Lab 4: Introduction to VRF and MPLS

Student Name: ....
Student No: ....

Objectives:

- ✓ Understanding VRF and MPLS
- ✓ Practising basic configuration of VRF and MPLS.

Content:

I. Virtual Routing and Forwarding

Virtual Routing and Forwarding (VRF) is an IP technology that allows multiple instances of a routing table to coexist on the same router at the same time. Because the routing instances are independent, the same or overlapping IP addresses can be used without conflict. "VRF" is also used to refer to a routing table instance that can exist in one or multiple instances per each VPN on a Provider Edge (PE) router.

"*Some people think of VRFs as a way to do virtualization and describe it as VMWare for your router. Each areas of isolation is thought of as a VMWare guest instance. I like to think VRFs as similar to VLANS, but at layer 3*" - Paul Stewart, CCIE 26009

Let's start with network topology in figure 1. Practice by configuring each router as below instructions:

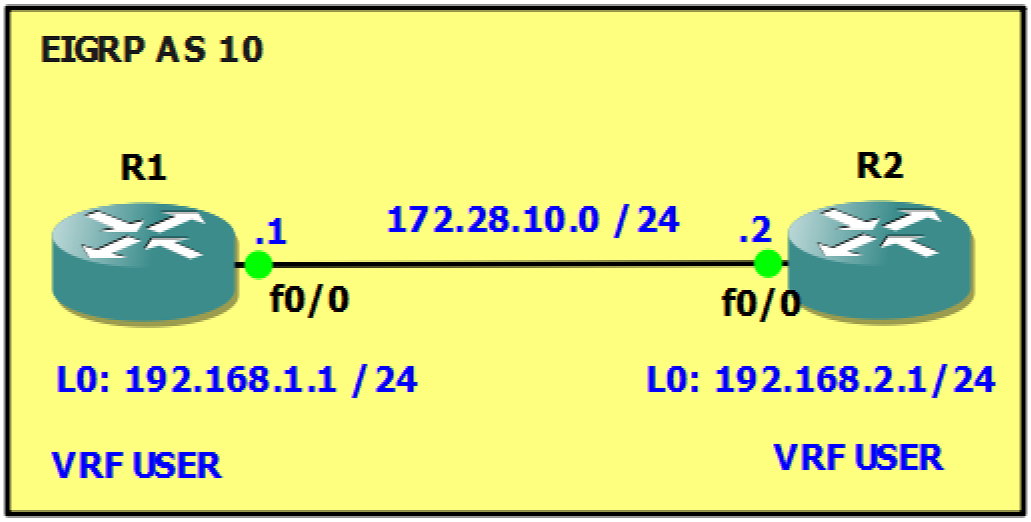

Figure 1: VRF configuration on 2 routers

R1:

```
conf t
ip vrf USER
exit
interface Loopback0
 ip vrf forwarding USER
 ip address 192.168.1.1 255.255.255.0

interface Tunnel1
 ip vrf forwarding USER
 ip address 192.168.21.1 255.255.255.0
 tunnel source FastEthernet0/0
 tunnel destination 172.28.10.2

interface FastEthernet0/0
 ip address 172.28.10.1 255.255.255.0
no shut
```

```
router eigrp 12
 no auto-summary
 address-family ipv4 vrf USER
  network 192.168.1.0
  network 192.168.21.0
  autonomous-system 12
 exit-address-family
```

R2:

```
conf t
ip vrf USER
exit
interface Loopback0
 ip vrf forwarding USER
 ip address 192.168.2.1 255.255.255.0

interface Tunnel1
 ip vrf forwarding USER
 ip address 192.168.21.2 255.255.255.0
 tunnel source FastEthernet0/0
 tunnel destination 172.28.10.1

interface FastEthernet0/0
 ip address 172.28.10.2 255.255.255.0
no shut

router eigrp 12
 no auto-summary
```

```
address-family ipv4 vrf USER
 network 192.168.2.0
 network 192.168.21.0
 autonomous-system 12
exit-address-family
```

Ping from R1 to R2's loopback interface by command:

```
ping 192.168.2.1.
ping vrf USER 192.168.2.1
```

Observe the result and give conclusions.

Check your configuration by:

```
Show ip route vrf USER
Show ip vrf interfaces
```

Practice 1:

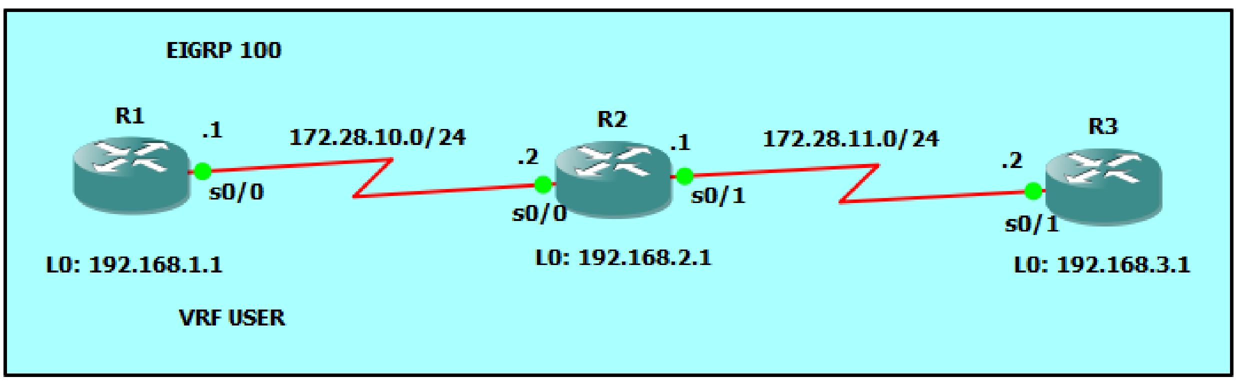

Figure 2: VRF configuration on 3 routers

Requirement: Every router's loopback 0 interface forwards "vrf USER". All routers' serial interfaces are not configured to forward "vrf USER". After configuring, the command "ping vrf USER 192.168.3.1" from R1 returns successfully.

II. Multiprotocol Label Switching

Multiprotocol Label Switching Overview

MPLS is a high-performance packet forwarding technology that integrates the performance and traffic management capabilities of data link layer (Layer 2) switching with the scalability, flexibility, and performance of network-layer (Layer 3) routing. It enables service providers to meet challenges brought about by explosive growth and provides the opportunity for differentiated services without necessitating the sacrifice of existing infrastructure.

The MPLS architecture is remarkable for its flexibility:

- Data can be transferred over any combination of Layer 2 technologies
- Support is offered for all Layer 3 protocols
- Scaling is possible well beyond anything offered in today's networks.

Specifically, MPLS can efficiently enable the delivery of IP services over an ATM switched network. It supports the creation of different routes between a source and a destination on a purely router-based Internet backbone. Service providers who use MPLS can save money and increase revenue and productivity.

Label Switching Functions

In conventional Layer 3 forwarding mechanisms, as a packet traverses the network, each router extracts all the information relevant to forwarding the packet from the Layer 3 header. This information is then used as an index for a routing table lookup to determine the next hop for the packet.

In the most common case, the only relevant field in the header is the destination address field, but in some cases other header fields might also be relevant. As a result, the header analysis must be done independently at each router through which the packet passes. A complicated table lookup must also be done at each router.

In label switching, the analysis of the Layer 3 header is done only once. The Layer 3 header is then mapped into a fixed length, unstructured value called a label.

Many different headers can map to the same label, as long as those headers always result in the same choice of next hop. In effect, a label represents aforwarding equivalence class—that is, a set of packets that, however different they may be, are indistinguishable by the forwarding function.

The initial choice of a label need not be based exclusively on the contents of the Layer 3 packet header; for example, forwarding decisions at subsequent hops can also be based on routing policy.

Once a label is assigned, a short label header is added at the front of the Layer 3 packet. This header is carried across the network as part of the packet. At subsequent hops through each MPLS router in the network, labels are swapped and forwarding decisions are made by means of MPLS forwarding table lookup for the label carried in the packet header. Hence, the packet header need not be reevaluated during packet transit through the network.

Because the label is of fixed length and unstructured, the MPLS forwarding table lookup process is both straightforward and fast.

Practice 2:

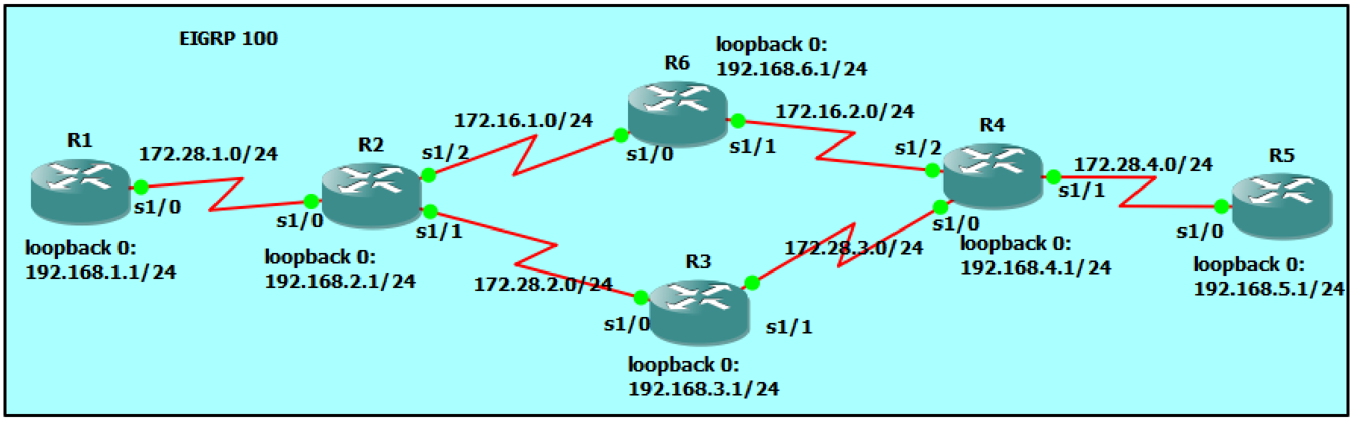

Figure 3: MPLS demo

Requirements:

Configure IP addresses for all router as shown in the picture.

Configure EIGRP routing for all routers.

Make sure R1 can ping loopback interface of R5.

Do "traceroute" from R1 to loopback interface of R5 and vice versa. (from R1: `traceroute 192.168.5.1`)

Configure MPLS on interface s1/0, s1/1 of R2, R3, R4. (hint: using command "`mpls ip`" under *config-if* mode)

Check the MPLS configuration on each router. (hint: `show mpls forwarding-table`)

Again, do "traceroute" from R1 to loopback interface of R5 and vice versa.

Observe the path that each packet travels from R1 to R5. Compare to the previous traceroute job and give your comment.

III. Submission

Complete the practice 1,2 on GNS3. Compress all the project into Lab4_<student_code>.zip and submit this file onto Sakai.

References:

http://www.cisco.com/c/en/us/td/docs/net_mgmt/active_network_abstraction/3-7/reference/guide/ANARefGuide37/vrf.html

http://www.packetu.com/2012/07/12/vrfing-101-understing-vrf-basics/

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