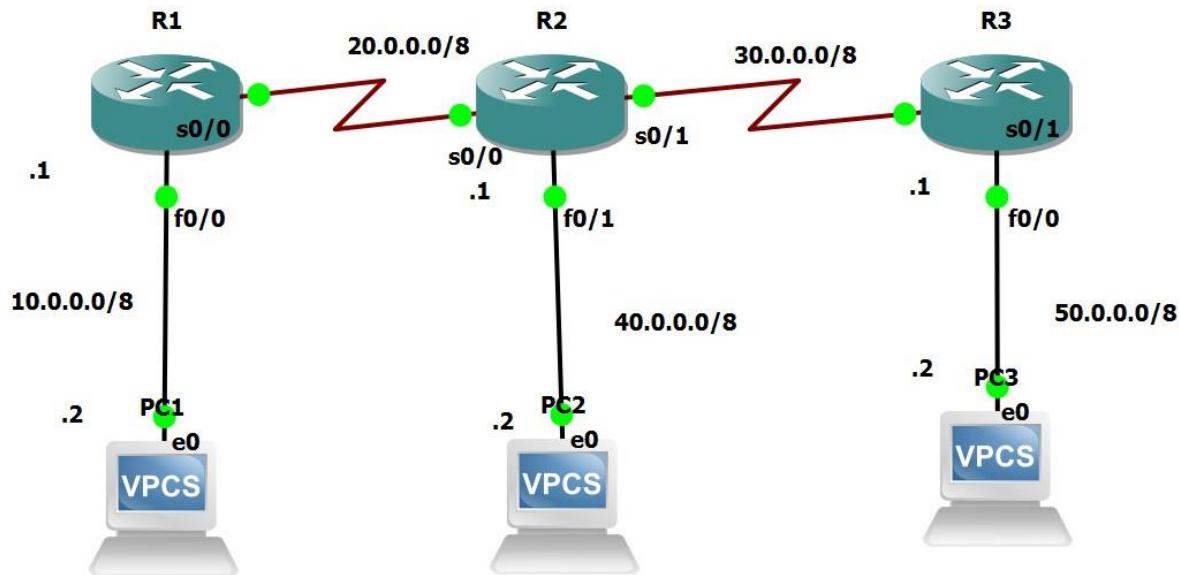


Practical No.1

Aim: Create the given topology with classless address.

Topology:



Theory:

In GNS3, configuration refers to the process of setting up and customizing the parameters of virtual routers and PCs within the network simulation environment. This involves defining the router's routing protocols, interface configurations, and various settings such as IP addresses, subnet masks, and security measures. For PCs, configuration typically includes assigning IP addresses, configuring network settings, and specifying applications or services that will be running. This crucial step allows users to emulate real-world network scenarios, enabling testing, learning, and troubleshooting in a virtual environment that mirrors actual network configurations.

Steps:

1. Configure networks for all routers and PCs.

Router R1:

```
R1#show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    10.0.0.1        YES NVRAM  up           up
Serial0/0          20.0.0.1        YES NVRAM  up           up
FastEthernet0/1    unassigned      YES NVRAM  administratively down  down
Serial0/1          unassigned      YES NVRAM  administratively down  down
Serial0/2          unassigned      YES NVRAM  administratively down  down
FastEthernet1/0    unassigned      YES NVRAM  administratively down  down
FastEthernet2/0    unassigned      YES NVRAM  administratively down  down
R1#
```

PC1:

```
PC1> show ip

NAME      : PC1[1]
IP/MASK   : 10.0.0.2/8
GATEWAY   : 10.0.0.1
DNS       :
MAC       : 00:50:79:66:68:02
LPORT     : 10000
RHOST:PORT: 127.0.0.1:10001
MTU:      : 1500

PC1>
```

Router R2:

```
R2#
R2#show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES NVRAM  administratively down  down
Serial0/0          20.0.0.2        YES NVRAM  up           up
FastEthernet0/1    40.0.0.1        YES NVRAM  up           up
Serial0/1          30.0.0.1        YES NVRAM  up           up
Serial0/2          unassigned      YES NVRAM  administratively down  down
FastEthernet1/0    unassigned      YES NVRAM  administratively down  down
FastEthernet2/0    unassigned      YES NVRAM  administratively down  down
R2#
```

PC2:

```
PC2> show ip

NAME      : PC2[1]
IP/MASK   : 40.0.0.2/8
GATEWAY   : 40.0.0.1
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 10002
RHOST:PORT: 127.0.0.1:10003
MTU:      : 1500

PC2>
```

Router R3:

```
adminstratively down
R3#
R3#show ip int bri
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    50.0.0.1        YES NVRAM up           up
Serial0/0          unassigned     YES NVRAM administratively down down
FastEthernet0/1    unassigned     YES NVRAM administratively down down
Serial0/1          30.0.0.2        YES NVRAM up           up
Serial0/2          unassigned     YES NVRAM administratively down down
FastEthernet1/0    unassigned     YES NVRAM administratively down down
FastEthernet2/0    unassigned     YES NVRAM administratively down down
R3#
```

PC3:

```
PC3> show ip

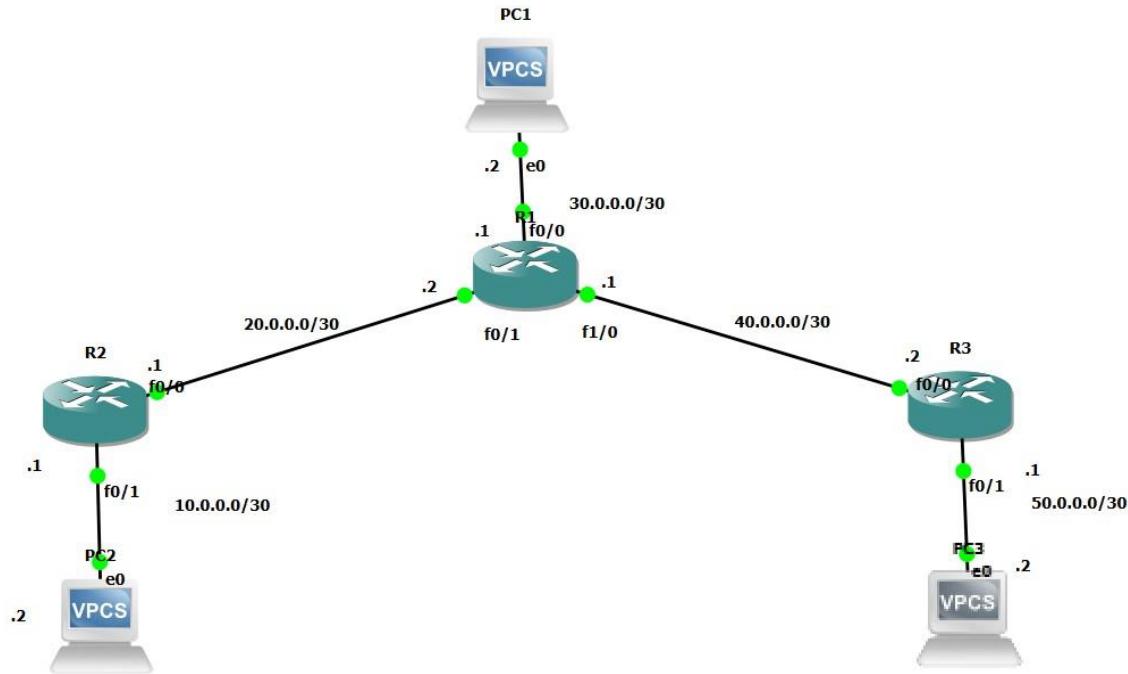
NAME      : PC3[1]
IP/MASK   : 50.0.0.2/8
GATEWAY   : 50.0.0.1
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10005
RHOST:PORT : 127.0.0.1:10006
MTU:      : 1500

PC3>
```

Practical No.2

Aim: Static Routing.

Topology:



Theory:

When working with static routing in GNS3, configuration refers to the process of manually defining and specifying routing paths between network devices, such as routers. This involves setting up static routes by specifying the destination network or host, along with the corresponding next-hop IP address or exit interface. Static routing allows network administrators to control and customize the routing decisions within the simulated network, making it a valuable tool for learning, testing, and troubleshooting. By configuring static routes, users can define explicit paths for data to follow, ensuring that traffic reaches its intended destination according to the predefined route entries. This capability enables the accurate emulation of specific routing scenarios in GNS3, closely mimicking real-world network configurations.

Steps:

1. Configuration of R1:

```

R1(config)#int fa0/1
R1(config-if)#ip add 20.0.0.2 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#
*Mar  1 00:12:28.175: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:12:29.175: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#exit
R1(config)#int fa0/0
R1(config-if)#ip add 30.0.0.1 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#
*Mar  1 00:13:18.167: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar  1 00:13:19.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#exit
R1(config)#int fa1/0
R1(config-if)#ip add 40.0.0.1 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#
*Mar  1 00:14:10.795: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Mar  1 00:14:11.795: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#exit
R1(config)#ip route 10.0.0.0 255.255.252.0 20.0.0.1
R1(config)#ip route 50.0.0.0 255.255.252.0 40.0.0.2
R1(config)#do wr
Building configuration...
[OK]
R1(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      50.0.0.0/22 is subnetted, 1 subnets
S          50.0.0.0 [1/0] via 40.0.0.2
      20.0.0.0/30 is subnetted, 1 subnets
C          20.0.0.0 is directly connected, FastEthernet0/1
      40.0.0.0/30 is subnetted, 1 subnets
C          40.0.0.0 is directly connected, FastEthernet1/0
      10.0.0.0/22 is subnetted, 1 subnets
S          10.0.0.0 [1/0] via 20.0.0.1
      30.0.0.0/30 is subnetted, 1 subnets
C          30.0.0.0 is directly connected, FastEthernet0/0
R1(config)#

```

2. Configuration of R2:



```

R2#
R2#
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int fa0/1
R2(config-if)#ip add 10.0.0.1 255.255.255.252
R2(config-if)#no shutdown
R2(config-if)#
*Mar 1 00:01:14.819: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:01:15.819: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config-if)#do wr
Building configuration...
[OK]
R2(config-if)#exit
R2(config)#int fa0/0
R2(config-if)#ip add 20.0.0.1 255.255.255.252
R2(config-if)#no shutdown
R2(config-if)#do wr
*Mar 1 00:02:16.399: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:02:17.399: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#do wr
Building configuration...
[OK]
R2(config-if)#exit
R2(config)#ip route 30.0.0.0 255.255.252.0 20.0.0.2
R2(config)#ip route 40.0.0.0 255.255.252.0 20.0.0.2
R2(config)#ip route 50.0.0.0 255.255.252.0 20.0.0.2
R2(config)#do wr
Building configuration...
[OK]
R2(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      50.0.0.0/22 is subnetted, 1 subnets
S        50.0.0.0 [1/0] via 20.0.0.2
      20.0.0.0/30 is subnetted, 1 subnets
C        20.0.0.0 is directly connected, FastEthernet0/0
      40.0.0.0/22 is subnetted, 1 subnets
S        40.0.0.0 [1/0] via 20.0.0.2
      10.0.0.0/30 is subnetted, 1 subnets
C        10.0.0.0 is directly connected, FastEthernet0/1
      30.0.0.0/22 is subnetted, 1 subnets
S        30.0.0.0 [1/0] via 20.0.0.2
R2(config)#exit
R2#sh

```

3. Configuration of R3:

```

R3#
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int fa0/0
R3(config-if)#ip add 40.0.0.2 255.255.255.252
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:13:45.159: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:13:46.159: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#do wr
Building configuration...
[OK]
R3(config-if)#exit
R3(config)#int fa0/1
R3(config-if)#ip add 50.0.0.1 255.255.255.252
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:14:25.775: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:14:26.775: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config-if)#do wr
Building configuration...
[OK]
R3(config-if)#exit
R3(config)#ip route 30.0.0.0 255.255.252.0 40.0.0.1
R3(config)#ip route 20.0.0.0 255.255.252.0 40.0.0.1
R3(config)#ip route 10.0.0.0 255.255.252.0 40.0.0.1
R3(config)#do wr
Building configuration...
[OK]
R3(config)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      50.0.0.0/30 is subnetted, 1 subnets
C        50.0.0.0 is directly connected, FastEthernet0/1
      20.0.0.0/22 is subnetted, 1 subnets
S          20.0.0.0 [1/0] via 40.0.0.1
      40.0.0.0/30 is subnetted, 1 subnets
C        40.0.0.0 is directly connected, FastEthernet0/0
      10.0.0.0/22 is subnetted, 1 subnets
S          10.0.0.0 [1/0] via 40.0.0.1
      30.0.0.0/22 is subnetted, 1 subnets
S          30.0.0.0 [1/0] via 40.0.0.1
R3(config)#

```

4. Pinging PC2 to PC3:

```

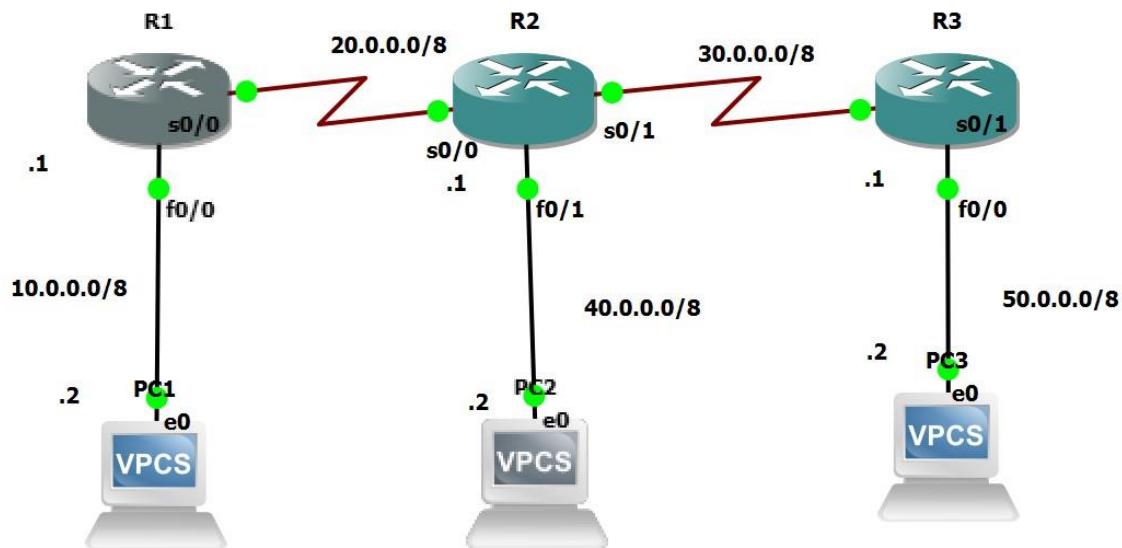
PC2> ping 50.0.0.2
84 bytes from 50.0.0.2 icmp_seq=1 ttl=61 time=76.813 ms
84 bytes from 50.0.0.2 icmp_seq=2 ttl=61 time=92.589 ms
84 bytes from 50.0.0.2 icmp_seq=3 ttl=61 time=92.722 ms
84 bytes from 50.0.0.2 icmp_seq=4 ttl=61 time=92.928 ms
84 bytes from 50.0.0.2 icmp_seq=5 ttl=61 time=93.716 ms

```

Practical No.3

Aim: Routing Information Protocol.

Topology:



Theory:

In the context of GNS3 and networking, configuring Routing Information Protocol (RIP) involves the setup and customization of this dynamic routing protocol within the virtual routers. Configuration tasks for RIP typically include enabling RIP on router interfaces, specifying network addresses that will participate in RIP routing, setting metric values, and adjusting routing parameters to control the exchange of routing information. This process allows users to simulate RIP-based network scenarios, making it possible to learn, test, and troubleshoot RIP routing behavior in a controlled and virtualized environment, closely resembling real-world networking configurations.

Steps:

1. RIP for R1:



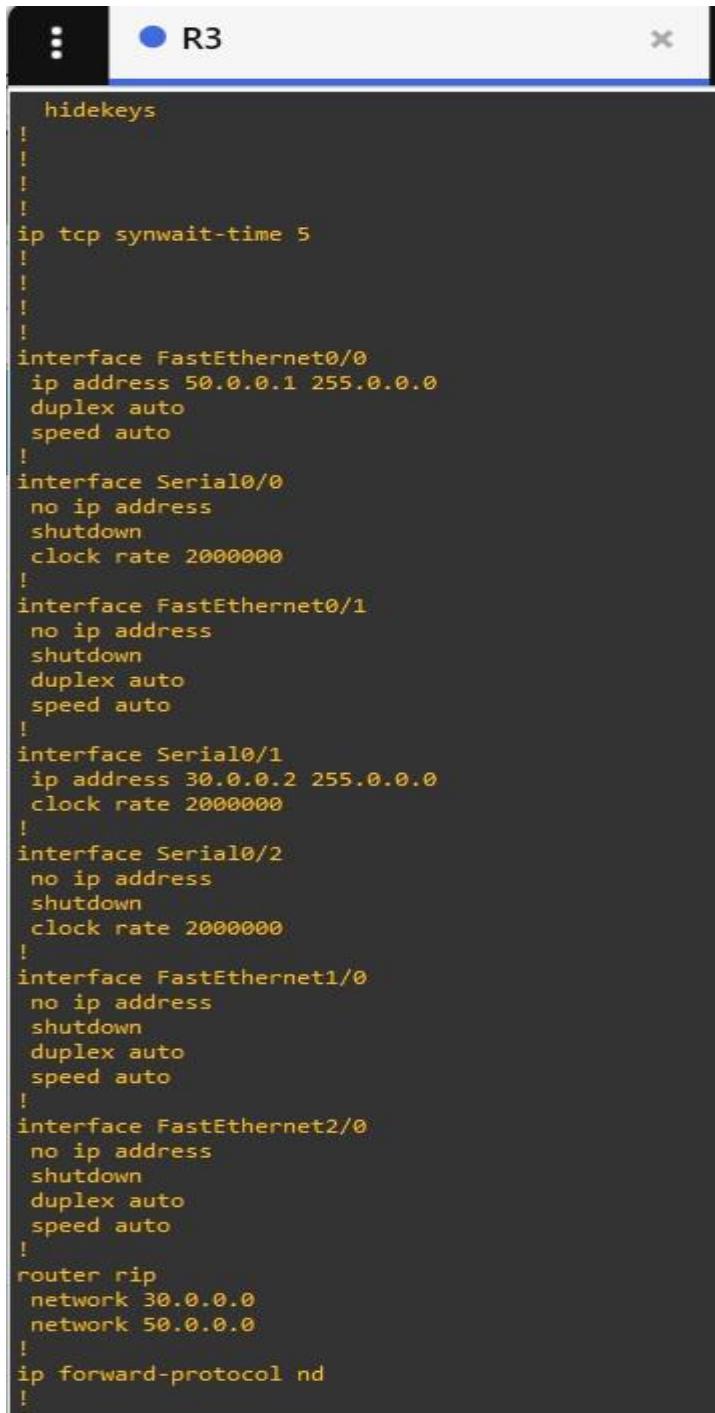
```
!
ip tcp synwait-time 5
!
!
!
interface FastEthernet0/0
 ip address 10.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface Serial0/0
 ip address 20.0.0.1 255.0.0.0
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/2
 no ip address
 shutdown
 clock rate 2000000
!
interface FastEthernet1/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet2/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
router rip
 network 10.0.0.0
 network 20.0.0.0
!
ip forward-protocol nd
!
!
no ip http server
no ip http secure-server
!
no cdp log mismatch duplex
!
```

2. RIP for R2:



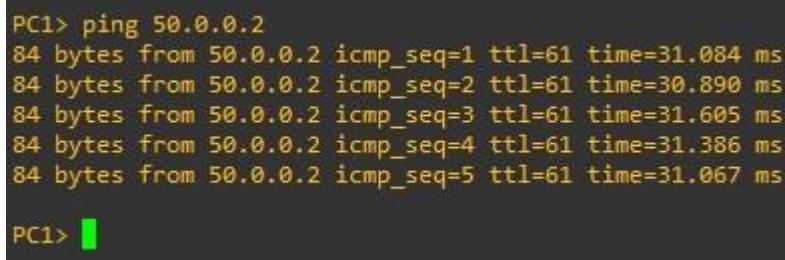
```
!  
!  
!  
ip tcp synwait-time 5  
!  
!  
!  
interface FastEthernet0/0  
no ip address  
shutdown  
duplex auto  
speed auto  
!  
interface Serial0/0  
ip address 20.0.0.2 255.0.0.0  
clock rate 2000000  
!  
interface FastEthernet0/1  
ip address 40.0.0.1 255.0.0.0  
duplex auto  
speed auto  
!  
interface Serial0/1  
ip address 30.0.0.1 255.0.0.0  
clock rate 2000000  
!  
interface Serial0/2  
no ip address  
shutdown  
clock rate 2000000  
!  
interface FastEthernet1/0  
no ip address  
shutdown  
duplex auto  
speed auto  
!  
interface FastEthernet2/0  
no ip address  
shutdown  
duplex auto  
speed auto  
!  
router rip  
network 20.0.0.0  
network 30.0.0.0  
network 40.0.0.0  
!  
ip forward-protocol nd  
!
```

3. RIP for R3:



```
hidekeys
!
!
!
!
ip tcp synwait-time 5
!
!
!
interface FastEthernet0/0
 ip address 50.0.0.1 255.0.0.0
 duplex auto
 speed auto
!
interface Serial0/0
 no ip address
 shutdown
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 ip address 30.0.0.2 255.0.0.0
 clock rate 2000000
!
interface Serial0/2
 no ip address
 shutdown
 clock rate 2000000
!
interface FastEthernet1/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet2/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
router rip
 network 30.0.0.0
 network 50.0.0.0
!
ip forward-protocol nd
!
```

4. Pinging PC1 with PC3:

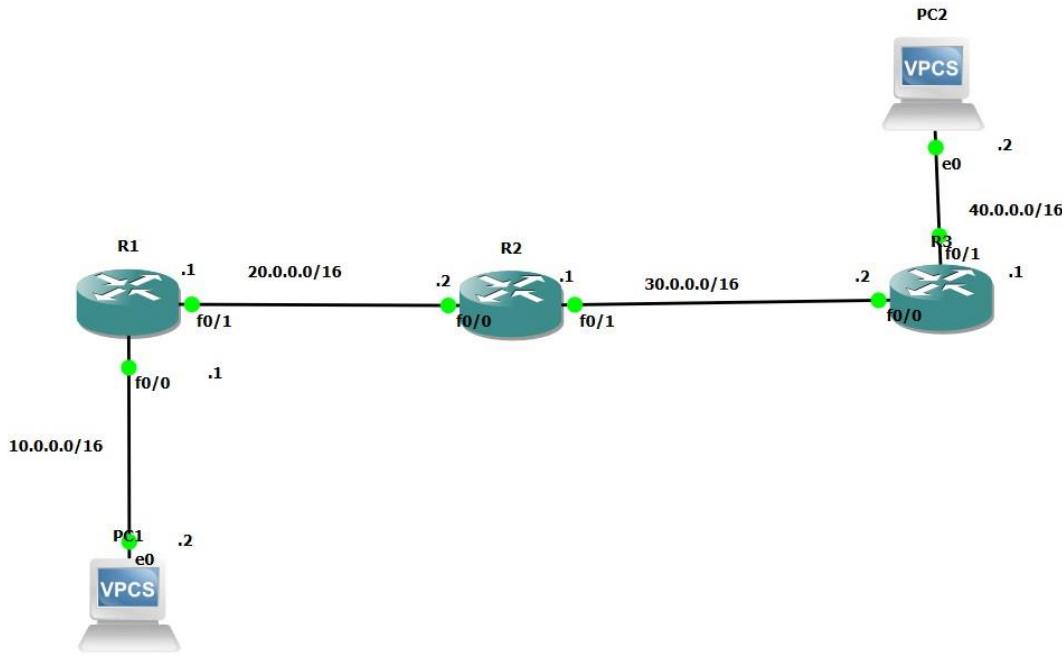


```
PC1> ping 50.0.0.2
84 bytes from 50.0.0.2 icmp_seq=1 ttl=61 time=31.084 ms
84 bytes from 50.0.0.2 icmp_seq=2 ttl=61 time=30.890 ms
84 bytes from 50.0.0.2 icmp_seq=3 ttl=61 time=31.605 ms
84 bytes from 50.0.0.2 icmp_seq=4 ttl=61 time=31.386 ms
84 bytes from 50.0.0.2 icmp_seq=5 ttl=61 time=31.067 ms
PC1> █
```

Practical No. 4

Aim: Open Shortest Path First.

Topology:



Theory:

In GNS3, configuring routers and PCs for OSPF entails setting up and customizing their parameters to participate in the OSPF routing protocol. For routers, this involves enabling OSPF on their interfaces, defining OSPF areas, specifying the Router ID, and configuring authentication if needed. On the other hand, for PCs, the configuration focuses on defining their network settings and ensuring they are within the OSPF-enabled network's IP address range. This essential configuration step in GNS3 allows users to create and simulate OSPF-based network topologies, enabling them to learn, test, and troubleshoot OSPF routing behavior in a virtual environment that closely mimics real-world networking setups.

Steps: OSPF area

1. R1:

```

R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int fa0/0
R1(config-if)#ip add 10.0.0.1 255.255.0.0
R1(config-if)#no shutdown
R1(config-if)#
*Mar 1 00:01:19.775: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:20.775: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#exit
R1(config)#int fa0/1
R1(config-if)#ip add 20.0.0.1 255.255.0.0
R1(config-if)#no shutdown
R1(config-if)#
*Mar 1 00:02:17.767: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:02:18.767: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#exit
R1(config)#router ospf 1
R1(config-router)#network 10.0.0.0 0.0.255.255 area 0
R1(config-router)#network 20.0.0.0 0.0.255.255 area 0
R1(config-router)#do wr
Building configuration...
[OK]
R1(config-router)#
*Mar 1 00:09:57.123: %OSPF-5-ADJCHG: Process 1, Nbr 30.0.0.1 on FastEthernet0/1 from LOADING to FULL, Loading Done
R1(config-router)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  20.0.0.0/16 is subnetted, 1 subnets
C        20.0.0.0 is directly connected, FastEthernet0/1
  40.0.0.0/16 is subnetted, 1 subnets
O          40.0.0.0 [110/30] via 20.0.0.2, 00:03:25, FastEthernet0/1
  10.0.0.0/16 is subnetted, 1 subnets
C        10.0.0.0 is directly connected, FastEthernet0/0
  30.0.0.0/16 is subnetted, 1 subnets
O          30.0.0.0 [110/20] via 20.0.0.2, 00:03:25, FastEthernet0/1
R1(config-router)#

```

2. R2:

```

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int fa0/0
R2(config-if)#ip add 20.0.0.2 255.255.0.0
R2(config-if)#no shutdown
R2(config-if)#
*Mar 1 00:01:53.955: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:01:54.955: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#do wr
Building configuration...
[OK]
R2(config-if)#exit
R2(config)#int fa0/1
R2(config-if)#ip add 30.0.0.1 255.255.0.0
R2(config-if)#no shutdown
R2(config-if)#
*Mar 1 00:02:26.723: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:02:27.723: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R2(config-if)#do wr
Building configuration...
[OK]
R2(config-if)#exit
R2(config)#router ospf 1
R2(config-router)#network 30.0.0.0 0.0.255.255 area 0
R2(config-router)#network 30.0.0.0 0.0.255.255 area 0
*Mar 1 00:07:31.379: %OSPF-5-ADJCHG: Process 1, Nbr 40.0.0.1 on FastEthernet0/1 from LOADING to FULL, Loading Done
R2(config-router)#network 20.0.0.0 0.0.255.255 area 0
R2(config-router)#do wr
Building configuration...
[OK]
R2(config-router)#
*Mar 1 00:08:57.107: %OSPF-5-ADJCHG: Process 1, Nbr 20.0.0.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R2(config-router)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

  20.0.0.0/16 is subnetted, 1 subnets
C        20.0.0.0 is directly connected, FastEthernet0/0
  40.0.0.0/16 is subnetted, 1 subnets
O        40.0.0.0 [110/20] via 30.0.0.2, 00:05:02, FastEthernet0/1
  10.0.0.0/16 is subnetted, 1 subnets
O        10.0.0.0 [110/20] via 20.0.0.1, 00:03:44, FastEthernet0/0
  30.0.0.0/16 is subnetted, 1 subnets
C        30.0.0.0 is directly connected, FastEthernet0/1
R2(config-router)#

```

3. R3:

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int fa0/0
R3(config-if)#ip add 30.0.0.2 255.255.0.0
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:02:27.163: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 1 00:02:28.163: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#do wr
Building configuration...
[OK]
R3(config-if)#int fa0/1
R3(config-if)#ip add 40.0.0.1 255.255.0.0
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:03:04.895: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar 1 00:03:05.895: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R3(config-if)#do wr
Building configuration...
[OK]
R3(config-if)#exit
R3(config)#router ospf 1
R3(config-router)#network 40.0.0.0 0.0.255.255 area 0
R3(config-router)#network 30.0.0.0 0.0.255.255 area 0
R3(config-router)#do wr
Building configuration...
[OK]
R3(config-router)#
*Mar 1 00:07:41.407: %OSPF-5-ADJCHG: Process 1, Nbr 30.0.0.1 on FastEthernet0/0 from LOADING to FULL, Loading Done
R3(config-router)#do show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route
Gateway of last resort is not set

      20.0.0.0/16 is subnetted, 1 subnets
O        20.0.0.0 [110/20] via 30.0.0.1, 00:04:57, FastEthernet0/0
      40.0.0.0/16 is subnetted, 1 subnets
C        40.0.0.0 is directly connected, FastEthernet0/1
      10.0.0.0/16 is subnetted, 1 subnets
O        10.0.0.0 [110/30] via 30.0.0.1, 00:03:42, FastEthernet0/0
      30.0.0.0/16 is subnetted, 1 subnets
C        30.0.0.0 is directly connected, FastEthernet0/0
R3(config-router)#

```

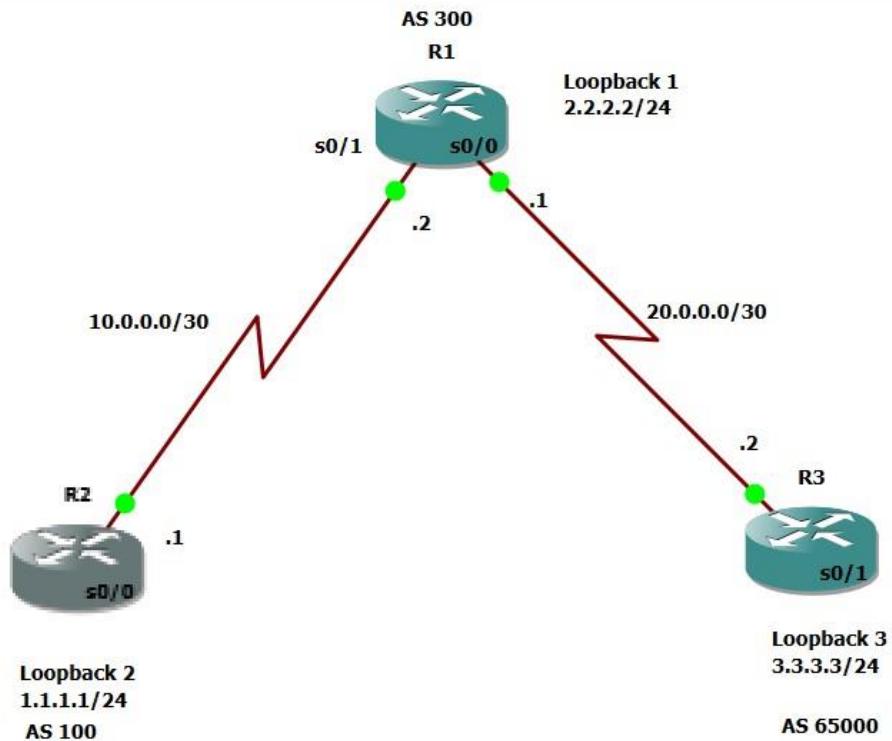
4. Pinging PC1 to PC2:

```
PC1> ping 40.0.0.2
40.0.0.2 icmp_seq=1 timeout
84 bytes from 40.0.0.2 icmp_seq=2 ttl=61 time=90.580 ms
84 bytes from 40.0.0.2 icmp_seq=3 ttl=61 time=90.773 ms
84 bytes from 40.0.0.2 icmp_seq=4 ttl=61 time=91.176 ms
84 bytes from 40.0.0.2 icmp_seq=5 ttl=61 time=90.479 ms
```

Practical No. 5

Aim: Border Gateway Protocol.

Topology:



Theory:

In GNS3, configuring routers and network devices for the Border Gateway Protocol (BGP) involves setting up and customizing their parameters to participate in the BGP routing protocol. For routers, this includes defining BGP neighbor relationships, specifying BGP autonomous system numbers (ASNs), configuring route advertisement and filtering policies, and setting BGP attributes for route selection and manipulation. Additionally, BGP configuration might involve tuning parameters such as route dampening, route aggregation, and loop prevention mechanisms. This crucial configuration step in GNS3 allows users to create and simulate BGP-based network topologies, enabling them to learn, test, and troubleshoot BGP routing behavior in a virtual environment that closely resembles real-world Internet routing configurations.

Steps:

Step1: Configuration for routers:

1. R1:

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int loopback0
R1(config-if)#ip a
*Mar 1 00:12:56.559: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#ip add 2.2.2.2 255.255.255.0
R1(config-if)#exit
R1(config)#int se0/1
R1(config-if)#ip add 10.0.0.2 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#
*Mar 1 00:14:02.607: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
R1(config-if)#
*Mar 1 00:03.611: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
R1(config-if)#exit
R1(config)#int se0/0
R1(config-if)#ip add 20.0.0.1 255.255.255.252
R1(config-if)#no shutdown
R1(config-if)#
*Mar 1 00:15:03.967: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
R1(config-if)#
*Mar 1 00:15:04.971: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0, changed state to up
R1(config-if)#do wr
Building configuration...
[OK]
```

2. R2:

```
interface Loopback0
 ip address 1.1.1.1 255.255.255.0
!
interface FastEthernet0/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/0
 ip address 10.0.0.1 255.255.255.252
 clock rate 2000000
!
interface FastEthernet0/1
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface Serial0/1
 no ip address
 shutdown
 clock rate 2000000
!
interface Serial0/2
 no ip address
 shutdown
 clock rate 2000000
!
interface FastEthernet1/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
interface FastEthernet2/0
 no ip address
 shutdown
 duplex auto
 speed auto
!
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 network 1.1.1.0 mask 255.255.255.0
 neighbor 10.0.0.2 remote-as 300
 no auto-summary
!
ip forward-protocol nd
!
```

3. R3:

```
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int loopback0
R3(config-if)#ip ad
*Mar 1 00:08:13.043: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#ip add 3.3.3.3 255.255.255.0
R3(config-if)#no shutdown
R3(config-if)#exit
R3(config)#int se0/1
R3(config-if)#ip add 20.0.0.2 255.255.255.252
R3(config-if)#no shutdown
R3(config-if)#
*Mar 1 00:09:36.771: %LINK-3-UPDOWN: Interface Serial0/1, changed state to up
R3(config-if)#
*Mar 1 00:09:37.775: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
R3(config-if)#do wr
Building configuration...
[OK]
```

Step 2: Configure BGP:**1. R1:**

```
R1(config)#router bgp 300
R1(config-router)#neighbor 10.0.0.1 remote-as 100
R1(config-router)#neighbor 20.0.0.2 remote-as 65000
R1(config-router)#
*Mar 1 00:22:30.411: %BGP-5-ADJCHANGE: neighbor 10.0.0.1 Up
R1(config-router)#network 2.2.2.0 mask 255.255.255.0
R1(config-router)#
*Mar 1 00:24:06.447: %BGP-5-ADJCHANGE: neighbor 20.0.0.2 Up
R1(config-router)#end
R1#
```

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

Gateway of last resort is not set

```
      1.0.0.0/24 is subnetted, 1 subnets
B        1.1.1.0 [20/0] via 10.0.0.1, 00:04:39
      2.0.0.0/24 is subnetted, 1 subnets
C        2.2.2.0 is directly connected, Loopback0
      3.0.0.0/24 is subnetted, 1 subnets
B        3.3.3.0 [20/0] via 20.0.0.2, 00:16:39
      20.0.0.0/30 is subnetted, 1 subnets
C        20.0.0.0 is directly connected, Serial0/0
      10.0.0.0/30 is subnetted, 1 subnets
C        10.0.0.0 is directly connected, Serial0/1
```

2. R2:

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

Gateway of last resort is not set

      1.0.0.0/24 is subnetted, 1 subnets
C        1.1.1.0 is directly connected, Loopback0
      2.0.0.0/24 is subnetted, 1 subnets
B          2.2.2.0 [20/0] via 10.0.0.2, 00:00:47
      3.0.0.0/24 is subnetted, 1 subnets
B          3.3.3.0 [20/0] via 10.0.0.2, 00:00:47
      10.0.0.0/30 is subnetted, 1 subnets
C            10.0.0.0 is directly connected, Serial0/0
```

3. R3:

```
R3(config)#router bgp 65000
R3(config-router)#neighbor 20.0.0.1 remote-as 300
R3(config-router)#netwo
*Mar 1 00:16:16.279: %BGP-5-ADJCHANGE: neighbor 20.0.0.1 Up
R3(config-router)#network 3.3.3.0 mask 255.255.255.0
R3(config-router)#end
R3#
*Mar 1 00:32:54.047: %SYS-5-CONFIG_I: Configured from console by console
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
      ia - IS-IS inter area, * - candidate default, U - per-user static route
      o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

      1.0.0.0/24 is subnetted, 1 subnets
B        1.1.1.0 [20/0] via 20.0.0.1, 00:04:00
      2.0.0.0/24 is subnetted, 1 subnets
B          2.2.2.0 [20/0] via 20.0.0.1, 00:16:44
      3.0.0.0/24 is subnetted, 1 subnets
C            3.3.3.0 is directly connected, Loopback0
      20.0.0.0/30 is subnetted, 1 subnets
C            20.0.0.0 is directly connected, Serial0/1
```

Step 3:

Pinging R1 to R3:

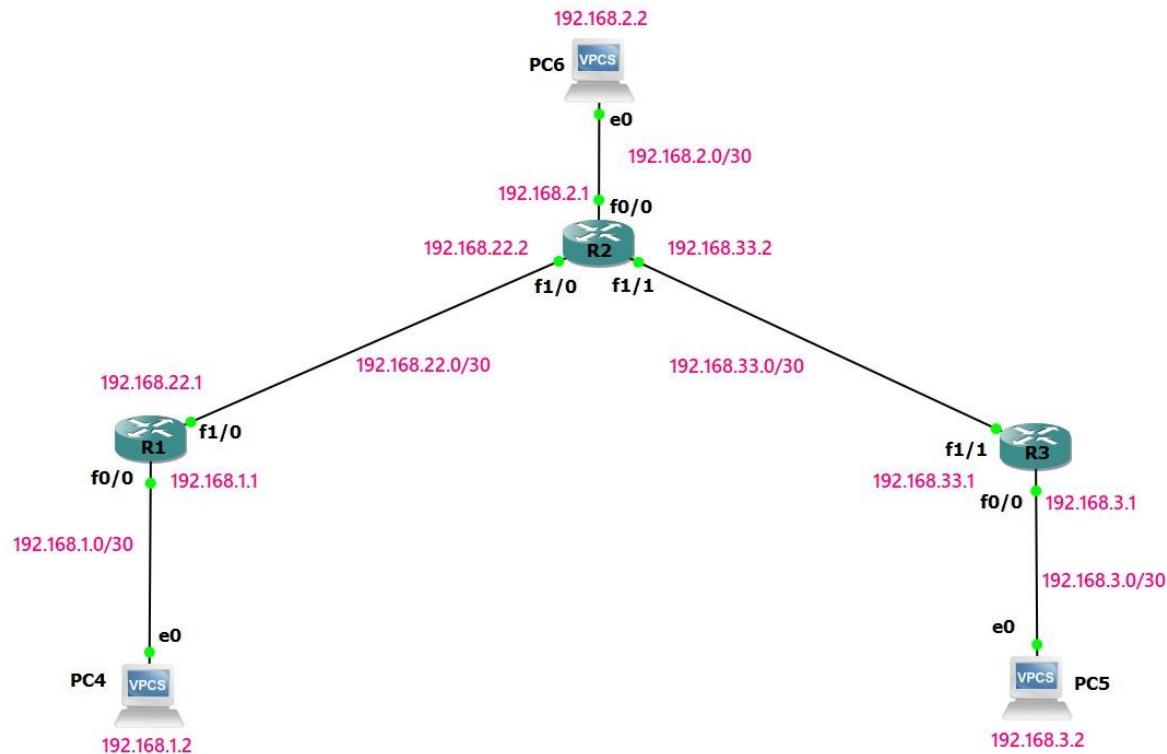
```
R2#ping 3.3.3.3 source 1.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
Packet sent with a source address of 1.1.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/12 ms
```

Practical No. 6

Aim: IPv4 ACL.

Part 1: Standard ACL.

Topology:



Theory:

Access control Lists (ACL) are the set of rules for identifying or controlling the network traffic.

Standard ACL: Permit or deny traffic based only on the source addresses (i.e source ip addresses).

Steps:

Task 1: Initial Configuration

- Configure Interfaces on Router R1, R2 and R3.
- Configure EIGRP (with Autonomous Number 100) on Router R1, R2 and R3.
- Configure IP addresses on PC1, PC2 and PC3

Note: Once Task 1 completed, move to Task 2 to configure ACL

On Router R1:

Configure Interfaces

```

: ● R1
x | +
Dec 4 22:52:55.855: %LINK-5-CHANGED: Interface Serial2/2, changed state to adm
inistratively down
Dec 4 22:52:55.855: %LINK-5-CHANGED: Interface Serial2/3, changed state to adm
inistratively down
R1(config) t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int f0/0
R1(config-if)#ip add 192.168.1.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
*Dec 4 22:54:21.667: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
R1(config)#
*Dec 4 22:54:21.667: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Administrative State Down
*Dec 4 22:54:22.667: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R1(config)#int f1/0
R1(config-if)#ip add 192.168.22.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
*Dec 4 22:55:00.895: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
R1(config-if)#
*Dec 4 22:55:00.895: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/0 Physical Port Administrative State Down
*Dec 4 22:55:01.895: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R1(config-if)#
R1(config-if)#

```

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Configure EIGRP

```

R1(config)#router eigrp 100
R1(config-router)#network 192.168.1.0
R1(config-router)#network 192.168.22.0
R1(config-router)#
*Nov 14 17:18:13.635: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor 192.168.22.2
(FastEthernet1/0) is up: new adjacency
R1(config-router)#

```

On Router R2:

Configure Interfaces

```

: ● R2
x | +
Dec 4 22:52:55.883: %LINK-5-CHANGED: Interface Serial2/3, changed state to adm
inistratively down
R2(config) t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int f1/0
R2(config-if)#ip add 192.168.22.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
*Dec 4 22:59:25.115: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
R2(config-if)#exit
R2(config)#
*Dec 4 22:59:25.115: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/0 Physical Port Administrative State Down
*Dec 4 22:59:26.115: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R2(config)#int f1/1
R2(config-if)#ip add 192.168.33.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Dec 4 23:00:13.875: %LINK-3-UPDOWN: Interface FastEthernet1/1, changed state to up
R2(config)#
*Dec 4 23:00:13.875: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/1 Physical Port Administrative State Down
*Dec 4 23:00:14.875: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to up
R2(config)#int f0/0
R2(config-if)#ip add 192.168.2.1 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
*Dec 4 23:00:54.283: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
R2(config)#
*Dec 4 23:00:54.283: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Administrative State Down
*Dec 4 23:00:55.283: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config)#

```

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Configure EIGRP

```
R2(config)#router eigrp 100
R2(config-router)#network 192.168.22.0
R2(config-router)#network 192.168.2.0
R2(config-router)#network 192.168.33.0
R2(config-router)#exit
*Nov 14 17:18:13.551: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor 192.168.22.1
(FastEthernet1/0) is up: new adjacency
R2(config-router)#exit
R2(config)#
*Nov 14 17:19:08.859: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor 192.168.33.1
(FastEthernet1/1) is up: new adjacency
```

On Router R3:

Configure Interfaces

The screenshot shows the Solar-PuTTY terminal window for router R3. The title bar says "R3". The terminal displays configuration commands for setting up interfaces and assigning IP addresses. The configuration includes setting interfaces to administratively down, then up, and finally assigning them to the EIGRP process.

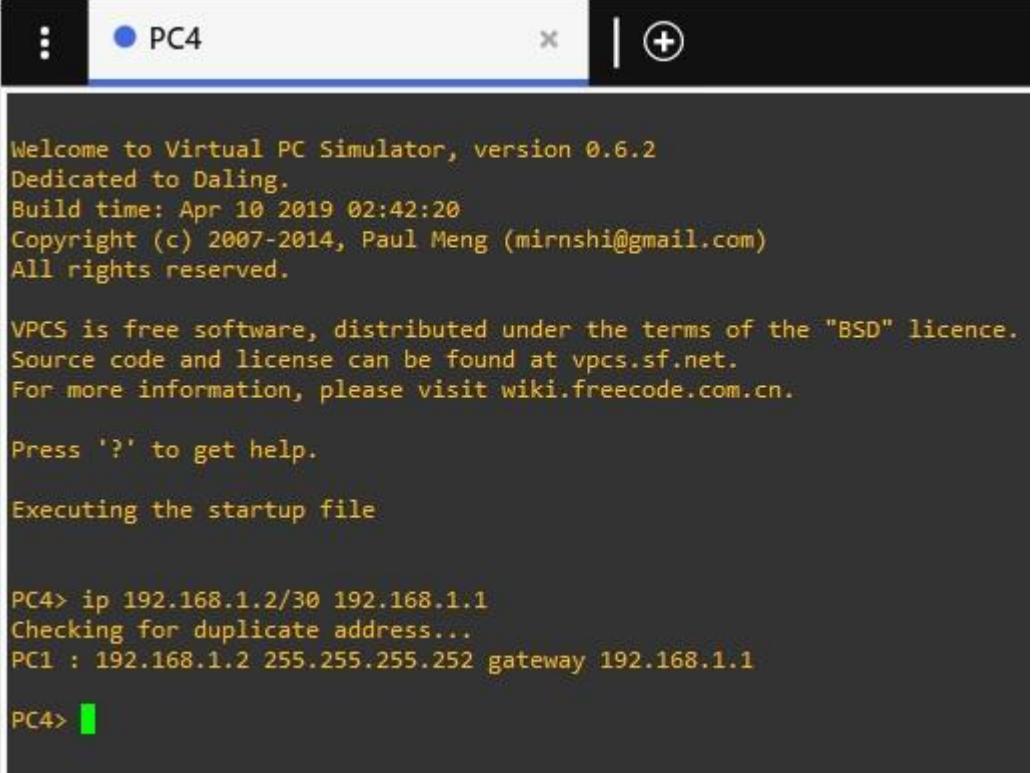
```
to administratively down
"Dec 4 22:52:55.859: %LINK-5-CHANGED: Interface FastEthernet1/0, changed state
to administratively down
"Dec 4 22:52:55.867: %LINK-5-CHANGED: Interface FastEthernet1/1, changed state
to administratively down
"Dec 4 22:52:55.871: %LINK-5-CHANGED: Interface Serial2/0, changed state to adm
inistratively down
"Dec 4 22:52:55.875: %LINK-5-CHANGED: Interface Serial2/1, changed state to adm
inistratively down
"Dec 4 22:52:55.875: %LINK-5-CHANGED: Interface Serial2/2, changed state to adm
inistratively down
"Dec 4 22:52:55.875: %LINK-5-CHANGED: Interface Serial2/3, changed state to adm
inistratively down
R3#config t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#int f0/0
R3(config-if)#ip add 192.168.3.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#
"Dec 4 23:02:28.679: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
R3(config-if)#
"Dec 4 23:02:28.679: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Administrative State Down
"Dec 4 23:02:29.679: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R3(config-if)#exit
R3(config)#
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```

Configure EIGRP

The screenshot shows the Solar-PuTTY terminal window for router R3. The title bar says "R3". The terminal displays configuration commands for the EIGRP process, including setting the process ID to 100 and defining networks.

```
R3(config)#router eigrp 100
R3(config-router)#network 192.168.3.0
R3(config-router)#network 192.168.33.0
R3(config-router)#exit
R3(config)#
*Nov 14 17:19:08.827: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor 192.168.33.2
(FastEthernet1/1) is up: new adjacency
```

Configure PC4, PC5 and PC6



PC4

```
Welcome to Virtual PC Simulator, version 0.6.2
Dedicated to Daling.
Build time: Apr 10 2019 02:42:20
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
All rights reserved.

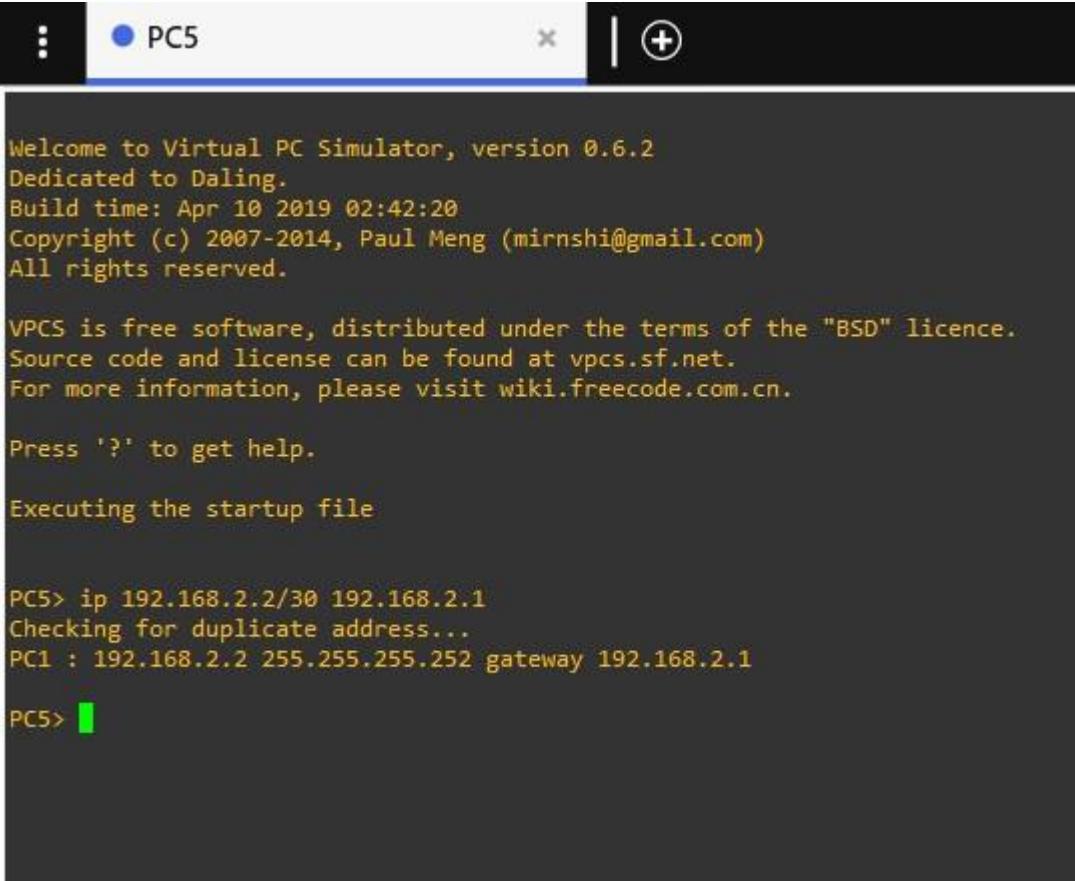
VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC4> ip 192.168.1.2/30 192.168.1.1
Checking for duplicate address...
PC1 : 192.168.1.2 255.255.255.252 gateway 192.168.1.1

PC4>
```



PC5

```
Welcome to Virtual PC Simulator, version 0.6.2
Dedicated to Daling.
Build time: Apr 10 2019 02:42:20
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
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Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC5> ip 192.168.2.2/30 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.2 255.255.255.252 gateway 192.168.2.1

PC5>
```

PC6

Welcome to Virtual PC Simulator, version 0.6.2
Dedicated to Daling.
Build time: Apr 10 2019 02:42:20
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For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC6> ip 192.168.3.2/30 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.2 255.255.255.252 gateway 192.168.3.1

PC6>

Task 2: Block 192.168.1.0/24 network from accessing 192.168.3.0 using named ACL and Permit rest of the traffic.

Before Blocking:

PC4 - PuTTY

PC4> ping 192.168.3.2
84 bytes from 192.168.3.2 icmp_seq=1 ttl=61 time=98.593 ms
84 bytes from 192.168.3.2 icmp_seq=2 ttl=61 time=168.725 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=61 time=187.608 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=61 time=167.471 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=61 time=164.891 ms

Configure Access List

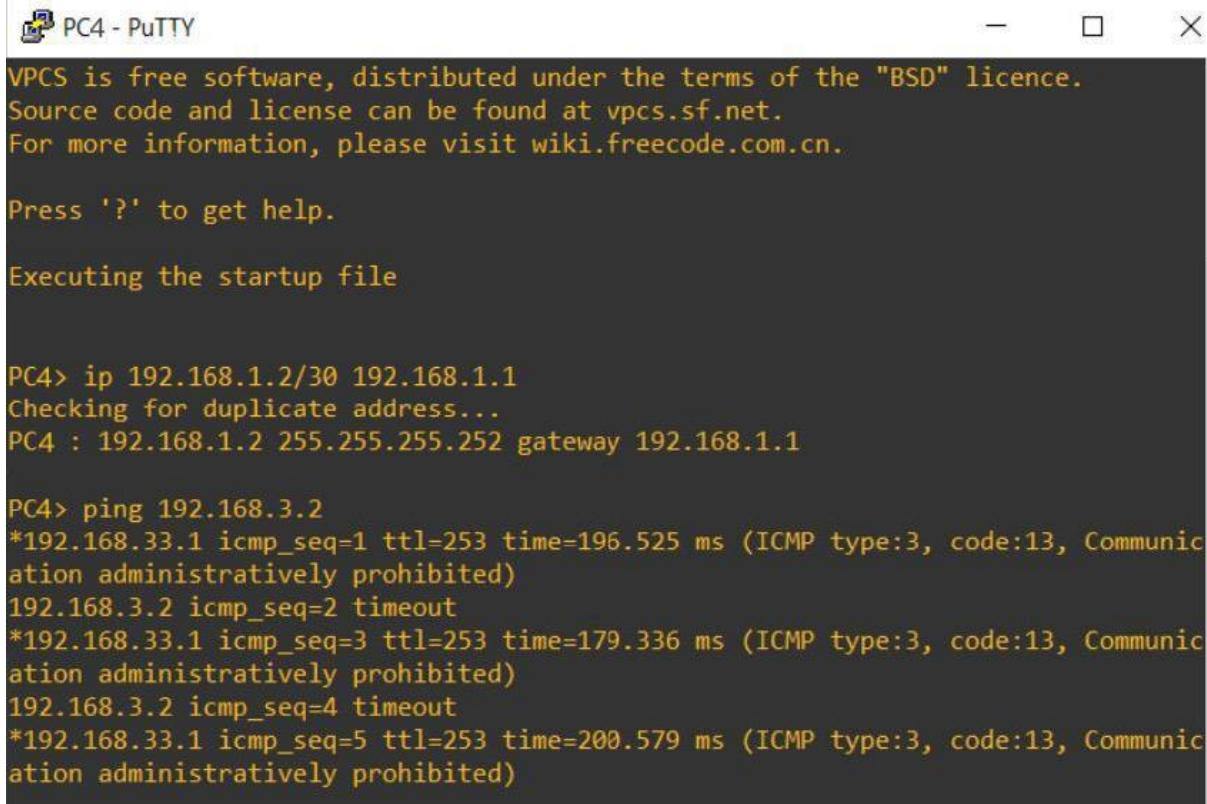
R3

R3(config)#ip access-list standard test
R3(config-std-nacl)#deny 192.168.1.0 0.0.0.3
R3(config-std-nacl)#permit any

Applying Access List on Interface f0/0

R3(config-std-nacl)#int f0/0
R3(config-if)#
R3(config-if)#ip access-group test out
R3(config-if)#

Verify Command: Successfully block the traffic (PC4 cannot ping PC6)



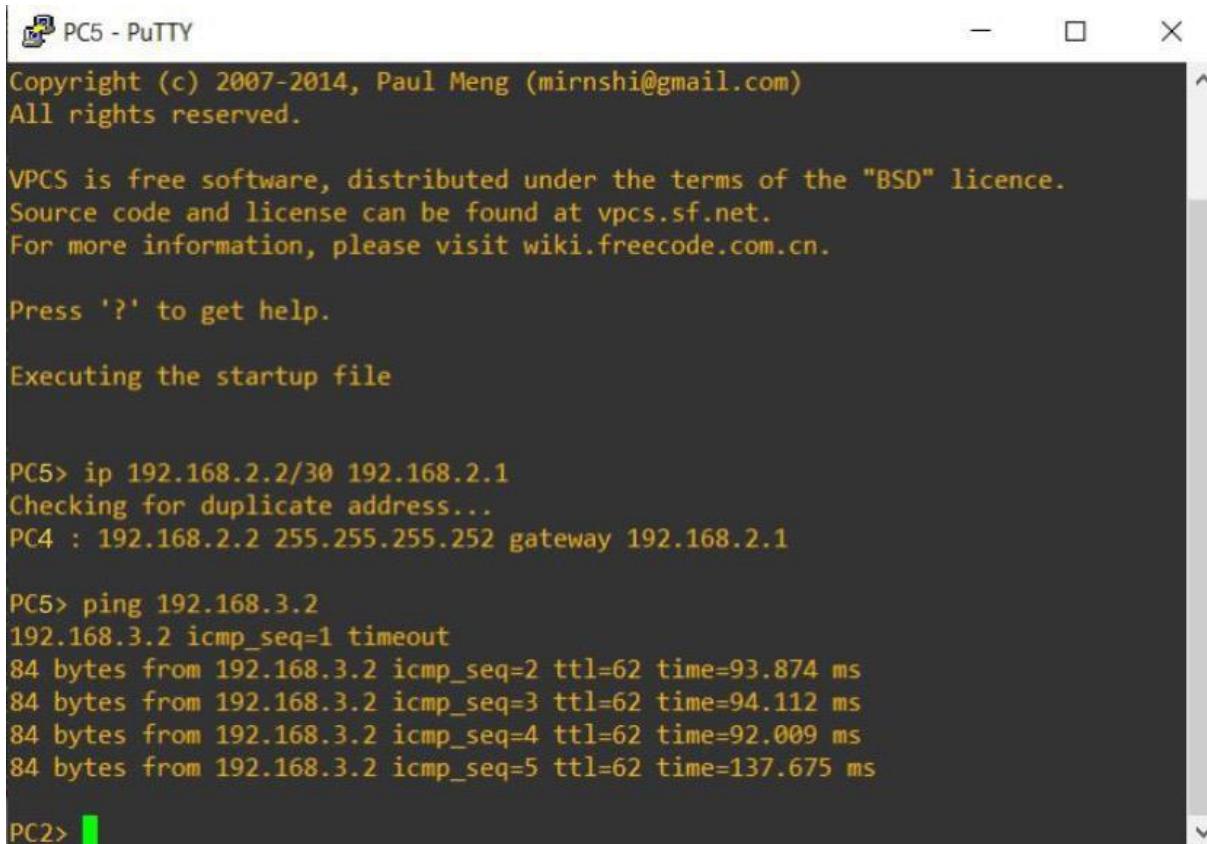
```
PC4 - PuTTY
VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC4> ip 192.168.1.2/30 192.168.1.1
Checking for duplicate address...
PC4 : 192.168.1.2 255.255.255.252 gateway 192.168.1.1

PC4> ping 192.168.3.2
*192.168.33.1 icmp_seq=1 ttl=253 time=196.525 ms (ICMP type:3, code:13, Communication administratively prohibited)
192.168.3.2 icmp_seq=2 timeout
*192.168.33.1 icmp_seq=3 ttl=253 time=179.336 ms (ICMP type:3, code:13, Communication administratively prohibited)
192.168.3.2 icmp_seq=4 timeout
*192.168.33.1 icmp_seq=5 ttl=253 time=200.579 ms (ICMP type:3, code:13, Communication administratively prohibited)
```



```
PC5 - PuTTY
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
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Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

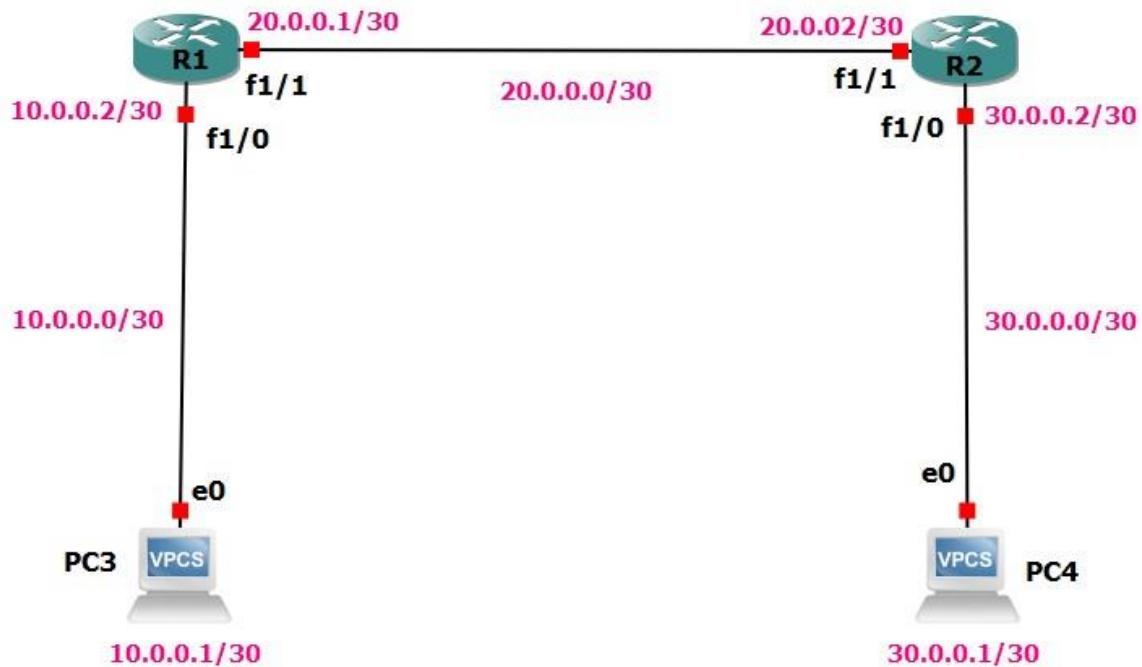
Executing the startup file

PC5> ip 192.168.2.2/30 192.168.2.1
Checking for duplicate address...
PC4 : 192.168.2.2 255.255.255.252 gateway 192.168.2.1

PC5> ping 192.168.3.2
192.168.3.2 icmp_seq=1 timeout
84 bytes from 192.168.3.2 icmp_seq=2 ttl=62 time=93.874 ms
84 bytes from 192.168.3.2 icmp_seq=3 ttl=62 time=94.112 ms
84 bytes from 192.168.3.2 icmp_seq=4 ttl=62 time=92.009 ms
84 bytes from 192.168.3.2 icmp_seq=5 ttl=62 time=137.675 ms
```

PC2> [green bar]

Part 2: Extended ACL.



Extended Access Control Lists (ACLs) allow you to permit or deny traffic from specific IP addresses to a specific destination IP address and port. It also allows you to specify different types of traffic such as ICMP, TCP, UDP, etc.

Steps:

Step 1: Assign Ip to interfaces and configure EIGRP in R1,R2 routers.

```

R1
R1#config t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#int f1/0
R1(config-if)#ip add 10.0.0.2 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
R1(config)#int f1/1
R1(config-if)#ip add 20.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
R1(config)#router eigrp 100
R1(config-router)#network 10.0.0.0
R1(config-router)#network 20.0.0.0
R1(config-router)#exit
R1(config)#
  
```

```
R2#config t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int f1/0
R2(config-if)#ip add 30.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
R2(config)#int f1/1
R2(config-if)#ip add 20.0.0.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
R2(config)#router eigrp 100
R2(config-router)#network 30.0.0.0
R2(config-router)#network 20.0.0.0
R2(config-router)#exit
R2(config)#
*Nov 14 20:52:15.575: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 100: Neighbor 20.0.0.1 (FastEthernet1/1) is up: new adjacency
R2(config)#
*Nov 14 20:52:17.387: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Nov 14 20:52:17.387: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/0 Physical Port Administrative State Down
*Nov 14 20:52:17.451: %LINK-3-UPDOWN: Interface FastEthernet1/1, changed state to up
R2(config)#
*Nov 14 20:52:17.451: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/1 Physical Port Administrative State Down
R2(config)#
*Nov 14 20:52:18.387: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
*Nov 14 20:52:18.451: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/1, changed state to up
R2(config)#

```

Step 2: Assign IP to PC1,PC2.

PC1 - PuTTY

```
Welcome to Virtual PC Simulator, version 0.6.2
Dedicated to Daling.
Build time: Apr 10 2019 02:42:20
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
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Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC1> ip 10.0.0.1/30 10.0.0.2
Checking for duplicate address...
PC1 : 10.0.0.1 255.255.255.252 gateway 10.0.0.2
```

PC2 - PuTTY

```
Welcome to Virtual PC Simulator, version 0.6.2
Dedicated to Daling.
Build time: Apr 10 2019 02:42:20
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
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For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC2> ip 30.0.0.1/30 30.0.0.2
Checking for duplicate address...
PC1 : 30.0.0.1 255.255.255.252 gateway 30.0.0.2
```

Step 3: Before adding this Extended ACL list, firstly, let's ping 30.0.0.1 from PC 1.

```

PC1> ping 30.0.0.1 -1
84 bytes from 30.0.0.1 icmp_seq=1 ttl=62 time=93.473 ms
84 bytes from 30.0.0.1 icmp_seq=2 ttl=62 time=92.911 ms
84 bytes from 30.0.0.1 icmp_seq=3 ttl=62 time=156.265 ms
84 bytes from 30.0.0.1 icmp_seq=4 ttl=62 time=128.666 ms
84 bytes from 30.0.0.1 icmp_seq=5 ttl=62 time=76.388 ms

PC1> trace

trace HOST [OPTION ...]
Print the path packets take to the network HOST. HOST can be an ip address or name.
Options:
  -P protocol    Use IP protocol in trace packets
                    1 - icmp, 17 - udp (default), 6 - tcp
  -m ttl          Maximum ttl, default 8

Notes: 1. Using names requires DNS to be set.
       2. Use Ctrl+C to stop the command.

```

```

PC1> trace 30.0.0.1 -P 1
trace to 30.0.0.1, 8 hops max (ICMP), press Ctrl+C to stop
 1  10.0.0.2   13.375 ms  33.423 ms  15.363 ms
 2  20.0.0.2   66.223 ms  73.758 ms  62.299 ms
 3  30.0.0.1   110.234 ms 105.462 ms  97.308 ms

```

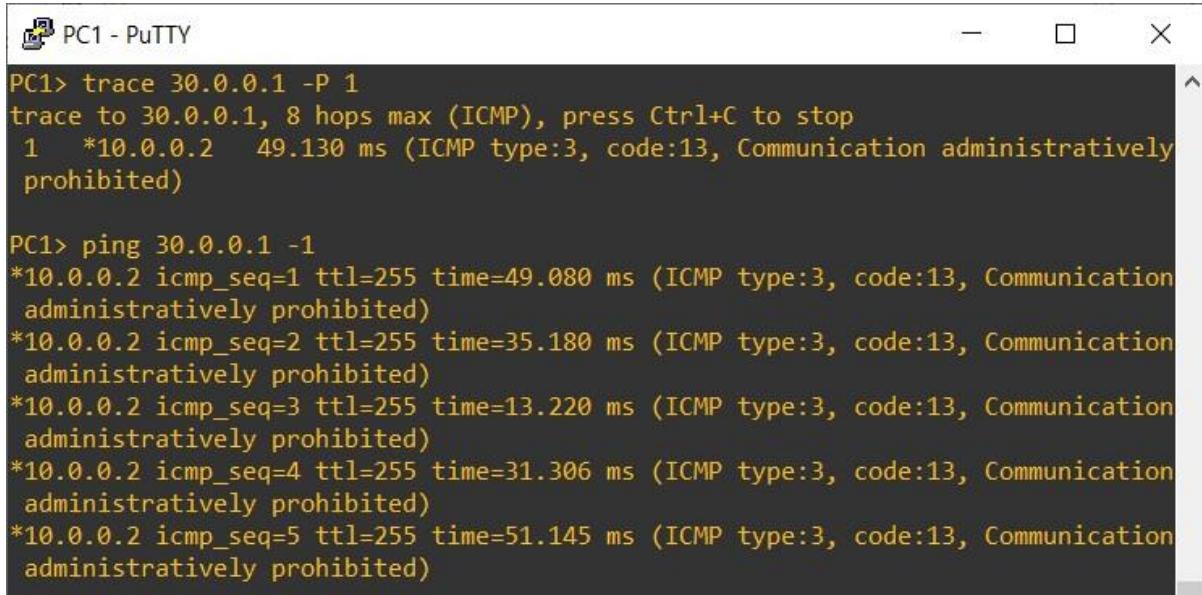
Step 4: created extended access-list, and add this access list to the related interface. This interface is the fa1/0 interface of Router 1.

```

R1(config)#ip access-list extended 100
R1(config-ext-nacl)#1 deny icmp 10.0.0.1 0.0.0.3 30.0.0.1 0.0.0.3
R1(config-ext-nacl)#2 permit ip any any
R1(config-ext-nacl)#int f1/0
R1(config-if)#ip access-group 100 in
R1(config-if)#
R1#
*Nov 14 20:56:07.883: %SYS-5-CONFIG_I: Configured from console by console

```

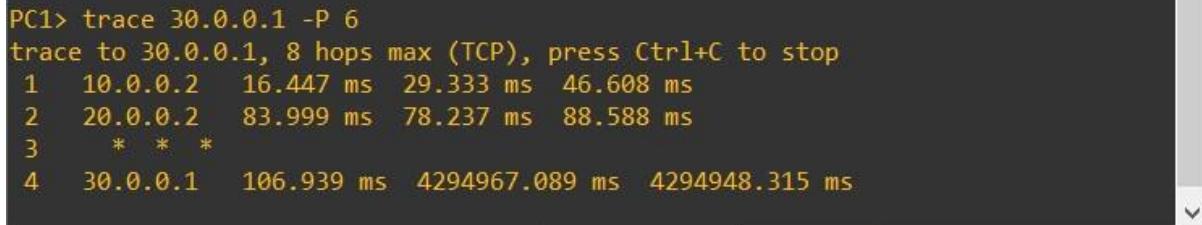
Step 5: To verify our Extended ACL Configuration, we will use ping and trace to check the reachability from PC 1 to 30.0.0.1 ip address again.



```
PC1> trace 30.0.0.1 -P 1
trace to 30.0.0.1, 8 hops max (ICMP), press Ctrl+C to stop
 1  *10.0.0.2  49.130 ms (ICMP type:3, code:13, Communication administratively prohibited)

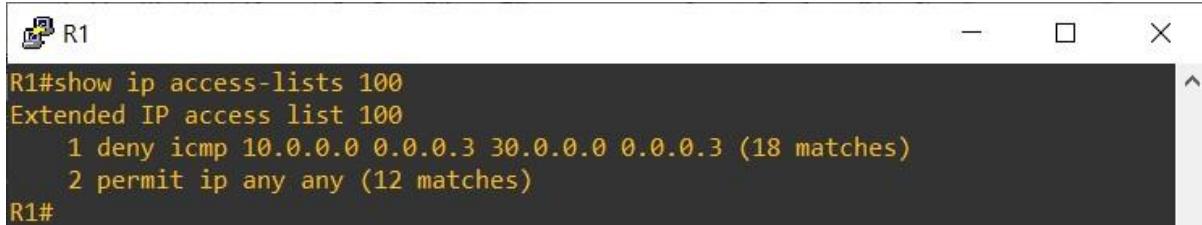
PC1> ping 30.0.0.1 -1
*10.0.0.2 icmp_seq=1 ttl=255 time=49.080 ms (ICMP type:3, code:13, Communication administratively prohibited)
*10.0.0.2 icmp_seq=2 ttl=255 time=35.180 ms (ICMP type:3, code:13, Communication administratively prohibited)
*10.0.0.2 icmp_seq=3 ttl=255 time=13.220 ms (ICMP type:3, code:13, Communication administratively prohibited)
*10.0.0.2 icmp_seq=4 ttl=255 time=31.306 ms (ICMP type:3, code:13, Communication administratively prohibited)
*10.0.0.2 icmp_seq=5 ttl=255 time=51.145 ms (ICMP type:3, code:13, Communication administratively prohibited)
```

But you can send the TCP or UDP packet .



```
PC1> trace 30.0.0.1 -P 6
trace to 30.0.0.1, 8 hops max (TCP), press Ctrl+C to stop
 1  10.0.0.2  16.447 ms  29.333 ms  46.608 ms
 2  20.0.0.2  83.999 ms  78.237 ms  88.588 ms
 3  * * *
 4  30.0.0.1  106.939 ms  4294967.089 ms  4294948.315 ms
```

Lastly, let's check our Extended Access List with “show ip access-lists 100” command.



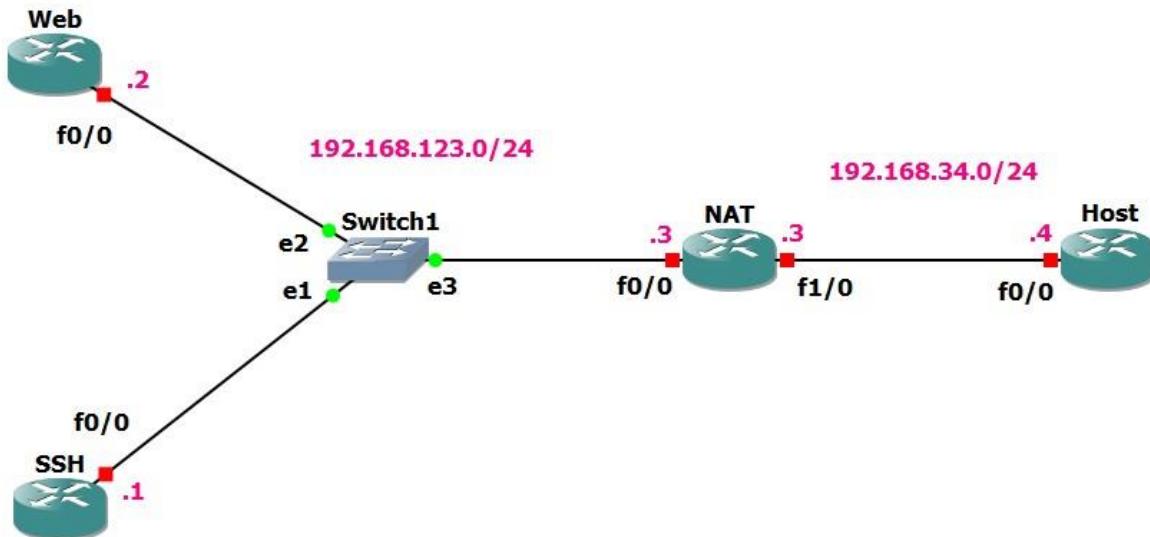
```
R1#show ip access-lists 100
Extended IP access list 100
  1 deny icmp 10.0.0.0 0.0.0.3 30.0.0.0 0.0.0.3 (18 matches)
  2 permit ip any any (12 matches)
R1#
```

Practical No. 7

Aim: Implement NAT.

Part 1: nat-port-forwarding

Topology:



In computer networking, port forwarding or port mapping is an application of network address translation (NAT) that redirects a communication request from one address and port number combination to another while the packets are traversing a network gateway, such as a router or firewall.

Steps:

Step 1: run “show cdp neighbors” command to find directly connected routers.

```
NAT
NAT>enable
NAT#
NAT#show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID      Local Intrfce     Holdtme   Capability Platform Port ID
Host           Fas 1/0          165        R S I       3640    Fas 0/0
Web            Fas 0/0          154        R S I       3640    Fas 0/0
SSH.SSH.local  Fas 0/0          154        R S I       3640    Fas 0/0
```

Step 2: configure NAT outside and inside router.

```
NAT#config t
Enter configuration commands, one per line. End with CNTL/Z.
NAT(config)#int f1/0
NAT(config-if)#ip nat outside
NAT(config-if)#
*Mar 1 00:02:50.011: %LINEPROTO-5-UPDOWN: Line protocol on Interface NVI0, changed state to up
```

```
NAT(config)#int f0/0
NAT(config-if)#ip nat inside
NAT(config-if)#exit
NAT(config)#{
```

Step 3: port forwarding TCP packets

```
NAT(config)#ip nat inside source static tcp 192.168.123.1 22 192.168.34.3 22
NAT(config)#{
```

```
NAT(config)#ip nat inside source static tcp 192.168.123.2 80 192.168.34.3 80
NAT(config)#{
```

Step 4: Try connecting to Web router using telnet.

```
Host
Host>enable
Host#telnet 192.168.34.3 80
Trying 192.168.34.3, 80 ... Open
```

Step 5: verify the host connection in Web router.

```
Web
Web>enable
Web#show ip http server connection

HTTP server current connections:
local-ipaddress:port  remote-ipaddress:port in-bytes  out-bytes
 192.168.123.2:80      192.168.34.4:47727 0          0

Web#
```

Check the interface connection on Host router

```
Host
Host#show ip int brief
Interface          IP-Address      OK? Method Status      Prot
octl
FastEthernet0/0    192.168.34.4    YES NVRAM up           up
FastEthernet1/0    unassigned      YES NVRAM administratively down down
Host#
```

Step 6: now try to connect to SSH router. But first note the username and password for SSH connection.

```

SSH>enable
SSH#show run
Building configuration...

Current configuration : 703 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname SSH
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
memory-size iomem 5
!
```

Try to connect

```

Host#ssh -l vault 192.168.34.3
% Connection refused by remote host
```

Step 7: we have to add the crypto key in SSH router, lets generate rsa key

```

SSH#config t
Enter configuration commands, one per line. End with CNTL/Z.
SSH(config)#crypto key generate rsa
The name for the keys will be: SSH.SSH.local
Choose the size of the key modulus in the range of 360 to 2048 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.

How many bits in the modulus [512]:
% Generating 512 bit RSA keys, keys will be non-exportable...[OK]

SSH(config)#
*Mar 1 00:05:57.655: %SSH-5-ENABLED: SSH 1.99 has been enabled
SSH(config)#

```

Step 8: now again try to connect to SSH router

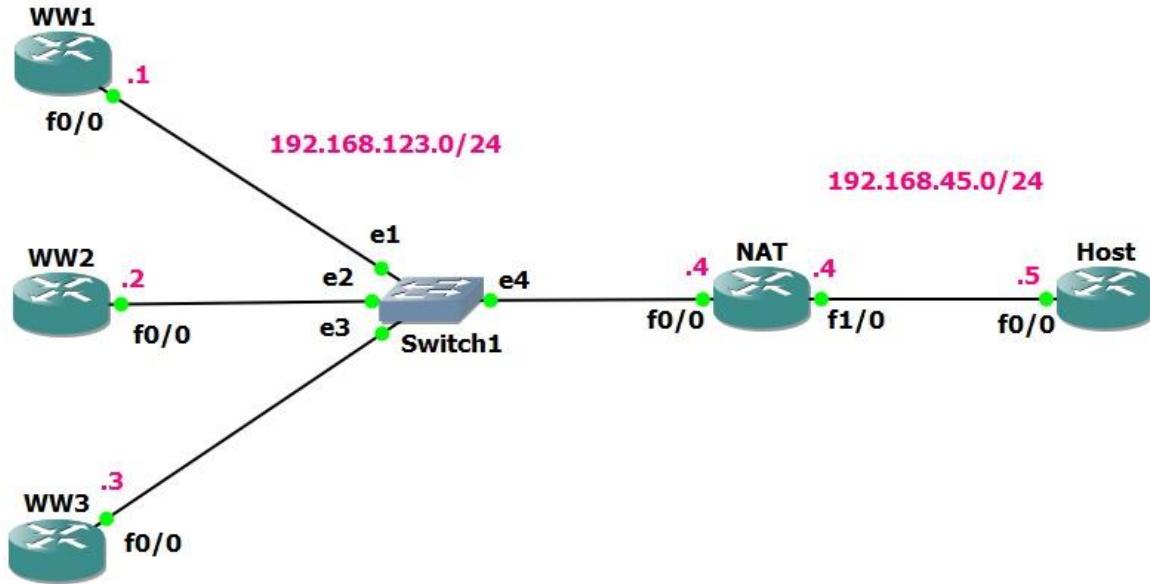
```

Host#ssh -l vault 192.168.34.3

Password:

SSH>
```

Part 2: nat-tcp-load-balancing.



Network Address Translation (NAT) and Load Balancing (LB) provides the ability to balance incoming traffic across multiple, similar network resources Load Balancing distributes traffic among similar network resources so that no single server becomes overwhelmed, allowing for reliability and redundancy.

Steps:

Step 1: Configure HTTP server on all webservers.

```

WWW1
WWW1>enable
WWW1#config t
Enter configuration commands, one per line. End with CNTL/Z.
WWW1(config)#ip http server
WWW1(config)#

```

```

WWW2
WWW2>enable
WWW2#config t
Enter configuration commands, one per line. End with CNTL/Z.
WWW2(config)#ip http server
WWW2(config)#

```

```

WWW3
WWW3>enable
WWW3#config t
Enter configuration commands, one per line. End with CNTL/Z.
WWW3(config)#ip http server
WWW3(config)#

```

Step 2: run “show cdp neighbors” command to find directly connected routers.

```
NAT>enable
NAT#config t
Enter configuration commands, one per line. End with CNTL/Z.
NAT(config)#do show cdp nei
Capability Codes: R - Router, T - Trans Bridge, B - Source Route Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater

Device ID      Local Intrfce     Holdtme   Capability  Platform  Port ID
Host           Fas 1/0          172        R S I       3640      Fas 0/0
WW3            Fas 0/0          172        R S I       3640      Fas 0/0
WW2            Fas 0/0          172        R S I       3640      Fas 0/0
WW1            Fas 0/0          172        R S I       3640      Fas 0/0
```

Step 3: configure NAT outside and inside router.

```
NAT(config)#int f1/0
NAT(config-if)#ip nat outside
NAT(config-if)#
*Mar 1 00:03:21.883: %LINEPROTO-5-UPDOWN: Line protocol on Interface NVI0, changed state to up
NAT(config)#int f0/0
NAT(config-if)#ip nat inside
NAT(config-if)#exit
```

Step 4: create IP NAT pool.

```
NAT(config)#int f0/0
NAT(config-if)#ip nat inside
NAT(config-if)#exit
NAT(config)#ip nat pool ROTATE prefix-length 24 type rotary
NAT(config-ipnat-pool)#add 192.168.123.1 192.168.123.3
NAT(config-ipnat-pool)#exit
```

Step 5: create access list.

```
NAT(config)#ip access-list extended LOADBALANCE
NAT(config-ext-nacl)#permit tcp any host 192.168.45.100 eq 80
NAT(config-ext-nacl)#exit
NAT(config)#

```

Step 6: add pool to destination list.

```
NAT(config)#ip nat inside destination list LOADBALANCE pool ROTATE
NAT(config)#

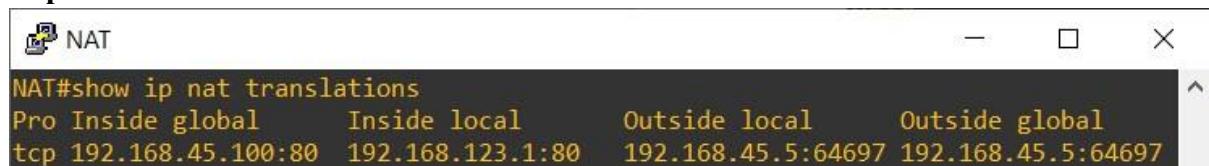
```

Step 7: create ip alias

```
NAT#config t
Enter configuration commands, one per line. End with CNTL/Z.
NAT(config)#ip alias 192.168.45.100 80
NAT(config)#exit
NAT#
*Mar 1 00:12:21.899: %SYS-5-CONFIG_I: Configured from console by console
NAT#
```

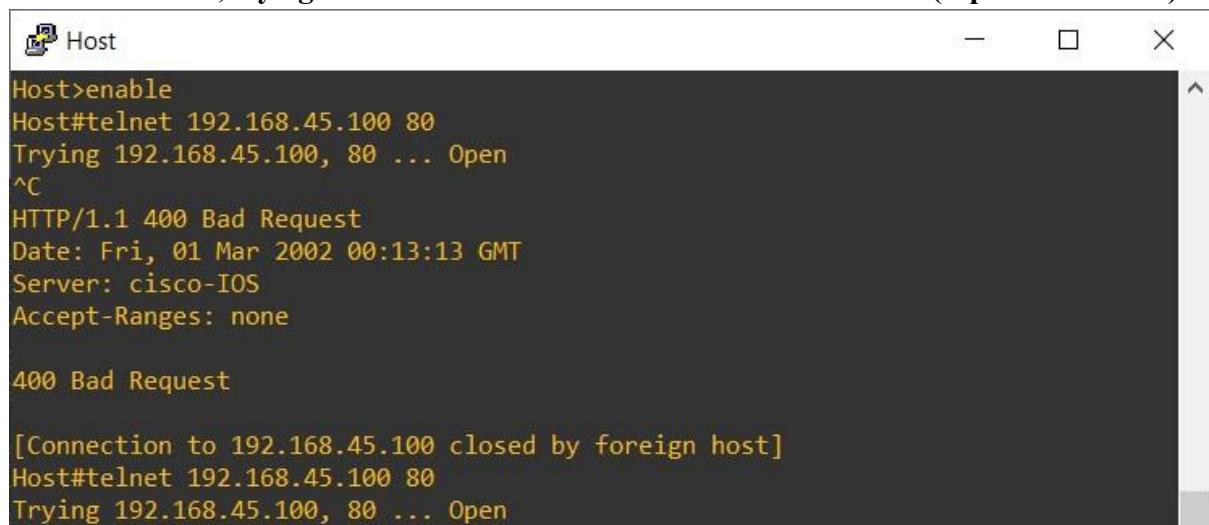
Step 8: Now try to connect


```
Host>enable
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
```

Step 9: check the nat translations


Protocol	Inside global	Inside local	Outside local	Outside global
tcp	192.168.45.100:80	192.168.123.1:80	192.168.45.5:64697	192.168.45.5:64697

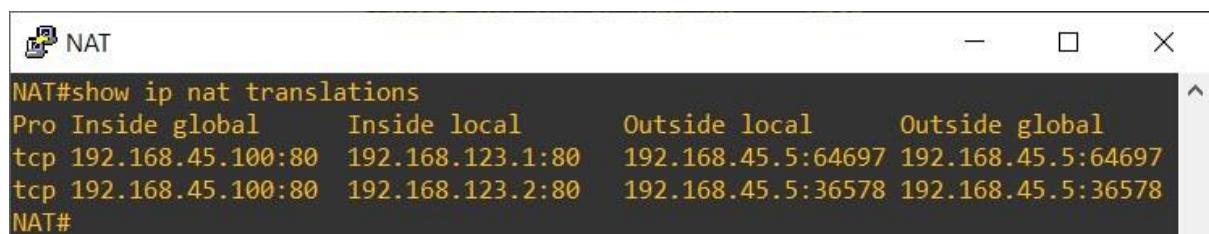
Disconnect host, try again to connect and check the nat translations (repeat 3 -2 times).



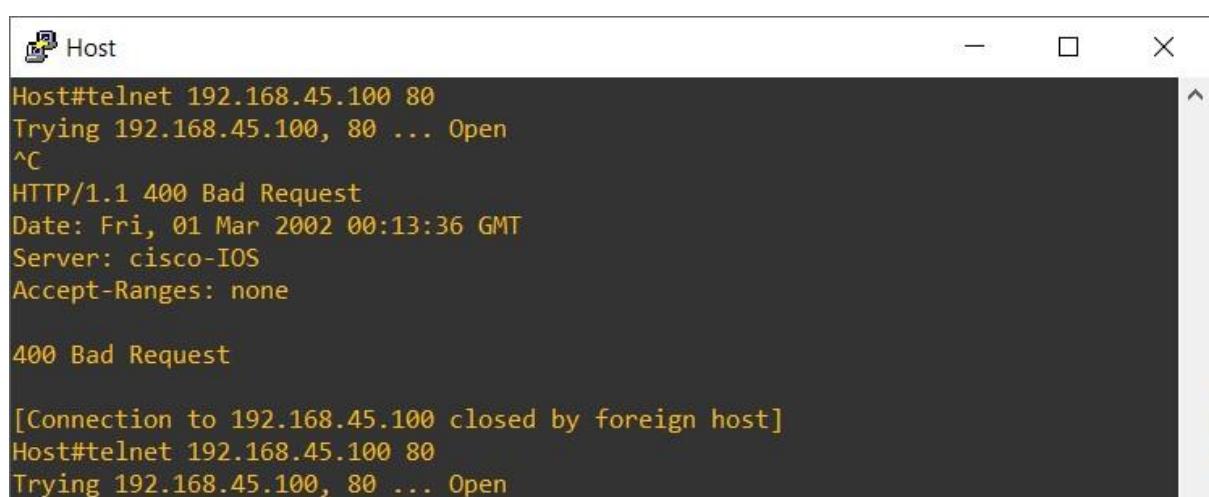
```
Host>enable
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
^C
HTTP/1.1 400 Bad Request
Date: Fri, 01 Mar 2002 00:13:13 GMT
Server: cisco-IOS
Accept-Ranges: none

400 Bad Request

[Connection to 192.168.45.100 closed by foreign host]
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
```



Protocol	Inside global	Inside local	Outside local	Outside global
tcp	192.168.45.100:80	192.168.123.1:80	192.168.45.5:64697	192.168.45.5:64697
tcp	192.168.45.100:80	192.168.123.2:80	192.168.45.5:36578	192.168.45.5:36578



```
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
^C
HTTP/1.1 400 Bad Request
Date: Fri, 01 Mar 2002 00:13:36 GMT
Server: cisco-IOS
Accept-Ranges: none

400 Bad Request

[Connection to 192.168.45.100 closed by foreign host]
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
```

The screenshot displays two terminal windows side-by-side. The left window, titled 'NAT', shows the command 'NAT#show ip nat translations' and its output:

```
NAT#show ip nat translations
Pro Inside global      Inside local      Outside local      Outside global
tcp 192.168.45.100:80  192.168.123.1:80  192.168.45.5:64697  192.168.45.5:64697
tcp 192.168.45.100:80  192.168.123.2:80  192.168.45.5:36578  192.168.45.5:36578
tcp 192.168.45.100:80  192.168.123.3:80  192.168.45.5:42223  192.168.45.5:42223
NAT#
```

The right window, titled 'Host', shows the command 'Host#telnet 192.168.45.100 80' and its output:

```
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
^C
HTTP/1.1 400 Bad Request
Date: Fri, 01 Mar 2002 00:14:01 GMT
Server: cisco-IOS
Accept-Ranges: none

400 Bad Request

[Connection to 192.168.45.100 closed by foreign host]
Host#telnet 192.168.45.100 80
Trying 192.168.45.100, 80 ... Open
```

Step 10: you can see it load-balanced using round-robin among the webservers.

The screenshot shows a single terminal window titled 'NAT'. It displays the command 'NAT#show ip nat translations' and its output:

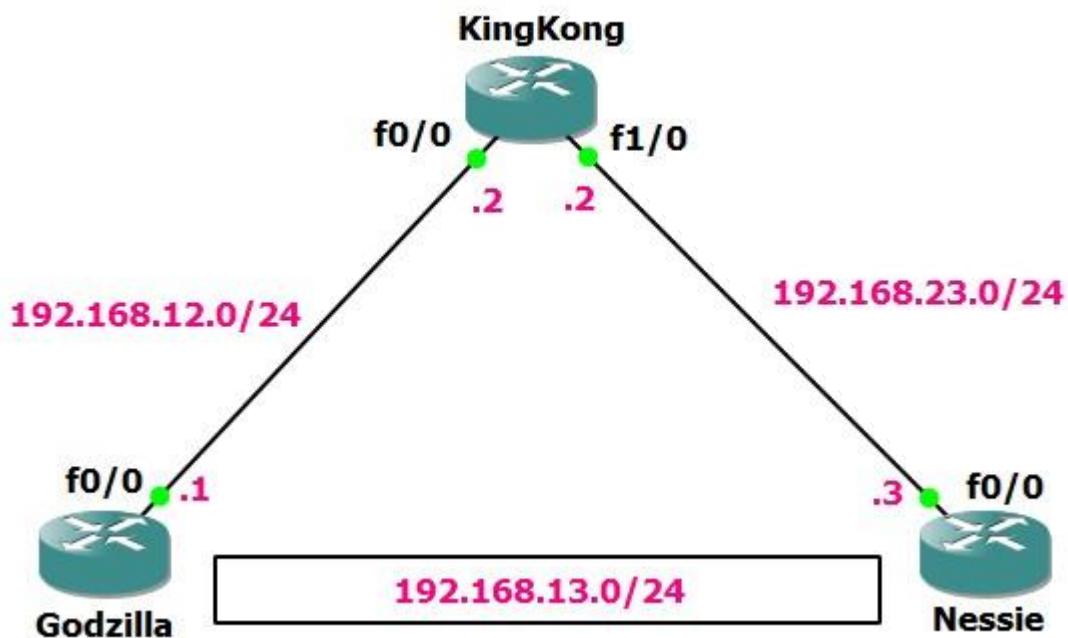
```
NAT#show ip nat translations
Pro Inside global      Inside local      Outside local      Outside global
tcp 192.168.45.100:80  192.168.123.1:80  192.168.45.5:26889  192.168.45.5:26889
tcp 192.168.45.100:80  192.168.123.1:80  192.168.45.5:43163  192.168.45.5:43163
tcp 192.168.45.100:80  192.168.123.2:80  192.168.45.5:19578  192.168.45.5:19578
tcp 192.168.45.100:80  192.168.123.3:80  192.168.45.5:28185  192.168.45.5:28185
NAT#
```

Practical No. 8

Aim: Site-to-Site VPNs.

Part 1: Implement GRE over IPsec Site-to-Site VPNs

Topology:



What is GRE?

Generic Routing Encapsulation (GRE) is a Cisco developed tunneling protocol. It is a simple IP packet encapsulation protocol. Generic Routing Encapsulation is used when IP packets need to be transported from one network to another network, without being notified as IP packets by any intermediate routers.

Steps:

Step 1: Configure all IP addresses as specified in the topology picture.

Router Godzilla and Nessie have the following loopback interfaces: Godzilla:

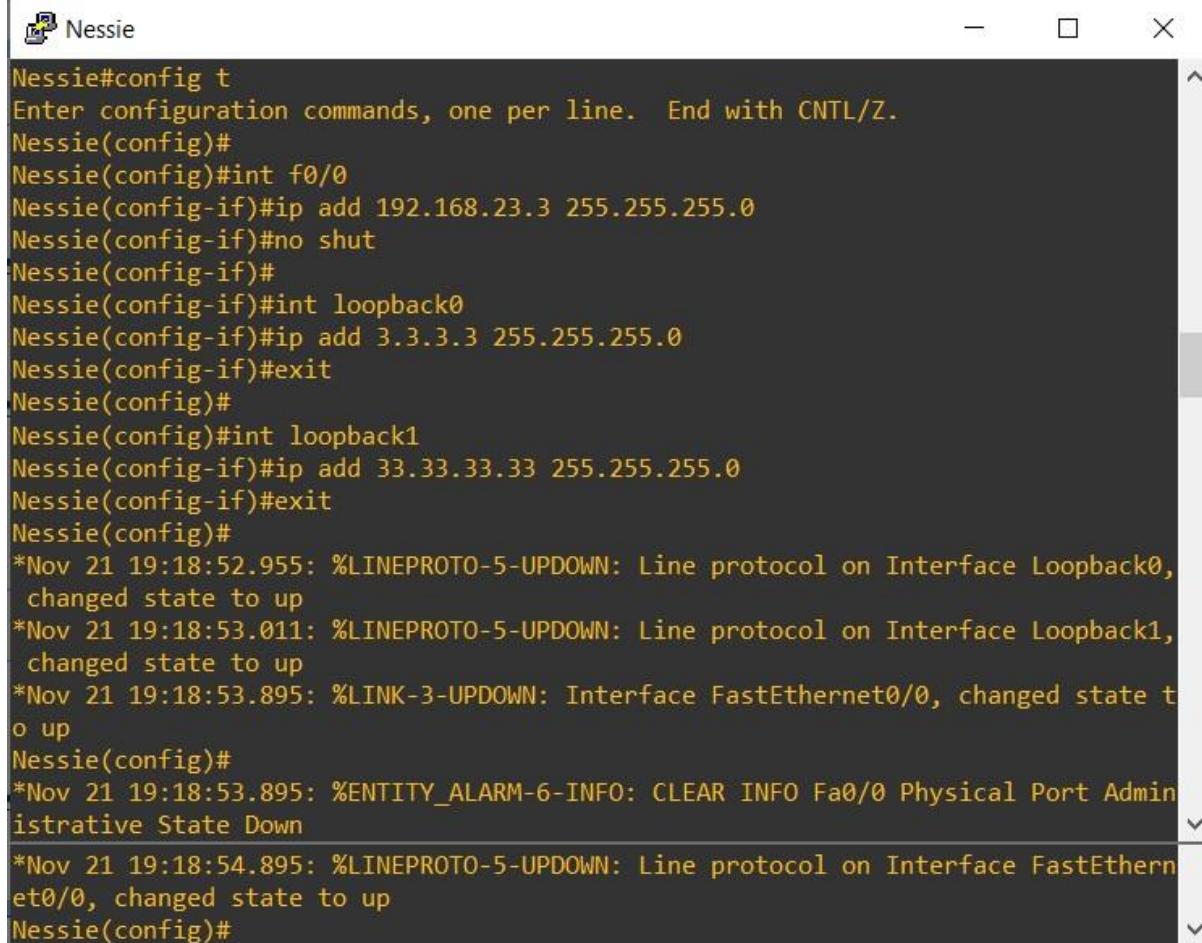
Loopback1: 11.11.11.11 /24

Nessie: Loopback1: 33.33.33.33 /24

KingKong#config t
Enter configuration commands, one per line. End with CNTL/Z.
KingKong(config)#
KingKong(config)#int f0/0
KingKong(config-if)#ip add 192.168.12.2 255.255.255.0
KingKong(config-if)#no shut
KingKong(config-if)#
KingKong(config-if)#int f1/0
KingKong(config-if)#ip add 192.168.23.2 255.255.255.0
KingKong(config-if)#no shut
KingKong(config-if)#
KingKong(config-if)#exit
KingKong(config)#
*Nov 21 19:18:35.247: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Nov 21 19:18:35.247: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Administrative State Down
*Nov 21 19:18:35.355: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
KingKong(config)#
*Nov 21 19:18:35.355: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/0 Physical Port Administrative State Down
KingKong(config)#
*Nov 21 19:18:36.247: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
*Nov 21 19:18:36.247: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
*Nov 21 19:18:36.355: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
KingKong(config)#

Godzilla#config t
Enter configuration commands, one per line. End with CNTL/Z.
Godzilla(config)#
Godzilla(config)#int f0/0
Godzilla(config-if)#ip add 192.168.12.1 255.255.255.0
Godzilla(config-if)#no shut
Godzilla(config-if)#
Godzilla(config-if)#int loopback0
Godzilla(config-if)#ip add 1.1.1.1 255.255.255.0
Godzilla(config-if)#exit
Godzilla(config)#
Godzilla(config)#int loopback1
Godzilla(config-if)#ip add 11.11.11.11 255.255.255.0
Godzilla(config-if)#exit
Godzilla(config)#
Godzilla(config)#
*Nov 21 19:18:43.231: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
*Nov 21 19:18:43.283: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
*Nov 21 19:18:44.143: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
Godzilla(config)#

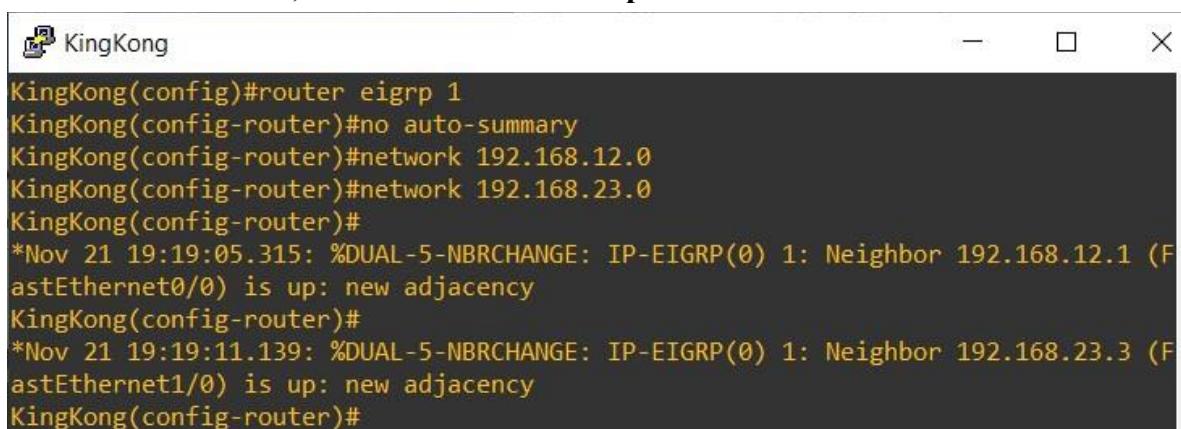
```
*Nov 21 19:18:44.143: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Admin
istrative State Down
*Nov 21 19:18:45.143: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Godzilla(config)#
```



```
Nessie#config t
Enter configuration commands, one per line. End with CNTL/Z.
Nessie(config)#
Nessie(config)#int f0/0
Nessie(config-if)#ip add 192.168.23.3 255.255.255.0
Nessie(config-if)#no shut
Nessie(config-if)#
Nessie(config-if)#int loopback0
Nessie(config-if)#ip add 3.3.3.3 255.255.255.0
Nessie(config-if)#exit
Nessie(config)#
Nessie(config)#int loopback1
Nessie(config-if)#ip add 33.33.33.33 255.255.255.0
Nessie(config-if)#exit
Nessie(config)#
*Nov 21 19:18:52.955: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
*Nov 21 19:18:53.011: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
*Nov 21 19:18:53.895: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
Nessie(config)#
*Nov 21 19:18:53.895: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Admin
istrative State Down
*Nov 21 19:18:54.895: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Nessie(config)#

```

Step 2: Configure EIGRP AS 1 on all 3 routers, only advertise the 192.168.12.0 and 192.168.23.0 network, do not advertise the loopbacks.



```
KingKong(config)#router eigrp 1
KingKong(config-router)#no auto-summary
KingKong(config-router)#network 192.168.12.0
KingKong(config-router)#network 192.168.23.0
KingKong(config-router)#
*Nov 21 19:19:05.315: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor 192.168.12.1 (FastEthernet0/0) is up: new adjacency
KingKong(config-router)#
*Nov 21 19:19:11.139: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor 192.168.23.3 (FastEthernet1/0) is up: new adjacency
KingKong(config-router)#

```

```
Godzilla#router eigrp 1
Godzilla(config-router)#no auto-summary
Godzilla(config-router)#network 192.168.12.0
Godzilla(config-router)#exit
Godzilla(config)#exit
Godzilla#
*Nov 21 19:19:05.535: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor 192.168.12.2 (FastEthernet0/0) is up: new adjacency
*Nov 21 19:19:06.043: %SYS-5-CONFIG_I: Configured from console by console
Godzilla#
```

```
Nessie#router eigrp 1
Nessie(config-router)#no auto-summary
Nessie(config-router)#network 192.168.23.0
Nessie(config-router)#exit
Nessie(config)#exit
*Nov 21 19:19:11.171: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 1: Neighbor 192.168.23.2 (FastEthernet0/0) is up: new adjacency
Nessie(config)#
```

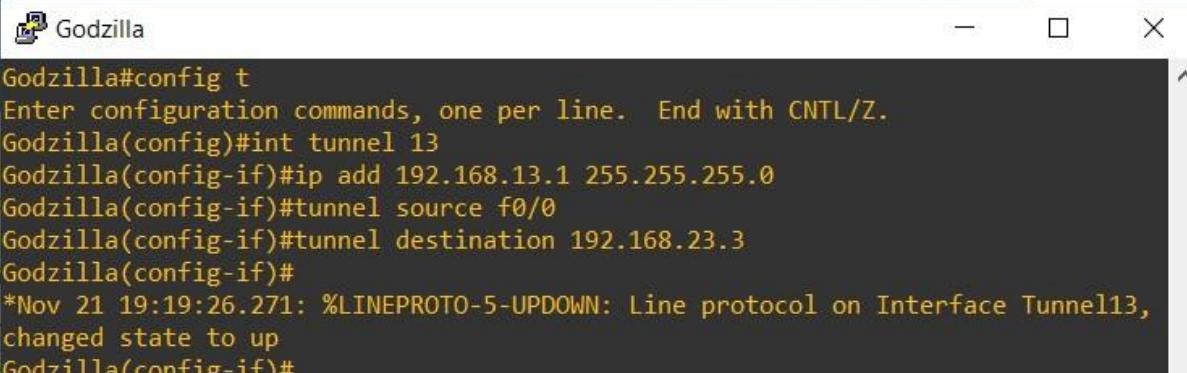
Step 3: Ensure Router Godzilla can ping Nessie.

```
Godzilla#ping 192.168.23.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.23.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 124/160/216 ms
Godzilla#
```

Step 4: Configure a IPSEC tunnel between Router Godzilla and Nessie.

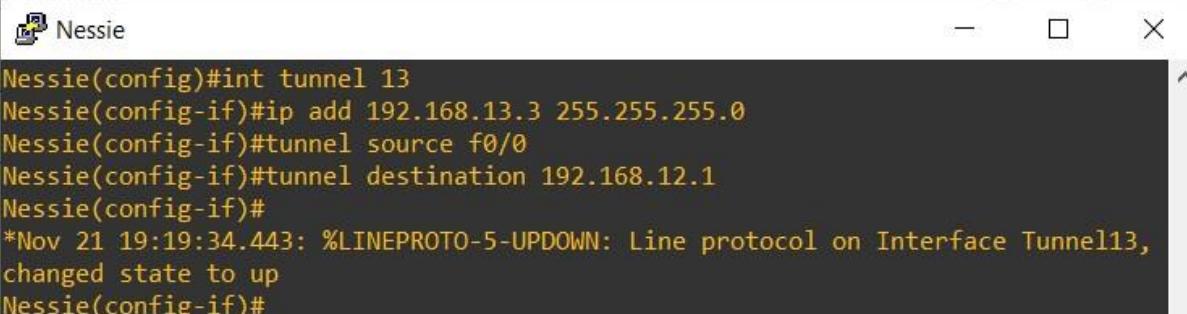
Configure the 192.168.13.0 /24 network on the IPSEC tunnel: Godzilla: 192.168.13.1

Nessie: 192.168.13.3



```
Godzilla#config t
Enter configuration commands, one per line. End with CNTL/Z.
Godzilla(config)#int tunnel 13
Godzilla(config-if)#ip add 192.168.13.1 255.255.255.0
Godzilla(config-if)#tunnel source f0/0
Godzilla(config-if)#tunnel destination 192.168.23.3
Godzilla(config-if)#
*Nov 21 19:19:26.271: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel13,
changed state to up
Godzilla(config-if)#

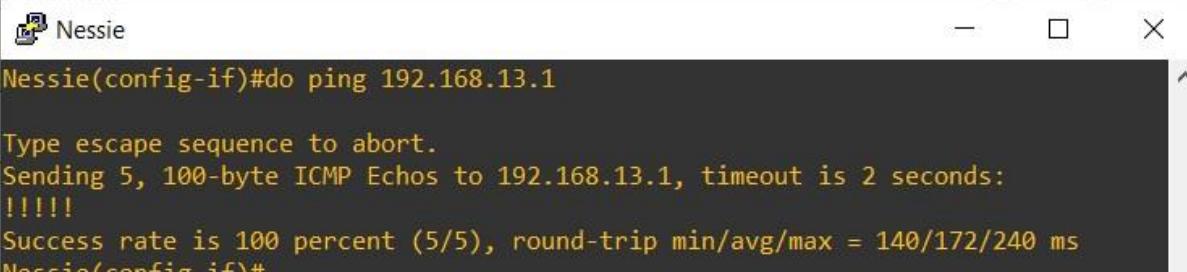
```



```
Nessie(config)#int tunnel 13
Nessie(config-if)#ip add 192.168.13.3 255.255.255.0
Nessie(config-if)#tunnel source f0/0
Nessie(config-if)#tunnel destination 192.168.12.1
Nessie(config-if)#
*Nov 21 19:19:34.443: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel13,
changed state to up
Nessie(config-if)#

```

Step 5: Ensure you can ping the IP addresses that you configured on the tunnel interface.

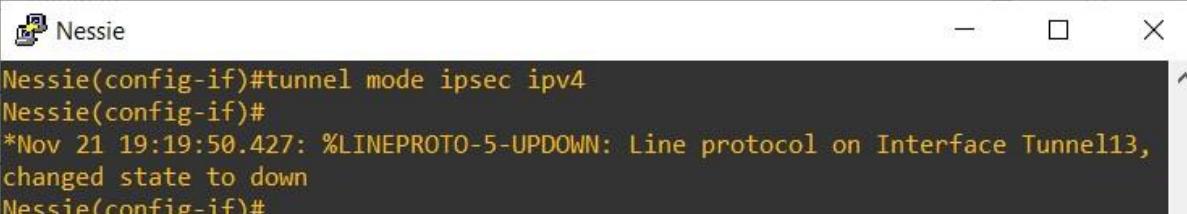


```
Nessie(config-if)#do ping 192.168.13.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.13.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 140/172/240 ms
Nessie(config-if)#

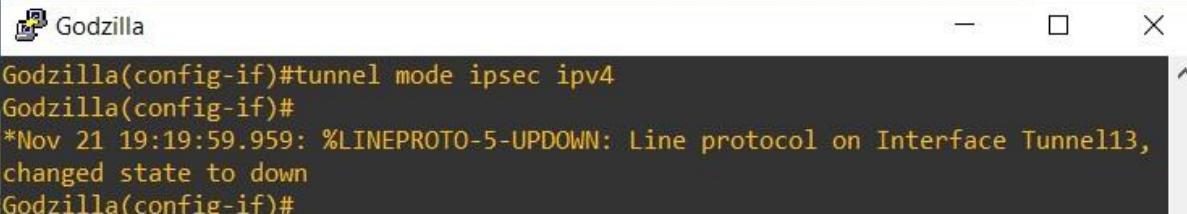
```

Now configure IPSEC tunnel.



```
Nessie(config-if)#tunnel mode ipsec ipv4
Nessie(config-if)#
*Nov 21 19:19:50.427: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel13,
changed state to down
Nessie(config-if)#

```



```
Godzilla(config-if)#tunnel mode ipsec ipv4
Godzilla(config-if)#
*Nov 21 19:19:59.959: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel13,
changed state to down
Godzilla(config-if)#

```

Step 6: Configure static routes on router Godzilla and Nessie so they can reach each other's loopback1 interface through the Tunnel interface.

```
Godzilla#ip route 33.33.33.33 255.255.255.255 192.168.13.3
Godzilla#
Nessie#ip route 11.11.11.11 255.255.255.255 192.168.13.1
Nessie#
```

Step 7: Create an IKE Policy with the following parameters: Authentication: pre-shared-key

Encryption: AES 256 Hashing: sha

DH: Group 5

Lifetime: 3600

```
Godzilla#crypto isakmp policy 10
Godzilla(config-isakmp)#encryption aes 256
Godzilla(config-isakmp)#authentication pre-share
Godzilla(config-isakmp)#group 5
Godzilla(config-isakmp)#exit
Godzilla(config)#
Nessie#crypto isakmp policy 10
Nessie(config-isakmp)#encryption aes 256
Nessie(config-isakmp)#authentication pre-share
Nessie(config-isakmp)#group 5
Nessie(config-isakmp)#exit
Nessie(config)#

```

Step 8: The pre-shared-key should be “Maneesh”.

```
Godzilla#crypto isakmp key 0 Maneesh address 192.168.23.3
Godzilla(config)#
Nessie#crypto isakmp key 0 Maneesh address 192.168.12.1
Nessie(config)#

```

Step 9: Create an IPSEC Transform-set with the following parameters: ESP (Encapsulating Security Payload)

Encryption: AES 256 Hashing: SHA-HMAC

The image shows two separate terminal windows. The top window is titled 'Godzilla' and the bottom one is titled 'Nessie'. Both windows display the same sequence of CLI commands:

```
Godzilla(config)#crypto ipsec transform-set MYTRANS esp-aes esp-sha-hmac
Godzilla(cfg-crypto-trans)#exit
Godzilla(config)#
Nessie(config)#crypto ipsec transform-set MYTRANS esp-aes esp-sha-hmac
Nessie(cfg-crypto-trans)#exit
Nessie(config)#

```

Step 10: Create the correct policy profile to finish the IPSEC configuration.

The image shows two separate terminal windows. The top window is titled 'Godzilla' and the bottom one is titled 'Nessie'. Both windows display the same sequence of CLI commands:

```
Godzilla(config)#crypto ipsec profile PROTECT
Godzilla(ipsec-profile)#set transform-set MYTRANS
Godzilla(ipsec-profile)#int tunnel 13
Godzilla(config-if)#tunnel protection ipsec profile PROTECT
Godzilla(config-if)#
*Nov 21 19:22:03.527: %CRYPTO-6-ISAKMP_ON_OFF: ISAKMP is ON
Godzilla(config-if)#
*Nov 21 19:22:13.387: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel13,
changed state to up
Godzilla(config-if)#
Nessie(config)#crypto ipsec profile PROTECT
Nessie(ipsec-profile)#set transform-set MYTRANS
Nessie(ipsec-profile)#int tunnel 13
Nessie(config-if)#tunnel protection ipsec profile PROTECT
Nessie(config-if)#exit
Nessie(config)#exit
Nessie#
*Nov 21 19:22:11.415: %CRYPTO-6-ISAKMP_ON_OFF: ISAKMP is ON
Nessie#
*Nov 21 19:22:12.171: %SYS-5-CONFIG_I: Configured from console by console
Nessie#
*Nov 21 19:22:13.307: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel13,
changed state to up
Nessie#

```

Step 11: Verify the IPSEC configuration. Before sending the packets.

```
Nessie#show crypto ipsec sa

interface: Tunnel13
    Crypto map tag: Tunnel13-head-0, local addr 192.168.23.3

    protected vrf: (none)
    local ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
    remote ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
    current_peer 192.168.12.1 port 500
        PERMIT, flags={origin_is_acl,}
        #pkts encaps: 0, #pkts encrypt: 0, #pkts digest: 0
        #pkts decaps: 0, #pkts decrypt: 0, #pkts verify: 0
        #pkts compressed: 0, #pkts decompressed: 0
        #pkts not compressed: 0, #pkts compr. failed: 0
        #pkts not decompressed: 0, #pkts decompress failed: 0
        #send errors 0, #recv errors 0

    local crypto endpt.: 192.168.23.3, remote crypto endpt.: 192.168.12.1
    path mtu 1500, ip mtu 1500, ip mtu idb FastEthernet0/0
    current outbound spi: 0x6C022F37(1812082487)

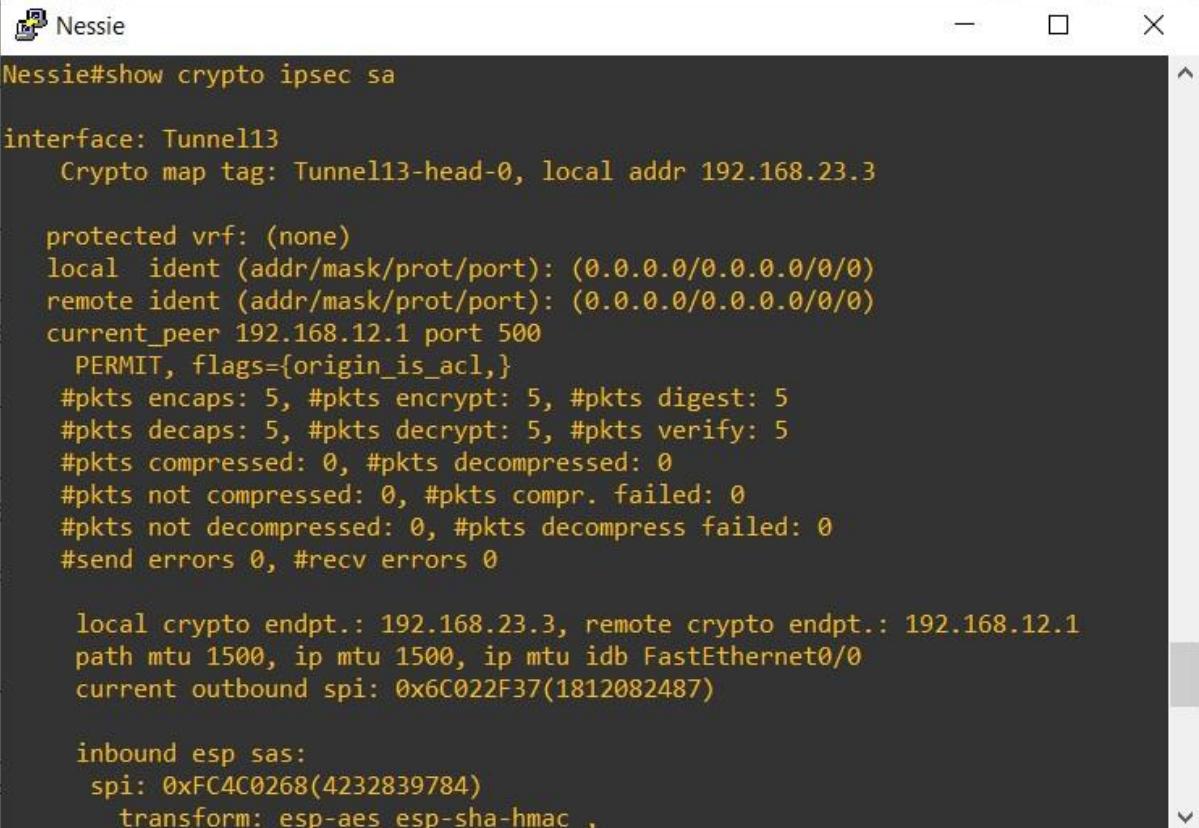
    inbound esp sas:
        spi: 0xFC4C0268(4232839784)
            transform: esp-aes esp-sha-hmac ,
```

Sending the packets....

```
Nessie#ping 11.11.11.11 source 33.33.33.33

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 11.11.11.11, timeout is 2 seconds:
Packet sent with a source address of 33.33.33.33
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/160/204 ms
Nessie#
```

After sending the packets

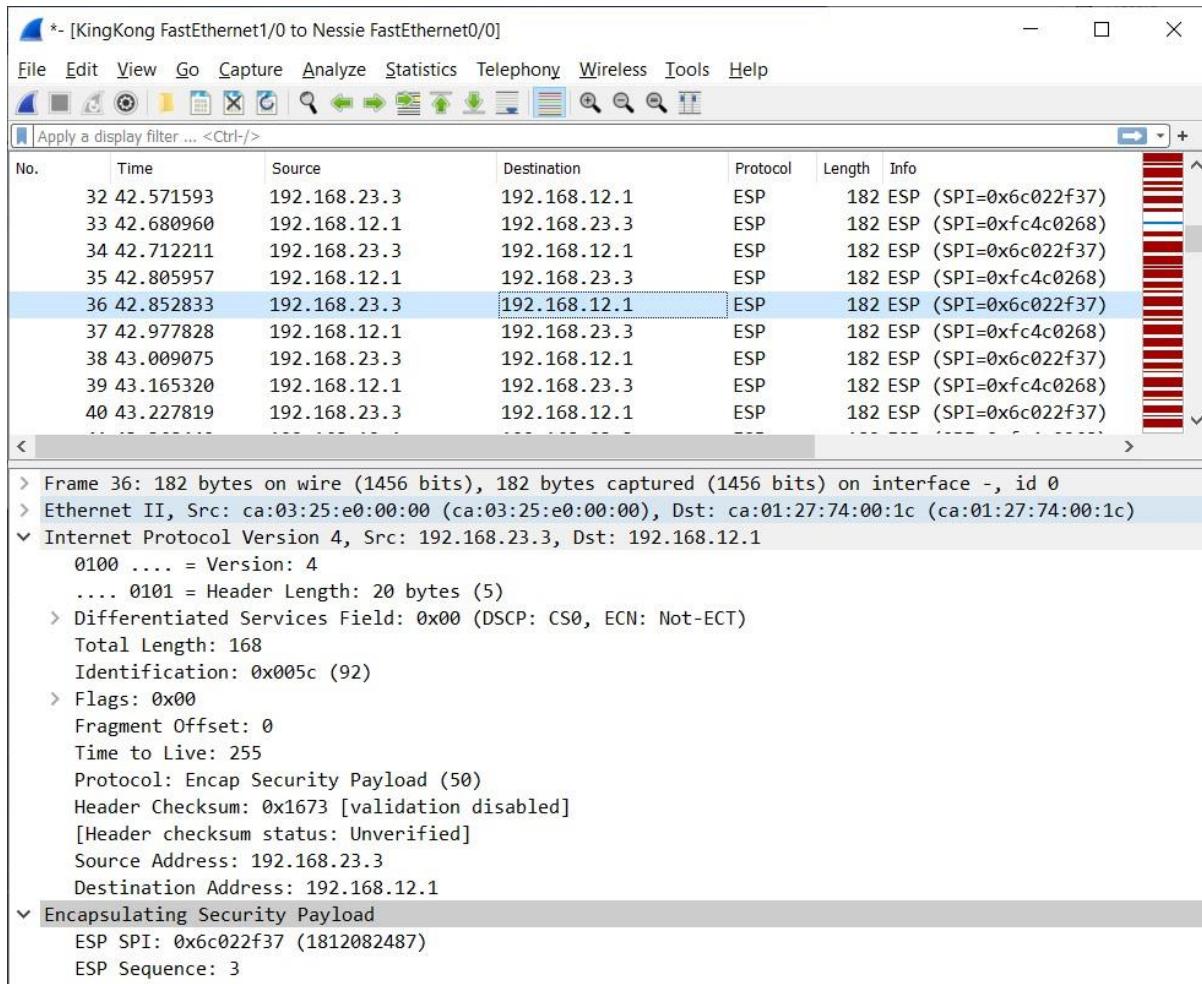


Nessie#show crypto ipsec sa

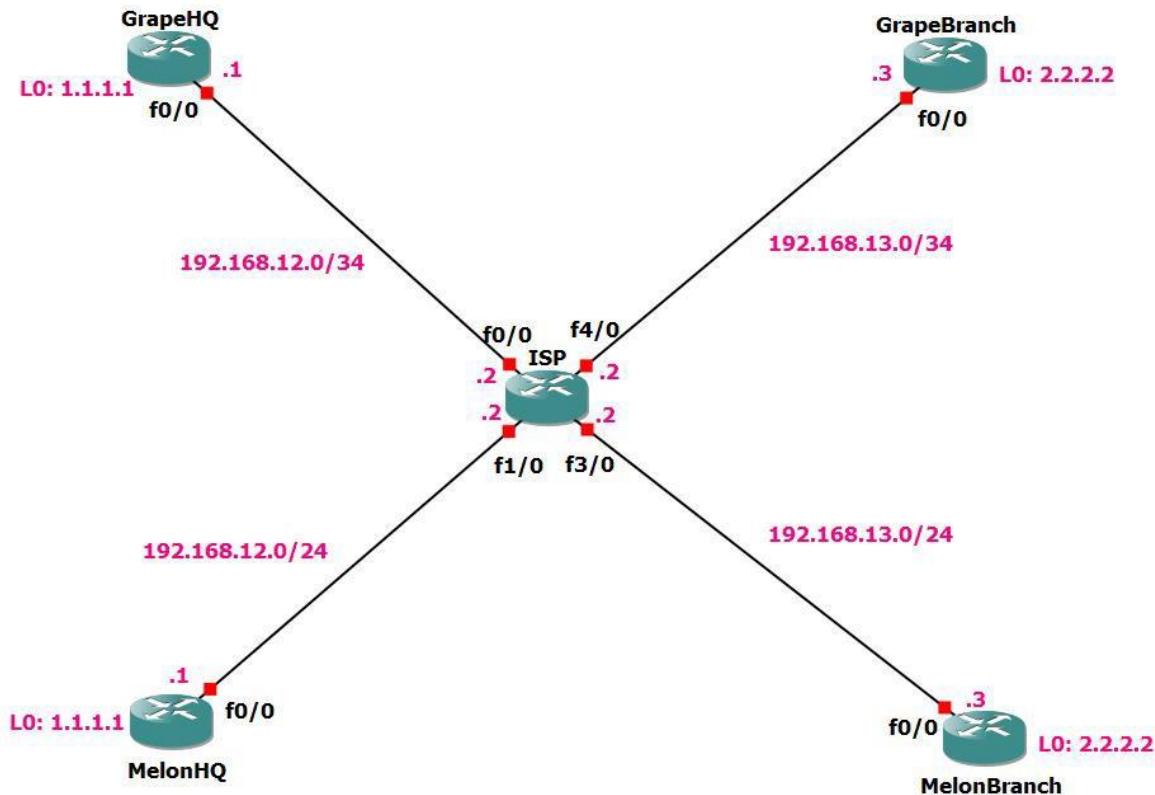
interface: Tunnel13
Crypto map tag: Tunnel13-head-0, local addr 192.168.23.3
protected vrf: (none)
local ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
remote ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
current_peer 192.168.12.1 port 500
PERMIT, flags={origin_is_acl,}
#pkts encaps: 5, #pkts encrypt: 5, #pkts digest: 5
#pkts decaps: 5, #pkts decrypt: 5, #pkts verify: 5
#pkts compressed: 0, #pkts decompressed: 0
#pkts not compressed: 0, #pkts compr. failed: 0
#pkts not decompressed: 0, #pkts decompress failed: 0
#send errors 0, #recv errors 0

local crypto endpt.: 192.168.23.3, remote crypto endpt.: 192.168.12.1
path mtu 1500, ip mtu 1500, ip mtu idb FastEthernet0/0
current outbound spi: 0x6C022F37(1812082487)

inbound esp sas:
spi: 0xFC4C0268(4232839784)
transform: esp-aes esp-sha-hmac ,



Part 2: Implement VRF Lite



VRF-lite is a feature that enables a service provider to support two or more VPNs, where IP addresses can be overlapped among the VPNs. VRF-lite uses input interfaces to distinguish routes for different VPNs and forms virtual packet-forwarding tables by associating one or more Layer 3 interfaces with each VRF.

Steps:

Step 1: Configure all IP and loopback addresses on the customer routers as specified in the topology picture.

```
GrapeHQ#config t
Enter configuration commands, one per line. End with CNTL/Z.
GrapeHQ(config)#interface Loopback0
GrapeHQ(config-if)#ip add 1.1.1.1 255.255.255.0
GrapeHQ(config-if)#exit
GrapeHQ(config)#
GrapeHQ(config)#interface f0/0
GrapeHQ(config-if)#ip add 192.168.12.1 255.255.255.0
GrapeHQ(config-if)#no shutdown
GrapeHQ(config-if)#exit
GrapeHQ(config)#
*Nov 21 20:51:27.787: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
    changed state to up
GrapeHQ(config)#
*Nov 21 20:51:29.107: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
    up
GrapeHQ(config)#
*Nov 21 20:51:29.107: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Admin
istrative State Down
*Nov 21 20:51:30.107: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
    changed state to up
GrapeHQ(config)#

```

```
MelonHQ#config t
Enter configuration commands, one per line. End with CNTL/Z.
MelonHQ(config)#interface Loopback0
MelonHQ(config-if)#ip add 1.1.1.1 255.255.255.0
MelonHQ(config-if)#exit
MelonHQ(config)#
MelonHQ(config)#interface f0/0
MelonHQ(config-if)#ip add 192.168.12.1 255.255.255.0
MelonHQ(config-if)#no shutdown
MelonHQ(config-if)#exit
*Nov 21 20:52:18.863: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
    changed state to up
MelonHQ(config-if)#exit
MelonHQ(config)#
*Nov 21 20:52:20.171: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
    up
MelonHQ(config)#
*Nov 21 20:52:20.171: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Admin
istrative State Down
*Nov 21 20:52:21.171: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
    changed state to up
MelonHQ(config)#

```

```
GrapeBranch#config t
Enter configuration commands, one per line. End with CNTL/Z.
GrapeBranch(config)#interface Loopback0
GrapeBranch(config-if)#ip add 2.2.2.2 255.255.255.0
GrapeBranch(config-if)#exit
GrapeBranch(config)#
GrapeBranch(config)#interface f0/0
GrapeBranch(config-if)#ip add 192.168.13.3 255.255.255.0
GrapeBranch(config-if)#no shutdown
GrapeBranch(config-if)#exit
GrapeBranch(config)#
*Nov 21 20:52:35.307: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
  changed state to up
GrapeBranch(config)#
*Nov 21 20:52:36.587: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
  up
GrapeBranch(config)#
*Nov 21 20:52:36.587: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Admin
istrative State Down
*Nov 21 20:52:37.587: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
  changed state to up
GrapeBranch(config)#

```

```
MelonBranch#config t
Enter configuration commands, one per line. End with CNTL/Z.
MelonBranch(config)#interface Loopback0
MelonBranch(config-if)#ip add 2.2.2.2 255.255.255.0
MelonBranch(config-if)#exit
MelonBranch(config)#
MelonBranch(config)#interface f0/0
MelonBranch(config-if)#ip add 192.168.13.3 255.255.255.0
MelonBranch(config-if)#no shutdown
MelonBranch(config-if)#exit
MelonBranch(config)#
*Nov 21 20:52:56.687: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0,
  changed state to up
*Nov 21 20:52:57.967: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
  up
MelonBranch(config)#
*Nov 21 20:52:57.967: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Admin
istrative State Down
*Nov 21 20:52:58.967: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
  changed state to up
MelonBranch(config)#

```

Step 2: Configure the vrf GRAPE and MELON. Before configuring the ISP router

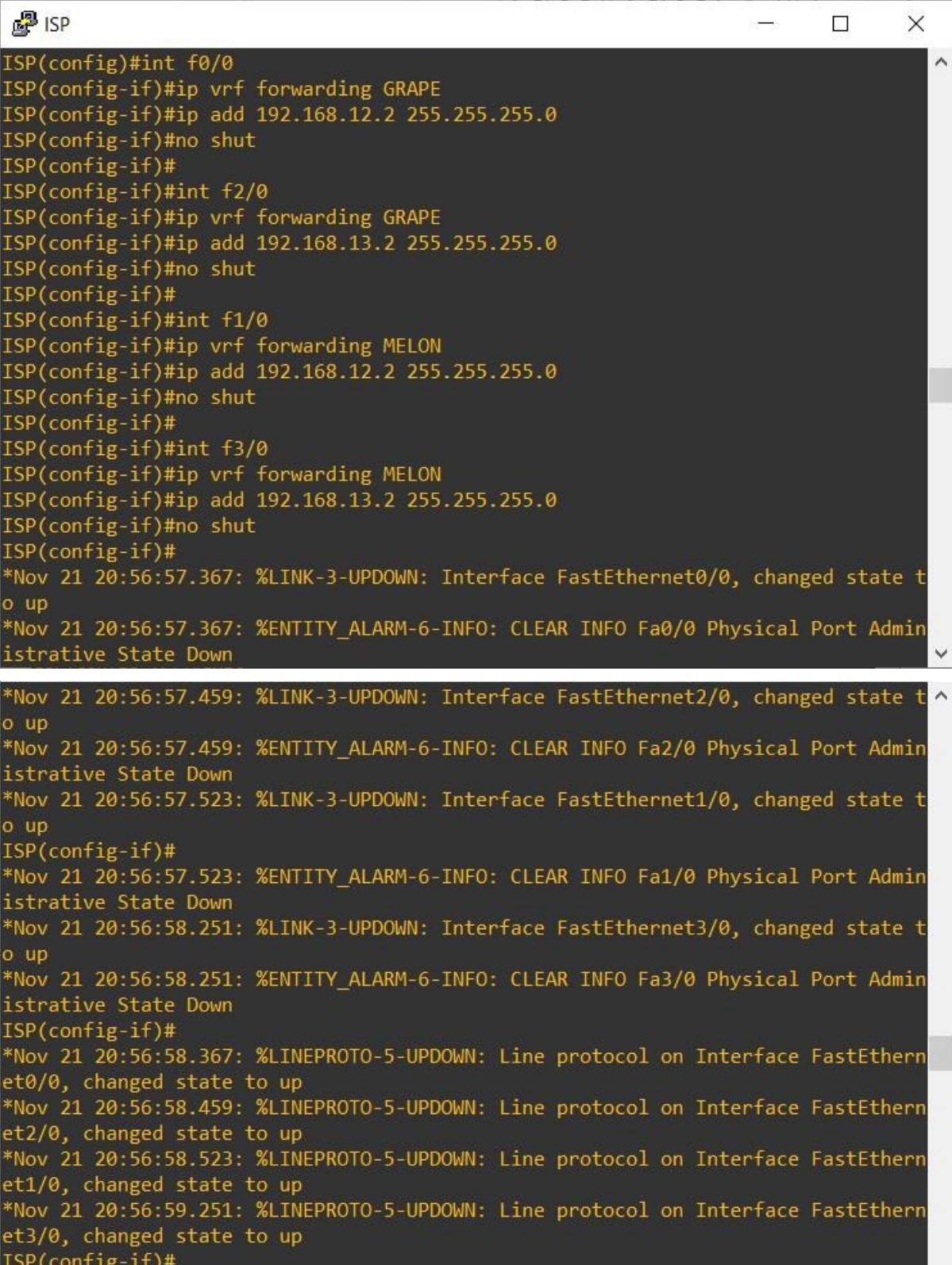
```
ISP#show ip int brief
Interface          IP-Address      OK? Method Status       Prot
FastEthernet0/0    unassigned      YES unset administratively down down
FastEthernet1/0    unassigned      YES unset administratively down down
FastEthernet1/1    unassigned      YES unset administratively down down
FastEthernet2/0    unassigned      YES unset administratively down down
FastEthernet2/1    unassigned      YES unset administratively down down
FastEthernet3/0    unassigned      YES unset administratively down down
FastEthernet3/1    unassigned      YES unset administratively down down
```



```
ISP#config t
Enter configuration commands, one per line. End with CNTL/Z.
ISP(config)#ip vrf GRAPE
ISP(config-vrf)#exit
ISP(config)#
ISP(config)#ip vrf MELON
ISP(config-vrf)#exit
ISP(config)#
ISP#
```

Configure the ISP router so you can ping router MelonHQ and MelonBranch.

Configure the ISP router so you can ping router GrapeHQ and GrapeBranch



```
ISP
ISP(config)#int f0/0
ISP(config-if)#ip vrf forwarding GRAPE
ISP(config-if)#ip add 192.168.12.2 255.255.255.0
ISP(config-if)#no shut
ISP(config-if)#
ISP(config-if)#int f2/0
ISP(config-if)#ip vrf forwarding GRAPE
ISP(config-if)#ip add 192.168.13.2 255.255.255.0
ISP(config-if)#no shut
ISP(config-if)#
ISP(config-if)#int f1/0
ISP(config-if)#ip vrf forwarding MELON
ISP(config-if)#ip add 192.168.12.2 255.255.255.0
ISP(config-if)#no shut
ISP(config-if)#
ISP(config-if)#int f3/0
ISP(config-if)#ip vrf forwarding MELON
ISP(config-if)#ip add 192.168.13.2 255.255.255.0
ISP(config-if)#no shut
ISP(config-if)#
*Nov 21 20:56:57.367: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Nov 21 20:56:57.367: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa0/0 Physical Port Administrative State Down
*Nov 21 20:56:57.459: %LINK-3-UPDOWN: Interface FastEthernet2/0, changed state to up
*Nov 21 20:56:57.459: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa2/0 Physical Port Administrative State Down
*Nov 21 20:56:57.523: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
ISP(config-if)#
*Nov 21 20:56:57.523: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa1/0 Physical Port Administrative State Down
*Nov 21 20:56:58.251: %LINK-3-UPDOWN: Interface FastEthernet3/0, changed state to up
*Nov 21 20:56:58.251: %ENTITY_ALARM-6-INFO: CLEAR INFO Fa3/0 Physical Port Administrative State Down
ISP(config-if)#
*Nov 21 20:56:58.367: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
*Nov 21 20:56:58.459: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
*Nov 21 20:56:58.523: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
*Nov 21 20:56:59.251: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3/0, changed state to up
ISP(config-if)#

```

After configuring the ISP router

ISP

```
ISP(config-if)#do show ip int brief
Interface          IP-Address      OK? Method Status      Prot
octl
FastEthernet0/0    192.168.12.2   YES manual up       up
FastEthernet1/0    192.168.12.2   YES manual up       up
FastEthernet1/1    unassigned     YES unset  administratively down down
FastEthernet2/0    192.168.13.2   YES manual up       up
FastEthernet2/1    unassigned     YES unset  administratively down down
FastEthernet3/0    192.168.13.2   YES manual up       up
FastEthernet3/1    unassigned     YES unset  administratively down down
Serial4/0          unassigned     YES unset  administratively down down
Serial4/1          unassigned     YES unset  administratively down down
Serial4/2          unassigned     YES unset  administratively down down
Serial4/3          unassigned     YES unset  administratively down down
```

Step 3: Configure OSPF Area 0 on GrapeHQ, MelonHQ, MelonBranch and GrapeBranch, to advertise all networks.

GrapeHQ

```
GrapeHQ(config)#router ospf 1
GrapeHQ(config-router)#network 0.0.0.0 255.255.255.255 area 0
GrapeHQ(config-router)#
*Nov 21 20:59:25.179: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.13.2 on FastEtherne
t0/0 from LOADING to FULL, Loading Done
GrapeHQ(config-router)#
GrapeHQ(config-router)#
GrapeHQ(config-router)#exit
GrapeHQ(config)#
GrapeHQ#
*Nov 21 21:02:53.711: %SYS-5-CONFIG_I: Configured from console by console
GrapeHQ#
```

GrapeBranch

```
GrapeBranch(config)#router ospf 1
GrapeBranch(config-router)#network 0.0.0.0 255.255.255.255 area 0
GrapeBranch(config-router)#
*Nov 21 20:59:25.091: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.13.2 on FastEtherne
t0/0 from LOADING to FULL, Loading Done
GrapeBranch(config-router)#

```

MelonHQ

```
MelonHQ(config)#router ospf 1
MelonHQ(config-router)#network 0.0.0.0 255.255.255.255 area 0
MelonHQ(config-router)#
*Nov 21 20:59:25.223: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.12.2 on FastEthernet0/0 from LOADING to FULL, Loading Done
MelonHQ(config-router)#

MelonBranch
```

MelonBranch

```
MelonBranch(config)#router ospf 1
MelonBranch(config-router)#network 0.0.0.0 255.255.255.255 area 0
MelonBranch(config-router)#
*Nov 21 20:59:24.883: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.12.2 on FastEthernet0/0 from LOADING to FULL, Loading Done
MelonBranch(config-router)#

```

Step 4: Configure OSPF Area 0 for vrf GRAPE and MELON on router ISP.

ISP

```
ISP(config-if)#router ospf 1 vrf GRAPE
ISP(config-router)#network 0.0.0.0 255.255.255.255 area 0
ISP(config-router)#exit
ISP(config)#
ISP(config)#router ospf 2 vrf MELON
ISP(config-router)#network 0.0.0.0 255.255.255.255 area 0
ISP(config-router)#exit
ISP#
*Nov 21 20:59:20.803: %SYS-5-CONFIG_I: Configured from console by console
ISP#
*Nov 21 20:59:24.735: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on FastEthernet0/0
from LOADING to FULL, Loading Done
*Nov 21 20:59:24.875: %OSPF-5-ADJCHG: Process 2, Nbr 1.1.1.1 on FastEthernet1/0
from LOADING to FULL, Loading Done
*Nov 21 20:59:24.879: %OSPF-5-ADJCHG: Process 2, Nbr 2.2.2.2 on FastEthernet3/0
from LOADING to FULL, Loading Done
*Nov 21 20:59:24.991: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on FastEthernet2/0
from LOADING to FULL, Loading Done
ISP#
```

Check OSPF neighbor

ISP

```
ISP#show ip ospf neighbor

Neighbor ID      Pri   State          Dead Time     Address       Interface
2.2.2.2           1    FULL/BDR      00:00:36     192.168.13.3  FastEthernet3/
0
1.1.1.1           1    FULL/BDR      00:00:34     192.168.12.1  FastEthernet1/
0
2.2.2.2           1    FULL/BDR      00:00:38     192.168.13.3  FastEthernet2/
0
1.1.1.1           1    FULL/BDR      00:00:30     192.168.12.1  FastEthernet0/
0
ISP#
```

We are not using global routed table you can check it

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

Gateway of last resort is not set

ISP#
```

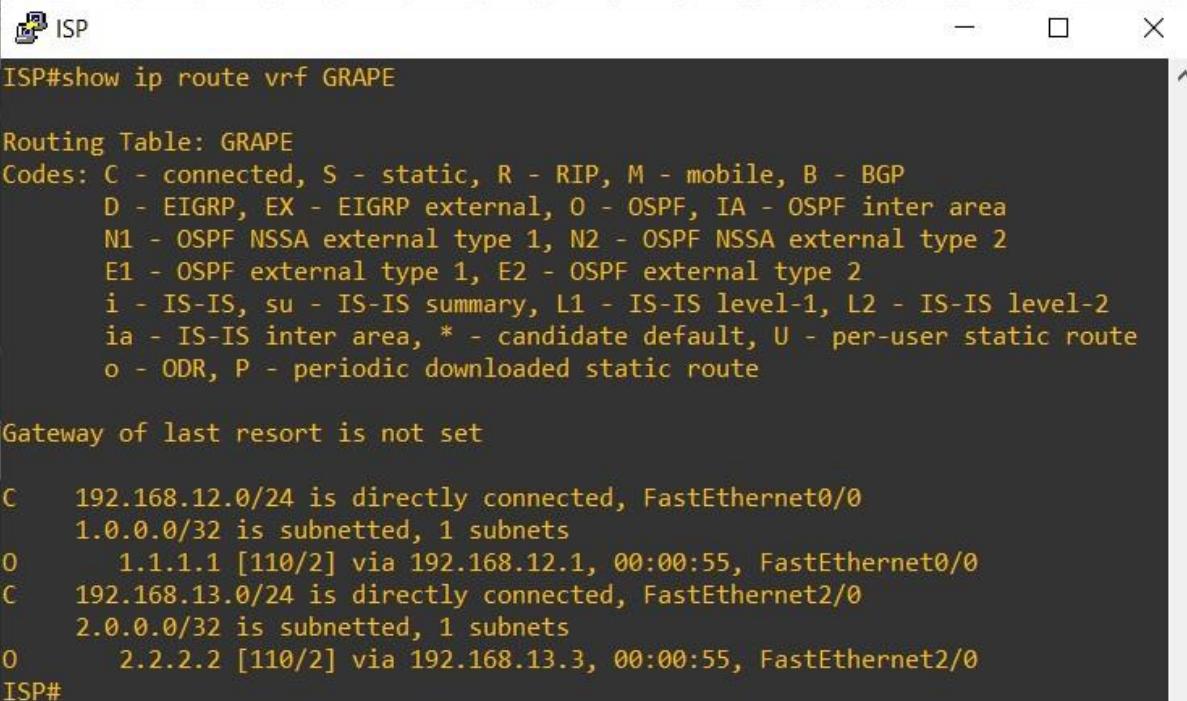
We can see the vrf routes for MELON and GRAPE

```
ISP#show ip route vrf MELON

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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet1/0
    1.0.0.0/32 is subnetted, 1 subnets
O      1.1.1.1 [110/2] via 192.168.12.1, 00:00:47, FastEthernet1/0
C    192.168.13.0/24 is directly connected, FastEthernet3/0
    2.0.0.0/32 is subnetted, 1 subnets
O      2.2.2.2 [110/2] via 192.168.13.3, 00:00:47, FastEthernet3/0
ISP#
```



```

ISP#show ip route vrf GRAPE

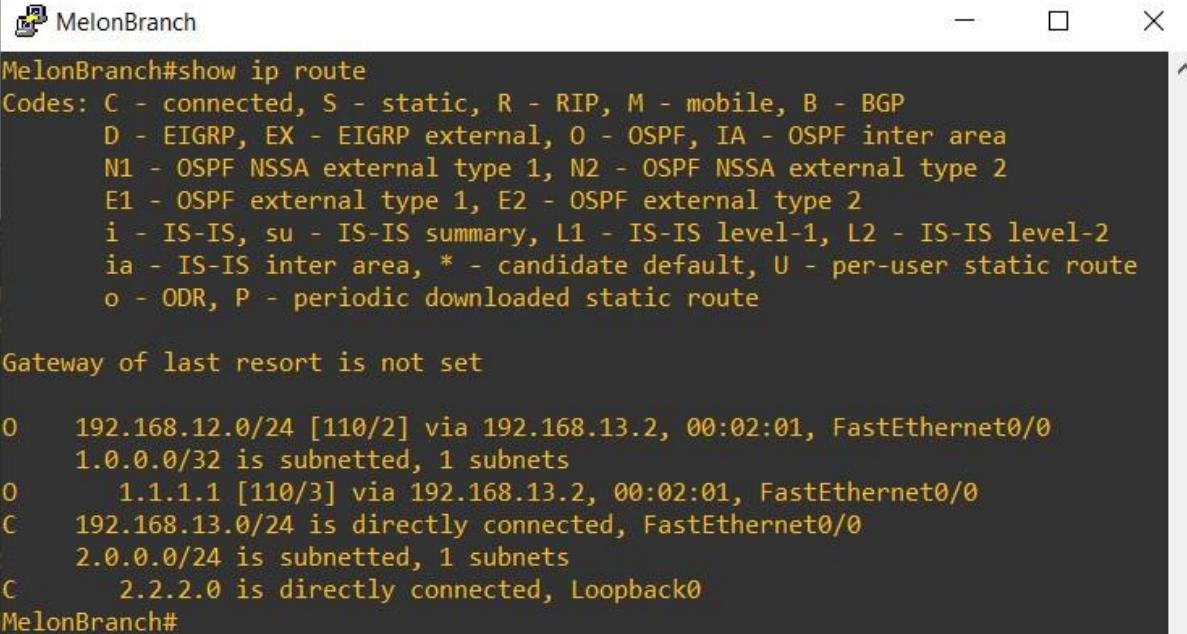
Routing Table: GRAPE
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
    1.0.0.0/32 is subnetted, 1 subnets
O      1.1.1.1 [110/2] via 192.168.12.1, 00:00:55, FastEthernet0/0
C    192.168.13.0/24 is directly connected, FastEthernet2/0
    2.0.0.0/32 is subnetted, 1 subnets
O      2.2.2.2 [110/2] via 192.168.13.3, 00:00:55, FastEthernet2/0
ISP#

```

Step 5: Router MelonHQ and MelonBranch should see each other's loopback networks.



```

MelonBranch#show ip route

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

Gateway of last resort is not set

O    192.168.12.0/24 [110/2] via 192.168.13.2, 00:02:01, FastEthernet0/0
    1.0.0.0/32 is subnetted, 1 subnets
O      1.1.1.1 [110/3] via 192.168.13.2, 00:02:01, FastEthernet0/0
C    192.168.13.0/24 is directly connected, FastEthernet0/0
    2.0.0.0/24 is subnetted, 1 subnets
C      2.2.2.0 is directly connected, Loopback0
MelonBranch#

```

Step 6: Router GrapeHQ and GrapeBranch should see each other's loopback networks.

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

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, FastEthernet0/0
     1.0.0.0/24 is subnetted, 1 subnets
       C    1.1.1.0 is directly connected, Loopback0
O    192.168.13.0/24 [110/2] via 192.168.12.2, 00:03:16, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
       O    2.2.2.2 [110/3] via 192.168.12.2, 00:03:16, FastEthernet0/0
GrapeHQ#
```

```
GrapeHQ#ping 2.2.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 408/444/532 ms
GrapeHQ#
```

```
MelonBranch#ping 1.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 332/544/784 ms
MelonBranch#
```