Jayathilaka H.A.D.T.T.

E/16/156

CO513 - Lab 04

Dynamic Routing - OSPF

1. **Explain the terms DR and BDR. What are the criteria/parameters used during the election of DR and BDR within an OSPF network?**

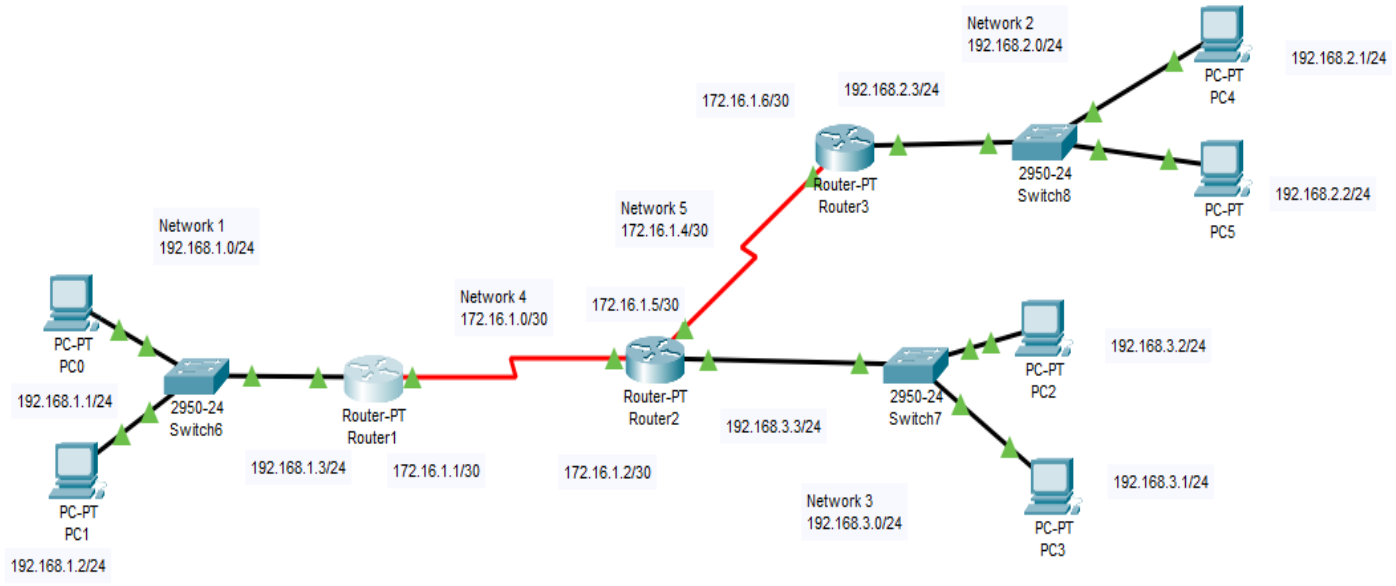
   Based on the network type, OSPF router can elect one router to be a designated router (DR) and one router to be a backup designated router (BDR). DR and BDR are elected to minimize the number of adjacencies formed and to serve as the central point for exchanging OSPF routing information. However, on point-to-point links, the DR and BDR are not elected since only two routers are directly connected.

   Upon the segment, each router will go through an election process, to elect a DR and BDR. There are two rules used to determine who is elected:

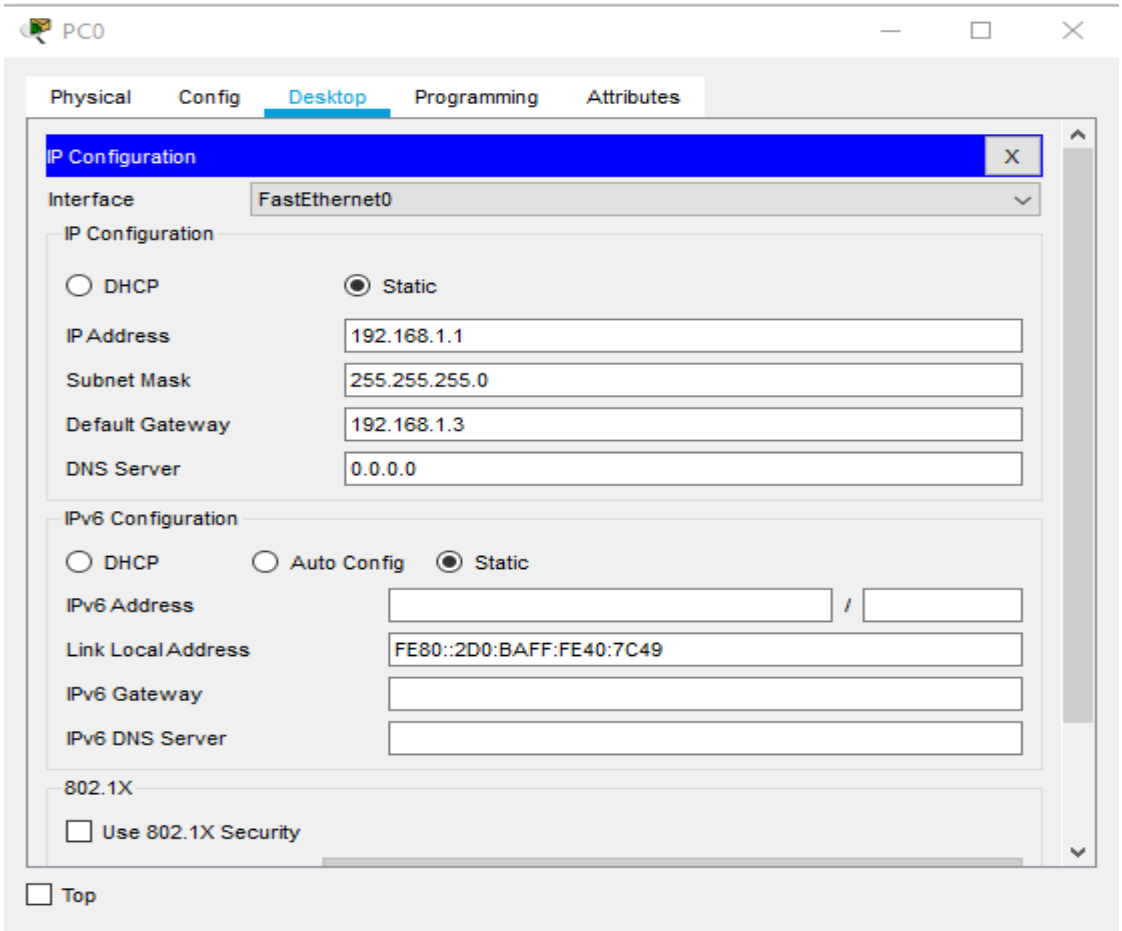
   - Priority - Router with the highest wins the election. The default priority is 1. This is configured on a per-interface level.
   - Router ID - If there is a tie, the highest router ID wins the election.

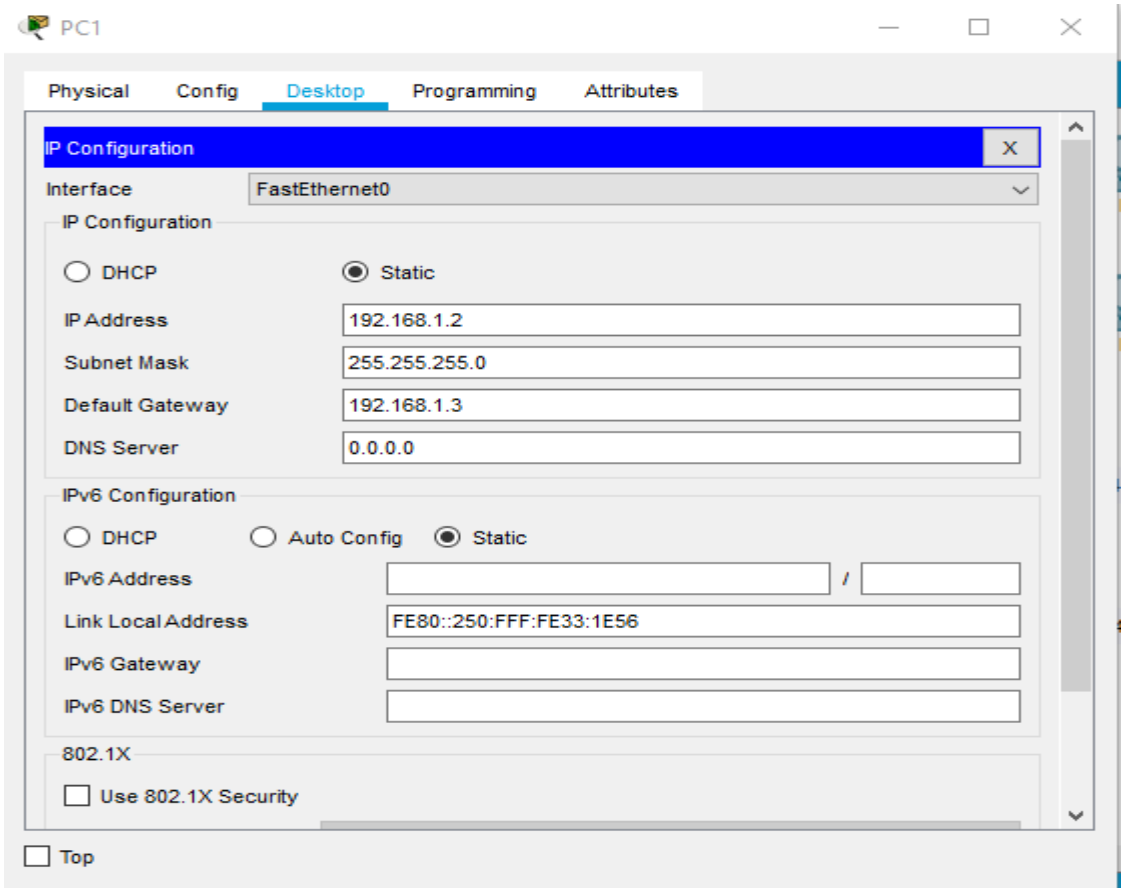
A. Configure OSPF

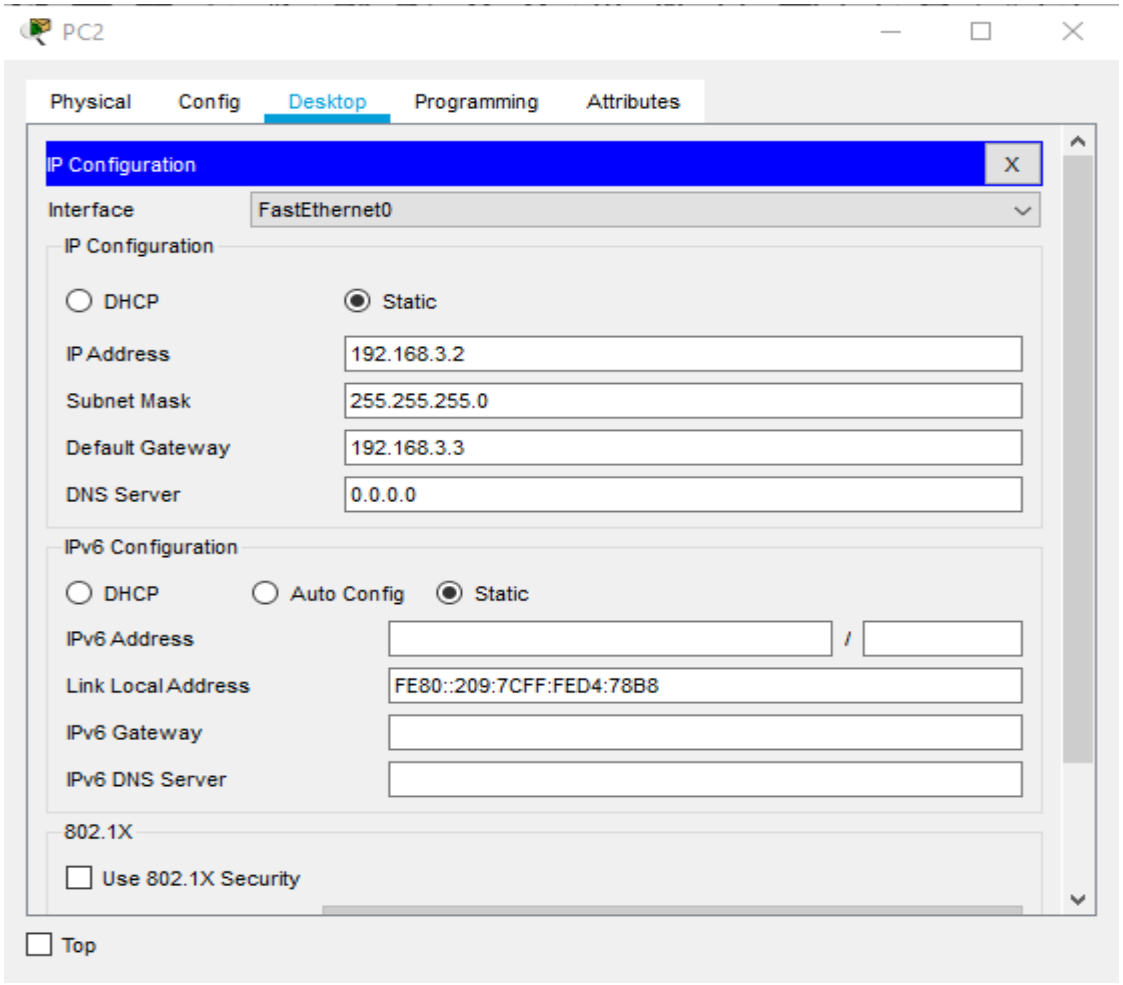
a. Draw the topology given in Figure 01, in Packet Tracer using appropriate networking and end devices.

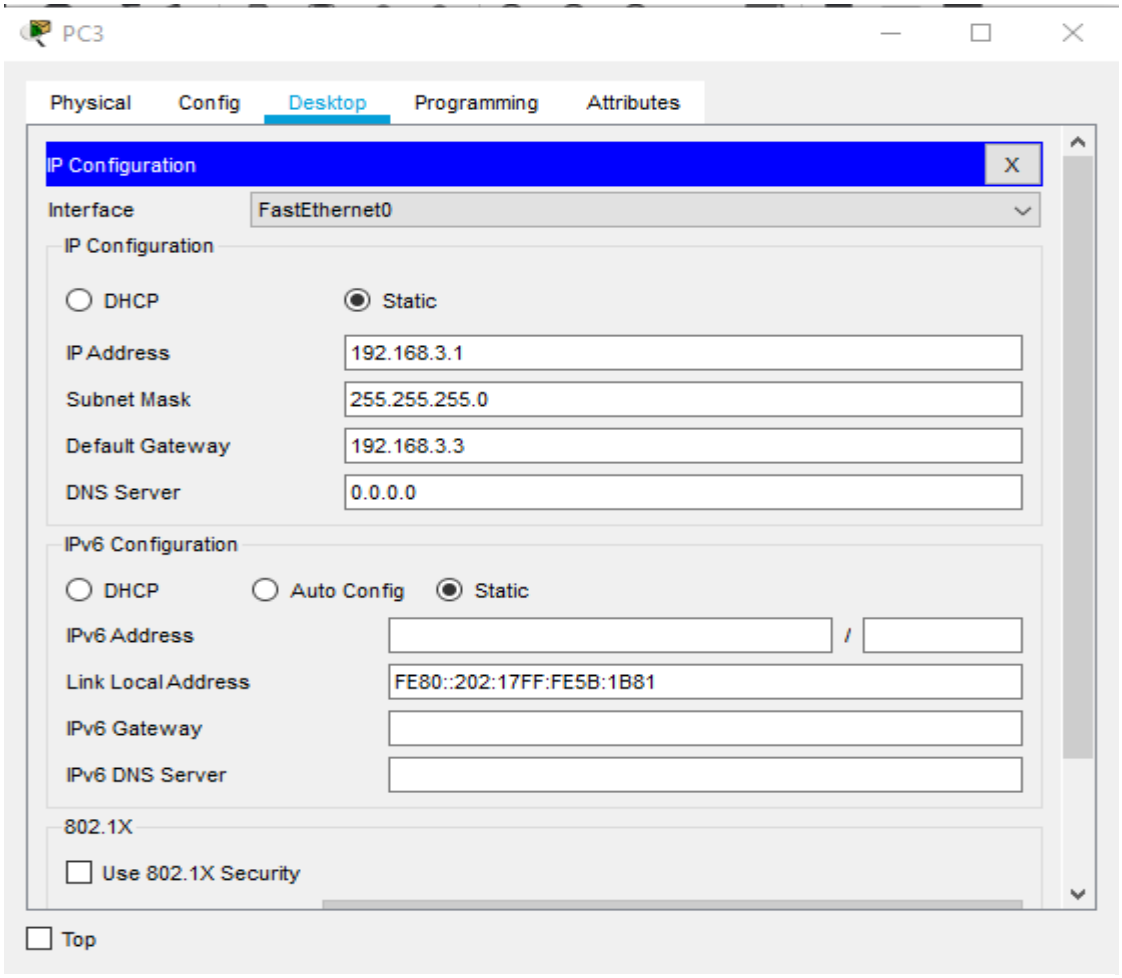


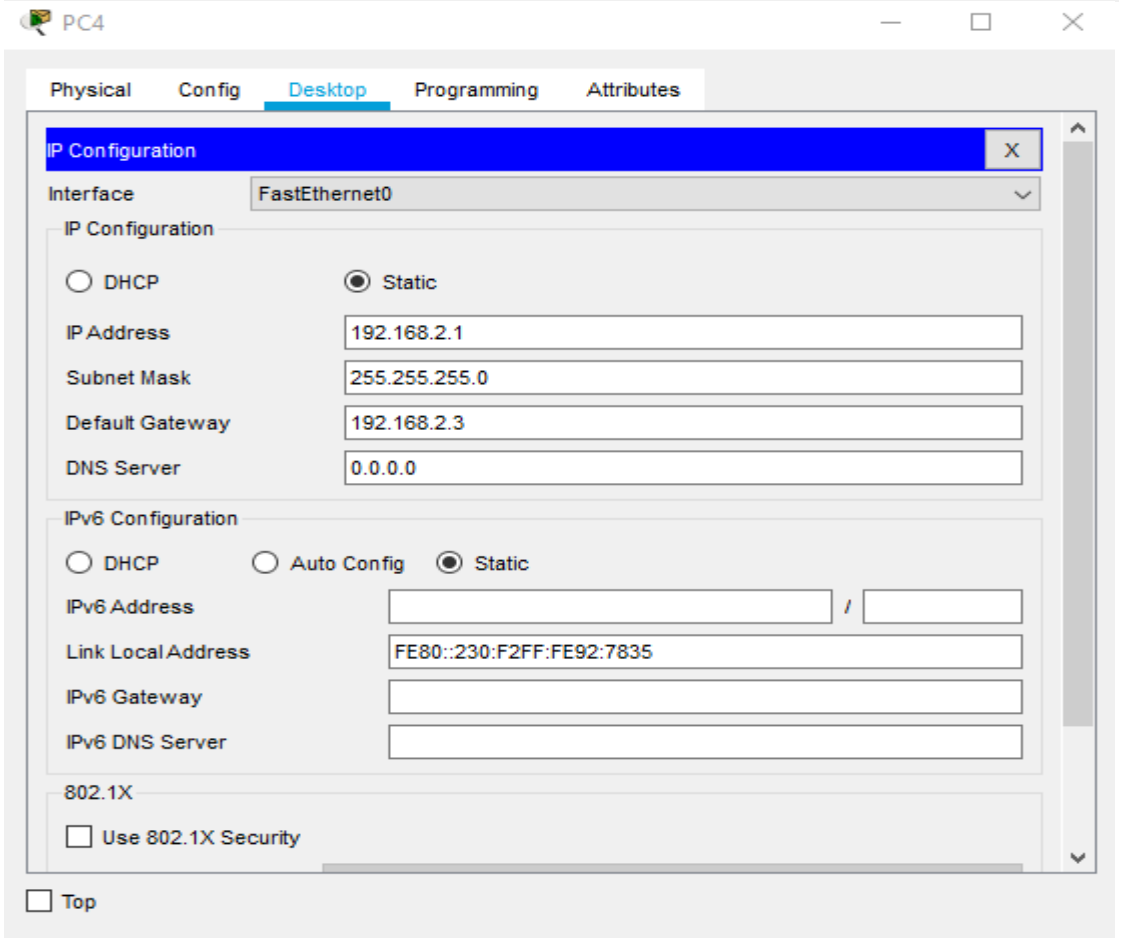
b. Assign IP addresses to each PC/router ports considering Table 01.

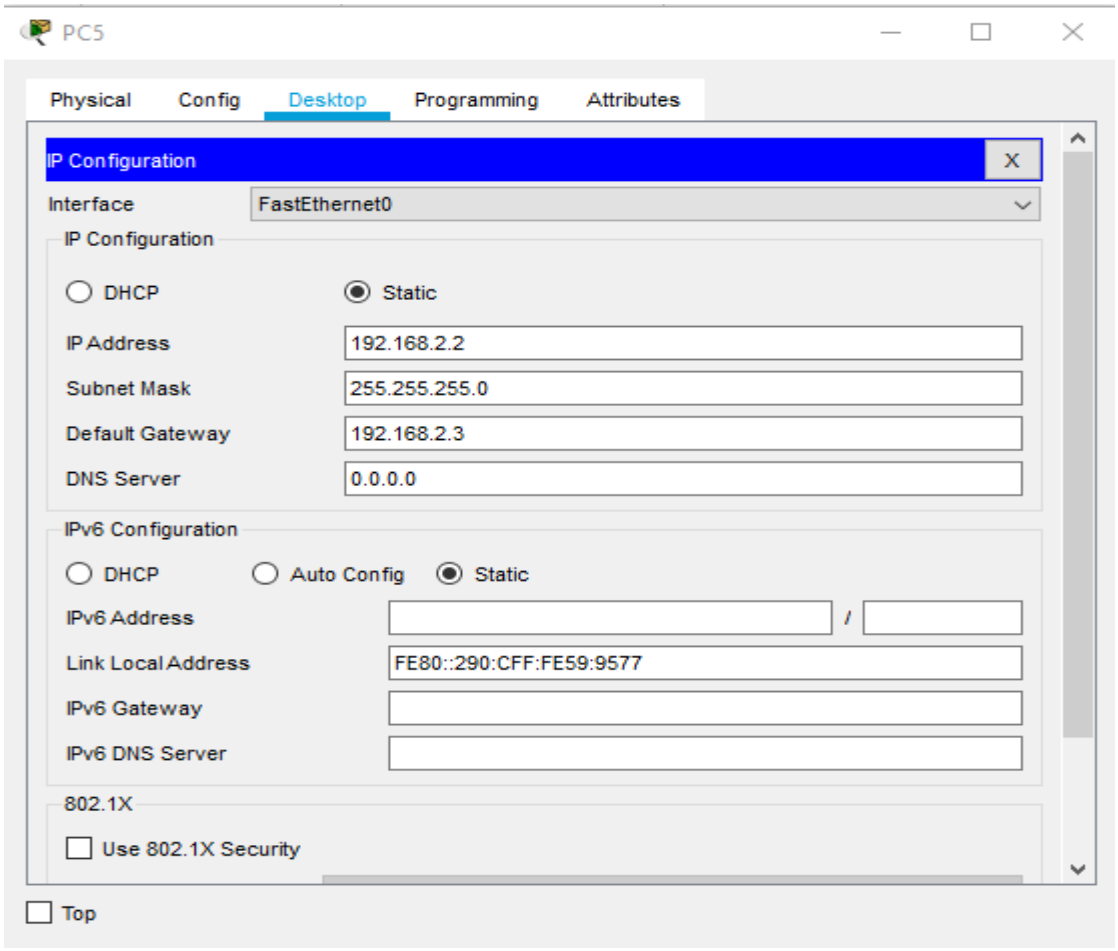


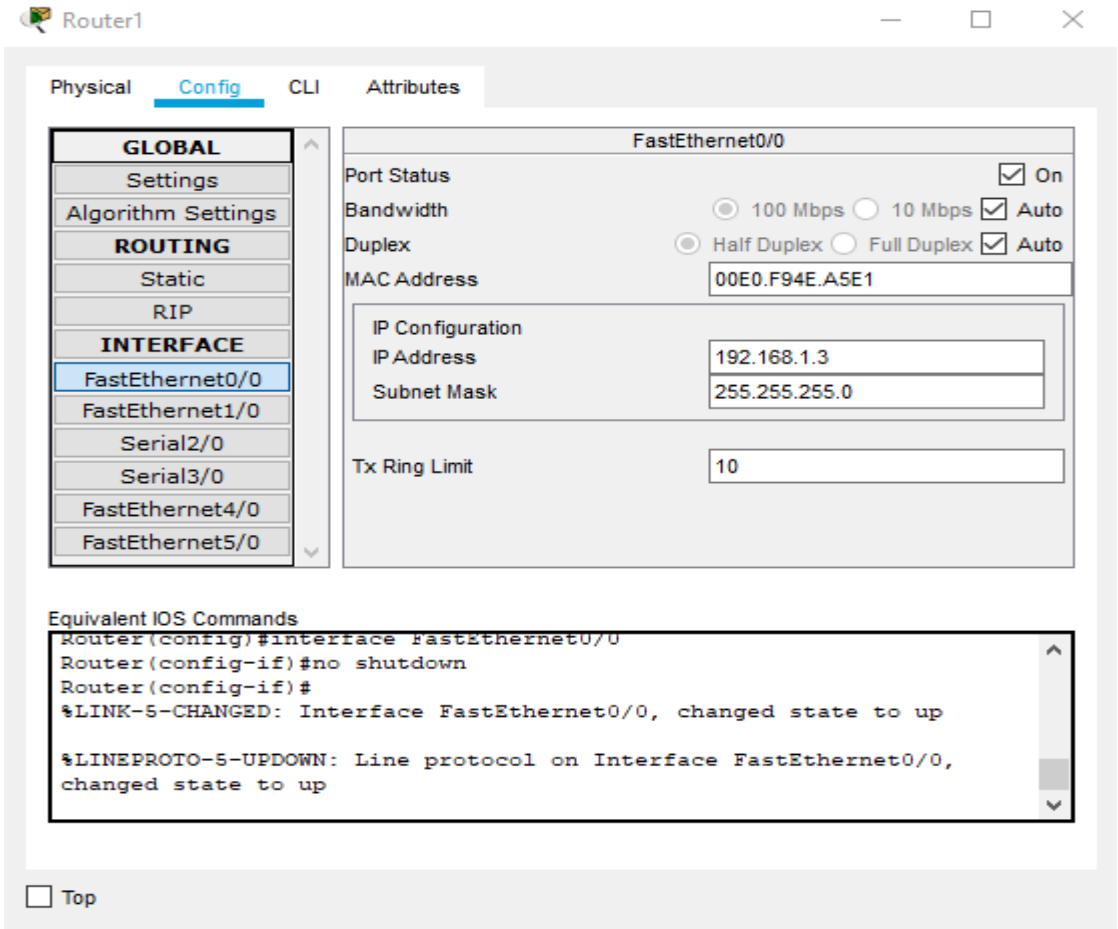

PC1
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IP Address
192.168.1.2
Subnet Mask
255.255.255.0
Default Gateway
192.168.1.3
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
/
Link Local Address
FE80::250:FFF:FE33:1E56
IPv6 Gateway
IPv6 DNS Server
802.1X
Use 802.1X Security
Top

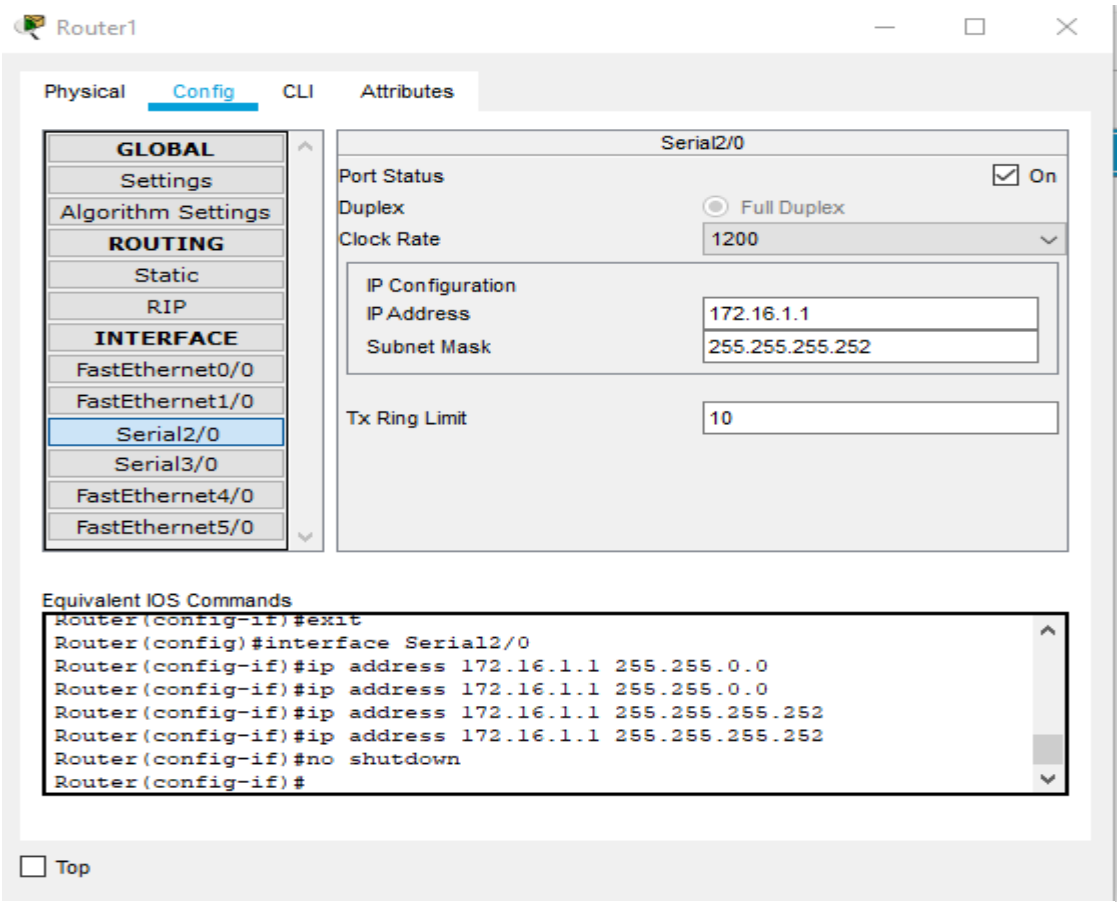

PC2
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IP Address
192.168.3.2
Subnet Mask
255.255.255.0
Default Gateway
192.168.3.3
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
/
Link Local Address
FE80::209:7CFF:FED4:78B8
IPv6 Gateway
IPv6 DNS Server
802.1X
Use 802.1X Security
Top

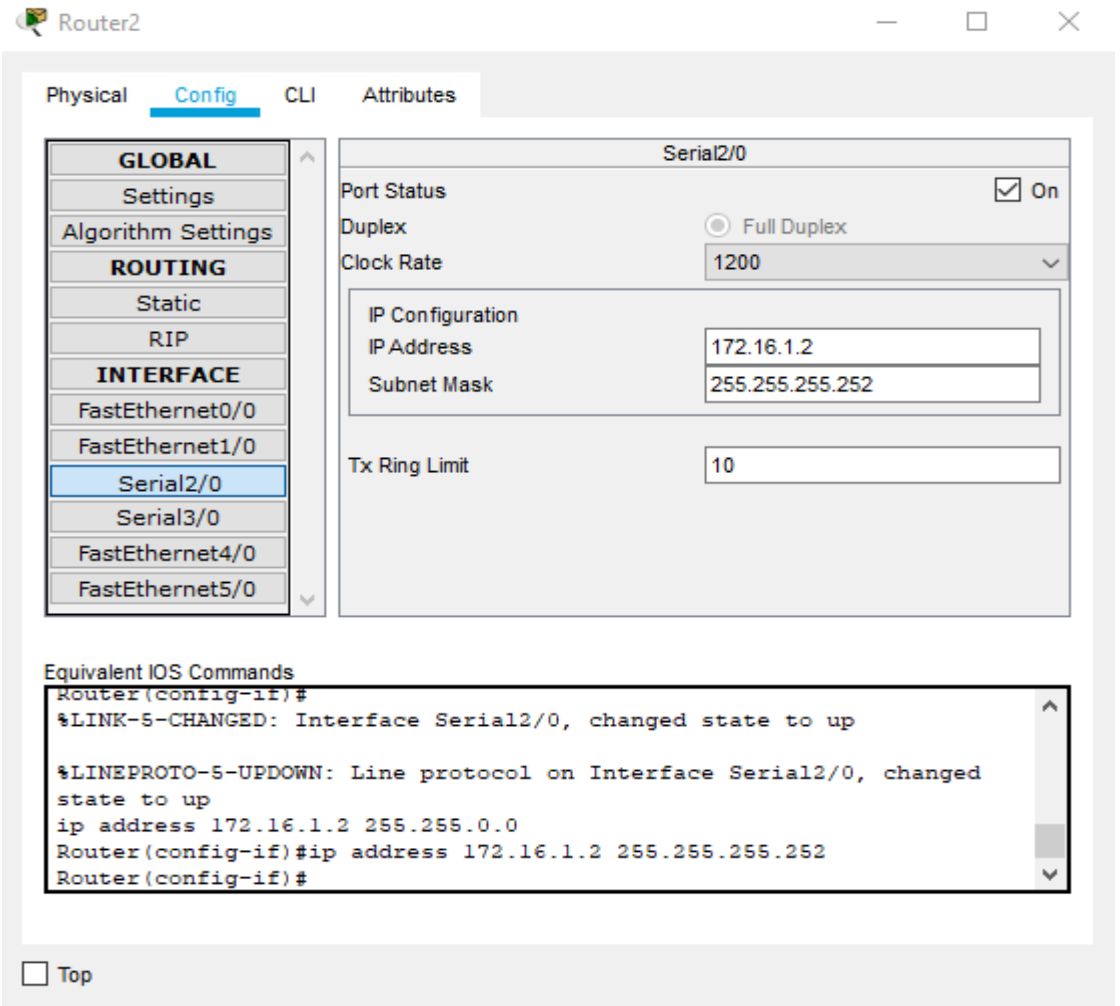

PC3
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IP Address
192.168.3.1
Subnet Mask
255.255.255.0
Default Gateway
192.168.3.3
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
/
Link Local Address
FE80::202:17FF:FE5B:1B81
IPv6 Gateway
IPv6 DNS Server
802.1X
Use 802.1X Security
Top

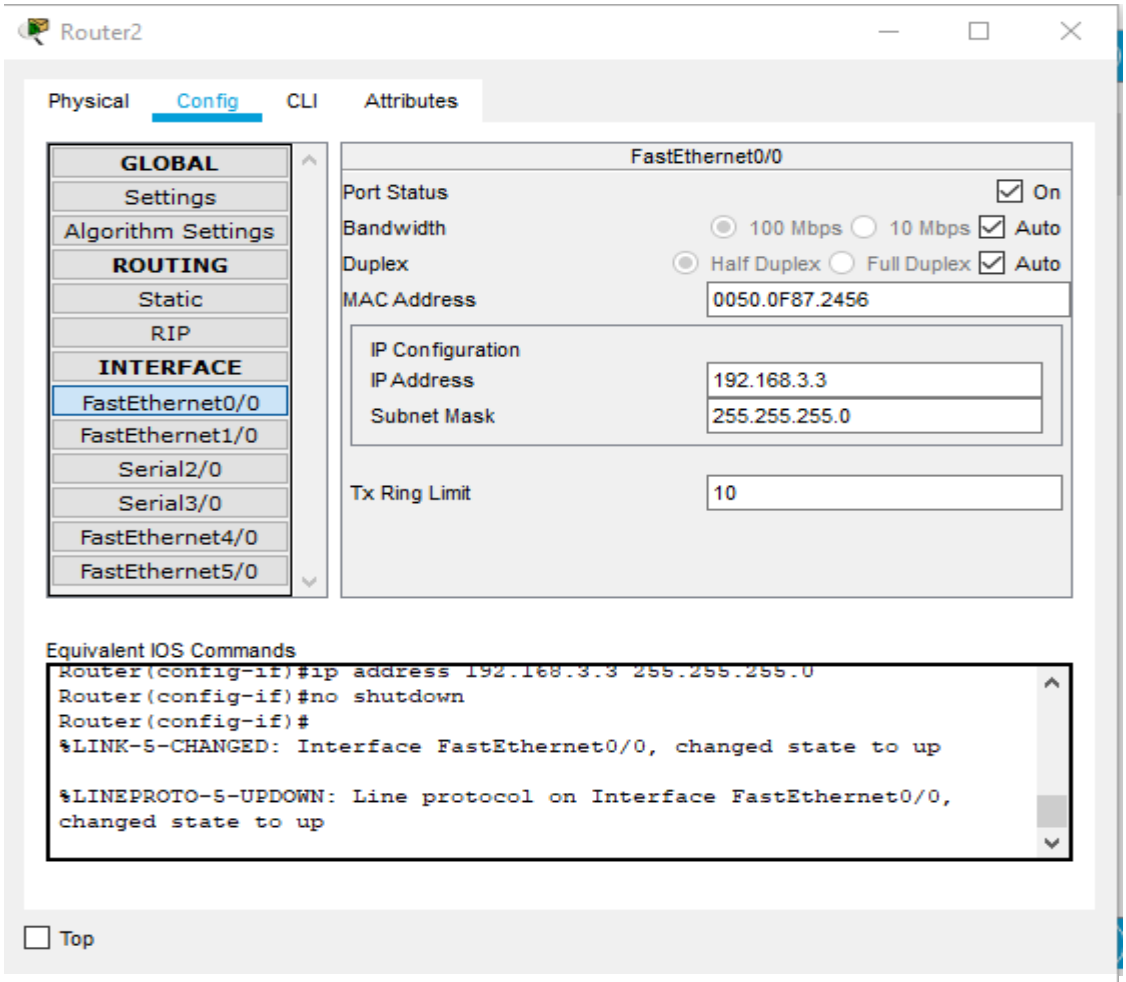

PC4
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IP Address
192.168.2.1
Subnet Mask
255.255.255.0
Default Gateway
192.168.2.3
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
/
Link Local Address
FE80::230:F2FF:FE92:7835
IPv6 Gateway
IPv6 DNS Server
802.1X
Use 802.1X Security
Top

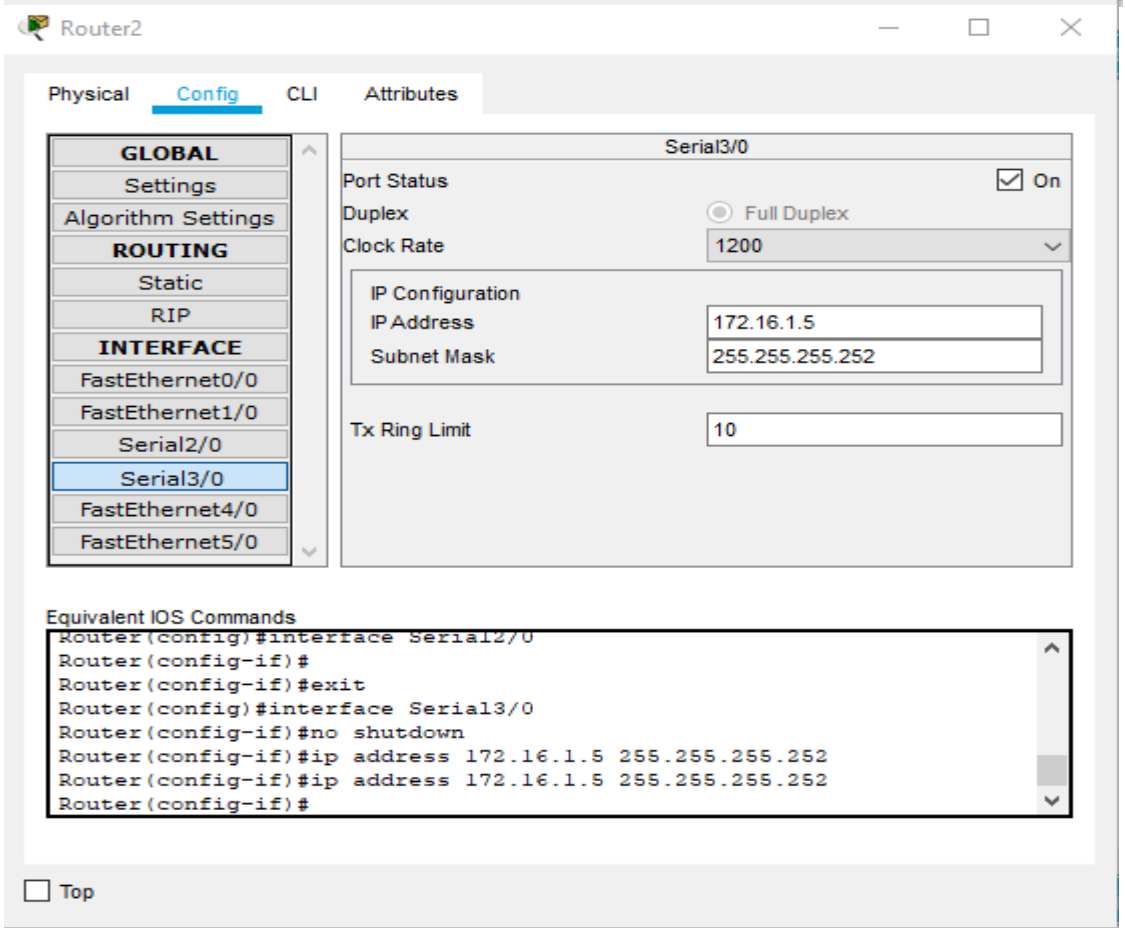

PC5
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IP Address
192.168.2.2
Subnet Mask
255.255.255.0
Default Gateway
192.168.2.3
DNS Server
0.0.0.0
IPv6 Configuration
DHCP
Auto Config
Static
IPv6 Address
Link Local Address
FE80::290:CFF:FE59:9577
IPv6 Gateway
IPv6 DNS Server
802.1X
Use 802.1X Security
Top

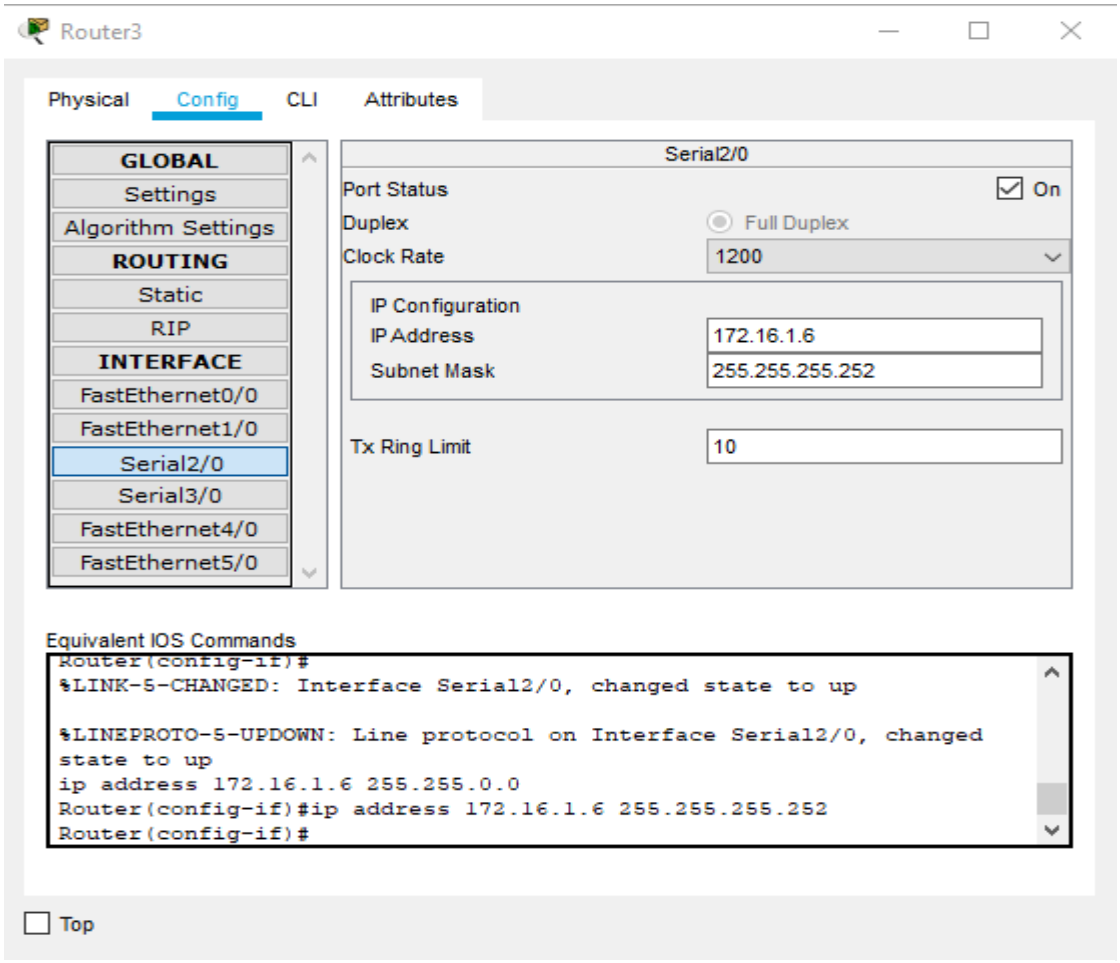

Router1
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
FastEthernet0/0
Port Status
On
Bandwidth
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
00E0.F94E.A5E1
IP Configuration
IP Address
192.168.1.3
Subnet Mask
255.255.255.0
Tx Ring Limit
10
Equivalent IOS Commands
Router(config)#interface FastEthernet0/0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
Top

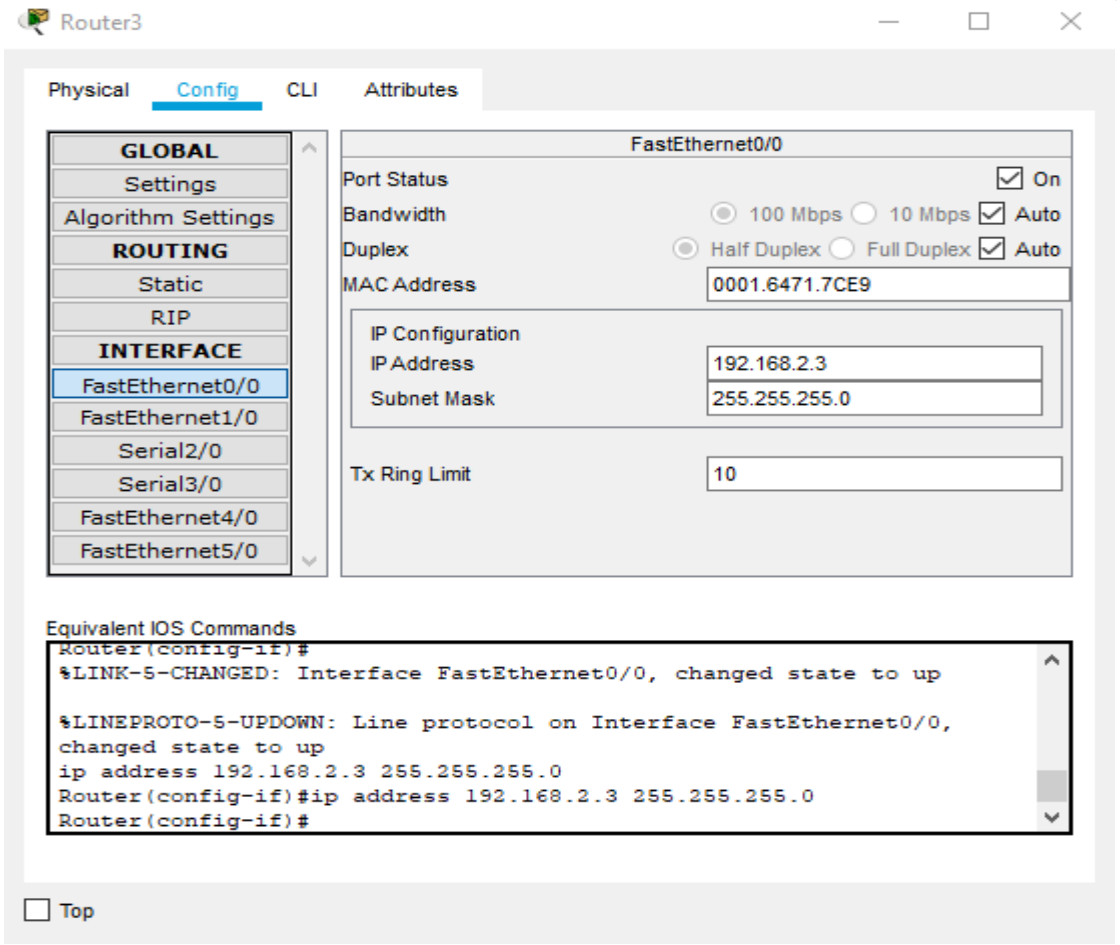

Router1
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Serial2/0
Port Status
On
Duplex
Full Duplex
Clock Rate
1200
IP Configuration
IP Address
172.16.1.1
Subnet Mask
255.255.255.252
Tx Ring Limit
10
Equivalent IOS Commands
Router(config-if)#exit
Router(config)#interface Serial2/0
Router(config-if)#ip address 172.16.1.1 255.255.0.0
Router(config-if)#ip address 172.16.1.1 255.255.0.0
Router(config-if)#ip address 172.16.1.1 255.255.255.252
Router(config-if)#ip address 172.16.1.1 255.255.255.252
Router(config-if)#no shutdown
Router(config-if)#
Top


Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Serial2/0
Port Status
On
Duplex
Full Duplex
Clock Rate
1200
IP Configuration
IP Address
172.16.1.2
Subnet Mask
255.255.255.252
Tx Ring Limit
10
Equivalent IOS Commands
Router(config-if)#
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed
state to up
ip address 172.16.1.2 255.255.0.0
Router(config-if)#ip address 172.16.1.2 255.255.255.252
Router(config-if)#
Top

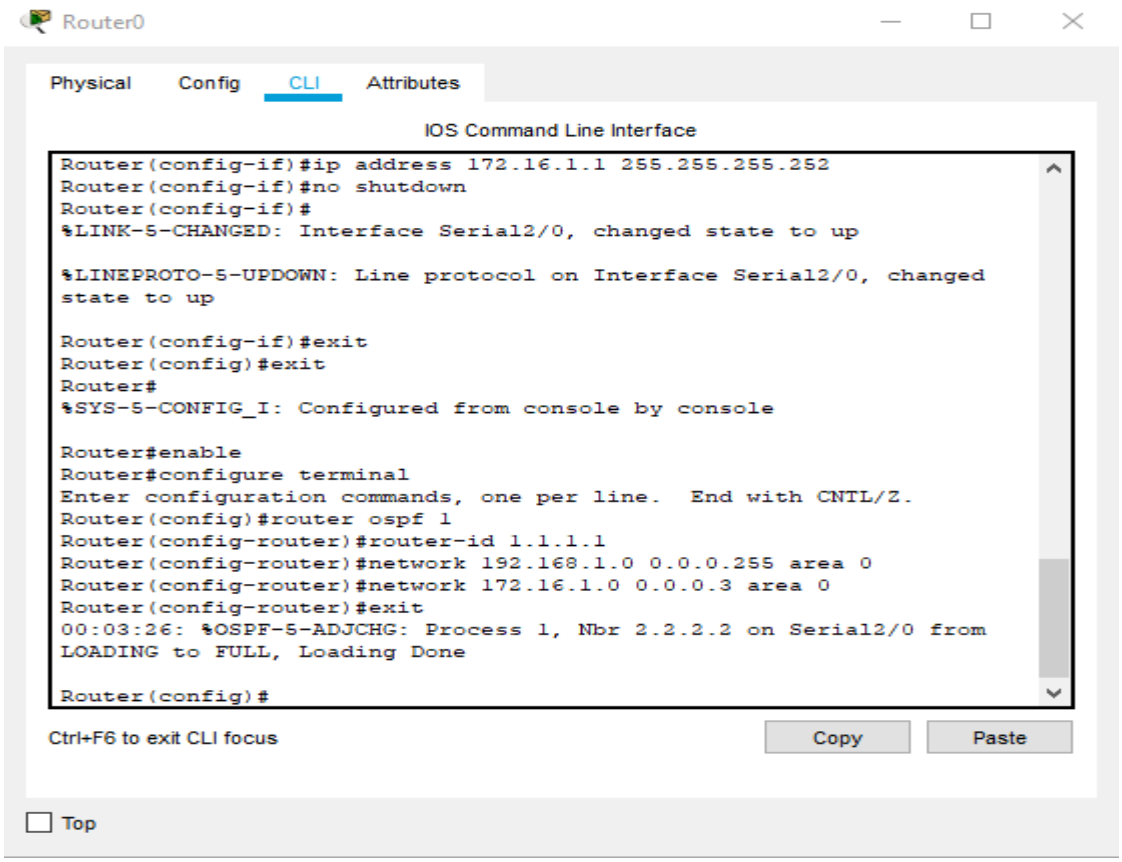

Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
FastEthernet0/0
Port Status
On
Bandwidth
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
0050.0F87.2456
IP Configuration
IP Address
192.168.3.3
Subnet Mask
255.255.255.0
Tx Ring Limit
10
Equivalent IOS Commands
Router(config-if)#ip address 192.168.3.3 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up
Top

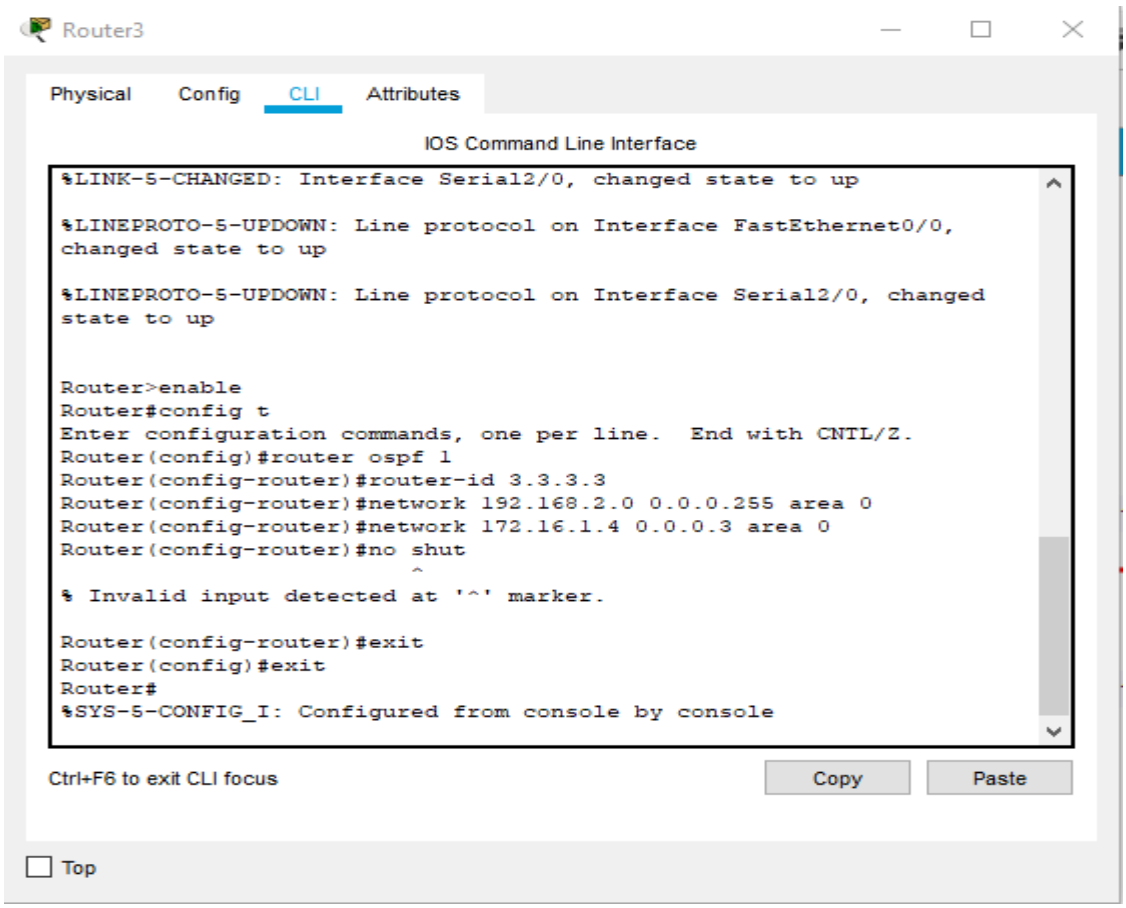

Router2
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Serial3/0
Port Status
On
Duplex
Full Duplex
Clock Rate
1200
IP Configuration
IP Address
172.16.1.5
Subnet Mask
255.255.255.252
Tx Ring Limit
10
Equivalent IOS Commands
Router(config)#interface Serial2/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial3/0
Router(config-if)#no shutdown
Router(config-if)#ip address 172.16.1.5 255.255.255.252
Router(config-if)#ip address 172.16.1.5 255.255.255.252
Router(config-if)#
Top

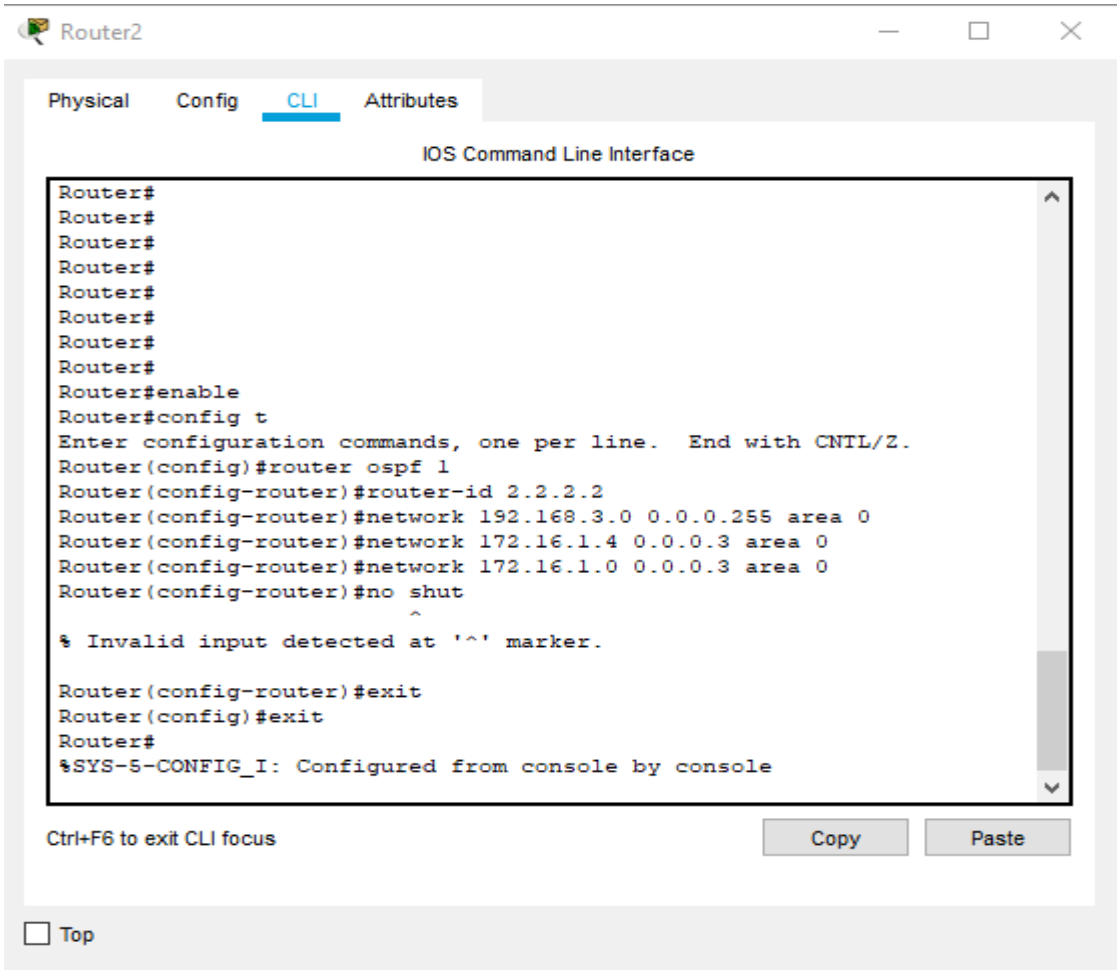

Router3
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
Serial2/0
Port Status
On
Duplex
Full Duplex
Clock Rate
1200
IP Configuration
IP Address
172.16.1.6
Subnet Mask
255.255.255.252
Tx Ring Limit
10
Equivalent IOS Commands
Router(config-if)#
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
ip address 172.16.1.6 255.255.0.0
Router(config-if)#ip address 172.16.1.6 255.255.255.252
Router(config-if)#
Top


Router3
Physical
Config
CLI
Attributes
GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
INTERFACE
FastEthernet0/0
FastEthernet1/0
Serial2/0
Serial3/0
FastEthernet4/0
FastEthernet5/0
FastEthernet0/0
Port Status
On
Bandwidth
100 Mbps
10 Mbps
Auto
Duplex
Half Duplex
Full Duplex
Auto
MAC Address
0001.6471.7CE9
IP Configuration
IP Address
192.168.2.3
Subnet Mask
255.255.255.0
Tx Ring Limit
10
Equivalent IOS Commands
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
ip address 192.168.2.3 255.255.255.0
Router(config-if)#ip address 192.168.2.3 255.255.255.0
Router(config-if)#
Top

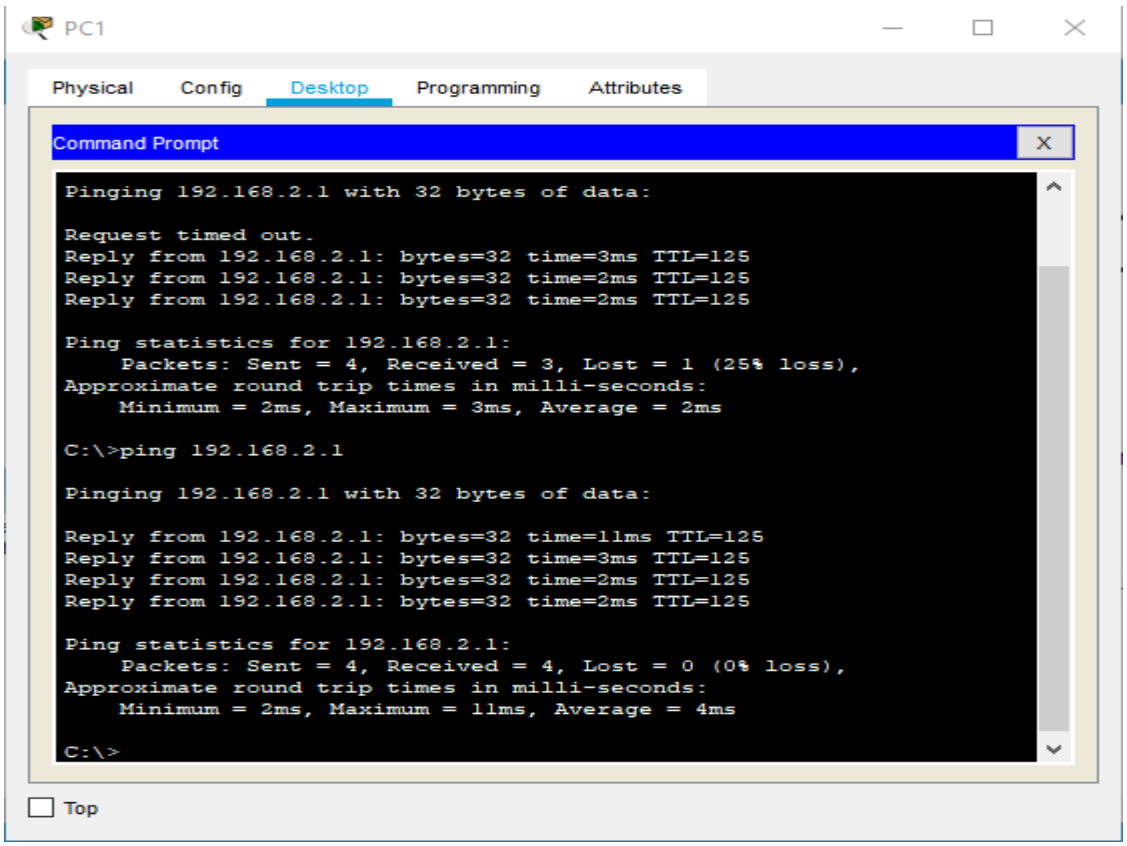
c. Configure OSPF in each of the routers accordingly (Configure each router with router ID or loopback IP addresses according to the data provided in Table 02).







d. Ping from one of the PCs in network 1 to another PCs in network 2 and 3.

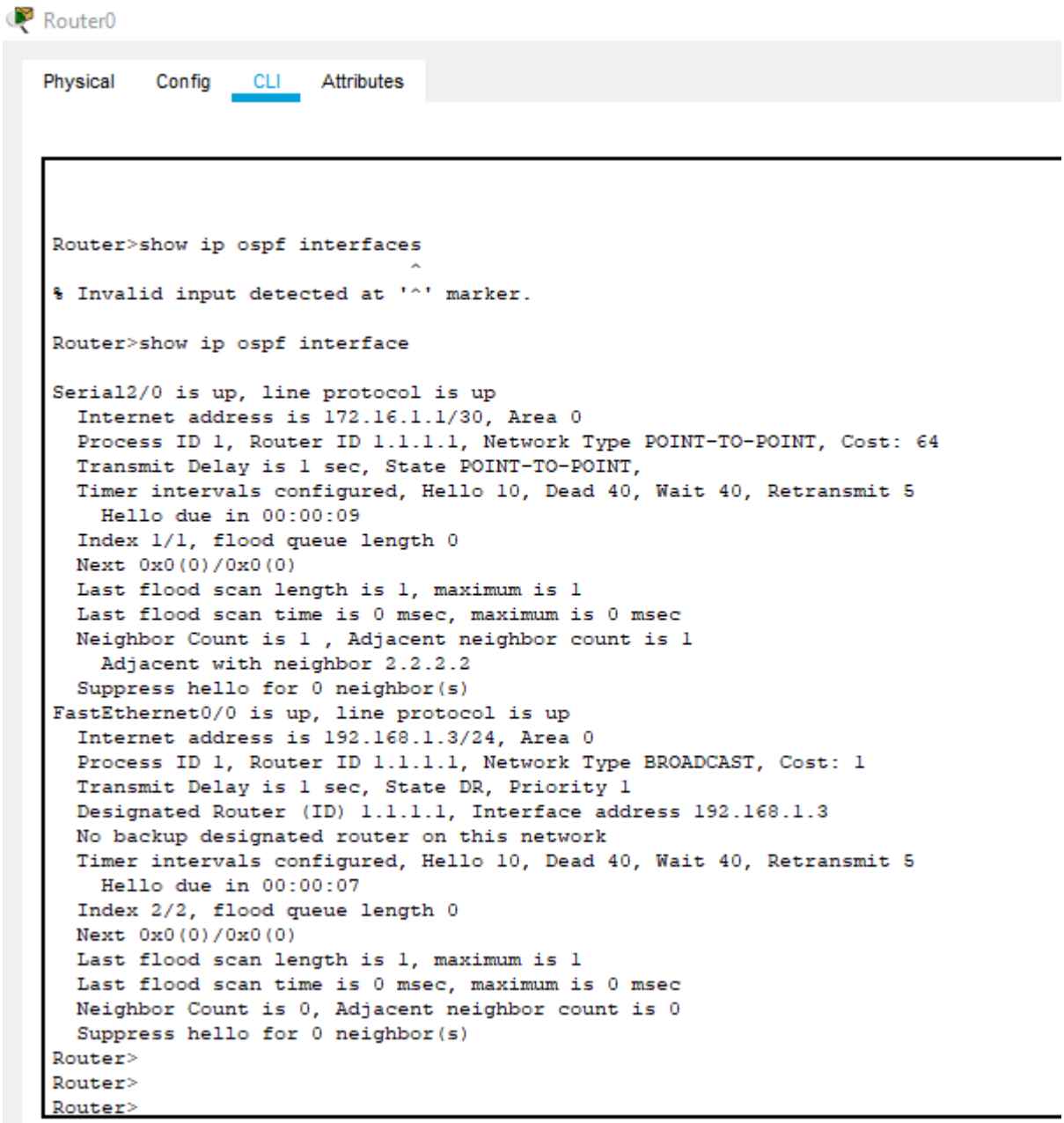


Network Verification

Use following commands to verify the implemented OSPF network. Include CLI screenshots for each command and mention what kind of information you have been retrieved via each command briefly.

i. #show ip ospf interfaces

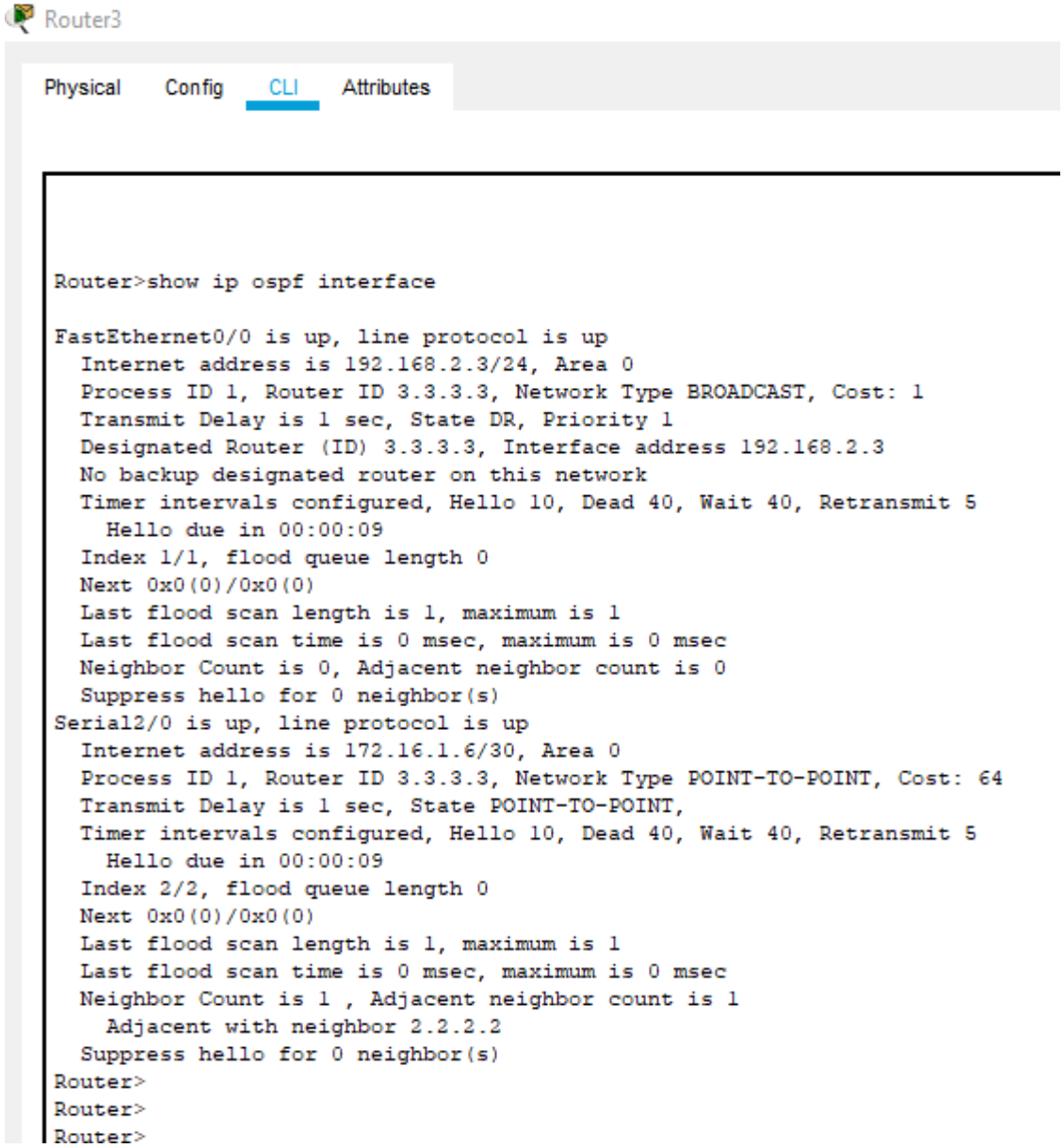
The **show ip ospf interface** [*type number* | **brief**] command can be used to display which interfaces are enabled into the OSPF process.



Router2

Physical Config CLI Attributes

```
Router>show ip ospf interface

Serial3/0 is up, line protocol is up
  Internet address is 172.16.1.5/30, Area 0
  Process ID 1, Router ID 2.2.2.2, Network Type POINT-TO-POINT, Cost: 64
  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 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 1 , Adjacent neighbor count is 1
    Adjacent with neighbor 3.3.3.3
  Suppress hello for 0 neighbor(s)
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.3.3/24, Area 0
  Process ID 1, Router ID 2.2.2.2, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 2.2.2.2, Interface address 192.168.3.3
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:09
  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 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Serial2/0 is up, line protocol is up
  Internet address is 172.16.1.2/30, Area 0
  Process ID 1, Router ID 2.2.2.2, Network Type POINT-TO-POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT-TO-POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:03
  Index 3/3, flood queue length 0
```



ii. #show ip protocols

The information displayed by show ip protocols is useful in debugging routing operations. The output indicates the parameters the particular protocol is using to send and receive updates, the metrics it is using, and the networks it is advertising. Information in the Routing Information Sources field output can help you identify a router suspected of delivering bad routing information.

Router0

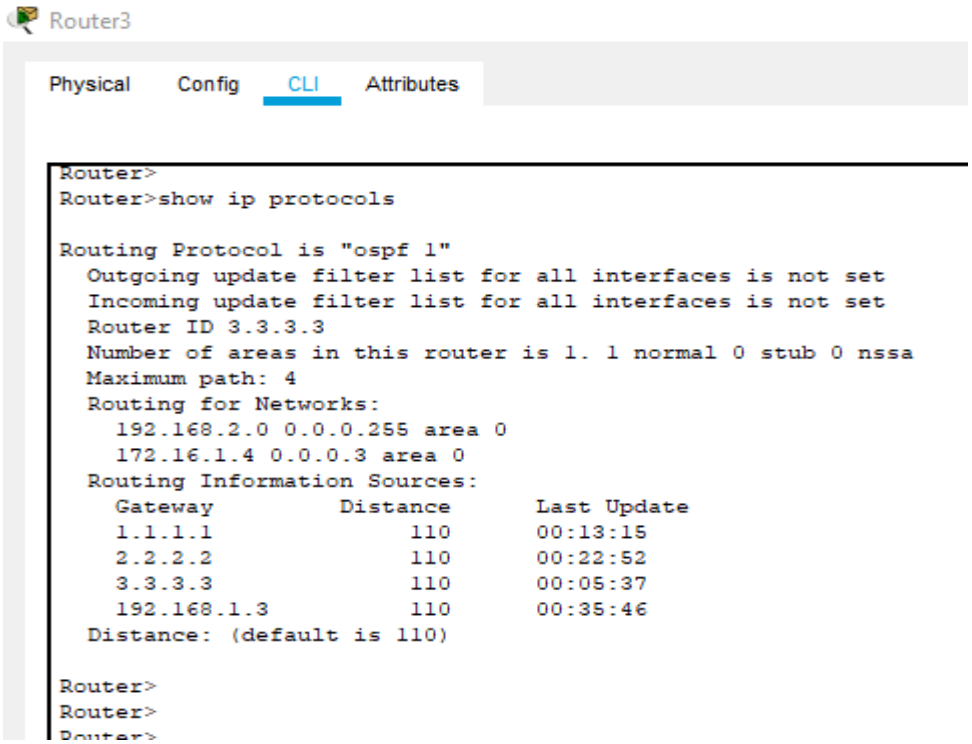
Physical Config CLI Attributes

```
Router>
Router>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 1.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    192.168.1.0 0.0.0.255 area 0
    172.16.1.0 0.0.0.3 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    1.1.1.1              110      00:03:16
    2.2.2.2              110      00:12:52
    3.3.3.3              110      00:25:39
    192.168.1.3          110      00:25:46
  Distance: (default is 110)

Router>
Router>
Router>
Router>
Router>
```

Router2

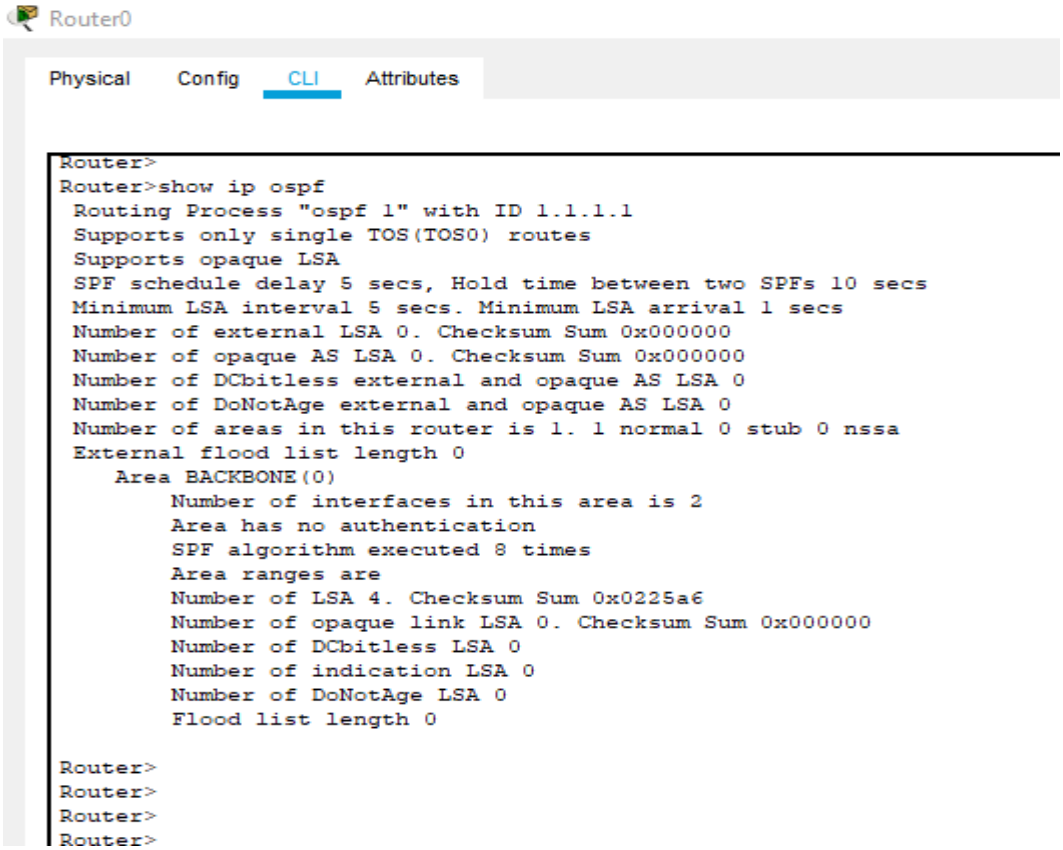
Physical Config CLI Attributes

```
Router>
Router>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 2.2.2.2
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.1.0 0.0.0.3 area 0
    172.16.1.4 0.0.0.3 area 0
    192.168.3.0 0.0.0.255 area 0
  Routing Information Sources:
    Gateway         Distance      Last Update
    1.1.1.1              110      00:08:35
    2.2.2.2              110      00:18:12
    3.3.3.3              110      00:00:57
    192.168.1.3          110      00:31:06
  Distance: (default is 110)

Router>
Router>
```



iii. #show ip ospf

#show ip ospf command shows information about database, debug route, interface [tunnel|vlan] <id>, neighbor, rapng-vpn aggregate-routes <ip-addr>, redistribute, subnet



Router2

Physical Config CLI Attributes

```
Router>
Router>show ip ospf
 Routing Process "ospf 1" with ID 2.2.2.2
 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 15 times
        Area ranges are
        Number of LSA 4. Checksum Sum 0x0223a7
        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

Router>
Router>
Router>
Router>
```

Router3

Physical Config CLI Attributes

```
Router>
Router>show ip ospf
 Routing Process "ospf 1" with ID 3.3.3.3
 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 2
        Area has no authentication
        SPF algorithm executed 14 times
        Area ranges are
        Number of LSA 4. Checksum Sum 0x0223a7
        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

Router>
Router>
Router>
```

iv. #show ip ospf neighbor

The **show ip ospf neighbor** command can be used to find information about any OSPF neighborships, including the interface, the state, the neighbor's address, and the neighbor's router ID.

Router0

Physical Config CLI Attributes

IOS

```
Router>
Router>show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:36    172.16.1.2      Serial2/0
Router>
Router>
Router>
Router>
Router>
Router>
Router>
Router>
```

Router2

Physical Config CLI Attributes

```
Router>
Router>show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           0   FULL/  -        00:00:38    172.16.1.1      Serial2/0
3.3.3.3           0   FULL/  -        00:00:33    172.16.1.6      Serial3/0
Router>
Router>
Router>
```

Router3

Physical Config CLI Attributes

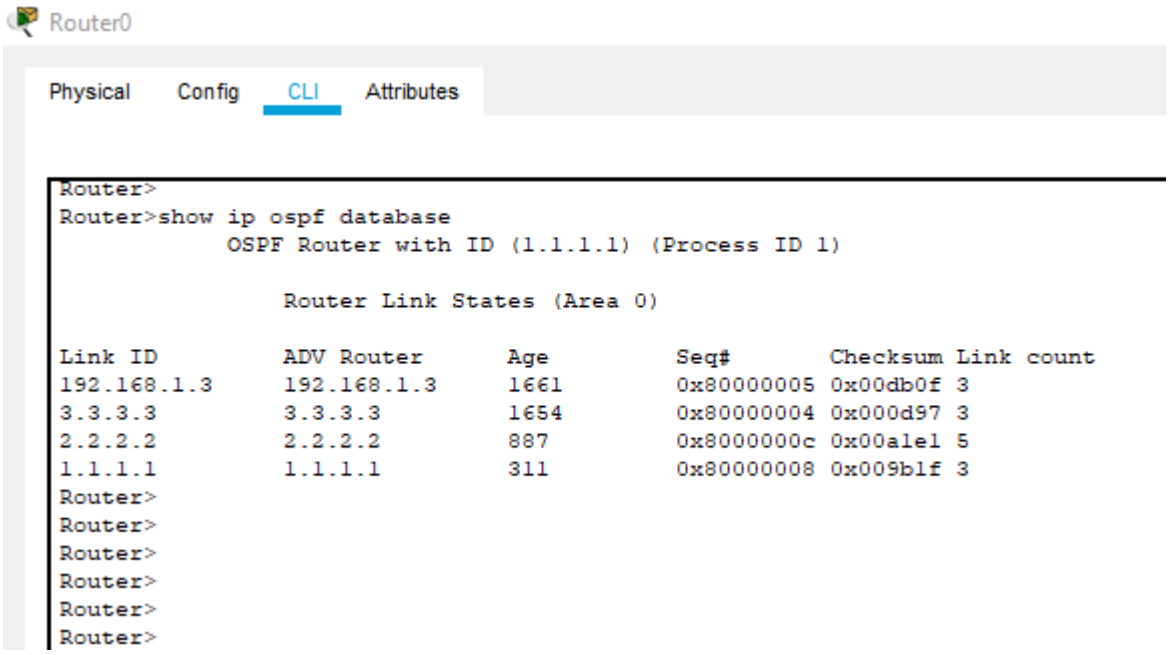
```
Router>
Router>show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:32    172.16.1.5      Serial2/0
Router>
Router>
Router>
Router>
```

v. #show ip ospf database

Use the ip ospf database command to display information about different OSPF LSAs.

When the link state advertisement is describing a network, the link-state-id argument can take one of two forms:

- The network's IP address (such as Type 3 summary link advertisements and autonomous system external link advertisements).
- A derived address obtained from the link state ID. (Note that masking a network links advertisement's link state ID with the network's subnet mask yields the network's IP address.)
- When the link state advertisement is describing a router, the link state ID is always the described router's OSPF router ID.
- When an autonomous system external advertisement (LS Type = 5) is describing a default route, its link state ID is set to Default Destination (0.0.0.0).



Router2

Physical Config CLI Attributes

```
Router>
Router>show ip ospf database
            OSPF Router with ID (2.2.2.2) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.1.3     192.168.1.3     1962        0x80000005 0x00db0f 3
2.2.2.2         2.2.2.2         1188        0x8000000c 0x00a1e1 5
1.1.1.1         1.1.1.1         611         0x80000008 0x009b1f 3
3.3.3.3         3.3.3.3         153         0x80000005 0x000b98 3
Router>
Router>
Router>
```

Router3

Physical Config CLI Attributes

```
Router>
Router>show ip ospf database
            OSPF Router with ID (3.3.3.3) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
3.3.3.3         3.3.3.3         410         0x80000005 0x000b98 3
192.168.1.3     192.168.1.3     2219        0x80000005 0x00db0f 3
2.2.2.2         2.2.2.2         1445        0x8000000c 0x00a1e1 5
1.1.1.1         1.1.1.1         868         0x80000008 0x009b1f 3
Router>
Router>
Router>
Router>
```