LAB1 - Network Configuration

Introduction

In this project, I configured an OSPF-based network topology with multiple routers (R1-R6) interconnected using different IP subnets and loopback interfaces. The objective was to:

1. Ensure that R1 can reach R6.
2. Route traffic through the path R1 → R3 → R5 → R4 → R6.
3. Block R6 from reaching R1's loopback and the network between R1 and R3.

Router	Interface	IP Address	Loopback	OSPF Area
R1	fa 0/0 (with R3)	192.168.1.1/24	1.1.1.1/32	Area 1
R2	fa 0/0 (with R4)	192.168.2.1/24	2.2.2.2/32	Area 2
R3	fa 0/0 (with R1)	192.168.1.2/24	3.3.3.3/32	Area 1
R3	fa 1/0 (with R5)	192.168.3.1/24		Area 0
R3	fa 3/0 (with R4)	192.168.4.1/24		Area 0
R4	fa 0/0 (with R2)	192.168.2.2/24	4.4.4.4/32	Area 2
R4	fa 2/0 (with R5)	192.168.5.2/24		Area 0
R4	fa 3/0 (with R3)	192.168.3.2/24		Area 0
R4	fa 4/0 (with R6)	192.168.6.1/24		Area 3
R5	fa 1/0 (with R3)	192.168.3.2/24	5.5.5.5/32	Area 0
R5	fa 2/0 (with R4)	192.168.5.1/24		Area 0
R6	fa 4/0 (with R4)	192.168.6.2/24	6.6.6.6/32	Area 3

Part 1: Connectivity Verification

1. Ping from R1 to R6:

```
R1#ping 6.6.6.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 6.6.6.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/119/292 ms
```

- Verified using the ping command with the loopback address as the source.
- Initial attempts failed due to access control lists (ACLs) and incorrect filtering configurations.
- After adjustments, R1 successfully reached R6 while ensuring the desired path was maintained.

```
R1#ping 6.6.6.6 source 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 6.6.6.6, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/72/88 ms
```

2. **Traceroute from R1 to R6:**

```
R1#traceroute 6.6.6.6

Type escape sequence to abort.
Tracing the route to 6.6.6.6

  1 192.168.1.2 44 msec 0 msec 0 msec
  2 192.168.3.2 16 msec 8 msec 4 msec
  3 192.168.5.2 104 msec 96 msec 16 msec
  4 192.168.6.2 92 msec *  52 msec
R1#
```

- Configured OSPF link costs to force traffic through the path **R1** → **R3** → **R5** → **R4** → **R6**.

AT R4,

```
interface FastEthernet3/0
 ip address 192.168.4.2 255.255.255.0
 ip ospf cost 100
 duplex half
```

AT R3,

```
interface FastEthernet3/0
 ip address 192.168.4.1 255.255.255.0
 ip ospf cost 100
 duplex half
```

3. Blocking R6 from Accessing R1 , R3 and R1 loopback

- **OSPF Stub Area and Summarization:**
  Initially, I attempted to use an OSPF stub area between R4 and R6.This did not fully achieve the requirement, as R6 could still resolve routes indirectly.
- For R6,

```
router ospf 1
 log-adjacency-changes
 area 3 stub
 network 6.6.6.6 0.0.0.0 area 3
 network 192.168.6.0 0.0.0.255 area 3
```

- For R4,

```
router ospf 1
 log-adjacency-changes
 area 0 range 192.168.0.0 255.255.0.0
 area 3 stub
 network 4.4.4.4 0.0.0.0 area 0
 network 192.168.2.0 0.0.0.255 area 2
 network 192.168.4.0 0.0.0.255 area 0
 network 192.168.5.0 0.0.0.255 area 0
 network 192.168.6.0 0.0.0.255 area 3
```

- **Prefix Filtering:**
  Applied prefix lists to prevent R1's loopback and the R1-R3 network from being advertised into OSPF.This ensured that R6 did not receive routes to these networks.

  At R6,(INBOUND)

```
router ospf 1
 log-adjacency-changes
 area 3 stub
 area 3 filter-list prefix BLOCK-R1 in
 network 6.6.6.6 0.0.0.0 area 3
 network 192.168.6.0 0.0.0.255 area 3
 distribute-list prefix BLOCK-R1 in
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
ip prefix-list BLOCK-R1 seq 5 deny 1.1.1.1/32
ip prefix-list BLOCK-R1 seq 10 deny 192.168.1.0/24
ip prefix-list BLOCK-R1 seq 15 permit 0.0.0.0/0 le 32
```

The filtering applied in R6 (distribute-list and prefix-list BLOCK-R1 in) ensures that R6 does not install R1's loopback and the R1-R3 network into its routing table. This blocks R6 from learning about R1's loopback and the subnet between R1 and R3.

At R4,(OUTBOUND)

```
router ospf 1
 log-adjacency-changes
 area 3 stub no-summary
 area 3 filter-list prefix BLOCK-R6 out
 network 4.4.4.4 0.0.0.0 area 0
 network 192.168.2.0 0.0.0.255 area 2
 network 192.168.4.0 0.0.0.255 area 0
 network 192.168.5.0 0.0.0.255 area 0
 network 192.168.6.0 0.0.0.255 area 3
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
ip prefix-list BLOCK-R6 seq 5 deny 192.168.1.0/24
ip prefix-list BLOCK-R6 seq 10 deny 1.1.1.1/32
ip prefix-list BLOCK-R6 seq 15 permit 0.0.0.0/0 le 32
```

Since R4 is an ABR (Area Border Router), it is responsible for advertising inter-area routes.
R6 can still learn about R1's loopback from R4, if R4 has received and forwarded those routes.
To ensure R6 does not learn about R1's loopback and the R1-R3 network from any path, filtering in R4 prevents those routes from being advertised into Area 3.

Results:

1. Blocking R6 from Accessing R1 and R3:

```
R6#traceroute 192.168.1.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1

  1  *  *  *
  2
```

2. Blocking R6 from Accessing R1 LOOPBACK:

```
R6#ping 1.1.1.1 source 6.6.6.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.1.1.1, timeout is 2 seconds:
Packet sent with a source address of 6.6.6.6
.....
Success rate is 0 percent (0/5)
```

Part 2: Adding Loopbacks on R3

```
router ospf 1
 router-id 3.3.3.3
 log-adjacency-changes
 network 3.3.3.3 0.0.0.0 area 1
 network 172.16.0.0 0.0.0.255 area 0
 network 172.16.1.0 0.0.0.255 area 0
 network 172.16.2.0 0.0.0.255 area 0
 network 172.16.3.0 0.0.0.255 area 0
 network 192.168.1.0 0.0.0.255 area 1
 network 192.168.3.0 0.0.0.255 area 0
 network 192.168.4.0 0.0.0.255 area 0
```

```
interface Loopback0
 ip address 3.3.3.3 255.255.255.255
!
interface Loopback1
 ip address 172.16.0.1 255.255.255.0
!
interface Loopback2
 ip address 172.16.1.1 255.255.255.0
!
interface Loopback3
 ip address 172.16.2.1 255.255.255.0
!
interface Loopback4
 ip address 172.16.3.1 255.255.255.0
!
```

Tasks:

1. Before applying OSPF summarization, we first inspect the routing table and LSDB (Link-State Database) on R1. The routing table will contain individual loopback routes. The LSDB will list multiple Type-3 LSAs (Summary LSAs) for each loopback, meaning R1 is receiving multiple specific routes from the ABR.

```
R1#show ip route ospf
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/5] via 192.168.1.2, 00:10:12, FastEthernet0/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 192.168.1.2, 00:31:01, FastEthernet0/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/4] via 192.168.1.2, 00:10:12, FastEthernet0/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/3] via 192.168.1.2, 00:31:01, FastEthernet0/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/5] via 192.168.1.2, 00:09:20, FastEthernet0/0
     172.16.0.0/22 is subnetted, 1 subnets
O IA    172.16.0.0 [110/2] via 192.168.1.2, 00:31:01, FastEthernet0/0
O IA 192.168.4.0/24 [110/101] via 192.168.1.2, 00:31:01, FastEthernet0/0
O IA 192.168.5.0/24 [110/3] via 192.168.1.2, 00:31:01, FastEthernet0/0
O IA 192.168.6.0/24 [110/4] via 192.168.1.2, 00:10:12, FastEthernet0/0
O IA 192.168.2.0/24 [110/4] via 192.168.1.2, 00:10:12, FastEthernet0/0
O IA 192.168.3.0/24 [110/2] via 192.168.1.2, 00:31:01, FastEthernet0/0
R1#
```

```
R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         2           0x80000004 0x004EEC 2
172.16.3.1      172.16.3.1      24          0x80000003 0x009F19 2

                Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.2     172.16.3.1      24          0x80000002 0x00AF97

                Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
2.2.2.2         172.16.3.1      628         0x80000001 0x00A7C8
4.4.4.4         172.16.3.1      628         0x80000001 0x004128
5.5.5.5         172.16.3.1      24          0x80000002 0x00075E
6.6.6.6         172.16.3.1      576         0x80000001 0x00EE71
172.16.0.0      172.16.3.1      24          0x80000002 0x004F71
192.168.2.0     172.16.3.1      628         0x80000001 0x0032DB
192.168.3.0     172.16.3.1      24          0x80000002 0x0011FC
192.168.4.0     172.16.3.1      24          0x80000002 0x00E7C1
192.168.5.0     172.16.3.1      24          0x80000002 0x000506
192.168.6.0     172.16.3.1      628         0x80000001 0x000604
```

2. After Summarization and Filtering:
   Summarized Address Appears (172.16.0.0/16):
   - Instead of multiple individual loopbacks appearing, they are now represented as a summary route (172.16.0.0/16).
   - The summary was likely configured using the area X range 172.16.0.0 255.255.0.0 command on the ABR.

Individual Subnets Disappear from Routing Table:
- The specific /32 loopback addresses no longer appear in the routing table.
- They are aggregated into a single summarized route (172.16.0.0/16 and 172.16.0.0/22).

Null0 Route (172.16.0.0/22 is a summary, Null0)
- The summarization resulted in the automatic addition of a Null0 route.
- This prevents routing loops by discarding packets that match the summary but do not correspond to an actual subnet.

```
R3#sh ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/2] via 192.168.1.1, 00:32:05, FastEthernet0/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/4] via 192.168.3.2, 00:11:03, FastEthernet1/0
     4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/3] via 192.168.3.2, 00:11:03, FastEthernet1/0
     5.0.0.0/32 is subnetted, 1 subnets
O       5.5.5.5 [110/2] via 192.168.3.2, 00:34:35, FastEthernet1/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/4] via 192.168.3.2, 00:10:10, FastEthernet1/0
     172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O       172.16.0.0/22 is a summary, 00:35:13, Null0
O    192.168.5.0/24 [110/2] via 192.168.3.2, 00:34:35, FastEthernet1/0
O IA 192.168.6.0/24 [110/3] via 192.168.3.2, 00:11:03, FastEthernet1/0
O IA 192.168.2.0/24 [110/3] via 192.168.3.2, 00:11:03, FastEthernet1/0
```

Results and Conclusion

- Successfully configured OSPF to force the desired path **R1** → **R3** → **R5** → **R4** → **R6**.
- R6 was blocked from reaching R1's loopback and the R1-R3 network.
- R1 was still able to reach R6 without issues.
- Summarization and prefix filtering helped optimize OSPF and control routing advertisements.