

iBGP Lab

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# Purpose

The purpose of this lab was to configure Interior Border Gateway Protocol (iBGP) to work with the Open Shortest Path First protocol (OSPF) to redistribute routes through multiple networks.

# Background Information

Border Gateway Protocol (BGP) is the protocol used by different autonomous systems (AS) to communicate with each other with high efficiency by providing services for these autonomous systems to be able to redistribute information through BGP with as little loss as possible. BGP is also a path vector protocol, meaning that, compared to link state protocols such as OSPF, it can handle much larger networks with higher efficiency. This is relevant since as networks converge together, for example through the internet, different routing protocols are used, and these protocols need to be able to communicate with each other, and BGP allows for speedy, lossless communication between these protocols. This speed and compatibility allow networks to distribute routes to faraway networks that are not even connected to them.

There are two types of BGP: internal and external. Internal BGP (iBGP) runs within the same AS, and typically is used along with another IGP, such as OSPF or RIP. External BGP (eBGP) runs between different AS, and can route between different AS. In practice, eBGP is used to transfer routing information between different AS, and iBGP is used to make this routing information accessible to routers in AS who are not edge routers, and to make sure BGP routing information is properly transferred from one edge to another in an AS.

# Lab Summary

In this lab, we configured five routers in a line, the center three of which are in the same AS and the two outside which are in their own AS. The center AS should be configured with iBGP and OSPF, and the two outer AS should be configured with eBGP and loopback interfaces. The goal is for all routers to be able to ping to each other. We started by configuring OSPF on the AS with multiple routers and set up loopback interfaces on the individual routers that would be used later to test connectivity between the AS. We then configured BGP on all the routers, using iBGP (same AS numbers as iBGP neighbors) for the center AS and eBGP (different AS numbers for eBGP neighbors) for the outer routers. We then redistributed OSPF routes with iBGP and vice versa, then set up network commands for BGP. Finally, we ensured we could ping between the two loopback interfaces, along with each different interface on each device. We ran into some trouble, but using show commands, we could properly debug our issues, and the fix that worked for us was adding network commands.

# Lab Commands

We did not use any new commands in this lab.

# Network Diagram

A diagram of a computer

Description automatically generated

# Configurations

## show running-config

### R0

Current configuration : 1532 bytes

! Last configuration change at 19:49:23 UTC Wed Feb 14 2024

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname JacobAidenAaronR0

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 4.4.4.4 255.255.255.0

interface GigabitEthernet0/0/0

no ip address

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

vrf forwarding Mgmt-intf

no ip address

negotiation auto

interface Vlan1

no ip address

router bgp 2

bgp log-neighbor-changes

neighbor 192.168.3.1 remote-as 1

address-family ipv4

network 4.4.4.0 mask 255.255.255.0

network 192.168.3.0

redistribute connected

neighbor 192.168.3.1 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

### R1

Current configuration : 1746 bytes

! Last configuration change at 20:06:22 UTC Wed Feb 14 2024

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname JacobAaronAidenR1

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 GigabitEthernet0/0/0

ip address 192.168.0.1 255.255.255.0

ip ospf 1 area 0

negotiation auto

interface GigabitEthernet0/0/1

ip address 192.168.3.1 255.255.255.0

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

router-id 1.1.1.1

redistribute bgp 1 subnets

router bgp 1

bgp log-neighbor-changes

neighbor 192.168.0.2 remote-as 1

neighbor 192.168.3.2 remote-as 2

address-family ipv4

network 2.2.2.0 mask 255.255.255.0

network 4.4.4.0 mask 255.255.255.0

network 192.168.0.0

network 192.168.1.0

network 192.168.2.0

network 192.168.3.0

redistribute ospf 1

neighbor 192.168.0.2 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

### R2

Current configuration : 1729 bytes

! Last configuration change at 20:05:28 UTC Wed Feb 14 2024

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname JacobAaronAidenR2

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 192.168.0.2 255.255.255.0

ip ospf 1 area 0

negotiation auto

interface GigabitEthernet0/0/1

ip address 192.168.1.1 255.255.255.0

ip ospf 1 area 0

negotiation auto

interface Serial0/1/0

interface Serial0/1/1

interface GigabitEthernet0

vrf forwarding Mgmt-intf

no ip address

shutdown

negotiation auto

interface Vlan1

no ip address

shutdown

router ospf 1

router-id 2.2.2.2

router bgp 1

bgp log-neighbor-changes

neighbor 192.168.0.1 remote-as 1

neighbor 192.168.1.2 remote-as 1

address-family ipv4

network 2.2.2.0 mask 255.255.255.0

network 4.4.4.0 mask 255.255.255.0

network 192.168.0.0

network 192.168.1.0

network 192.168.2.0

network 192.168.3.0

redistribute connected

neighbor 192.168.0.1 activate

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

### R3

Current configuration : 1878 bytes

! Last configuration change at 20:20:57 UTC Wed Feb 14 2024

version 15.5

service timestamps debug datetime msec

service timestamps log datetime msec

no platform punt-keepalive disable-kernel-core

hostname JacobAaronAidenR3

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 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

ip ospf 1 area 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

router-id 3.3.3.3

redistribute bgp 1 subnets

router bgp 1

bgp log-neighbor-changes

neighbor 192.168.1.1 remote-as 1

neighbor 192.168.2.2 remote-as 3

address-family ipv4

network 2.2.2.0 mask 255.255.255.0

network 4.4.4.0 mask 255.255.255.0

network 192.168.0.0

network 192.168.1.0

network 192.168.2.0

network 192.168.3.0

redistribute ospf 1

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

### R4

Current configuration : 1638 bytes

! Last configuration change at 19:47:15 UTC Wed Feb 14 2024

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 JacobAaronAidenR4

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

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 2.2.2.2 255.255.255.0

interface GigabitEthernet0/0/0

ip address 192.168.2.2 255.255.255.0

negotiation auto

interface GigabitEthernet0/0/1

no ip address

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 192.168.2.1 remote-as 1

address-family ipv4

network 2.2.2.0 mask 255.255.255.0

network 192.168.2.0

redistribute connected

neighbor 192.168.2.1 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

## show ip route

Codes: L - local, 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, H - NHRP, l - LISP

a - application route

+ - replicated route, % - next hop override, p - overrides from PfR

### R0

Gateway of last resort is not set

2.0.0.0/24 is subnetted, 1 subnets

B 2.2.2.0 [20/1] via 192.168.3.1, 00:31:39

4.0.0.0/8 is variably subnetted, 2 subnets, 2 masks

C 4.4.4.0/24 is directly connected, Loopback0

L 4.4.4.4/32 is directly connected, Loopback0

B 192.168.0.0/24 [20/0] via 192.168.3.1, 00:44:57

B 192.168.1.0/24 [20/2] via 192.168.3.1, 00:38:49

B 192.168.2.0/24 [20/1] via 192.168.3.1, 00:36:16

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

### R1

Gateway of last resort is not set

2.0.0.0/24 is subnetted, 1 subnets

O E2 2.2.2.0 [110/1] via 192.168.0.2, 00:33:54, GigabitEthernet0/0/0

4.0.0.0/24 is subnetted, 1 subnets

B 4.4.4.0 [20/0] via 192.168.3.2, 00:38:59

192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.0.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.0.1/32 is directly connected, GigabitEthernet0/0/0

O 192.168.1.0/24 [110/2] via 192.168.0.2, 00:43:55, GigabitEthernet0/0/0

O E2 192.168.2.0/24 [110/1] via 192.168.0.2, 00:36:14, GigabitEthernet0/0/0

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 192.168.3.1/32 is directly connected, GigabitEthernet0/0/1

### R2

Gateway of last resort is not set

2.0.0.0/24 is subnetted, 1 subnets

O E2 2.2.2.0 [110/1] via 192.168.1.2, 00:32:49, GigabitEthernet0/0/1

4.0.0.0/24 is subnetted, 1 subnets

O E2 4.4.4.0 [110/1] via 192.168.0.1, 00:43:32, GigabitEthernet0/0/0

192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks

C 192.168.0.0/24 is directly connected, GigabitEthernet0/0/0

L 192.168.0.2/32 is directly connected, 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 192.168.1.1/32 is directly connected, GigabitEthernet0/0/1

### R3

Gateway of last resort is not set

2.0.0.0/24 is subnetted, 1 subnets

B 2.2.2.0 [20/0] via 192.168.2.2, 00:33:07

4.0.0.0/24 is subnetted, 1 subnets

O E2 4.4.4.0 [110/1] via 192.168.1.1, 00:35:33, GigabitEthernet0/0/1

O 192.168.0.0/24 [110/2] via 192.168.1.1, 00:35:33, GigabitEthernet0/0/1

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 E2 192.168.3.0/24 [110/1] via 192.168.1.1, 00:35:33, GigabitEthernet0/0/1

### R4

Gateway of last resort is not set

2.0.0.0/8 is variably subnetted, 2 subnets, 2 masks

C 2.2.2.0/24 is directly connected, Loopback0

L 2.2.2.2/32 is directly connected, Loopback0

4.0.0.0/24 is subnetted, 1 subnets

B 4.4.4.0 [20/1] via 192.168.2.1, 00:28:53

B 192.168.0.0/24 [20/2] via 192.168.2.1, 00:31:24

B 192.168.1.0/24 [20/0] via 192.168.2.1, 00:31:24

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

B 192.168.3.0/24 [20/1] via 192.168.2.1, 00:31:24

## show ip bgp

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

### R0

BGP table version is 14, local router ID is 4.4.4.4

Network Next Hop Metric LocPrf Weight Path

\*> 2.2.2.0/24 192.168.3.1 1 0 1 i

\*> 4.4.4.0/24 0.0.0.0 0 32768 i

\*> 192.168.0.0 192.168.3.1 0 0 1 i

\*> 192.168.1.0 192.168.3.1 2 0 1 i

\*> 192.168.2.0 192.168.3.1 1 0 1 i

\* 192.168.3.0 192.168.3.1 0 0 1 i

\*> 0.0.0.0 0 32768 i

### R1

BGP table version is 17, local router ID is 192.168.3.1

Network Next Hop Metric LocPrf Weight Path

\*> 2.2.2.0/24 192.168.0.2 1 32768 i

\* i 192.168.1.2 1 100 0 i

\*> 4.4.4.0/24 192.168.3.2 0 0 2 i

\* i 192.168.0.0 192.168.0.2 0 100 0 i

\*> 0.0.0.0 0 32768 i

\*> 192.168.1.0 192.168.0.2 2 32768 i

\* i 192.168.0.2 0 100 0 i

\*> 192.168.2.0 192.168.0.2 1 32768 i

\* i 192.168.1.2 1 100 0 i

\* 192.168.3.0 192.168.3.2 0 0 2 i

\*> 0.0.0.0 0 32768 i

### R2

BGP table version is 29, local router ID is 192.168.1.1

Network Next Hop Metric LocPrf Weight Path

\*> 2.2.2.0/24 192.168.1.2 1 32768 i

\* i 192.168.2.2 0 100 0 3 i

\*> 4.4.4.0/24 192.168.0.1 1 32768 i

\* i 192.168.3.2 0 100 0 2 i

\* i 192.168.0.0 192.168.0.1 0 100 0 i

\*> 0.0.0.0 0 32768 i

\* i 192.168.1.0 192.168.1.2 0 100 0 i

\*> 0.0.0.0 0 32768 i

\* i 192.168.2.0 192.168.1.2 0 100 0 i

\*> 192.168.1.2 1 32768 i

\*> 192.168.3.0 192.168.0.1 1 32768 i

\* i 192.168.0.1 0 100 0 i

### R3

BGP table version is 7, local router ID is 192.168.2.1

Network Next Hop Metric LocPrf Weight Path

\*> 2.2.2.0/24 192.168.2.2 0 0 3 i

\* i 4.4.4.0/24 192.168.0.1 1 100 0 i

\*> 192.168.1.1 1 32768 i

\*> 192.168.0.0 192.168.1.1 2 32768 i

\* i 192.168.1.1 0 100 0 i

\*> 192.168.1.0 0.0.0.0 0 32768 i

\* i 192.168.1.1 0 100 0 i

\* 192.168.2.0 192.168.2.2 0 0 3 i

\*> 0.0.0.0 0 32768 i

\*> 192.168.3.0 192.168.1.1 1 32768 i

\* i 192.168.0.1 1 100 0 i

### R4

BGP table version is 8, local router ID is 2.2.2.2

Network Next Hop Metric LocPrf Weight Path

\*> 2.2.2.0/24 0.0.0.0 0 32768 i

\*> 4.4.4.0/24 192.168.2.1 1 0 1 i

\*> 192.168.0.0 192.168.2.1 2 0 1 i

\*> 192.168.1.0 192.168.2.1 0 0 1 i

\*> 192.168.2.0 0.0.0.0 0 32768 i

\* 192.168.2.1 0 0 1 i

\*> 192.168.3.0 192.168.2.1 1 0 1 i

## traceroutes

### R0

JacobAidenAaronR0#traceroute 2.2.2.2

Type escape sequence to abort.

Tracing the route to 2.2.2.2

VRF info: (vrf in name/id, vrf out name/id)

1 192.168.3.1 0 msec 0 msec 0 msec

2 192.168.0.2 [AS 1] 0 msec 1 msec 0 msec

3 192.168.1.2 [AS 1] 1 msec 1 msec 0 msec

4 192.168.2.2 [AS 1] 1 msec 1 msec \*

### R4

JacobAaronAidenR4#traceroute

Protocol [ip]:

Target IP address: 4.4.4.4

Ingress traceroute [n]: yes

Ingress interface: Loopback0

DSCP Value [0]:

Numeric display [n]:

Timeout in seconds [3]:

Probe count [3]:

Minimum Time to Live [1]:

Maximum Time to Live [30]:

Port Number [33434]:

Loose, Strict, Record, Timestamp, Verbose[none]:

Type escape sequence to abort.

Tracing the route to 4.4.4.4

VRF info: (vrf in name/id, vrf out name/id)

1 2.2.2.2 1 msec 1 msec 0 msec

2 192.168.2.1 1 msec 1 msec 0 msec

3 192.168.1.1 [AS 1] 0 msec 1 msec 1 msec

4 192.168.0.1 [AS 1] 0 msec 1 msec 1 msec

5 192.168.3.2 [AS 1] 1 msec 2 msec \*

# Problems

During this lab, we only faced one problem that took us a while to resolve, and it was the routers were not redistributing the BGP routes they received. We resolved this by configuring network statements for all the networks for all the iBGP configurations.

# Conclusion

In this lab, we learned importance of iBGP and how it should be used, and configured it along with OSPF to redistribute loopback addresses received from different edge routers.

Lost signoff sheet, but in group with Jacob and Aidan

A paper with a logo

Description automatically generated