

CCNP ROUTING AND SWITCHING



Configuring VRF Lite

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Purpose:

The purpose of this lab is to configure VRF Lite on a single network to virtually separate traffic belonging to each VRF. Using OSPF and sub interfaces, traffic can be separated and pinging between the two networks is prevented.

Background:

Virtual Routing and Forwarding (VRF) is a technology that allows multiple routing table instances to exist in the same router, meaning that overlapping IP addresses can be used without conflicts. VRFs work at Layer 3 of the OSI model as network isolation/virtualization, helping separate network traffic between two different networks using the same hardware. Some of the advantages of using VRF are that it allows for multiple routes on one device, segmenting network paths, MPLS, multiple routing tables and multiple VPNs.

VRFs vs VLANs

VRFs and VLANs use essentially the same processes of virtualization. They do have different uses and work somewhat differently. Again we know that VRFs work on Layer 3 and help multiple VRs work on a single router or other hardware. VLANs work on Layer 2 and split ethernet networks, either for network security or performance and help eliminate constraints on the physical layout of the network.

VRF vs VRF Lite

There are two types of VRF, VRF and VRF Lite. VRF uses MPLS, which distributes route information across routers and helps it move traffic across service provider networks. VRF lite does not use MPLS, instead the route information is kept locally in routers routing and forwarding tables and can be shared through IGPs like OSPF. In this case we used VRF Lite because our LAN used the same devices and we needed separation between those networks.

Lab Summary:

When configuring VRF Lite for IPv4, I set up four 4321 Cisco Routers, with all routers connected to each other by a crossover cable and the end routers connected to two PCs respectively with a straight-through. For the routers, I used the network of 10.0.0.0/16 and 10.0.0.0/24 for the PCs. The Loopbacks were in the networks of 192.168.0.0/16. PC1 and 3 were Apple and PC2 and 4 were Facebook. Subinterfaces and encapsulation were designated as either 10 for apple or 11 for Facebook. We set up OSPF throughout all routers to exchange routing information. Show commands stated below were used to confirm that VFR was configured correctly and pinging was used to ensure VRF was doing its job.

Lab Commands:

```
show ip route vrf Facebook
```

This command shows the VRF routing table for a specific VRF.

```
show ip vrf int
```

This command shows the interfaces using VRF and to which VRF they are assigned.

```
ip vrf forwarding
```

This command adds an interface from a VRF.

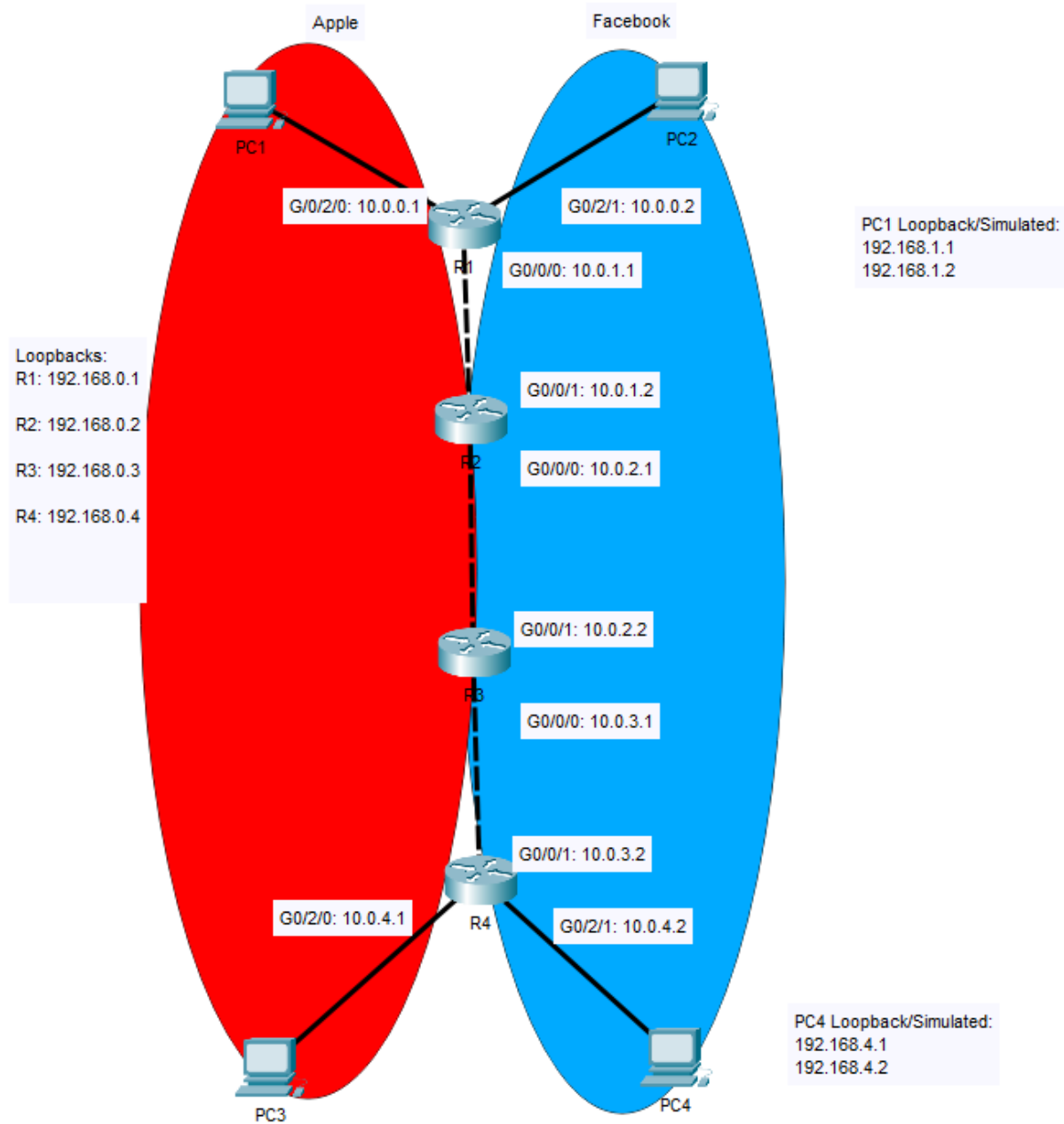
```
ip vrf _
```

This command creates the VRF instance and gives it a name.

```
ip ospf _ vrf _
```

This command splits the router into multiple virtual routers through VRF.

Topology Diagram



Addressing Table:

Devices	Interface	IP Address	Link-Local Addresses
R1	G0/0/0	10.0.1.1	192.168.0.1
	G0/2/0	10.0.0.1	
	G0/2/1	10.0.0.2	
R2	G0/0/0	10.0.2.1	192.168.0.2
	G0/0/1	10.0.1.2	
R3	G0/0/0	10.0.3.1	192.168.0.3
	G0/0/1	10.0.2.1	

R4	G0/0/1	10.0.3.2	192.168.0.4
	G0/2/0	10.0.4.1	
	G0/2/1	10.0.4.2	
PC1	NIC	10.0.0.1	192.168.1.1
PC2	NIC	10.0.0.2	192.168.1.2
PC3	NIC	10.0.0.3	192.168.4.1
PC4	NIC	10.0.0.4	192.168.4.2

R1 Running Config

Conclusion:

R1

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 Apple

description Extranet

!

ip vrf Facebook

description Intranet

!

subscriber templating

ipv6 unicast-routing

!

!

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 Loopback0
  ip address 192.168.100.1 255.255.255.255
  ipv6 address 2001:DB8:ACAD:A::1/64
!
interface GigabitEthernet0/0/0
  no ip address
  negotiation auto
!
interface GigabitEthernet0/0/0.1
  encapsulation dot1Q 10
  ip vrf forwarding Apple
  ip address 10.10.1.1 255.255.255.0
!
interface GigabitEthernet0/0/0.2
  encapsulation dot1Q 11
  ip vrf forwarding Facebook
  ip address 10.11.1.1 255.255.255.0
!
interface GigabitEthernet0/0/1
  no ip address
  negotiation auto
!
interface Serial0/1/0
  no ip address
  shutdown
!
interface Serial0/1/1
  no ip address
  shutdown
!
interface GigabitEthernet0/2/0
  ip vrf forwarding Apple
  ip address 10.0.0.1 255.255.255.0
  negotiation auto
!
interface GigabitEthernet0/2/1
  ip vrf forwarding Facebook
  ip address 192.168.0.2 255.255.255.0
  negotiation auto
!
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
!

```

```

router ospf 10 vrf Apple
  router-id 1.1.1.10
  network 10.0.0.0 0.0.0.255 area 0
  network 10.10.1.0 0.0.0.255 area 0
!
router ospf 11 vrf Facebook
  router-id 1.1.1.11
  network 192.168.0.0 0.0.0.255 area 0
  network 10.11.1.0 0.0.0.255 area 0
!
ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip tftp source-interface GigabitEthernet0
ip route vrf Facebook 0.0.0.0 0.0.0.0 10.0.0.2
!
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 ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.11	1	FULL/DR	00:00:37	10.11.1.2	
GigabitEthernet0/0/0.2					
2.2.2.10	1	FULL/DR	00:00:30	10.10.1.2	
GigabitEthernet0/0/0.1					

R1#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
-----------	-----	------	-----------------	------	-------	------	-----

Gi0/0/0.2	11	0	10.11.1.1/24	1	BDR	1/1
Gi0/2/1	11	0	192.168.0.2/24	1	DOWN	0/0
Gi0/0/0.1	10	0	10.10.1.1/24	1	BDR	1/1
Gi0/2/0	10	0	10.0.0.1/24	1	DR	0/0

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

```

10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C      10.11.1.0/24 is directly connected, GigabitEthernet0/0/0.2
L      10.11.1.1/32 is directly connected, GigabitEthernet0/0/0.2
O      10.11.2.0/24 [110/2] via 10.11.1.2, 00:02:58, GigabitEthernet0/0/0.2
O      10.11.3.0/24 [110/3] via 10.11.1.2, 00:02:58, GigabitEthernet0/0/0.2
192.168.11.0/32 is subnetted, 1 subnets
O      192.168.11.4 [110/4] via 10.11.1.2, 00:02:58, GigabitEthernet0/0/0.2

```

R1#show ip route vrf Apple

Routing Table: Apple

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

```

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C      10.0.0.0/24 is directly connected, GigabitEthernet0/2/0
L      10.0.0.1/32 is directly connected, GigabitEthernet0/2/0
C      10.10.1.0/24 is directly connected, GigabitEthernet0/0/0.1
L      10.10.1.1/32 is directly connected, GigabitEthernet0/0/0.1
O      10.10.2.0/24 [110/2] via 10.10.1.2, 00:03:06, GigabitEthernet0/0/0.1

```

```
O      10.10.3.0/24 [110/3] via 10.10.1.2, 00:03:06, GigabitEthernet0/0/0.1
192.168.10.0/32 is subnetted, 1 subnets
O      192.168.10.4 [110/4] via 10.10.1.2, 00:03:06, GigabitEthernet0/0/0.1
```

R1#show ip vrf int

Interface	IP-Address	VRF	Protocol
Gi0/0/0.1	10.10.1.1	Apple	up
Gi0/2/0	10.0.0.1	Apple	up
Gi0/0/0.2	10.11.1.1	Facebook	up
Gi0/2/1	192.168.0.2	Facebook	down
Gi0	unassigned	Mgmt-intf	down

R1#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0.2	11	0	10.11.1.1/24	1	BDR	1/1	
Gi0/2/1	11	0	192.168.0.2/24	1	DOWN	0/0	
Gi0/0/0.1	10	0	10.10.1.1/24	1	BDR	1/1	
Gi0/2/0	10	0	10.0.0.1/24	1	DR	0/0	

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

```
      192.168.100.0/32 is subnetted, 1 subnets
C      192.168.100.1 is directly connected, Loopback0
R1#
```

R2 Running Config

```
Current configuration : 2165 bytes
!
! Last configuration change at 15:59:33 UTC Wed Mar 23 2022
!
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
```



```
no platform punt-keepalive disable-kernel-core
!
hostname R2
!
boot-start-marker
boot-end-marker
!
!
vrf definition Mgmt-intf
!
    address-family ipv4
    exit-address-family
!
    address-family ipv6
    exit-address-family
!
!
no aaa new-model
!
ip vrf Apple
    description Extranet
!
ip vrf Facebook
    description Intranet
!
!
ipv6 unicast-routing
!
subscriber templating
multilink bundle-name authenticated
!
license udi pid ISR4321/K9 sn FDO214420HM
!
spanning-tree extend system-id
!
!
redundancy
    mode none
!
!
vlan internal allocation policy ascending
!
interface Loopback0
    ip address 192.168.0.2 255.255.255.255
    ipv6 address 2001:DB8:ACAD:B::1/64
!
interface GigabitEthernet0/0/0
    no ip address
    negotiation auto
!
interface GigabitEthernet0/0/0.1
```

```

encapsulation dot1Q 10
ip vrf forwarding Apple
ip address 10.10.2.1 255.255.255.0
!
interface GigabitEthernet0/0/0.2
encapsulation dot1Q 11
ip vrf forwarding Facebook
ip address 10.11.2.1 255.255.255.0
!
interface GigabitEthernet0/0/1
no ip address
negotiation auto
!
interface GigabitEthernet0/0/1.1
encapsulation dot1Q 10
ip vrf forwarding Apple
ip address 10.10.1.2 255.255.255.0
!
interface GigabitEthernet0/0/1.2
encapsulation dot1Q 11
ip vrf forwarding Facebook
ip address 10.11.1.2 255.255.255.0
!
interface Serial0/1/0
no ip address
shutdown
!
interface Serial0/1/1
no ip address
shutdown
!
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
!
interface Vlan1
no ip address
shutdown
!
router ospf 10 vrf Apple
router-id 2.2.2.10
network 10.10.1.0 0.0.0.255 area 0
network 10.10.2.0 0.0.0.255 area 0
!
router ospf 11 vrf Facebook
router-id 2.2.2.11
network 10.11.1.0 0.0.0.255 area 0
network 10.11.2.0 0.0.0.255 area 0
!

```

```

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#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
3.3.3.11	1	FULL/DR	00:00:32	10.11.2.2	GigabitEthernet0/0/0.2
1.1.1.11	1	FULL/BDR	00:00:38	10.11.1.1	GigabitEthernet0/0/1.2
3.3.3.10	1	FULL/DR	00:00:38	10.10.2.2	GigabitEthernet0/0/0.1
1.1.1.10	1	FULL/BDR	00:00:38	10.10.1.1	GigabitEthernet0/0/1.1

R2#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0.2	11	0	10.11.2.1/24	1	BDR	1/1	
Gi0/0/1.2	11	0	10.11.1.2/24	1	DR	1/1	
Gi0/0/0.1	10	0	10.10.2.1/24	1	BDR	1/1	
Gi0/0/1.1	10	0	10.10.1.2/24	1	DR	1/1	

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

```

10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C      10.11.1.0/24 is directly connected, GigabitEthernet0/0/1.2
L      10.11.1.2/32 is directly connected, GigabitEthernet0/0/1.2
C      10.11.2.0/24 is directly connected, GigabitEthernet0/0/0.2
L      10.11.2.1/32 is directly connected, GigabitEthernet0/0/0.2
O      10.11.3.0/24 [110/2] via 10.11.2.2, 00:33:12, GigabitEthernet0/0/0.2
192.168.11.0/32 is subnetted, 1 subnets
O      192.168.11.4 [110/3] via 10.11.2.2, 00:33:02, GigabitEthernet0/0/0.2

```

R2#show ip route vrf Apple

Routing Table: Apple

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

```

10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O      10.0.0.0/24 [110/2] via 10.10.1.1, 00:04:59, GigabitEthernet0/0/1.1
C      10.10.1.0/24 is directly connected, GigabitEthernet0/0/1.1
L      10.10.1.2/32 is directly connected, GigabitEthernet0/0/1.1
C      10.10.2.0/24 is directly connected, GigabitEthernet0/0/0.1
L      10.10.2.1/32 is directly connected, GigabitEthernet0/0/0.1
O      10.10.3.0/24 [110/2] via 10.10.2.2, 00:33:18, GigabitEthernet0/0/0.1
192.168.10.0/32 is subnetted, 1 subnets
O      192.168.10.4 [110/3] via 10.10.2.2, 00:33:08, GigabitEthernet0/0/0.1

```

R2#show ip vrf int

Interface	IP-Address	VRF	Protocol
Gi0/0/0.1	10.10.2.1	Apple	up
Gi0/0/1.1	10.10.1.2	Apple	up
Gi0/0/0.2	10.11.2.1	Facebook	up
Gi0/0/1.2	10.11.1.2	Facebook	up
Gi0	unassigned	Mgmt-intf	down

R2#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0.2	11	0	10.11.2.1/24	1	BDR	1/1	
Gi0/0/1.2	11	0	10.11.1.2/24	1	DR	1/1	
Gi0/0/0.1	10	0	10.10.2.1/24	1	BDR	1/1	
Gi0/0/1.1	10	0	10.10.1.2/24	1	DR	1/1	

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

192.168.0.0/32 is subnetted, 1 subnets
C 192.168.0.2 is directly connected, Loopback0

R3 Running Config

```
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 Apple
description Extranet
!
ip vrf Facebook
description Intranet
!
!
```

```

!
ipv6 unicast-routing
!
subscriber templating
multilink bundle-name authenticated
!
!
!
!
license udi pid ISR4321/K9 sn FDO214414DZ
!
spanning-tree extend system-id
!
!
redundancy
mode none
!
!
vlan internal allocation policy ascending
!
interface Loopback0
 ip address 192.168.0.3 255.255.255.255
 ipv6 address 2001:DB8:ACAD:C::1/64
!
interface GigabitEthernet0/0/0
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/0.1
 encapsulation dot1Q 10
 ip vrf forwarding Apple
 ip address 10.10.3.1 255.255.255.0
!
interface GigabitEthernet0/0/0.2
 encapsulation dot1Q 11
 ip vrf forwarding Facebook
 ip address 10.11.3.1 255.255.255.0
!
interface GigabitEthernet0/0/1
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/1.1
 encapsulation dot1Q 10
 ip vrf forwarding Apple
 ip address 10.10.2.2 255.255.255.0
!
interface GigabitEthernet0/0/1.2
 encapsulation dot1Q 11
 ip vrf forwarding Facebook
 ip address 10.11.2.2 255.255.255.0

```

```

!
interface Serial0/1/0
  no ip address
  shutdown
!
interface Serial0/1/1
  no ip address
  shutdown
!
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
!
interface Vlan1
  no ip address
  shutdown
!
router ospf 10 vrf Apple
  router-id 3.3.3.10
  network 10.10.2.0 0.0.0.255 area 0
  network 10.10.3.0 0.0.0.255 area 0
!
router ospf 11 vrf Facebook
  router-id 3.3.3.11
  network 10.11.2.0 0.0.0.255 area 0
  network 10.11.3.0 0.0.0.255 area 0
!
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 ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
4.4.4.11	1	FULL/DR	00:00:34	10.11.3.2	GigabitEthernet0/0/0.2
2.2.2.11	1	FULL/BDR	00:00:30	10.11.2.1	GigabitEthernet0/0/1.2
4.4.4.10	1	FULL/DR	00:00:33	10.10.3.2	GigabitEthernet0/0/0.1
2.2.2.10	1	FULL/BDR	00:00:38	10.10.2.1	GigabitEthernet0/0/1.1

R3#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0.2	11	0	10.11.3.1/24	1	BDR	1/1	
Gi0/0/1.2	11	0	10.11.2.2/24	1	DR	1/1	
Gi0/0/0.1	10	0	10.10.3.1/24	1	BDR	1/1	
Gi0/0/1.1	10	0	10.10.2.2/24	1	DR	1/1	

R3#show ip int br

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0/0	unassigned	YES	unset	up	up
GigabitEthernet0/0/0.1	10.10.3.1	YES	manual	up	up
GigabitEthernet0/0/0.2	10.11.3.1	YES	manual	up	up
GigabitEthernet0/0/1	unassigned	YES	unset	up	up
GigabitEthernet0/0/1.1	10.10.2.2	YES	manual	up	up
GigabitEthernet0/0/1.2	10.11.2.2	YES	manual	up	up
Serial0/1/0	unassigned	YES	manual	administratively down	down
Serial0/1/1	unassigned	YES	manual	administratively down	down
GigabitEthernet0	unassigned	YES	unset	administratively down	down
Loopback0	192.168.0.3	YES	manual	up	up
Vlan1	unassigned	YES	unset	administratively down	down

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

10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks


```

O      10.11.1.0/24 [110/2] via 10.11.2.1, 00:09:07, GigabitEthernet0/0/1.2
C      10.11.2.0/24 is directly connected, GigabitEthernet0/0/1.2
L      10.11.2.2/32 is directly connected, GigabitEthernet0/0/1.2
C      10.11.3.0/24 is directly connected, GigabitEthernet0/0/0.2
L      10.11.3.1/32 is directly connected, GigabitEthernet0/0/0.2
      192.168.11.0/32 is subnetted, 1 subnets
O      192.168.11.4 [110/2] via 10.11.3.2, 00:34:44, GigabitEthernet0/0/0.2

```

R3#show ip route vrf Apple

Routing Table: Apple

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

```

      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
O      10.0.0.0/24 [110/3] via 10.10.2.1, 00:06:32, GigabitEthernet0/0/1.1
O      10.10.1.0/24 [110/2] via 10.10.2.1, 00:09:13, GigabitEthernet0/0/1.1
C      10.10.2.0/24 is directly connected, GigabitEthernet0/0/1.1
L      10.10.2.2/32 is directly connected, GigabitEthernet0/0/1.1
C      10.10.3.0/24 is directly connected, GigabitEthernet0/0/0.1
L      10.10.3.1/32 is directly connected, GigabitEthernet0/0/0.1
      192.168.10.0/32 is subnetted, 1 subnets
O      192.168.10.4 [110/2] via 10.10.3.2, 00:34:51, GigabitEthernet0/0/0.1

```

R3#show ip vrf int

Interface	IP-Address	VRF	Protocol
Gi0/0/0.1	10.10.3.1	Apple	up
Gi0/0/1.1	10.10.2.2	Apple	up
Gi0/0/0.2	10.11.3.1	Facebook	up
Gi0/0/1.2	10.11.2.2	Facebook	up
Gi0	unassigned	Mgmt-intf	down

R3#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Gi0/0/0.2	11	0	10.11.3.1/24	1	BDR	1/1	
Gi0/0/1.2	11	0	10.11.2.2/24	1	DR	1/1	
Gi0/0/0.1	10	0	10.10.3.1/24	1	BDR	1/1	
Gi0/0/1.1	10	0	10.10.2.2/24	1	DR	1/1	

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

192.168.0.0/32 is subnetted, 1 subnets

C 192.168.0.3 is directly connected, Loopback0

R4 Running Config

```
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-core
!
hostname R4
!
boot-start-marker
boot-end-marker
!
!
vrf definition Mgmt-intf
!
address-family ipv4
exit-address-family
!
address-family ipv6
exit-address-family
!
!
no aaa new-model
!
ip vrf Apple
description Extranet
!
ip vrf Facebook
description Intranet
!
!
!
!
```

```

!
ipv6 unicast-routing
subscriber templating
vtp domain cisco
vtp mode transparent
multilink bundle-name authenticated
!
!
!
!
license udi pid ISR4321/K9 sn FDO214417Q4
!
spanning-tree extend system-id
!
!
redundancy
  mode none
!
!
vlan internal allocation policy ascending
!
interface Loopback1
  ip vrf forwarding Apple
  ip address 192.168.10.4 255.255.255.255
  ipv6 address 2001:DB8:ACAD:D::1/64
!
interface Loopback2
  ip vrf forwarding Facebook
  ip address 192.168.11.4 255.255.255.255
!
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 10
  ip vrf forwarding Apple
  ip address 10.10.3.2 255.255.255.0
!
interface GigabitEthernet0/0/1.2
  encapsulation dot1Q 11
  ip vrf forwarding Facebook
  ip address 10.11.3.2 255.255.255.0
!
interface Serial0/1/0
  no ip address
  shutdown

```

```

!
interface Serial0/1/1
  no ip address
  shutdown
!
interface GigabitEthernet0
  vrf forwarding Mgmt-intf
  no ip address
  shutdown
  negotiation auto
!
interface Vlan1
  no ip address
  shutdown
!
router ospf 10 vrf Apple
  router-id 4.4.4.10
  network 10.10.3.0 0.0.0.255 area 0
  network 192.168.10.4 0.0.0.0 area 0
!
router ospf 11 vrf Facebook
  router-id 4.4.4.11
  network 10.11.3.0 0.0.0.255 area 0
  network 192.168.11.4 0.0.0.0 area 0
!
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#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
3.3.3.11	1	FULL/BDR	00:00:31	10.11.3.1	
GigabitEthernet0/0/1.2					
3.3.3.10	1	FULL/BDR	00:00:39	10.10.3.1	
GigabitEthernet0/0/1.1					

R4#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Lo2	11	0	192.168.11.4/32	1	LOOP	0/0	
Gi0/0/1.2	11	0	10.11.3.2/24	1	DR	1/1	
Lo1	10	0	192.168.10.4/32	1	LOOP	0/0	
Gi0/0/1.1	10	0	10.10.3.2/24	1	DR	1/1	

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

10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks

O	10.11.1.0/24	[110/3]	via 10.11.3.1, 00:10:47, GigabitEthernet0/0/1.2
O	10.11.2.0/24	[110/2]	via 10.11.3.1, 00:36:24, GigabitEthernet0/0/1.2
C	10.11.3.0/24		is directly connected, GigabitEthernet0/0/1.2
L	10.11.3.2/32		is directly connected, GigabitEthernet0/0/1.2

192.168.11.0/32 is subnetted, 1 subnets

C	192.168.11.4		is directly connected, Loopback2
---	--------------	--	----------------------------------

R4#show ip route vrf Apple

Routing Table: Apple

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

10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks

O	10.0.0.0/24	[110/4]	via 10.10.3.1, 00:08:14, GigabitEthernet0/0/1.1
O	10.10.1.0/24	[110/3]	via 10.10.3.1, 00:10:55, GigabitEthernet0/0/1.1
O	10.10.2.0/24	[110/2]	via 10.10.3.1, 00:36:32, GigabitEthernet0/0/1.1

```

C      10.10.3.0/24 is directly connected, GigabitEthernet0/0/1.1
L      10.10.3.2/32 is directly connected, GigabitEthernet0/0/1.1
      192.168.10.0/32 is subnetted, 1 subnets
C      192.168.10.4 is directly connected, Loopback1

```

R4#show ip vrf int

Interface	IP-Address	VRF	Protocol
Lo1	192.168.10.4	Apple	up
Gi0/0/1.1	10.10.3.2	Apple	up
Lo2	192.168.11.4	Facebook	up
Gi0/0/1.2	10.11.3.2	Facebook	up
Gi0	unassigned	Mgmt-intf	down

R4#show ip ospf int br

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Lo2	11	0	192.168.11.4/32	1	LOOP	0/0	
Gi0/0/1.2	11	0	10.11.3.2/24	1	DR	1/1	
Lo1	10	0	192.168.10.4/32	1	LOOP	0/0	
Gi0/0/1.1	10	0	10.10.3.2/24	1	DR	1/1	

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

```
C:\Windows\system32>ping 192.168.10.4
```

Pinging 192.168.10.4 with 32 bytes of data:

```

Reply from 192.168.10.4: bytes=32 time<1ms TTL=252
Reply from 192.168.10.4: bytes=32 time<1ms TTL=252
Reply from 192.168.10.4: bytes=32 time<1ms TTL=252
Reply from 192.168.10.4: bytes=32 time<1ms TTL=252

```

Ping statistics for 192.168.10.4:

```

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

```

```
C:\Windows\system32>ping 192.168.11.4
```

Pinging 192.168.11.4 with 32 bytes of data:

```
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.

Ping statistics for 192.168.11.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

C:\Windows\system32>ping 10.10.3.1

Pinging 10.10.3.1 with 32 bytes of data:
Reply from 10.10.3.1: bytes=32 time<1ms TTL=253
Reply from 10.10.3.1: bytes=32 time<1ms TTL=253
Reply from 10.10.3.1: bytes=32 time<1ms TTL=253
Reply from 10.10.3.1: bytes=32 time<1ms TTL=253

Ping statistics for 10.10.3.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Windows\system32>ping 10.11.3.1

Pinging 10.11.3.1 with 32 bytes of data:
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.

Ping statistics for 10.11.3.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

```

Reply from 192.168.10.4: bytes=32 time<1ms TTL=252

Ping statistics for 192.168.10.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Windows\system32>ping 10.11.1.1

Pinging 10.11.1.1 with 32 bytes of data:
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.
Reply from 10.0.0.1: Destination host unreachable.

Ping statistics for 10.11.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

C:\Windows\system32>tracert 192.168.10.4

Tracing route to 192.168.10.4 over a maximum of 30 hops

  0  <1 ms    <1 ms    <1 ms    10.0.0.1
  1  <1 ms    <1 ms    <1 ms    10.10.1.2
  2  <1 ms    <1 ms    <1 ms    10.10.2.2
  3  <1 ms    <1 ms    <1 ms    192.168.10.4

Trace complete.

C:\Windows\system32>

```

Problems:

We encountered several problems while configuring VRF-lite, some spawning from configuration errors. The first error I encountered was that only the VRF Apple .10 network for OSPF was showing up on R3. I issued show ip ospf interface and other requisite commands on R3 and R2. I noticed that there was no OSPF neighbor relationship between R2 and R3 on the G0/0/0 interface after running a show ip ospf neighbor command. Checking R3 again, I compared the running configs and discovered that not only was the encapsulation wrong on R3, but R4 was also wrong. I had put the encapsulation as 1 and 2 instead of 10 and 11. Also found out that VRF 11 was registered to Apple instead of Facebook on R4 after doing a show ip route vrf Facebook and seeing no entries for R4. Fixed some layer 1 problems as well, as I discovered that the PC couldn't ping the routers because it was going through the WIFI instead of the ethernet and there was no default gateway set. I think the source of most of these problems was an incorrectly copied running-config.

Conclusion:

VRF and VRF Lite are integral technologies when more than one company is using the same physical infrastructure whether that be locally or across multiple ISPs. VRF allows for network traffic to be segmented into their respective VRFS with no way to contact or ping between them, ensuring network security. While this is not completely secure as there will always be ways to intercept data as they are running on the same links, it provides an added layer and is more cost efficient than buying more physical infrastructure.