EINTE Lab 4 - BGP

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Task A

Router	AS	Interface	Address
R1	AS100	L0	1.1.1.1/32
		L1	192.168.11.1/24
R4	AS400	L0	4.4.4.4/32
		L1	192.168.41.1/24
		L2	192.168.42.1/24
		L3	192.168.43.1/24
R5	AS500	L0	5.5.5.5/32
		L1	192.168.51.1/24
R2	AS230	L0	2.2.2.2/32
		L1	192.168.21.1/24
R3	AS230	L0	3.3.3.3/32
		L1	192.168.31.1/24

Figure 1 Routing table for the lab

Task B

```
R2#sh 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

     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 10.0.23.2, 00:00:22, FastEthernet2/0
C    192.168.21.0/24 is directly connected, Loopback1
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.12.0 is directly connected, FastEthernet0/0
C       10.0.24.0 is directly connected, FastEthernet1/0
C       10.0.23.0 is directly connected, FastEthernet2/0
```

Figure 2 ip route for R2

```
R3#sh 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

     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.23.1, 00:00:05, FastEthernet2/0
C    192.168.31.0/24 is directly connected, Loopback1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.23.0 is directly connected, FastEthernet2/0
C       10.0.34.0 is directly connected, FastEthernet3/0
C       10.0.35.0 is directly connected, FastEthernet0/0
```

Figure 3 ip route for R3

```
R2#ping 3.3.3.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 3.3.3.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/12/20 ms
```

Figure 4 ping command output for R2

```
R3#ping 2.2.2.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2.2.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 12/20/24 ms
```

Figure 5 ping command output for R3

Task C

Task C1

Below, we include screenshots of ‘sh ip bgp neighbors’ as proof that the protocol has been established and is running correctly:

```
R2#sh ip bgp neighbors
BGP neighbor is 3.3.3.3,  remote AS 230, internal link
  BGP version 4, remote router ID 192.168.31.1
  BGP state = Established, up for 00:02:19
  Last read 00:00:14, last write 00:00:19, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                0          0
    Keepalives:             5          5
    Route Refresh:          1          1
    Total:                  7          7
  Default minimum time between advertisement runs is 0 seconds
```

Figure 6 BGP session state for R2

```
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 255
Local host: 2.2.2.2, Local port: 52020
Foreign host: 3.3.3.3, Foreign port: 179
```

Figure 7 BGP connection states for R2

```
R3#sh ip bgp neighbors
BGP neighbor is 2.2.2.2,  remote AS 230, internal link
  BGP version 4, remote router ID 192.168.21.1
  BGP state = Established, up for 00:02:37
  Last read 00:00:37, last write 00:00:32, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(old & new)
    Address family IPv4 Unicast: advertised and received
  Message statistics:
    InQ depth is 0
    OutQ depth is 0
                         Sent       Rcvd
    Opens:                  1          1
    Notifications:          0          0
    Updates:                0          0
    Keepalives:             5          5
    Route Refresh:          1          1
    Total:                  7          7
  Default minimum time between advertisement runs is 0 seconds
```

Figure 8 BGP session state for R3

```
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Connection is ECN Disabled, Mininum incoming TTL 0, Outgoing TTL 255
Local host: 3.3.3.3, Local port: 179
Foreign host: 2.2.2.2, Foreign port: 52020
```

Figure 9 BGP connection state for R3

Task C2

In this task we configure an eBGP connection. As per the suggestion in the lab exercise, we use direct link addresses instead of loopbacks to achieve this goal.

```
R1#sh ip bgp summary
BGP router identifier 192.168.11.1, local AS number 100
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.0.12.2       4   230       4       4        1    0    0 00:00:48        0
```

Figure 10 summary of the protocol on R1

```
R2#sh ip bgp summary
BGP router identifier 192.168.21.1, local AS number 230
BGP table version is 1, main routing table version 1

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4   230      18      18        1    0    0 00:13:20        0
10.0.12.1       4   100       4       4        1    0    0 00:00:58        0
```

Figure 11 summary of the protocol on R2

Task C3

In this part of the task we have to establish the connection between R1 and R3 routers. First, we have to advertise the L1 address pool on both routers:

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

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
B    192.168.31.0/24 [20/0] via 10.0.12.2, 00:00:59
C    192.168.11.0/24 is directly connected, Loopback1
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.12.0 is directly connected, FastEthernet0/0
R1#sh ip bgp
BGP table version is 3, local router ID is 192.168.11.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 192.168.11.0     0.0.0.0                  0         32768 i
*> 192.168.31.0     10.0.12.2                              0 230 i
```

Figure 12 Address pool on R1

```
R3#sh 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

     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.23.1, 00:41:27, FastEthernet2/0
C    192.168.31.0/24 is directly connected, Loopback1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.23.0 is directly connected, FastEthernet2/0
C       10.0.34.0 is directly connected, FastEthernet3/0
C       10.0.35.0 is directly connected, FastEthernet0/0
R3#sh ip bgp
BGP table version is 2, local router ID is 192.168.31.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
* i192.168.11.0     10.0.12.1                0    100      0 100 i
*> 192.168.31.0     0.0.0.0                  0         32768 i
```

Figure 13 Address pool on R3

If we analyze the below table, we can see that L1 of R1 is unreachable from R3. The reason that R1 is not visible from R3 is that we have not told loopback0 the route to f0/0 interface. We can easily fix that by adding the address of f0/0 on R2.

```
R3#sh 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

     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.23.1, 00:00:21, FastEthernet2/0
C    192.168.31.0/24 is directly connected, Loopback1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
B    192.168.11.0/24 [200/0] via 10.0.12.1, 00:00:15
     10.0.0.0/30 is subnetted, 4 subnets
O       10.0.12.0 [110/11] via 10.0.23.1, 00:00:21, FastEthernet2/0
C       10.0.23.0 is directly connected, FastEthernet2/0
C       10.0.34.0 is directly connected, FastEthernet3/0
C       10.0.35.0 is directly connected, FastEthernet0/0
```

Figure 14 Fixed ip pool on R3

```
R3#ping 192.168.11.1 source 192.168.31.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.11.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.31.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/20/24 ms
```

Figure 15 Ping with a given source

```
R3#ping 192.168.11.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.11.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

Figure 16 Ping without a given source

Above we can see the tests for a ping command. The second one fails, because we haven't specified a source. The reason why in this specific case the ping command has to have a specified source is because the automatically chosen source will most likely be f2/0 interface on R2, which is the first destination on the routing table below. Most likely what happens is that the protocol goes crazy as the first hop destination is also the source. If we specify the source to be something different the issue is fixed.

```
R3#traceroute 192.168.11.1

Type escape sequence to abort.
Tracing the route to 192.168.11.1

  1 10.0.23.1 12 msec 28 msec 16 msec
  2  *  *  *
  3  *  *  *
  4  *  *  *
  5  *  *  *
  6  *  *  *
  7  *  *  *
  8  *  *  *
  9  *  *  *
 10  *  *  *
 11  *  *  *
 12  *  *  *
 13  *  *  *
 14  *  *  *
 15  *  *  *
```

Figure 17 traceroute on R3 without a given source

Task C4

In this part of the task, we are to configure the remaining eBGP in the network. We configure it on fast ethernet interfaces, as opposed to on loopbacks like in iBGP.

```
R1#sh ip bgp summary
BGP router identifier 192.168.11.1, local AS number 100
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
2 path entries using 104 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 734 total bytes of memory
BGP activity 2/0 prefixes, 2/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.0.12.2       4   230      63      63        3    0    0 00:58:38        1
```

Figure 18 Protocol summary for R1

```
R2#sh ip bgp summary
BGP router identifier 192.168.21.1, local AS number 230
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
2 path entries using 104 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 734 total bytes of memory
BGP activity 2/0 prefixes, 2/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4   230      77      77        3    0    0 01:11:04        1
10.0.12.1       4   100      63      63        3    0    0 00:58:43        1
10.0.24.2       4   400      12      14        3    0    0 00:08:26        0
```

Figure 19 Protocol summary for R2

```
R3#sh ip bgp summary
BGP router identifier 192.168.31.1, local AS number 230
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
2 path entries using 104 bytes of memory
3/2 BGP path/bestpath attribute entries using 372 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 734 total bytes of memory
BGP activity 2/0 prefixes, 2/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2.2.2.2         4   230      77      77        3    0    0 01:11:19        1
10.0.34.2       4   400       6       6        3    0    0 00:00:17        0
10.0.35.2       4   500      16      18        3    0    0 00:12:08        0
```

Figure 20 Protocol summary for R3

```
R4#sh ip bgp summary
BGP router identifier 192.168.43.1, local AS number 400
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
6 path entries using 312 bytes of memory
6/2 BGP path/bestpath attribute entries using 744 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1386 total bytes of memory
BGP activity 2/0 prefixes, 6/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.0.24.1       4   230      14      12        3    0    0 00:08:47        2
10.0.34.1       4   230       6       6        3    0    0 00:00:23        2
10.0.45.2       4   500      12      12        3    0    0 00:06:49        2
```

Figure 21 Protocol summary for R4

```
R5#sh ip bgp summary
BGP router identifier 192.168.51.1, local AS number 500
BGP table version is 3, main routing table version 3
2 network entries using 234 bytes of memory
4 path entries using 208 bytes of memory
5/2 BGP path/bestpath attribute entries using 620 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1158 total bytes of memory
BGP activity 2/0 prefixes, 4/0 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.0.35.1       4   230      18      16        3    0    0 00:12:18        2
10.0.45.1       4   400      12      12        3    0    0 00:06:53        2
```

Figure 22 Protocol summary for R5

The missing connections were:

R2 -> AS400

R3 -> AS500; AS400

R4 -> AS230; AS230

R5 -> AS230; AS400

Task C5

In this part of the task, we are supposed to advertise the remaining loopbacks to the protocol.

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

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1 is directly connected, Loopback0
B    192.168.31.0/24 [20/0] via 10.0.12.2, 01:25:39
B    192.168.42.0/24 [20/0] via 10.0.12.2, 00:18:14
B    192.168.43.0/24 [20/0] via 10.0.12.2, 00:18:14
C    192.168.11.0/24 is directly connected, Loopback1
B    192.168.41.0/24 [20/0] via 10.0.12.2, 00:18:45
B    192.168.21.0/24 [20/0] via 10.0.12.2, 00:00:34
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.12.0 is directly connected, FastEthernet0/0
B    192.168.51.0/24 [20/0] via 10.0.12.2, 00:01:07
```

Figure 23 ip route for the R1

```
R2#sh 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

     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback0
B    192.168.31.0/24 [200/0] via 3.3.3.3, 01:25:45
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 10.0.23.2, 01:20:58, FastEthernet2/0
B    192.168.42.0/24 [20/0] via 10.0.24.2, 00:18:20
B    192.168.43.0/24 [20/0] via 10.0.24.2, 00:18:20
B    192.168.11.0/24 [20/0] via 10.0.12.1, 01:26:47
B    192.168.41.0/24 [20/0] via 10.0.24.2, 00:18:51
C    192.168.21.0/24 is directly connected, Loopback1
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.12.0 is directly connected, FastEthernet0/0
C       10.0.24.0 is directly connected, FastEthernet1/0
C       10.0.23.0 is directly connected, FastEthernet2/0
B    192.168.51.0/24 [20/0] via 10.0.24.2, 00:01:15
```

Figure 24 ip route for the R2

```
R3#sh 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

     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.0.23.1, 01:21:06, FastEthernet2/0
C    192.168.31.0/24 is directly connected, Loopback1
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3 is directly connected, Loopback0
B    192.168.42.0/24 [20/0] via 10.0.34.2, 00:18:28
B    192.168.43.0/24 [20/0] via 10.0.34.2, 00:18:28
B    192.168.11.0/24 [200/0] via 10.0.12.1, 01:21:00
B    192.168.41.0/24 [20/0] via 10.0.34.2, 00:18:59
B    192.168.21.0/24 [200/0] via 2.2.2.2, 00:00:50
     10.0.0.0/30 is subnetted, 4 subnets
O       10.0.12.0 [110/11] via 10.0.23.1, 01:21:08, FastEthernet2/0
C       10.0.23.0 is directly connected, FastEthernet2/0
C       10.0.34.0 is directly connected, FastEthernet3/0
C       10.0.35.0 is directly connected, FastEthernet0/0
B    192.168.51.0/24 [20/0] via 10.0.35.2, 00:01:22
```

Figure 25 ip route for the R3

```
R4#sh 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

B    192.168.31.0/24 [20/0] via 10.0.24.1, 00:48:49
C    192.168.42.0/24 is directly connected, Loopback2
     4.0.0.0/32 is subnetted, 1 subnets
C       4.4.4.4 is directly connected, Loopback0
C    192.168.43.0/24 is directly connected, Loopback3
B    192.168.11.0/24 [20/0] via 10.0.24.1, 00:48:49
C    192.168.41.0/24 is directly connected, Loopback1
B    192.168.21.0/24 [20/0] via 10.0.24.1, 00:00:56
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.24.0 is directly connected, FastEthernet1/0
C       10.0.45.0 is directly connected, FastEthernet2/0
C       10.0.34.0 is directly connected, FastEthernet3/0
B    192.168.51.0/24 [20/0] via 10.0.45.2, 00:01:28
```

Figure 26 ip route for the R4

```
R5#sh 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

B    192.168.31.0/24 [20/0] via 10.0.35.1, 00:52:22
B    192.168.42.0/24 [20/0] via 10.0.45.1, 00:18:41
B    192.168.43.0/24 [20/0] via 10.0.45.1, 00:18:41
     5.0.0.0/32 is subnetted, 1 subnets
C       5.5.5.5 is directly connected, Loopback0
B    192.168.11.0/24 [20/0] via 10.0.35.1, 00:52:22
B    192.168.41.0/24 [20/0] via 10.0.45.1, 00:19:12
B    192.168.21.0/24 [20/0] via 10.0.35.1, 00:01:01
     10.0.0.0/30 is subnetted, 2 subnets
C       10.0.45.0 is directly connected, FastEthernet2/0
C       10.0.35.0 is directly connected, FastEthernet0/0
C    192.168.51.0/24 is directly connected, Loopback1
```

Figure 27 ip route for the R5

The above screenshots prove that the advertisements have propagated to the routing tables correctly.

Task C6

As can be seen on the 3 screenshots below, there is a clear issue with the connectivity. Namely, R1 cannot ping R5's loopback without specifying a source.

```
R1#ping 192.168.51.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.51.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

Figure 28 ping on R1 to check connectivity

```
R1#ping 192.168.51.1 source 192.168.11.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.51.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.11.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/58/68 ms
```

Figure 29 ping with a given source on R1 to check connectivity

```
R1#traceroute 192.168.51.1

Type escape sequence to abort.
Tracing the route to 192.168.51.1

  1 10.0.12.2 12 msec 24 msec 24 msec
  2  *  *  *
  3  *  *  *
  4  *  *  *
  5  *  *  *
  6  *  *  *
  7  *
```

Figure 30 tracert on R1 to check the packet path

The way to resolve the issue is to set a R3 as a next hop target for any packet coming to 2.2.2.2 (R2). If we run the tracert command afterwards, we can see that the issue has been resolved.

```
R3#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#router bgp 230
R3(config-router)#neighbor 2.2.2.2 next-hop-self
R3(config-router)#
```

Figure 31 neighbor configuration on R3

```
R1#traceroute 192.168.51.1 source 192.168.11.1

Type escape sequence to abort.
Tracing the route to 192.168.51.1

  1 10.0.12.2 12 msec 20 msec 20 msec
  2 10.0.23.2 48 msec 44 msec 20 msec
  3 10.0.35.2 68 msec 68 msec 56 msec
```

Figure 32 tracert with a given source on R1 to check if the issue is resolved

Task C7

The aim of this last part is to configure local preference on the AS230 in such a way that all traffic coming from R1 to R4 will leave through R3. Below we include the commands we have run and the output for the tracert command to prove that it has been set up properly.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#route-map R2OVERRIDE permit 10
R2(config-route-map)#set local-preference 1000
R2(config-route-map)#exit
R2(config)#router bgp 230
R2(config-router)#neighbor 3.3.3.3 route-map R2OVERRIDE in
R2(config-router)#do clear ip bgp * soft
R2(config-router)#
```

Figure 33 Configuring local preference

```
R1#traceroute 192.168.41.1 source 192.168.11.1

Type escape sequence to abort.
Tracing the route to 192.168.41.1

  1 10.0.12.2 16 msec 16 msec 24 msec
  2 10.0.23.2 48 msec 44 msec 40 msec
  3 10.0.34.2 60 msec 44 msec 28 msec
```

Figure 34 Tracert to check the local preference