Introduction:

Internal Border Gateway Protocol (iBGP) is a bit different than External Border Gateway Protocol (eBGP). This lab was designed to build our understanding of iBGP and its difference from eBGP which we used in our previous BGP lab. In this lab, we used both iBGP, eBGP, and a form of IGP, which in this case we chose OSPF.

Background Information:

Internal Border Gateway Protocol (iBGP) is a form of BGP used within an autonomous system (AS). Unlike External Boarder Gateway Protocol (eBGP), which is used to connect different ASes together, iBGP is used in transitional ASes and backup routes within ASes due to its extensive scalability. Due to this difference iBGP and eBGP have many differences in the way the act but the main one we saw during this lab was that iBGP has routers within the same AS while eBGP has routers in different ASes. IBGP also has a different Administrative Distance (AD) of 200 compared to eBGP's of 20.

IBGP uses a full mesh configuration with other iBGP routers within the AS. Creating a full mesh requires a router to maintain a connection with every other iBGP router. This is a downside in large networks as having to maintain a session with every other iBGP router within the AS will degrade the performance of those routers. Route Reflectors (RRs) mitigate this issue by reducing the number of connections required within the AS. Using RRs multiple client routers will peer into a central router which is the RR which acts like a server. This lowers the amount of peering happening within the AS as routers will only have to peer into the RR instead of all other routers. The RR system does have its flaws as RRs are single points of failure which is why a backup RR should be configured to provide redundancy. A RR and its clients form a cluster which include a cluster ID on all RRs and clients.

IBGP is used extensively today by large enterprise networks to ensure best routes are chosen and no routing loops are present. IBGP can be used within these networks similar to how an Interior Gateway Protocol (IGP) like OSPF or EIGRP. However iBGP offers greater scalability, stability and flexibility than IGPs can

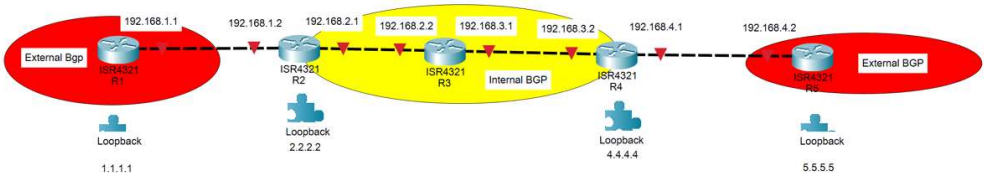
which fits the requirements of many large enterprise networks that handle tens of thousands of packets per second, enough to break a IGP network.

Lab Summary:

This lab uses 5 routers in a daisy chain configuration. The middle 3 routers are an AS running both iBGP and OSPF while the two outer routers, R1 and R5, are running eBGP running in separate ASes acting as outside networks from routers 2, 3, and 4. Routers 1, 2, 4, and 5 have loopback interfaces. Router 2 and 4s loopback interface is used as loopback interfaces don't go down and used for the update-source loopback command. This command creates a BGP neighbor relation between router 2 and 4 without them being physically connected to each other directly which in turn creates a full mesh network within AS 2. The loopback interfaces on R1 and R5 are meant for pinging across as proof of connectivity. OSPF is used as iBGP itself doesn't have enough routing information alone requiring the use of a IGP as a backbone protocol.

Refer below for a visual reference.

Network Diagram:



Lab Commands:

Rx(config)#interface g0/0/x

Rx(config)#ip address 192.168.x.x 255.255.255.0

Rx(config)#interface loopback0

Rx(config)#ip address x.x.x.x 255.255.255.255

Rx(config)#router bgp x

Rx(config-router)#address-family ipv4

Rx(config-router)#network x.x.x.x mask 255.255.255.255

Rx(config-router)#network 192.168.x.x area 0

Rx(config-router)#neighbor 192.168.x.x remote-as x

Rx(config-router)#neighbor 192.168.x.x activate

Rx(config-router)#redistribute OSPF

Rx(config-router)#neighbor x.x.x.x update-source loopback

Rx(config)#router ospf 1

Rx(config-router)#network 192.168.x.x area 0

Rx(config-router)#redistribute bgp x subnets

Configurations:

R1:

```
Building configuration...
Current configuration : 1473 bytes
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-core
hostname R1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO214421CF
```

```
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 1.1.1.1 255.255.255.255
interface GigabitEthernet0/0/0
ip address 192.168.1.1 255.255.255.0
negotiation auto
interface GigabitEthernet0/0/1
no ip address
negotiation auto
interface Serial0/1/0
no ip address
interface Serial0/1/1
no ip address
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
negotiation auto
interface Vlan1
no ip address
router bgp 1
bgp log-neighbor-changes
neighbor 192.168.1.2 remote-as 2
address-family ipv4
network 1.1.1.1 mask 255.255.255.255
neighbor 192.168.1.2 activate
```

```
exit-address-family
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end


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
2.0.0.0/32 is subnetted, 1 subnets
B 2.2.2.2 [20/0] via 192.168.1.2, 00:55:45
4.0.0.0/32 is subnetted, 1 subnets
B 4.4.4.4 [20/0] via 192.168.1.2, 00:54:43
5.0.0.0/32 is subnetted, 1 subnets
B 5.5.5.5 [20/0] via 192.168.1.2, 00:54:43
192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.1.0/24 is directly connected, GigabitEthernet0/0/0
L 192.168.1.1/32 is directly connected, GigabitEthernet0/0/0
B 192.168.2.0/24 [20/0] via 192.168.1.2, 00:55:45
B 192.168.3.0/24 [20/2] via 192.168.1.2, 00:55:14
```

```
B 192.168.4.0/24 [20/3] via 192.168.1.2, 00:55:14
```

R2:

```
Building configuration...
Current configuration : 1981 bytes
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-core
hostname R2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO211216BL
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 2.2.2.2 255.255.255.255
```

```
interface GigabitEthernet0/0/0
ip address 192.168.2.1 255.255.255.0
negotiation auto
interface GigabitEthernet0/0/1
ip address 192.168.1.2 255.255.255.0
negotiation auto
interface Serial0/1/0
no ip address
interface Serial0/1/1
no ip address
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
negotiation auto
interface Vlan1
no ip address
router ospf 1
redistribute bgp 2 subnets
network 192.168.1.0 0.0.0.255 area 0
network 192.168.2.0 0.0.0.255 area 0
network 192.168.3.0 0.0.0.255 area 0
router bgp 2
bgp log-neighbor-changes
neighbor 1.1.1.1 remote-as 1
neighbor 1.1.1.1 update-source Loopback0
neighbor 4.4.4.4 remote-as 2
neighbor 4.4.4.4 update-source Loopback0
neighbor 192.168.1.1 remote-as 1
```

```
neighbor 192.168.2.2 remote-as 2
address-family ipv4
network 1.1.1.1 mask 255.255.255.255
network 2.2.2.2 mask 255.255.255.255
redistribute ospf 1
neighbor 1.1.1.1 activate
neighbor 4.4.4.4 activate
neighbor 192.168.1.1 activate
neighbor 192.168.2.2 activate
exit-address-family
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end


Gateway of last resort is not set
1.0.0.0/32 is subnetted, 1 subnets
B 1.1.1.1 [20/0] via 192.168.1.1, 00:56:47
2.0.0.0/32 is subnetted, 1 subnets
C 2.2.2.2 is directly connected, Loopback0
```

```
4.0.0.0/32 is subnetted, 1 subnets

O E2 4.4.4.4 [110/1] via 192.168.2.2, 00:56:29,
GigabitEthernet0/0/0

5.0.0.0/32 is subnetted, 1 subnets

O E2 5.5.5.5 [110/1] via 192.168.2.2, 00:56:29,
GigabitEthernet0/0/0

192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.1.0/24 is directly connected, GigabitEthernet0/0/1

L 192.168.1.2/32 is directly connected, GigabitEthernet0/0/1

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.2.1/32 is directly connected, GigabitEthernet0/0/0

O 192.168.3.0/24 [110/2] via 192.168.2.2, 00:56:29,
GigabitEthernet0/0/0

O 192.168.4.0/24 [110/3] via 192.168.2.2, 00:56:29,
GigabitEthernet0/0/0
```

R3:

```
Building configuration...

Current configuration : 1625 bytes

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname R3

boot-start-marker

boot-end-marker

vrf definition Mgmt-intf

address-family ipv4
```

```
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO214420G7
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface GigabitEthernet0/0/0
ip address 192.168.3.1 255.255.255.0
negotiation auto
int
ip address 192.168.2.2 255.255.255.0
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
```

```
interface Vlan1
no ip address
shutdown
router ospf 1
redistribute bgp 2 subnets
network 192.168.2.0 0.0.0.255 area 0
network 192.168.3.0 0.0.0.255 area 0
router bgp 2
bgp log-neighbor-changes
neighbor 192.168.2.1 remote-as 2
neighbor 192.168.3.2 remote-as 2
address-family ipv4
neighbor 192.168.2.1 activate
neighbor 192.168.3.2 activate
exit-address-family
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```
Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets

O E2 1.1.1.1 [110/1] via 192.168.2.1, 00:57:11,
GigabitEthernet0/0/1

2.0.0.0/32 is subnetted, 1 subnets

O E2 2.2.2.2 [110/1] via 192.168.2.1, 00:57:11,
GigabitEthernet0/0/1

4.0.0.0/32 is subnetted, 1 subnets

O E2 4.4.4.4 [110/1] via 192.168.3.2, 00:57:21,
GigabitEthernet0/0/0

5.0.0.0/32 is subnetted, 1 subnets

O E2 5.5.5.5 [110/1] via 192.168.3.2, 00:57:21,
GigabitEthernet0/0/0

O 192.168.1.0/24 [110/2] via 192.168.2.1, 00:57:11,
GigabitEthernet0/0/1

192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.2.0/24 is directly connected, GigabitEthernet0/0/1

L 192.168.2.2/32 is directly connected, GigabitEthernet0/0/1

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.3.1/32 is directly connected, GigabitEthernet0/0/0

O 192.168.4.0/24 [110/2] via 192.168.3.2, 00:57:21,
GigabitEthernet0/0/0



BGP table version is 19, local router ID is 192.168.3.1

Status codes: s suppressed, d damped, h history, * valid, > best,
i - internal,

r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,

x best-external, a additional-path, c RIB-compressed,

Origin codes: i - IGP, e - EGP, ? - incomplete

RPKI validation codes: V valid, I invalid, N Not found
```

```
Network Next Hop Metric LocPrf Weight Path
r>i 1.1.1.1/32 192.168.1.1 0 100 0 1 i
r>i 2.2.2.2/32 192.168.2.1 0 100 0 i
r>i 4.4.4.4/32 192.168.3.2 0 100 0 i
r>i 5.5.5.5/32 192.168.4.2 0 100 0 3 i
r>i 192.168.1.0 192.168.2.1 0 100 0 ?
r>i 192.168.2.0 192.168.2.1 0 100 0 ?
r>i 192.168.3.0 192.168.3.2 0 100 0 ?
r>i 192.168.4.0 192.168.3.2 0 100 0 ?
```

R4:

```
Building configuration...
Current configuration : 2012 bytes
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-core
hostname R4
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
```

```
license udi pid ISR4321/K9 sn FDO21442B21
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 4.4.4.4 255.255.255.255
interface GigabitEthernet0/0/0
ip address 192.168.4.1 255.255.255.0
negotiation auto
interface GigabitEthernet0/0/1
ip address 192.168.3.2 255.255.255.0
negotiation auto
interface Serial0/1/0
no ip address
interface Serial0/1/1
no ip address
interface GigabitEthernet0/2/0
no ip address
negotiation auto
interface GigabitEthernet0/2/1
no ip address
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
negotiation auto
interface Vlan1
```

```
no ip address
router ospf 1
redistribute bgp 2 subnets
network 192.168.1.0 0.0.0.255 area 0
network 192.168.2.0 0.0.0.255 area 0
network 192.168.3.0 0.0.0.255 area 0
network 192.168.4.0 0.0.0.255 area 0
router bgp 2
bgp log-neighbor-changes
neighbor 2.2.2.2 remote-as 2
neighbor 2.2.2.2 update-source Loopback0
neighbor 192.168.3.1 remote-as 2
neighbor 192.168.4.2 remote-as 3
address-family ipv4
network 4.4.4.4 mask 255.255.255.255
redistribute ospf 1
neighbor 2.2.2.2 activate
neighbor 192.168.3.1 activate
neighbor 192.168.4.2 activate
exit-address-family
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
```

```
stopbits 1

line vty 0 4

login

end


Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets

O E2 1.1.1.1 [110/1] via 192.168.3.1, 00:59:01,
GigabitEthernet0/0/1

2.0.0.0/32 is subnetted, 1 subnets

O E2 2.2.2.2 [110/1] via 192.168.3.1, 00:59:01,
GigabitEthernet0/0/1

4.0.0.0/32 is subnetted, 1 subnets

C 4.4.4.4 is directly connected, Loopback0

5.0.0.0/32 is subnetted, 1 subnets

B 5.5.5.5 [20/0] via 192.168.4.2, 00:59:50

O 192.168.1.0/24 [110/3] via 192.168.3.1, 00:59:01,
GigabitEthernet0/0/1

O 192.168.2.0/24 [110/2] via 192.168.3.1, 00:59:11,
GigabitEthernet0/0/1

192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.3.0/24 is directly connected, GigabitEthernet0/0/1

L 192.168.3.2/32 is directly connected, GigabitEthernet0/0/1

192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.4.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.4.1/32 is directly connected, GigabitEthernet0/0/0
```

R5:

```
Building configuration...
```

```
Current configuration : 3782 bytes
version 16.9
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
hostname R5
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
login on-success log
subscriber templating
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-2270144787
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-2270144787
revocation-check none
rsakeypair TP-self-signed-2270144787
crypto pki certificate chain TP-self-signed-2270144787
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D0609 2A864886 F70D0101
05050030
31312F30 2D060355 04031326 494F532D 53656C66 2D536967 6E65642D
43657274
```

69666963 6174652D 32323730 31343437 3837301E 170D3234 30333037
31363239

34335A17 0D333030 31303130 30303030 305A3031 312F302D 06035504
03132649

4F532D53 656C662D 5369676E 65642D43 65727469 66696361 74652D32
32373031

34343738 37308201 22300D06 092A8648 86F70D01 01010500 0382010F
00308201

0A028201 0100AD04 57BC8DA9 B8D45E4D 3A1EF181 D8CEB3E9 AFDB3597
C1A36BD1

413452CF 531997D8 B1DD6DD0 9550A68A 7D7B6D01 D200BD53 30AD877D
821EB73F

3A2E1851 0A1E4979 902E4957 F0A3D1F1 B10E1609 B77C5BB9 78E2E8DD
17769BE5

AF488D8C 0C5C4CE2 2A2905ED 30B5D104 0B019DE0 278A34E5 1A2EEEC0
136FCD5F

C147BB86 E4869C22 150FFA8D CD8E85B0 6A6E8290 43071C83 1C29C396
4DA4FD5D

A1A935DA 4DBA7218 92398BF4 ADE801D9 E687E13F FF4FEE8D E3F891E3
A5031A84

00E3427F 327B5DCD 108AF61C 24AD76C2 314E099C 96AD023B B09F4806
B6059680

33218C60 E40D4AE0 F69090EB 675A7232 41F3A27E FF6045DE 6585687E
36EB870C

C5CAED56 BF310203 010001A3 53305130 0F060355 1D130101 FF040530
030101FF

301F0603 551D2304 18301680 14BAA654 1EA898A2 ED5A1AF3 C603E221
DB6ECD28

5E301D06 03551D0E 04160414 BAA6541E A898A2ED 5A1AF3C6 03E221DB
6ECD285E

300D0609 2A864886 F70D0101 05050003 82010100 0207C166 41D11656
8C8E4F8A

146DD04B 59121822 5CE7562B 79AA6669 D7351530 D9544732 4D7D9C3A
C5C53BDD

0208D2A7 1B68189F 800BAEA6 33165649 4443EDE3 DD8EDBC9 BBA956B9
3012001A

3E4F1531 B092E04B 5E3419D5 3F03BE53 65CAA480 FA722790 A882FD3E

```
2286E97C

2FD22AB6 58C76DEA 7F43C255 4C223508 F36DD419 2134D0DA 5A258E40
1C7233FA

C7C7305B 20138E75 2EC362A2 09D61E3B 6E44FFAC 24A83FF0 7A2A7399
E318F272

DA9D67A9 4AAFCD1E 2747F195 DC413859 6A1D2F1D 00D69486 8D0A9052
7270C8DF

2E8D4E11 A968A77C FAA11230 B317BF9B 3600A7CB 86C00025 C9D816EF
E036064F

10E72AF7 5CD42E8D EAA7B877 0B1D50BB A1151AFA

quit

license udi pid ISR4321/K9 sn FLM24060912

no license smart enable

diagnostic bootup level minimal

spanning-tree extend system-id

redundancy

mode none

interface Loopback0

ip address 5.5.5.5 255.255.255.255

interface GigabitEthernet0/0/0

no ip address

negotiation auto

interface GigabitEthernet0/0/1

ip address 192.168.4.2 255.255.255.0

negotiation auto

interface GigabitEthernet0/2/0

no ip address

negotiation auto

interface GigabitEthernet0/2/1

no ip address
```

```
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
negotiation auto
router bgp 3
bgp log-neighbor-changes
neighbor 192.168.4.1 remote-as 2
address-family ipv4
network 5.5.5.5 mask 255.255.255.255
neighbor 192.168.4.1 activate
exit-address-family
ip forward-protocol nd
no ip http server
ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
transport input none
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end

Gateway of last resort is not set
1.0.0.0/32 is subnetted, 1 subnets
```

```
B 1.1.1.1 [20/0] via 192.168.4.1, 00:56:53
2.0.0.0/32 is subnetted, 1 subnets
B 2.2.2.2 [20/0] via 192.168.4.1, 00:56:53
4.0.0.0/32 is subnetted, 1 subnets
B 4.4.4.4 [20/0] via 192.168.4.1, 00:58:03
5.0.0.0/32 is subnetted, 1 subnets
C 5.5.5.5 is directly connected, Loopback0
B 192.168.1.0/24 [20/3] via 192.168.4.1, 00:56:53
B 192.168.2.0/24 [20/2] via 192.168.4.1, 00:57:23
B 192.168.3.0/24 [20/0] via 192.168.4.1, 00:58:03
192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C 192.168.4.0/24 is directly connected, GigabitEthernet0/0/1
L 192.168.4.2/32 is directly connected, GigabitEthernet0/0/1
```

Issues:

We experienced an issue where we couldn't the end routers couldn't the other end router's loopback while all 3 of the middle routers were able to see all routers. We still are not sure the why this happened, however I believe it was due to iBGP not working yet as there was no full mesh configuration yet as we didn't set up the update-source loopbacks on R2 and R4. When this issue occurred, we didn't understand that iBGP needed to be configured with a full mesh meaning we didn't have loopbacks on R2 and R4 nor update-source loopback commands. We redid the lab using a guide online with a similar 5 router configuration as the lab requires and with a bit of modification to fit this lab's requirements, we got pings across the network and were able to see all loopbacks from all routers.

Conclusion:

I learned a lot from this lab, for most of the time doing the lab I didn't have much knowledge of iBGP and how it works. Only when doing this writeup I learned a lot more how iBGP and how an IGP is important in this lab. I now understand

how iBGP works as well as how update-source loopbacks. I also learned the difference between iBGP and eBGP in not only their use case (only knew that eBGP was used for connecting networks in the web) but also how they function. This lab was important in building on our understanding of BGP from our previous BGP lab. It also creates a scenario that we could run into outside the lab environment.