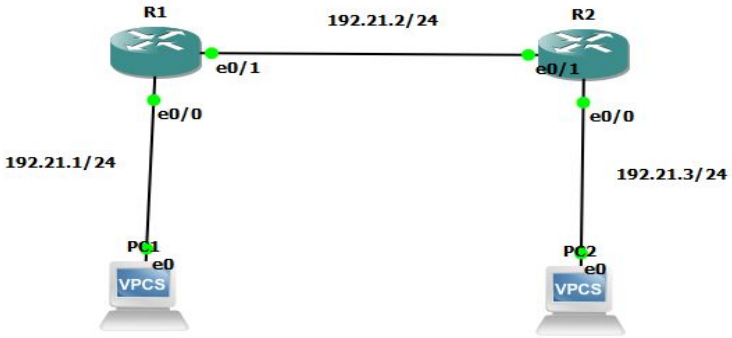
P. JAITESH | CS17B021

Assignment - 6
Understanding the behavior of OSPFv2 and RIPv2 using GNS3 and Cisco Router images

Section 1: RIP Protocol

Step - I



2) R1's Routing Table The Networks 192.21.1 and 192.21.2 are directly connected to R1 where as 192.21.3 is reachable via 192.21.2 (via R2)

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

Gateway of last resort is not set

C    192.21.1.0/24 is directly connected, Ethernet0/0
C    192.21.2.0/24 is directly connected, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.2.102, 00:00:08, Ethernet0/1
R1#
```

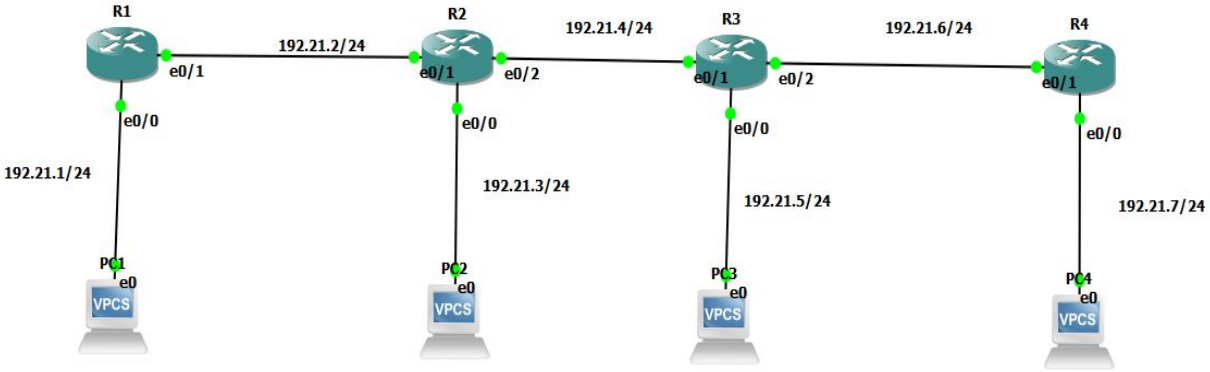
R2's Routing Table The Networks 192.21.3 and 192.21.2 are directly connected to R2 where as 192.21.1 is reachable via 192.21.2 (via R1)

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

Gateway of last resort is not set

R    192.21.1.0/24 [120/1] via 192.21.2.101, 00:00:24, Ethernet0/1
C    192.21.2.0/24 is directly connected, Ethernet0/1
C    192.21.3.0/24 is directly connected, Ethernet0/0
R2#
```

4) Ping from PC1 to both R1's interfaces, R2's interfaces and PC2's interface. We can see that as the no of routers increases, RTT also increases.

```
PC1> ping 192.21.1.101
84 bytes from 192.21.1.101 icmp_seq=1 ttl=255 time=10.313 ms
84 bytes from 192.21.1.101 icmp_seq=2 ttl=255 time=9.315 ms
84 bytes from 192.21.1.101 icmp_seq=3 ttl=255 time=11.216 ms
84 bytes from 192.21.1.101 icmp_seq=4 ttl=255 time=11.402 ms
84 bytes from 192.21.1.101 icmp_seq=5 ttl=255 time=12.295 ms

PC1> ping 192.21.2.101
84 bytes from 192.21.2.101 icmp_seq=1 ttl=255 time=5.325 ms
84 bytes from 192.21.2.101 icmp_seq=2 ttl=255 time=6.373 ms
84 bytes from 192.21.2.101 icmp_seq=3 ttl=255 time=5.293 ms
84 bytes from 192.21.2.101 icmp_seq=4 ttl=255 time=4.284 ms
84 bytes from 192.21.2.101 icmp_seq=5 ttl=255 time=12.303 ms

PC1> ping 192.21.2.102
84 bytes from 192.21.2.102 icmp_seq=1 ttl=254 time=33.220 ms
84 bytes from 192.21.2.102 icmp_seq=2 ttl=254 time=32.305 ms
84 bytes from 192.21.2.102 icmp_seq=3 ttl=254 time=34.062 ms
84 bytes from 192.21.2.102 icmp_seq=4 ttl=254 time=30.325 ms
84 bytes from 192.21.2.102 icmp_seq=5 ttl=254 time=29.268 ms

PC1> ping 192.21.3.102
84 bytes from 192.21.3.102 icmp_seq=1 ttl=254 time=31.215 ms
84 bytes from 192.21.3.102 icmp_seq=2 ttl=254 time=30.303 ms
84 bytes from 192.21.3.102 icmp_seq=3 ttl=254 time=34.306 ms
84 bytes from 192.21.3.102 icmp_seq=4 ttl=254 time=32.305 ms
84 bytes from 192.21.3.102 icmp_seq=5 ttl=254 time=34.218 ms

PC1> ping 192.21.3.2
192.21.3.2 icmp_seq=1 timeout
84 bytes from 192.21.3.2 icmp_seq=2 ttl=62 time=36.244 ms
84 bytes from 192.21.3.2 icmp_seq=3 ttl=62 time=34.326 ms
84 bytes from 192.21.3.2 icmp_seq=4 ttl=62 time=39.290 ms
84 bytes from 192.21.3.2 icmp_seq=5 ttl=62 time=45.239 ms

PC1>
```

Step - II



R1's Routing Table The Networks 192.21.1 and 192.21.2 are directly connected to R1 where as the rest are reachable via 192.21.2 (via R2)

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

Gateway of last resort is not set

R    192.21.4.0/24 [120/1] via 192.21.2.102, 00:00:07, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.2.102, 00:00:07, Ethernet0/1
R    192.21.6.0/24 [120/1] via 192.21.2.102, 00:00:07, Ethernet0/1
R    192.21.7.0/24 [120/1] via 192.21.2.102, 00:00:07, Ethernet0/1
C    192.21.1.0/24 is directly connected, Ethernet0/0
C    192.21.2.0/24 is directly connected, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.2.102, 00:00:07, Ethernet0/1
R1#
```

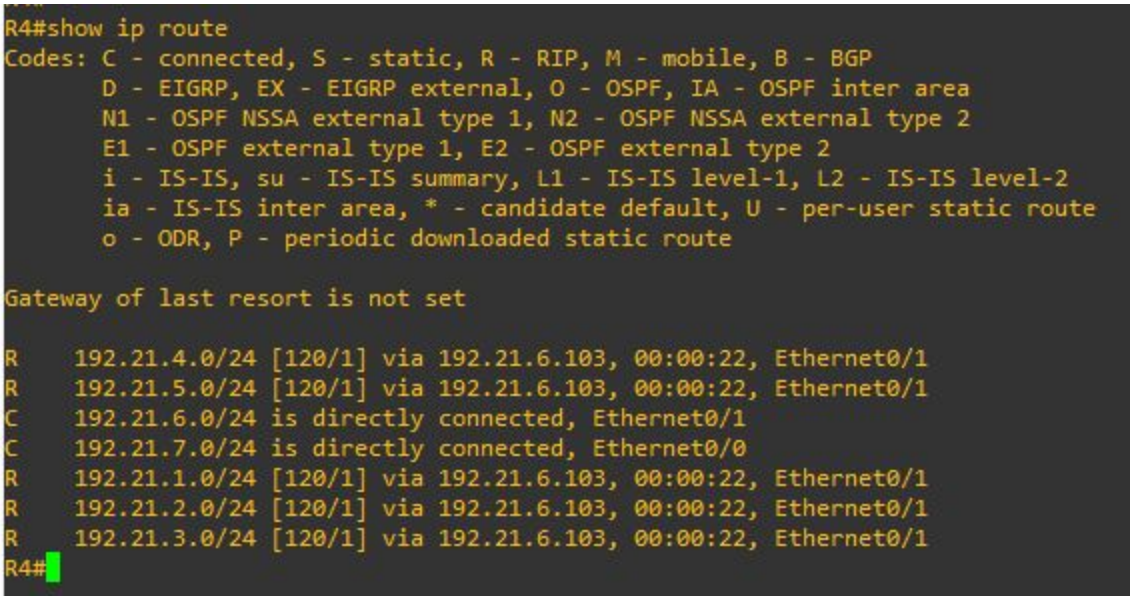
R2's Routing Table The Networks 192.21.2, 192.21.3 and 192.21.4 are directly connected to R2 where as the rest are reachable via R1 or R3

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

Gateway of last resort is not set

C    192.21.4.0/24 is directly connected, Ethernet0/2
R    192.21.5.0/24 [120/1] via 192.21.4.103, 00:00:09, Ethernet0/2
R    192.21.6.0/24 [120/1] via 192.21.4.103, 00:00:09, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.4.103, 00:00:09, Ethernet0/2
R    192.21.1.0/24 [120/1] via 192.21.2.101, 00:00:05, Ethernet0/1
C    192.21.2.0/24 is directly connected, Ethernet0/1
C    192.21.3.0/24 is directly connected, Ethernet0/0
R2#
```

R3's Routing Table The Networks 192.21.4, 192.21.5 and 192.21.6 are directly connected to R3 where as the rest are reachable via R2 or R4

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.21.4.0/24 is directly connected, Ethernet0/1
C    192.21.5.0/24 is directly connected, Ethernet0/0
C    192.21.6.0/24 is directly connected, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.6.104, 00:00:13, Ethernet0/2
R    192.21.1.0/24 [120/1] via 192.21.4.102, 00:00:14, Ethernet0/1
R    192.21.2.0/24 [120/1] via 192.21.4.102, 00:00:14, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.4.102, 00:00:14, Ethernet0/1
R3#
```

R4's Routing Table The Networks 192.21.7 and 192.21.6 are directly connected to R4 where as the rest are reachable via R3



Contents of RIP Message from R2, exchanged between R1 and R2. R2 is broadcasting the information about networks 192.21. 4, 5, 6, 7 (Networks which are to the right of R2).

```
Ethernet II, Src: cc:02:37:18:00:01 (cc:02:37:18:00:01), Dst: IPv4mcast_09 (01:00:5e:00:00:09)
Internet Protocol Version 4, Src: 192.21.2.102, Dst: 224.0.0.9
User Datagram Protocol, Src Port: 520, Dst Port: 520
Routing Information Protocol
   Command: Response (2)
   Version: RIPv2 (2)
   IP Address: 192.21.3.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.3.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
   IP Address: 192.21.4.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.4.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
   IP Address: 192.21.5.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.5.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
   IP Address: 192.21.6.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.6.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
   IP Address: 192.21.7.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.7.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
```

Contents of RIP Message from R2, exchanged between R2 and R3. We can see that R2 is broadcasting the information about networks 192.21. 1, 2, 3 (Networks which are to the leftof R2).

```
> Frame 7: 106 bytes on wire (848 bits), 106 bytes captured (848 bits)
> Ethernet II, Src: cc:02:37:18:00:02 (cc:02:37:18:00:02), Dst: IPv4mcast_09 (01:00:5e:00:00:09)
> Internet Protocol Version 4, Src: 192.21.4.102, Dst: 224.0.0.9
> User Datagram Protocol, Src Port: 520, Dst Port: 520
v Routing Information Protocol
    Command: Response (2)
    Version: RIPv2 (2)
  v IP Address: 192.21.1.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.1.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
  v IP Address: 192.21.2.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.2.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
  v IP Address: 192.21.3.0, Metric: 1
      Address Family: IP (2)
      Route Tag: 0
      IP Address: 192.21.3.0
      Netmask: 255.255.255.0
      Next Hop: 0.0.0.0
      Metric: 1
```

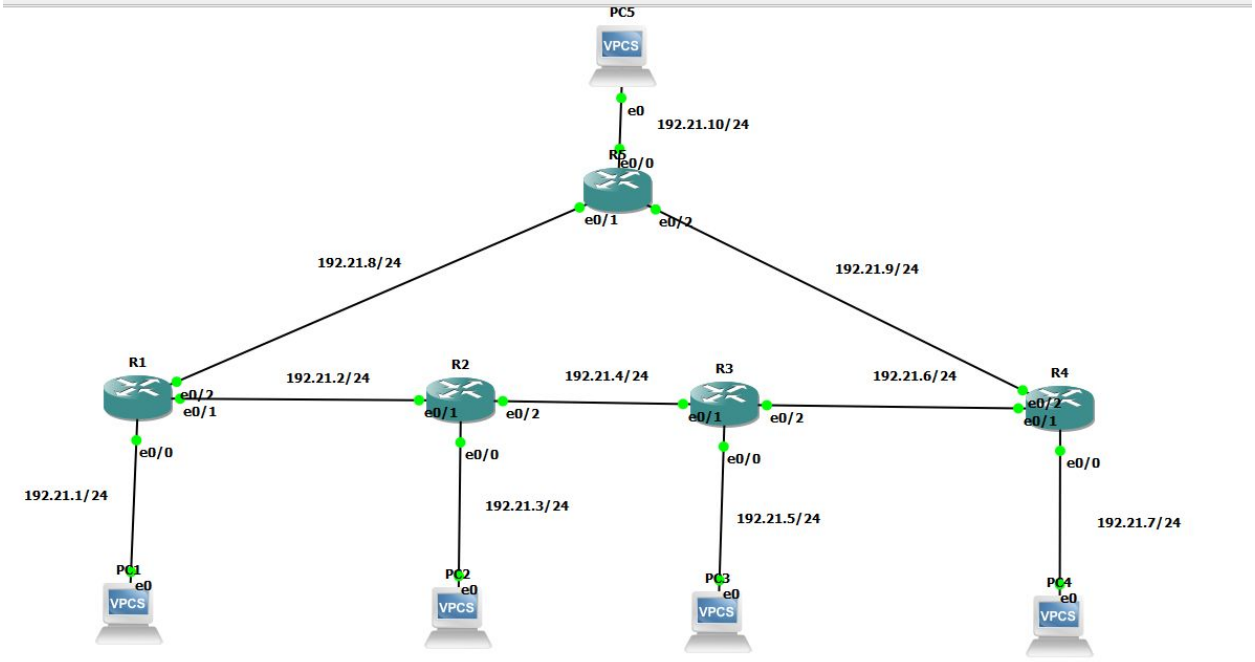
Traceroute message at R1 to R4's 192.21.6.104. We can see that hops are R2, R3, R4

```
R1#traceroute 192.21.6.104

Type escape sequence to abort.
Tracing the route to 192.21.6.104

  1 192.21.2.102 20 msec 20 msec 24 msec
  2 192.21.4.103 40 msec 44 msec 44 msec
  3 192.21.6.104 64 msec 64 msec 64 msec
```

Traceroute message at R1 to R3's 192.21.6.103. We can see that hops are R2, R3

```
R1#traceroute 192.21.6.103

Type escape sequence to abort.
Tracing the route to 192.21.6.103

  1 192.21.2.102 12 msec 24 msec 20 msec
  2 192.21.4.103 44 msec 44 msec 44 msec
R1#
```

Step - III



R1's Routing Table. Unlike The previous topology, there are two routes from R1 to 192.21.9 (one is via 192.21.8 and the other is via 192.21.2) This is because of adding new router T5 to our topology.

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

Gateway of last resort is not set

C    192.21.8.0/24 is directly connected, Ethernet0/2
R    192.21.9.0/24 [120/1] via 192.21.8.105, 00:00:02, Ethernet0/2
                   [120/1] via 192.21.2.102, 00:00:16, Ethernet0/1
R    192.21.10.0/24 [120/1] via 192.21.8.105, 00:00:02, Ethernet0/2
R    192.21.4.0/24 [120/1] via 192.21.2.102, 00:00:16, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.2.102, 00:00:16, Ethernet0/1
R    192.21.6.0/24 [120/1] via 192.21.2.102, 00:00:16, Ethernet0/1
R    192.21.7.0/24 [120/1] via 192.21.2.102, 00:00:17, Ethernet0/1
C    192.21.1.0/24 is directly connected, Ethernet0/0
C    192.21.2.0/24 is directly connected, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.2.102, 00:00:17, Ethernet0/1
R1#
```

R2's Routing Table.

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

Gateway of last resort is not set

R    192.21.8.0/24 [120/1] via 192.21.2.101, 00:00:13, Ethernet0/1
R    192.21.9.0/24 [120/1] via 192.21.4.103, 00:00:26, Ethernet0/2
R    192.21.10.0/24 [120/1] via 192.21.2.101, 00:00:13, Ethernet0/1
C    192.21.4.0/24 is directly connected, Ethernet0/2
R    192.21.5.0/24 [120/1] via 192.21.4.103, 00:00:26, Ethernet0/2
R    192.21.6.0/24 [120/1] via 192.21.4.103, 00:00:26, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.4.103, 00:00:26, Ethernet0/2
R    192.21.1.0/24 [120/1] via 192.21.2.101, 00:00:13, Ethernet0/1
C    192.21.2.0/24 is directly connected, Ethernet0/1
C    192.21.3.0/24 is directly connected, Ethernet0/0
R2#
```

R3's Routing Table. Again, there are multiple routes from R3 to 192.21.10

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

R    192.21.8.0/24 [120/1] via 192.21.4.102, 00:00:29, Ethernet0/1
R    192.21.9.0/24 [120/1] via 192.21.6.104, 00:00:04, Ethernet0/2
R    192.21.10.0/24 [120/1] via 192.21.6.104, 00:00:04, Ethernet0/2
                    [120/1] via 192.21.4.102, 00:00:29, Ethernet0/1
C    192.21.4.0/24 is directly connected, Ethernet0/1
C    192.21.5.0/24 is directly connected, Ethernet0/0
C    192.21.6.0/24 is directly connected, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.6.104, 00:00:04, Ethernet0/2
R    192.21.1.0/24 [120/1] via 192.21.4.102, 00:00:00, Ethernet0/1
R    192.21.2.0/24 [120/1] via 192.21.4.102, 00:00:00, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.4.102, 00:00:00, Ethernet0/1
R3#
```

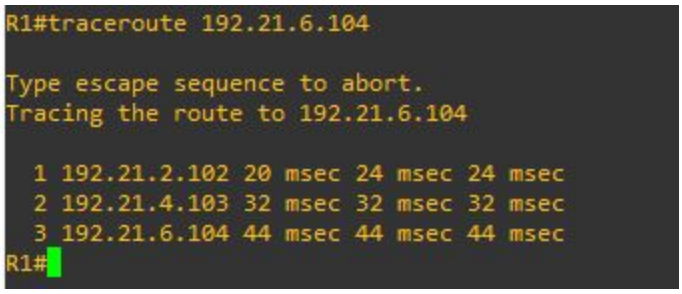
R4's Routing Table. Again, there are multiple routes from R4 to 192.21.8,4,5,1,2,3

```
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

R    192.21.8.0/24 [120/1] via 192.21.9.105, 00:00:04, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:19, Ethernet0/1
C    192.21.9.0/24 is directly connected, Ethernet0/2
R    192.21.10.0/24 [120/1] via 192.21.9.105, 00:00:04, Ethernet0/2
R    192.21.4.0/24 [120/1] via 192.21.9.105, 00:00:04, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:19, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.9.105, 00:00:04, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:19, Ethernet0/1
C    192.21.6.0/24 is directly connected, Ethernet0/1
C    192.21.7.0/24 is directly connected, Ethernet0/0
R    192.21.1.0/24 [120/1] via 192.21.9.105, 00:00:06, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:20, Ethernet0/1
R    192.21.2.0/24 [120/1] via 192.21.9.105, 00:00:06, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:20, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.9.105, 00:00:11, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:25, Ethernet0/1
R4#
```

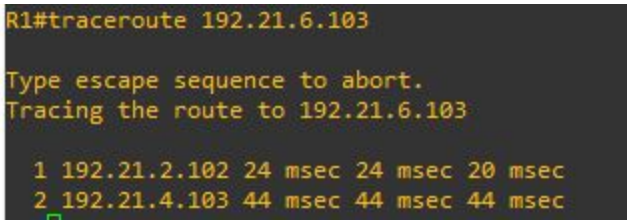
R5's Routing Table. There are multiple routes from R5 to 192.21.6, 7.

```
R5#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.21.8.0/24 is directly connected, Ethernet0/1
C    192.21.9.0/24 is directly connected, Ethernet0/2
C    192.21.10.0/24 is directly connected, Ethernet0/0
R    192.21.4.0/24 [120/1] via 192.21.8.101, 00:00:20, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.8.101, 00:00:20, Ethernet0/1
R    192.21.6.0/24 [120/1] via 192.21.9.104, 00:00:16, Ethernet0/2
                   [120/1] via 192.21.8.101, 00:00:20, Ethernet0/1
R    192.21.7.0/24 [120/1] via 192.21.9.104, 00:00:16, Ethernet0/2
                   [120/1] via 192.21.8.101, 00:00:21, Ethernet0/1
R    192.21.1.0/24 [120/1] via 192.21.8.101, 00:00:21, Ethernet0/1
R    192.21.2.0/24 [120/1] via 192.21.8.101, 00:00:21, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.8.101, 00:00:21, Ethernet0/1
R5#
```

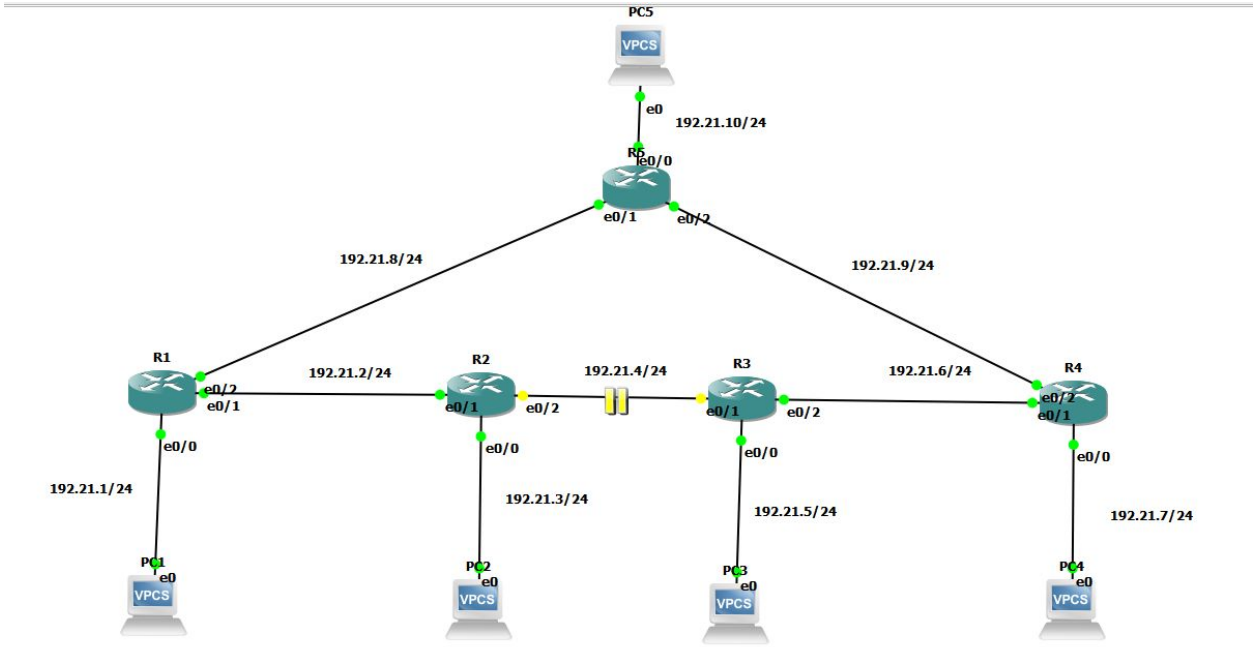
Traceroute from R1 to 192.21.6.104. In this new topology, there can be multiple routes from R1 to 192.21.6.104. One is via 192.21.8 and the other is via 192.21.2



Traceroute from R1 to 192.21.6.103. In this new topology, there can be multiple routes from R1 to 192.21.6.104. One is via 192.21.8 and the other is via 192.21.2



Step - IV



R1's Routing Table. Now, unlike previous step 3, there is only a single route to 192.21.9 from R1 because we shutdown R3's interface at 192.21.4

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

Gateway of last resort is not set

C    192.21.8.0/24 is directly connected, Ethernet0/2
R    192.21.9.0/24 [120/1] via 192.21.8.105, 00:00:17, Ethernet0/2
R    192.21.10.0/24 [120/1] via 192.21.8.105, 00:00:17, Ethernet0/2
R    192.21.4.0/24 [120/1] via 192.21.2.102, 00:00:11, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.8.105, 00:00:17, Ethernet0/2
R    192.21.6.0/24 [120/1] via 192.21.8.105, 00:00:17, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.8.105, 00:00:17, Ethernet0/2
C    192.21.1.0/24 is directly connected, Ethernet0/0
C    192.21.2.0/24 is directly connected, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.2.102, 00:00:12, Ethernet0/1
R1#
R1#
```

R2's Routing Table. The route from R2 to 192.21. 5, 6, 7, 8, 9 have changed to be via 192.21.2 instead of via 192.21.5. Again, this is because we shutdown R3's interface at 192.21.4

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

Gateway of last resort is not set

R    192.21.8.0/24 [120/1] via 192.21.2.101, 00:00:08, Ethernet0/1
R    192.21.9.0/24 [120/1] via 192.21.2.101, 00:00:08, Ethernet0/1
R    192.21.10.0/24 [120/1] via 192.21.2.101, 00:00:08, Ethernet0/1
C    192.21.4.0/24 is directly connected, Ethernet0/2
R    192.21.5.0/24 [120/1] via 192.21.2.101, 00:00:08, Ethernet0/1
R    192.21.6.0/24 [120/1] via 192.21.2.101, 00:00:08, Ethernet0/1
R    192.21.7.0/24 [120/1] via 192.21.2.101, 00:00:08, Ethernet0/1
R    192.21.1.0/24 [120/1] via 192.21.2.101, 00:00:09, Ethernet0/1
C    192.21.2.0/24 is directly connected, Ethernet0/1
C    192.21.3.0/24 is directly connected, Ethernet0/0
R2#
```

R3's Routing Table. All of the below (R3, R4, R5)'s routing tables are similarly modified i.e either the routes are changed or multiple routes have become single routes because of the shutdown of R3's interface at 192.21.4.

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

R    192.21.8.0/24 [120/1] via 192.21.6.104, 00:00:27, Ethernet0/2
R    192.21.9.0/24 [120/1] via 192.21.6.104, 00:00:27, Ethernet0/2
R    192.21.10.0/24 [120/1] via 192.21.6.104, 00:00:27, Ethernet0/2
C    192.21.4.0/24 is directly connected, Ethernet0/1
C    192.21.5.0/24 is directly connected, Ethernet0/0
C    192.21.6.0/24 is directly connected, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.6.104, 00:00:27, Ethernet0/2
R    192.21.1.0/24 [120/1] via 192.21.6.104, 00:00:27, Ethernet0/2
R    192.21.2.0/24 [120/1] via 192.21.6.104, 00:00:01, Ethernet0/2
R    192.21.3.0/24 [120/1] via 192.21.6.104, 00:00:01, Ethernet0/2
R3#
```

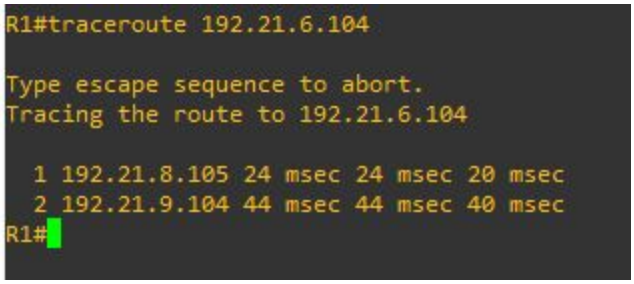
R4's Routing Table.

```
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

R    192.21.8.0/24 [120/1] via 192.21.9.105, 00:00:12, Ethernet0/2
C    192.21.9.0/24 is directly connected, Ethernet0/2
R    192.21.10.0/24 [120/1] via 192.21.9.105, 00:00:12, Ethernet0/2
R    192.21.4.0/24 [120/1] via 192.21.9.105, 00:00:12, Ethernet0/2
                   [120/1] via 192.21.6.103, 00:00:09, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.6.103, 00:00:09, Ethernet0/1
C    192.21.6.0/24 is directly connected, Ethernet0/1
C    192.21.7.0/24 is directly connected, Ethernet0/0
R    192.21.1.0/24 [120/1] via 192.21.9.105, 00:00:13, Ethernet0/2
R    192.21.2.0/24 [120/1] via 192.21.9.105, 00:00:13, Ethernet0/2
R    192.21.3.0/24 [120/1] via 192.21.9.105, 00:00:13, Ethernet0/2
R4#
```

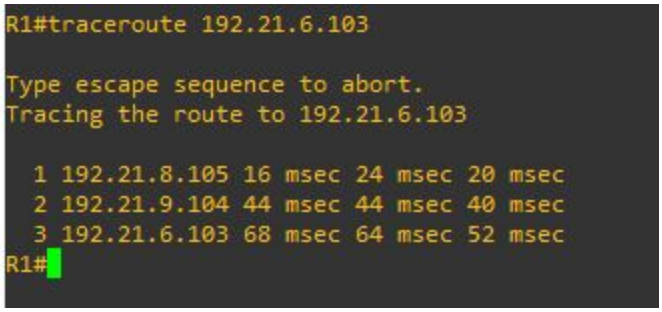
R5's Routing Table.

```
R5#
R5#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.21.8.0/24 is directly connected, Ethernet0/1
C    192.21.9.0/24 is directly connected, Ethernet0/2
C    192.21.10.0/24 is directly connected, Ethernet0/0
R    192.21.4.0/24 [120/1] via 192.21.8.101, 00:00:26, Ethernet0/1
R    192.21.5.0/24 [120/1] via 192.21.9.104, 00:00:20, Ethernet0/2
R    192.21.6.0/24 [120/1] via 192.21.9.104, 00:00:20, Ethernet0/2
R    192.21.7.0/24 [120/1] via 192.21.9.104, 00:00:20, Ethernet0/2
R    192.21.1.0/24 [120/1] via 192.21.8.101, 00:00:26, Ethernet0/1
R    192.21.2.0/24 [120/1] via 192.21.8.101, 00:00:00, Ethernet0/1
R    192.21.3.0/24 [120/1] via 192.21.8.101, 00:00:00, Ethernet0/1
R5#
```

Traceroute from R1 to 192.21.6.104. In the previous section, the traceroute was via 192.21.2, 4, and 6. But in this step, because of shutdown, it is via 192.21.8, 9

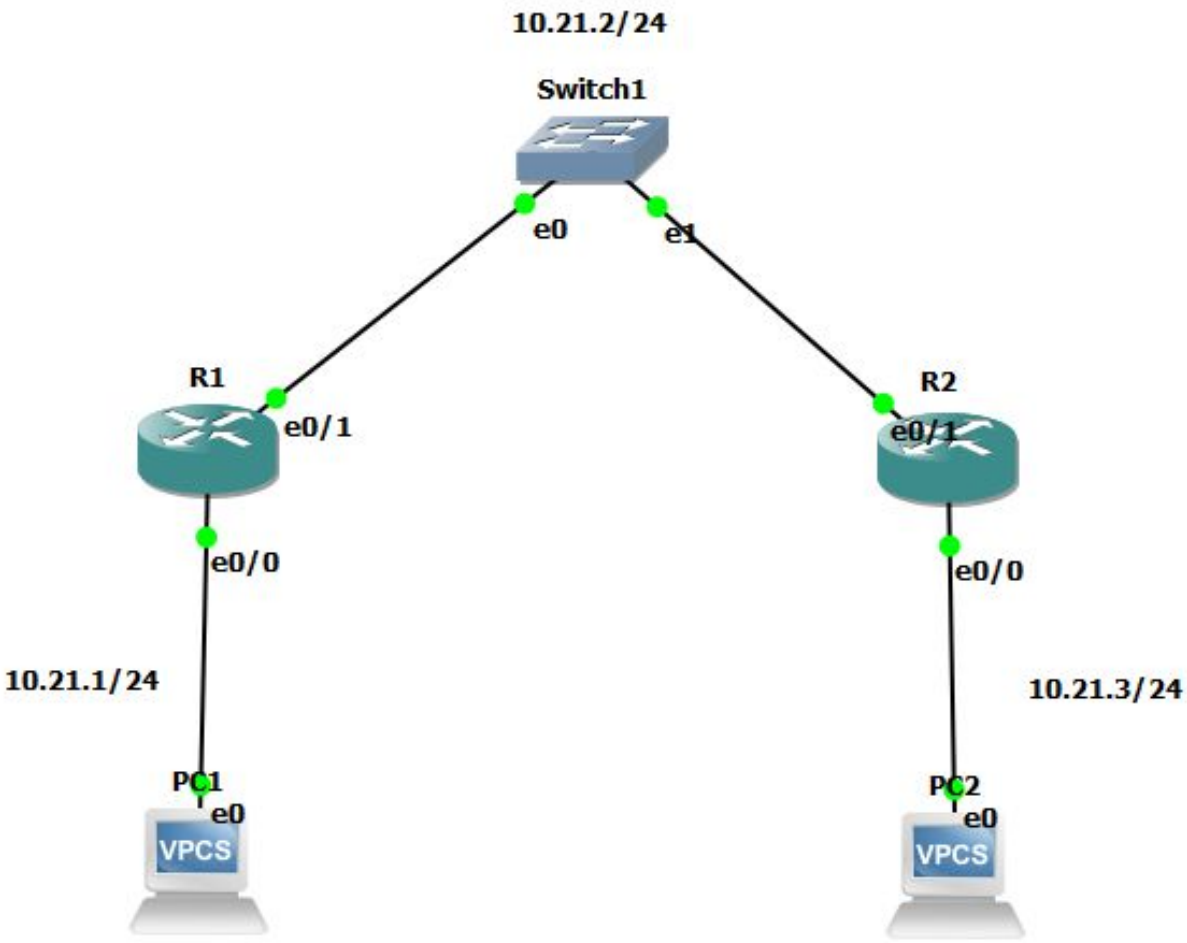


Traceroute from R1 to 192.21.6.103. In the previous section, the traceroute was via 192.21.2 and 4. But in this step, because of shutdown, it is via 192.21.8, 9, 6



Section 2: OSPF Protocol

Step - I



R1's Routing Table. The networks 10.21.1 and 2 are directly connected to R1 whereas 10.21.3 is connected via R2.

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 3 subnets
O       10.21.3.0 [110/20] via 10.21.2.102, 00:00:31, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
C       10.21.1.0 is directly connected, Ethernet0/0
R1#
```

R2's Routing Table. The networks 10.21.2 and 3 are directly connected to R2 whereas 10.21.1 is connected via R1.

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 3 subnets
C       10.21.3.0 is directly connected, Ethernet0/0
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:01:04, Ethernet0/1
R2#
```

Link State Database of R1. It has 3 LSAs.

There are 2 Router LSAs (R1 and R2) and one Network LSA (10.21.3)

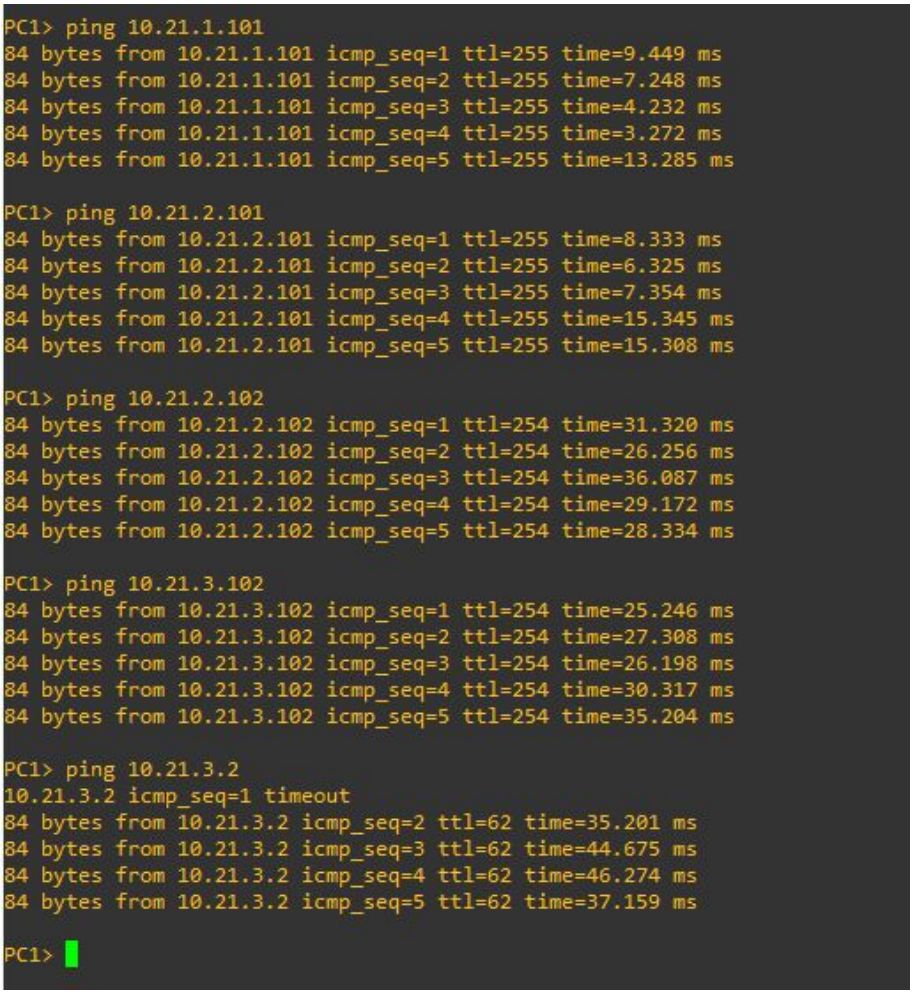
```
R1#show ip ospf database

            OSPF Router with ID (10.21.2.101) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     91          0x80000002 0x00B71C 2
10.21.3.102     10.21.3.102     92          0x80000002 0x00CDFE 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.102     10.21.3.102     92          0x80000001 0x00A674
R1#
```

Link State Database of R2. It has 3 LSAs.

There are 2 Router LSAs (R1 and R2) and one Network LSA (10.21.2)

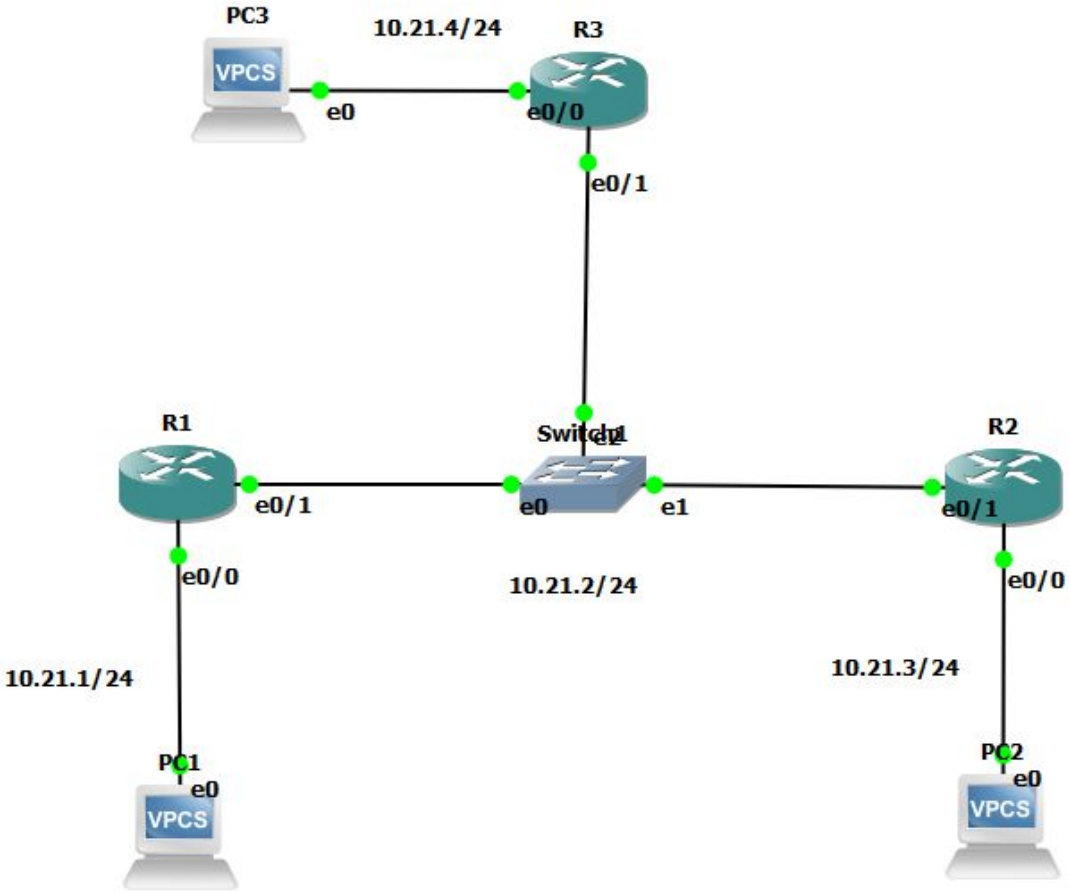
```
R2#show ip ospf database

            OSPF Router with ID (10.21.3.102) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     110         0x80000002 0x00B71C 2
10.21.3.102     10.21.3.102     109         0x80000002 0x00CDFE 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.102     10.21.3.102     109         0x80000001 0x00A674
R2#
```

The **PING** from PC1 to both R1's interfaces, R2's interfaces and PC2 interface has been successful.



Inside the 'R1Switch.pcapng' (present in OSPFv2_Routers.zip) file, the packets which constitute the LS DataBase Exchange sequence are the packets with S.Nos 24 to 26 and 28 to 31.

Step - II


PC3
10.21.4/24
R3
VPCS
e0
e0/0
e0/1
R1
Switch1
R2
e0/1
e0
e1
e0/1
e0/0
10.21.2/24
e0/0
10.21.1/24
10.21.3/24
PC1
e0
PC2
e0
VPCS
VPCS

Step 2A)

R1's Routing Table. As no other Routers are currently configured, the only networks in R1's routing table now are 10.21.1, 2.

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 2 subnets
C       10.21.2.0 is directly connected, Ethernet0/1
C       10.21.1.0 is directly connected, Ethernet0/0
```

Link State Database of R1. R1 currently has only one Router LSA (of itself)

```
R1#show ip ospf database

            OSPF Router with ID (10.21.2.101) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     18          0x80000001 0x00B709 2
```

We can see that currently, R1 has no OSPF Neighbors.

```
R1#show ip ospf neighbor

R1#
```

Step 2b)

R1's Routing Table. As only the Routers R1 and R2 are currently configured and running, the networks in R1's routing table now are 10.21.1, 2 and 3.

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 3 subnets
O       10.21.3.0 [110/20] via 10.21.2.102, 00:00:10, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
C       10.21.1.0 is directly connected, Ethernet0/0
```

R2's Routing Table

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 3 subnets
C       10.21.3.0 is directly connected, Ethernet0/0
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:00:37, Ethernet0/1
R2#
```

Link State Database of R1. R1 currently has 2 Router LSAs (R1 and R2) and one Network LSA (10.21.2)

```
R1#show ip ospf database

            OSPF Router with ID (10.21.2.101) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     34          0x80000002 0x00AD27 2
10.21.3.102     10.21.3.102     30          0x80000002 0x00C30A 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.101     10.21.2.101     34          0x80000001 0x00C558
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.21.3.102       1   FULL/BDR        00:00:36    10.21.2.102     Ethernet0/1
R1#
```

Link State Database of R2

```
R2#show ip ospf database

            OSPF Router with ID (10.21.3.102) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     61          0x80000002 0x00AD27 2
10.21.3.102     10.21.3.102     56          0x80000002 0x00C30A 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.101     10.21.2.101     61          0x80000001 0x00C558
R2#
```

R1 currently has R2 as it's only OSPF Neighbor

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.21.3.102       1   FULL/BDR        00:00:36    10.21.2.102     Ethernet0/1
R1#
```

R2 currently has R1 as it's only OSPF Neighbor.

```
R2#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.21.2.101       1   FULL/DR         00:00:34    10.21.2.101     Ethernet0/1
R2#
```

R1 is the **Designated Router** (DR) and **R2** is the **Backup Designated Router** (BDR). This information is found from the above screenshots. It can also be found from the Wireshark capture's ('R1.pcap') ospf packets.

Step 2c)

R1's and R3's Routing Tables. We can see that the network 10.21.4 is added to both R1's and R3's routing tables.

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O       10.21.4.0 [110/20] via 10.21.2.103, 00:00:04, Ethernet0/1
O       10.21.3.0 [110/20] via 10.21.2.102, 00:00:04, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
C       10.21.1.0 is directly connected, Ethernet0/0
```

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
C       10.21.4.0 is directly connected, Ethernet0/0
O       10.21.3.0 [110/20] via 10.21.2.102, 00:00:21, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:00:21, Ethernet0/1
```

R3 has R1 and R2 as it's OSPF Neighbors. **R1** is the **Designated Router** (DR) and **R2** is the **Backup Designated Router** (BDR). This information is found from the above screenshots. It can also be found from the Wireshark capture's ('R1.pcap') ospf packets.

```
R3#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.21.2.101       1   FULL/DR         00:00:30    10.21.2.101     Ethernet0/1
10.21.3.102       1   FULL/BDR        00:00:36    10.21.2.102     Ethernet0/1
R3#
```

Link State Database of R1. R1 has 3 Router LSAs (R1, R2 and R3) and 1 Network LSA (10.21.2)

```
R1#show ip ospf database

           OSPF Router with ID (10.21.2.101) (Process ID 2)

               Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     396         0x80000002 0x00AD27 2
10.21.3.102     10.21.3.102     392         0x80000002 0x00C30A 2
10.21.4.103     10.21.4.103     16          0x80000002 0x00C403 2

               Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.101     10.21.2.101     15          0x80000002 0x003D51
R1#show ip ospf neig
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.21.3.102       1   FULL/BDR        00:00:34    10.21.2.102     Ethernet0/1
10.21.4.103       1   FULL/DROTHER    00:00:39    10.21.2.103     Ethernet0/1
R1#
```

Link State Database of R3. R3 has 3 Router LSAs (R1, R2 and R3) and 1 Network LSA (10.21.2)

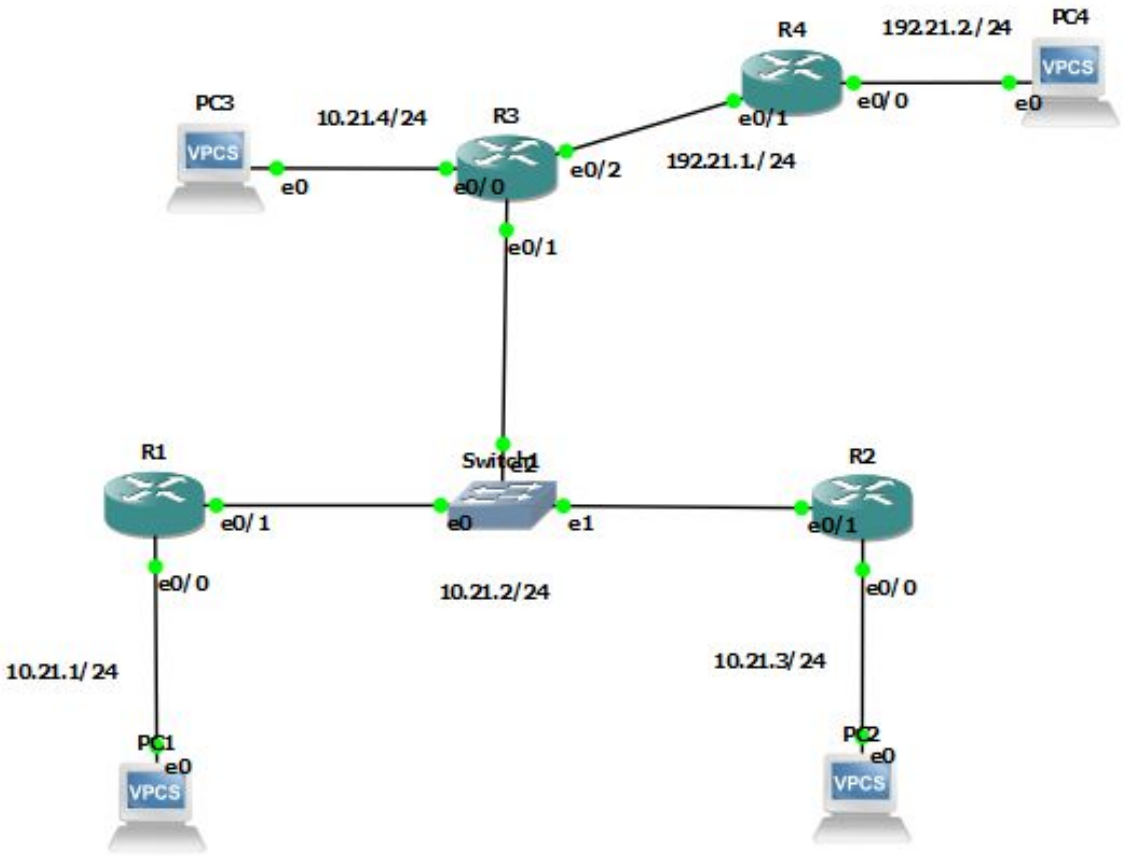
```
R3#show ip ospf database

            OSPF Router with ID (10.21.4.103) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     416         0x80000002 0x00AD27 2
10.21.3.102     10.21.3.102     410         0x80000002 0x00C30A 2
10.21.4.103     10.21.4.103     33          0x80000002 0x00C403 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.101     10.21.2.101     35          0x80000002 0x003D51
R3#show ip ospf neig
R3#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.21.2.101       1   FULL/DR         00:00:30    10.21.2.101     Ethernet0/1
10.21.3.102       1   FULL/BDR        00:00:36    10.21.2.102     Ethernet0/1
R3#
```

Link State Database of R2. R2 has 3 Router LSAs (R1, R2 and R3) and 1 Network LSA (10.21.2)

```
R2#show ip ospf  database

           OSPF Router with ID (10.21.3.102) (Process ID 2)

               Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     1480        0x80000002 0x00AD27 2
10.21.3.102     10.21.3.102     1474        0x80000002 0x00C30A 2
10.21.4.103     10.21.4.103     1099        0x80000002 0x00C403 2

               Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.101     10.21.2.101     1100        0x80000002 0x003D51
R2#
```

The **Wireshark Comments and Analysis** can be found in the file **'R1Final.pcapng**'. Which is present in the file 'OSPFv3_Routers.zip'.

Step - III


R4
192.21.2/24
PC4
VPCS
PC3
10.21.4/24
R3
e0/1
e0/0
e0
VPCS
e0
e0/0
e0/2
192.21.1/24
e0/1
R1
Switch1
R2
e0/1
e0
e1
e0/1
e0/0
10.21.2/24
e0/0
10.21.1/24
10.21.3/24
PC1
e0
VPCS
PC2
e0
VPCS

Step 3a)

R1's Routing Table with only interfaces associated with the backbone enabled after topology and routes converged

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O       10.21.4.0 [110/20] via 10.21.2.103, 00:01:23, Ethernet0/1
O       10.21.3.0 [110/20] via 10.21.2.102, 00:01:23, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
C       10.21.1.0 is directly connected, Ethernet0/0
```

R2's Routing Table

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O       10.21.4.0 [110/20] via 10.21.2.103, 00:01:44, Ethernet0/1
C       10.21.3.0 is directly connected, Ethernet0/0
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:01:44, Ethernet0/1
```

R3's Routing Table

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
C       10.21.4.0 is directly connected, Ethernet0/0
O       10.21.3.0 [110/20] via 10.21.2.102, 00:09:47, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:09:47, Ethernet0/1
```

Link State Database of R1. R1 currently has 3 Router LSAs (R1, R2 and R3) and one Network LSA (10.21.2)

```
R1#show ip ospf database

            OSPF Router with ID (10.21.2.101) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     92          0x80000002 0x00C111 2
10.21.3.102     10.21.3.102     93          0x80000002 0x00F2D8 2
10.21.4.103     10.21.4.103     93          0x80000002 0x00F3D1 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.103     10.21.4.103     93          0x80000001 0x00F890
R1#
```

Link State Database of R2. R2 currently has 3 Router LSAs (R1, R2 and R3) and one Network LSA (10.21.2)

```
R2#show ip ospf database

           OSPF Router with ID (10.21.3.102) (Process ID 2)

               Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     112         0x80000002 0x00C111 2
10.21.3.102     10.21.3.102     111         0x80000002 0x00F2D8 2
10.21.4.103     10.21.4.103     112         0x80000002 0x00F3D1 2

               Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.103     10.21.4.103     112         0x80000001 0x00F890
R2#
```

Link State Database of R3. R3 currently has 3 Router LSAs (R1, R2 and R3) and one Network LSA (10.21.2)

```
R3#show ip ospf database

           OSPF Router with ID (10.21.4.103) (Process ID 2)

               Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     598         0x80000002 0x00C111 2
10.21.3.102     10.21.3.102     598         0x80000002 0x00F2D8 2
10.21.4.103     10.21.4.103     597         0x80000002 0x00F3D1 2

               Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.103     10.21.4.103     597         0x80000001 0x00F890
R3#
```

Step 3b)

R4's Routing Table with all interfaces in the topology enabled.

```
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O IA    10.21.4.0 [110/20] via 192.21.1.103, 00:01:15, Ethernet0/1
O IA    10.21.3.0 [110/30] via 192.21.1.103, 00:01:15, Ethernet0/1
O IA    10.21.2.0 [110/20] via 192.21.1.103, 00:01:15, Ethernet0/1
O IA    10.21.1.0 [110/30] via 192.21.1.103, 00:01:15, Ethernet0/1
C    192.21.1.0/24 is directly connected, Ethernet0/1
C    192.21.2.0/24 is directly connected, Ethernet0/0
R4#
```

Link State Database of R4. R1 currently has 2 Router LSAs (R3 and R4) and one Network LSA (192.21.1), and 4 Summary Network LSAs (10.21.1, 2, 3, 4).

```
R4#show ip ospf database

            OSPF Router with ID (192.21.2.104) (Process ID 2)

                Router Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.4.103     10.21.4.103     116         0x80000002 0x005342 1
192.21.2.104    192.21.2.104    115         0x80000002 0x003DFA 2

                Net Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum
192.21.1.104    192.21.2.104    115         0x80000001 0x0025CA

                Summary Net Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.1.0       10.21.4.103     124         0x80000001 0x003C42
10.21.2.0       10.21.4.103     124         0x80000001 0x00CCBA
10.21.3.0       10.21.4.103     124         0x80000001 0x002656
10.21.4.0       10.21.4.103     124         0x80000001 0x00B6CE
R4#
```

Step 3c)

For R1 and R2, the new LSAs added are Summary Network LSAs (192.21.1 and .2).

For R3, a new area (area 100) with all 3 types of LSA's are added. These are generated by R3

Routing Table and Link State Database of R1

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O       10.21.4.0 [110/20] via 10.21.2.103, 00:21:17, Ethernet0/1
O       10.21.3.0 [110/20] via 10.21.2.102, 00:21:17, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
C       10.21.1.0 is directly connected, Ethernet0/0
O IA 192.21.1.0/24 [110/20] via 10.21.2.103, 00:21:17, Ethernet0/1
O IA 192.21.2.0/24 [110/30] via 10.21.2.103, 00:21:08, Ethernet0/1
R1#show ip ospf database

            OSPF Router with ID (10.21.2.101) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     193         0x80000003 0x00BF12 2
10.21.3.102     10.21.3.102     207         0x80000003 0x00F0D9 2
10.21.4.103     10.21.4.103     1299        0x80000003 0x00F4CE 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.103     10.21.4.103     183         0x80000002 0x00F691

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.21.1.0      10.21.4.103     1295        0x80000001 0x009041
192.21.2.0      10.21.4.103     1285        0x80000001 0x00E9DC
R1#
```

Routing Table and Link State Database of R2

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

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O       10.21.4.0 [110/20] via 10.21.2.103, 00:21:27, Ethernet0/1
C       10.21.3.0 is directly connected, Ethernet0/0
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:21:27, Ethernet0/1
O IA 192.21.1.0/24 [110/20] via 10.21.2.103, 00:21:27, Ethernet0/1
O IA 192.21.2.0/24 [110/30] via 10.21.2.103, 00:21:17, Ethernet0/1
R2#show ip ospf database

            OSPF Router with ID (10.21.3.102) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     190         0x80000003 0x00BF12 2
10.21.3.102     10.21.3.102     202         0x80000003 0x00F0D9 2
10.21.4.103     10.21.4.103     1295        0x80000003 0x00F4CE 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.103     10.21.4.103     179         0x80000002 0x00F691

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.21.1.0      10.21.4.103     1291        0x80000001 0x009041
192.21.2.0      10.21.4.103     1281        0x80000001 0x00E9DC
R2#
```

Routing Table and Link State Database of R3

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
C       10.21.4.0 is directly connected, Ethernet0/0
O       10.21.3.0 [110/20] via 10.21.2.102, 00:21:37, Ethernet0/1
C       10.21.2.0 is directly connected, Ethernet0/1
O       10.21.1.0 [110/20] via 10.21.2.101, 00:21:37, Ethernet0/1
C    192.21.1.0/24 is directly connected, Ethernet0/2
O    192.21.2.0/24 [110/20] via 192.21.1.104, 00:21:27, Ethernet0/2
R3#show ip ospf database

            OSPF Router with ID (10.21.4.103) (Process ID 2)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.2.101     10.21.2.101     200         0x80000003 0x00BF12 2
10.21.3.102     10.21.3.102     213         0x80000003 0x00F0D9 2
10.21.4.103     10.21.4.103     1304        0x80000003 0x00F4CE 2

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.2.103     10.21.4.103     187         0x80000002 0x00F691

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.21.1.0      10.21.4.103     1299        0x80000001 0x009041
192.21.2.0      10.21.4.103     1289        0x80000001 0x00E9DC

                Router Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.4.103     10.21.4.103     1295        0x80000002 0x005342 1
192.21.2.104    192.21.2.104    1306        0x80000002 0x003DFA 2

                Net Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum
192.21.1.104    192.21.2.104    1306        0x80000001 0x0025CA

                Summary Net Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.1.0       10.21.4.103     1315        0x80000001 0x003C42
10.21.2.0       10.21.4.103     1316        0x80000001 0x00CCBA
10.21.3.0       10.21.4.103     1316        0x80000001 0x002656
10.21.4.0       10.21.4.103     1316        0x80000001 0x00B6CE
R3#
```

Routing Table and Link State Database of R4

```
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/24 is subnetted, 4 subnets
O IA    10.21.4.0 [110/20] via 192.21.1.103, 00:21:35, Ethernet0/1
O IA    10.21.3.0 [110/30] via 192.21.1.103, 00:21:35, Ethernet0/1
O IA    10.21.2.0 [110/20] via 192.21.1.103, 00:21:35, Ethernet0/1
O IA    10.21.1.0 [110/30] via 192.21.1.103, 00:21:35, Ethernet0/1
C    192.21.1.0/24 is directly connected, Ethernet0/1
C    192.21.2.0/24 is directly connected, Ethernet0/0
R4#show ip ospf database

            OSPF Router with ID (192.21.2.104) (Process ID 2)

                Router Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.21.4.103     10.21.4.103     1303        0x80000002 0x005342 1
192.21.2.104    192.21.2.104    1302        0x80000002 0x003DFA 2

                Net Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum
192.21.1.104    192.21.2.104    1301        0x80000001 0x0025CA

                Summary Net Link States (Area 100)

Link ID         ADV Router      Age         Seq#       Checksum
10.21.1.0       10.21.4.103     1311        0x80000001 0x003C42
10.21.2.0       10.21.4.103     1311        0x80000001 0x00CCBA
10.21.3.0       10.21.4.103     1311        0x80000001 0x002656
10.21.4.0       10.21.4.103     1311        0x80000001 0x00B6CE
R4#
```

The **Wireshark Comments and Analysis** can be found in the file **'R3SwitchE2FInal.pcapng'**. Which is present in the file 'OSPFv2_ABR_Routers.zip'.