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Advanced Cisco CCNP Networking

VRF Configuration

Lab 6

Purpose
The intent of this lab was to create a basic VRF configuration to transmit traffic between an EIGRP and an autonomous system.

Background Information on Lab Concepts
Imagine you are a network engineer working inside a Facebook building. Nearby is another Google building. Both companies choose the same network provider, and traffic to both companies passes through the same routers. Facebook and Google want to keep their traffic secure so neither company can sniff packets from the other. One method of doing so would be to purchase two separate physical routers for both companies, but this is not cost-efficient and scalable. However, Virtual routing and forwarding (VRF) is a technology that allows multiple routing tables to coexist on the same routers at the same time. This means that both Facebook and Google can use the same routers while maintaining the security of their networks. VRF can be thought of as creating virtual routers on one physical router. This means that interfaces, subnets, routing tables, and IPs can be segmented. Other common scenario where VRF is used is for data centers.

Lab Summary
After being introduced to the lab, we began by researching VRF. After feeling confident in our understanding of the protocol, we began by creating an IP addressing scheme. We then planned how we were going to segment the network using VRF. Once our configuration was created and the commands were compiled, we applied them to the Cisco 4321 routers. We found some problems with our configuration that are detailed in the problems section of this document. After troubleshooting these issues, our configuration functioned correctly and properly segmented the network traffic between Facebook and Google.

Lab Commands

CLI-Command	A statement necessary for a configuration to work, denoted in bold
[*Argument*]	An argument necessary for a command to function, denoted in bold italics.
Optional-Statement <*Optional Argument*>	An optional argument or statement, not necessary for a command to function, denoted in italics

Router> **enable**
Turns on privileged exec mode which allows changes to be made to the router.

Router# **config t**
Enters the router config file and allows you to make changes to the router configuration file.

Router# **copy run start**
Saves the running-configuration (current config on the router, includes the edits you have made during the session, clears when the router powers off) to the startup-configuration (file that router pulls running-config from on bootup, default config)

Router(config)# **ipv6 unicast-routing**
Enables ipv6 protocol on router. Without this command you cannot route ipv6 traffic through that router or configure any ipv6 related commands.

Router# show **ip route**

Displays information about the various routes that are available to the router, including the protocol by which the route was acquired (OSPF, RIP, EGRIP, static, etc.)

Router(config)# **router eigrp** [instance]
Enables EIGRP of a particular instance on the router and enters router configuration mode.
There can be multiple instances of EIGRP running on a router, however, adjacent routers will only communicate if they are using the same instance.

Router# show **ip[v6] route**
Displays information about the various routes that are available to the router, including the protocol by which the route was acquired (OSPF, RIP, EGRIP, static, etc.)

Router(config)# **interface [*interface*] [*id*]**
Enables configuration on a specific interface.

Router(config-router)# **network [*network address*] [*wildcard mask*] area [*area number*]**
Activates OSPFv2 for a specific subnet.
This command is typed after you enter router OSPF configuration mode. Routers in a particular area share a complete topological database and have route summaries of external areas.

Router(config-router)# **address-family [*protocol*]**
Enters configuration mode for a BGP address family
As a basic premise, address families are used to separate certain protocols BGP supports. I find that address-families are more workspaces for the desired protocol. For example, one might enter the "ipv4" or "ipv6" address-families to configure IP routing. This is where redistribution, network statements or activation commands occur.

Router(config-router)# **network [*network address*] mask [*subnet mask*]**
Advertises a directly connected network to the BGP routing table
BGP's network statements are not to be confused with OSPF or EIGRPs; they aren't used to form adjacencies between BGP routers. A BGP network statement is typically configured alongside a neighbor statement, where one advertises the network and the other the neighbor establishment.

Router(config-router)# **neighbor [*IP address*] remote-as [*neighbor's ASN*]**
Used in forming BGP neighbor adjacencies
Unlike a network statement, this command takes the singular *IP* address of the neighbor's connected interface. The second argument is to specify the neighbor's ASN. For a BGP neighborship to be established, each router must have *routes to the neighbor's IP* and *the correct IP and ASN of their neighbor*. Having proper routes to each neighbor's IP is critical to forming adjacencies, but this also means these two BGP neighbors could lie anywhere. For example, routers *A* and *C* are connectedd via router *B*. Theoretically, you could establish a BGP neighbor relationship between routers *A* and *C* if they both have routes to each other's IPs.

Router(config-router-af)# **network [*IPv6 network address*]**
Specifies a directly connected network on the router that will be broadcasted to other BGP routers similarly to OSPF network statements. However, to form an adjacency with another BGP router, you also need a neighbor statement.

Router(config-router)# **neighbor [*IP address*] remote-as [*neighbor's ASN*]**
Used in forming BGP neighbor adjacencies. Unlike network statements, this command takes a host address (not a network address) of the neighbor's connected interface. The second argument is for the neighbors ASN.

Router(config-router-af)# **neighbor [*IPv6 address*] activate**
Enables the exchange of an address with a BGP neighbor.

Router(config-router-af)# **neighbor [*IPv6 address*] next-hop-self**
Updates the next-hop attribute of BGP routes received through BGP updates.
This command is necessary for the function of iBGP networks as routers will add iBGP adjacencies from updates sent by other routers without updating the next-hop attribute, making hosts learned through BGP updates unreachable.

Router(config-router)# **redistribute [*routing protocol*] [*protocol instance*] *metric* <*value*>>** *subnets*
Redistributes routes from specified routing protocol into the table of a local router
The command is typed in the router where you'd want the routes to redistribute. There are many different additional options when redistributing routes, but I've found the *metric* and *subnets* to be the most useful. Each routing protocol has a different *metric*, so when redistributing be sure to use the right one. *Subnets* usually always refers to redistributing classless networks.

Router(config-if)# **ipv6 ospf [*process id*] area [*number*]**
Activates OSPFv3 under a specific interface.
This command is typed when in interface configuration mode. It is good practice for the process ID to be the same, however isn't necessary for OSPF to form adjacencies; process ID is only locally significant. Each OSPF process retains a different routing table, so depending on the configuration, process ID could determine what routes are redistributed. A router can have multiple OSPF processes but will contain a separate OSPF database per process. Routers in a particular area share a complete topological database and have route summaries of external areas.

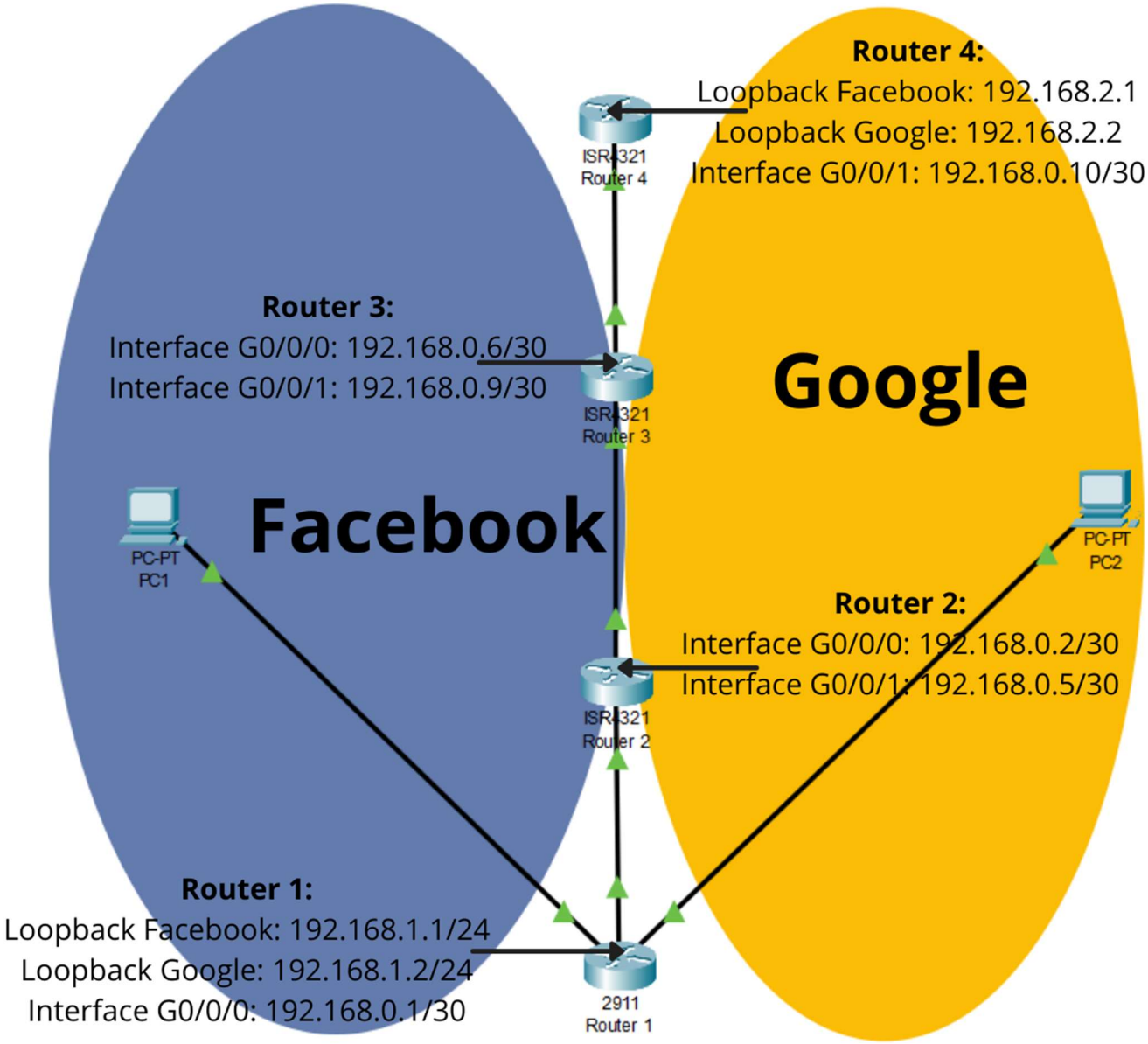
Router(config)# **ipv6 router ospf [*process id*]**
Enables configuration for OSPFv3.
It is good practice for the process ID to be the same, however isn't necessary for OSPF to form adjacencies; process ID is only locally significant. Each OSPF process retains a different routing table, so depending on the configuration, process ID could determine what routes are redistributed. A router can have multiple OSPF processes but will contain a separate OSPF database per process.

Router(config)# **router ospf [*process id*] vrf [*vrf-id*]**
Enables the OSPF routing protocol and enters router configuration mode.
It is good practice for the process ID to be the same, however isn't necessary for OSPF to form adjacencies; process ID is only locally significant. Each OSPF process retains a different routing table, so depending on the configuration, process ID could determine what routes are redistributed. A router can have multiple OSPF processes but will contain a separate OSPF database per process. The VRF qualifier assigns the specified OSPF process to the be assigned to a vrf process.

Router(config)# **router eigrp [process id] vrf [*vrf-id*]**
Enables EIGRP of a particul ar instance on the router and enters router configuration mode.
There can be multiple instances of EIGRP running on a router, however, adjacent routers will only communicate if they are using the same instance. The VRF qualifier assigns the specified EIGRP process to the be assigned to a vrf process.

Router(config)# **router eigrp [process id] vrf [*vrf-id*]**
Enables EIGRP of a particular instance on the router and enters router configuration mode.
There can be multiple instances of EIGRP running on a router, however, adjacent routers will only communicate if they are using the same instance. The VRF qualifier assigns the specified EIGRP process to the be assigned to a vrf process.

Network Diagram with IP's



Configuration:

Router 1:

```
R1#show run
Building configuration...
Current configuration : 2065 bytes
Last configuration change at 18:53:12 UTC Mon Apr 4 2022
version 16.7
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
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
ip vrf facebook
rd 1:2
ip vrf google
rd 1:1
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO220523GF
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
mode none
interface Loopback1
ip vrf forwarding google
ip address 192.168.1.2 255.255.255.0
ip ospf 2 area 2
interface GigabitEthernet0/0/0
no ip address
negotiation auto
interface GigabitEthernet0/0/1
no ip address
negotiation auto
interface GigabitEthernet0/0/1.1
encapsulation dot1Q 80
ip vrf forwarding facebook
ip address 192.168.0.1 255.255.255.252
ip ospf 1 area 1
interface GigabitEthernet0/0/1.2
encapsulation dot1Q 90
ip vrf forwarding google
ip address 192.168.0.1 255.255.255.252
ip ospf 2 area 2
interface Serial0/1/0
interface Serial0/1/1
interface GigabitEthernet0/2/0
ip vrf forwarding facebook
ip address 192.168.1.1 255.255.255.0
ip ospf 1 area 1
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
```

```
negotiation auto
router ospf 1 vrf facebook
router-id 1.1.1.1
router ospf 2 vrf google
router-id 2.2.2.2
ip forward-protocol nd
ip http server
ip http authentication local
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
wsma agent exec
wsma agent config
wsma agent filesys
wsma agent notify
end
```

R1#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
Gateway of last resort is not set
```

R1#show ip route vrf google

```
Routing Table: google
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
      192.168.0.0/24 is variably subnetted, 4 subnets, 2 masks
C        192.168.0.0/30 is directly connected, GigabitEthernet0/0/1.2
L        192.168.0.1/32 is directly connected, GigabitEthernet0/0/1.2
O        192.168.0.4/30
           [110/2] via 192.168.0.2, 00:29:49, GigabitEthernet0/0/1.2
O        192.168.0.8/30
```

```
           [110/3] via 192.168.0.2, 00:28:15, GigabitEthernet0/0/1.2
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback1
L        192.168.1.2/32 is directly connected, Loopback1
      192.168.2.0/32 is subnetted, 1 subnets
O        192.168.2.2 [110/4] via 192.168.0.2, 00:03:11, GigabitEthernet0/0/1.2
```

R1#show ip route vrf facebook

```
Routing Table: facebook
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
      192.168.0.0/24 is variably subnetted, 4 subnets, 2 masks
C        192.168.0.0/30 is directly connected, GigabitEthernet0/0/1.1
L        192.168.0.1/32 is directly connected, GigabitEthernet0/0/1.1
O        192.168.0.4/30
           [110/2] via 192.168.0.2, 00:29:56, GigabitEthernet0/0/1.1
O        192.168.0.8/30
           [110/3] via 192.168.0.2, 00:28:22, GigabitEthernet0/0/1.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, GigabitEthernet0/2/0
L        192.168.1.1/32 is directly connected, GigabitEthernet0/2/0
O     192.168.2.0/24 [110/4] via 192.168.0.2, 00:22:01, GigabitEthernet0/0/1.1
```

R1#show ip ospf

```
Routing Process "ospf 2" with ID 2.2.2.2
   Domain ID type 0x0005, value 0.0.0.2
Start time: 00:05:01.991, Time elapsed: 00:32:24.187
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF google
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 50 msecs
Minimum hold time between two consecutive SPFs 200 msecs
Maximum wait time between two consecutive SPFs 5000 msecs
Incremental-SPF disabled
Initial LSA throttle delay 50 msecs
Minimum hold time for LSA throttle 200 msecs
Maximum wait time for LSA throttle 5000 msecs
Minimum LSA arrival 100 msecs
LSA group pacing timer 240 secs
```

```
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 2
        Number of interfaces in this area is 2 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:03:08.070 ago
        SPF algorithm executed 21 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x029BE3
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
Routing Process "ospf 1" with ID 1.1.1.1
   Domain ID type 0x0005, value 0.0.0.1
Start time: 00:05:01.945, Time elapsed: 00:32:24.233
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF facebook
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 50 msecs
Minimum hold time between two consecutive SPFs 200 msecs
Maximum wait time between two consecutive SPFs 5000 msecs
Incremental-SPF disabled
Initial LSA throttle delay 50 msecs
Minimum hold time for LSA throttle 200 msecs
Maximum wait time for LSA throttle 5000 msecs
Minimum LSA arrival 100 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
```

```
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 1
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm last executed 00:12:13.635 ago
        SPF algorithm executed 22 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x02FAC7
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Router 2:

```
R2#show run
Building configuration...
Current configuration : 4384 bytes
  Last configuration change at 18:15:16 UTC Mon Apr 4 2022
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 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
ip vrf facebook
rd 1:2
ip vrf google
rd 1:1
login on-success log
subscriber templating
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-2189345785
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-2189345785
revocation-check none
rsakeypair TP-self-signed-2189345785
license udi pid ISR4321/K9 sn FDO21482DXE
no license smart enable
diagnostic bootup level minimal
```

```
spanning-tree extend system-id
redundancy
mode none
interface GigabitEthernet0/0/0
no ip address
negotiation auto
interface GigabitEthernet0/0/0.1
encapsulation dot1Q 80
ip vrf forwarding facebook
ip address 192.168.0.2 255.255.255.252
ip ospf 1 area 1
interface GigabitEthernet0/0/0.2
encapsulation dot1Q 90
ip vrf forwarding google
ip address 192.168.0.2 255.255.255.252
ip ospf 2 area 2
interface GigabitEthernet0/0/1
no ip address
negotiation auto
interface GigabitEthernet0/0/1.1
encapsulation dot1Q 80
ip vrf forwarding facebook
ip address 192.168.0.5 255.255.255.252
ip ospf 1 area 1
interface GigabitEthernet0/0/1.2
encapsulation dot1Q 90
ip vrf forwarding google
ip address 192.168.0.5 255.255.255.252
ip ospf 2 area 2
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1 vrf facebook
router-id 3.3.3.3
router ospf 2 vrf google
router-id 4.4.4.4
ip forward-protocol nd
ip http server
```

```
ip http authentication local
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
```

R2#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
Gateway of last resort is not set
```

R2#show ip route vrf google

```
Routing Table: google
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
      192.168.0.0/24 is variably subnetted, 5 subnets, 2 masks
C        192.168.0.0/30 is directly connected, GigabitEthernet0/0/0.2
L        192.168.0.2/32 is directly connected, GigabitEthernet0/0/0.2
C        192.168.0.4/30 is directly connected, GigabitEthernet0/0/1.2
L        192.168.0.5/32 is directly connected, GigabitEthernet0/0/1.2
O        192.168.0.8/30
           [110/2] via 192.168.0.6, 00:30:31, GigabitEthernet0/0/1.2
      192.168.1.0/32 is subnetted, 1 subnets
O        192.168.1.2 [110/2] via 192.168.0.1, 00:05:15, GigabitEthernet0/0/0.2
      192.168.2.0/32 is subnetted, 1 subnets
O        192.168.2.2 [110/3] via 192.168.0.6, 00:05:26, GigabitEthernet0/0/1.2
```

R2#show ip route vrf facebook

```
Routing Table: facebook
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
      192.168.0.0/24 is variably subnetted, 5 subnets, 2 masks
C        192.168.0.0/30 is directly connected, GigabitEthernet0/0/0.1
L        192.168.0.2/32 is directly connected, GigabitEthernet0/0/0.1
C        192.168.0.4/30 is directly connected, GigabitEthernet0/0/1.1
L        192.168.0.5/32 is directly connected, GigabitEthernet0/0/1.1
O        192.168.0.8/30
           [110/2] via 192.168.0.6, 00:30:38, GigabitEthernet0/0/1.1
O     192.168.1.0/24 [110/2] via 192.168.0.1, 00:15:05, GigabitEthernet0/0/0.1
O     192.168.2.0/24 [110/3] via 192.168.0.6, 00:24:16, GigabitEthernet0/0/1.1

R2#show ip ospf
Routing Process "ospf 2" with ID 4.4.4.4
   Domain ID type 0x0005, value 0.0.0.2
Start time: 00:06:19.876, Time elapsed: 00:33:20.920
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF google
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 50 msecs
Minimum hold time between two consecutive SPFs 200 msecs
Maximum wait time between two consecutive SPFs 5000 msecs
Incremental-SPF disabled
Initial LSA throttle delay 50 msecs
Minimum hold time for LSA throttle 200 msecs
Maximum wait time for LSA throttle 5000 msecs
Minimum LSA arrival 100 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 2
```

```
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm last executed 00:05:24.823 ago
        SPF algorithm executed 19 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x0299E4
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
Routing Process "ospf 1" with ID 3.3.3.3
   Domain ID type 0x0005, value 0.0.0.1
Start time: 00:06:19.821, Time elapsed: 00:33:20.975
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF facebook
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 50 msecs
Minimum hold time between two consecutive SPFs 200 msecs
Maximum wait time between two consecutive SPFs 5000 msecs
Incremental-SPF disabled
Initial LSA throttle delay 50 msecs
Minimum hold time for LSA throttle 200 msecs
Maximum wait time for LSA throttle 5000 msecs
Minimum LSA arrival 100 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 1
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm last executed 00:15:07.825 ago
        SPF algorithm executed 18 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x02F6C9
        Number of opaque link LSA 0. Checksum Sum 0x000000
```

```
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Router 3:

```
R3#show run
Building configuration...
Current configuration : 1911 bytes
Last configuration change at 18:09:57 UTC Mon Apr 4 2022
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
ip vrf facebook
rd 1:2
ip vrf google
rd 1:1
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21441WDF
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface GigabitEthernet0/0/0
no ip address
negotiation auto
interface GigabitEthernet0/0/0.1
encapsulation dot1Q 80
ip vrf forwarding facebook
ip address 192.168.0.6 255.255.255.252
ip ospf 1 area 1
interface GigabitEthernet0/0/0.2
encapsulation dot1Q 90
ip vrf forwarding google
ip address 192.168.0.6 255.255.255.252
ip ospf 2 area 2
interface GigabitEthernet0/0/1
no ip address
negotiation auto
interface GigabitEthernet0/0/1.1
encapsulation dot1Q 80
ip vrf forwarding facebook
```

```
ip address 192.168.0.9 255.255.255.252
ip ospf 1 area 1
interface GigabitEthernet0/0/1.2
encapsulation dot1Q 90
ip vrf forwarding google
ip address 192.168.0.9 255.255.255.252
ip ospf 2 area 2
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 vrf facebook
router-id 4.4.4.4
router ospf 2 vrf google
router-id 5.5.5.5
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#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
Gateway of last resort is not set

R3#show ip route vrf google
Routing Table: google
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
      192.168.0.0/24 is variably subnetted, 5 subnets, 2 masks
O        192.168.0.0/30
           [110/2] via 192.168.0.5, 00:33:36, GigabitEthernet0/0/0.2
C        192.168.0.4/30 is directly connected, GigabitEthernet0/0/0.2
L        192.168.0.6/32 is directly connected, GigabitEthernet0/0/0.2
C        192.168.0.8/30 is directly connected, GigabitEthernet0/0/1.2
L        192.168.0.9/32 is directly connected, GigabitEthernet0/0/1.2
      192.168.1.0/32 is subnetted, 1 subnets
O        192.168.1.2 [110/3] via 192.168.0.5, 00:06:45, GigabitEthernet0/0/0.2
      192.168.2.0/32 is subnetted, 1 subnets
O        192.168.2.2
           [110/2] via 192.168.0.10, 00:08:16, GigabitEthernet0/0/1.2

R3#show ip route vrf facebook
Routing Table: facebook
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
      192.168.0.0/24 is variably subnetted, 5 subnets, 2 masks
O        192.168.0.0/30
           [110/2] via 192.168.0.5, 00:33:44, GigabitEthernet0/0/0.1
C        192.168.0.4/30 is directly connected, GigabitEthernet0/0/0.1
L        192.168.0.6/32 is directly connected, GigabitEthernet0/0/0.1
C        192.168.0.8/30 is directly connected, GigabitEthernet0/0/1.1
L        192.168.0.9/32 is directly connected, GigabitEthernet0/0/1.1
O     192.168.1.0/24 [110/3] via 192.168.0.5, 00:16:36, GigabitEthernet0/0/0.1
O     192.168.2.0/24
           [110/2] via 192.168.0.10, 00:25:48, GigabitEthernet0/0/1.1

R3#show ip ospf
Routing Process "ospf 2" with ID 5.5.5.5
   Domain ID type 0x0005, value 0.0.0.2
Start time: 00:03:32.666, Time elapsed: 00:38:00.251
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF google
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
```

```
Initial SPF schedule delay 5000 msecs
Minimum hold time between two consecutive SPFs 10000 msecs
Maximum wait time between two consecutive SPFs 10000 msecs
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 2
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm last executed 00:06:56.784 ago
        SPF algorithm executed 13 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x028DEA
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
Routing Process "ospf 1" with ID 4.4.4.4
   Domain ID type 0x0005, value 0.0.0.1
Start time: 00:03:32.616, Time elapsed: 00:38:00.302
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF facebook
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msecs
Minimum hold time between two consecutive SPFs 10000 msecs
Maximum wait time between two consecutive SPFs 10000 msecs
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
```

```
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 1
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm last executed 00:16:39.760 ago
        SPF algorithm executed 11 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x02F2CB
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Router 4:

```
R4#show run
Building configuration...
Current configuration : 4299 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 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
ip vrf facebook
rd 1:2
ip vrf google
rd 1:1
login on-success log
subscriber templating
vtp domain cisco
vtp mode transparent
multilink bundle-name authenticated
crypto pki trustpoint TP-self-signed-2557841031
enrollment selfsigned
```

```
subject-name cn=IOS-Self-Signed-Certificate-2557841031
revocation-check none
rsakeypair TP-self-signed-2557841031
license udi pid ISR4321/K9 sn FDO21500G1N
no license smart enable
diagnostic bootup level minimal
spanning-tree extend system-id
redundancy
mode none
interface Loopback1
ip vrf forwarding google
ip address 192.168.2.2 255.255.255.0
ip ospf 2 area 2
interface GigabitEthernet0/0/0
no ip address
negotiation auto
interface GigabitEthernet0/0/1
no ip address
negotiation auto
interface GigabitEthernet0/0/1.1
encapsulation dot1Q 80
ip vrf forwarding facebook
ip address 192.168.0.10 255.255.255.252
ip ospf 1 area 1
interface GigabitEthernet0/0/1.2
encapsulation dot1Q 90
ip vrf forwarding google
ip address 192.168.0.10 255.255.255.252
ip ospf 2 area 2
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0/2/0
ip vrf forwarding facebook
ip address 192.168.2.1 255.255.255.0
ip ospf 1 area 1
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
router ospf 1 vrf facebook
router-id 6.6.6.6
router ospf 2 vrf google
router-id 7.7.7.7
ip forward-protocol nd
```

```
ip http server
ip http authentication local
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
```

R4#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
Gateway of last resort is not set
```

R4#show ip route vrf google

```
Routing Table: google
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
      192.168.0.0/24 is variably subnetted, 4 subnets, 2 masks
O        192.168.0.0/30
           [110/3] via 192.168.0.9, 00:34:08, GigabitEthernet0/0/1.2
O        192.168.0.4/30
           [110/2] via 192.168.0.9, 00:34:08, GigabitEthernet0/0/1.2
C        192.168.0.8/30 is directly connected, GigabitEthernet0/0/1.2
L        192.168.0.10/32 is directly connected, GigabitEthernet0/0/1.2
      192.168.1.0/32 is subnetted, 1 subnets
O        192.168.1.2 [110/4] via 192.168.0.9, 00:08:52, GigabitEthernet0/0/1.2
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, Loopback1
L        192.168.2.2/32 is directly connected, Loopback1
```

R4#show ip route vrf facebook

```
Routing Table: facebook
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
      192.168.0.0/24 is variably subnetted, 4 subnets, 2 masks
O        192.168.0.0/30
           [110/3] via 192.168.0.9, 00:34:14, GigabitEthernet0/0/1.1
O        192.168.0.4/30
           [110/2] via 192.168.0.9, 00:34:14, GigabitEthernet0/0/1.1
C        192.168.0.8/30 is directly connected, GigabitEthernet0/0/1.1
L        192.168.0.10/32 is directly connected, GigabitEthernet0/0/1.1
O     192.168.1.0/24 [110/4] via 192.168.0.9, 00:18:41, GigabitEthernet0/0/1.1
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, GigabitEthernet0/2/0
L        192.168.2.1/32 is directly connected, GigabitEthernet0/2/0

R4#show ip ospf
Routing Process "ospf 2" with ID 7.7.7.7
   Domain ID type 0x0005, value 0.0.0.2
Start time: 00:07:43.193, Time elapsed: 00:35:30.853
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF google
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 50 msecs
Minimum hold time between two consecutive SPFs 200 msecs
Maximum wait time between two consecutive SPFs 5000 msecs
Incremental-SPF disabled
Initial LSA throttle delay 50 msecs
Minimum hold time for LSA throttle 200 msecs
Maximum wait time for LSA throttle 5000 msecs
Minimum LSA arrival 100 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
```

```
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 2
        Number of interfaces in this area is 2 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:09:02.283 ago
        SPF algorithm executed 11 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x028DEA
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
Routing Process "ospf 1" with ID 6.6.6.6
   Domain ID type 0x0005, value 0.0.0.1
Start time: 00:07:43.146, Time elapsed: 00:35:30.900
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
Connected to MPLS VPN Superbackbone, VRF facebook
Event-log disabled
It is an area border router
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 50 msecs
Minimum hold time between two consecutive SPFs 200 msecs
Maximum wait time between two consecutive SPFs 5000 msecs
Incremental-SPF disabled
Initial LSA throttle delay 50 msecs
Minimum hold time for LSA throttle 200 msecs
Maximum wait time for LSA throttle 5000 msecs
Minimum LSA arrival 100 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
    Area 1
        Number of interfaces in this area is 2
        Area has no authentication
        SPF algorithm last executed 00:18:45.282 ago
```

```
        SPF algorithm executed 12 times
        Area ranges are
        Number of LSA 7. Checksum Sum 0x02F0CC
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Pings:

```
PS C:\Users\user> ping 192.168.2.3
Pinging 192.168.2.3 with 32 bytes of data:
Reply from 192.168.2.3: bytes=32 time=1ms TTL=124
Reply from 192.168.2.3: bytes=32 time=1ms TTL=124
Reply from 192.168.2.3: bytes=32 time<1ms TTL=124
Reply from 192.168.2.3: bytes=32 time<1ms TTL=124

Ping statistics for 192.168.2.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

PS C:\Users\user> ping 192.168.1.3
Pinging 192.168.1.3 with 32 bytes of data:
Reply from 192.168.1.3: bytes=32 time=1ms TTL=124
Reply from 192.168.1.3: bytes=32 time=1ms TTL=124
Reply from 192.168.1.3: bytes=32 time<1ms TTL=124
Reply from 192.168.1.3: bytes=32 time<1ms TTL=124

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

R1#ping vrf google 192.168.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

R2#ping vrf google 192.168.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Problems

The main problem we encountered when configuring VRF was figuring out that we should use loopback addresses. We initially began with creating sub-interfaces that were linked to either the Google or Facebook VRF. However, after conversations with our team, we switched to using loopback addresses because VRF needs a loopback device for each VRF table since VRF is based on interfaces, not IP addresses. After solving this issue, our configuration worked correctly.

Conclusions

In this lab, we accomplished the set-up of VRF by reviewing the documentation from Cisco on VRF. We created a configuration of VRF and thoroughly reviewed it before applying it to the routers. After testing our configuration on the routers, we troubleshooted errors. Once our configuration properly functioned, we used pings to ensure the computers could not ping outside of their VRF.

Instructor Signoff