BGP Lab

Name: Jacob Chen

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Lab Partner: Aaron Yu, Aiden Yin

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**Purpose**

Previously, we did a lab about eBGP, aka external BGP. External BGP allows for various autonomous systems to peer and connect efficiently. BGP’s simplicity, and customizability makes it highly adaptable to any situation. Furthermore, BGP is the primary routing protocol used on the internet and is an important skill for any network engineer. In this lab, we learned about another variant of BGP, iBGP. IBGP is used within an autonomous system in conjunction with another Interior Gateway Protocol (Such as EIGRP or OSPF) to provide scalability and efficient management. We’re learning about IBGP because it helps us combine our experience with IGPs with BGP and get a better understanding of how to creating scalable networks.

**Background**

There are two common ways to route traffic within an autonomous system (Any privately managed network can be considered its own autonomous system). The first is through an interior gateway protocol such as OSPF (Open Shortest Path First). OSPF combines routers into logical sections called areas, in which network information such as with the topology is spread throughout the OSPF domain. Each OSPF router receives and maintains information about all other routers in the same area. Each router is able to make efficient routing decisions based on its own knowledge. One area where OSPF suffers is when it comes to scalability.

That’s where IBGP comes in. Unlike EBGP, which was the focus of our previous lab, IBGP is run in conjunction with an interior gateway routing protocol like OSPF to optimize it’s performance. IBGP has the advantages of BGP and helps improve OSPF’s scalability and provides a better level of control. Furthermore, when it comes to communicating with external networks, IBGP really shines. Because most external networks (and much of the internet) relies on BGP, using IBGP we can redistribute routes that we’ve learned (Such as the 800,000+ routes on the internet) into our IGP without OSPF having to learn all 800,000 of those routes. Since BGP can handle more routes than OSPF, IBGP is a necessary if we don’t want to have to manually redistribute all the routes.

Finally, BGP in general (and by extension IBGP) has great options to customize its functionality based on requirements. Playing around with BGP attributes allows network administrators to control important features like next-hop router and the costs associated with certain routes. Combining BGP with IGPs allows us to take advantage of this feature in network management.

**Lab Summary**

First, we created a general topology for the entire setup including 3 different autonomous systems, two networks running eBGP and one network in the middle connecting them running iBGP and OSPF.

After wiring up the diagram, on each of the routers we preformed the following rough steps.

1. Set up basic device configuration including hostname and general device security.
2. Turned on interfaces and loopbacks and set associated IPv4 on said interfaces.
3. Configured BGP Border Routers with the AS number/IP addresses of their neighbors.
4. Set up redistribute and network commands to allow the redistribution of routes between eBGP and iBGP.

**Lab Commands**

**Hostname JacobAaronRX**: Sets a unique hostname to identify the various routers

**Interface g0/0/X**: Access the interfaces

**No shut**: Turns on the interfaces

**Ip add 192.168.x.x 255.255.255.0**: sets an ipv4 address on an interface

**Ip ospf 1 area x**: Sets an OSPF process id of 1 and an associated area on an interface

**Router ospf 1**: access ospfv2 configuration on the router

**Router-id x.x.x.x**: sets a specific router id for that router to use for OSPF

**Redistribute x:** Informs the routing protocol to inject certain types of routes routes into the routing protocol. Examples include Redistribute connected, Redistribute OSPF etc.

**Router BGP**: Access BGP configuration

**Neighbor x.x.x.x remote-as x**: Informs a device of its BGP neighbors. Can be used for both internal and external BGP.

**Neighbor 2001::x activate:** Activates BGP neighbor peering with IPv6

**No auto-summary:** prevents the auto summarization of subnets into classful networks. This is important because BGP needs the exact subnet to match in order to redistribute the routes.

**Network x.x.x.x:** Specifies which BGP networks to advertise

**Network Diagram**

A diagram of a diagram

Description automatically generated

**Configuration:**

hostname JacobAidenAaronR0

int G0/0/1

ip add 192.168.3.2 255.255.255.0

no shutdown

int lo0

ip add 4.4.4.4 255.255.255.0

no shutdown

router bgp 2

neighbor 192.168.3.1 remote-as 1

address-family ipv4 unicast

redistribute connected

network 192.168.3.0 mask 255.255.255.0

network 4.4.4.4 mask 255.255.255.0

hostname JacobAaronAidenR1

interface GigabitEthernet0/0/0

ip address 192.168.0.1 255.255.255.0

ip ospf 1 area 0

no shutdown

interface GigabitEthernet0/0/1

ip address 192.168.3.1 255.255.255.0

no shutdown

router ospf 1

router-id 1.1.1.1

redistribute bgp 1

router bgp 1

neighbor 192.168.0.2 remote-as 1

neighbor 192.168.3.2 remote-as 2

address-family ipv4 unicast

redistribute ospf 1

network 192.168.0.0 mask 255.255.255.0

network 192.168.1.0 mask 255.255.255.0

network 192.168.2.0 mask 255.255.255.0

network 192.168.3.0 mask 255.255.255.0

no auto-summary

hostname JacobAaronAidenR2

interface GigabitEthernet0/0/0

ip address 192.168.0.2 255.255.255.0

ip ospf 1 area 0

no shutdown

interface GigabitEthernet0/0/1

ip address 192.168.1.1 255.255.255.0

ip ospf 1 area 0

no shutdown

router ospf 1

router-id 2.2.2.2

router bgp 1

neighbor 192.168.0.1 remote-as 1

neighbor 192.168.1.2 remote-as 1

address-family ipv4 unicast

redistribute connected

network 192.168.0.0 mask 255.255.255.0

network 192.168.1.0 mask 255.255.255.0

no auto-summary

hostname JacobAaronAidenR3

int g0/0/0

ip address 192.168.2.1 255.255.255.0

no shut

int g0/0/1

ip address 192.168.1.2 255.255.255.0

ip ospf 1 area 0

no shut

router ospf 1

router-id 3.3.3.3

redistribute bgp 1

router bgp 1

neighbor 192.168.2.2 remote-as 3

neighbor 192.168.1.1 remote-as 1

address-family ipv4 unicast

redistribute ospf 1

network 192.168.0.0 mask 255.255.255.0

network 192.168.1.0 mask 255.255.255.0

network 192.168.2.0 mask 255.255.255.0

network 192.168.3.0 mask 255.255.255.0

no auto-summary

hostname JacobAaronAidenR4

int g0/0/0

ip address 192.168.2.2 255.255.255.0

no shutdown

int lo0

ip address 2.2.2.2 255.255.255.0

no shutdown

router bgp 3

neighbor 192.168.2.1 remote-as 1

address-family ipv4 unicast

redistribute connected

network 192.168.2.0 mask 255.255.255.0

network 2.2.2.2 mask 255.255.255.0

**Show Run:**

**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**

**R0**

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

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**

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

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**

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

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**

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

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**

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

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**

**R0**

BGP table version is 14, local router ID is 4.4.4.4

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

\*> 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

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

\*> 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

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

\*> 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

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

\*> 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

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,

t secondary path, L long-lived-stale,

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

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

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**

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 \*

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**

The first problem that we realized was that we misconfigured OSPF. We used the command ip ospf area 1 instead of ip ospf 1 area 0. By setting the area to 1, OSPF wouldn’t function properly. The aforementioned command worked on the device but it didn’t function properly. Fixing the problem involved refamiliarizing ourselves with how to configure OSPF and finding commands that were typed wrong.

The other main problem that we experienced was with regards to pinging across the network. After our initial configuration, each edge router had the ability to ping the central router (R2) but could not ping each other. Furthermore, the middle router had the ability to ping each loopback address. To solve this problem, we added additional network statements into the BGP process. By installing these network prefixes into the BGP table, we were ultimately able to get the edge routers to be able to ping across the OSPF network.

**Conclusion**

An interesting lab that was shorter than most other labs we’ve done. Our background research step took around a day to finish (the main “new” information that we learned was around how to configure internal BGP and the purpose of running iBGP along with an IGP. Configuration and lab specifics (like creating a network diagram) took another couple days. From there, the main issues were around debugging. It’s been a while since we’ve done routing so it took more time to re-learn different protocols and fixing those issues.

I’m happy that we finished this lab. In general, I’ve found BGP to be one of the more challenging routing protocols because of the amount of specific details involved in it’s configuration. That level of specification also allows for many interesting uses, such as with internal BGP. I think overall, despite not enjoying the seemingly endless debugging, I think I’ve come out of it with a better understanding of how enterprise networks work.

