```

☆ To view routing table enable the debug ip routing command. Configure the floating static route

```
R1#debug ip routing
IP routing debugging is on
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1
R1(config)#
*Jun 17 22:23:37.947: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1 1048578
*Jun 17 22:23:37.947: RT: closer admin distance for 0.0.0.0, flushing 1 routes
*Jun 17 22:23:37.951: RT: add 0.0.0.0/0 via 209.165.201.1, static metric [2/0]
*Jun 17 22:23:37.951: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1 1048578
*Jun 17 22:23:37.955: RT: rib update return code: 17
*Jun 17 22:23:37.959: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1 1048578
*Jun 17 22:23:37.963: RT: rib update return code: 17
```

☆ Repeat the steps

```
R1(config)#track 2 ip sla 22 reachability
R1(config-track)#delay down 10 up 1
R1(config-track)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.202.129 3 track 2
R1(config)#
*Jun 17 22:24:55.007: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1 1048578
*Jun 17 22:24:55.011: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1 1048578
*Jun 17 22:24:55.015: RT: rib update return code: 17
*Jun 17 22:24:55.023: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.202.129 1048578
*Jun 17 22:24:55.023: RT: rib update return code: 17
R1(config)#^Z
^Z
```

☆ Verify the routing table again.

```

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 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, Serial1/0
L     209.165.201.2/32 is directly connected, Serial1/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C     209.165.202.128/30 is directly connected, Serial1/2
L     209.165.202.130/32 is directly connected, Serial1/2
R1#

```

☆ Verify IP SLA operation.

```

ISP1(config-if)#int lo1
ISP1(config-if)#shutdown
ISP1(config-if)#
*Jun 17 22:25:58.699: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to down

```

☆ On R1, verify the routing table.

```

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 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, Serial1/0
L     209.165.201.2/32 is directly connected, Serial1/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C     209.165.202.128/30 is directly connected, Serial1/2
L     209.165.202.130/32 is directly connected, Serial1/2

```

☆ Verify the IP SLA statistics.

```

R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 11
  Latest RTT: 28 milliseconds
Latest operation start time: 22:27:25 UTC Sat Jun 17 2023
Latest operation return code: OK
Number of successes: 64
Number of failures: 2
Operation time to live: Forever

IPSLA operation id: 22
  Latest RTT: 60 milliseconds
Latest operation start time: 22:27:29 UTC Sat Jun 17 2023
Latest operation return code: OK
Number of successes: 52
Number of failures: 2
Operation time to live: Forever

R1#trace 209.165.200.254 source 192.168.1.1
Type escape sequence to abort.
Tracing the route to 209.165.200.254
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 56 msec 28 msec 28 msec
  2 209.165.201.1 !H !H !H

```

☆ On R1, initiate a trace to the web server

```

R1#trace 209.165.200.254 source 192.168.1.1
Type escape sequence to abort.
Tracing the route to 209.165.200.254
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 56 msec 28 msec 28 msec
  2 209.165.201.1 !H !H !H

```

☆ Again examine the IP SLA statistics.

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

IPSLA operation id: 11
  Latest RTT: 20 milliseconds
Latest operation start time: 22:28:55 UTC Sat Jun 17 2023
Latest operation return code: OK
Number of successes: 73
Number of failures: 2
Operation time to live: Forever

IPSLA operation id: 22
  Latest RTT: 48 milliseconds
Latest operation start time: 22:28:59 UTC Sat Jun 17 2023
Latest operation return code: OK
Number of successes: 61
Number of failures: 2
Operation time to live: Forever
```

☆ Verify the routing table.

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

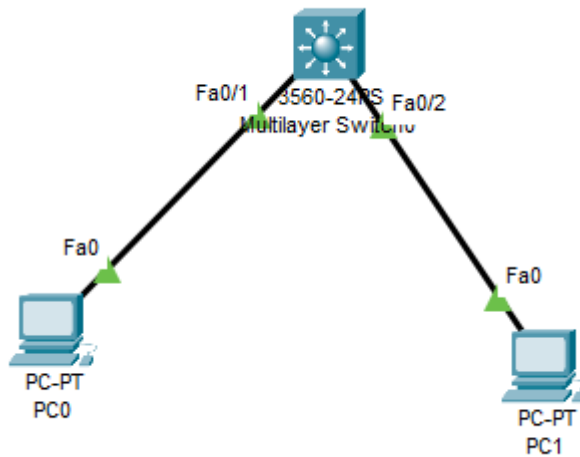
S*   0.0.0.0/0 [2/0] via 209.165.201.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C     192.168.1.0/24 is directly connected, Loopback0
L     192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C     209.165.201.0/30 is directly connected, Serial1/0
L     209.165.201.2/32 is directly connected, Serial1/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C     209.165.202.128/30 is directly connected, Serial1/2
L     209.165.202.130/32 is directly connected, Serial1/2
R1#
```

Practical No 7

Inter-VLAN Routing

Aim: Inter-VLAN Routing

Solution: Consider the following topology:-



We configure this by using the cisco packet tracer.

1. Start cisco packet tracer → first we select host Pc → take two pc as per topology PC0 & PC 1 → then take multilayer switch from switches tool. Arrange them as per topology.
2. To do connection, click on wire connection.
 - I. Click on PC 0 → select interface Fast Ethernet 0 → connect to → Multilayer switch → select Fast Ethernet 0/1.
 - II. Click on PC 1 → select interface Fast Ethernet 0 → connect to → Multilayer switch → select Fast Ethernet 0/2.
3. To configure IP Address,
 - ☆ Click on PC 0 → Desktop → IP Configure → Put IPv4 Address as 192.168.1.2 & default gateway as 192.168.1.1.
 - ☆ Click on PC 1 → Desktop → IP Configure → Put IPv4 Address as 192.168.2.2 & default gateway as 192.168.2.1.
 - ☆ Click on Multilayer switch → CLI → Click inside window → It will ask Yes or No → type No → Press Enter.

```
Switch>enable
Switch#conf t
Enter configuration commands, one
Switch(config)#vlan 10
Switch(config-vlan)#name smile
Switch(config-vlan)#exit
Switch(config)#vlan 20
Switch(config-vlan)#name cisco
Switch(config-vlan)#exit
```

☆ Now, configure interface

```
Switch(config)#interface fastethernet 0/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 10
Switch(config-if)#exit
Switch(config)#interface fastethernet 0/2
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 20
Switch(config-if)#exit
```

☆ Now, we have to configure IP address for interfaces. To do so type commands

```

Switch(config)#interface vlan 10
Switch(config-if)#
%LINK-S-CHANGED: Interface Vlan10, changed state to up

%LINEPROTO-S-UPDOWN: Line protocol on Interface Vlan10, changed state to up

Switch(config-if)#ip address 192.168.1.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
Switch(config)#interface vlan 20
Switch(config-if)#
%LINK-S-CHANGED: Interface Vlan20, changed state to up

%LINEPROTO-S-UPDOWN: Line protocol on Interface Vlan20, changed state to up

Switch(config-if)#ip address 192.168.2.1 255.255.255.0
Switch(config-if)#no shutdown
Switch(config-if)#exit
Switch(config)#exit

```

4. To check IP interface connectivity. It will show us VLAN 10 & VLAN 20.

```

Switch#show ip interface brief

```

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/1	unassigned	YES	unset	up	up
FastEthernet0/2	unassigned	YES	unset	up	up
FastEthernet0/3	unassigned	YES	unset	down	down
FastEthernet0/4	unassigned	YES	unset	down	down
FastEthernet0/5	unassigned	YES	unset	down	down
FastEthernet0/6	unassigned	YES	unset	down	down
FastEthernet0/7	unassigned	YES	unset	down	down
FastEthernet0/8	unassigned	YES	unset	down	down
FastEthernet0/9	unassigned	YES	unset	down	down
FastEthernet0/10	unassigned	YES	unset	down	down
FastEthernet0/11	unassigned	YES	unset	down	down
FastEthernet0/12	unassigned	YES	unset	down	down
FastEthernet0/13	unassigned	YES	unset	down	down
FastEthernet0/14	unassigned	YES	unset	down	down
FastEthernet0/15	unassigned	YES	unset	down	down
FastEthernet0/16	unassigned	YES	unset	down	down
FastEthernet0/17	unassigned	YES	unset	down	down
FastEthernet0/18	unassigned	YES	unset	down	down
FastEthernet0/19	unassigned	YES	unset	down	down
FastEthernet0/20	unassigned	YES	unset	down	down
FastEthernet0/21	unassigned	YES	unset	down	down
FastEthernet0/22	unassigned	YES	unset	down	down
FastEthernet0/23	unassigned	YES	unset	down	down
FastEthernet0/24	unassigned	YES	unset	down	down
GigabitEthernet0/1	unassigned	YES	unset	down	down
GigabitEthernet0/2	unassigned	YES	unset	down	down
Vlan1	unassigned	YES	unset	administratively down	down
Vlan10	192.168.1.1	YES	manual	up	up
Vlan20	192.168.2.1	YES	manual	up	up

5. Now, to enable routing

```

Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#ip routing
Switch(config)#exit
Switch#

```

Now, to check this we have to come out from this window, close window.

```

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:

Request timed out.
Reply from 192.168.2.2: bytes=32 time<1ms TTL=127
Reply from 192.168.2.2: bytes=32 time<1ms TTL=127
Reply from 192.168.2.2: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>

```

6. To check connectivity, go to PC 0 → click on Desktop → command Prompt → type command.

```

Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.2

Pinging 192.168.1.2 with 32 bytes of data:

Reply from 192.168.1.2: bytes=32 time<1ms TTL=127
Reply from 192.168.1.2: bytes=32 time<1ms TTL=127
Reply from 192.168.1.2: bytes=32 time<1ms TTL=127
Reply from 192.168.1.2: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>

```