PRACTICAL e-Journal
MSCIT (PART I) SEMESTER - II
2018-19

SUBJECT
ADVANCED COMPUTER NETWORKS

SUBMITTED BY

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Seat No. 13

Submitted in partial fulfillment of the requirement for
Qualifying
M.Sc. Part I Semester II Examination
2018-19

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CERTIFICATE

This is to certify that Miss SHAIKH SEEMA ABDUL RASHID with Seat No. 13 has successfully completed the necessary course of experiments in the subject of ADVANCED COMPUTER NETWORKS during the academic year 2018 – 2019 complying with the requirements of RAMNIRANJAN JHUNJHUNWALA COLLEGE OF ARTS, SCIENCE AND COMMERCE, for the course of M.Sc. (IT) semester -II.

Internal Examiner Date: _____

Head of Department College Seal External Examiner

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PRACTICAL NUMBER 1
Simulating RIP

Overview of Commands:

Step 1:- Configure all routers.

1) Right click each router and click configure
2) Select r1 and slots and select adapters for slots 0, 1, 2
3) Fill slot 0, slot1, slot 2 and click ok.
4) Do step 1 to 3 for all other routers.

Step 2:- Configure network and RIP for all routers.

interface f0/0
ip address 10.1.1.1 255.255.255.0
no shut

Step 3:- Displaying the interface brief:

#show ip interface brief

Displaying the details about neighbouring devices of all routers:

#show cdp neighbors

Step 4:- Configure RIP for all routers.

router rip
network 10.1.1.0
no auto-summary

Step 5:- Displaying the current configuration of all routers:

R1#show running

Displaying the Routing Table:

R1#show ip route

Step 6:- Performing ping to check connectivity amongst routers:

#ping 10.0.23.1

Step 7:- Configuring RIP Authentication on the Routers:

#key chain acn
#key 1
#key-string rippracts

Configuring the RIP Authentication Mode (MD5) on the interface of routers:

int s0/0
R1(config-if)#ip rip authentication key-chain acn

R1(config-if)#ip rip authentication mode md5

Verifying RIP Authentication mode on the routers:

#debug ip rip

Enabling Split Horizon on the routers:

int s0/0
R4(config-if)#ip split-horizon

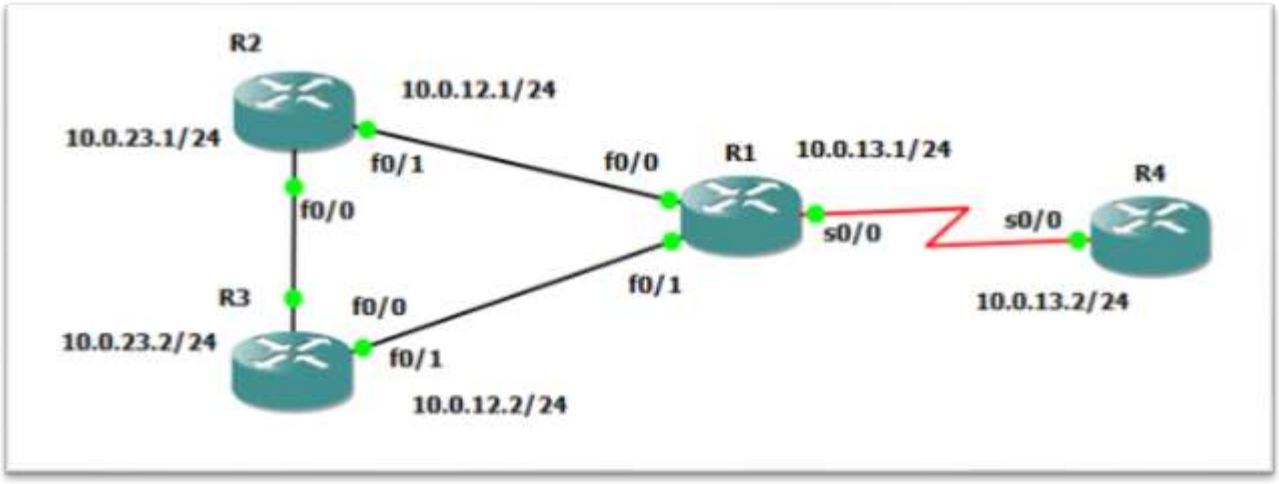
Disabling Split Horizon on the routers:

int s0/0
no ip split-horizon

Configuring Router to send and receive RIP version updates:

int f0/0
R2(config-if)#ip rip receive version 1
R2(config-if)#ip rip send version 2

Topology:-



Assigning IP addresses to R1:

```
R1#en
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 10.0.12.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#
R1(config-if)#int f0/1
R1(config-if)#ip address 10.0.13.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#int
R1(config-if)#int s0/0
R1(config-if)#ip address 20.0.14.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#^Z
R1#exit
```

Assigning IP addresses to R2:

```
R2#en
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip address 10.0.23.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#int
R2(config-if)#int f0/1
R2(config-if)#ip address 10.0.12.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#^Z
R2#exit
```

Assigning IP addresses to R3:

```
R3#en
R3#conf t
R3(config)#int f0/0
R3(config-if)#ip address 10.0.23.2 255.255.255.0
R3(config-if)#no shut
R3(config-if)#int
R3(config-if)#int f0/1
R3(config-if)#ip address 10.0.13.2 255.255.255.0
R3(config-if)#no shut
R3(config-if)#^Z
R3#exit
```

Assigning IP addresses to R4:

```
R4#en
R4#conf t
R4(config)#int s0/0
R4(config-if)#ip address 20.0.14.2 255.255.255.252
R4(config-if)#no shut
R4(config-if)#
R4(config-if)#^Z
R4#exit
```

OUTPUT:

For R1:

```
R1#show ip interface brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 10.0.12.1 YES manual up up
Serial0/0 20.0.14.1 YES manual up up
FastEthernet0/1 10.0.13.1 YES manual up up
Serial0/1 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 unassigned YES unset administratively down down
```

For R2:

```
R2#show ip interface brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 10.0.23.1 YES manual up up
FastEthernet0/1 10.0.12.2 YES manual up up
R2#exit
```

For R3:

```
R3#show ip interface brief
Interface      IP-Address OK?    Method Status  Protocol
FastEthernet0/0 10.0.23.2 YES    manual   up      up
FastEthernet0/1 10.0.13.2 YES    manual   up      up
FastEthernet1/0 unassigned YES unset administratively down down
R3#exit
```

For R4:

```
R4#show ip interface brief
Interface IP-Address OK? Method Status Protocol
FastEthernet0/0 unassigned YES unset administratively down down
Serial0/0 20.0.14.2 YES manual up up
FastEthernet0/1 unassigned YES unset administratively down down
Serial0/1 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 unassigned YES unset administratively down down
R4#exit
```

Displaying the details about neighbouring devices of all routers:

For R1:

```
R1#show cdp neighbors
Device ID Local Intrfce Holdtme Capability Platform Port ID
R2 Fas 0/0 131 R S I 3725 Fas 0/1
R3 Fas 0/1 130 R S I 3725 Fas 0/1
R4 Ser 0/0 131 R S I 3725 Ser 0/0
R1#exit
```

For R2:

```
R2#show cdp neighbors
Device ID Local Intrfce Holdtme Capability Platform Port ID
R3 Fas 0/0 149 R S I 3725 Fas 0/0
R1 Fas 0/1 151 R S I 3725 Fas 0/0
R2#exit
```

For R3:

```
R3#show cdp neighbors
Device ID Local Intrfce Holdtme Capability Platform Port ID
R2 Fas 0/0 120 R S I 3725 Fas 0/0
R1 Fas 0/1 121 R S I 3725 Fas 0/1
R3#exit
```

For R4:

```
R4#show cdp neighbors
Device ID Local Intrfce Holdtme Capability Platform Port ID
R1 Ser 0/0 161 R S I 3725 Ser 0/0
R4#exit
```

Configuring RIP on the routers:

For R1:

```
R1#en
R1#conf t
R1(config)#router rip
R1(config-router)#network 10.0.12.0
R1(config-router)#network 10.0.13.0
R1(config-router)#network 20.0.14.0
R1(config-router)#^Z
R1#exit
```

For R2:

```
R2#en
R2#conf t
R2(config)#router rip
R2(config-router)#network 10.0.23.0
R2(config-router)#network 10.0.12.0
R2(config-router)#^Z
R2#exit
```

For R3:

```
R3#en
R3#conf t
R3(config)#router rip
R3(config-router)#network 10.0.23.0
R3(config-router)#network 10.0.13.0
R3(config-router)#^Z
R3#exit
```

For R4:

```
R4#en
R4#conf t
R4(config)#router rip
R4(config-router)#network 20.0.14.0
R4(config-router)#^Z
R4#exit
```

Displaying the current configuration of all routers:

For R1:

```
R1#show running
Building configuration...
Current configuration : 1409 bytes
!
version 12.3
service timestamps debug datetimemsec
service timestamps log datetimemsec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
!
memory-sizeiomem 5
no network-clock-participate aim 0
no network-clock-participate aim 1
noaaa new-model
ip subnet-zero
noipicmp rate-limit unreachable
ipcef
!
!
iptcpsynwait-time 5
!
!
noip domain lookup
ipipspo max-events 100
no ftp-server write-enable
```

For R2:

```
Press Enter to get the prompt

R2#show running
Building configuration...
Current configuration : 962 bytes
!
version 12.3
service timestamps debug datetimemsec
service timestamps log datetimemsec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
memory-sizeiomem 5
no network-clock-participate aim 0
no network-clock-participate aim 1
noaaa new-model
ip subnet-zero
noipicmp rate-limit unreachable
ipcef
!
!
--More-
```

For R3:

```
R3#show running
Building configuration...
Current configuration : 1040 bytes
!
version 12.3
service timestamps debug datetimemsec
service timestamps log datetimemsec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
!
memory-sizeiomem 5
no network-clock-participate aim 0
no network-clock-participate aim 1
noaaa new-model
ip subnet-zero
noipicmp rate-limit unreachable
ipcef
!
!
--More-
R3#exit
```

For R4:

```
R4#show running
Building configuration...
Current configuration : 1369 bytes
!
version 12.3
service timestamps debug datetimemsec
service timestamps log datetimemsec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
memory-sizeiomem 5
no network-clock-participate aim 0
no network-clock-participate aim 1
noaaa new-model
ip subnet-zero
noipicmp rate-limit unreachable
ipcef
```

Output Routing Tables:

For R1:

```
R1#show ip route
20.0.0.0/30 is subnetted, 1 subnets
C 20.0.14.0 is directly connected, Serial0/0
10.0.0.0/24 is subnetted, 3 subnets
C 10.0.12.0 is directly connected, FastEthernet0/0
C 10.0.13.0 is directly connected, FastEthernet0/1
R 10.0.23.0 [120/1] via 10.0.13.2, 00:00:01, FastEthernet0/1
            [120/1] via 10.0.12.2, 00:00:02, FastEthernet0/0
R1#exit
```

For R2:

```
R2#show ip route
R 20.0.0.0/8 [120/1] via 10.0.12.1, 00:00:02, FastEthernet0/1
10.0.0.0/24 is subnetted, 3 subnets
C 10.0.12.0 is directly connected, FastEthernet0/1
R 10.0.13.0 [120/1] via 10.0.23.2, 00:00:17, FastEthernet0/0
            [120/1] via 10.0.12.1, 00:00:02, FastEthernet0/1
C 10.0.23.0 is directly connected, FastEthernet0/0
R2#exit
```

For R3:

```
R3#show ip route
R 20.0.0.0/8 [120/1] via 10.0.13.1, 00:00:26, FastEthernet0/1
10.0.0.0/24 is subnetted, 3 subnets
R 10.0.12.0 [120/1] via 10.0.23.1, 00:00:06, FastEthernet0/0
[120/1] via 10.0.13.1, 00:00:26, FastEthernet0/1
C 10.0.13.0 is directly connected, FastEthernet0/1
C 10.0.23.0 is directly connected, FastEthernet0/0
R3#exit
```

For R4:

```
R4#show ip route
20.0.0.0/30 is subnetted, 1 subnets
C 20.0.14.0 is directly connected, Serial0/0
R 10.0.0.0/8 [120/1] via 20.0.14.1, 00:00:06, Serial0/0
R4#exit
```

Performing ping to check connectivity amongst routers:

For R1:

```
R1#ping 10.0.23.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.23.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
332/368/420 ms
R1#ping 10.0.23.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.23.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
372/388/436 ms
R1#exit
```

For R2:

```
R2#ping 20.0.14.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.0.14.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
332/552/796 ms
R2#exit
```

For R3:

```
R3#ping 20.0.14.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.0.14.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
420/462/512 ms
R3#exit
```

For R4:

```
R4#ping 10.0.13.0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.13.0, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
216/244/280 ms
R4#exit
```

Configuring the RIP Authentication Mode (MD5) on the interface of routers:

For R1:

```
R1#en
R1#conf t
R1(config)#int s0/0
R1(config-if)#ip rip authentication key-chain acn
R1(config-if)#ip rip authentication mode md5
R1(config-if)#^Z
R1#exit
```

For R4:

```
R4#en
R4#conf t
R4(config)#int s0/0
R4(config-if)#ip rip authentication key-chain acn
R4(config-if)#ip rip authentication mode md5
R4(config-if)#^Z
R4#exit
```

Configuring the RIP Authentication Mode (Text [default]) on the interface of routers:

For R2:

```
R2#en
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip rip authentication key-chain acn1
R2(config-if)#^Z
R2#exit
```

For R3:

```
R3#en
R3#conf t
R3(config)#int f0/0
R3(config-if)#ip rip authentication key-chain acn1
R3(config-if)#^Z
R3#exit
```

Verifying RIP Authentication mode on the routers:

For R2:

```
R2#debug ip rip
RIP protocol debugging is on
R2#
*Mar 3 02:11:29.351: RIP: received v2 update from 10.0.12.1 on
FastEthernet0/0
*Mar 3 02:11:29.351: 10.0.13.0/24 via 0.0.0.0 in 1 hops
*Mar 3 02:11:29.355: 20.0.14.0/30 via 0.0.0.0 in 1 hops
R2#
*Mar 3 02:11:35.151: RIP: sending v2 update to 224.0.0.9 via
FastEthernet0/0 (10.0.12.2)
*Mar 3 02:11:35.151: RIP: build update entries
*Mar 3 02:11:35.151: 10.0.23.0/24 via 0.0.0.0, metric 1, tag 0
R2#
*Mar 3 02:11:39.079: RIP: received packet with text authentication
rippracts1
*Mar 3 02:11:39.079: RIP: received v2 update from 10.0.23.2 on
FastEthernet0/1
*Mar 3 02:11:39.079: 10.0.13.0/24 via 0.0.0.0 in 1 hops
*Mar 3 02:11:39.083: 20.0.14.0/30 via 0.0.0.0 in 2 hops
```

For R3:

```
R3#debug ip rip
RIP protocol debugging is on
R3#
*Mar 1 02:20:46.083: RIP: sending v1 update to 255.255.255.255 via
FastEthernet0/1 (10.0.13.2)
*Mar 1 02:20:46.083: RIP: build update entries
*Mar 1 02:20:46.083: subnet 10.0.23.0 metric 1
R3#
*Mar 1 02:20:49.699: RIP: sending v1 update to 255.255.255.255 via
FastEthernet0/0 (10.0.23.2)
*Mar 1 02:20:49.699: RIP: build update entries
*Mar 1 02:20:49.699: subnet 10.0.13.0 metric 1
*Mar 1 02:20:49.699: network 20.0.0.0 metric 2
*Mar 1 02:20:50.103: RIP: received v1 update from 10.0.13.1 on
FastEthernet0/1
*Mar 1 02:20:50.103: 10.0.12.0 in 1 hops
*Mar 1 02:20:50.107: 20.0.0.0 in 1 hops
R3#
*Mar 1 02:21:03.739: RIP: received packet with text authentication
rippracts1
*Mar 1 02:21:03.739: RIP: received v2 update from 10.0.23.1 on
FastEthernet0/0
*Mar 1 02:21:03.739: 10.0.12.0/24 via 0.0.0.0 in 1 hops
*Mar 1 02:21:03.743: 20.0.0.0/8 via 0.0.0.0 in 2 hops
R3#
*Mar 1 02:21:14.739: RIP: sending v1 update to 255.255.255.255 via
FastEthernet0/1 (10.0.13.2)
*Mar 1 02:21:14.739: RIP: build update entries
*Mar 1 02:21:14.739: subnet 10.0.23.0 metric 1
R3#
```

```
R3#
*Mar 1 02:21:17.327: RIP: received v1 update from 10.0.13.1 on
FastEthernet0/1
*Mar 1 02:21:17.327: 10.0.12.0 in 1 hops
*Mar 1 02:21:17.327: 20.0.0.0 in 1 hops
*Mar 1 02:21:17.911: RIP: sending v1 update to 255.255.255.255 via
FastEthernet0/0 (10.0.23.2)
*Mar 1 02:21:17.911: RIP: build update entries
*Mar 1 02:21:17.911: subnet 10.0.13.0 metric 1
*Mar 1 02:21:17.911: network 20.0.0.0 metric 2
R3#
*Mar 1 02:21:29.947: RIP: received packet with text authentication
rippracts1
*Mar 1 02:21:29.947: RIP: received v2 update from 10.0.23.1 on
FastEthernet0/0
*Mar 1 02:21:29.951: 10.0.12.0/24 via 0.0.0.0 in 1 hops
*Mar 1 02:21:29.951: 20.0.0.0/8 via 0.0.0.0 in 2 hops
R3#undebug all
All possible debugging has been turned off
R3#exit
```

For R4:

```
R4#debug ip rip
RIP protocol debugging is on
R4#
*Mar 1 00:41:40.403: RIP: sending v2 update to 224.0.0.9 via Serial0/0
(20.0.14.2)
*Mar 1 00:41:40.403: RIP: build update entries - suppressing null update
R4#
*Mar 1 00:41:51.587: RIP: received packet with MD5 authentication
*Mar 1 00:41:51.587: RIP: received v2 update from 20.0.14.1 on Serial0/0
*Mar 1 00:41:51.587: 10.0.12.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:41:51.591: 10.0.13.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:41:51.591: 10.0.23.0/24 via 0.0.0.0 in 2 hops
R4#
*Mar 1 00:42:08.695: RIP: sending v2 update to 224.0.0.9 via Serial0/0
(20.0.14.2)
*Mar 1 00:42:08.695: RIP: build update entries - suppressing null update
R4#
*Mar 1 00:42:17.211: RIP: received packet with MD5 authentication
*Mar 1 00:42:17.211: RIP: received v2 update from 20.0.14.1 on Serial0/0
*Mar 1 00:42:17.211: 10.0.12.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:42:17.215: 10.0.13.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:42:17.215: 10.0.23.0/24 via 0.0.0.0 in 2 hops
R4#
*Mar 1 00:42:38.491: RIP: sending v2 update to 224.0.0.9 via Serial0/0
(20.0.14.2)
*Mar 1 00:42:38.491: RIP: build update entries - suppressing null update
R4#
*Mar 1 00:42:46.447: RIP: received packet with MD5 authentication
*Mar 1 00:42:46.447: RIP: received v2 update from 20.0.14.1 on Serial0/0
*Mar 1 00:42:46.447: 10.0.12.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:42:46.451: 10.0.13.0/24 via 0.0.0.0 in 1 hops
*Mar 1 00:42:46.451: 10.0.23.0/24 via 0.0.0.0 in 2 hops
```

Enabling Split Horizon on the routers:
For R4:
R4#en
R4#conf t
R4(config)#int s0/0
R4(config-if)#ip split-horizon
R4(config-if)#^Z
R4#exit

Disabling Split Horizon on the routers:
For R4:
R4#en
R4#conf t
R4(config)#int s0/0
R4(config-if)#no ip split-horizon
R4(config-if)#^Z
R4#exit

Configuring Router to send and receive RIP version updates:
For R2:

```
R2#en
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip rip receive version 1
R2(config-if)#ip rip send version 2
R2(config-if)#
R2(config-if)#^Z
R2#exit
```

PRACTICAL NUMBER 2
Simulating OSPF

Practical 2A: Simulating OSPF in Broadcast Routers Using a topology of five routers as shown in the below picture.

OVERVIEW OF COMMANDS

Step 1:- Assigning IP addresses to R1

config)#int f0/0
R1(config-if)#ip address 10.0.12.1 255.255.255.0
R1(config-if)#no shut

Configuring OSPF on the routers

R1(config)#router ospf 1
R1(config-router)#network 10.0.12.0 0.0.0.255 area 0
R1(config-router)#network 10.0.13.0 0.0.0.255 area 0
R1(config-router)#^Z

Displaying the details about neighbouring devices of all routers:
R1#show ip ospf neighbor

Routing Table of all routers:
R1#show ip route

Performing ping to check connectivity amongst routers:
R1#ping 20.0.24.2

Specifying Router Priority for DR and BDR Election (R1 is the DR for interface f0/1 with highest of priority 255):

int f0/0
R1(config-if)#ip ospf priority 0
R1(config-if)#!
R1(config-if)#int f0/1
R1(config-if)#ip ospf priority 255

Displaying Interface Data Structure of interface 0/1 of R2 and interface 0/1 of R3:

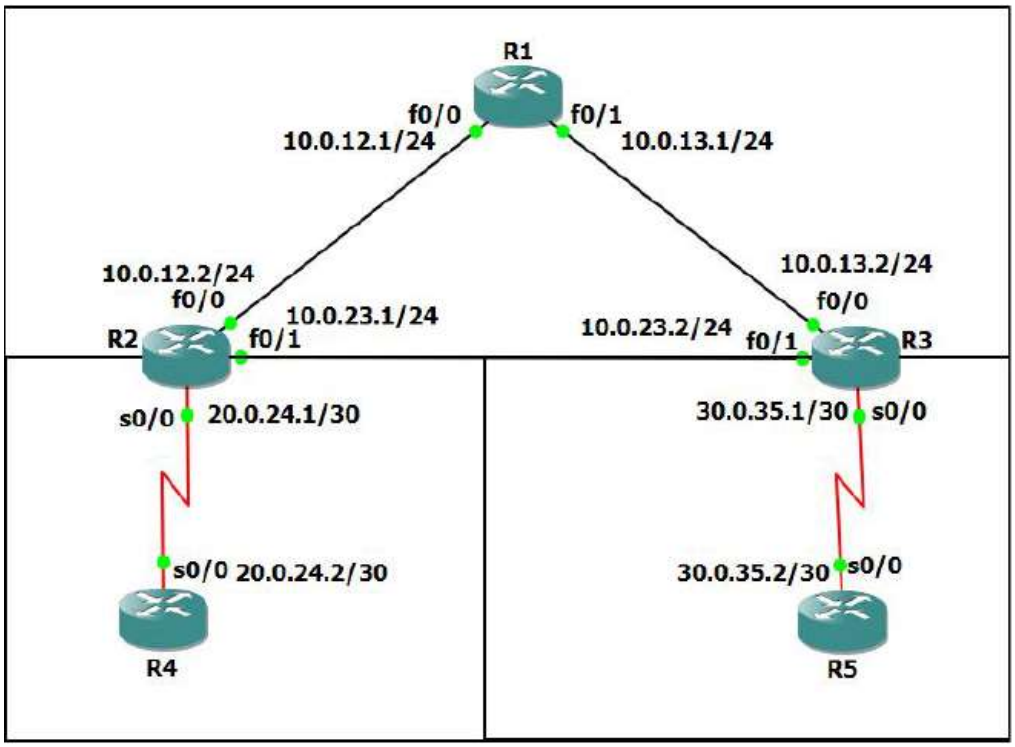
R2#show ip ospf int f0/1

Changing Hello and Dead Interval of the routers:

interface fastethernet0/1
R2(config-if)#ip ospf hello-interval 9

Displaying Interface Data Structure of interface 0/1 of R2 and interface 0/1 of R3 after changing the hello and dead intervals of interface 0/1 of R2 and interface 0/1 of R3.

```
R2#show ip ospf int f0/1
```



Assigning IP addresses to R1:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 10.0.12.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int f0/1
Router(config-if)#ip address 10.0.13.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R2:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 10.0.12.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int
Router(config-if)#int f0/1
Router(config-if)#ip address 10.0.23.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int
Router(config-if)#int s0/0
Router(config-if)#ip address 20.0.24.1 255.255.255.252
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R3:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 10.0.13.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int
Router(config-if)#int f0/1
Router(config-if)#ip address 10.0.23.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int s
Router(config-if)#int s0/0
Router(config-if)#ip address 30.0.35.1 255.255.255.252
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R4:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 20.0.24.2 255.255.255.252
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R5:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 30.0.35.2 255.255.255.252
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Configuring OSPF on the routers:

For R1:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 10.0.12.0 0.0.0.255 area 0
Router(config-router)#network 10.0.13.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

For R2:

```
Router#en
Router#conf t
Router(config-router)#router ospf 1
Router(config-router)#network 10.0.12.0 0.0.0.255 area 0
Router(config-router)#network 10.0.23.0 0.0.0.255 area 0
Router(config-router)#network 20.0.24.0 0.0.0.3 area 4
Router(config-router)#^Z
Router#exit
```

For R3:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 10.0.13.0 0.0.0.255 area 0
Router(config-router)#network 10.0.13.0 0.0.0.255 area 0
Router(config-router)#network 10.0.23.0 0.0.0.255 area 0
Router(config-router)#network 10.0.23.0 0.0.0.255 area 5
Router(config-router)#network 30.0.35.0 0.0.0.3 area 5
Router(config-router)#^Z
Router#exit
```

For R4:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 20.0.24.0 0.0.0.3 area 4
Router(config-router)#
Router(config-router)#^Z
Router#exit
```

For R5:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 30.0.35.0 0.0.0.3 area 5
Router(config-router)#^Z
Router#exit
```

Displaying the details about neighbouring devices of all routers:

For R1:

```
Router              #show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
30.0.35.1 1 FULL/BDR 00:00:32 10.0.13.2 FastEthernet0/1
20.0.24.1 1 FULL/BDR 00:00:31 10.0.12.2 FastEthernet0/0
```

For R2:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
30.0.35.1 1 FULL/BDR 00:00:30 10.0.23.2 FastEthernet0/1
10.0.13.1 1 FULL/DR 00:00:39 10.0.12.1 FastEthernet0/0
20.0.24.2 0 FULL/ - 00:00:31 20.0.24.2 Serial0/0
```

For R3:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
20.0.24.1 1 FULL/DR 00:00:37 10.0.23.1 FastEthernet0/1
10.0.13.1 1 FULL/DR 00:00:37 10.0.13.1 FastEthernet0/0
30.0.35.2 0 FULL/ - 00:00:37 30.0.35.2 Serial0/0
```

For R4:

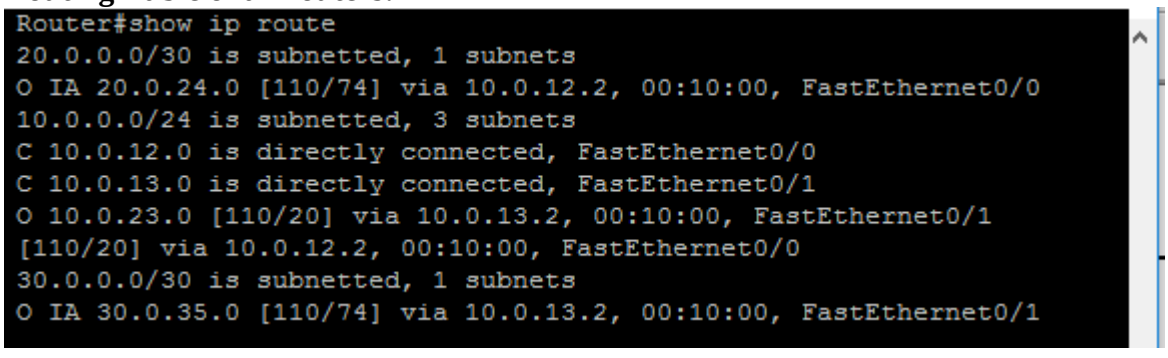
```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
20.0.24.1 0 FULL/ - 00:00:36 20.0.24.1 Serial0/0
```

For R5:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
30.0.35.1 0 FULL/ - 00:00:31 30.0.35.1 Serial0/0
```

OUTPUT:

Routing Table of all routers:



```
Router#show ip route
20.0.0.0/30 is subnetted, 1 subnets
C 20.0.24.0 is directly connected, Serial0/0
10.0.0.0/24 is subnetted, 3 subnets
C 10.0.12.0 is directly connected, FastEthernet0/0
O 10.0.13.0 [110/20] via 10.0.23.2, 00:13:15, FastEthernet0/1
[110/20] via 10.0.12.1, 00:13:15, FastEthernet0/0
C 10.0.23.0 is directly connected, FastEthernet0/1
30.0.0.0/30 is subnetted, 1 subnets
O IA 30.0.35.0 [110/74] via 10.0.23.2, 00:13:15, FastEthernet0/1
```

```
Router#show ip route
20.0.0.0/30 is subnetted, 1 subnets
O IA 20.0.24.0 [110/74] via 10.0.23.1, 00:11:05, FastEthernet0/1
10.0.0.0/24 is subnetted, 3 subnets
O 10.0.12.0 [110/20] via 10.0.23.1, 00:11:05, FastEthernet0/1
[110/20] via 10.0.13.1, 00:11:05, FastEthernet0/0
C 10.0.13.0 is directly connected, FastEthernet0/0
C 10.0.23.0 is directly connected, FastEthernet0/1
30.0.0.0/30 is subnetted, 1 subnets
C 30.0.35.0 is directly connected, Serial0/0
```

```
Router#show ip route
20.0.0.0/30 is subnetted, 1 subnets
C 20.0.24.0 is directly connected, Serial0/0
10.0.0.0/24 is subnetted, 3 subnets
O IA 10.0.12.0 [110/74] via 20.0.24.1, 00:27:44, Serial0/0
O IA 10.0.13.0 [110/84] via 20.0.24.1, 00:46:49, Serial0/0
O IA 10.0.23.0 [110/74] via 20.0.24.1, 00:12:04, Serial0/0
30.0.0.0/30 is subnetted, 1 subnets
O IA 30.0.35.0 [110/138] via 20.0.24.1, 00:12:09, Serial0/0
```

```
Router#show ip route
20.0.0.0/30 is subnetted, 1 subnets
O IA 20.0.24.0 [110/138] via 30.0.35.1, 00:12:23, Serial0/0
10.0.0.0/24 is subnetted, 3 subnets
O IA 10.0.12.0 [110/84] via 30.0.35.1, 00:27:58, Serial0/0
O IA 10.0.13.0 [110/74] via 30.0.35.1, 00:45:11, Serial0/0
O IA 10.0.23.0 [110/74] via 30.0.35.1, 00:12:18, Serial0/0
30.0.0.0/30 is subnetted, 1 subnets
C 30.0.35.0 is directly connected, Serial0/0
```

Performing ping to check connectivity amongst routers:

For R1:

```
Router#ping 20.0.24.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.0.24.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 780/927/
1080 ms
```

For R2:

```
Router#ping 30.0.35.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 30.0.35.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1188/927/
1080 ms
```

For R3:

```
Router#ping 20.0.24.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.0.24.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 608/632/
660 ms
```

For R4:

```
Router#ping 10.0.13.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.13.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 716/813/
920 ms
```

For R5:

```
Router#ping 10.0.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
936/1032/1076 ms
```

Specifying Router Priority for DR and BDR Election (R1 is the DR for interface f0/1 with highest of priority 255):

For R1:

Router#en

```
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip ospf priority 0
Router(config-if)#!
Router(config-if)#int f0/1
Router(config-if)#ip ospf priority 255
Router(config-if)#^Z
Router#exit
```

Displaying Interface Data Structure of interface 0/1 of R2 and interface 0/1 of R3:

For R2:

```
Router#show ip ospf int f0/1
FastEthernet0/1 is up, line protocol is up
Internet Address 10.0.23.1/24, Area 0
Process ID 2, Router ID 20.0.24.1, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 20.0.24.1, Interface address 10.0.23.1
Backup Designated router (ID) 30.0.35.1, Interface address 10.0.23.2
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
oob-resync timeout 40
Hello due in 00:00:05
Supports Link-local Signaling (LLS)
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Adjacent with neighbor 30.0.35.1 (Backup Designated Router)
Suppress hello for 0 neighbor(s)
```

For R3:

```
Router#show ip ospf int f0/1
FastEthernet0/1 is up, line protocol is up
Internet Address 10.0.23.2/24, Area 0
Process ID 1, Router ID 30.0.35.1, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 20.0.24.1, Interface address 10.0.23.1
Backup Designated router (ID) 30.0.35.1, Interface address 10.0.23.2
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
oob-resync timeout 40
Hello due in 00:00:08
Supports Link-local Signaling (LLS)
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 20.0.24.1 (Designated Router)
Suppress hello for 0 neighbor(s)
```

Changing Hello and Dead Interval of the routers:

For R2:

```
Router#en
Router#conf t
Router(config)#interface fastethernet0/1
Router(config-if)#ip ospf hello-interval 9
Router(config-if)#^Z
Router#exit
```

For R3:

```
Router#en
Router#conf t
Router(config)#interface fastethernet0/1
Router(config-if)#ip ospf hello-interval 9
Router(config-if)#^Z
Router#exit
```

Displaying Interface Data Structure of interface 0/1 of R2 and interface 0/1 of R3 after changing the hello and dead intervals of interface 0/1 of R2 and interface 0/1 of R3.

For R2:

```
Router#show ip ospf int f0/1
FastEthernet0/1 is up, line protocol is up
Internet Address 10.0.23.1/24, Area 0
Process ID 2, Router ID 20.0.24.1, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 30.0.35.1, Interface address 10.0.23.2
Backup Designated router (ID) 20.0.24.1, Interface address 10.0.23.1
Flush timer for old DR LSA due in 00:02:49
Timer intervals configured, Hello 9, Dead 36, Wait 36, Retransmit 5
Hello due in 00:00:05
Supports Link-local Signaling (LLS)
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 4 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 30.0.35.1 (Designated Router)
Suppress hello for 0 neighbor(s)
```

For R3:

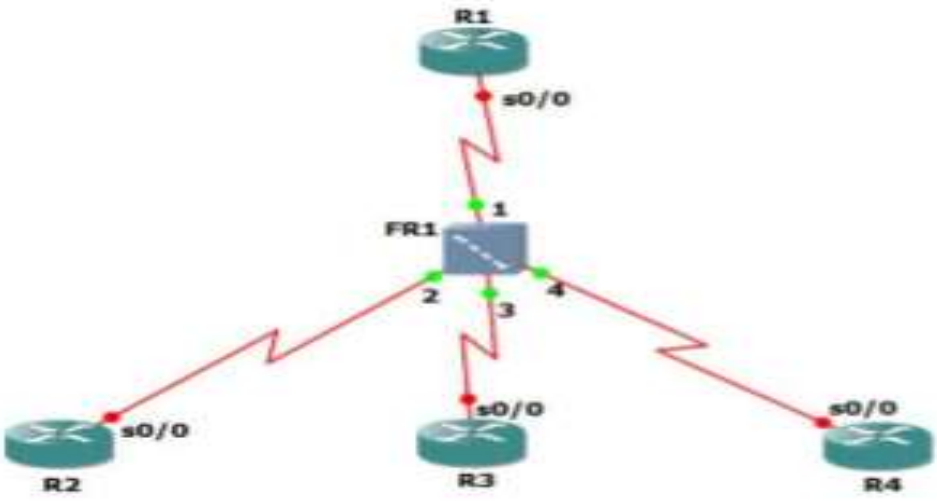
```
Router#show ip ospf int f0/1
FastEthernet0/1 is up, line protocol is up
Internet Address 10.0.23.2/24, Area 0
Process ID 1, Router ID 30.0.35.1, Network Type BROADCAST, Cost: 10
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 30.0.35.1, Interface address 10.0.23.2
Backup Designated router (ID) 20.0.24.1, Interface address 10.0.23.1
```

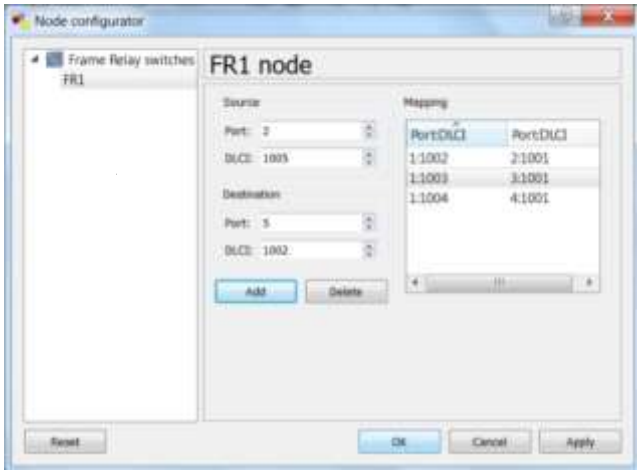
Timer intervals configured, **Hello 9, Dead 36**, Wait 36, Retransmit 5
oob-resync timeout 40
Hello due in 00:00:08
Supports Link-local Signaling (LLS)
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
Adjacent with neighbor 20.0.24.1 (Backup Designated Router)
Suppress hello for 0 neighbor(s

Practical 2B: Simulating OSPF in Non-Broadcast Routers

- Drag and drop a ***"Frame Relay switch"*** on a new project window in GNS3.
- It asks for configuration for the FR1 node (Frame Relay switch).
- Here, router R1 is connected to all the other 3 routers (R2, R3 & R4) via the FR1 switch.
- First Mapping can be seen in the following window.
- Click on ***"Add"*** button after giving the "Port" and "DLCI" values to add the mapping to the list.

Topology:





Configuring OSPF on all the routers

```
#int s0/0
#ip address 10.0.0.1 255.255.255.248
#encapsulation frame-relay
#ip ospf network non-broadcast
#ip ospf priority 100
#frame-relay map ip 10.0.0.2 1002
#no shut
#exit
#router ospf 1
#network 10.0.0.0 0.0.0.7 area 0
#neighbor 10.0.0.2
#^Z
```

Displaying the details about neighbouring devices of all routers:

```
R1#show ip ospf neighbor
```

Performing ping to check connectivity amongst routers:

```
#ping 10.0.0.2
```

Configuring OSPF on all the routers:

For R1:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 10.0.0.1 255.255.255.248
Router(config-if)#encapsulation frame-relay
Router(config-if)#ip ospf network non-broadcast
Router(config-if)#ip ospf priority 100
Router(config-if)#frame-relay map ip 10.0.0.2 1002
```

```
Router(config-if)#frame-relay map ip 10.0.0.3 1003
Router(config-if)#frame-relay map ip 10.0.0.4 1004
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#router ospf 1
Router(config-router)#network 10.0.0.0 0.0.0.7 area 0
Router(config-router)#neighbor 10.0.0.2
Router(config-router)#neighbor 10.0.0.3
Router(config-router)#neighbor 10.0.0.4
Router(config-router)#^Z
Router#exit
```

For R2:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 10.0.0.2 255.255.255.248
Router(config-if)#encapsulation frame-relay
Router(config-if)#ip ospf network non-broadcast
Router(config-if)#ip ospf priority 0
Router(config-if)#frame-relay map ip 10.0.0.1 1001
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#router ospf 1
Router(config-router)#network
Router(config-router)#network 10.0.0.0 0.0.0.7 area 0
Router(config-router)#neighbor 10.0.0.1
Router(config-router)#^Z
Router#exit
```

For R3:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 10.0.0.3 255.255.255.248
Router(config-if)#encapsulation frame-relay
Router(config-if)#ipospf network non-broadcast
Router(config-if)#ipospf priority 0
Router(config-if)#frame-relay map ip 10.0.0.1 1001
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#router ospf 1
Router(config-router)#network 10.0.0.0 0.0.0.7 area 0
Router(config-router)#neighbor 10.0.0.1
Router(config-router)#^Z
Router#exit
```

For R4:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 10.0.0.4 255.255.255.248
Router(config-if)#encapsulation frame-relay
Router(config-if)#ip ospf network non-broadcast
Router(config-if)#ip ospf priority 0
Router(config-if)#frame-relay map ip 10.0.0.1 1001
Router(config-if)#no shut
Router(config-if)#exit
Router(config)#router ospf 1
Router(config-router)#network 10.0.0.0 0.0.0.7 area 0
Router(config-router)#neighbor 10.0.01
Router(config-router)#neighbor 10.0.0.1
Router(config-router)#^Z
Router#exit
```

Displaying the details about neighbouring devices of all routers:
For R1:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
10.0.0.2 0 FULL/DROTHER 00:01:48 10.0.0.2 Serial0/0
10.0.0.3 0 FULL/DROTHER 00:01:55 10.0.0.3 Serial0/0
10.0.0.4 0 FULL/DROTHER 00:01:46 10.0.0.4 Serial0/0
```

For R2:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
10.0.0.1 100 FULL/DR 00:01:51 10.0.0.1 Serial0/0
```

For R3:

```
Router#show ipospf neighbor
Neighbor ID Pri State Dead Time Address Interface
10.0.0.1 100 FULL/DR 00:01:54 10.0.0.1 Serial0/0
```

For R4:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
10.0.0.1 100 FULL/DR 00:01:43 10.0.0.1 Serial0/0
```

Performing ping to check connectivity amongst routers:

```
Router#ping 10.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
112/222/268 ms
Router#ping 10.0.0.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
156/241/404 ms
Router#ping 10.0.0.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
124/251/404 ms
```

```
Router#ping 10.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
184/272/408 ms
```

```
Router#ping 10.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
140/232/440 ms
```

```
Router#ping 10.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
204/281/344 ms
```

PRACTICAL NUMBER 3
Simulating OSPF with STUB AREA, NSSA, Restricting LSA's

OVERVIEW OF COMMANDS:

Assigning IP address and Loopback Interfaces to router R1:

```
R1(config)#int s0/0
R1(config-if)#ip address 10.1.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#int loopback0
R1(config-if)#ip address 10.1.2.1 255.255.255.0
R1(config-if)#ip address 10.1.2.1 255.255.255.0
R1(config-if)#no shut
```

Configuring OSPF on routers R1, R2, R4 and R5:

```
R1#en
R1#conf t
R1(config)#router ospf 1
R1(config-router)#network 10.1.1.0 0.0.0.255 area 1
R1(config-router)#^Z
R1#exit
```

Configuring RIP and OSPF on R3:

```
R3(config)#router rip
R3(config-router)#network 99.9.1.0
R3(config-router)#network 99.9.2.0
R3(config-router)#network 99.9.3.0
R3(config-router)#network 99.9.4.0
R3(config-router)#network 99.9.5.0
R3(config-router)#exit
```

Displaying Routing tables of all routers:

```
R1#show ip route
```

Displaying OSPF neighbors of all routers:

```
R1#show ip ospf neighbor
```

Displaying OSPF Interface details of all routers:

```
R1#show ip ospf interface brief
```

Configure Area 1 as stub area:

```
R1(config)#router ospf 1
R1(config-router)#area 1 stub
R1(config-router)#^Z
R1#exit
```

Displaying Routing Table of R1 to verify Area1 as Stub Area:

```
R1#show ip route
```

Displaying global OSPF Configuration of the R1:

```
R1#show ip ospf
```

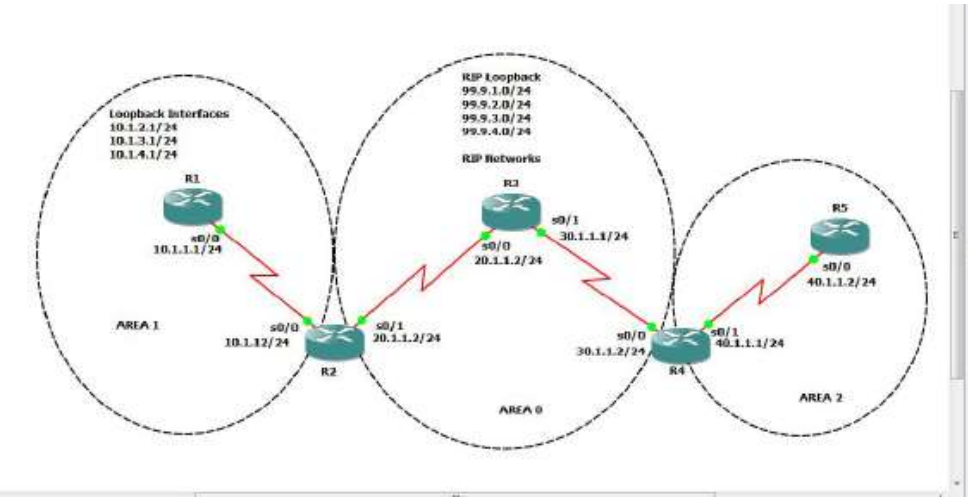
Configure Area2 as NSSA on R4:

```
R4(config)#router ospf 1
R4(config-router)#no area 2 stub
R4(config-router)#area 2 nssa
R4(config-router)#^Z
```

Configure R4 to advertise default routes for NSSA:

```
R4(config)#router ospf 1
R4(config-router)#area 2 nssa default-information-originate
R4(config-router)#^Z
```

Topology:



Assigning IP address and Loopback Interfaces to router R1:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 10.1.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback0
Router(config-if)#ip address 10.1.2.1 255.255.255.0
Router(config-if)#ip address 10.1.2.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 10.1.3.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback2
Router(config-if)#ip address 10.1.4.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to router R2:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip addres
Router(config-if)#ip address 20.1.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP address and Loopback Interfaces to router R3:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 20.1.1.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int s0/1
Router(config-if)#ip address 30.1.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback0
Router(config-if)#ip address 99.9.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 99.9.2.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback2
Router(config-if)#ip address 99.9.3.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback3
Router(config-if)#ip address 99.9.4.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback4
Router(config-if)#ip address 99.9.5.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to router R4:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 30.1.1.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int s0/1
Router(config-if)#ip address 40.1.1.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to router R5:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 40.1.1.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
```

Configuring OSPF on routers R1, R2, R4 and R5:

For R1:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 10.1.1.0 0.0.0.255 area 1
Router(config-router)#^Z
Router#exit
```

For R2:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 10.1.1.0 0.0.0.255 area 1
Router(config-router)#network 20.1.1.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

Configuring RIP and OSPF on R3:

```
Router#en
Router#conf t
Router(config)#router rip
Router(config-router)#network 99.9.1.0
Router(config-router)#network 99.9.2.0
Router(config-router)#network 99.9.3.0
Router(config-router)#network 99.9.4.0
Router(config-router)#network 99.9.5.0
Router(config-router)#exit
Router(config)#router ospf 1
Router(config-router)#network 20.1.1.0 0.0.0.255 area 0
Router(config-router)#network 30.1.1.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

For R4:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 30.1.1.0 0.0.0.255 area 0
Router(config-router)#network 40.1.1.0 0.0.0.255 area 2
Router(config-router)#^Z
Router#exit
```

For R5:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 40.1.1.0 0.0.0.255 area 2
Router(config-router)#^Z
```

Displaying Routing tables of all routers:

For R1:

Router#show ip route
20.0.0.0/24 is subnetted, 1 subnets
O IA 20.1.1.0 [110/128] via 10.1.1.2, 00:02:23, Serial0/0
40.0.0.0/24 is subnetted, 1 subnets
O IA 40.1.1.0 [110/256] via 10.1.1.2, 00:00:15, Serial0/0
10.0.0.0/24 is subnetted, 4 subnets
C 10.1.3.0 is directly connected, Loopback2
C 10.1.2.0 is directly connected, Loopback1
C 10.1.1.0 is directly connected, Serial0/0
C 10.1.4.0 is directly connected, Loopback3
30.0.0.0/24 is subnetted, 1 subnets
O IA 30.1.1.0 [110/192] via 10.1.1.2, 00:00:51, Serial0/0

For R2:

Router#show ip route
20.0.0.0/24 is subnetted, 1 subnets
C 20.1.1.0 is directly connected, Serial0/1
40.0.0.0/24 is subnetted, 1 subnets
O IA 40.1.1.0 [110/192] via 20.1.1.2, 00:04:24, Serial0/1
10.0.0.0/24 is subnetted, 1 subnets
C 10.1.1.0 is directly connected, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
O 30.1.1.0 [110/128] via 20.1.1.2, 00:04:24, Serial0/1

For R3:

Router#show ip route
99.0.0.0/24 is subnetted, 5 subnets
C 99.9.2.0 is directly connected, Loopback1
C 99.9.3.0 is directly connected, Loopback2
C 99.9.1.0 is directly connected, Loopback0
C 99.9.4.0 is directly connected, Loopback3
C 99.9.5.0 is directly connected, Loopback4
20.0.0.0/24 is subnetted, 1 subnets
C 20.1.1.0 is directly connected, Serial0/0
40.0.0.0/24 is subnetted, 1 subnets
O IA 40.1.1.0 [110/128] via 30.1.1.2, 00:04:30, Serial0/1
10.0.0.0/24 is subnetted, 1 subnets
O IA 10.1.1.0 [110/128] via 20.1.1.1, 00:04:54, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
C 30.1.1.0 is directly connected, Serial0/1

For R4:

Router#show ip route
20.0.0.0/24 is subnetted, 1 subnets
O 20.1.1.0 [110/128] via 30.1.1.1, 00:04:31, Serial0/0
40.0.0.0/24 is subnetted, 1 subnets
C 40.1.1.0 is directly connected, Serial0/1
10.0.0.0/24 is subnetted, 1 subnets
O IA 10.1.1.0 [110/192] via 30.1.1.1, 00:04:31, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
C 30.1.1.0 is directly connected, Serial0/0

For R5:

Router#show ip route
40.0.0.0/24 is subnetted, 1 subnets
C 40.1.1.0 is directly connected, Serial0/0

Displaying OSPF neighbors of all routers:

For R1:

Router#show ip ospf neighbor

Neighbor ID Pri State Dead Time Address Interface
20.1.1.1 0 FULL/ - 00:00:35 10.1.1.2 Serial0/0

For R2:

Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
99.9.5.1 0 FULL/ - 00:00:38 20.1.1.2 Serial0/1
10.1.4.1 0 FULL/ - 00:00:37 10.1.1.1 Serial0/0

For R3:

Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
40.1.1.2 0 FULL/ - 00:00:38 30.1.1.2 Serial0/1
20.1.1.1 0 FULL/ - 00:00:32 20.1.1.1 Serial0/0

For R4:

Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
99.9.5.1 0 FULL/ - 00:00:35 30.1.1.1 Serial0/0
40.1.1.2 0 FULL/ - 00:00:34 40.1.1.2 Serial0/1

For R5:

Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
40.1.1.1 0 FULL/ - 00:00:31 40.1.1.1 Serial0/0

Displaying OSPF Interface details of all routers:

For R1:

Router#show ip ospf interface brief
Interface PID Area IP Address/Mask Cost State Nbrs F/C
Se0/0 1 1 10.1.1.1/24 64 P2P 1/1

For R2:

Router#show ip ospf interface brief
Interface PID Area IP Address/Mask Cost State Nbrs F/C
Se0/1 1 0 20.1.1.1/24 64 P2P 1/1
Se0/0 1 1 10.1.1.2/24 64 P2P 1/1

For R3:

Router#show ip ospf interface brief
Interface PID Area IP Address/Mask Cost State Nbrs F/C
Se0/1 1 0 30.1.1.1/24 64 P2P 1/1
Se0/0 1 0 20.1.1.2/24 64 P2P 1/1

For R4:

Router#show ip ospf interface brief

Interface PID Area IP Address/Mask Cost State Nbrs F/C
Se0/0 1 0 30.1.1.2/24 64 P2P 1/1
Se0/1 1 2 40.1.1.1/24 64 P2P 0/0

For R5:

Router#show ip ospf interface brief
Interface PID Area IP Address/Mask Cost State Nbrs F/C
Se0/0 1 2 40.1.1.2/24 64 P2P 0/0

Configure Area 1 as stub area:

For R1:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#area 1 stub
Router(config-router)#^Z
Router#exit

For R2:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#area 1 stub
Router(config-router)#^Z
Router#exit

Displaying Routing Table of R1 to verify Area1 as Stub Area:

For R1:

```
Router#show ip route
20.0.0.0/24 is subnetted, 1 subnets
O IA 20.1.1.0 [110/128] via 10.1.1.2, 00:00:23, Serial0/0
40.0.0.0/24 is subnetted, 1 subnets
O IA 40.1.1.0 [110/256] via 10.1.1.2, 00:00:23, Serial0/0
10.0.0.0/24 is subnetted, 4 subnets
C 10.1.3.0 is directly connected, Loopback2
C 10.1.2.0 is directly connected, Loopback1
C 10.1.1.0 is directly connected, Serial0/0
C 10.1.4.0 is directly connected, Loopback3
30.0.0.0/24 is subnetted, 1 subnets
O IA 30.1.1.0 [110/192] via 10.1.1.2, 00:00:51, Serial0/0
O*IA 0.0.0.0/0 [110/65] via 10.1.1.2, 00:00:51, Serial0/0
```

Displaying global OSPF Configuration of the R1:

For R1:

```
Router#show ip ospf
Routing Process "ospf 1" with ID 10.1.4.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Initial SPF schedule delay 5000 msecs
Minimum hold time between two consecutive SPFs 10000 msecs
Maximum wait time between two consecutive SPFs 10000 msecs
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 0 normal 1 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
Area 1
Number of interfaces in this area is 1
It is a stub area
Area has no authentication
SPF algorithm last executed 00:02:38.152 ago
SPF algorithm executed 5 times
Area ranges are
Number of LSA 6. Checksum Sum 0x0260F4
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of DCbitless LSA 0
```

Configure Area2 as Totally Stubby Area:

For R5:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#area 2 stub
Router(config-router)#^Z
Router#exit

For R4:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#area 2 stub no-summary
Router(config-router)#^Z

Router#exit

Displaying Routing Table of R5 to verify Area2 as Totally Stubby Area:

For R4:

```
Router#show ip route
40.0.0.0/24 is subnetted, 1 subnets
C 40.1.1.0 is directly connected, Serial0/0
O*IA 0.0.0.0/0 [110/65] via 40.1.1.1, 00:00:24, Serial0/0
```

Configure Area2 as NSSA on R4:

For R4:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#no area 2 stub
Router(config-router)#area 2 nssa
Router(config-router)#^Z
Router#exit

For R5:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#no area 2 stub
Router(config-router)#area 2 nssa
Router(config-router)#^Z
Router#exit

Configure R4 to advertise default routes for NSSA:

For R4:

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#area 2 nssa default-information-originate
Router(config-router)#^Z
Router#exit

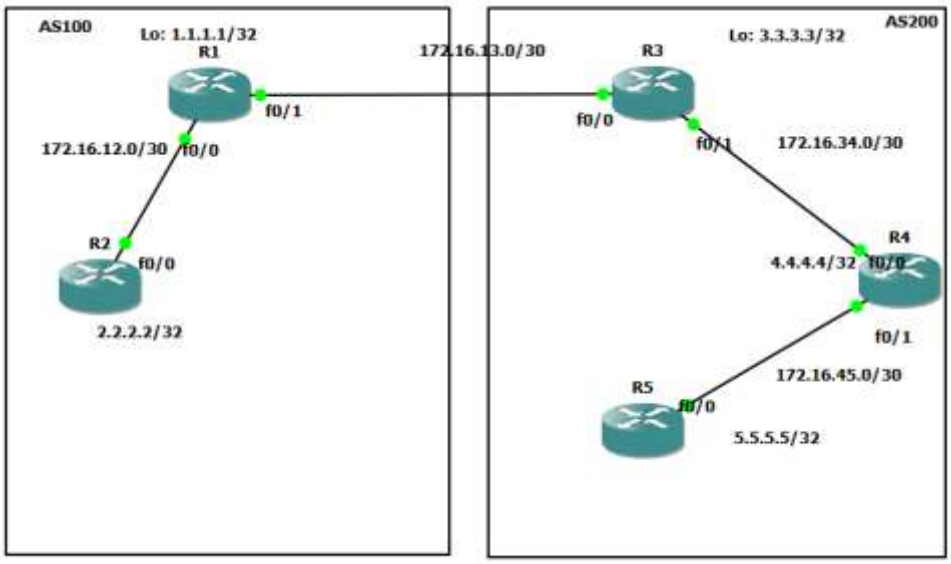
Displaying routing table of R5 to verify Area2 as a NSSA

For R5:

```
Router#show ip route
20.0.0.0/24 is subnetted, 1 subnets
O IA 20.1.1.0 [110/192] via 40.1.1.1, 00:01:31, Serial0/0
40.0.0.0/24 is subnetted, 1 subnets
C 40.1.1.0 is directly connected, Serial0/0
10.0.0.0/24 is subnetted, 1 subnets
O IA 10.1.1.0 [110/256] via 40.1.1.1, 00:01:31, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
O IA 30.1.1.0 [110/128] via 40.1.1.1, 00:01:31, Serial0/0
O*N2 0.0.0.0/0 [110/1] via 40.1.1.1, 00:00:31, Serial0/0
```

PRACTICAL NUMBER 4
Simulating BGP

Topology:-



STEPS Overview:

1. Assigning IP Addresses and Loopback Address R1:
2. Configuring OSPF on all routers:
3. Configure Static Routes on R1 and R3:
4. Configure BGP Network on R1 and R3
5. Displaying routing tables of all routers:
6. Performing Ping on all routers to check Connectivity:

Assigning IP Addresses and Loopback Address R1:

```
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int f0/1
Router(config-if)#ip address 172.16.13.1 255.255.255.0
Router(config-if)#ip address 172.16.13.1 255.255.255.252
Router(config-if)#no shut
Router(config-if)#
```

```
Router(config-if)#int f0/0
Router(config-if)#ip address 172.16.12.1 255.255.255.252
Router(config-if)#no shut
```

```
Router(config-if)#int loopback1
Router(config-if)#ip address 1.1.1.1 255.255.255.255
Router(config-if)#
Router(config-if)#no shut
Router(config-if)#
```

Assigning IP Addresses and Loopback Address R2:

```
Router>
Router>
Router>en
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int f0/0
Router(config-if)#ip address 172.16.12.1 255.255.255.252
Router(config-if)#no shut
```

```
Router(config-if)#ip address 2.2.2.2 255.255.255.255
Router(config-if)#no shut
Router(config-if)#
```

Assigning IP Addresses and Loopback Address R3:

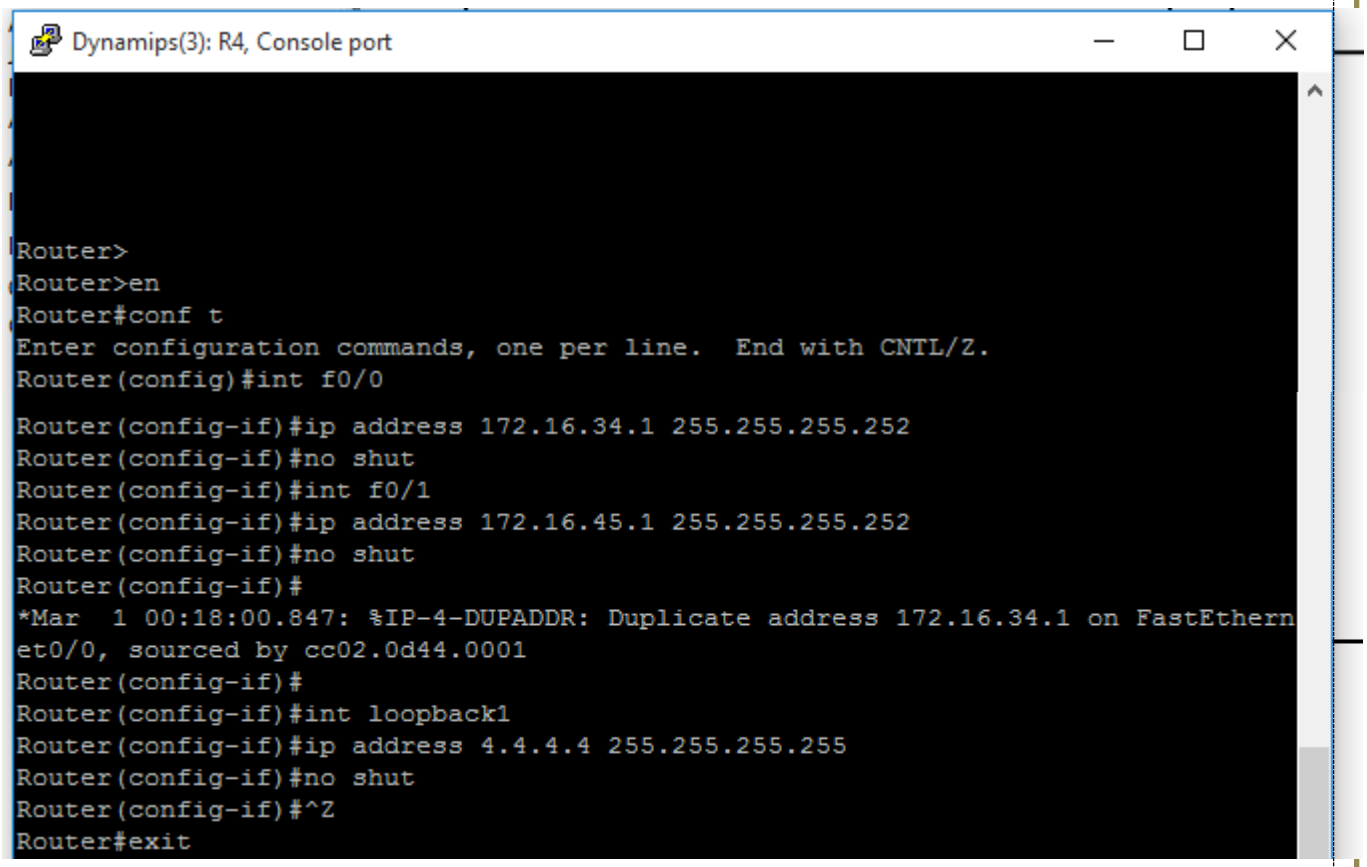
Dynamips(2): R3, Console port

```
 a cold start
Router>
Router>
Router>
Router>en
Router# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int f0/1
Router(config-if)#ip address 172.16.34.1 255.255.25.252
Bad mask 0xFFFF19FC for address 172.16.34.1
Router(config-if)#ip address 172.16.34.1 255.255.255.252
Router(config-if)#no shut
Router(config-if)#ip address 172.16.34.1 255.255.25.252
```

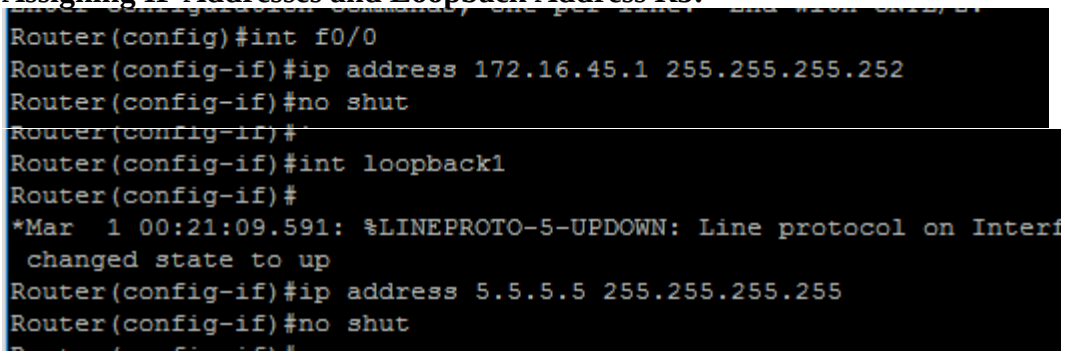
```
Router(config-if)#
Router(config-if)#int f0/0
Router(config-if)#ip address 172.16.13.1 255.255.255.252
Router(config-if)#no shut
Router(config-if)#int
```

```
Router(config)#int loopback1
Router(config-if)#i
*Mar  1 00:13:50.755: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1,
 changed state to upp address 3.3.3.3 255.255.255.255
Router(config-if)#no shut
Router(config-if)#^Z
```

Assigning IP Addresses and Loopback Address R4:

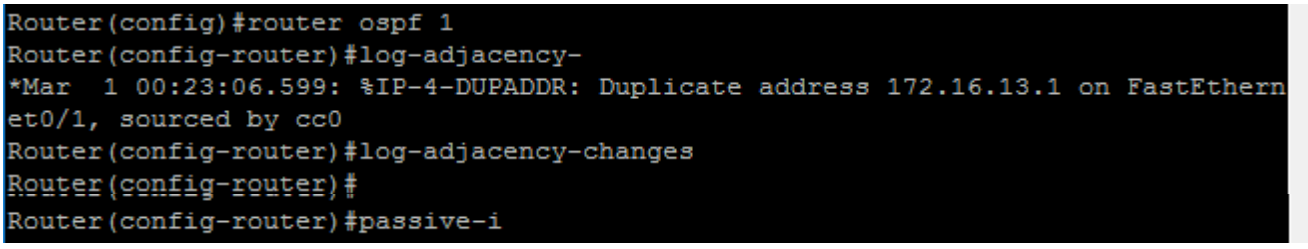


Assigning IP Addresses and Loopback Address R5:



Configuring OSPF on all routers:

For R1:



```
Router(config-router)#passive-int f0/0
Router(config-router)#network 1.1.1.1 0.0.0.0 area 0
Router(config-router)#network 17
*Mar  1 00:25:37.563: %IP-4-DUPADDR: Duplicate address 172.16.13.1 on FastEthern
et0/1, sourced by cc02.0d44.0000
% Incomplete command.

Router(config-router)#network 172.16.12.0 0.0.0.3 area 0
Router(config-router)#network 172.16.13.0 0.0.0.3 area 0
Router(config-router)#^Z
Router#
```

For R2:

```
Router(config)#router ospf 1
Router(config-router)#log-adjacency-changes
Router(config-router)#network 2.2.2.2 0

Router(config-router)#network 2.2.2.2 0.0.0.0 area 0
Router(config-router)#network 172.16.12.0 0.0.0. area 0

Router(config-router)#network 172.16.12.0 0.0.0.3 area 0
Router(config-router)#^Z
Router#
```

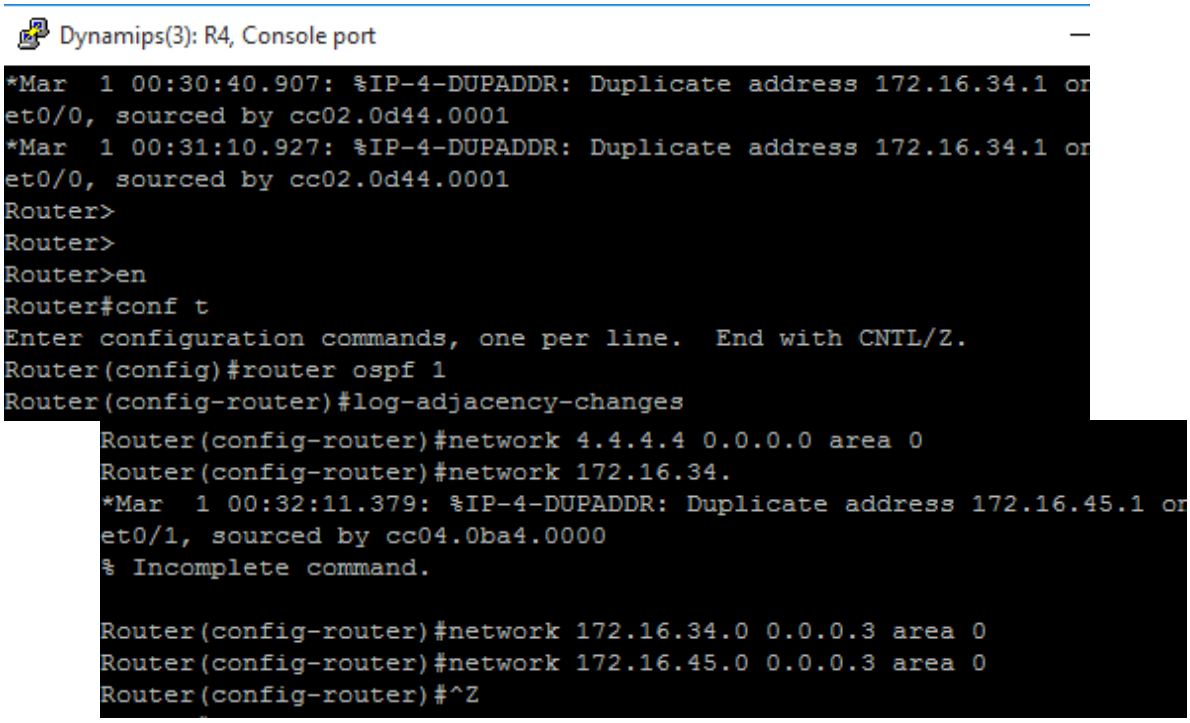
For R3:

Dynamips(2): R3, Console port

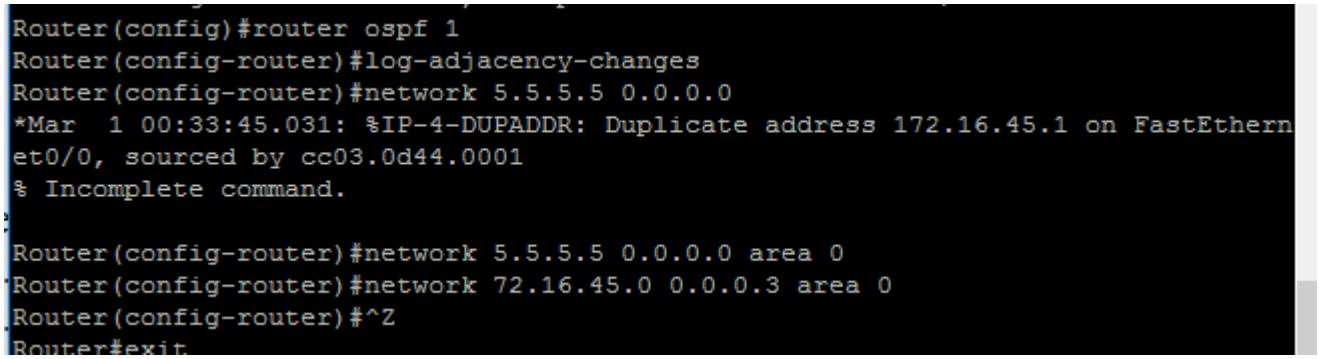
```
Router>en
Router# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 1
Router(config-router)#log-adjacency-changes
Router(config-router)#passive-int f0/0
Router(config-router)#network 3.3.3.3
```

```
Router(config-router)#network 3.3.3.3 0.0.0.0 area 0
Router(config-router)#network 172.16.13.0 0.0.0.3 area 0
Router(config-router)#network 172.16.13.0 0.0.0.3 area 0
*Mar  1 00:30:16.411: %IP-4-DUPADDR: Duplicate address 172.16.13.1 on Fa
1
Router(config-router)#
Router(config-router)#network 172.16.34.0 0.0.0.3 area 0
Router(config-router)#^Z
Router#exit
```

For R4:



For R5:



Configure Static Routes on R1 and R3:

For R1:

```
Router#en
Router#conf t
Router(config)#ip route 100.100.100.0 255.255.255.0 null0
Router(config)#ip route 100.100.101.0 255.255.255.0 null0
Router(config)#ip route 100.100.102.0 255.255.255.0 null0
Router(config)#ip route 100.100.103.0 255.255.255.0 null0
Router(config)#^Z
Router#exit
```

For R3:

```
Router#en
Router#conf t
Router(config)#ip route 200.200.200.0 255.255.255.0 null0
Router(config)#ip route 200.200.201.0 255.255.255.0 null0
Router(config)#ip route 200.200.202.0 255.255.255.0 null0
Router(config)#ip route 200.200.203.0 255.255.255.0 null0
Router(config)#^Z
Router#exit
```

Configure BGP Network on R1 and R3:

For R1:

```
Router#en
Router#conf t
Router(config)#router bgp 100
Router(config-router)#network 100.100.100.0 mask 255.255.255.0
Router(config-router)#network 100.100.101.0 mask 255.255.255.0
Router(config-router)#network 100.100.102.0 mask 255.255.255.0
Router(config-router)#network 100.100.103.0 mask 255.255.255.0
Router(config-router)#network 1.1.1.1 mask 255.255.255.255
Router(config-router)#network 2.2.2.2 mask 255.255.255.255
Router(config-router)#network 172.16.12.0 mask 255.255.255.252
Router(config-router)#^Z
Router#exit
```

For R3:

```
Router#en
Router#conf t
Router(config)#router bgp 200
Router(config-router)#network 200.200.200.0 mask 255.255.255.0
Router(config-router)#network 200.200.201.0 mask 255.255.255.0
Router(config-router)#network 200.200.202.0 mask 255.255.255.0
Router(config-router)#network 200.200.203.0 mask 255.255.255.0
Router(config-router)#network 3.3.3.3 mask 255.255.255.255
Router(config-router)#network 4.4.4.4 mask 255.255.255.255
Router(config-router)#network 5.5.5.5 mask 255.255.255.255
Router(config-router)#network 172.16.34.0 mask 255.255.255.252
Router(config-router)#network 172.16.45.0 mask 255.255.255.252
Router(config-router)#^Z
Router#exit
```

Displaying routing tables of all routers:

For R1:

```
Router#show ip route
B 200.200.200.0/24 [20/0] via 172.16.13.2, 00:03:42
```

1.0.0.0/32 is subnetted, 1 subnets
C 1.1.1.1 is directly connected, Loopback1
B 200.200.201.0/24 [20/0] via 172.16.13.2, 00:02:42
2.0.0.0/32 is subnetted, 1 subnets
O 2.2.2.2 [110/11] via 172.16.12.2, 01:55:15, FastEthernet0/1
100.0.0.0/24 is subnetted, 4 subnets
S 100.100.100.0 is directly connected, Null0
S 100.100.101.0 is directly connected, Null0
S 100.100.102.0 is directly connected, Null0
S 100.100.103.0 is directly connected, Null0
B 200.200.202.0/24 [20/0] via 172.16.13.2, 00:02:51
3.0.0.0/32 is subnetted, 1 subnets
B 3.3.3.3 [20/0] via 172.16.13.2, 00:02:49
B 200.200.203.0/24 [20/0] via 172.16.13.2, 00:03:58
4.0.0.0/32 is subnetted, 1 subnets
B 4.4.4.4 [20/11] via 172.16.13.2, 00:02:58
5.0.0.0/32 is subnetted, 1 subnets
B 5.5.5.5 [20/21] via 172.16.13.2, 00:02:59
172.16.0.0/30 is subnetted, 4 subnets
B 172.16.45.0 [20/20] via 172.16.13.2, 00:01:59
B 172.16.34.0 [20/0] via 172.16.13.2, 00:02:24
C 172.16.12.0 is directly connected, FastEthernet0/1
C 172.16.13.0 is directly connected, FastEthernet0/0

For R2:

Router#show ip route
B 200.200.200.0/24 [200/0] via 172.16.13.2, 00:03:55
1.0.0.0/32 is subnetted, 1 subnets
O 1.1.1.1 [110/11] via 172.16.12.1, 01:55:30, FastEthernet0/0
B 200.200.201.0/24 [200/0] via 172.16.13.2, 00:02:55
2.0.0.0/32 is subnetted, 1 subnets
C 2.2.2.2 is directly connected, Loopback1
100.0.0.0/24 is subnetted, 4 subnets
B 100.100.100.0 [200/0] via 172.16.12.1, 00:07:09
B 100.100.101.0 [200/0] via 172.16.12.1, 00:07:09
B 100.100.102.0 [200/0] via 172.16.12.1, 00:06:09
B 100.100.103.0 [200/0] via 172.16.12.1, 00:06:23
B 200.200.202.0/24 [200/0] via 172.16.13.2, 00:03:10
3.0.0.0/32 is subnetted, 1 subnets
B 3.3.3.3 [200/0] via 172.16.13.2, 00:03:03
B 200.200.203.0/24 [200/0] via 172.16.13.2, 00:04:03
4.0.0.0/32 is subnetted, 1 subnets
B 4.4.4.4 [200/11] via 172.16.13.2, 00:04:24
5.0.0.0/32 is subnetted, 1 subnets
B 5.5.5.5 [200/21] via 172.16.13.2, 00:04:24
172.16.0.0/30 is subnetted, 4 subnets
B 172.16.45.0 [200/20] via 172.16.13.2, 00:03:25
B 172.16.34.0 [200/0] via 172.16.13.2, 00:03:25

C 172.16.12.0 is directly connected, FastEthernet0/0
O 172.16.13.0 [110/20] via 172.16.12.1, 01:58:53, FastEthernet0/0

For R3:

Router#show ip route
S 200.200.200.0/24 is directly connected, Null0
1.0.0.0/32 is subnetted, 1 subnets
B 1.1.1.1 [20/0] via 172.16.13.1, 00:06:27
S 200.200.201.0/24 is directly connected, Null0
2.0.0.0/32 is subnetted, 1 subnets
B 2.2.2.2 [20/11] via 172.16.13.1, 00:05:27
100.0.0.0/24 is subnetted, 4 subnets
B 100.100.100.0 [20/0] via 172.16.13.1, 00:07:28
B 100.100.101.0 [20/0] via 172.16.13.1, 00:07:28
B 100.100.102.0 [20/0] via 172.16.13.1, 00:06:27
B 100.100.103.0 [20/0] via 172.16.13.1, 00:06:45
S 200.200.202.0/24 is directly connected, Null0
3.0.0.0/32 is subnetted, 1 subnets
C 3.3.3.3 is directly connected, Loopback1
S 200.200.203.0/24 is directly connected, Null0
4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/11] via 172.16.34.2, 01:50:38, FastEthernet0/1
5.0.0.0/32 is subnetted, 1 subnets
O 5.5.5.5 [110/21] via 172.16.34.2, 01:50:38, FastEthernet0/1
172.16.0.0/30 is subnetted, 4 subnets
O 172.16.45.0 [110/20] via 172.16.34.2, 01:50:49, FastEthernet0/1
C 172.16.34.0 is directly connected, FastEthernet0/1
B 172.16.12.0 [20/0] via 172.16.13.1, 00:05:47
C 172.16.13.0 is directly connected, FastEthernet0/0

For R4:

Router#show ip route
B 200.200.200.0/24 [200/0] via 172.16.34.1, 00:04:03
1.0.0.0/32 is subnetted, 1 subnets
B 1.1.1.1 [200/0] via 172.16.13.1, 00:06:17
B 200.200.201.0/24 [200/0] via 172.16.34.1, 00:03:03
2.0.0.0/32 is subnetted, 1 subnets
B 2.2.2.2 [200/11] via 172.16.13.1, 00:05:16
100.0.0.0/24 is subnetted, 4 subnets
B 100.100.100.0 [200/0] via 172.16.13.1, 00:07:17
B 100.100.101.0 [200/0] via 172.16.13.1, 00:07:17
B 100.100.102.0 [200/0] via 172.16.13.1, 00:06:17
B 100.100.103.0 [200/0] via 172.16.13.1, 00:06:39
B 200.200.202.0/24 [200/0] via 172.16.34.1, 00:03:26
3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/11] via 172.16.34.1, 01:50:32, FastEthernet0/0
B 200.200.203.0/24 [200/0] via 172.16.34.1, 00:04:16

4.0.0.0/32 is subnetted, 1 subnets
C 4.4.4.4 is directly connected, Loopback1
5.0.0.0/32 is subnetted, 1 subnets
O 5.5.5.5 [110/11] via 172.16.45.2, 01:52:26, FastEthernet0/1
172.16.0.0/30 is subnetted, 4 subnets
C 172.16.45.0 is directly connected, FastEthernet0/1
C 172.16.34.0 is directly connected, FastEthernet0/0
B 172.16.12.0 [200/0] via 172.16.13.1, 00:07:24
O 172.16.13.0 [110/20] via 172.16.34.1, 01:52:39, FastEthernet0/0

For R5:

Router#show ip route
B 200.200.200.0/24 [200/0] via 172.16.34.1, 00:04:30
1.0.0.0/32 is subnetted, 1 subnets
B 1.1.1.1 [200/0] via 172.16.13.1, 00:06:43
B 200.200.201.0/24 [200/0] via 172.16.34.1, 00:03:30
2.0.0.0/32 is subnetted, 1 subnets
B 2.2.2.2 [200/11] via 172.16.13.1, 00:05:43
100.0.0.0/24 is subnetted, 4 subnets
B 100.100.100.0 [200/0] via 172.16.13.1, 00:07:43
B 100.100.101.0 [200/0] via 172.16.13.1, 00:07:43
B 100.100.102.0 [200/0] via 172.16.13.1, 00:06:43
B 100.100.103.0 [200/0] via 172.16.13.1, 00:07:06
B 200.200.202.0/24 [200/0] via 172.16.34.1, 00:03:53
3.0.0.0/32 is subnetted, 1 subnets
O 3.3.3.3 [110/21] via 172.16.45.1, 01:50:43, FastEthernet0/0
B 200.200.203.0/24 [200/0] via 172.16.34.1, 00:04:20
4.0.0.0/32 is subnetted, 1 subnets
O 4.4.4.4 [110/11] via 172.16.45.1, 01:50:43, FastEthernet0/0
5.0.0.0/32 is subnetted, 1 subnets
C 5.5.5.5 is directly connected, Loopback1
172.16.0.0/30 is subnetted, 4 subnets
C 172.16.45.0 is directly connected, FastEthernet0/0
O 172.16.34.0 [110/20] via 172.16.45.1, 01:52:36, FastEthernet0/0
B 172.16.12.0 [200/0] via 172.16.13.1, 00:07:26
O 172.16.13.0 [110/30] via 172.16.45.1, 01:52:36, FastEthernet0

Performing Ping on all routers to check Connectivity:

For R1:

```
Router#ping 172.16.34.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.34.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
1352/1572/1796 ms
Router#ping 172.16.45.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.45.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 856/
1053/1248 ms
```

For R2:

```
Router#ping 172.16.45.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.45.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
1372/1556/1712 ms

R2#ping 172.16.34.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.34.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 700/838/96
ms
```

For R3:

```
Router#ping 172.16.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 700/838/
964 ms
```

For R4:

```
Router#ping 172.16.13.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.13.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 624/657/68
ms
Router#ping 172.16.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.2, timeout is 2 seconds:
!!!!!
```

For R5:

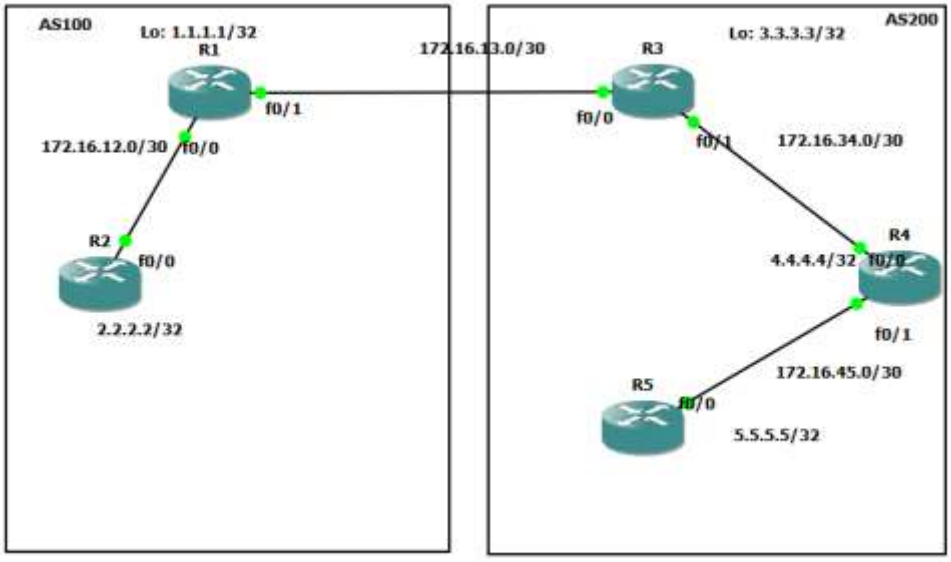
```
Router#ping 172.16.13.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.13.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
1196/1387/1564 ms
Router#ping 172.16.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 672/1059/
1336 ms
```

PRACTICAL NUMBER 5
Simulating IBGP

STEPS OVERVEW:

1. Configure I-BGP between R1 and R2 (AS100):
2. Configure I-BGP between R3 and R4 (AS200):
3. Configure I-BGP between R3 and R5 (AS200):
4. Displaying I-BGP summary of the routers:
5. Configure R3 as Route Reflector for R4 and R5:
6. Performing ping to check the working of I-BGP Connectivity:

Topology:



Configure I-BGP between R1 and R2 (AS100):

For R1:

```
Router#en
Router#conf t
Router(config)#router bgp 100
Router(config-router)#neighbor 2.2.2.2 remote-as 100
Router(config-router)#neighbor 2.2.2.2 update-source loopback1
Router(config-router)#neighbor 172.16.12.2 remote-as 100
Router(config-router)#^Z
Router#exit
```

For R2:

```
Router#en
```

```
Router#conf t
Router(config)#router bgp 100
Router(config-router)#neighbor 1.1.1.1 remote-as 100
Router(config-router)#neighbor 1.1.1.1 update-source loopback1
Router(config-router)#neighbor 172.16.12.1 remote-as 100
Router(config-router)#^Z
Router#exit
```

Configure I-BGP between R3 and R4 (AS200):

For R3:

```
Router#en
Router#conf t
Router(config)#
Router(config)#router bgp 200
Router(config-router)#neighbor 4.4.4.4 remote-as 200
Router(config-router)#neighbor 4.4.4.4 update-source loopback1
Router(config-router)#neighbor 172.16.34.2 remote-as 200
Router(config-router)#^Z
Router#exit
```

For R4:

```
Router#en
Router#conf t
Router(config)#router bgp 200
Router(config-router)#neighbor 3.3.3.3 remote-as 200
Router(config-router)#neighbor 3.3.3.3 update-source loopback1
Router(config-router)#neighbor 172.16.34.1 remote-as 200
Router(config-router)#^Z
Router#exit
```

Configure I-BGP between R3 and R5 (AS200):

For R3:

```
Router#en
Router#conf t
Router(config)#router bgp 200
Router(config-router)#neighbor 5.5.5.5 remote-as 200
Router(config-router)#neighbor 5.5.5.5 update-source loopback1
Router(config-router)#neighbor 172.16.45.2 remote-as 200
Router(config-router)#^Z
Router#exit
```

For R5:

```
Router#en
Router#conf t
Router(config)#router bgp 200
Router(config-router)#neighbor 3.3.3.3 remote-as 200
```

```
Router(config-router)#neighbor 3.3.3.3 update-source loopback1
Router(config-router)#neighbor 172.16.34.1 remote-as 200
Router(config-router)#^Z
Router#exit
```

Displaying I-BGP summary of the routers:

For R1:

```
Router#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 100
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
2.2.2.2 4 100 19 19 1 0 0 00:15:34 0
172.16.12.2 4 100 18 18 1 0 0 00:14:53 0
172.16.13.2 4 200 32 32 1 0 0 00:26:45 0
```

For R2:

```
Router#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 100
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
1.1.1.1 4 100 22 22 1 0 0 00:18:12 0
172.16.12.1 4 100 21 21 1 0 0 00:17:31 0
```

For R3:

```
Router#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 200
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
4.4.4.4 4 200 15 15 1 0 0 00:11:36 0
5.5.5.5 4 200 7 7 1 0 0 00:03:11 0
172.16.13.1 4 100 34 34 1 0 0 00:28:56 0
172.16.34.2 4 200 14 14 1 0 0 00:10:28 0
172.16.45.2 4 200 5 5 1 0 0 00:01:53 0
```

For R4:

```
Router#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 200
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
3.3.3.3 4 200 16 16 1 0 0 00:12:33 0
172.16.34.1 4 200 15 15 1 0 0 00:11:24 0
```

For R5:

```
Router#show ip bgp summary
BGP router identifier 5.5.5.5, local AS number 200
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
3.3.3.3 4 200 8 8 1 0 0 00:04:17 0
172.16.34.1 4 200 6 7 1 0 0 00:02:59 0
```

Configure R3 as Route Reflector for R4 and R5:

For R3:

```
Router#en
Router#conf t
Router(config)#router bgp 200
Router(config-router)#neighbor 4.4.4.4 route-reflector-client
Router(config-router)#neighbor 5.5.5.5 route-reflector-client
Router(config-router)#^Z
Router#exit
```

Performing ping to check the working of I-BGP Connectivity:

For R1:

```
Router#ping 172.16.12.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 328/379/
480 ms
```

For R2:

```
Router#ping 172.16.12.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.12.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 264/362/
424 ms
```

For R3:

```
Router#ping 172.16.34.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.34.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 312/329/
352 ms
Router#ping 172.16.45.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.45.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 576/735/
888 ms
```

For R4:

```
Router#ping 172.16.34.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.34.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 280/362/
424 ms
```

For R5:

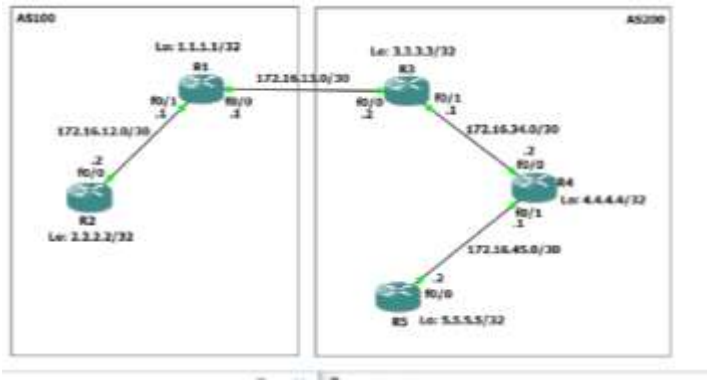
```
Router#ping 172.16.34.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.34.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 716/830/
972 ms
```

PRACTICAL NUMBER 6
Simulating EBGP

STEPS OVERVIEW:

1. Configure E-BGP between R1 and R3 (AS100 and AS200):
2. Displaying E-BGP Summary of R1 and R3:
3. Performing Ping to check the working of E-BGP Connectivity:

Topology:



Configure E-BGP between R1 and R3 (AS100 and AS200):

For R1:

```
Router#en
Router#conf t
Router(config)#router bgp 100
Router(config-router)#no synchronization
Router(config-router)#neighbor 172.16.13.2 remote-as 200
Router(config-router)#^Z
Router#exit
```

For R3:

```
Router#en
Router#conf t
Router(config)#router bgp 200
Router(config-router)#no synchronization
Router(config-router)#neighbor 172.16.13.1 remote-as 100
Router(config-router)#^Z
Router#exit
```

Displaying E-BGP Summary of R1 and R3:

For R1:

```
Router#show ip bgp summary
BGP router identifier 1.1.1.1, local AS number 100
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
172.16.13.2 4 200 7 7 1 0 0 00:01:24 0
```

For R3:

```
Router#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 200
BGP table version is 1, main routing table version 1
Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd
172.16.13.1 4 100 7 7 1 0 0 00:01:48 0
```

Performing Ping to check the working of E-BGP Connectivity:

For R1:

```
Router#ping 172.16.13.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.13.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 300/333/
392 ms
```

For R3:

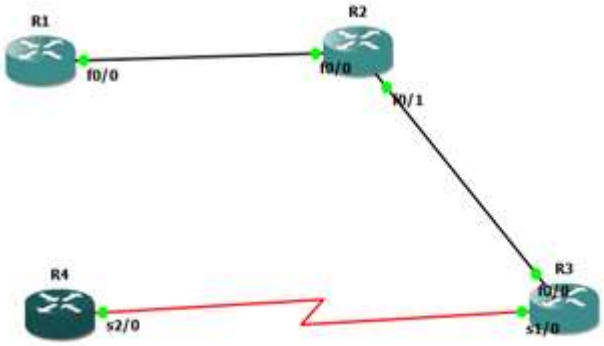
```
Router#ping 172.16.13.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.13.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 296/359/
468 ms
```

PRACTICAL NUMBER 7
Configuring IP Multicast Routing

STEPS OVERVIEW;

1. **Assigning IP Addresses and Loopback Address R**
2. **Configuring OSPF on all routers:**
3. **Displaying routing tables of all routers:**
4. **Configuring IP Multicasting (PIM Sparse Dense mode) on all the routers:**
5. **Configure RP on all the routers:**
6. **Configure RP on all the routers:**
7. **Performing ping from R1 to generate multicast traffic:**
8. **Displaying IGMP groups of all the routers:**
9. **Displaying PIM Neighbor of all routers:**
10. **Displaying RP Mapping of all the routers:**
11. **Displaying Multicast Routing Table of all the routers:**

Topology:



Assigning IP Addresses and Loopback Address R1:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 192.168.12.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 1.1.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP Addresses and Loopback Address R2:

```
Router#en
Router#conf t
```

```
Router(config)#int f0/0
Router(config-if)#ip address 192.168.12.2 255.255.255.0
Router(config-if)#no shut
Router(config)#int s0/0
Router(config-if)#ip address 192.168.23.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 2.2.2.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP Addresses and Loopback Address R3:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 192.168.34.2 255.255.255.0
Router(config-if)#no shut
Router(config)#int s0/0
Router(config-if)#ip address 192.168.23.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 3.3.3.3 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP Addresses and Loopback Address R4:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 192.168.34.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 4.4.4.4 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Configuring OSPF on all routers:

R1:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 192.168.12.0 0.0.0.255 area 0
```

```
Router(config-router)#^Z
Router#exit
```

R2:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 192.168.12.0 0.0.0.255 area 0
Router(config-router)#network 192.168.23.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

R3:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 192.168.23.0 0.0.0.255 area 0
Router(config-router)#network 192.168.34.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

R4:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 192.168.34.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

Displaying routing tables of all routers:

R1:

```
Router#show ip route
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, Loopback1
O 192.168.23.0/24 [110/74] via 192.168.12.2, 00:02:15,
FastEthernet0/0
O 192.168.34.0/24 [110/84] via 192.168.12.2, 00:02:15,
FastEthernet0/0
```

R2:

```
Router#show ip route
C 192.168.12.0/24 is directly connected, FastEthernet0/0
2.0.0.0/24 is subnetted, 1 subnets
C 2.2.2.0 is directly connected, Loopback1
C 192.168.23.0/24 is directly connected, Serial0/0
O 192.168.34.0/24 [110/74] via 192.168.23.2, 00:02:23, Serial0/0
```

R3:

```
Router#show ip route
O 192.168.12.0/24 [110/74] via 192.168.23.1, 00:02:32, Serial0/0
3.0.0.0/24 is subnetted, 1 subnets
C 3.3.3.0 is directly connected, Loopback1
C 192.168.23.0/24 is directly connected, Serial0/0
C 192.168.34.0/24 is directly connected, FastEthernet0/0
```

R4:

```
Router#show ip route
O 192.168.12.0/24 [110/84] via 192.168.34.2, 00:02:41,
FastEthernet0/0
4.0.0.0/24 is subnetted, 1 subnets
C 4.4.4.0 is directly connected, Loopback1
O 192.168.23.0/24 [110/74] via 192.168.34.2, 00:02:42,
FastEthernet0/0
C 192.168.34.0/24 is directly connected, FastEthernet0/0
```

Configuring IP Multicasting (PIM Sparse Dense mode) on all the routers:

R1:

Router#en
Router#conf t
Router(config)#ip multicast-routing
Router(config)#int f0/0
Router(config-if)#ip pim sparse-dense-mode
Router(config-if)#^Z
Router#exit

R2:

Router#en
Router#conf t
Router(config)#ip multicast-routing
Router(config)#int f0/0
Router(config-if)#ip pim sparse-dense-mode
Router(config-if)#int s0/0
Router(config-if)#ip pim sparse-dense-mode
Router(config-if)#^Z
Router#exit

R3:

Router#en
Router#conf t
Router(config)#ip multicast-routing
Router(config)#int f0/0
Router(config-if)#ip pim sparse-dense-mode
Router(config-if)#int s0/0
Router(config-if)#ip pim sparse-dense-mode
Router(config-if)#^Z

```
Router#exit
```

R4:

```
Router#en
Router#conf t
Router(config)#ip multicast-routing
Router(config)#int f0/0
Router(config-if)#ip pim sparse-dense-mode
Router(config-if)#^Z
Router#exit
```

Configure RP on all the routers:

R1:

```
Router#en
Router#conf t
Router(config)#ip pim rp-address 3.3.3.3 1
Router(config)#access-list 1 permit 224.4.4.4
Router(config)#^Z
Router#exit
```

R2:

```
Router#en
Router#conf t
Router(config)#ip pim rp-address 3.3.3.3 1
Router(config)#access-list 1 permit 224.4.4.4
Router(config)#^Z
Router#exit
```

R3:

```
Router#en
Router#conf t
Router(config)#ip pim rp-address 3.3.3.3 1
Router(config)#access-list 1 permit 224.4.4.4
Router(config)#^Z
Router#exit
```

R4:

```
Router#en
Router#conf t
Router(config)#ip pim rp-address 3.3.3.3 1
Router(config)#access-list 1 permit 224.4.4.4
Router(config)#^Z
Router#exit
```

Configure R4 to join the multicast group:

```
Router#en
Router#conf t
```

```
Router(config)#int f0/0
Router(config-if)#ip igmp join-group 224.4.4.4
Router(config-if)#^Z
Router#exit
```

Performing ping from R1 to generate multicast traffic:

```
Router#ping 224.4.4.4 repeat 10
Type escape sequence to abort.
Sending 10, 100-byte ICMP Echos to 224.4.4.4, timeout is 2 seconds:
..........
```

Displaying IGMP groups of all the routers:

For R1:

```
Router#show ip igmp groups
IGMP Connected Group Membership
Group Address Interface Uptime Expires Last Reporter
224.0.1.40 FastEthernet0/0 00:15:49 00:02:51 192.168.12.1
```

For R2:

```
Router#show ip igmp groups
IGMP Connected Group Membership
Group Address Interface Uptime Expires Last Reporter
224.0.1.40 FastEthernet0/0 00:14:45 00:02:00 192.168.12.1
```

For R3:

```
Router#show ip igmp groups
IGMP Connected Group Membership
Group Address Interface Uptime Expires Last Reporter
224.4.4.4 FastEthernet0/0 00:02:48 00:02:31 192.168.34.1
224.0.1.40 FastEthernet0/0 00:13:50 00:02:31 192.168.34.2
```

For R4:

```
Router#show ip igmp groups
IGMP Connected Group Membership
Group Address Interface Uptime Expires Last Reporter
224.4.4.4 FastEthernet0/0 00:03:00 00:02:19 192.168.34.1
224.0.1.40 FastEthernet0/0 00:13:15 00:02:20 192.168.34.2
```

Displaying PIM Neighbor of all routers:

```
Router#show ip pim neighbor
PIM Neighbor Table
Neighbor Interface Uptime/Expires Ver DR
Address Prio/Mode
192.168.12.2 FastEthernet0/0 00:17:41/00:01:20 v2 1 / DR S
```

```
Router#show ip pim neighbor
PIM Neighbor Table
Neighbor Interface Uptime/Expires Ver DR
Address Prio/Mode
192.168.12.1 FastEthernet0/0 00:17:52/00:01:34 v2 1 / S
192.168.23.2 Serial0/0 00:16:24/00:01:36 v2 1 / S
```

```
Router#show ip pim neighbor
PIM Neighbor Table
Neighbor Interface Uptime/Expires Ver DR
Address Prio/Mode
192.168.34.1 FastEthernet0/0 00:15:57/00:01:32 v2 1 / S
192.168.23.1 Serial0/0 00:16:37/00:01:22 v2 1 / S
```

```
Router#show ip pim neighbor
PIM Neighbor Table
Neighbor Interface Uptime/Expires Ver DR
Address Prio/Mode
192.168.34.2 FastEthernet0/0 00:16:07/00:01:23 v2 1 / DR S
```

Displaying RP Mapping of all the routers:

```
Router#show ip pim rp mapping
PIM Group-to-RP Mappings
Acl: 1, Static
RP: 3.3.3.3 (?)
```

```
Router#show ip pim rp mapping
PIM Group-to-RP Mappings
Acl: 1, Static
RP: 3.3.3.3 (?)
```

```
Router#show ip pim rp mapping
PIM Group-to-RP Mappings
Acl: 1, Static
RP: 3.3.3.3 (?)
```

```
Router#show ip pim rp mapping
PIM Group-to-RP Mappings
Acl: 1, Static
RP: 3.3.3.3 (?)
```

Displaying Multicast Routing Table of all the routers:

```
Router#show ip mroute
IP Multicast Routing Table
(*, 224.0.1.40), 00:16:55/00:02:04, RP 0.0.0.0, flags: DCL
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list:
FastEthernet0/0, Forward/Sparse-Dense, 00:16:55/00:00:00
```

```
Router#show ip mroute
IP Multicast Routing Table
(*, 224.0.1.40), 00:16:38/00:02:34, RP 0.0.0.0, flags: DCL
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list:
Serial0/0, Forward/Sparse-Dense, 00:16:38/00:00:00
FastEthernet0/0, Forward/Sparse-Dense, 00:16:38/00:00:00
```

```
Router#show ip mroute
IP Multicast Routing Table
(*, 224.4.4.4), 00:10:39/00:02:38, RP 3.3.3.3, flags: SJC
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list:
FastEthernet0/0, Forward/Sparse-Dense, 00:10:39/00:02:38
(*, 224.0.1.40), 00:15:37/00:02:43, RP 0.0.0.0, flags: DCL
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list:
Serial0/0, Forward/Sparse-Dense, 00:15:37/00:00:00
FastEthernet0/0, Forward/Sparse-Dense, 00:15:37/00:00:00
```

```
Router#show ip mroute
IP Multicast Routing Table
(*, 224.4.4.4), 00:10:30/00:02:47, RP 3.3.3.3, flags: SJPL
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list: Null
(*, 224.0.1.40), 00:13:59/00:02:52, RP 0.0.0.0, flags: DCL
Incoming interface: Null, RPF nbr 0.0.0.0
Outgoing interface list: FastEthernet0/0, Forward/Sparse-Dense,
00:13:59/00:00:00
```

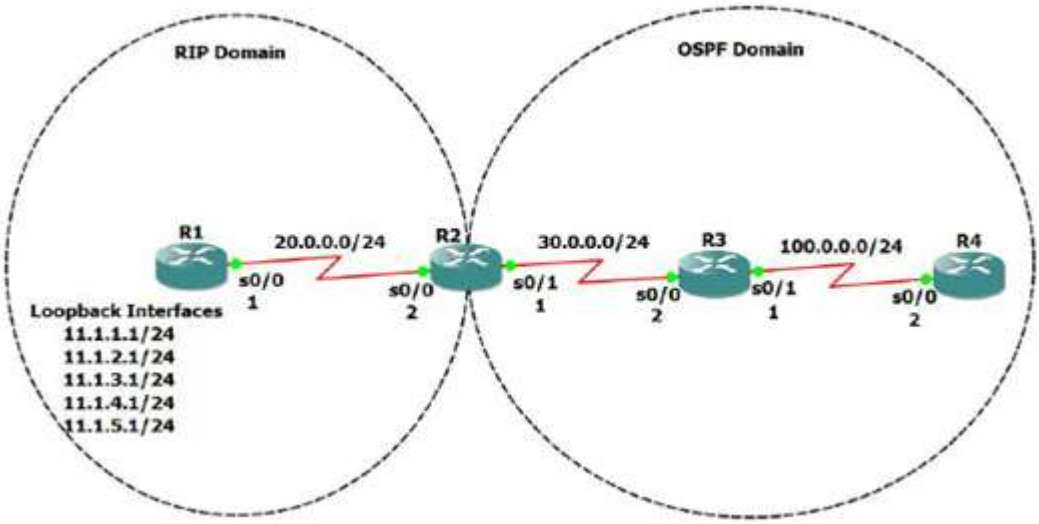
PRACTICAL NUMBER 8A
Simulating Routing Redistribution

STEPS OVERVIEW

1. Assigning IP address and Loopback addresses to R1:
2. Configuring RIP on router R1:
3. Configuring rip and ospf on router R2:
4. Configuring OSPF on routers:
5. Displaying the routing tables before Redistribution:
6. Redistributing OSPF routes in RIP Domain and RIP in OSPF Domain in R2:
7. Displaying the routing tables after Redistribution:
8. Using Ping command:

Aim-Simulating routing redistribution

Topology:



Assigning IP address and Loopback addresses to R1:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 20.0.0.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
Router#en
Router#conf t
Router(config)#int loopback1
Router(config-if)#ip address 11.1.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback2
```

```
Router(config-if)#ip address 11.1.2.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback3
Router(config-if)#ip address 11.1.3.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback4
Router(config-if)#ip address 11.1.4.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback5
Router(config-if)#ip address 11.1.5.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R2:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 20.0.0.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int s0/1
Router(config-if)#ip address 30.0.0.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R3:

```
Router#en
Router#conf t
Router(config)#int s0/0
Router(config-if)#ip address 30.0.0.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int s0/1
Router(config-if)#int s0/1
Router(config-if)#ip address 100.0.0.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R4:

```
Router#en
Router#conf t
Router(config)#int s0/1
Router(config-if)#int s0/0
Router(config-if)#ip address 100.0.0.2 255.255.255.0
```

```
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Configuring RIP on router R1:

```
Router#en
Router#conf t
Router(config)#router rip
Router(config-router)#network 20.0.0.0
Router(config-router)#network 11.1.1.0
Router(config-router)#network 11.1.2.0
Router(config-router)#network 11.1.3.0
Router(config-router)#network 11.1.4.0
Router(config-router)#network 11.1.5.0
Router(config-router)#no auto-summary
Router(config-router)#^Z
Router#exit
```

Configuring rip and ospf on router R2:

```
Router#en
Router#conf t
Router(config)#router rip
Router(config-router)#network 20.0.0.0
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#router ospf 1
Router(config-router)#network 30.0.0.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

Configuring OSPF on routers:

For R3

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 30.0.0.0 0.0.0.255 area 0
Router(config-router)#network 30.0.0.0 0.0.0.255 area 0
Router(config-router)#network 100.0.0.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

For R4

```
Router#en
Router#conf t
Router(config)#router ospf 1
```

```
Router(config-router)#network 100.0.0.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

Displaying the routing tables before Redistribution:

For R1:

```
Router#show ip route
20.0.0.0/24 is subnetted, 1 subnets
C 20.0.0.0 is directly connected, Serial0/0
11.0.0.0/24 is subnetted, 5 subnets
C 11.1.2.0 is directly connected, Loopback2
C 11.1.3.0 is directly connected, Loopback3
C 11.1.1.0 is directly connected, Loopback1
C 11.1.4.0 is directly connected, Loopback4
C 11.1.5.0 is directly connected, Loopback5
```

For R2:

```
Router#show ip route
100.0.0.0/24 is subnetted, 1 subnets
O 100.0.0.0 [110/128] via 30.0.0.2, 00:04:54, Serial0/1
20.0.0.0/24 is subnetted, 1 subnets
C 20.0.0.0 is directly connected, Serial0/0
R 11.0.0.0/8 [120/1] via 20.0.0.1, 00:00:16, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
C 30.0.0.0 is directly connected, Serial0/1
```

For R3:

```
Router#show ip route
100.0.0.0/24 is subnetted, 1 subnets
C 100.0.0.0 is directly connected, Serial0/1
30.0.0.0/24 is subnetted, 1 subnets
C 30.0.0.0 is directly connected, Serial0/0
```

For R4:

```
Router#show ip route
100.0.0.0/24 is subnetted, 1 subnets
C 100.0.0.0 is directly connected, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
O 30.0.0.0 [110/128] via 100.0.0.1, 00:05:17, Serial0/0
```

Redistributing OSPF routes in RIP Domain and RIP in OSPF Domain in R2:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#redistribute rip subnets metric 5
Router(config-router)#exit
Router(config)#router rip
```

```
Router(config-router)#redistribute ospf 1 metric 10
Router(config-router)#^Z
Router#exit
```

Displaying the routing tables after Redistribution:

For R1:

```
Router#show ip route
R 100.0.0.0/8 [120/10] via 20.0.0.2, 00:00:15, Serial0/0
20.0.0.0/24 is subnetted, 1 subnets
C 20.0.0.0 is directly connected, Serial0/0
11.0.0.0/24 is subnetted, 5 subnets
C 11.1.2.0 is directly connected, Loopback2
C 11.1.3.0 is directly connected, Loopback3
C 11.1.1.0 is directly connected, Loopback1
C 11.1.4.0 is directly connected, Loopback4
C 11.1.5.0 is directly connected, Loopback5
R 30.0.0.0/8 [120/10] via 20.0.0.2, 00:00:15, Serial0/0
```

For R2:

```
Router#show ip route
100.0.0.0/24 is subnetted, 1 subnets
O 100.0.0.0 [110/128] via 30.0.0.2, 00:05:36, Serial0/1
20.0.0.0/24 is subnetted, 1 subnets
C 20.0.0.0 is directly connected, Serial0/0
R 11.0.0.0/8 [120/1] via 20.0.0.1, 00:00:07, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
C 30.0.0.0 is directly connected, Serial0/1
```

For R3:

```
Router#show ip route
100.0.0.0/24 is subnetted, 1 subnets
C 100.0.0.0 is directly connected, Serial0/1
20.0.0.0/24 is subnetted, 1 subnets
O E2 20.0.0.0 [110/5] via 30.0.0.1, 00:05:45, Serial0/0
O E2 11.0.0.0/8 [110/5] via 30.0.0.1, 00:05:45, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
C 30.0.0.0 is directly connected, Serial0/0
```

For R4:

```
Router#show ip route
100.0.0.0/24 is subnetted, 1 subnets
C 100.0.0.0 is directly connected, Serial0/0
20.0.0.0/24 is subnetted, 1 subnets
O E2 20.0.0.0 [110/5] via 100.0.0.1, 00:06:36, Serial0/0
O E2 11.0.0.0/8 [110/5] via 100.0.0.1, 00:06:36, Serial0/0
30.0.0.0/24 is subnetted, 1 subnets
O 30.0.0.0 [110/128] via 100.0.0.1, 00:06:36, Serial0/0
```

```
Router#ping 100.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 100.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 576/649/
748 ms
```

```
Router#ping 100.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 100.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 456/534/
624 ms
```

```
Router#ping 20.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 352/577/
1096 ms
```

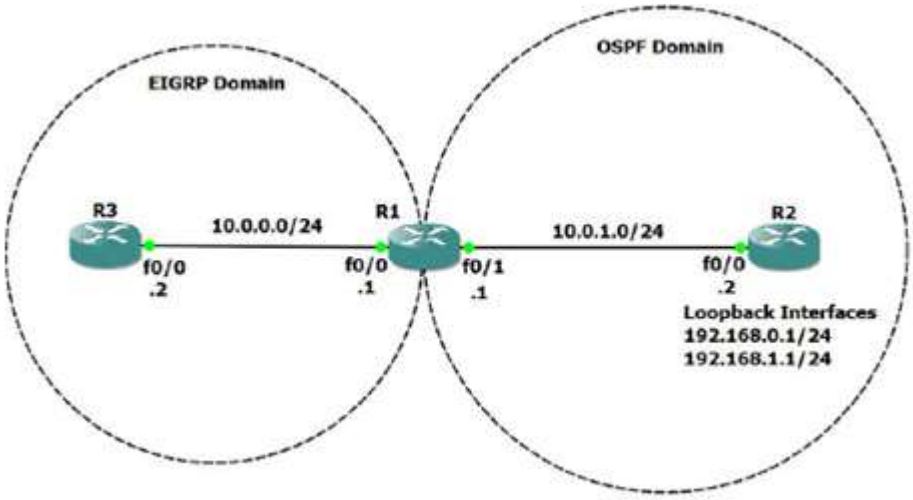
```
Router#ping 20.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 488/584/672ms
```

PRACTICAL 8B
Redistribution between EIGRP and OSPF

STEPS OVERVIEW:

1. Assigning IP addresses to R1:
2. Configuring OSPF and EIGRP on router R1:
3. Configuring EIGRP on router R2:
4. Configuring OSPF on router R3:
5. Displaying OSPF and EIGRP neighbors of R1:
6. Displaying OSPF neighbors of R2:
7. Displaying EIGRP neighbors of R3:
8. Displaying Routing Tables of all routers before Redistribution:
9. Redistributing OSPF and EIGRP
10. Displaying route tables of all routers after redistributing:
11. Performing Ping to check connectivity:

Topology:



Assigning IP addresses to R1:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 10.0.0.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#i
Router(config-if)#int f0/1
Router(config-if)#ip address 10.0.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP address and loopback addresses to R2:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 10.0.1.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback0
Router(config-if)#ip address 192.168.0.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#int loopback1
Router(config-if)#ip address 192.168.1.1 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Assigning IP addresses to R3:

```
Router#en
Router#conf t
Router(config)#int f0/0
Router(config-if)#ip address 10.0.0.2 255.255.255.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#exit
```

Configuring OSPF and EIGRP on router R1:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 10.0.1.0 0.0.0.255 area 0
Router(config-router)#exit
Router(config)#router eigrp 10
Router(config-router)#network 10.0.0.0
Router(config-router)#no auto-summary
Router(config-router)#^Z
Router#exit
```

Configuring EIGRP on router R2:

```
Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#network 10.0.1.0 0.0.0.255 area 0
```

```
Router(config-router)#network 192.168.0.0 0.0.0
Router(config-router)#network 192.168.0.0 0.0.0.255 area 0
Router(config-router)#network 192.168.1.0 0.0.0.255 area 0
Router(config-router)#^Z
Router#exit
```

Configuring OSPF on router R3:

```
Router#en
Router#conf t
Router(config)#router eigrp 10
Router(config-router)#network 10.0.0.0
Router(config-router)#no auto-summary
Router(config-router)#^Z
Router#exit
```

Displaying OSPF and EIGRP neighbors of R1:

```
Router#show ip eigrp neighbor
IP-EIGRP neighbors for process 10
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 10.0.0.2 Fa0/0 14 00:00:59 1020 5000 0 4
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
192.168.1.1 1 FULL/BDR 00:00:36 10.0.1.2 FastEthernet0/1
```

Displaying OSPF neighbors of R2:

```
Router#show ip ospf neighbor
Neighbor ID Pri State Dead Time Address Interface
10.0.1.1 1 FULL/DR 00:00:34 10.0.1.1 FastEthernet0/0
```

Displaying EIGRP neighbors of R3:

```
Router#show ip eigrp neighbor
IP-EIGRP neighbors for process 10
H Address Interface Hold Uptime SRTT RTO Q Seq
(sec) (ms) Cnt Num
0 10.0.0.1 Fa0/0 11 00:08:29 368 2208 0 2
```

Displaying Routing Tables of all routers before Redistribution:

For R1:

```
Router#show ip route
10.0.0.0/24 is subnetted, 2 subnets
C 10.0.0.0 is directly connected, FastEthernet0/0
C 10.0.1.0 is directly connected, FastEthernet0/1
```

192.168.0.0/32 is subnetted, 1 subnets
O 192.168.0.1 [110/11] via 10.0.1.2, 00:12:59, FastEthernet0/1
192.168.1.0/32 is subnetted, 1 subnets
O 192.168.1.1 [110/11] via 10.0.1.2, 00:12:59, FastEthernet0/1

For R2:

Router#show ip route
10.0.0.0/24 is subnetted, 1 subnets
C 10.0.1.0 is directly connected, FastEthernet0/0
C 192.168.0.0/24 is directly connected, Loopback0
C 192.168.1.0/24 is directly connected, Loopback1

For R3:

Router#show ip route
10.0.0.0/24 is subnetted, 2 subnets
C 10.0.0.0 is directly connected, FastEthernet0/0
D 10.0.1.0 [90/307200] via 10.0.0.1, 00:10:13, FastEthernet0/0

Redistributing OSPF and EIGRP

Router#en
Router#conf t
Router(config)#router ospf 1
Router(config-router)#redistribute eigrp 10 metric 100 metric-type 1 subnets
Router(config-router)#exit
Router(config)#router eigrp 10
Router(config-router)#redistribute ospf 1 metric 10000 10 255 5 1500
Router(config-router)#^Z
Router#exit

Displaying route tables of all routers after redistributing:

For R1:

Router#show ip route
10.0.0.0/24 is subnetted, 2 subnets
C 10.0.0.0 is directly connected, FastEthernet0/0
C 10.0.1.0 is directly connected, FastEthernet0/1
192.168.0.0/32 is subnetted, 1 subnets
O 192.168.0.1 [110/11] via 10.0.1.2, 00:03:57, FastEthernet0/1
192.168.1.0/32 is subnetted, 1 subnets
O 192.168.1.1 [110/11] via 10.0.1.2, 00:03:57, FastEthernet0/1

For R2:

Router#show ip route
10.0.0.0/24 is subnetted, 2 subnets
O E1 10.0.0.0 [110/110] via 10.0.1.1, 00:04:05, FastEthernet0/0
C 10.0.1.0 is directly connected, FastEthernet0/0
C 192.168.0.0/24 is directly connected, Loopback0

C 192.168.1.0/24 is directly connected, Loopback1

For R3:

Router#show ip route
10.0.0.0/24 is subnetted, 2 subnets
C 10.0.0.0 is directly connected, FastEthernet0/0
D 10.0.1.0 [90/307200] via 10.0.0.1, 00:19:45, FastEthernet0/0
192.168.0.0/32 is subnetted, 1 subnets
D EX 192.168.0.1 [170/284160] via 10.0.0.1, 00:02:49, FastEthernet0/0
192.168.1.0/32 is subnetted, 1 subnets
D EX 192.168.1.1 [170/284160] via 10.0.0.1, 00:02:49, FastEthernet0/0

Performing Ping to check connectivity:

For R2:

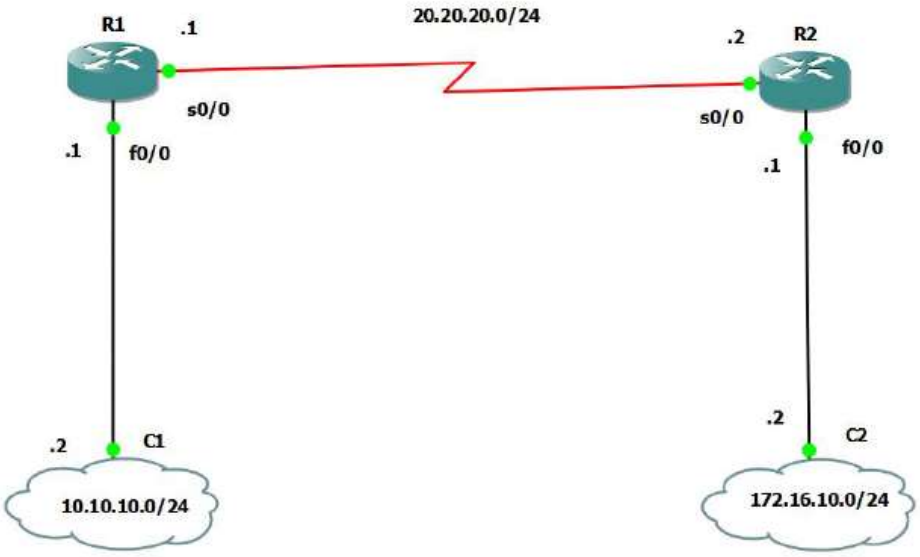
```
Router#ping 10.0.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.1.2, timeout is 2 seconds:!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

For R3:

```
Router#ping 10.0.0.2
Sending 5, 100-byte ICMP Echos to 10.0.0.2, timeout is 2 seconds:!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

PRACTICAL NUMBER 9
Designing a Remote Access VPN

Topology:



For R1:

R1(config)#int s1/0

R1(config-if)#ip address 20.20.20.1 255.255.255.252

R1(config-if)#no shut

R1(config-if)#router rip

R1(config-router)#version 2

R1(config-router)#no auto-summary

R1(config-router)#network 20.20.20.0

R1(config-router)#exit

R1(config)#int f0/0

R1(config-if)#ip address 192.168.42.243 255.255.255.0

R1(config-if)#no shut

R1(config-if)#exit

R1(config)#exit

R1(config)#router rip

R1(config-router)#version 2

R1(config-router)#no auto-summary

R1(config-router)#network 192.168.42.0

R1(config-router)#

R1(config-router)#exit

R1(config)#exit

```
R1#show ip int brief
Interface                  IP-Address      OK? Method Status       Protocol
FastEthernet0/0            192.168.42.243  YES manual up             up
Serial1/0                  20.20.20.1      YES manual up             up
```

R1(config)#crypto isakmp policy 1

R1(config-isakmp)#authentication pre-share

R1(config-isakmp)#hash sha

R1(config-isakmp)#exit

R1(config)#crypto isakmp key cisco address 20.20.20.2

R1(config)#crypto ipsec transform-set myset esp-sha-hmac esp-aes

R1(cfg-crypto-trans)#exit

```
R1(config)#$  101 permit ip 192.168.42.0 0.0.0.255 192.168.43.0 0.0.0.255
R1(config)#crypto map R1-R2 10 ipsec-is
% NOTE: This new crypto map will remain disabled until a peer
        and a valid access list have been configured.
R1(config-if)#^Z
R1#
R1#sh crypto session
Crypto session current status
Interface: Serial1/0
Session status: DOWN
Peer: 20.20.20.2 port 500
 IPSEC FLOW: permit ip 192.168.42.0/255.255.255.0 192.168.43.0/255.255.255.0
 Active SAs: 0, origin: crypto map
R1#sh crypto isakmp sa
dst             src             state          conn-id slot status
```

For Router R2

R2(config)#int s1/0
R2(config-if)#ip address 20.20.20.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#router rip
R2(config-router)#version 2
R2(config-router)#no auto-summary
R2(config-router)#network 20.20.20.0
R2(config-router)#exit
R2(config)#exit
R2#
*Mar 1 00:22:51.827: %SYS-5-CONFIG_I: Configured from console by console
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int f0/0
R2(config-if)#ip address 192.168.42.154
% Incomplete command.

R2(config-if)#ip address 192.168.42.154 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#router rip

R2(config-router)#version 2
R2(config-router)#no auto-summary
R2(config-router)#network 192.168.42.0
R2(config-router)#exit
R2(config)#exit

```
R2#show

*Mar  1 00:24:36.595: %SYS-5-CONFIG_I: Configured from console by console

R2#show ip int brief

Interface                  IP-Address      OK? Method Status
Protocol

FastEthernet0/0            192.168.42.154  YES manual up
up

Serial1/0                  20.20.20.2      YES manual up
up
```

R2(config)#crypto isakmp policy 1
R2(config-isakmp)#authentication pre-share
R2(config-isakmp)#hash sha
R2(config-isakmp)#exit
R2(config)#crypto isakmp key cisco address 20.20.20.1
R2(config)#crypto ipsec transform-set myset esp-sha-hmac esp-aes
R2(cfg-crypto-trans)#exit
R2(config)#$ 101 permit ip 192.168.43.0 0.0.0.255 192.168.42.0 0.0.0.255
R2(config)#crypto map R1-R2 10 ipsec-is
% NOTE: This new crypto map will remain disabled until a peer
and a valid access list have been configured.
R2(config-if)#^Z

```
R2#sh crypto session

Crypto session current status

Interface: Serial1/0

Session status: DOWN

Peer: 20.20.20.1 port 500 IPSEC FLOW: permit ip

192.168.43.0/255.255.255.0 192.168.42.0/255.255.255.0 Active SAs: 0,

origin: crypto map

R1#sh crypto isakmp sa

dst             src             state          conn-id slot status
```

```
R2#ping 20.20.20.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.20.20.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/12/24 ms


R2#ping 20.20.20.1 source 172.16.10.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.20.20.1, timeout is 2 seconds:
Packet sent with a source address of 172.16.10.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/16/32 ms
```

```
R1#ping 20.20.20.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.20.20.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/12/28 ms
R1#ping 20.20.20.2 source f0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 20.20.20.2, timeout is 2 seconds:
Packet sent with a source address of 10.10.10.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/10/20 ms
R1#sh run
Building configuration...
Current configuration : 1325 bytes
!
version 12.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
<--more-->
```

Third Step

- Open your cmd prompt of windows on which your GNS3 install and ping the ipaddress of Routers
- R1 and R2 simultaneously.
- It should be reply from both IP.