COMP 3721 (Introduction to Data Communications)

Total mark: 12

GNS3 Lab – Routing

1.1. Downloading/Installing FRR appliance in GNS3

You need to install an appliance called FRR (Free Range Routing) in your GNS3. To download this appliance from GNS3 marketplace, you need to visit https://gns3.com/frr. There are two components to download, the first one is the FRR appliance file (frr.gns3a) and the second one is a FRR disk image (frr-8.2.2.qcow2). Figures 1 and 2 show the download pages for these items.

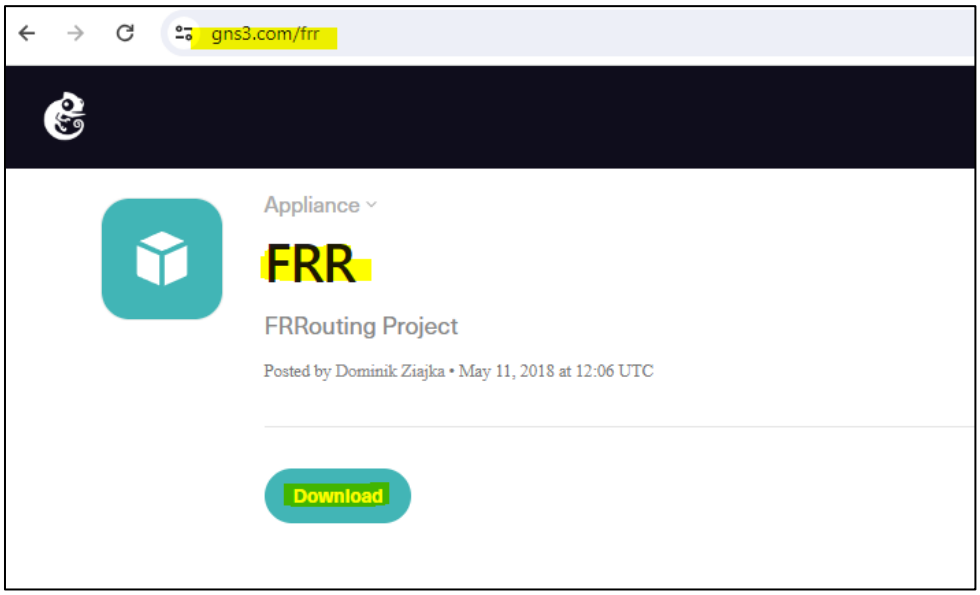

Figure 1. The download page for FRR appliance.

After completing download, you can import the appliance from **File > Import appliance** section in GNS3. To import, select **frr.gns3a** and then choose the "**Install the appliance on the GNS3 VM (recommended)**" option. In the next step, you will be asked for the path to Qemu binary file on your computer and you can continue with the default option. In the next window, ensure that the status value for FRR version 8.2.2 is "Ready to install" and then press the next button. Finally, by pressing the "Finish" button the installation will be completed. Figure 3 shows the installation process window and the required file to complete the installation.

Figure 2. The download page for FRR 8.2.2 disk image.

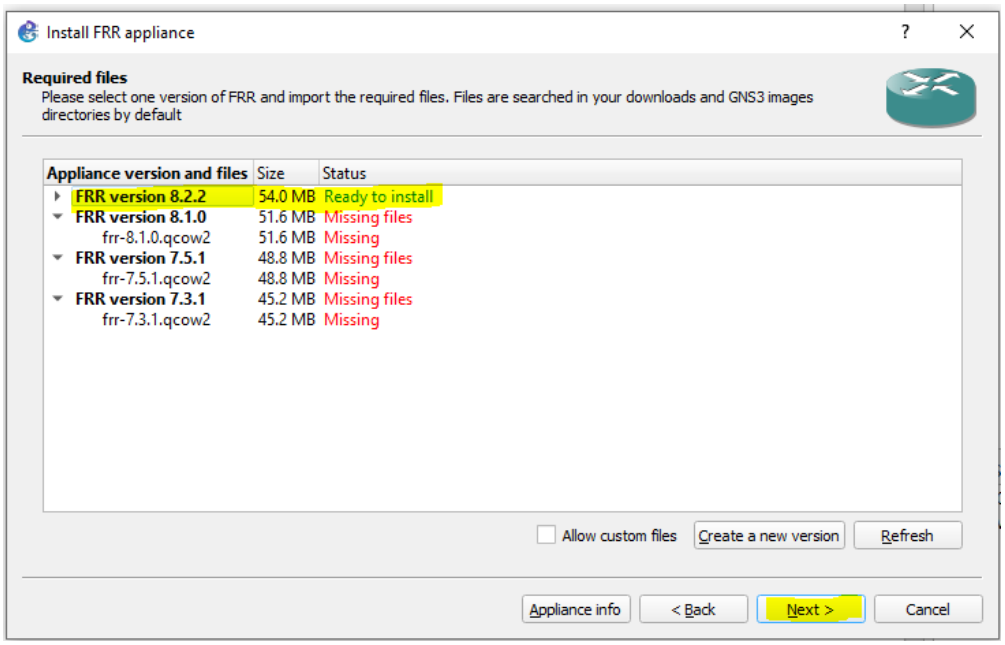

Figure 3. Installation of the FRR appliance in GNS3.

Once installation completed, if you click on the Router icon from the side menu (the first item) in GNS3 GUI, you can find the imported FRR 8.2.2 appliance and it can be dragged it into your workspace in GNS3. Similar to other appliances (such as Alpine Linux), you can Start the FRR router and access to it by opening a console. Figure 4 illustrates an FRR router placed in GNS3 GUI. You can start the router and access it (similar to Alpine Linux) by right-click and choosing the console option.

If you tried to start the FRR router and encountered an error like "KVM acceleration cannot be used (/dev/kvm doesn't exist)", then you need to exit from GNS3 GUI and power off GNS3 VM. Next, check the VM settings for GNS3 VM and ensure the highlighted section in Figure 5 is selected. After powering on the GNS3 VM and starting the GNS3 GUI, the error should be fixed.

Now, you are ready to carry out the next lab section by creating a topology with 3 FRR routers.

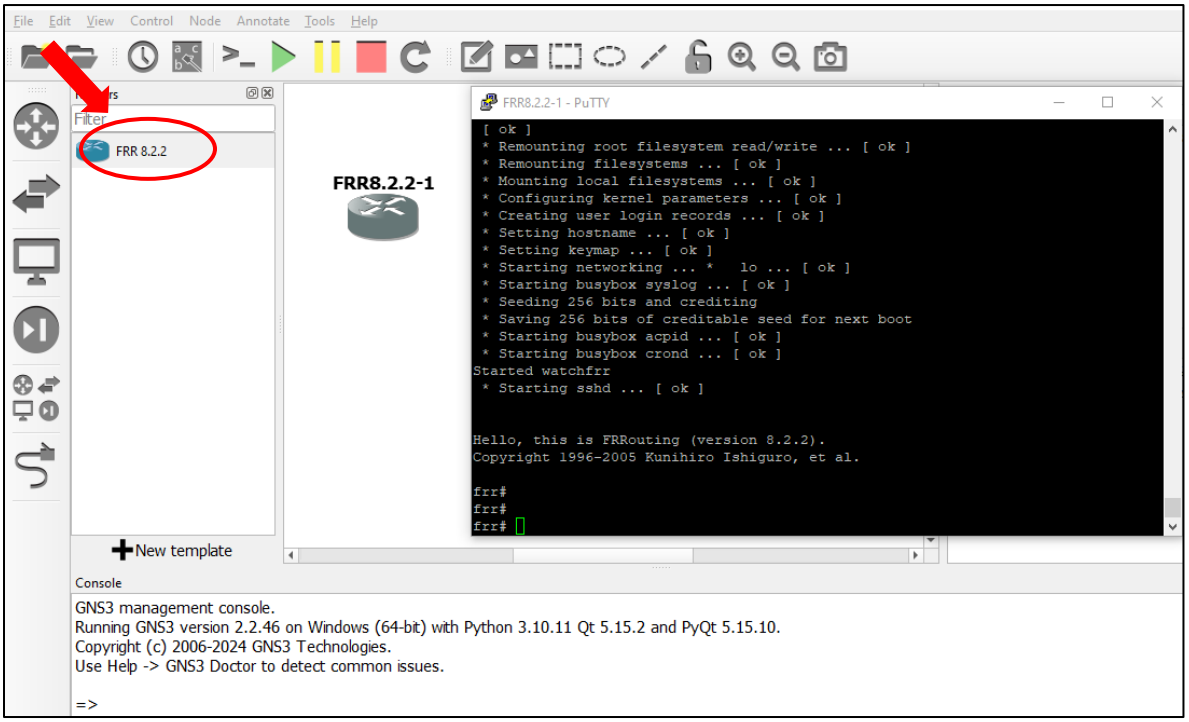

Figure 4. Installation of the FRR appliance in GNS3.

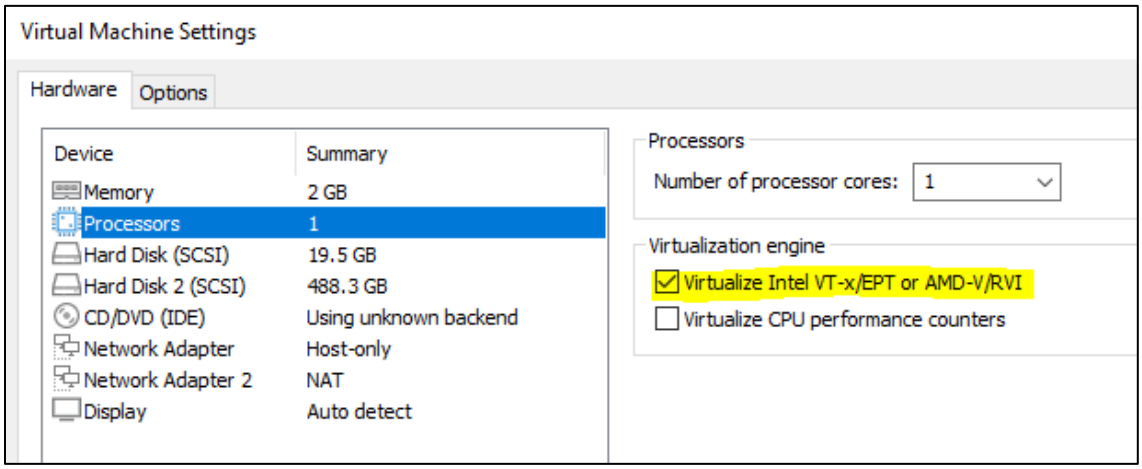

Figure 5. Enabling VT-x/EPT feature in GNS3 VM.

1.2. Implementing Static Routing scenario

In this section, first build the GNS3 topology illustrated in Figure 6. Then, set up three FRR routers exactly as shown in the same figure, following the given details. The IP addresses assigned to the router interfaces and Alpine Linux nodes are clearly stated in Figure 6. Each router has three connections to different networks. For instance, R2 is

connected to three separate networks including **20.0.0.0/24**, **40.0.0.0/24**, and **60.0.0.0/24**. You can see that R2 and each of the other two routers are connected to an Ethernet switch, and an Alpine Linux host is connected to the same switch. This setup is like real-life setups where computers are not directly connected to routers, instead Ethernet (Layer-2) switches are used to connect multiple computers to a network router. The first step to configure every router is to assign the IP addresses shown in Figure 6 to respective interfaces. To do this, run the following set of commands on each router.

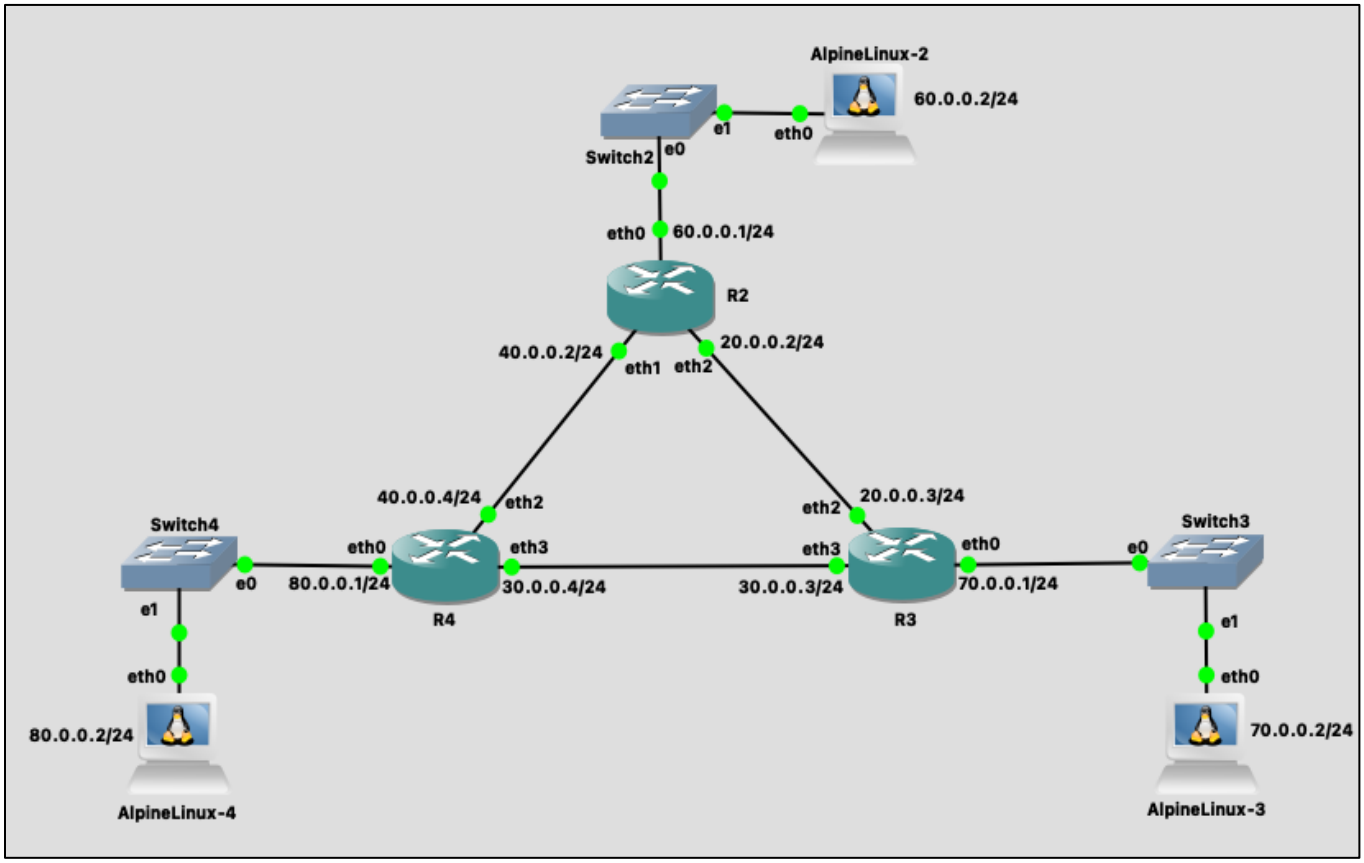

Figure 6. Creating a topology using three FRR routers to test static/dynamic routing.

Router #2 (R2)

```
[R2] frr# conf t
[R2] frr(config)# interface eth0
[R2] frr(config-if)# ip address 60.0.0.1/24
[R2] frr(config-if)# exit
[R2] frr(config)# interface eth1
[R2] frr(config-if)# ip address 40.0.0.2/24
[R2] frr(config-if)# exit
[R2] frr(config)# interface eth2
[R2] frr(config-if)# ip address 20.0.0.2/24
[R2] frr(config-if)# exit
```

Router #3 (R3)

```
[R3] frr# conf t
[R3] frr(config)# interface eth0
[R3] frr(config-if)# ip address 70.0.0.1/24
[R3] frr(config-if)# exit
[R3] frr(config)# interface eth2
[R3] frr(config-if)# ip address 20.0.0.3/24
[R3] frr(config-if)# exit
[R3] frr(config)# interface eth3
[R3] frr(config-if)# ip address 30.0.0.3/24
[R3] frr(config-if)# exit
```

Router #4 (R4)

```
[R4] frr# conf t
[R4] frr(config)# interface eth0
[R4] frr(config-if)# ip address 80.0.0.1/24
[R4] frr(config-if)# exit
[R4] frr(config)# interface eth2
[R4] frr(config-if)# ip address 40.0.0.4/24
[R4] frr(config-if)# exit
[R4] frr(config)# interface eth3
[R4] frr(config-if)# ip address 30.0.0.4/24
[R4] frr(config-if)# exit
```

After completing the configuration of router interfaces, set the interface IP and default gateway for the Alpine Linux hosts connected to each router (via a switch). This can be done by running the following commands on respective Linux hosts:

```
AlpineLinux-2# ip address add 60.0.0.2/24 dev eth0
AlpineLinux-2# ip route add default via 60.0.0.1 dev eth0

AlpineLinux-3# ip address add 70.0.0.2/24 dev eth0
AlpineLinux-3# ip route add default via 70.0.0.1 dev eth0

AlpineLinux-4# ip address add 80.0.0.2/24 dev eth0
AlpineLinux-4# ip route add default via 80.0.0.1 dev eth0
```

Once all this IP assignments are done, get a console from AlpineLinux-2 and run the following ping commands. Can you ping all these three IP addresses successfully? Why?

```
AlpineLinux-2# ping –c 5 60.0.0.1
AlpineLinux-2# ping –c 5 20.0.0.2
AlpineLinux-2# ping –c 5 40.0.0.2
```

Question1: **T**ry to ping a new set of IPs which are assigned to R3, Alpine Linux-4 and AlpineLinux-3. Can you ping all these three IP addresses successfully? Why? Explain and add a screenshot.

AlpineLinux-2# ping –c 5 30.0.0.3
AlpineLinux-2# ping –c 5 70.0.0.2
AlpineLinux-2# ping –c 5 80.0.0.2

Now, using '**ip route**' command, set static routes on each router. This will allow you to reach networks (by pinging the IP addresses) that you were not able to ping them in previous section. Note that similar to former commands, first need to switch to 'configuration terminal' mode by running '**conf t**' command. Then, run '**ip forwarding**' command to enable IP forwarding between router interfaces. If you look at the topology shown in Figure 8, you can see that indeed each router is representing a network that is connected to its interface **eth0** via an Ethernet switch. To connect this network that includes an Alpine Linux host to other networks in the given topology using Static Routing, you need to run the following commands on the respective routers.

Router #2 (R2)
[R2] frr# conf t
[R2] frr(config)# ip forwarding
[R2] frr(config)# ip route 70.0.0.0/24 20.0.0.3
[R2] frr(config)# ip route 80.0.0.0/24 40.0.0.4

Router #3 (R3)
[R3] frr# conf t
[R3] frr(config)# ip forwarding
[R3] frr(config)# ip route 60.0.0.0/24 20.0.0.2
[R3] frr(config)# ip route 80.0.0.0/24 30.0.0.4

Router #4 (R4)
[R4] frr# conf t
[R4] frr(config)# ip forwarding
[R4] frr(config)# ip route 60.0.0.0/24 40.0.0.2
[R4] frr(config)# ip route 70.0.0.0/24 30.0.0.3

Question2: After running the above set of commands, do another try again to ping following IPs from AlpineLinux-2. Any change in the result? Why? Explain and add a screenshot.

AlpineLinux-2# ping –c 5 30.0.0.3
AlpineLinux-2# ping –c 5 70.0.0.2
AlpineLinux-2# ping –c 5 80.0.0.2

Question 3: Another command that you can use to check the connectivity and intermediate nodes (hops) between your computer and the destination is '**traceroute**'. Try this command on AlpineLinux-2 for the following destinations and capture/put the results as screenshots.

AlpineLinux-2# traceroute –n 70.0.0.2
AlpineLinux-2# traceroute –n 80.0.0.2

Question 4: Now, first remove the link between R2 and R3 in the topology illustrated in Figure 6, and from AlpineLinux-2 try to ping AlpineLinux-3 for one minute (60 seconds) by running the following command. What is the ping result? Explain and add a screenshot.

AlpineLinux-2# ping –c 60 70.0.0.2

1.3. Implementing Dynamic Routing scenario

First, you should remove the static routes. You can do this in two ways (choose one):

1. **Edit the Commands:** Add "no" at the beginning of the six "ip route" commands shown on previous page (for all routers) and re-run them on each router. For instance, on R2 you have to run the following two commands.
   #no ip route 70.0.0.0/24 20.0.0.3
   #no ip route 80.0.0.0/24 40.0.0.4
2. **Restart the Routers:** Stop and start each router. Note that this method will also remove the router's interface IPs as well and you need to repeat the interface configuration again.

In this section, you apply the Routing Information Protocol (RIP) as one of the simplest dynamic routing protocols to the routers shown in Figure 6. As you know, RIP uses hop count as its primary metric to select a route between two hosts in the network. You can keep using the assigned IPs to the router interfaces and just need to replace the '**ip forwarding**' and '**ip route**' commands shown at the beginning of this page with the following commands for each router.
As you can see, each set of the following commands enables the dynamic routing protocol on every router by listing the networks that the router is directly connected to them. For instance, R2 is directly connected to three networks including **20.0.0.0/24**, **40.0.0.0/24** and **60.0.0.0/24**, and all listed here. By applying this configuration, every router starts advertising its routing table in the network and other routers receive these advertisements and update their routing tables.

Router #2 (R2)

```
[R2] frr# conf t
[R2] frr(config)# router rip
[R2] frr(config-router)# network 20.0.0.0/24
[R2] frr(config-router)# network 40.0.0.0/24
[R2] frr(config-router)# network 60.0.0.0/24
[R2] frr(config-router)# exit
[R2] frr(config)# exit
```

Router #3 (R3)

```
[R3] frr# conf t
[R3] frr(config)# router rip
[R3] frr(config-router)# network 20.0.0.0/24
[R3] frr(config-router)# network 30.0.0.0/24
[R3] frr(config-router)# network 70.0.0.0/24
[R3] frr(config-router)# exit
```

[R3] frr(config)# exit

Router #4 (R4)
[R4] frr# conf t
[R4] frr(config)# router rip
[R4] frr(config-router)# network 30.0.0.0/24
[R4] frr(config-router)# network 40.0.0.0/24
[R4] frr(config-router)# network 80.0.0.0/24
[R4] frr(config-router)# exit
[R4] frr(config)# exit

In the last part of this lab, we want to explore one of the key features of the dynamic routing protocols which is dynamic link recovery. On AlpineLinux-3 run '**traceroute –n 80.0.0.2**' command and take a screenshot form the output and place it in your report. Then, on AlpineLinux-3 start pinging AlpineLinux-4 by running '**ping 80.0.0.2**'. You should be able to see a few milliseconds response time in the output of the ping command.

Question 5: While the ping continuously is running on AlpineLinux-3, remove the link between routers R3 and R4 from the topology shown in Figure 8. Is there any change in the ping output and its response time? How long does it take for the ping command to recover its response? Explain and add a screenshot.

Question 6: Now, on AlpineLinux-3 run '**traceroute –n 80.0.0.2**' command and compare its result with the output you obtained from traceroute command in previous section. What is the difference? Explain and add a screenshot.

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