

VRF Lab

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# Purpose

The purpose of this lab was to configure virtual routing and forwarding (VRF) on several routers using GNS3 in order to split the routing tables of two networks so that even when on the same network, end devices would be unable to ping each other.

# Background Information

VRF is a layer 3 routing technology that can split the routing table of a routing device into several different tables, which are unable to communicate with each other. VRF is important because in networks where several different groups are connected to, but should be isolated, routing can be isolated and devices on different routing tables would theoretically be isolated from each other.

VRF is different from VLANs, firstly because VRF is layer 3 and VLANs are layer 2. VRF completely isolates created virtual routing tables, acting as if each routing table represented its own router. VLANs, on the other hand, only segments VLANs, allowing different configurations for different VLANs, which could include isolating the VLANs from each other.

Graphical Network Simulator-3 (GNS3) is a network emulator software that allows the simulation of complex networks, without needing physical hardware. It can, however, integrate real devices in its emulation.

# Lab Summary

I started off by researching VRF, and after figuring out what commands I needed to use, I set up GNS3 with the appropriate router OS, then I set up my topology, then made my configurations using a python script I made, since all the routers had the same configuration, but with different IPs. I first configured IPs and VRF, then I set up OSPF to allow the routers to communicate with one another, and tested connectivity and debugged as needed.

# Lab Commands

ip vrf <name>: Creates a VRF table with the specified name

interface <interface>

ip vrf forwarding <VRF name>: Assigns an interface to specified VRF

router ospf <#> vrf <VRF name>: Creates an OSPF process with specified number that uses the specified VRF table

# Network Diagram

A computer network diagram with green circles and white text

Description automatically generated

# Configurations

## show run

### R1

Current configuration : 1458 bytes

upgrade fpd auto

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R1

boot-start-marker

boot-end-marker

no aaa new-model

no ip icmp rate-limit unreachable

ip vrf vrf1

ip vrf vrf2

no ip domain lookup

ip cef

no ipv6 cef

multilink bundle-name authenticated

redundancy

ip tcp synwait-time 5

interface FastEthernet0/0

no ip address

shutdown

duplex half

interface GigabitEthernet1/0

ip vrf forwarding vrf1

ip address 10.1.2.1 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding vrf1

ip address 10.1.1.2 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding vrf2

ip address 10.2.2.1 255.255.255.0

ip ospf 20 area 0

negotiation auto

interface GigabitEthernet4/0

ip vrf forwarding vrf2

ip address 10.2.1.2 255.255.255.0

ip ospf 20 area 0

negotiation auto

router ospf 10 vrf vrf1

router ospf 20 vrf vrf2

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line aux 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line vty 0 4

login

transport input all

end

### R2

Current configuration : 1458 bytes

upgrade fpd auto

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R2

boot-start-marker

boot-end-marker

no aaa new-model

no ip icmp rate-limit unreachable

ip vrf vrf1

ip vrf vrf2

no ip domain lookup

ip cef

no ipv6 cef

multilink bundle-name authenticated

redundancy

ip tcp synwait-time 5

interface FastEthernet0/0

no ip address

shutdown

duplex half

interface GigabitEthernet1/0

ip vrf forwarding vrf1

ip address 10.1.3.1 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding vrf1

ip address 10.1.2.2 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding vrf2

ip address 10.2.3.1 255.255.255.0

ip ospf 20 area 0

negotiation auto

interface GigabitEthernet4/0

ip vrf forwarding vrf2

ip address 10.2.2.2 255.255.255.0

ip ospf 20 area 0

negotiation auto

router ospf 10 vrf vrf1

router ospf 20 vrf vrf2

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line aux 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line vty 0 4

login

transport input all

end

### R3

Current configuration : 1458 bytes

upgrade fpd auto

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R3

boot-start-marker

boot-end-marker

no aaa new-model

no ip icmp rate-limit unreachable

ip vrf vrf1

ip vrf vrf2

no ip domain lookup

ip cef

no ipv6 cef

multilink bundle-name authenticated

redundancy

ip tcp synwait-time 5

interface FastEthernet0/0

no ip address

shutdown

duplex half

interface GigabitEthernet1/0

ip vrf forwarding vrf1

ip address 10.1.4.1 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding vrf1

ip address 10.1.3.2 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding vrf2

ip address 10.2.4.1 255.255.255.0

ip ospf 20 area 0

negotiation auto

interface GigabitEthernet4/0

ip vrf forwarding vrf2

ip address 10.2.3.2 255.255.255.0

ip ospf 20 area 0

negotiation auto

router ospf 10 vrf vrf1

router ospf 20 vrf vrf2

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line aux 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line vty 0 4

login

transport input all

end

### R4

Current configuration : 1458 bytes

upgrade fpd auto

version 15.2

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname R4

boot-start-marker

boot-end-marker

no aaa new-model

no ip icmp rate-limit unreachable

ip vrf vrf1

ip vrf vrf2

no ip domain lookup

ip cef

no ipv6 cef

multilink bundle-name authenticated

redundancy

ip tcp synwait-time 5

interface FastEthernet0/0

no ip address

shutdown

duplex half

interface GigabitEthernet1/0

ip vrf forwarding vrf1

ip address 10.1.5.1 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding vrf1

ip address 10.1.4.2 255.255.255.0

ip ospf 10 area 0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding vrf2

ip address 10.2.5.1 255.255.255.0

ip ospf 20 area 0

negotiation auto

interface GigabitEthernet4/0

ip vrf forwarding vrf2

ip address 10.2.4.2 255.255.255.0

ip ospf 20 area 0

negotiation auto

router ospf 10 vrf vrf1

router ospf 20 vrf vrf2

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

mgcp profile default

gatekeeper

shutdown

line con 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line aux 0

exec-timeout 0 0

privilege level 15

logging synchronous

stopbits 1

line vty 0 4

login

transport input all

end

## PC commands

### PC1

ip 10.1.1.1/24 10.1.1.2/24

### PC2

ip 10.1.5.2/24 10.1.5.1/24

### PC3

ip 10.2.1.1/24 10.2.1.2/24

### PC4

ip 10.2.5.2/24 10.2.5.1/24

## show ip routes

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

+ - replicated route, % - next hop override

### R1

Routing Table: vrf1

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

C 10.1.1.0/24 is directly connected, GigabitEthernet2/0

L 10.1.1.2/32 is directly connected, GigabitEthernet2/0

C 10.1.2.0/24 is directly connected, GigabitEthernet1/0

L 10.1.2.1/32 is directly connected, GigabitEthernet1/0

O 10.1.3.0/24 [110/2] via 10.1.2.2, 00:06:00, GigabitEthernet1/0

O 10.1.4.0/24 [110/3] via 10.1.2.2, 00:06:00, GigabitEthernet1/0

O 10.1.5.0/24 [110/4] via 10.1.2.2, 00:06:00, GigabitEthernet1/0

Routing Table: vrf2

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

C 10.2.1.0/24 is directly connected, GigabitEthernet4/0

L 10.2.1.2/32 is directly connected, GigabitEthernet4/0

C 10.2.2.0/24 is directly connected, GigabitEthernet3/0

L 10.2.2.1/32 is directly connected, GigabitEthernet3/0

O 10.2.3.0/24 [110/2] via 10.2.2.2, 00:06:00, GigabitEthernet3/0

O 10.2.4.0/24 [110/3] via 10.2.2.2, 00:06:00, GigabitEthernet3/0

O 10.2.5.0/24 [110/4] via 10.2.2.2, 00:06:00, GigabitEthernet3/0

### R2

Routing Table: vrf1

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.1.1.0/24 [110/2] via 10.1.2.1, 00:08:33, GigabitEthernet2/0

C 10.1.2.0/24 is directly connected, GigabitEthernet2/0

L 10.1.2.2/32 is directly connected, GigabitEthernet2/0

C 10.1.3.0/24 is directly connected, GigabitEthernet1/0

L 10.1.3.1/32 is directly connected, GigabitEthernet1/0

O 10.1.4.0/24 [110/2] via 10.1.3.2, 00:08:38, GigabitEthernet1/0

O 10.1.5.0/24 [110/3] via 10.1.3.2, 00:08:38, GigabitEthernet1/0

Routing Table: vrf2

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.2.1.0/24 [110/2] via 10.2.2.1, 00:08:33, GigabitEthernet4/0

C 10.2.2.0/24 is directly connected, GigabitEthernet4/0

L 10.2.2.2/32 is directly connected, GigabitEthernet4/0

C 10.2.3.0/24 is directly connected, GigabitEthernet3/0

L 10.2.3.1/32 is directly connected, GigabitEthernet3/0

O 10.2.4.0/24 [110/2] via 10.2.3.2, 00:08:38, GigabitEthernet3/0

O 10.2.5.0/24 [110/3] via 10.2.3.2, 00:08:38, GigabitEthernet3/0

### R3

Routing Table: vrf1

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.1.1.0/24 [110/3] via 10.1.3.1, 00:11:43, GigabitEthernet2/0

O 10.1.2.0/24 [110/2] via 10.1.3.1, 00:11:48, GigabitEthernet2/0

C 10.1.3.0/24 is directly connected, GigabitEthernet2/0

L 10.1.3.2/32 is directly connected, GigabitEthernet2/0

C 10.1.4.0/24 is directly connected, GigabitEthernet1/0

L 10.1.4.1/32 is directly connected, GigabitEthernet1/0

O 10.1.5.0/24 [110/2] via 10.1.4.2, 00:11:53, GigabitEthernet1/0

Routing Table: vrf2

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.2.1.0/24 [110/3] via 10.2.3.1, 00:11:43, GigabitEthernet4/0

O 10.2.2.0/24 [110/2] via 10.2.3.1, 00:11:48, GigabitEthernet4/0

C 10.2.3.0/24 is directly connected, GigabitEthernet4/0

L 10.2.3.2/32 is directly connected, GigabitEthernet4/0

C 10.2.4.0/24 is directly connected, GigabitEthernet3/0

L 10.2.4.1/32 is directly connected, GigabitEthernet3/0

O 10.2.5.0/24 [110/2] via 10.2.4.2, 00:11:53, GigabitEthernet3/0

### R4

Routing Table: vrf1

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.1.1.0/24 [110/4] via 10.1.4.1, 00:14:45, GigabitEthernet2/0

O 10.1.2.0/24 [110/3] via 10.1.4.1, 00:14:50, GigabitEthernet2/0

O 10.1.3.0/24 [110/2] via 10.1.4.1, 00:14:55, GigabitEthernet2/0

C 10.1.4.0/24 is directly connected, GigabitEthernet2/0

L 10.1.4.2/32 is directly connected, GigabitEthernet2/0

C 10.1.5.0/24 is directly connected, GigabitEthernet1/0

L 10.1.5.1/32 is directly connected, GigabitEthernet1/0

Routing Table: vrf2

10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks

O 10.2.1.0/24 [110/4] via 10.2.4.1, 00:14:45, GigabitEthernet4/0

O 10.2.2.0/24 [110/3] via 10.2.4.1, 00:14:50, GigabitEthernet4/0

O 10.2.3.0/24 [110/2] via 10.2.4.1, 00:14:55, GigabitEthernet4/0

C 10.2.4.0/24 is directly connected, GigabitEthernet4/0

L 10.2.4.2/32 is directly connected, GigabitEthernet4/0

C 10.2.5.0/24 is directly connected, GigabitEthernet3/0

L 10.2.5.1/32 is directly connected, GigabitEthernet3/0

## Pings and Traceroutes

### R1

PC1> ping 10.1.5.2

84 bytes from 10.1.5.2 icmp\_seq=1 ttl=60 time=285.469 ms

84 bytes from 10.1.5.2 icmp\_seq=2 ttl=60 time=201.895 ms

84 bytes from 10.1.5.2 icmp\_seq=3 ttl=60 time=270.817 ms

84 bytes from 10.1.5.2 icmp\_seq=4 ttl=60 time=176.535 ms

84 bytes from 10.1.5.2 icmp\_seq=5 ttl=60 time=221.533 ms

PC1> ping 10.2.1.1

\*10.1.1.2 icmp\_seq=1 ttl=255 time=21.118 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=2 ttl=255 time=33.366 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=3 ttl=255 time=22.678 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=4 ttl=255 time=25.667 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=5 ttl=255 time=33.020 ms (ICMP type:3, code:1, Destination host unreachable)

PC1> ping 10.2.5.2

\*10.1.1.2 icmp\_seq=1 ttl=255 time=18.664 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=2 ttl=255 time=34.233 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=3 ttl=255 time=30.066 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=4 ttl=255 time=38.529 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.1.1.2 icmp\_seq=5 ttl=255 time=35.649 ms (ICMP type:3, code:1, Destination host unreachable)

PC1> trace 10.1.5.2

trace to 10.1.5.2, 8 hops max, press Ctrl+C to stop

1 10.1.1.2 41.627 ms 35.418 ms 36.878 ms

2 10.1.2.2 61.633 ms 66.815 ms 60.000 ms

3 10.1.3.2 160.645 ms 160.141 ms 132.139 ms

4 10.1.4.2 211.258 ms 169.440 ms 230.862 ms

5 \*10.1.5.2 225.730 ms (ICMP type:3, code:3, Destination port unreachable)

### R3

PC3> ping 10.2.5.2

84 bytes from 10.2.5.2 icmp\_seq=1 ttl=60 time=296.207 ms

84 bytes from 10.2.5.2 icmp\_seq=2 ttl=60 time=273.087 ms

84 bytes from 10.2.5.2 icmp\_seq=3 ttl=60 time=163.685 ms

84 bytes from 10.2.5.2 icmp\_seq=4 ttl=60 time=146.905 ms

84 bytes from 10.2.5.2 icmp\_seq=5 ttl=60 time=282.402 ms

PC3> ping 10.1.1.1

\*10.2.1.2 icmp\_seq=1 ttl=255 time=33.792 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=2 ttl=255 time=15.401 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=3 ttl=255 time=24.669 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=4 ttl=255 time=14.971 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=5 ttl=255 time=18.262 ms (ICMP type:3, code:1, Destination host unreachable)

PC3> ping 10.1.5.2

\*10.2.1.2 icmp\_seq=1 ttl=255 time=14.447 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=2 ttl=255 time=18.785 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=3 ttl=255 time=23.163 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=4 ttl=255 time=22.157 ms (ICMP type:3, code:1, Destination host unreachable)

\*10.2.1.2 icmp\_seq=5 ttl=255 time=18.951 ms (ICMP type:3, code:1, Destination host unreachable)

PC3> trace 10.2.5.2

trace to 10.2.5.2, 8 hops max, press Ctrl+C to stop

1 10.2.1.2 33.495 ms 35.195 ms 33.986 ms

2 10.2.2.2 110.421 ms 100.461 ms 101.460 ms

3 10.2.3.2 171.920 ms 147.209 ms 67.494 ms

4 10.2.4.2 174.270 ms 221.215 ms 205.971 ms

5 \*10.2.5.2 223.690 ms (ICMP type:3, code:3, Destination port unreachable)

# Problems

Only thing I had difficulty with in this lab was the redistribution of routes. I initially tried to use static routes, thinking it was easier, but apparently with VRF, next-hop IPs are required, so I changed to just using OSPF, which was easier even if static routes didn’t require next-hops.

# Conclusion

In this lab we configured VRF for a 4 router topology with 2 PCs on each side in GNS3. This lab taught us how to use GNS3, a better way to simulate networks compared to Packet Tracer, meaning planning out a topology can be less cumbersome, and how to configure a basic VRF setup. It was a nice end of the year lab.

A white paper with black text

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