A close-up of a white card

Description automatically generated**Purpose**

This lab helps us learn the practical skills of using virtual routing and forwarding (VRF) to route across a virtual network using a tool called GNS3 (Graphical Network Simulator-3), which allows the creation of virtual networks.

**Background Information**

Virtual routing and forwarding, or VRF, is a computer technology which allows for the creation of virtual routers (VRs) and virtual router instances (VRIs) within a single router. VRFs have a similar function to VLANs, which were used to route in previous labs. Similar to how VLANs are virtually used to separate devices into smaller subsets, VRFs are used to virtually isolate networks, except VLANs are utilized at the 2nd layer of the OSI model whereas VRFs operate at Layer 3. Multiple interfaces, either logical or physical, can operate a VRF. VRFs do not share routes with each other and only interfaces on the same VRF can communicate with packets. Virtual routing enables users to virtually install multiple routes on a singular physical device and simultaneously manage multiple routing tables.

VRF allows for traffic isolation at the Layer 3 level, as each VRF instance operates individually and maintains its own routing and forwarding information. The same physical router is able to have multiple copies of the routing table, so that traffic from each VRF remains separate despite having the same physical appearance. This allows for additional security and privacy since a VRF can’t be visible to other VRFs. Such segmentation is useful in environments with multiple customers, departments, or applications that require their own workspace.

To set up VRFs, first VLANs and router sub-interfaces need to be set up in order to establish the VRF on them. Each VRF is then assigned a Route Distinguisher which allows the routing between each other even if they share the same IP and a Route Target which allows the sharing of routes.

While the isolation VRF provides leads to increased security and more efficient use of infrastructure, the VRF configuration and management process can become complicated and require high amounts of processing power that can lead to negative impacts on performance. Since routing information on each VRF is isolated, troubleshooting on VRF tends to be more tedious.

To complete this lab, we used GNS3 (Graphical Network Simulator-3) which is a network software emulator which allows for the virtualization of networks. GNS3 is usually used by network engineers to be able to design and test networks without utilizing physical hardware. Using a software like GNS3 saves costs while mimicking real world scenarios and helping test network configurations effectively.

**Lab Summary**

To complete this lab, we followed these procedures:

1. Download GNS3 software and Cisco 7200 router file to load into the application.
2. Create a topology with 4 routers and 4 PCs.
3. Define VRF instances for both company A and B.
4. Assign physical interfaces to VRFs on all routers.
5. Configure OSPF for all router interfaces and attach VRF instances.
6. Check connectivity on each VRF and troubleshoot as necessary.

**Lab Commands**

**no ip domain-lookup**  
Disables DNS domain lookups for unrecognized commands.

**ip vrf** [VRF name]  
Creates a Virtual Routing and Forwarding (VRF) instance with a name.  
  
**ip vrf forwarding** [VRF name]  
Applied in the interface, assigning the interface to a specified VRF.  
  
**router ospf** [process ID] **vrf** [VRF name]  
Enter OSPF configuration mode within a specified VRF.  
  
**network** [ipv4 address] [wildcard mask] **area** [number]Specify a network and its subnet to be included in the OSPF routing process.

**Topology & IP Scheme**

A diagram of a network

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**Configurations**

**Router A1:**

Show run:

Current configuration : 1619 bytes

upgrade fpd auto

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname A1

boot-start-marker

boot-end-marker

logging message-counter syslog

no aaa new-model

ip source-route

no ip icmp rate-limit unreachable

ip cef

ip vrf A

ip vrf B

no ip domain lookup

no ipv6 cef

multilink bundle-name authenticated

archive

log config

hidekeys

ip tcp synwait-time 5

interface Ethernet0/0

no ip address

shutdown

duplex auto

interface GigabitEthernet0/0

ip vrf forwarding A

ip address 10.1.0.1 255.255.255.0

duplex full

speed 1000

media-type gbic

negotiation auto

interface GigabitEthernet1/0

ip vrf forwarding A

ip address 10.100.0.2 255.255.255.0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding B

ip address 10.100.0.2 255.255.255.0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding B

ip address 10.1.0.1 255.255.255.0

negotiation auto

router ospf 1 vrf A

log-adjacency-changes

network 10.1.0.0 0.0.0.255 area 0

network 10.100.0.0 0.0.0.255 area 0

router ospf 2 vrf B

log-adjacency-changes

network 10.1.0.0 0.0.0.255 area 0

network 10.100.0.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

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

end

**Router A2:**

Show run:

Current configuration : 1611 bytes

upgrade fpd auto

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname A2

boot-start-marker

boot-end-marker

logging message-counter syslog

no aaa new-model

ip source-route

no ip icmp rate-limit unreachable

ip cef

ip vrf A

ip vrf B

no ip domain lookup

no ipv6 cef

multilink bundle-name authenticated

archive

log config

hidekeys

ip tcp synwait-time 5

interface Ethernet0/0

no ip address

shutdown

duplex auto

interface GigabitEthernet0/0

ip vrf forwarding A

ip address 10.1.0.2 255.255.255.0

duplex full

speed 1000

media-type gbic

negotiation auto

interface GigabitEthernet1/0

ip vrf forwarding A

ip address 10.0.0.1 255.255.255.0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding B

ip address 10.0.0.1 255.255.255.0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding B

ip address 10.1.0.2 255.255.255.0

negotiation auto

router ospf 1 vrf A

log-adjacency-changes

network 10.0.0.0 0.0.0.255 area 0

network 10.1.0.0 0.0.0.255 area 0

router ospf 2 vrf B

log-adjacency-changes

network 10.0.0.0 0.0.0.255 area 0

network 10.1.0.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

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

end

**Router A3:**

Show run:

Current configuration : 1611 bytes

upgrade fpd auto

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname A3

boot-start-marker

boot-end-marker

logging message-counter syslog

no aaa new-model

ip source-route

no ip icmp rate-limit unreachable

ip cef

ip vrf A

ip vrf B

no ip domain lookup

no ipv6 cef

multilink bundle-name authenticated

archive

log config

hidekeys

ip tcp synwait-time 5

interface Ethernet0/0

no ip address

shutdown

duplex auto

interface GigabitEthernet0/0

ip vrf forwarding A

ip address 10.2.0.1 255.255.255.0

duplex full

speed 1000

media-type gbic

negotiation auto

interface GigabitEthernet1/0

ip vrf forwarding A

ip address 10.0.0.2 255.255.255.0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding B

ip address 10.0.0.2 255.255.255.0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding B

ip address 10.2.0.1 255.255.255.0

negotiation auto

router ospf 1 vrf A

log-adjacency-changes

network 10.0.0.0 0.0.0.255 area 0

network 10.2.0.0 0.0.0.255 area 0

router ospf 2 vrf B

log-adjacency-changes

network 10.0.0.0 0.0.0.255 area 0

network 10.2.0.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

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

end

**Router A4:**

Show run:

Current configuration : 1619 bytes

upgrade fpd auto

version 12.4

service timestamps debug datetime msec

service timestamps log datetime msec

no service password-encryption

hostname A4

boot-start-marker

boot-end-marker

logging message-counter syslog

no aaa new-model

ip source-route

no ip icmp rate-limit unreachable

ip cef

ip vrf A

ip vrf B

no ip domain lookup

no ipv6 cef

multilink bundle-name authenticated

archive

log config

hidekeys

ip tcp synwait-time 5

interface Ethernet0/0

no ip address

shutdown

duplex auto

interface GigabitEthernet0/0

ip vrf forwarding A

ip address 10.2.0.2 255.255.255.0

duplex full

speed 1000

media-type gbic

negotiation auto

interface GigabitEthernet1/0

ip vrf forwarding A

ip address 10.101.0.2 255.255.255.0

negotiation auto

interface GigabitEthernet2/0

ip vrf forwarding B

ip address 10.101.0.2 255.255.255.0

negotiation auto

interface GigabitEthernet3/0

ip vrf forwarding B

ip address 10.2.0.2 255.255.255.0

negotiation auto

router ospf 1 vrf A

log-adjacency-changes

network 10.2.0.0 0.0.0.255 area 0

network 10.101.0.0 0.0.0.255 area 0

router ospf 2 vrf B

log-adjacency-changes

network 10.2.0.0 0.0.0.255 area 0

network 10.101.0.0 0.0.0.255 area 0

ip forward-protocol nd

no ip http server

no ip http secure-server

no cdp log mismatch duplex

control-plane

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

end

**PC A1:**

Show IP:

NAME : PCA1[1]

IP/MASK : 10.100.0.1/24

GATEWAY : 10.100.0.2

DNS :

MAC : 00:50:79:66:68:00

LPORT : 10052

RHOST:PORT : 127.0.0.1:10053

MTU: : 1500

**PC A2:**

Show IP:

NAME : PCA2[1]

IP/MASK : 10.101.0.1/24

GATEWAY : 10.101.0.2

DNS :

MAC : 00:50:79:66:68:02

LPORT : 10056

RHOST:PORT : 127.0.0.1:10057

MTU: : 1500

**PC B1:**

Show IP:

NAME : PCB1[1]

IP/MASK : 10.100.0.1/24

GATEWAY : 10.100.0.2

DNS :

MAC : 00:50:79:66:68:01

LPORT : 10054

RHOST:PORT : 127.0.0.1:10055

MTU: : 1500

**PC B2:**

Show IP:

NAME : PCB2[1]

IP/MASK : 10.101.0.1/24

GATEWAY : 10.101.0.2

DNS :

MAC : 00:50:79:66:68:03

LPORT : 10058

RHOST:PORT : 127.0.0.1:10059

MTU: : 1500

**Problems**

Cisco 7200 image files were missing despite being downloaded already and the message displayed on screen showed: “files missing.” In reality, this message was misleading because the image upload did actually work and the message just did not update accurately.

The library.zip file was found to be missing from GNS as it showed: “FileNotFoundError: [Errno 2] No such file or directory: 'C:\\Program Files\\GNS3\\lib\\library.zip'.” Fixing this issue required to uninstall and reinstall the file.

After reinstallation, SolarPutty was not installed. It had to be installed separately and placed within the GNS3 project files manually in order to console into the devices.

**Conclusion**

This lab helped us become more comfortable with using virtual networking tools like GNS3 (Graphical Network Simulator-3) to emulate a real physical network and apply virtual routing and forwarding (VRF) skills to route across the virtual network.

**Lab Signoff**

A close-up of a paper

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