Final Report

Data Transmission, Lab 5

Configuring Basic Aspects of BGP Routing Protocol

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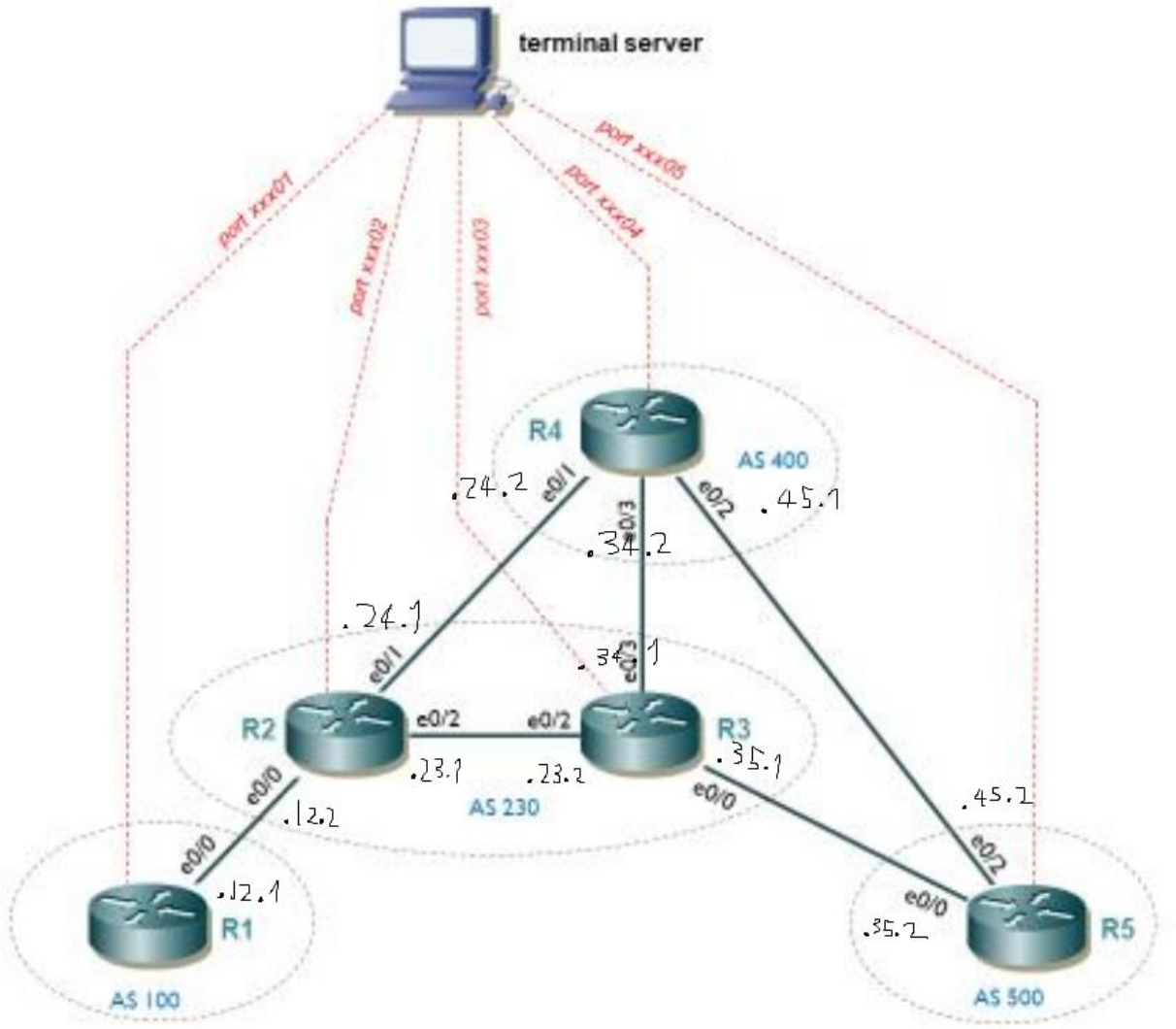
3A. IP ADDRESS ASSIGNMENT

The image below depicts how we configured the given subnets.
We also configured the loopbacks as required.



Subnet	Subnet address
R1-R2	10.0.12.0/30
R2-R4	10.0.24.0/30
R3-R4	10.0.34.0/30
R3-R5	10.0.35.0/30
R4-R5	10.0.45.0/30
R2-R3	10.0.23.0/30

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
		L2	192.168.52.1/24
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

3B. OSFP CONFIGURATION IN AS230

We configured OSPF on R2 – R3 link and tested it by pinging in both directions.

```
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 = 20/22/28 ms
```

```
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 = 20/127/388 ms
```

3C. BASIC BGP CONFIGURATION

I. Task C1

```
R2#sho ip bgp nei
BGP neighbor is 3.3.3.3,  remote AS 230, internal link
  BGP version 4, remote router ID 0.0.0.0
  BGP state = Active
  Last read 00:00:45, last write 00:00:45, hold time is
```

```
R3#sho ip bgp nei
BGP neighbor is 2.2.2.2,  remote AS 230, internal link
  BGP version 4, remote router ID 0.0.0.0
  BGP state = Active
  Last read 00:01:16, last write 00:01:16, hold time is
```

After we configured the source of BGP session, we can see that it finally became established.

```
R2#sho ip bgp nei
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 00:00:27
  Last read 00:00:27, last write 00:00:27, hold time is
```

```
R3#sho ip bgp nei
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 00:00:59
  Last read 00:00:59, last write 00:00:59, hold time is
```

II. Task C2

```
R1#sho ip bgp summ
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 00:00:29        0
```

```
R2#sho ip bgp summ
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       6       6        1    0    0 00:02:44        0
10.0.12.1       4   100       4       4        1    0    0 00:00:06        0
```

The link between R1 and R2 is established.

III. Task C3

```
R3#sho ip ro
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 [110/11] via 10.0.23.1, 00:23:26, Ethernet0/2
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, Ethernet0/2
C       10.0.34.0 is directly connected, Ethernet0/3
C       10.0.35.0 is directly connected, Ethernet0/0
```

```
R3#sho 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
```

R2 advertises loopback1 of R1 to R3, but as R3 technically does not know how to reach the R1 – R2 subnet; it simply omits it from its routing table. We fix this by running “neighbor 3.3.3.3 next-hop-self” in config mode on R2 to clarify that all the networks that R2 advertises to R3 can be reached via the internal connection to R2.

```
R3#sho ip ro
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 [110/11] via 10.0.23.1, 00:26:07, Ethernet0/2
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 2.2.2.2, 00:00:25
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.23.0 is directly connected, Ethernet0/2
C       10.0.34.0 is directly connected, Ethernet0/3
C       10.0.35.0 is directly connected, Ethernet0/0
```

We can see now that the loopback1 network on R1 is added to the routing table of R3 and R3 now knows that it is reachable via R2.

```
R3#ping 192.168.11.1 so lo1

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 = 40/44/56 ms
```

We can see that loopback1 on R1 is reachable from R3 if we specify that the source of the ping is R3's loopback1, but if we do not then R1 wouldn't know how to reach R3. This is because loopback0 will be used by default for the ping, but we are only using BGP and we aren't advertising loopback0 over BGP.

We would still have the same problem if we did specify the source but still used loopback0, as in something like "ping 192.168.11.1 source lo0".

IV. Task C4

```
R1#sho ip bgp summ
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 00:00:29        0
```

```
R2#sho ip bgp summ
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      27      29        3    0    0 00:20:44        1
10.0.12.1       4   100      23      23        3    0    0 00:18:06        1
10.0.24.2       4   400       7       7        3    0    0 00:01:51        0
```

```
R3#sho ip bgp summ
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      29      27        3    0    0 00:20:53        1
10.0.34.2       4   400       7       7        3    0    0 00:01:39        0
10.0.35.2       4   500       6       6        3    0    0 00:00:27        0
```

```
R4#sho ip bgp summ
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       8       8        3    0    0 00:02:19        2
10.0.34.1       4   230       7       7        3    0    0 00:01:57        2
10.0.45.2       4   500       6       6        3    0    0 00:00:27        2
```

```
R5#sho ip bgp summ
BGP router identifier 192.168.52.1, 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       6       6        3    0    0 00:00:55        2
10.0.45.1       4   400       6       6        3    0    0 00:00:38        2
```

We can see that all the BGP neighbors have been configured.

V. Task C5

```
R1#sho ip ro
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, 00:15:39
B    192.168.42.0/24 [20/0] via 10.0.12.2, 00:02:31
B    192.168.43.0/24 [20/0] via 10.0.12.2, 00:02:31
C    192.168.11.0/24 is directly connected, Loopback1
B    192.168.41.0/24 [20/0] via 10.0.12.2, 00:03:01
B    192.168.21.0/24 [20/0] via 10.0.12.2, 00:03:32
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.12.0 is directly connected, Ethernet0/0
B    192.168.52.0/24 [20/0] via 10.0.12.2, 00:01:31
B    192.168.51.0/24 [20/0] via 10.0.12.2, 00:02:02
```

```
R2#sho ip ro
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, 00:15:05
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/11] via 10.0.23.2, 00:37:34, Ethernet0/2
B    192.168.42.0/24 [20/0] via 10.0.24.2, 00:01:57
B    192.168.43.0/24 [20/0] via 10.0.24.2, 00:01:57
B    192.168.11.0/24 [20/0] via 10.0.12.1, 00:21:01
B    192.168.41.0/24 [20/0] via 10.0.24.2, 00:02:27
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, Ethernet0/0
C       10.0.24.0 is directly connected, Ethernet0/1
C       10.0.23.0 is directly connected, Ethernet0/2
B    192.168.52.0/24 [200/0] via 3.3.3.3, 00:01:08
B    192.168.51.0/24 [200/0] via 3.3.3.3, 00:01:38
```

```
R3#sho ip ro
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 [110/11] via 10.0.23.1, 00:40:00, Ethernet0/2
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, 00:04:23
B    192.168.43.0/24 [20/0] via 10.0.34.2, 00:04:23
B    192.168.11.0/24 [200/0] via 2.2.2.2, 00:14:18
B    192.168.41.0/24 [20/0] via 10.0.34.2, 00:04:53
B    192.168.21.0/24 [200/0] via 2.2.2.2, 00:05:25
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.23.0 is directly connected, Ethernet0/2
C       10.0.34.0 is directly connected, Ethernet0/3
```

```
R4#sho ip ro
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, 00:10:45
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, 00:10:45
C    192.168.41.0/24 is directly connected, Loopback1
B    192.168.21.0/24 [20/0] via 10.0.24.1, 00:06:34
     10.0.0.0/30 is subnetted, 3 subnets
C       10.0.24.0 is directly connected, Ethernet0/1
C       10.0.45.0 is directly connected, Ethernet0/2
C       10.0.34.0 is directly connected, Ethernet0/3
B    192.168.52.0/24 [20/0] via 10.0.45.2, 00:04:33
B    192.168.51.0/24 [20/0] via 10.0.45.2, 00:05:05
```

```
R5#sho ip ro
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, 00:09:43
B    192.168.42.0/24 [20/0] via 10.0.45.1, 00:06:05
B    192.168.43.0/24 [20/0] via 10.0.45.1, 00:06:05
     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, 00:09:43
B    192.168.41.0/24 [20/0] via 10.0.45.1, 00:06:35
B    192.168.21.0/24 [20/0] via 10.0.35.1, 00:07:06
     10.0.0.0/30 is subnetted, 2 subnets
C       10.0.45.0 is directly connected, Ethernet0/2
C       10.0.35.0 is directly connected, Ethernet0/0
C    192.168.52.0/24 is directly connected, Loopback2
C    192.168.51.0/24 is directly connected, Loopback1
```

We can see that each router has every “customer network” in its routing table.

VI. Task C6

```
R1#tra 192.168.51.1 so lo1

Type escape sequence to abort.
Tracing the route to 192.168.51.1

  1 10.0.12.2 20 msec 24 msec 20 msec
  2 10.0.24.2 24 msec 44 msec 40 msec
  3 10.0.45.2 120 msec 68 msec 72 msec
```

We can see that although BGP would prefer the shortest AS-path to R5, the main problem is that although R3 does advertise its connection to R5 to R2, we once again have the same problem as in Task C3 where R2 still does not know how to reach R5 through R3 because we didn’t clarify the next hop and so because R2 then omits this path from its routing table, R1 can only reach R5 through R4.

```
R1#tra 192.168.51.1 so lo1

Type escape sequence to abort.
Tracing the route to 192.168.51.1

  1 10.0.12.2 12 msec 16 msec 24 msec
  2 10.0.23.2 40 msec 32 msec 44 msec
  3 10.0.35.2 56 msec 72 msec 52 msec
```

After configuring R3 to clarify to R2 that it is indeed the next hop for the networks that it advertises to R2, R2 adds the R2-R3-R5 path to its routing table. Now as we can see, BGP will prefer this one over the R2-R4-R5 one because it has a shorter AS-path (230->500->i vs 230->400->500->i respectively).

3D. ADVANCED BGP CONFIGURATION

I. Task D1

```
R1#tra 192.168.41.1 so lo1

Type escape sequence to abort.
Tracing the route to 192.168.41.1

  1 10.0.12.2 20 msec 12 msec 20 msec
  2 10.0.24.2 32 msec 32 msec 44 msec
```

We set the local preference on R2.

```
R2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)#route-map R3PREF permit 10
R2(config-route-map)#set lo 4294967295
R2(config-route-map)#ex
R2(config)#router bgp 230
R2(config-router)#nei 3.3.3.3 ro?
route-map  route-reflector-client

R2(config-router)#nei 3.3.3.3 route-m R3PREF in
```

```
R1#tra 192.168.41.1 so lo1

Type escape sequence to abort.
Tracing the route to 192.168.41.1

  1 10.0.12.2 12 msec 12 msec 24 msec
  2 10.0.23.2 32 msec 44 msec 44 msec
  3 10.0.34.2 52 msec 48 msec 32 msec
```

II. Task D2

```
R3#sho ip bgp
BGP table version is 21, 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     2.2.2.2                  0    100      0 100 i
*>i192.168.21.0     2.2.2.2                  0    100      0 i
*> 192.168.31.0     0.0.0.0                  0         32768 i
*  192.168.41.0     10.0.35.2                              0 500 400 i
*>                  10.0.34.2                0             0 400 i
*  192.168.42.0     10.0.35.2                              0 500 400 i
*>                  10.0.34.2                0             0 400 i
*  192.168.43.0     10.0.35.2                              0 500 400 i
*>                  10.0.34.2                0             0 400 i
*  192.168.48.0/21  10.0.34.2                              0 400 500 i
*>                  10.0.35.2                0             0 500 i
```

```
R1#sho ip ro
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, 01:09:37
B    192.168.42.0/24 [20/0] via 10.0.12.2, 00:56:28
B    192.168.43.0/24 [20/0] via 10.0.12.2, 00:56:28
C    192.168.11.0/24 is directly connected, Loopback1
B    192.168.41.0/24 [20/0] via 10.0.12.2, 00:56:58
B    192.168.21.0/24 [20/0] via 10.0.12.2, 00:57:29
     10.0.0.0/30 is subnetted, 1 subnets
C       10.0.12.0 is directly connected, Ethernet0/0
B    192.168.48.0/21 [20/0] via 10.0.12.2, 00:01:07
R1#tr 192.168.51.1 so lo1

Type escape sequence to abort.
Tracing the route to 192.168.51.1

  1 10.0.12.2 4 msec 28 msec 16 msec
  2 10.0.23.2 40 msec 28 msec 44 msec
  3 10.0.35.2 76 msec 48 msec 72 msec
```

We configured R5 to aggregate its “customer network” addresses and we checked that R3 indeed has the aggregated address instead of each 192.168.5X.0/24 network, and that R1 can still reach it.

III. Task D3

```
R5#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R5(config)#ro?
route-map  router

R5(config)#route-m PREMAP permit 10
R5(config-route-map)#set as-path prepend 500
R5(config-route-map)#ex
R5(config)#router bgp 500
R5(config-router)#nei 10.0.35.1 route-map PREMAP out
R5(config-router)#end
```

```
R3#sho ip bgp
BGP table version is 8, 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     2.2.2.2                  0    100      0 100 i
*>i192.168.21.0     2.2.2.2                  0    100      0 i
*> 192.168.31.0     0.0.0.0                  0         32768 i
*  192.168.41.0     10.0.35.2                              0 500 500 400 i
*>                  10.0.34.2                0             0 400 i
*  192.168.42.0     10.0.35.2                              0 500 500 400 i
*>                  10.0.34.2                0             0 400 i
*  192.168.43.0     10.0.35.2                              0 500 500 400 i
*>                  10.0.34.2                0             0 400 i
*  192.168.48.0/21  10.0.35.2                0             0 500 500 i
*>                  10.0.34.2                              0 400 500 i
```

We used path prepending to artificially extend the path that R3 sees to R5, so that the BGP best path selection algorithm defaults to using the path through R4.
We can see how compared to the BGP table of R3 from Task D2, the path to 192.168.48.0/21 via 10.0.35.2 is now 500->500->i whereas is was simply 500->i before this configuration.

```
R1#tr 192.168.51.1 so lo1

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 10.0.23.2 32 msec 40 msec 72 msec
  3 10.0.34.2 56 msec 44 msec 56 msec
  4 10.0.45.2 64 msec 80 msec 60 msec
```

We can see from the traceroute command that the packet is now taking the path through R4 to R5.