Department of Computer Science and Engineering

Islamic University of Technology (IUT)

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Laboratory Report

CSE 4412: Data Communication and Networking Lab

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Section: B(Even)

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Title: Configuring and Verifying of RIP and OSPF in a network topology.

Objective:

1. Describe the concept of dynamic routing
2. Explain disadvantages of RIPv1 and improvement in RIPv2
3. Configure Routing Information Protocol (RIP) in a network topology following given specifications
4. Describe the concept of OSPF and related terminologies
5. Explain the advantages of OSPF over RIP
6. Configure OSPF in a network topology following the given specifications

Devices/ software Used:

1. Cisco Packet Tracer

Theory:

(Explain in brief the listed keywords)

Routing Information Protocol (RIP):

1. **Distance-Vector:** RIP is a distance-vector routing protocol, which means routers exchange routing information based on the distance (number of hops) and direction (vector) to reach a destination network.
2. **Routing Metric:** RIP uses the number of hops (intermediate routers) as its metric for path selection. It assumes the shortest path is the one with the fewest hops. RIP has a maximum hop count of 15. If a route exceeds this limit, it is considered unreachable.
3. **Algorithm:** RIP utilizes the Bellman-Ford algorithm to determine the best path to a destination. Routers periodically share their routing tables with neighboring routers.
4. **Routing Table Updates:** RIP routers exchange routing information with their neighbors at regular intervals (typically every 30 seconds), broadcasting their entire routing table.
5. **Convergence Time:** RIP's convergence time can be slow, especially in large networks. The network experiences temporary routing inconsistencies during the convergence process.
6. **Version:** RIP has two versions - RIPv1 and RIPv2. RIPv2 includes improvements such as support for Variable Length Subnet Masking (VLSM) and better security features.
7. **Use Cases:** RIP is suitable for small to medium-sized networks where simplicity is valued over advanced features. It's commonly used in educational institutions and smaller organizations.

Forwarding Table used in RIP:

RIP routers utilize a forwarding table for routing decisions. This table includes entries for destination networks, next-hop IP addresses, and metrics based on hop count. The route type indicates if a route is directly connected, static, or learned through RIP updates. Split horizon prevents routers from advertising routes back out of the interface they were received. Route aging, hold-down timers, and garbage collection maintain the table's integrity. RIP's simplicity is reflected in its straightforward metric and periodic updates. While effective in small to medium-sized networks, RIP's limitations include slower convergence and scalability challenges.

Hop Count as cost:

In networking, hop count refers to the number of routers or network devices a packet must traverse to reach its destination. The concept of hop count serves as a cost metric in distance-vector routing protocols like RIP (Routing Information Protocol). In RIP, routes are chosen based on the lowest hop count, considering paths with fewer intermediate devices as more favorable. Each router along the path increments the hop count. RIP routers exchange this information, and the shortest path, with the least hop count, is chosen for forwarding packets. While hop count is a simple and intuitive metric, it may not accurately reflect the actual speed or quality of a network link. RIP's maximum hop count limit is 15, and routes exceeding this limit are considered unreachable.

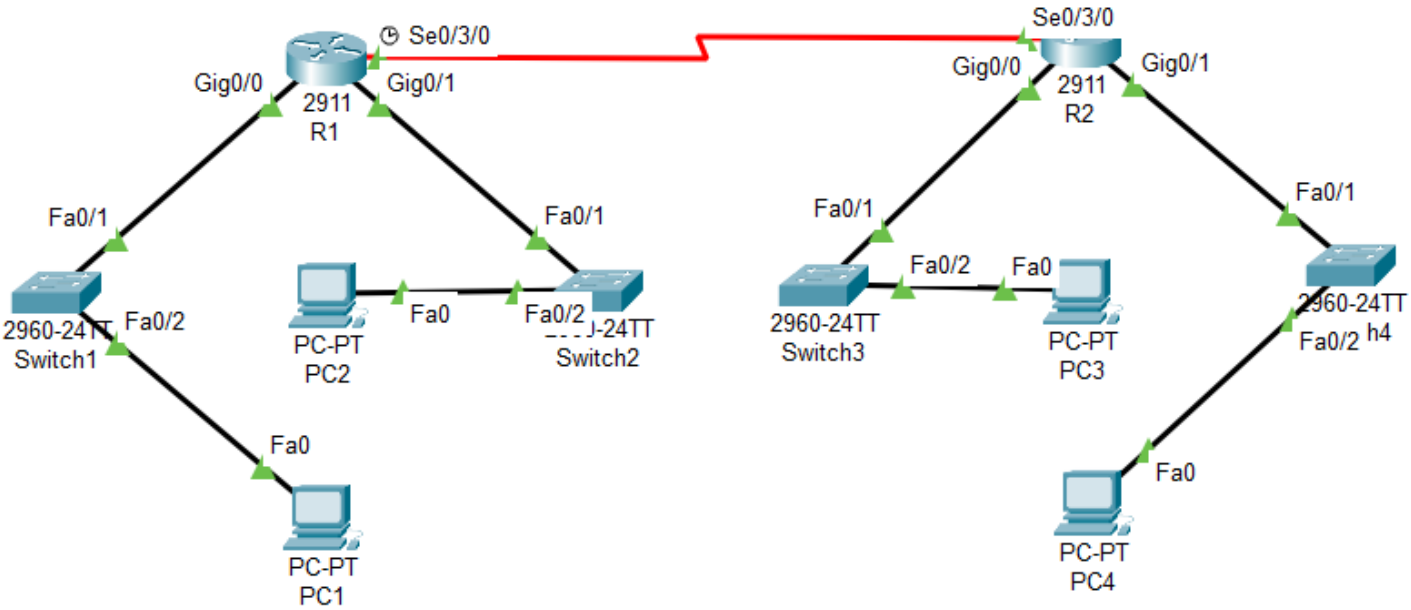
Timers in RIP:

In RIP, timers play a crucial role in managing routing information and ensuring network stability. The update timer, typically set to 30 seconds, determines how often routers exchange routing information. The invalid timer, set to three times the update timer, marks a route as invalid if no updates are received within this period. The holddown timer, initiated after an update indicating a route is unreachable, prevents the router from accepting new information about that route for a specified duration, usually three times the update timer. These timers collectively contribute to RIP's convergence process by regulating when routers share information, detect invalid routes, and stabilize the routing tables. Properly configured timers are essential for maintaining accurate and timely routing information in RIP-based networks.

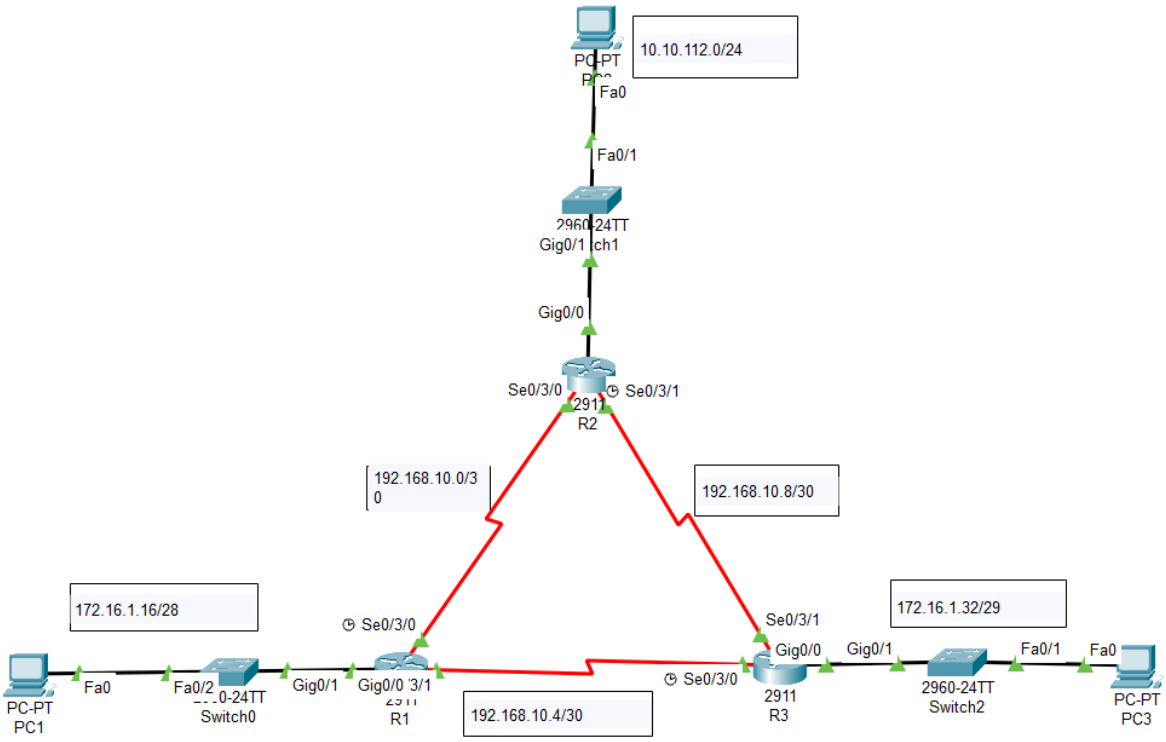
Diagram of the experiment:

(Provide screenshot of the final network topology. Make sure to label the network components.)

Task #01:



Task #02:

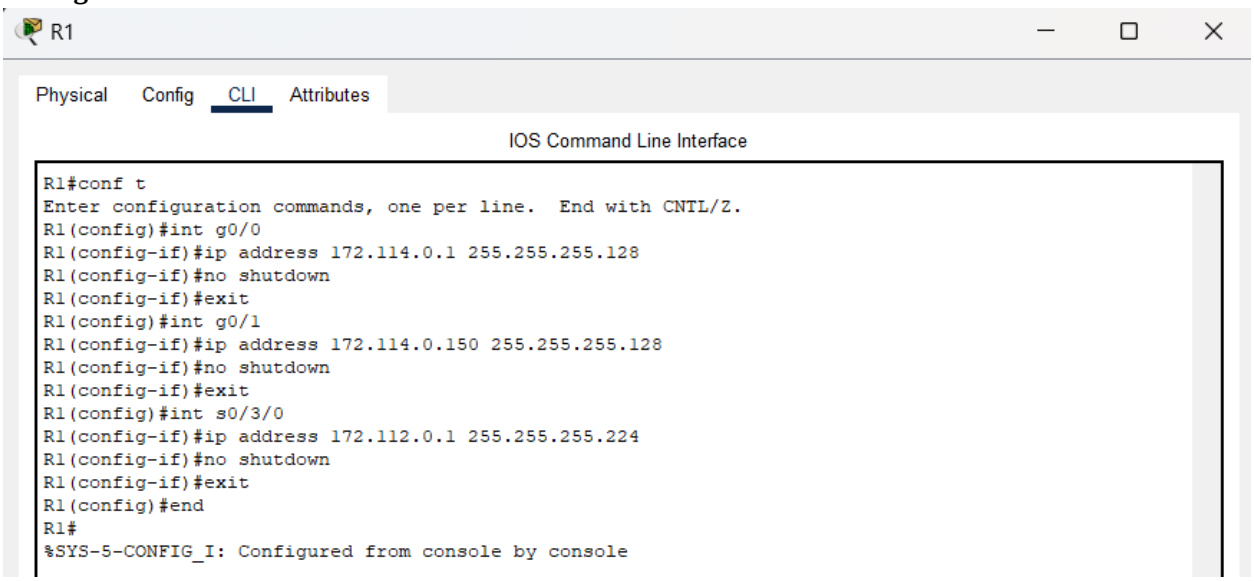


Working Procedure:

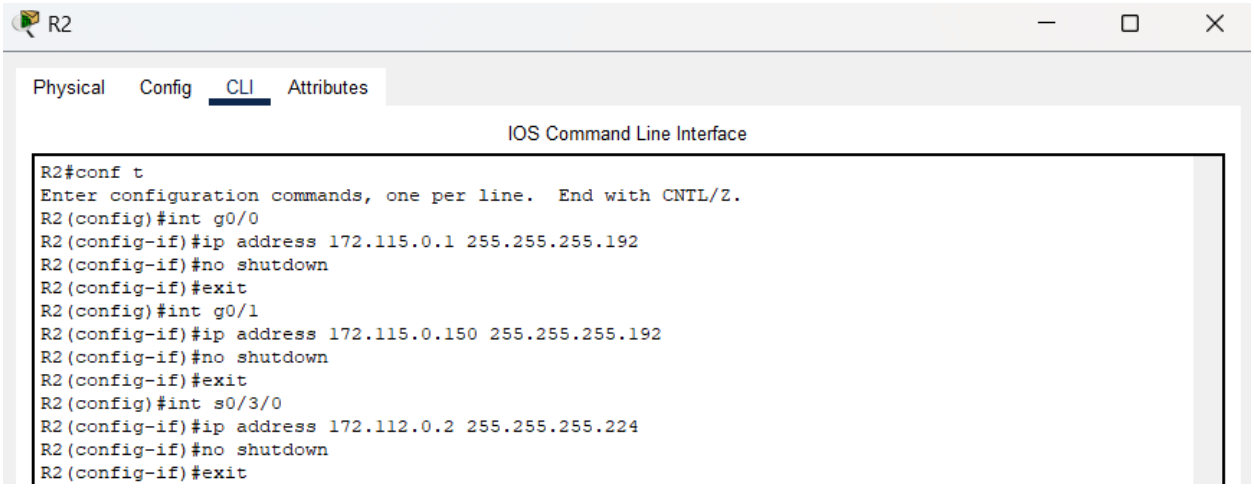
(Explain in brief how you completed the tasks. Provide necessary screenshots of used commands for each task.)

Task #01:

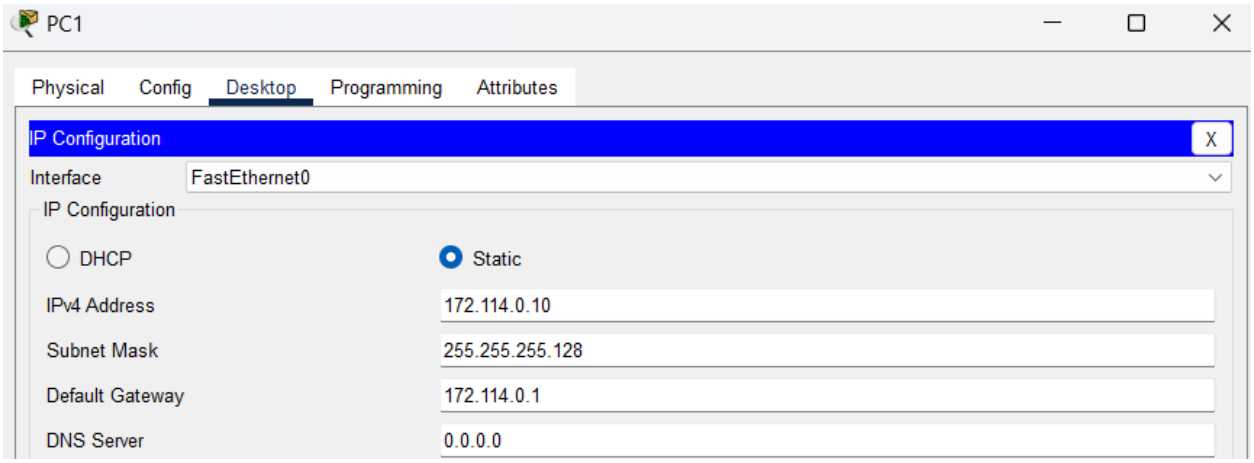
Configure R1 interfaces:



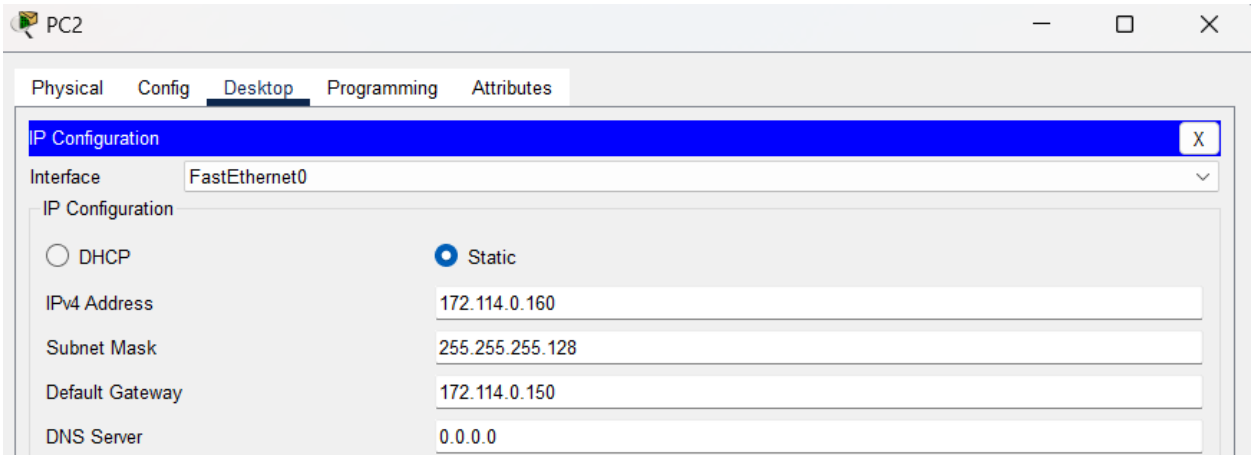
Configure R2 interfaces:



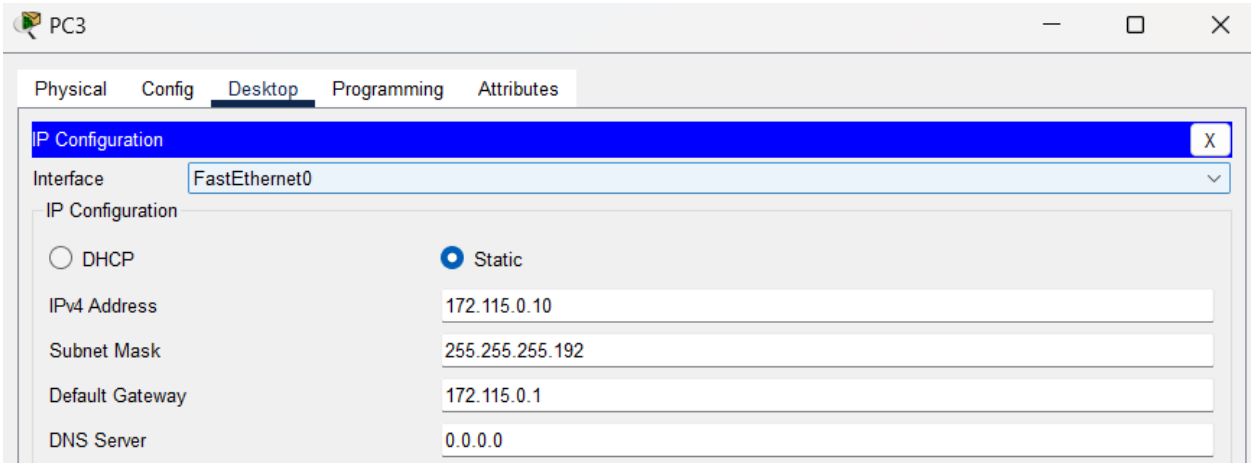
Configure PC1:



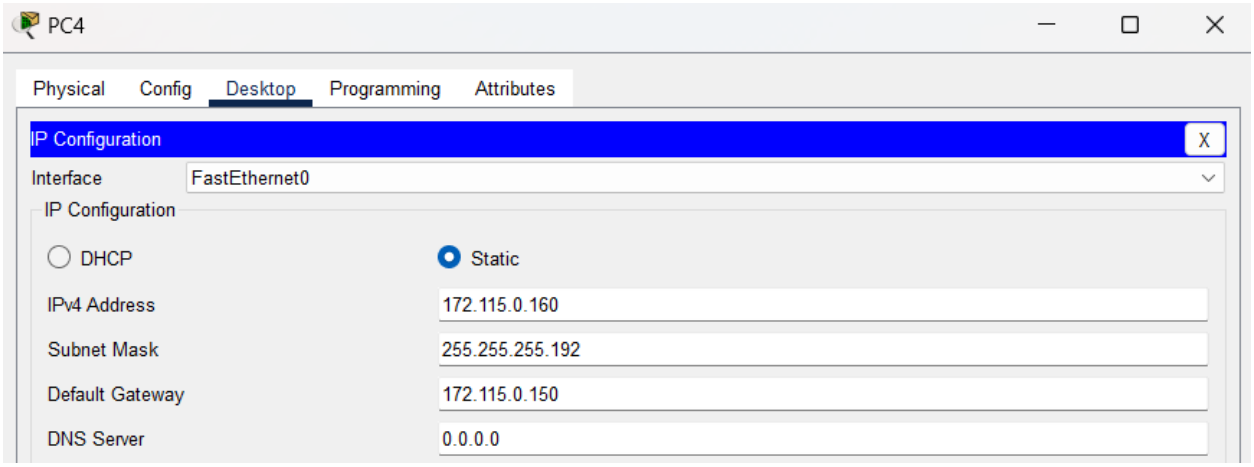
Configure PC2:



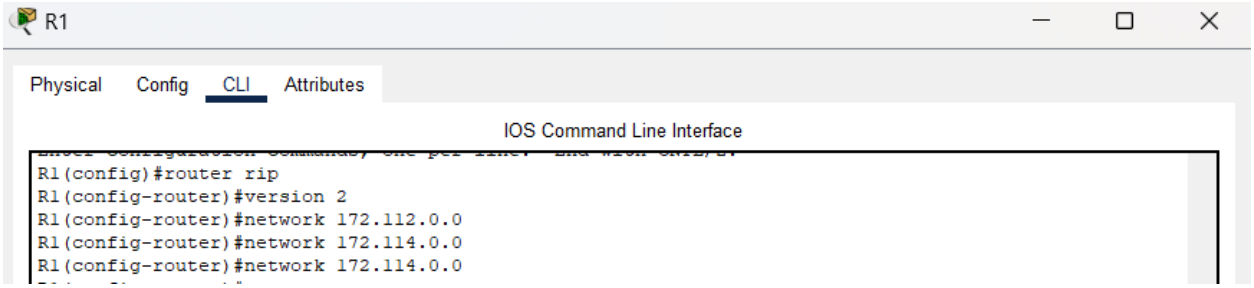
Configure PC3:



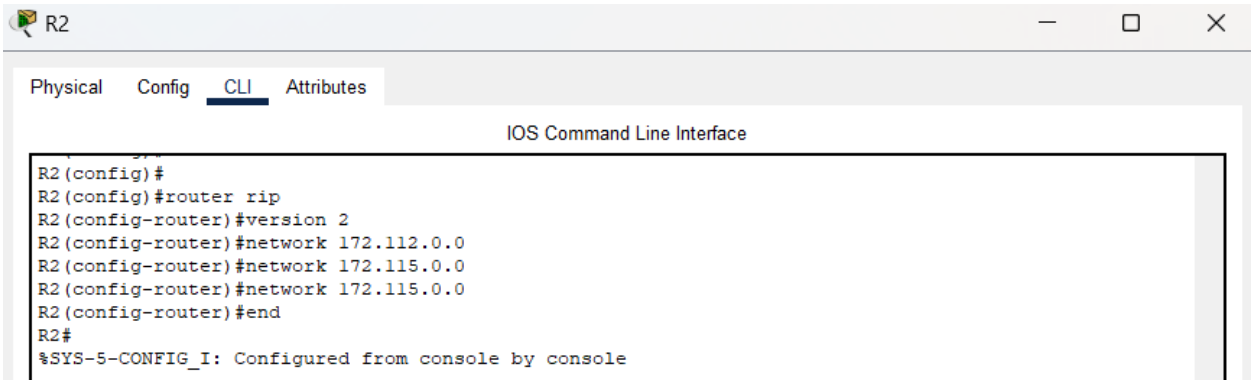
Configure PC4:



Configure RIP in R1:



Configure RIP in R2:

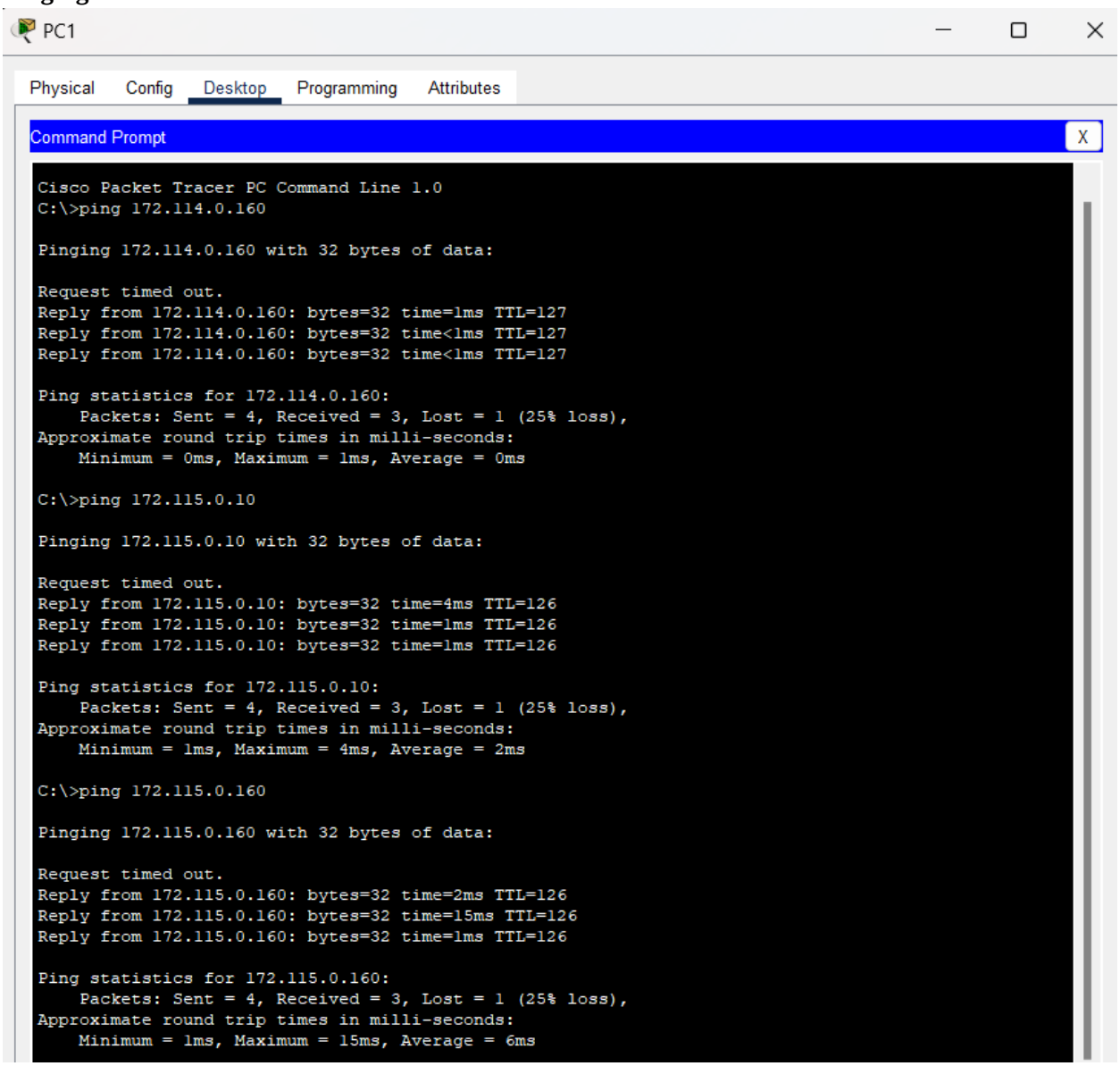


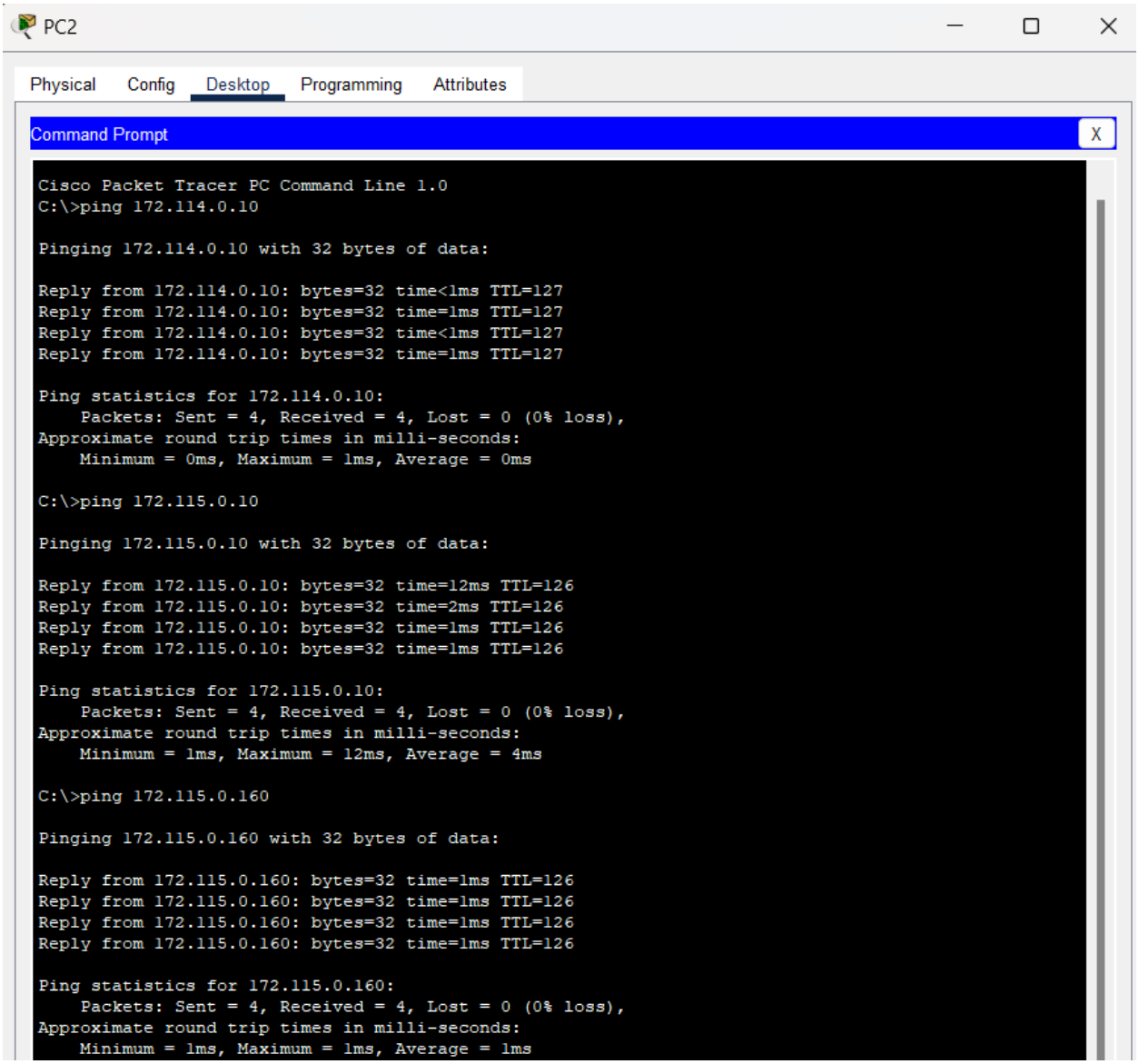
Verify:

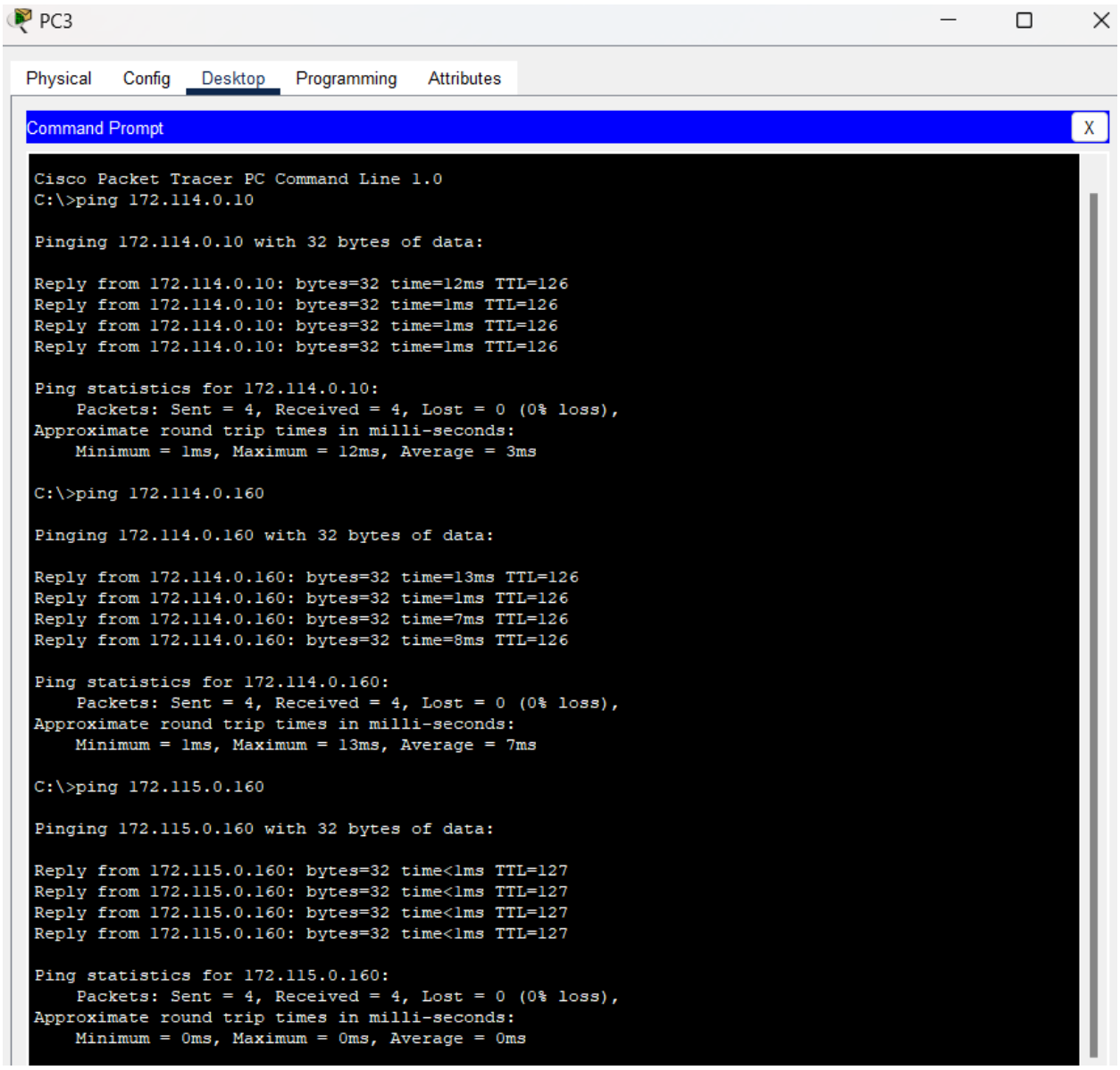
```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

     172.112.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.112.0.0/27 is directly connected, Serial0/3/0
L       172.112.0.1/32 is directly connected, Serial0/3/0
     172.114.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.114.0.0/25 is directly connected, GigabitEthernet0/0
L       172.114.0.1/32 is directly connected, GigabitEthernet0/0
C       172.114.0.128/25 is directly connected, GigabitEthernet0/1
L       172.114.0.150/32 is directly connected, GigabitEthernet0/1
R    172.115.0.0/16 [120/1] via 172.112.0.2, 00:00:23, Serial0/3/0
```

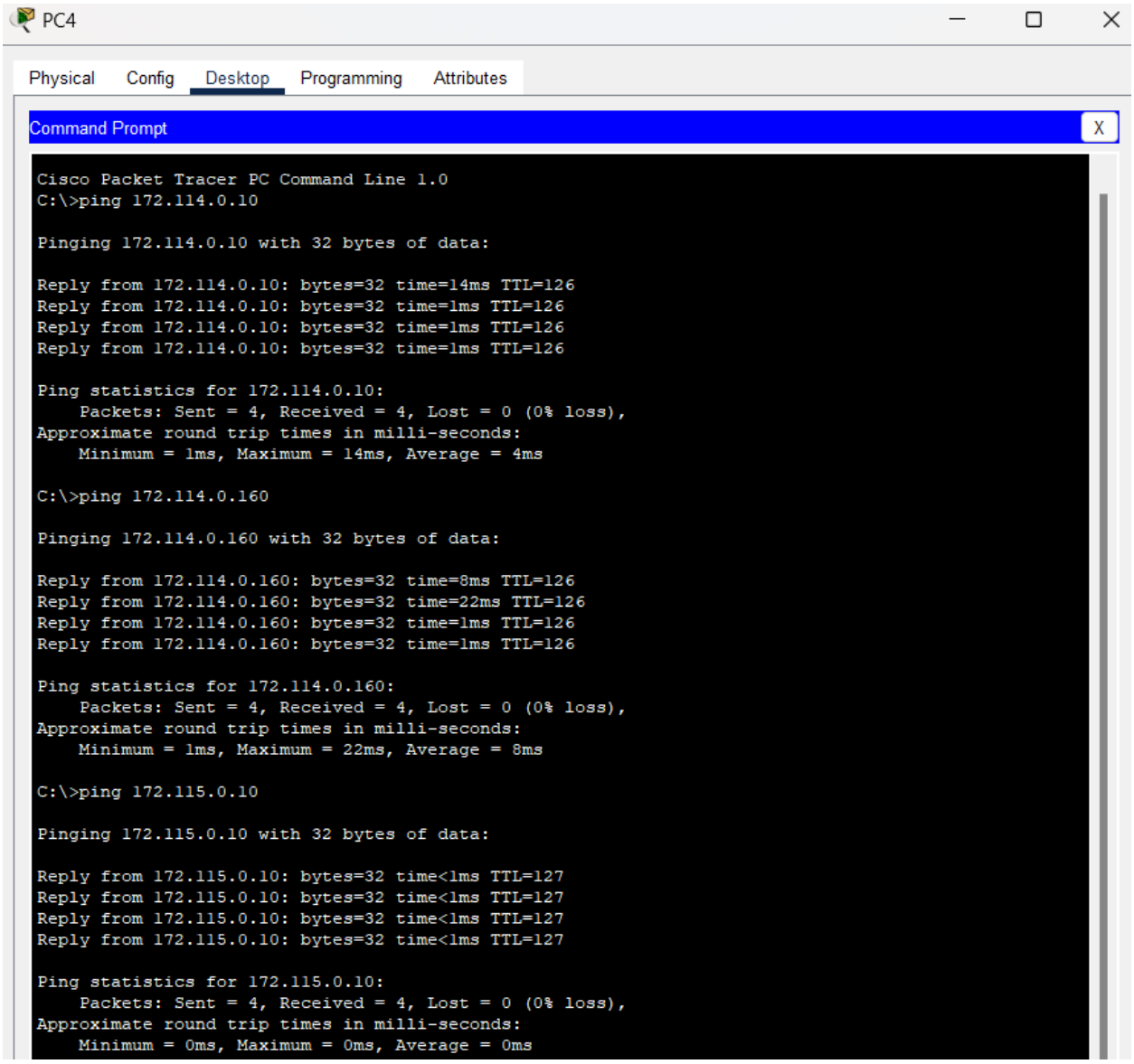
```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

     172.112.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.112.0.0/27 is directly connected, Serial0/3/0
L       172.112.0.2/32 is directly connected, Serial0/3/0
R    172.114.0.0/16 [120/1] via 172.112.0.1, 00:00:03, Serial0/3/0
     172.115.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.115.0.0/26 is directly connected, GigabitEthernet0/0
L       172.115.0.1/32 is directly connected, GigabitEthernet0/0
C       172.115.0.128/26 is directly connected, GigabitEthernet0/1
L       172.115.0.150/32 is directly connected, GigabitEthernet0/1
```

Pinging from PCs:




PC2
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 172.114.0.10
Pinging 172.114.0.10 with 32 bytes of data:
Reply from 172.114.0.10: bytes=32 time<1ms TTL=127
Reply from 172.114.0.10: bytes=32 time=1ms TTL=127
Reply from 172.114.0.10: bytes=32 time<1ms TTL=127
Reply from 172.114.0.10: bytes=32 time=1ms TTL=127
Ping statistics for 172.114.0.10:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>ping 172.115.0.10
Pinging 172.115.0.10 with 32 bytes of data:
Reply from 172.115.0.10: bytes=32 time=12ms TTL=126
Reply from 172.115.0.10: bytes=32 time=2ms TTL=126
Reply from 172.115.0.10: bytes=32 time=1ms TTL=126
Reply from 172.115.0.10: bytes=32 time=1ms TTL=126
Ping statistics for 172.115.0.10:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 12ms, Average = 4ms
C:\>ping 172.115.0.160
Pinging 172.115.0.160 with 32 bytes of data:
Reply from 172.115.0.160: bytes=32 time=1ms TTL=126
Reply from 172.115.0.160: bytes=32 time=1ms TTL=126
Reply from 172.115.0.160: bytes=32 time=1ms TTL=126
Reply from 172.115.0.160: bytes=32 time=1ms TTL=126
Ping statistics for 172.115.0.160:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 1ms, Average = 1ms


PC3
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 172.114.0.10
Pinging 172.114.0.10 with 32 bytes of data:
Reply from 172.114.0.10: bytes=32 time=12ms TTL=126
Reply from 172.114.0.10: bytes=32 time=1ms TTL=126
Reply from 172.114.0.10: bytes=32 time=1ms TTL=126
Reply from 172.114.0.10: bytes=32 time=1ms TTL=126
Ping statistics for 172.114.0.10:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 12ms, Average = 3ms
C:\>ping 172.114.0.160
Pinging 172.114.0.160 with 32 bytes of data:
Reply from 172.114.0.160: bytes=32 time=13ms TTL=126
Reply from 172.114.0.160: bytes=32 time=1ms TTL=126
Reply from 172.114.0.160: bytes=32 time=7ms TTL=126
Reply from 172.114.0.160: bytes=32 time=8ms TTL=126
Ping statistics for 172.114.0.160:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 13ms, Average = 7ms
C:\>ping 172.115.0.160
Pinging 172.115.0.160 with 32 bytes of data:
Reply from 172.115.0.160: bytes=32 time<1ms TTL=127
Reply from 172.115.0.160: bytes=32 time<1ms TTL=127
Reply from 172.115.0.160: bytes=32 time<1ms TTL=127
Reply from 172.115.0.160: bytes=32 time<1ms TTL=127
Ping statistics for 172.115.0.160:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms


PC4
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 172.114.0.10
Pinging 172.114.0.10 with 32 bytes of data:
Reply from 172.114.0.10: bytes=32 time=14ms TTL=126
Reply from 172.114.0.10: bytes=32 time=1ms TTL=126
Reply from 172.114.0.10: bytes=32 time=1ms TTL=126
Reply from 172.114.0.10: bytes=32 time=1ms TTL=126
Ping statistics for 172.114.0.10:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 14ms, Average = 4ms
C:\>ping 172.114.0.160
Pinging 172.114.0.160 with 32 bytes of data:
Reply from 172.114.0.160: bytes=32 time=8ms TTL=126
Reply from 172.114.0.160: bytes=32 time=22ms TTL=126
Reply from 172.114.0.160: bytes=32 time=1ms TTL=126
Reply from 172.114.0.160: bytes=32 time=1ms TTL=126
Ping statistics for 172.114.0.160:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 22ms, Average = 8ms
C:\>ping 172.115.0.10
Pinging 172.115.0.10 with 32 bytes of data:
Reply from 172.115.0.10: bytes=32 time<1ms TTL=127
Reply from 172.115.0.10: bytes=32 time<1ms TTL=127
Reply from 172.115.0.10: bytes=32 time<1ms TTL=127
Reply from 172.115.0.10: bytes=32 time<1ms TTL=127
Ping statistics for 172.115.0.10:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms

Task #02:

Configure the routers:

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname R1
R1(config)#
R1(config)#
R1(config)#
R1(config)#line console 0
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#exit
R1(config)#line vty 0 4
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#exit
R1(config)#enable secret class
R1(config)#exit
R1#
%SYS-5-CONFIG_I: Configured from console by console
```

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname R@
R@(config)#
R@(config)#hostname R2
R2(config)#
R2(config)#
R2(config)#line console 0
R2(config-line)#password cisco
R2(config-line)#login
R2(config-line)#exit
R2(config)#line vty 0 4
R2(config-line)#password cisco
R2(config-line)#login
R2(config-line)#exit
R2(config)#enable secret class
R2(config)#exit
R2#
%SYS-5-CONFIG_I: Configured from console by console
```

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname R3
R3(config)#
R3(config)#
R3(config)#line console 0
R3(config-line)#password cisco
R3(config-line)#login
R3(config-line)#exit
R3(config)#line vty 0 4
R3(config-line)#password cisco
R3(config-line)#login
R3(config-line)#exit
R3(config)#enable secret class
R3(config)#exit
R3#
%SYS-5-CONFIG_I: Configured from console by console
```

Disable DNS lookup:

```
R1(config)#no ip domain-lookup
```

```
R2(config)#no ip domain-lookup
```

```
R3(config)#no ip domain-lookup
```

Configure the interfaces in R1,R2,R3:

```
R1(config)#int g0/0
R1(config-if)#ip address 172.16.1.17 255.255.255.240
R1(config-if)#no shutdown

R1(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

R1(config-if)#exit
R1(config)#int s0/3/0
R1(config-if)#ip address 192.168.10.1 255.255.255.252
R1(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/3/0, changed state to down
R1(config-if)#exit
R1(config)#int s0/3/1
R1(config-if)#ip address 192.168.10.5 255.255.255.252
R1(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/3/1, changed state to down
R1(config-if)#exit
R1(config)#exit
R1#
%SYS-5-CONFIG_I: Configured from console by console
```

```
R2(config)#int g0/0
R2(config-if)#ip address 10.10.112.1
% Incomplete command.
R2(config-if)#ip address 10.10.112.1 255.255.255.0
R2(config-if)#no shutdown

R2(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

R2(config-if)#exit
R2(config)#int s0/3/0
R2(config-if)#ip address 192.168.10.2 255.255.255.252
R2(config-if)#no shutdown

R2(config-if)#
%LINK-5-CHANGED: Interface Serial0/3/0, changed state to up
exit
R2(config)#int s0/3/1
R2(config-if)#ip address 192.168.10.2 255.255.255.252
%LINEPROTO-5-UPDOWN: Line protocol on Inte
R2(config-if)#int s0/3/1
R2(config-if)#ip address 192.168.10.9 255.255.255.252
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/3/1, changed state to down
R2(config-if)#exit
R2(config)#exit
R2#
%SYS-5-CONFIG_I: Configured from console by console
```

```
R3(config)#int g0/0
R3(config-if)#ip address 172.16.1.33
% Incomplete command.
R3(config-if)#ip address 172.16.1.33 255.255.255.248
R3(config-if)#no shutdown

R3(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up
exit
R3(config)#int s0/3/0
R3(config-if)#ip address 192.168.10.6 255.255.255.252
R3(config-if)#no shutdown

R3(config-if)#
%LINK-5-CHANGED: Interface Serial0/3/0, changed state to up
exit
R3(config)#int s0/3/1
R3(config-if)#ip address
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/3/0, changed state to up

% Incomplete command.
R3(config-if)#ip address 192.168.10.10 255.255.255.252
R3(config-if)#no shutdown

R3(config-if)#
%LINK-5-CHANGED: Interface Serial0/3/1, changed state to up

R3(config-if)#exit
R3(config)#exit
R3#
%SYS-5-CONFIG_I: Configured from console by console
```

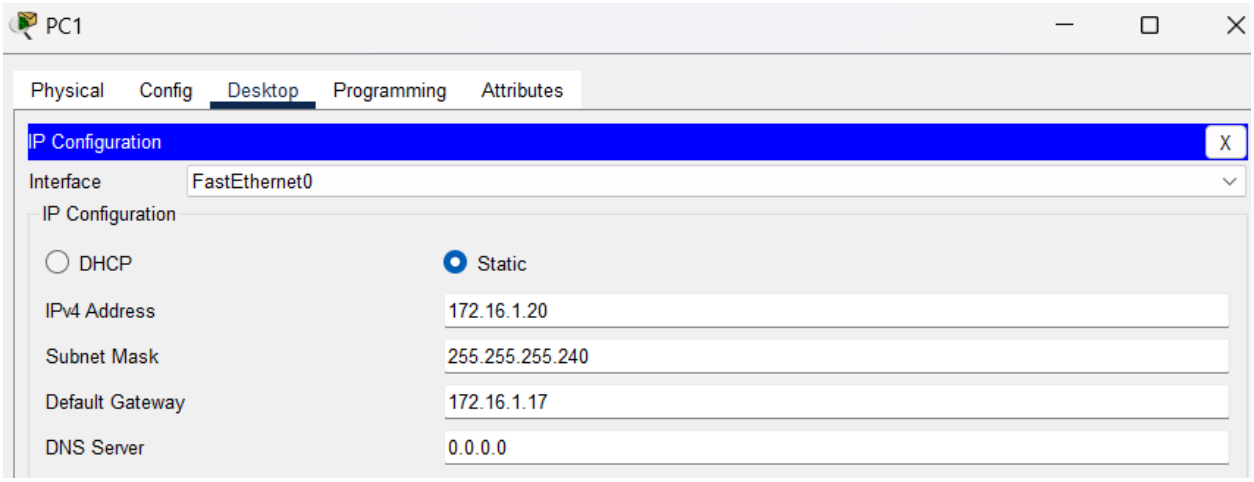
Verify IP addressing and interfaces:

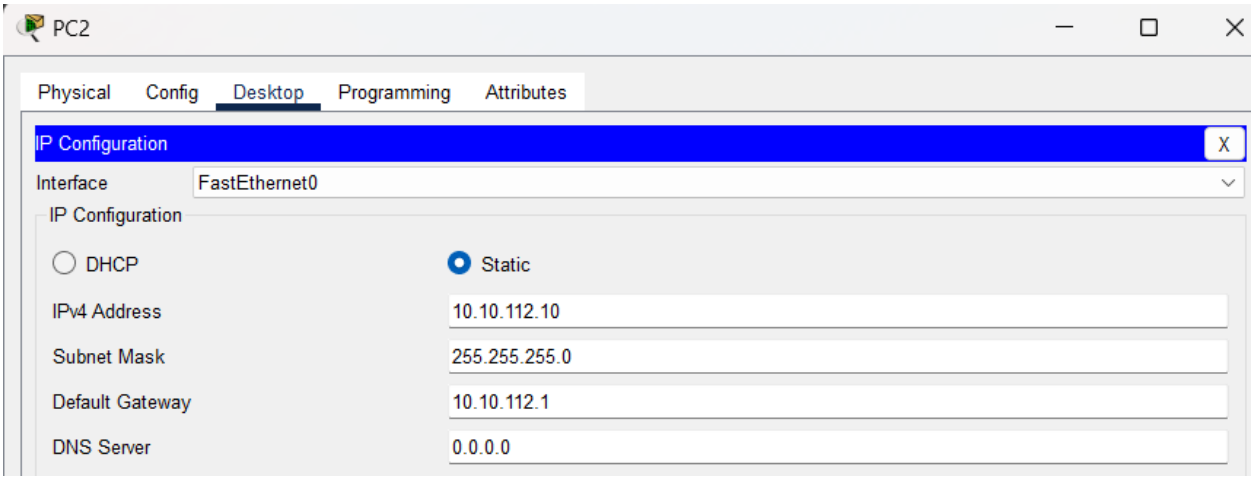
```
R1#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     172.16.1.17     YES manual up                    up
GigabitEthernet0/1     unassigned      YES unset  administratively down down
GigabitEthernet0/2     unassigned      YES unset  administratively down down
Serial0/3/0            192.168.10.1    YES manual up                    up
Serial0/3/1            192.168.10.5    YES manual up                    up
Vlan1                  unassigned      YES unset  administratively down down
```

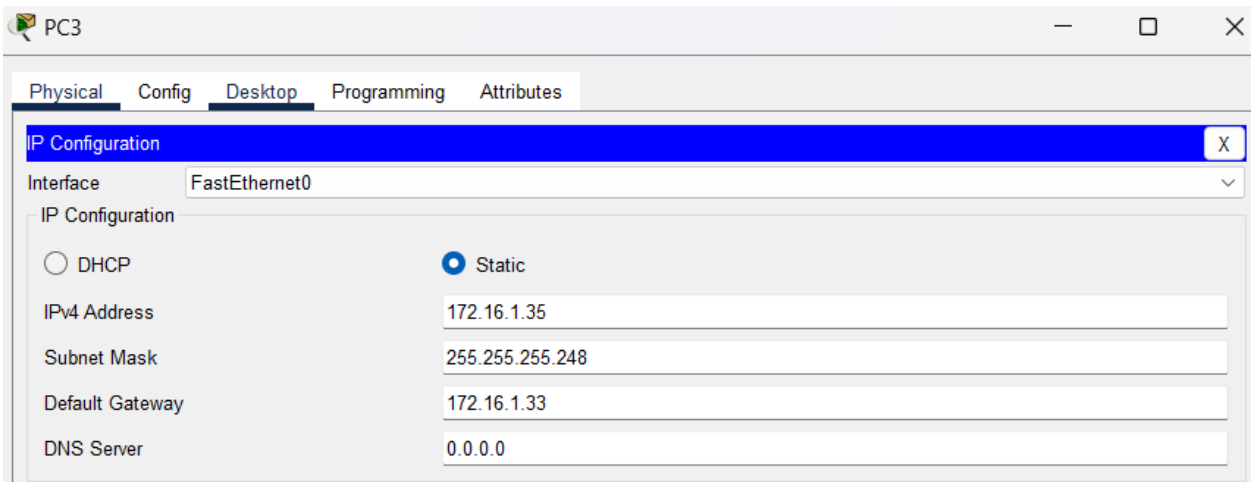
```
R2#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     10.10.112.1     YES manual up                    up
GigabitEthernet0/1     unassigned      YES unset  administratively down down
GigabitEthernet0/2     unassigned      YES unset  administratively down down
Serial0/3/0            192.168.10.2    YES manual up                    up
Serial0/3/1            192.168.10.9    YES manual up                    up
Vlan1                  unassigned      YES unset  administratively down down
```

```
R3#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     172.16.1.33     YES manual up                    up
GigabitEthernet0/1     unassigned      YES unset  administratively down down
GigabitEthernet0/2     unassigned      YES unset  administratively down down
Serial0/3/0            192.168.10.6    YES manual up                    up
Serial0/3/1            192.168.10.10   YES manual up                    up
Vlan1                  unassigned      YES unset  administratively down down
```

Configure ethernet interfaces of PC1,PC2,PC3:







Configure OSPF on the R1,R2,R3 Router:

```
R1(config)#router ospf 1
R1(config-router)#network 172.16.1.16 0.0.0.15 area 0
R1(config-router)#network 192.168.10.0 0.0.0.3 area 0
R1(config-router)#network 192.168.10.4 0.0.0.3 area 0
R1(config-router)#end
R1#
%SYS-5-CONFIG_I: Configured from console by console
```

```
R2(config)#router ospf 1
R2(config-router)#network 10.10.112.0 0.0.0.255 area 0
R2(config-router)#network 192.168.10.1 0.0.0.3 area 0
R2(config-router)#network 192.168.10.8 0.0.0.3 area 0
00:43:00: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/3/0 from LOADING to FULL, Loading
Done

R2(config-router)#end
R2#
%SYS-5-CONFIG_I: Configured from console by console
```

```
R3(config)#router ospf 1
R3(config-router)#network 172.16.1.32 0.0.0.7 area 0
R3(config-router)#network 192.168.10.5 0.0.0.3 area 0
R3(config-router)#
00:44:20: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.5 on Serial0/3/0 from LOADING to FULL, Loading
Done
network 192.168.10.10 0.0.0.3 area 0
R3(config-router)#end
00:44:37: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.10.9 on Serial0/3/1 from LOADING to FULL, Loading
Done

R3#
%SYS-5-CONFIG_I: Configured from console by console
```

Configure OSPF router IDs:

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.5
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 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. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 7 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x017c47
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R1#
R1#interface loopback 0
          ^
% Invalid input detected at '^' marker.

R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface loopback 0

R1(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ip address 10.1.1.1 255.255.255.255
```

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 10.1.1.1
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 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. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 9 times
        Area ranges are
        Number of LSA 6. Checksum Sum 0x03b50b
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R1#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          0   FULL/  -        00:00:38    192.168.10.2    Serial0/3/0
10.3.3.3          0   FULL/  -        00:00:39    192.168.10.6    Serial0/3/1
```

```
R2#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.9
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 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. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 7 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x017c47
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#interface loopback 0

R2(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ip address 10.2.2.2 255.255.255.255
```

```
R2#show ip ospf
 Routing Process "ospf 1" with ID 10.2.2.2
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 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. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 6 times
        Area ranges are
        Number of LSA 6. Checksum Sum 0x03b50b
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R2#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.3.3.3          0   FULL/  -        00:00:39    192.168.10.10   Serial0/3/1
10.1.1.1          0   FULL/  -        00:00:30    192.168.10.1    Serial0/3/0
```

```
R3#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.10
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 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. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 3 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x017c47
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#interface loopback 0

R3(config-if)#
%LINK-5-CHANGED: Interface Loopback0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ip address 10.3.3.3 255.255.255.255
```

```
R3#show ip ospf
 Routing Process "ospf 1" with ID 10.3.3.3
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 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. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 3
        Area has no authentication
        SPF algorithm executed 2 times
        Area ranges are
        Number of LSA 6. Checksum Sum 0x03b50b
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R3#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.1.1.1          0   FULL/  -        00:00:33    192.168.10.5    Serial0/3/0
10.2.2.2          0   FULL/  -        00:00:33    192.168.10.9    Serial0/3/1
```

Step 5: Use the router-id command to change the router ID on the R1 router:

```
clear ip ospf process
Reset ALL OSPF processes? [no]: y

R1#
00:07:35: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/3/0 from FULL to DOWN, Neighbor Down:
Adjacency forced to reset

00:07:35: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/3/0 from FULL to DOWN, Neighbor Down:
Interface down or detached

00:07:35: %OSPF-5-ADJCHG: Process 1, Nbr 10.3.3.3 on Serial0/3/1 from FULL to DOWN, Neighbor Down:
Adjacency forced to reset

00:07:35: %OSPF-5-ADJCHG: Process 1, Nbr 10.3.3.3 on Serial0/3/1 from FULL to DOWN, Neighbor Down:
Interface down or detached

00:07:35: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/3/0 from LOADING to FULL, Loading Done

00:07:36: %OSPF-5-ADJCHG: Process 1, Nbr 10.3.3.3 on Serial0/3/1 from LOADING to FULL, Loading Done
```

Step 6: Use the show ip ospf neighbor command on router R2 to verify that the router ID of R1 has been changed:

```
R2#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.3.3.3          0   FULL/  -        00:00:34    192.168.10.10   Serial0/3/1
10.4.4.4          0   FULL/  -        00:00:35    192.168.10.1    Serial0/3/0
R2#
```

Verify OSPF operation:

```
R1#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          0   FULL/  -        00:00:32    192.168.10.2    Serial0/3/0
10.3.3.3          0   FULL/  -        00:00:32    192.168.10.6    Serial0/3/1
R1#show ip protocols

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.4.4.4
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.1.16 0.0.0.15 area 0
    192.168.10.0 0.0.0.3 area 0
    192.168.10.4 0.0.0.3 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.1.1             110      00:06:06
    10.2.2.2             110      00:00:14
    10.3.3.3             110      00:00:14
    10.4.4.4             110      00:02:15
    192.168.10.5         110      00:35:31
    192.168.10.9         110      00:13:20
    192.168.10.10        110      00:12:24
  Distance: (default is 110)
```

Examine OSPF routes in the routing tables:

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

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.112.0/24 [110/65] via 192.168.10.2, 00:01:49, Serial0/3/0
     172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C       172.16.1.16/28 is directly connected, GigabitEthernet0/0
L       172.16.1.17/32 is directly connected, GigabitEthernet0/0
O       172.16.1.32/29 [110/65] via 192.168.10.6, 00:01:49, Serial0/3/1
     192.168.10.0/24 is variably subnetted, 5 subnets, 2 masks
C       192.168.10.0/30 is directly connected, Serial0/3/0
L       192.168.10.1/32 is directly connected, Serial0/3/0
C       192.168.10.4/30 is directly connected, Serial0/3/1
L       192.168.10.5/32 is directly connected, Serial0/3/1
O       192.168.10.8/30 [110/128] via 192.168.10.2, 00:01:49, Serial0/3/0
                        [110/128] via 192.168.10.6, 00:01:49, Serial0/3/1
```

Configure OSPF cost:

```
R1(config)#int s0/3/0
R1(config-if)#bandwidth 64
R1(config-if)#int s0/3/1
R1(config-if)#bandwidth 64
R1(config-if)#
```

```
R2(config)#int s0/3/0
R2(config-if)#bandwidth 64
R2(config-if)#int s0/3/1
R2(config-if)#bandwidth 64
R2(config-if)#
```

Use the show ip ospf interface command on the R1 router to verify the cost of the serial links:

```
R1#show ip ospf interface

GigabitEthernet0/0 is up, line protocol is up
  Internet address is 172.16.1.17/28, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 10.4.4.4, Interface address 172.16.1.17
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:08
  Index 1/1, 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 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial0/3/1 is up, line protocol is up
  Internet address is 192.168.10.5/30, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type POINT-TO-POINT, Cost: 1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:07
  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 10.3.3.3
  Suppress hello for 0 neighbor(s)
Serial0/3/0 is up, line protocol is up
  Internet address is 192.168.10.1/30, Area 0
  Process ID 1, Router ID 10.4.4.4, Network Type POINT-TO-POINT, Cost: 1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:07
  Index 3/3, 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 10.2.2.2
  Suppress hello for 0 neighbor(s)
```

For R3:

```
R3(config)#int s0/3/0
R3(config-if)#ip ospf cost 1562
R3(config-if)#int s0/3/1
R3(config-if)#ip ospf cost 1562
R3(config-if)#end
```

```
show ip ospf interface

GigabitEthernet0/0 is up, line protocol is up
  Internet address is 172.16.1.33/29, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 10.3.3.3, Interface address 172.16.1.33
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
  Index 1/1, 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 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial0/3/1 is up, line protocol is up
  Internet address is 192.168.10.10/30, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type POINT-TO-POINT, Cost: 1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:00
  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 10.2.2.2
  Suppress hello for 0 neighbor(s)
Serial0/3/0 is up, line protocol is up
  Internet address is 192.168.10.6/30, Area 0
  Process ID 1, Router ID 10.3.3.3, Network Type POINT-TO-POINT, Cost: 1562
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:05
  Index 3/3, 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 10.4.4.4
  Suppress hello for 0 neighbor(s)
```

Redistribute an OSPF default route:

```
R1(config)#interface loopback1
R1(config-if)#ip address 172.30.1.1 255.255.255.252
R1(config-if)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 loopback1
R1(config)#router ospf 1
R1(config-router)#deafult-information originate
                  ^
% Invalid input detected at '^' marker.

R1(config-router)#default-information originate
```

Configure additional OSPF features:

```
R1(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all routers.
```

```
R2(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all routers.
```

```
R3(config-router)#auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all routers.
```

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

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.1.1.1/32 is directly connected, Loopback0
O       10.10.112.0/24 [110/25188] via 192.168.10.2, 00:03:32, Serial0/3/0
     172.16.0.0/16 is variably subnetted, 3 subnets, 3 masks
C       172.16.1.16/28 is directly connected, GigabitEthernet0/0
L       172.16.1.17/32 is directly connected, GigabitEthernet0/0
O       172.16.1.32/29 [110/25188] via 192.168.10.6, 00:03:04, Serial0/3/1
     172.30.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.30.1.0/30 is directly connected, Loopback1
L       172.30.1.1/32 is directly connected, Loopback1
     192.168.10.0/24 is variably subnetted, 5 subnets, 2 masks
C       192.168.10.0/30 is directly connected, Serial0/3/0
L       192.168.10.1/32 is directly connected, Serial0/3/0
C       192.168.10.4/30 is directly connected, Serial0/3/1
L       192.168.10.5/32 is directly connected, Serial0/3/1
O       192.168.10.8/30 [110/26740] via 192.168.10.6, 00:03:32, Serial0/3/1
S*   0.0.0.0/0 is directly connected, Loopback1

R1#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          0   FULL/  -        00:00:35    192.168.10.2    Serial0/3/0
10.3.3.3          0   FULL/  -        00:00:35    192.168.10.6    Serial0/3/1
```

```
R1(config)#int s0/3/0
R1(config-if)#ip ospf hello-interval 5
R1(config-if)#ip ospf dead-interval 20
R1(config-if)#
00:45:22: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/3/0 from FULL to DOWN, Neighbor Down:
Dead timer expired

00:45:22: %OSPF-5-ADJCHG: Process 1, Nbr 10.2.2.2 on Serial0/3/0 from FULL to DOWN, Neighbor Down:
Interface down or detached
```

```
R2(config)#int s0/3/0
R2(config-if)#ip ospf hello-interval 5
R2(config-if)#ip ospf dead-interval 20
R2(config-if)#
00:58:35: %OSPF-5-ADJCHG: Process 1, Nbr 10.4.4.4 on Serial0/3/0 from LOADING to FULL, Loading Done
```

```
show ip ospf int s0/3/0

Serial0/3/0 is up, line protocol is up
  Internet address is 192.168.10.2/30, Area 0
  Process ID 1, Router ID 10.2.2.2, Network Type POINT-TO-POINT, Cost: 25178
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 5, Dead 20, Wait 20, Retransmit 5
    Hello due in 00:00:00
  Index 3/3, 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 10.4.4.4
  Suppress hello for 0 neighbor(s)
```

```
R1#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
10.2.2.2          0   FULL/  -        00:00:15    192.168.10.2    Serial0/3/0
10.3.3.3          0   FULL/  -        00:00:35    192.168.10.6    Serial0/3/1
```

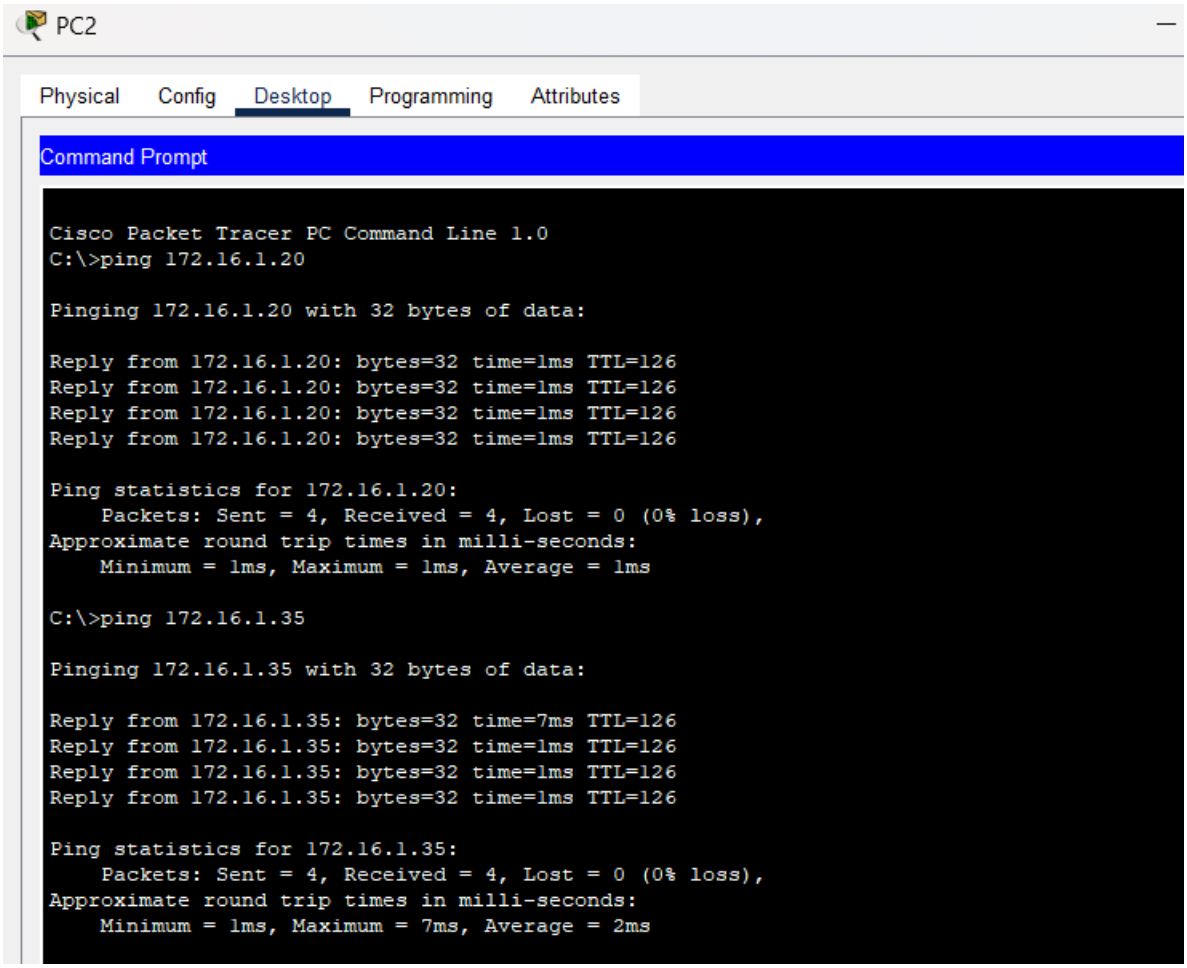
Ping from PCs:

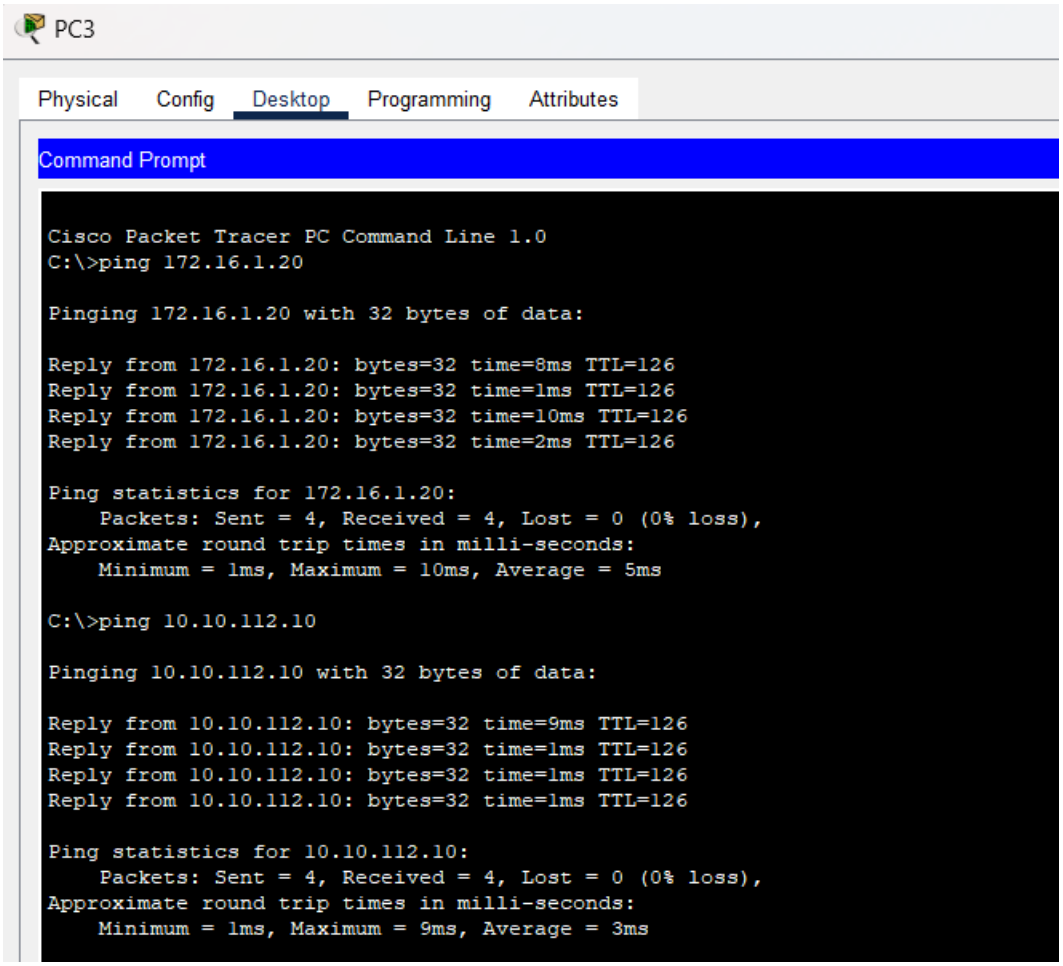
PC1

Physical | Config | Desktop | Programming | Attributes

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 10.10.112.10

Pinging 10.10.112.10 with 32 bytes of data:

Request timed out.
Reply from 10.10.112.10: bytes=32 time=1ms TTL=126
Reply from 10.10.112.10: bytes=32 time=1ms TTL=126
Reply from 10.10.112.10: bytes=32 time=11ms TTL=126

Ping statistics for 10.10.112.10:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 11ms, Average = 4ms

C:\>ping 172.16.1.35

Pinging 172.16.1.35 with 32 bytes of data:

Request timed out.
Reply from 172.16.1.35: bytes=32 time=1ms TTL=126
Reply from 172.16.1.35: bytes=32 time=1ms TTL=126
Reply from 172.16.1.35: bytes=32 time=1ms TTL=126

Ping statistics for 172.16.1.35:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```


PC2
Physical
Config
Desktop
Programming
Attributes
Command Prompt
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 172.16.1.20
Pinging 172.16.1.20 with 32 bytes of data:
Reply from 172.16.1.20: bytes=32 time=1ms TTL=126
Reply from 172.16.1.20: bytes=32 time=1ms TTL=126
Reply from 172.16.1.20: bytes=32 time=1ms TTL=126
Reply from 172.16.1.20: bytes=32 time=1ms TTL=126
Ping statistics for 172.16.1.20:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 1ms, Average = 1ms
C:\>ping 172.16.1.35
Pinging 172.16.1.35 with 32 bytes of data:
Reply from 172.16.1.35: bytes=32 time=7ms TTL=126
Reply from 172.16.1.35: bytes=32 time=1ms TTL=126
Reply from 172.16.1.35: bytes=32 time=1ms TTL=126
Reply from 172.16.1.35: bytes=32 time=1ms TTL=126
Ping statistics for 172.16.1.35:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 7ms, Average = 2ms



Q/A for the tasks:

(There were many q/a sections inside the task pdfs. Copy the questions and your answers here.)

Task #02:

Step 1: Examine the current router IDs in the topology.

Since no router IDs or loopback interfaces have been configured on the three routers, the router ID for each router is determined by the highest IP address of any active interface.

What is the router ID for R1?

Ans:192.168.10.5

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.5
 Supports only single TOS(TOS0) routes
```

What is the router ID for R2?

Ans: 192.168.10.9

```
R2#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.9
 Supports only single TOS(TOS0) routes
```

What is the router ID for R3?
Ans:192.168.10.10

```
R3#show ip ospf
 Routing Process "ospf 1" with ID 192.168.10.10
 Supports only single TOS(TOS0) routes
```

Step 3: Reload the routers to force the new Router IDs to be used.
When a new Router ID is configured, it will not be used until the OSPF process is restarted. Make sure that the current configuration is saved to NRAM, and then use the reload command to restart each of the routers.
When the router is reloaded, what is the router ID for R1?
Ans:10.1.1.1

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 10.1.1.1
```

When the router is reloaded, what is the router ID for R2?
Ans:10.2.2.2

```
R2#show ip ospf
 Routing Process "ospf 1" with ID 10.2.2.2
```

When the router is reloaded, what is the router ID for R3?
Ans:10.3.3.3

```
R3#show ip ospf
 Routing Process "ospf 1" with ID 10.3.3.3
```

Observation:

RIP:

- **Simplicity:** RIP is easy to configure due to its simple hop count metric and minimal configuration parameters.
- **Convergence Speed:** RIP may exhibit slower convergence times in larger networks due to periodic updates and limited route information.
- **Scalability:** RIP may face scalability challenges in larger networks, as its maximum hop count is 15 and periodic updates can generate significant network traffic.
- **Ease of Implementation:** RIP is straightforward to implement, making it suitable for small to medium-sized networks with simpler topologies.

OSPF:

- **Complexity:** OSPF configuration is more complex compared to RIP, with detailed area design, network types, and various configuration options.
- **Convergence Speed:** OSPF typically offers faster convergence compared to RIP, thanks to its link-state database and Dijkstra's SPF algorithm.
- **Scalability:** OSPF is well-suited for larger networks due to its hierarchical design, support for variable subnetting, and reduced routing table sizes.
- **Resource Utilization:** OSPF minimizes network traffic by sending updates only when there are changes, enhancing network efficiency.

Common Observations:

- **Security:** OSPF supports authentication for routing updates, enhancing network security, while RIP lacks built-in security features.
- **Flexibility:** OSPF provides more flexibility in terms of summarization, allowing for efficient use of IP address space.
- **Route Summarization:** OSPF enables route summarization, leading to smaller routing tables and reduced overhead.
- **Compatibility:** Both RIP and OSPF may coexist in a network if needed, allowing for a phased migration strategy.

Challenges (if any):

The OSPF task was harder because there was a lot of things to do. It was confusing to keep up with the instructions.