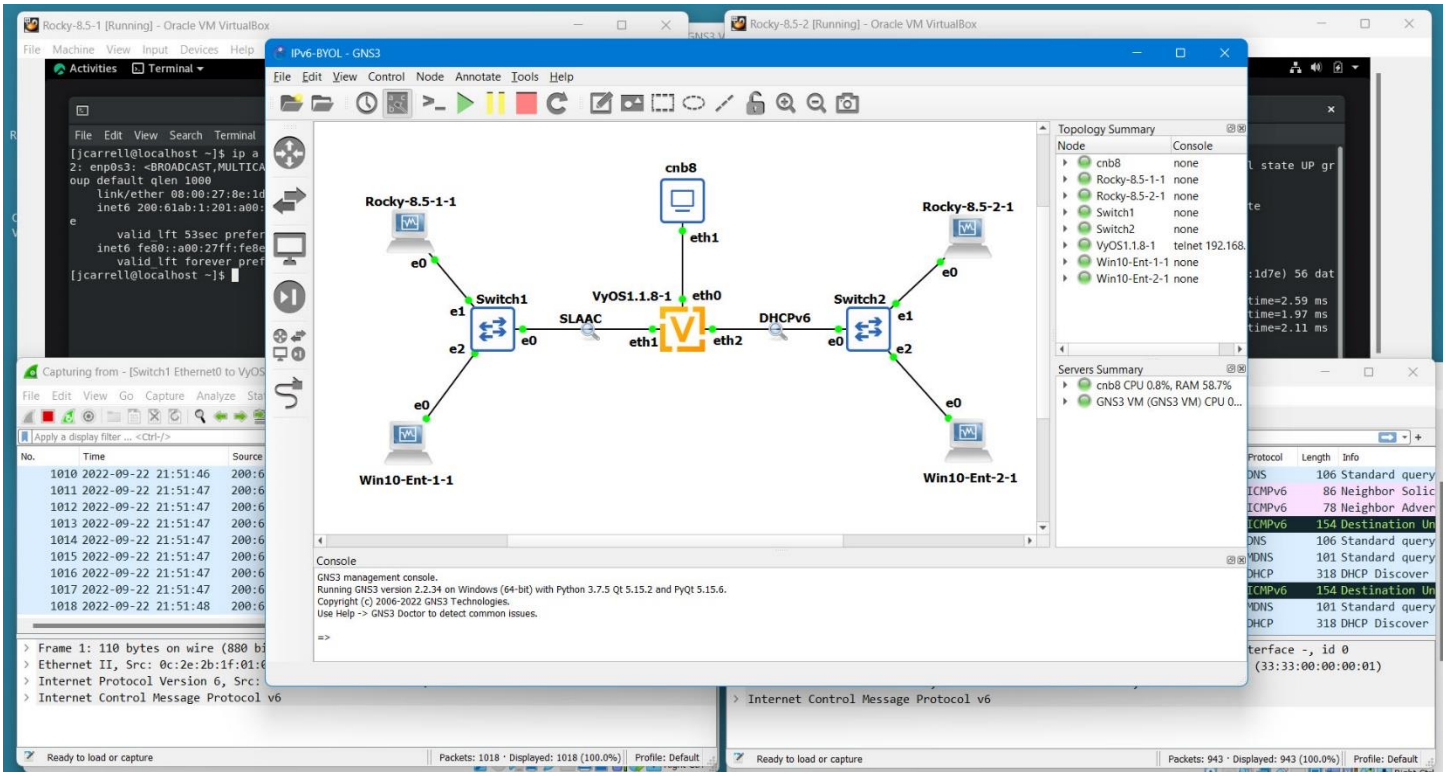
Welcome to the Build Your Own IPv6 Learning Lab for Free - Workshop



Overview of lab procedures

- Install and configure VirtualBox and Extensions
- Import and configure GNS3 VM
- Install and configure GNS3
- Create VyOS router VM
- Configure VyOS
- Create 2 or more clients

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I. Lab IPv4 & IPv6 Address Schema

1. Host computer = 10.1.199.1 and 200:61ab:199:1011::1
2. GNS3 VM = 10.1.199.101 (bridged to host interface above)
3. VyOS eth0 = 10.1.199.201 and 200:61ab:199:1011::201
4. VyOS eth1 = 172.20.1.1 and 200:61ab:1:201::1
5. VyOS eth2 = 10.10.1.1 and 200:61ab:1:1010::1

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II. Obtain software

- If not already done so, download the following:

1. https://www.virtualbox.org/wiki/Downloads
    a) Download platform package for your host OS
    b) Download Oracle VM VirtualBox Extension Pack
2. https://github.com/GNS3/gns3-gui/releases
    a) Download latest 2.2.xx, select for your host OS
    b) Download VirtualBox VM zip file for same version as GNS3
    ** note, VirtualBox VM must be same version as GNS3
3. https://s3.amazonaws.com/s3-us.vyos.io/vyos-1.1.8-amd64.iso
4. https://sourceforge.net/projects/gns-3/files/Empty%20Qemu%20disk/empty8G.qcow2/download
5. https://vyos.io/wp-content/themes/vyos_theme/images/main/vyos-logo.svg
    ^^ right-click and save after downloading, rename to vyos.svg
6. https://www.wireshark.org/#download
    a) Download platform package for your host OS
7. https://dl.rockylinux.org/vault/rocky/8.5/isos/x86_64/Rocky-8.5-x86_64-dvd1.iso
8. https://go.microsoft.com/fwlink/p/?LinkID=2195400&clcid=0x409&culture=en-us&country=US
9. http://old.kali.org/kali-images/kali-2021.1/kali-linux-2021.1-live-arm64.iso
    ^^ optional

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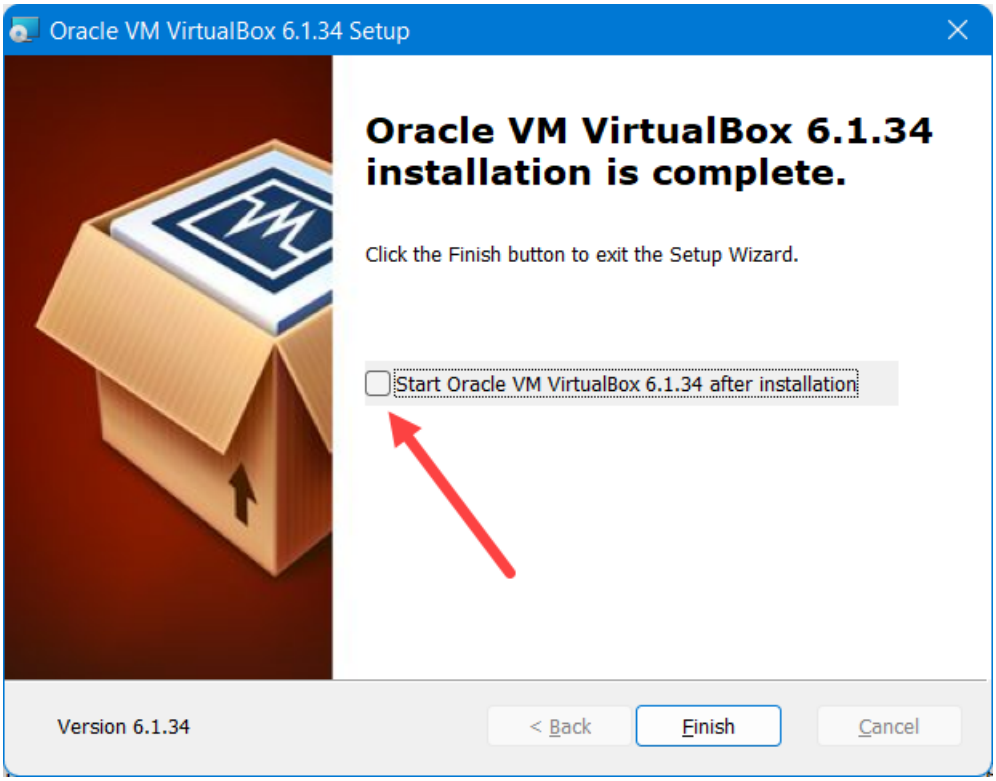
III.Install VirtualBox

VirtualBox was chosen for the virtual machine platform as it is a free application, supports many different host OS's, but more importantly, it allows for having multiple network adapters and choosing different adapters for the various VM clients you may use

1. Navigate to directory where you copied the VirtualBox installer file and install VirtualBox (can accept the defaults options during install, or customize for your specific requirements, your version may be different than seen in these screen shots)

   a) At the "Oracle VM VirtualBox installation is complete" untic the "Start Oracle VM VirtualBox 6.1.34 after installation" box (ie, do not start VB yet)



2. Select finish

3. Install the VirtualBox Extension Pack

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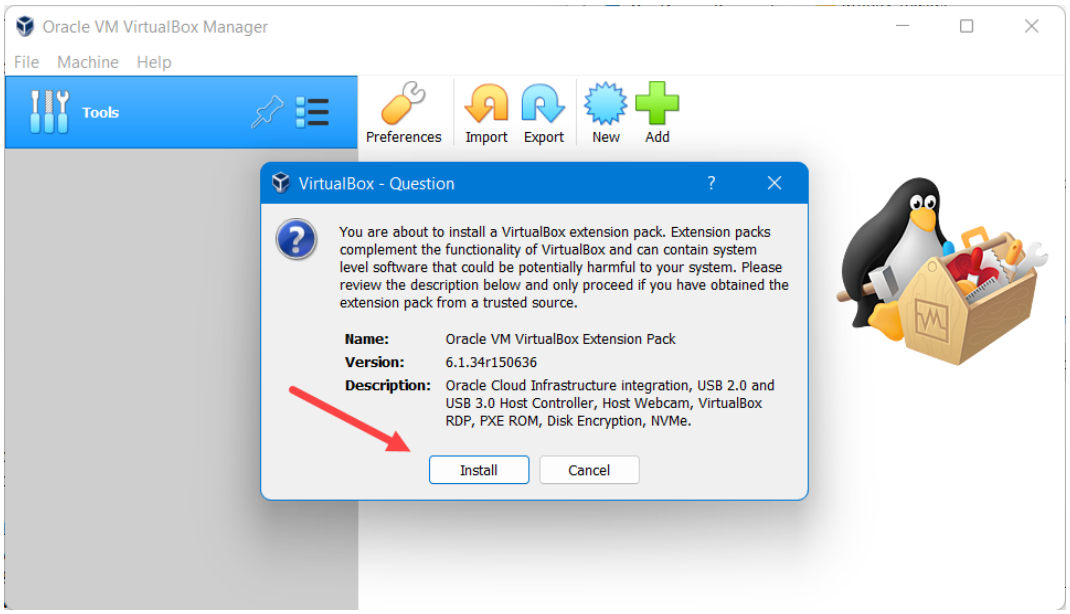
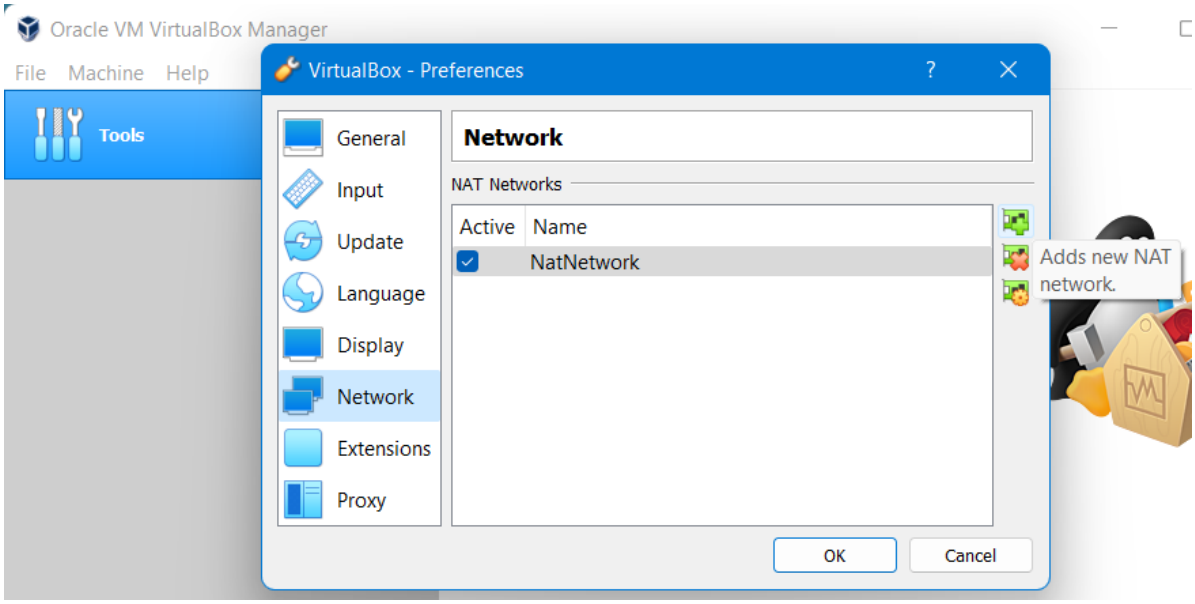
4. VirtualBox started and you are presented with a welcome screen



5. After successful installation of the Extension Pack, configure VirtualBox:

a) Add a NAT interface: >File >Preferences >Network >select the "+" symbol



b) Add a host-only network interface: >File >Host Network Manager >Create. After the interface has been created:

(1) select Properties and configure the IPv4 address to 192.168.56.1/24

(2) select the DHCP Server tab, tic "Enable Server"

(3) Server Address = 192.168.56.1/24

(4) Lower Address Bound = 192.168.56.81

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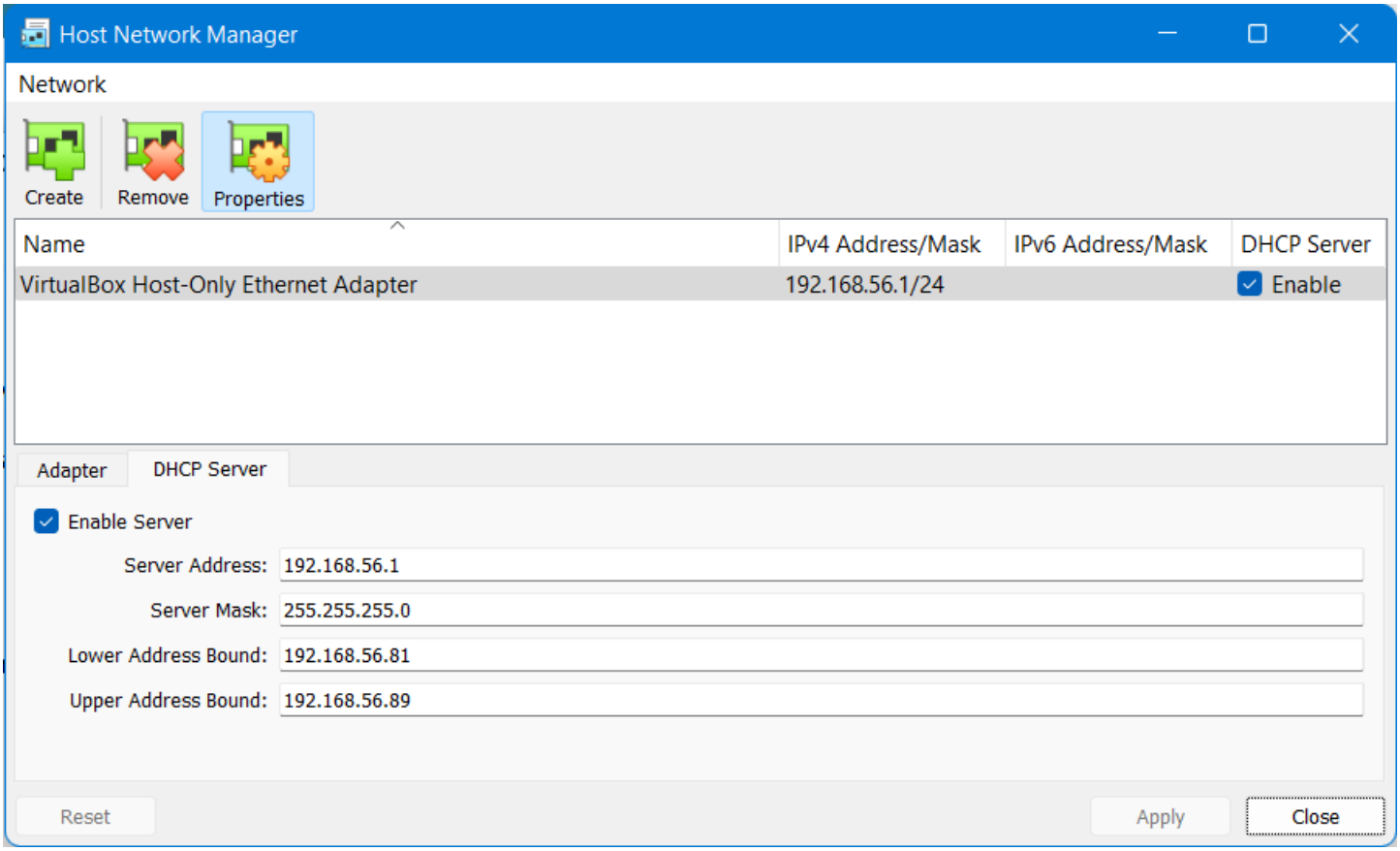
(5) Upper Address Bound = 192.168.56.89

(6) selecting “Apply” the screen will update to all the new settings



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IV. Import and configure GNS3 VM

1. Import the GNS3 VirtualBox VM (note, the GNS3 VM must be the same version of GNS3 that will soon be installed)

    a) Extract the GNS3.ova from the GNS3.VM.VirtualBox zip file

    b) In VirtualBox, import the VM: >File >Import Appliance, navigate to select the GNS3.ova file

    c) Edit the Appliance settings:

        (1) RAM = 4G if host has 8G, or 8G if the host => 16G

        (2) CPU = 2

        (3) Network Adapters = "Intel PRO/1000 MT Desktop (82540EM)"

    d) Select Import (this may take up to ~ 5 minutes)

2. After the VM has been imported, select the Settings Icon

    a) >Network >Adapter 1 tab

        (1) Ensure the “Enable Network Adapter” box is tic’d

        (2) Ensure the “Attached to” is selected to “Host-only Adapter”

        (3) Select the “Advanced” dropdown

            (a) Promiscuous Mode = Allow All

    b) >Network >Adapter 2 tab

        (1) Ensure the “Enable Network Adapter” box is tic’d

        (2) Attached to = Bridged Adapter

        (3) Name = <the host system wired or wireless interface>

        (4) Select the “Advanced” dropdown

            (a) Promiscuous Mode = Allow All

    c) Network >Adapter 3 tab

        (1) tic the “Enable Network Adapter” box

        (2) Attached to = NAT (not NAT Network)

        (3) Select OK

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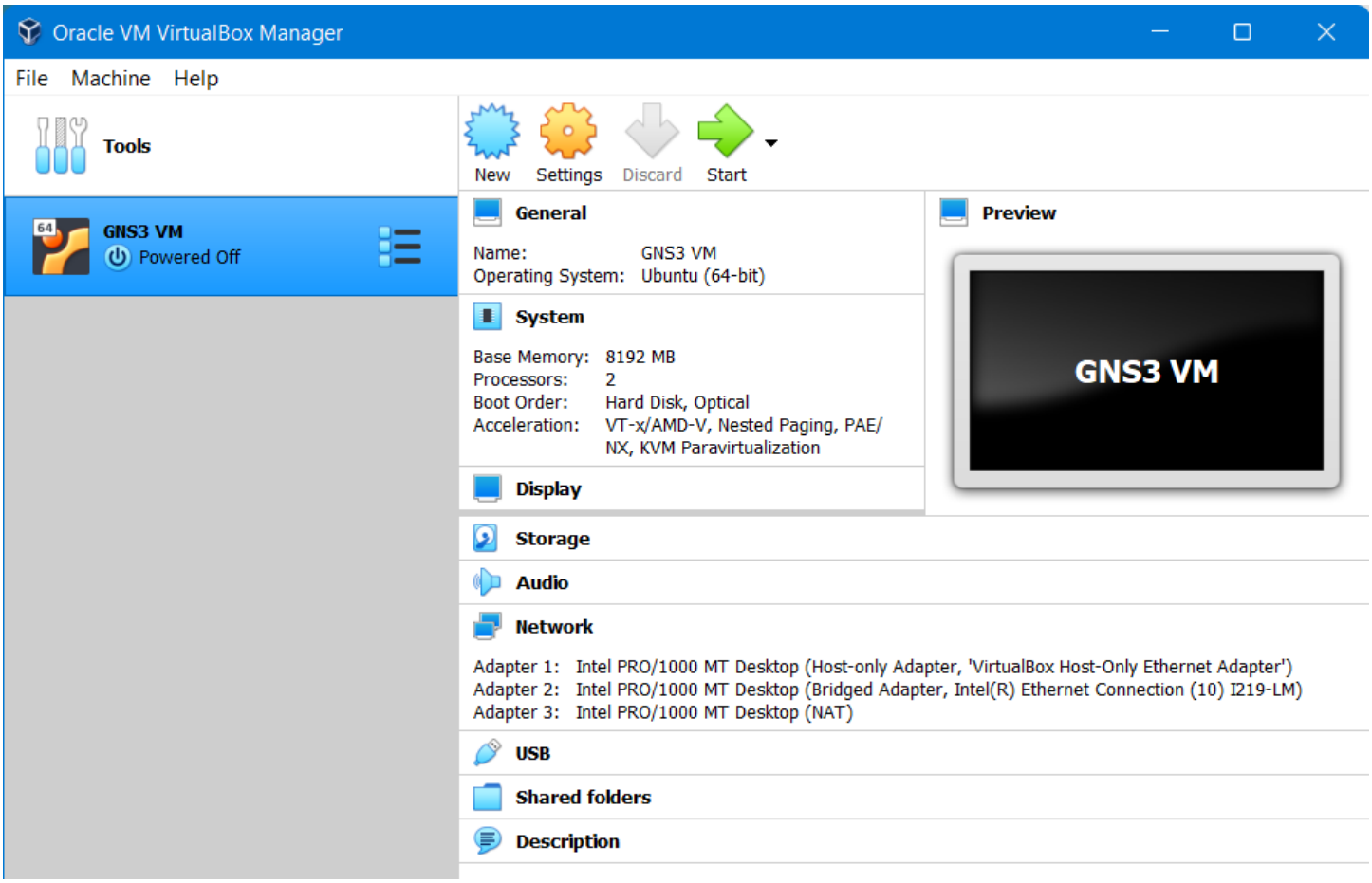

3. Start the GNS3 VM, select “OK”, type “n” to select “Configure network settings”, select “Yes” (server will reboot after viewing or configuring network settings)

a) uncomment all fields starting with "network"

b) edit the eth0 address to be 192.168.56.101

c) edit the eth0 gateway4 to be 192.168.56.1

d) create a new section for eth1, with same entries as eth0, except;
^^ make sure there is a blank line before the eth1 section

(1) eth1 address to be 10.1.199.101

(2) eth1 gateway to be 10.1.199.199

e) “ctrl+o” to save, “ctrl+x” to exit the editor

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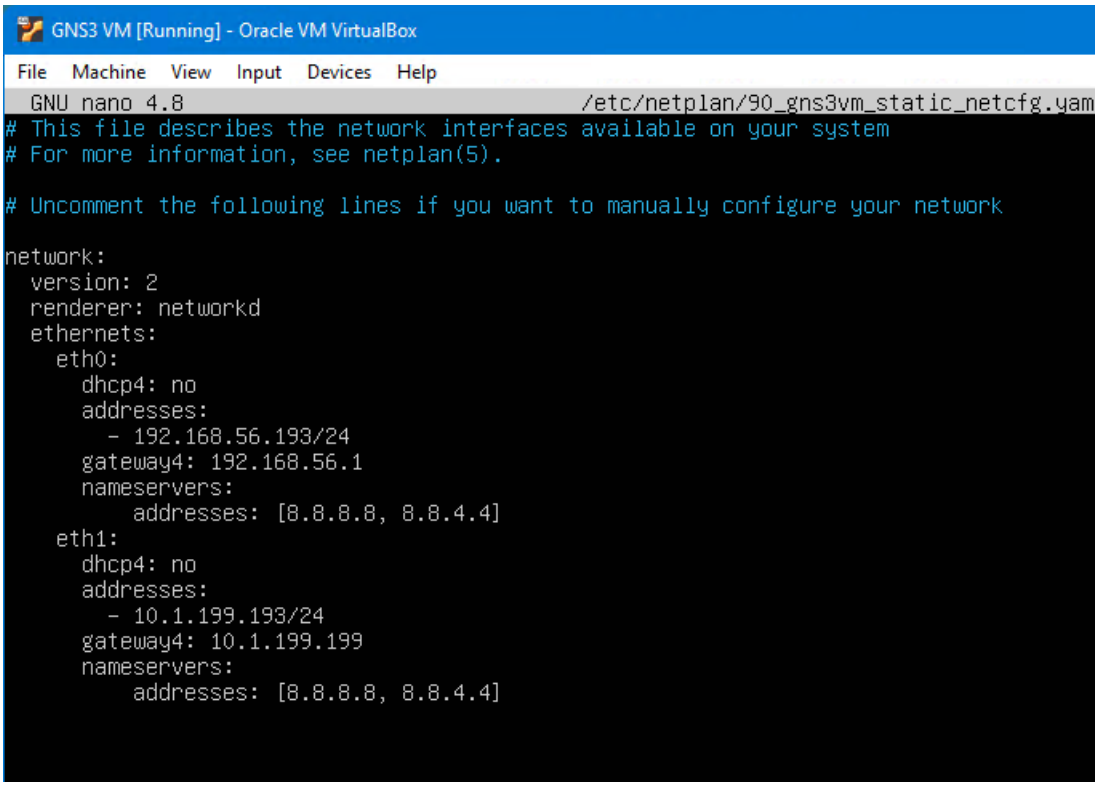

f) select "OK", type "s" 4 times to select "Shutdown the VM", press <enter> to shutdown the VM

V. Install Wireshark

1. Navigate to directory where you copied the Wireshark installer file and install Wireshark (can accept the defaults options during install, or customize for your specific requirements)

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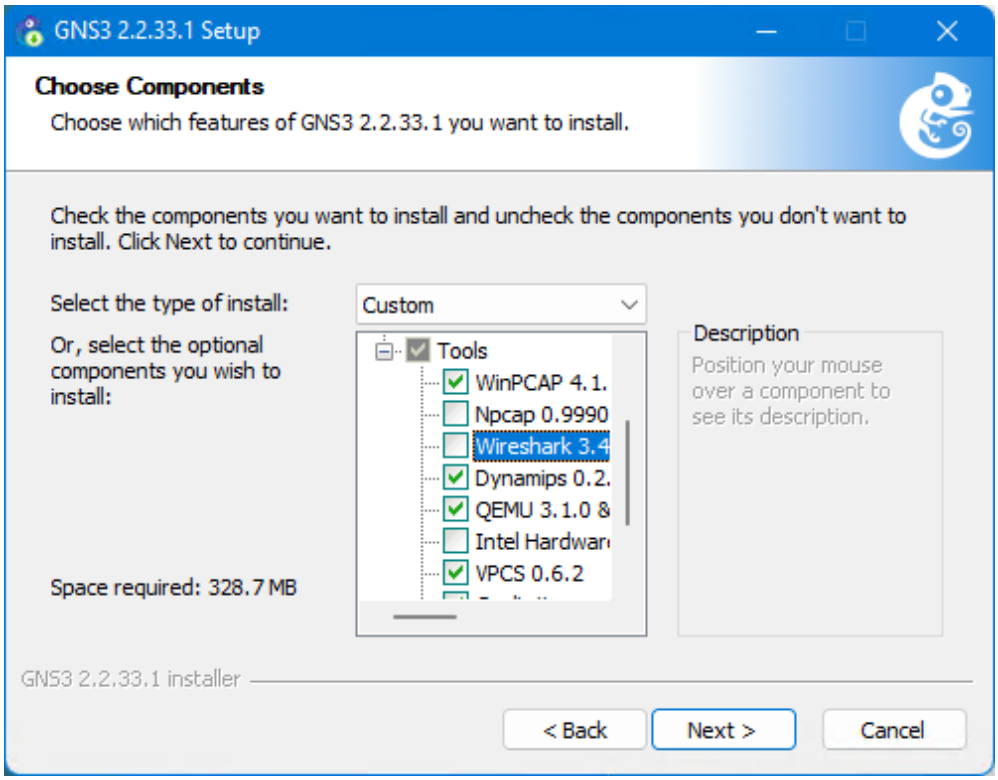
VI. Install and configure GNS3

GNS3 was chosen for the network simulation platform as it is a free application, and supports many different host OS's.

1. Navigate to directory where you copied the GNS3 installer file and install GNS3

   a) At the "Choose Components" window, expand the "Tools" section



   (1) Untic the Npcap box

   (2) Untic the Wireshark box

   Note, we want to use the newer versions installed in the previous step

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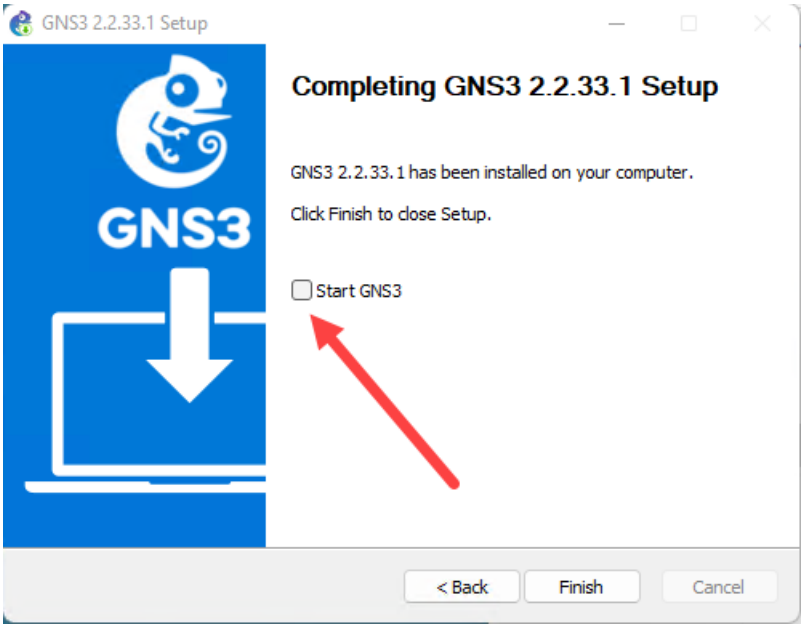
2. At the “Solarwinds Standard Toolset”, select “No”, however if your computer has Internet access, feel free to try the toolset.

3. At the “Completing GNS3 Setup” untic the “Start GNS3” box (ie, do not start GNS3 yet), select finish

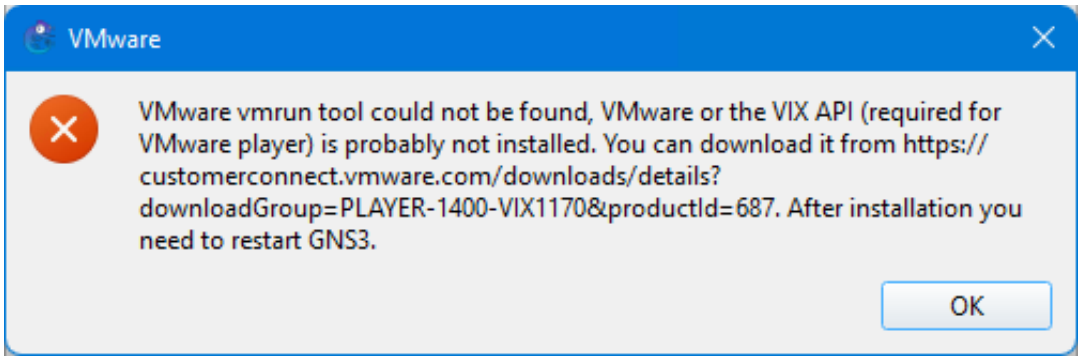


4. Start GNS3

a) at the “Setup Wizard”, select “Run appliances in a virtual machine”

b) click “Next” 3 more times

c) a VMware error box will appear, select “OK” (in this setup option, GNS3 initially attempts to contact the VMware application, as we are using VirtualBox we will select that option in the next step)



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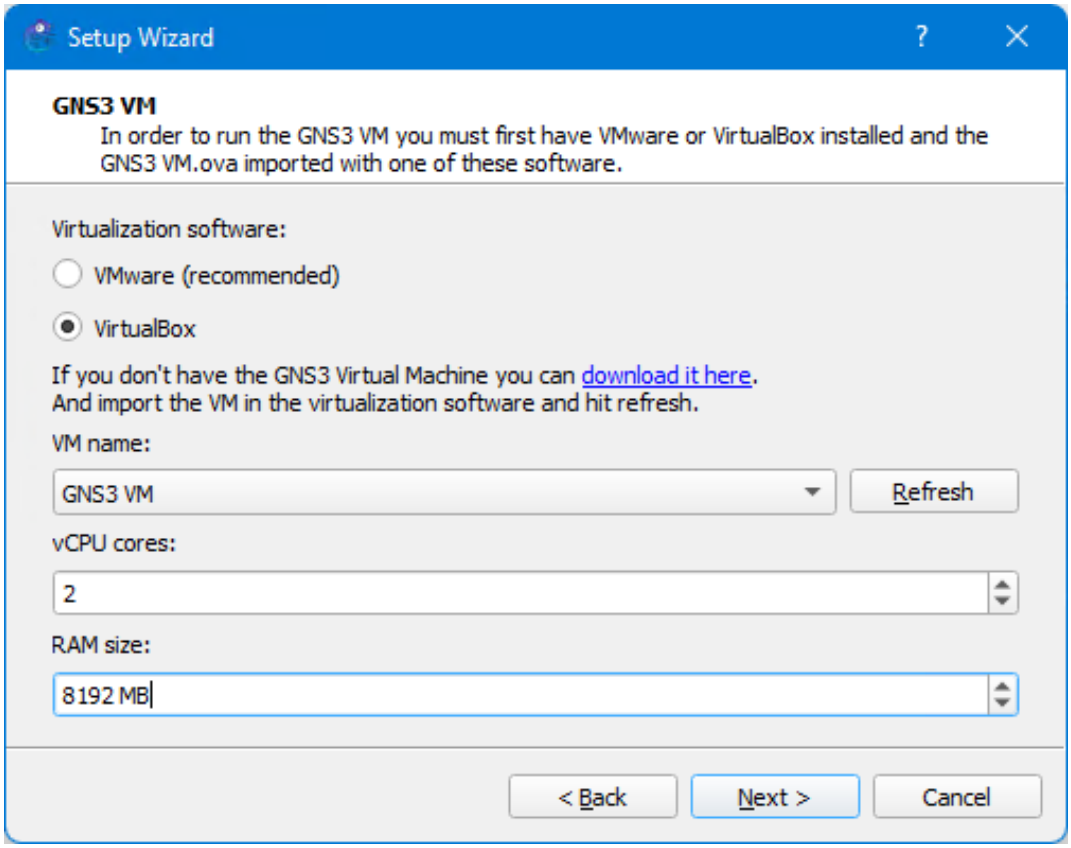
d) at GNS3 VM, select "VirtualBox, (GNS3 will then find the VirtualBox-GNS3 VM previously configured)

e) change vCPU cores to 2

f) change RAM size to match your GNS3 VM as configured in VirtualBox



g) select Next and review the Summary, then select Finish

h) you should observe VirtualBox will start and then the GNS3 VM will start, this is due to the API connections GNS3 has with VirtualBox.

i) quit GNS3
^^ GNS3 will signal the GSN3 VM to shutdown, as well as signal VirtualBox to close

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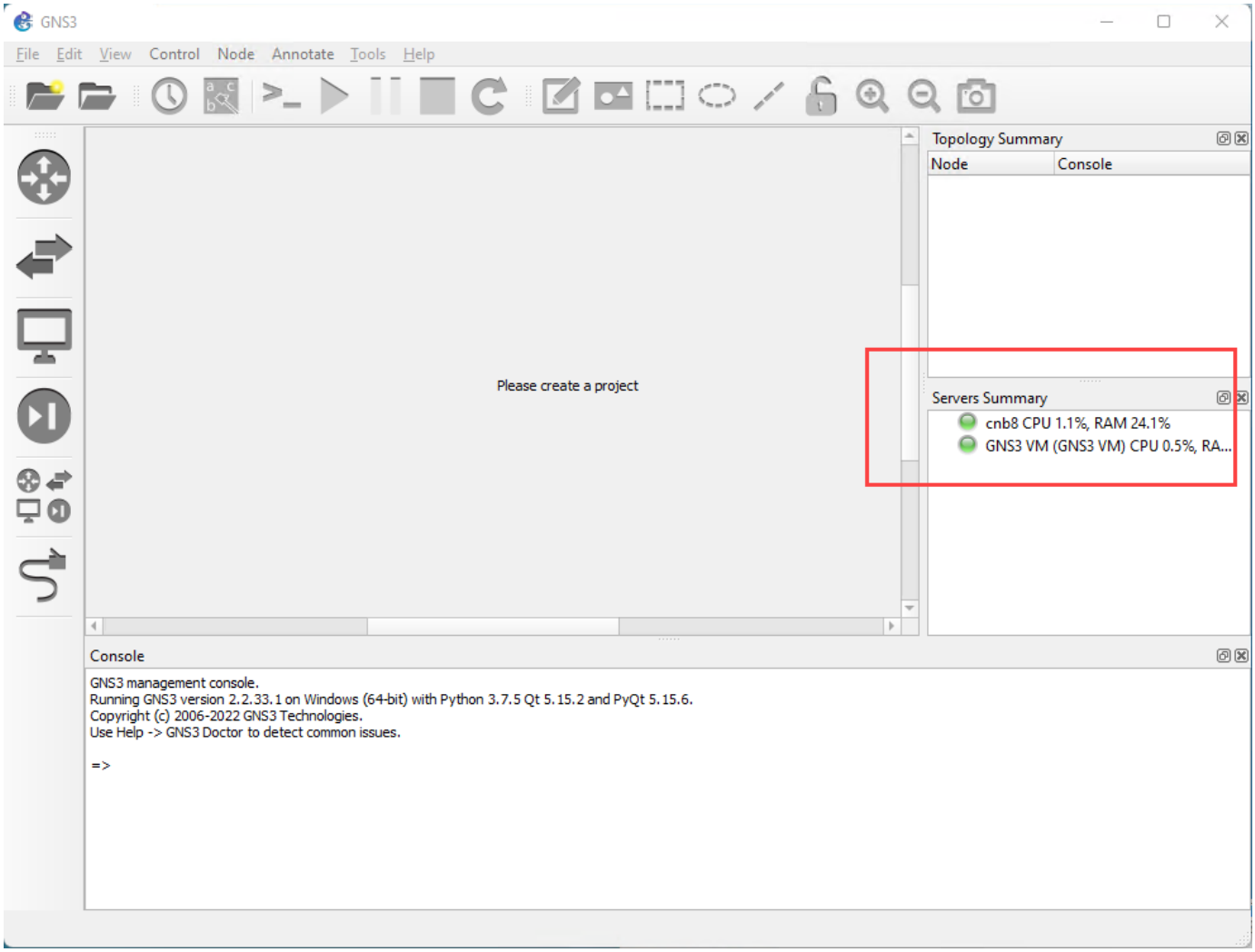
5. After installing/configuring GNS3, navigate to /<user>/GNS3/symbols folder, copy the "vyos.svg" file from the directory where you copied the lab files

6. navigate to /<user>/GNS3/images, copy the "vyos-1.1.8-amd64.iso", "vyos-1.1.8-amd64.iso.md5sum", and "empty8G.qcow2" files from the directory where you copied the lab files

7. Start GNS3

8. After a few minutes, after GNS3 loads, connects to its local server, runs VirtualBox and starts the GNS3 VM, select cancel on the Projects screen, in the Servers Summary pane (middle right side of GNS3) you should observe the local computer and GNS3 VM icons are green



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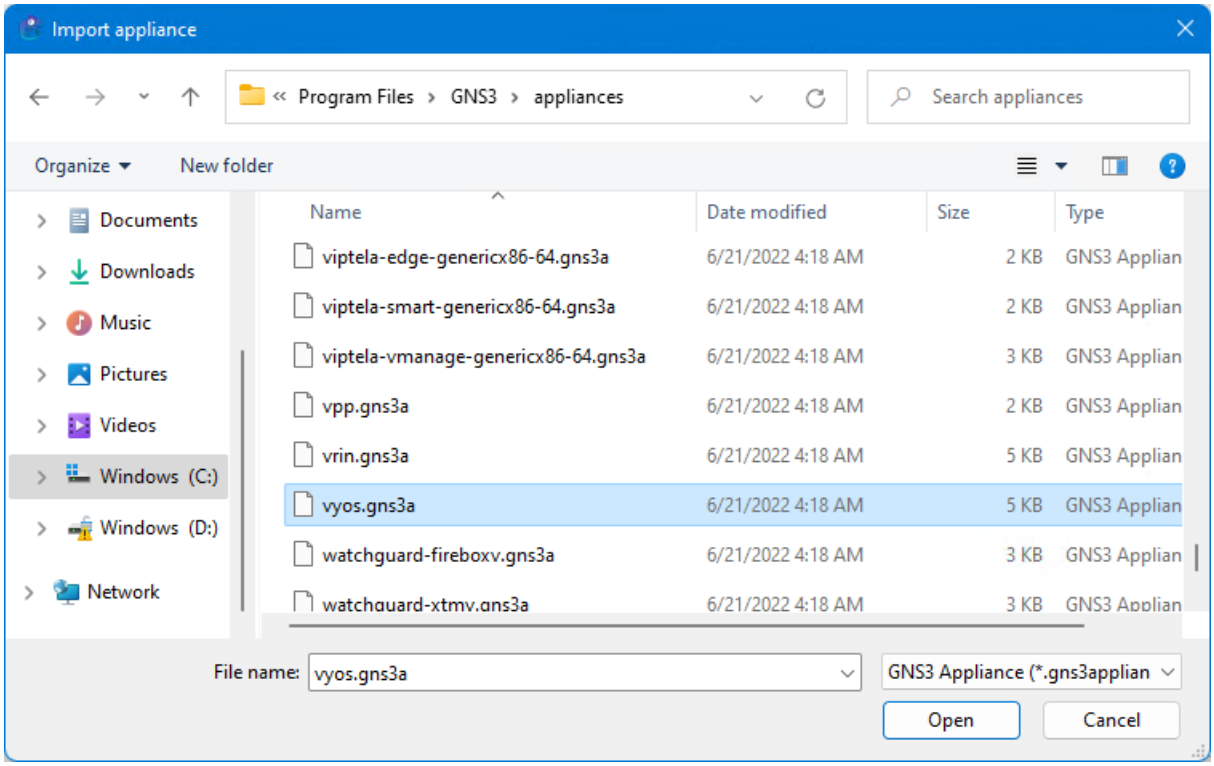
9. Import the VyOS appliance

a) >File >Import appliance

b) Navigate to C:\Program Files\GNS3\appliances, select vyos.gns3a, select Open



c) Select Next to “Install the appliance on the GNS3 VM (recommended)”

d) Select Next to use the QEMU settings

e) at VyOS version 1.1.8, select empty8G.qcow2

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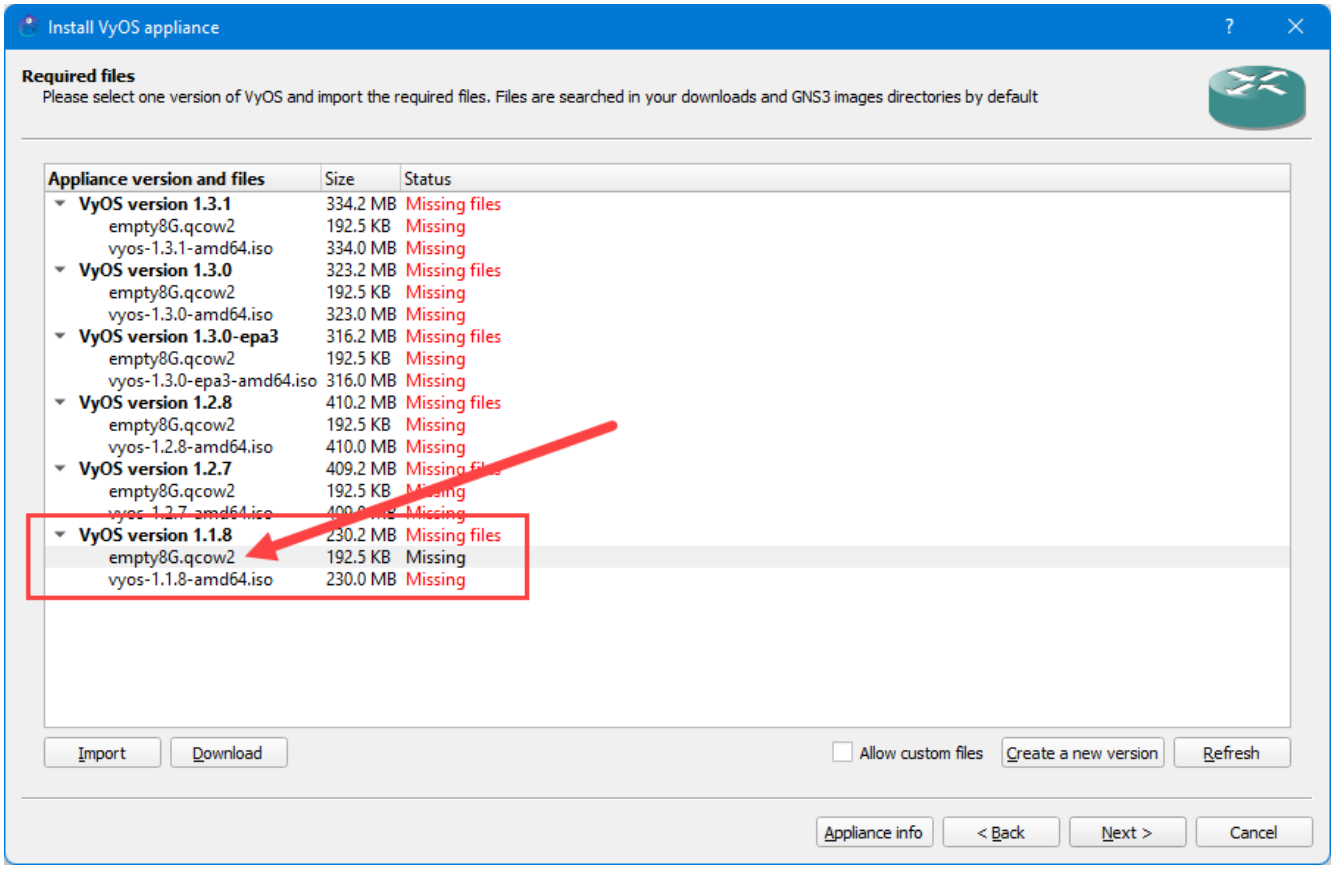
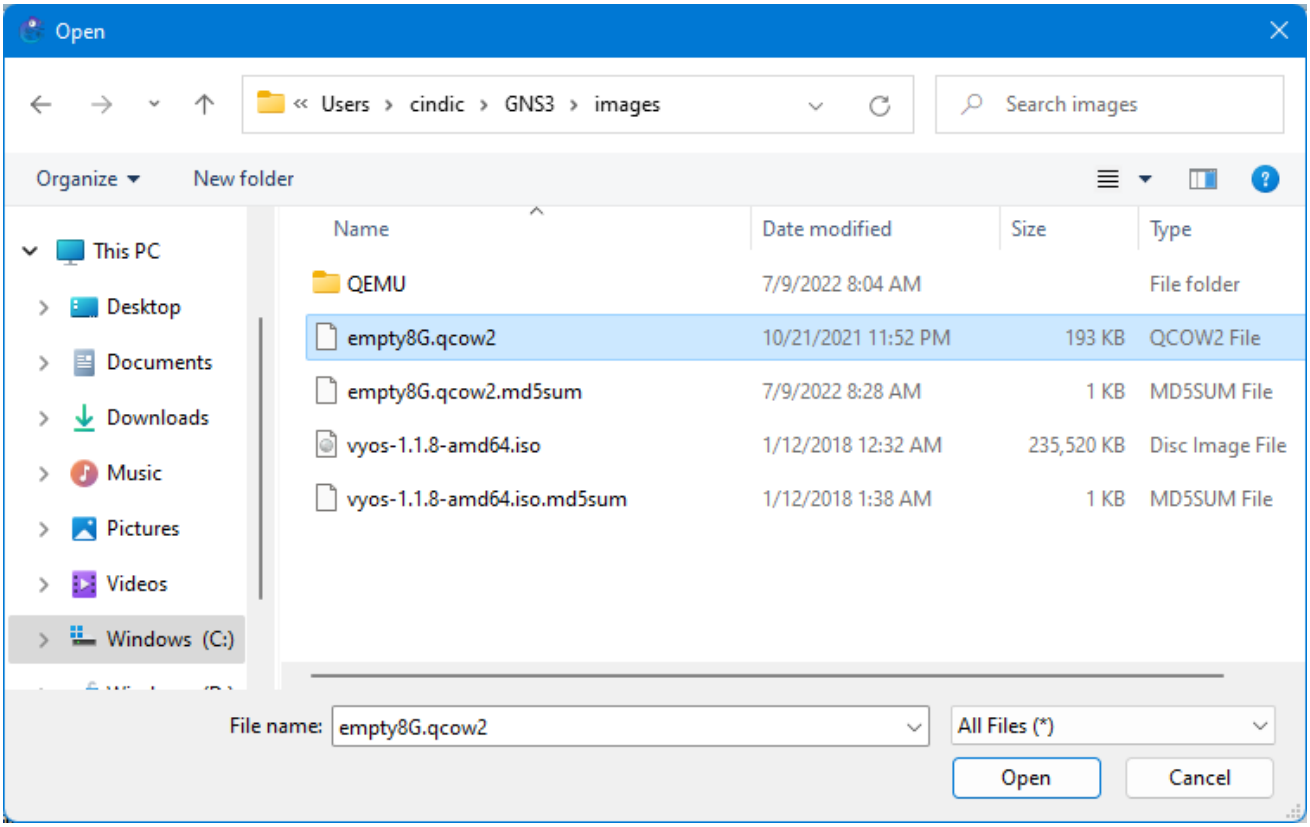


f) select Import, then navigate to /<user>/GNS3/images, select "empty8G.qcow2", select Open



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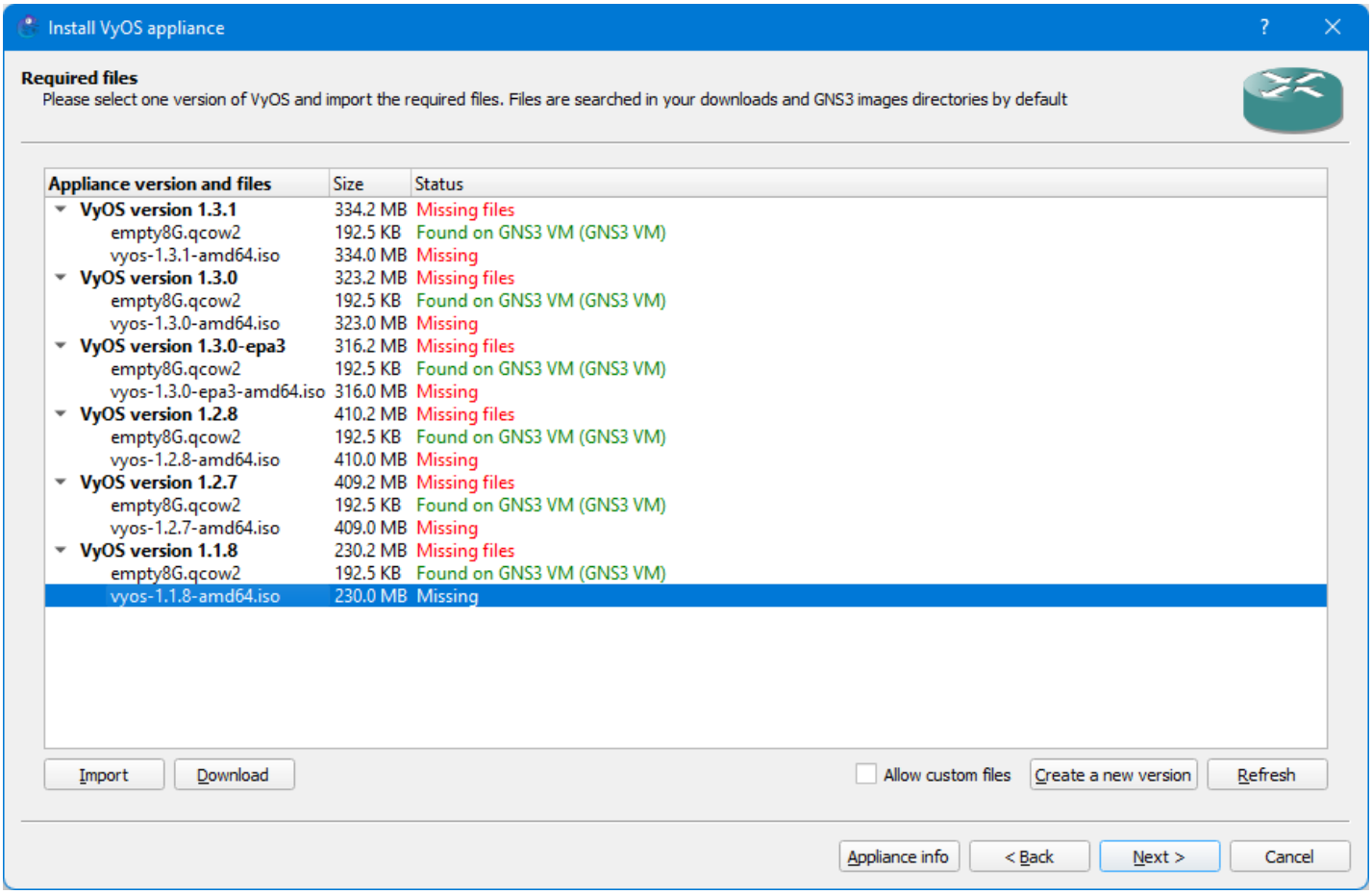
g) at VyOS version 1.1.8, select vyos-1.1.8-amd64.iso, then select Import



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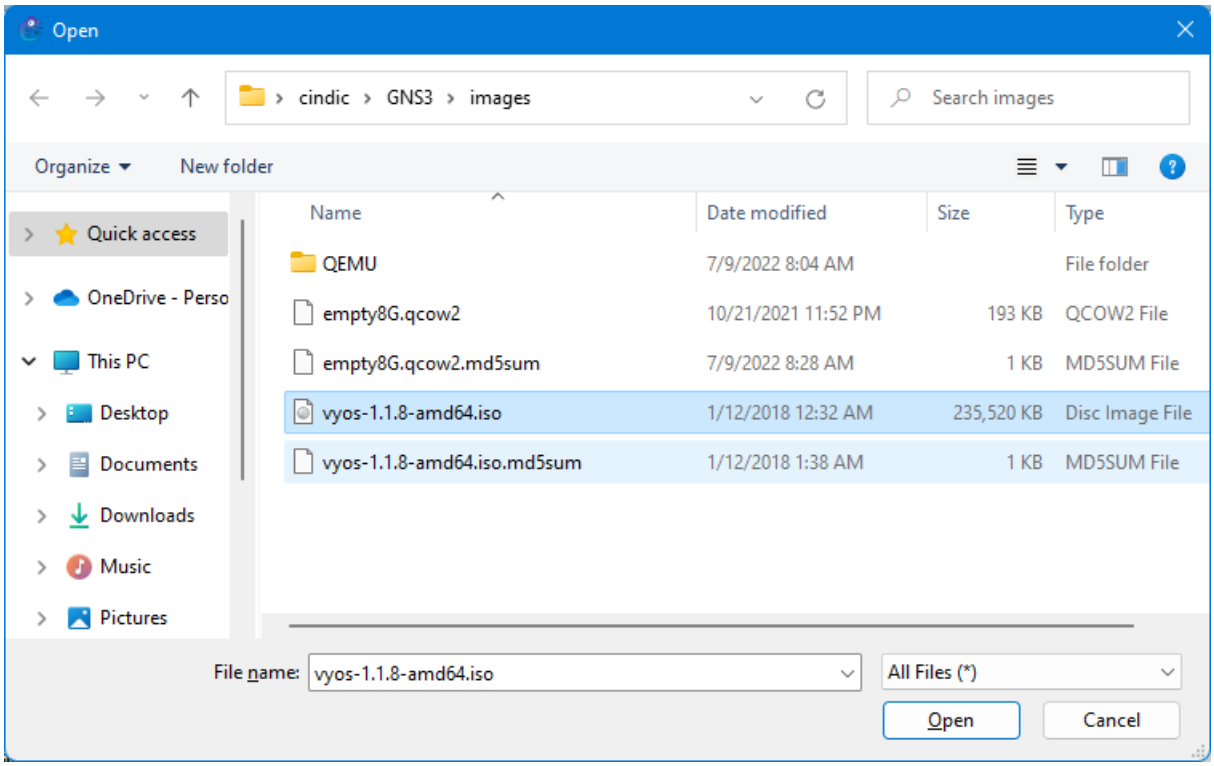
a) select Import, then navigate to /<user>/GNS3/images, select "vyos-1.1.8-amd64.iso", select Open



b) select VyOS version 1.1.8, select Next to install the VyOS appliance, select Yes to install the appliance, select finish

c) observe the appliance info box and in the foreground window the appliance was installed

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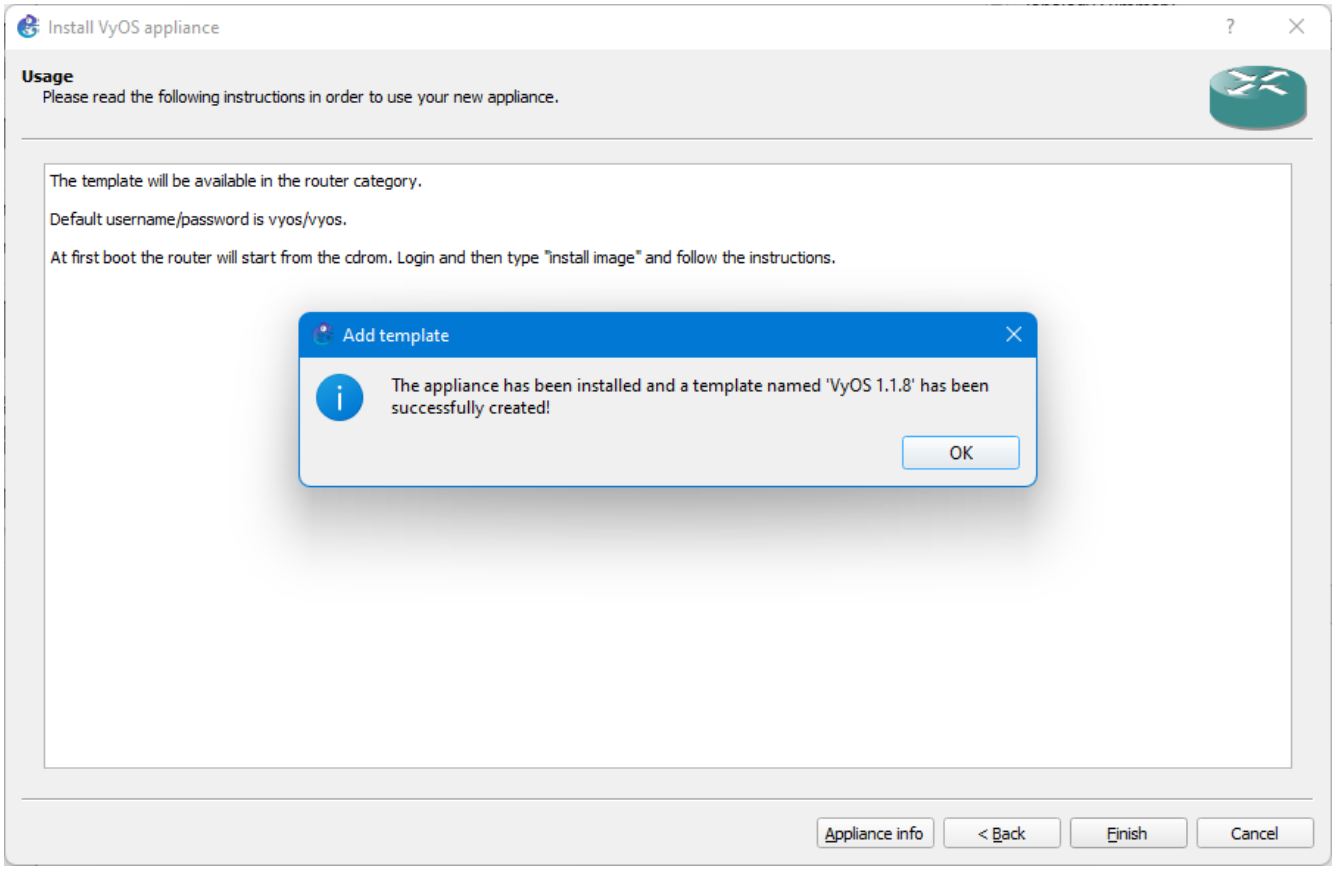

d) select OK

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VII. Create IPv6 BYOL project, add VyOS VM

VyOS is used to for many operations in this lab system. It is the router between the multiple networks you will be configuring and also SSH/Telnet/SNMP/DHCP/DHCPv6 services.

1. In GNS3,>File >New blank project

    a) Set Name to be IPv6-BYOL, select "OK"

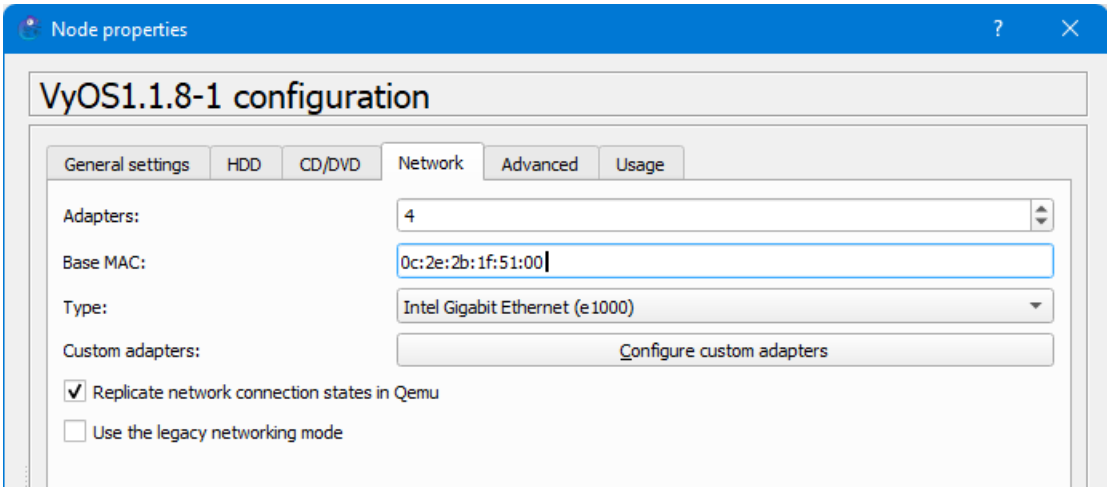
2. In the IPv6-BYOL – GNS3 window, select the "Browse Routers" icon in the left-side navigation

3. Click and drag the VyOS1.1.8-1 icon to the middle of the projects main screen, click the "Browse Routers" icon again to close the window

4. Configure the VyOS VM: right-click the VyOS icon, select Configure, select the "Network" tab

    a) set Adapters to 4

    b) set Base MAC to 0c:2e:2b:1f:01:00



    c) click "OK"

5. Start VyOS: right-click to VyOS icon, select Start, then right-click the VyOS icon and select Console (a PuTTY session will popup for the console access)

6. Log into VyOS using vyos and vyos

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7. Install the VyOS Image: type “install image” at the CLI

   a) accept most default settings

   b) at “This will destroy all data on /dev/sda”, type “yes”

   c) set name to be VyOS-1.1.8-1

   d) at “Enter password for user vyos”, enter vyos 2 times

   e) when the main prompt returns, installation has been completed, enter “poweroff now”, then VM will stop and the console window will close

8. Configure the VyOS VM, right-click the VyOS icon, select Configure, select the “CD/DVD” tab

   a) Clear the Image field (ie, remove the iso filename)

   b) click “OK”

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VIII. Configure VyOS

The overall process to configure VyOS as an IPv4/IPv6 router and DHCP/DHCPv6 server is very long, with many steps. As you maneuver through this section, go slow and check the commands you have entered closely.

1. In GNS3 UI, right-click the VyOS router icon, select the "Start" button to load the VyOS-router VM

2. In GNS3 UI, right-click the VyOS router icon, select the "Console" button to open a terminal session to the VyOS router

3. In the terminal session for the VyOS router, login: login as "vyos", password is "vyos"

4. Navigate to the configuration mode

    a) configure

5. configure host name

    a) set system host-name VyOS-1.1.8-1

6. configure SSH access

    a) set service ssh port 22

    b) set service ssh allow-root

7. configure Telnet access

    a) set service telnet port 23

    b) set service telnet allow-root

8. configure IPv6 name servers

    a) set system name-server 200:61ab:1:1681::53

9. configure SNMP

    a) set service snmp community private authorization rw

    b) set service snmp community public authorization ro

    c) set service snmp contact lab-NOC

    d) set service snmp description VyOS-1.1.8-1

    e) set service snmp location GNS3-VM

    f) set service snmp trap-target 200:61ab:1:1681::53

10. configure timezone

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a) set system time-zone America/Chicago

(1) (to select your specific time zone, type 'set system time-zone ?" to find Region, type in your region, then add '?' to find city.)

b) commit

c) save

11. Configuring IPv4 and IPv6 addresses, and RA for no-advertise on the eth0 interface

a) set interfaces ethernet eth0 address 10.1.199.201/24

b) set interfaces ethernet eth0 address 200:61ab:199:1011::201/64

c) set interfaces ethernet eth0 ipv6 router-advert max-interval 180

d) set interfaces ethernet eth0 ipv6 router-advert min-interval 60

e) set interfaces ethernet eth0 ipv6 router-advert managed-flag false

f) set interfaces ethernet eth0 ipv6 router-advert other-config-flag false

g) set interfaces ethernet eth0 ipv6 router-advert default-lifetime 1800

h) set interfaces ethernet eth0 ipv6 router-advert send-advert false

i) set interfaces ethernet eth0 ipv6 router-advert prefix 200:61ab:199:1011::/64

j) set interfaces ethernet eth0 ipv6 router-advert prefix 200:61ab:199:1011::/64 autonomous-flag true

k) set interfaces ethernet eth0 ipv6 router-advert prefix 200:61ab:199:1011::/64 on-link-flag true

l) set interfaces ethernet eth0 ipv6 router-advert prefix 200:61ab:199:1011::/64 preferred-lifetime 120

m) set interfaces ethernet eth0 ipv6 router-advert prefix 200:61ab:199:1011::/64 valid-lifetime 140

n) commit

o) save

12. Configuring IPv6 address and RA for SLAAC advertise on the eth1 interface

a) set interfaces ethernet eth1 address 200:61ab:1:201::1/64

b) set interfaces ethernet eth1 ipv6 router-advert max-interval 180

c) set interfaces ethernet eth1 ipv6 router-advert min-interval 60

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d) set interfaces ethernet eth1 ipv6 router-advert managed-flag false

e) set interfaces ethernet eth1 ipv6 router-advert other-config-flag false

f) set interfaces ethernet eth1 ipv6 router-advert default-lifetime 1800

g) set interfaces ethernet eth1 ipv6 router-advert send-advert true

h) set interfaces ethernet eth1 ipv6 router-advert prefix 200:61ab:1:201::/64

i) set interfaces ethernet eth1 ipv6 router-advert prefix 200:61ab:1:201::/64 autonomous-flag true

j) set interfaces ethernet eth1 ipv6 router-advert prefix 200:61ab:1:201::/64 on-link-flag true

k) set interfaces ethernet eth1 ipv6 router-advert prefix 200:61ab:1:201::/64 preferred-lifetime 120

l) set interfaces ethernet eth1 ipv6 router-advert prefix 200:61ab:1:201::/64 valid-lifetime 140

m) commit

n) save

13. Configuring IPv6 address and RA for Stateful DHCPv6 advertise on the eth2 interface

a) set interfaces ethernet eth2 address 200:61ab:1:1010::1/64

b) set interfaces ethernet eth2 ipv6 router-advert max-interval 180

c) set interfaces ethernet eth2 ipv6 router-advert min-interval 60

d) set interfaces ethernet eth2 ipv6 router-advert managed-flag true

e) set interfaces ethernet eth2 ipv6 router-advert other-config-flag false

f) set interfaces ethernet eth2 ipv6 router-advert default-lifetime 1800

g) set interfaces ethernet eth2 ipv6 router-advert send-advert true

h) set interfaces ethernet eth2 ipv6 router-advert prefix 200:61ab:1:1010::/64

i) set interfaces ethernet eth2 ipv6 router-advert prefix 200:61ab:1:1010::/64 autonomous-flag false

j) set interfaces ethernet eth2 ipv6 router-advert prefix 200:61ab:1:1010::/64 on-link-flag true

k) set interfaces ethernet eth2 ipv6 router-advert prefix 200:61ab:1:1010::/64 preferred-lifetime 120

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l) set interfaces ethernet eth2 ipv6 router-advert prefix 200:61ab:1:1010::/64 valid-lifetime 140

m) commit

n) save

14. Configuring DHCPv6 Service for the eth2 interface

a) set service dhcpv6-server shared-network-name eth2 subnet 200:61ab:1:1010::/64 address-range start 200:61ab:1:1010::101 stop 200:61ab:1:1010::119

b) set service dhcpv6-server shared-network-name eth2 subnet 200:61ab:1:1010::/64 lease-time default 300

c) set service dhcpv6-server shared-network-name eth2 subnet 200:61ab:1:1010::/64 lease-time maximum 300

d) set service dhcpv6-server shared-network-name eth2 subnet 200:61ab:1:1010::/64 lease-time minimum 225

e) set service dhcpv6-server shared-network-name eth2 subnet 200:61ab:1:1010::/64 name-server 200:61ab:1:1681::53

f) commit

g) save

15. Configuring IPv6 default route for workshop core

a) set protocols static route6 0::/0 next-hop fe80::20c:29ff:fe17:957b interface eth0

b) commit

c) save

d) exit

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IX. Configuring the IPv6-BYOL project, add the host and Switches

1. In the IPv6-BYOL – GNS3 window, select the “Browse End Devices” icon in the left-side navigation

2. Click and drag the Cloud icon to the middle of the projects main screen, above the VyOS icon

    a) choose “GNS3 VM” as the Server, select OK

    b) click the “Browse End Devices” icon again to close the window

3. Configure the Cloud resource: right-click the Cloud icon, select Change hostname

    a) set Hostname to be name of host computer

4. Configure the Cloud resource: right-click the Cloud icon, select Change symbol

    a) expand “Affinity-square-blue

    b) select the “client” icon

    c) select “OK”

5. Align icons as needed

6. Connect the VyOS router to the host

    a) click the “Add a link” icon in the left-side navigation

    b) select the host icon, select eth1

    c) select the VyOS icon, select eth0

    d) click the “Add a link” icon again to exit adding links

7. On the GNS3 toolbar, select the “Show/Hide interface labels” icon (this will show the interfaces that have connections in the project)

8. Adjust labels/icons as needed for viewing clarity

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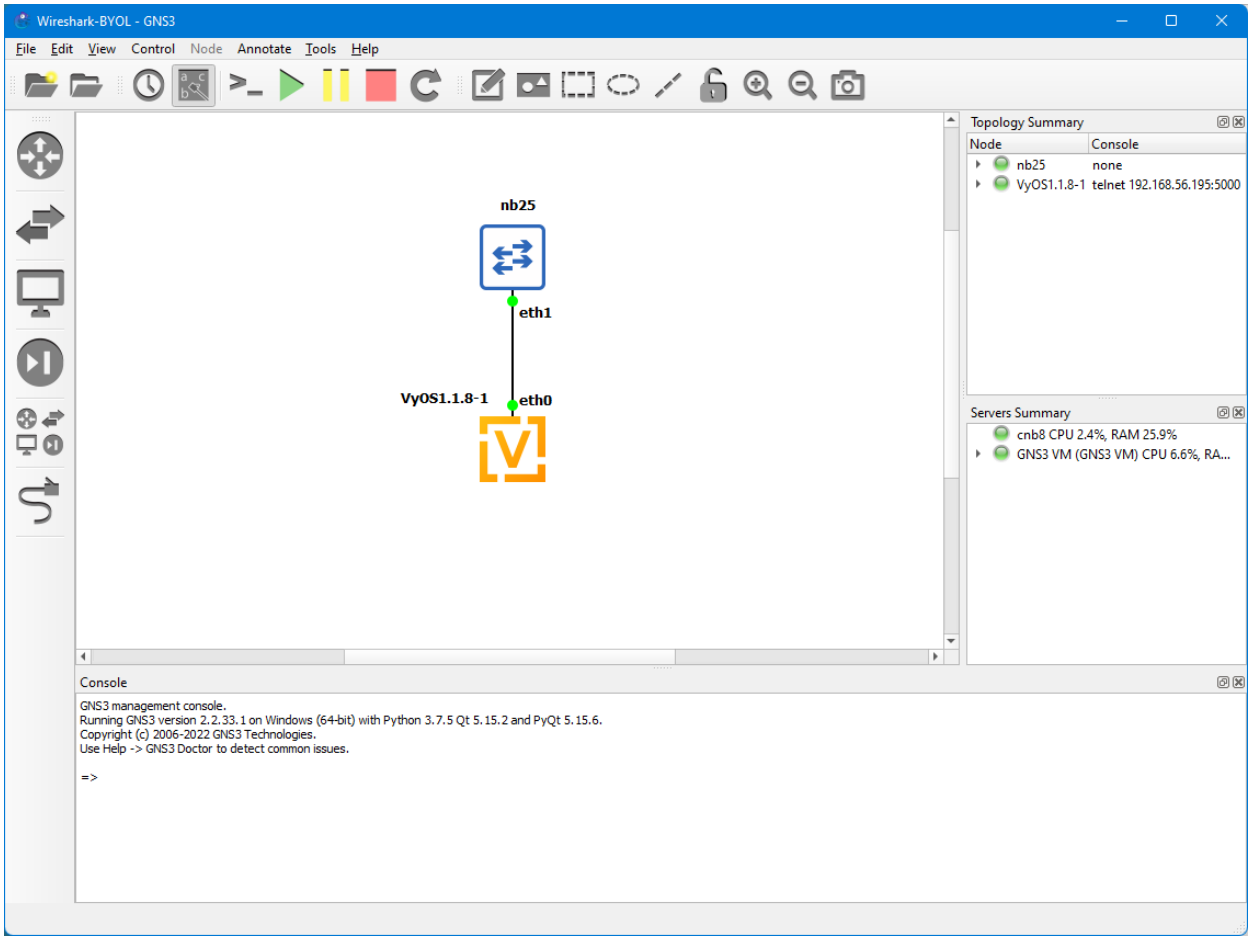

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9. In the VyOS console window, ping the host (if the host has an address in the 10.1.199.0/24 network)

10. In the IPv6-BYOL – GNS3 window, select the "Browse Switches" icon in the left-side navigation

11. Click and drag the Ethernet switch icon to the left of the VyOS icon

    a) choose "GNS3 VM" as the Server, select OK

12. Click and drag the Ethernet switch icon to the right of the VyOS icon

    a) choose "GNS3 VM" as the Server, select OK

13. Configure each of the Switch resources: right-click each of the Switch icons, select Change symbol

    a) expand "Affinity-square-blue

    b) select the "switch" icon

    c) select "OK"

14. Align icons as needed

15. Connect the VyOS router to each switch

    a) click the "Add a link" icon in the left-side navigation

    b) select the Switch1 icon, select eth0

    c) select the VyOS icon, select eth1

    d) select the Switch2 icon, select eth0

    e) select the VyOS icon, select eth2

    f) click the "Add a link" icon again to exit adding links

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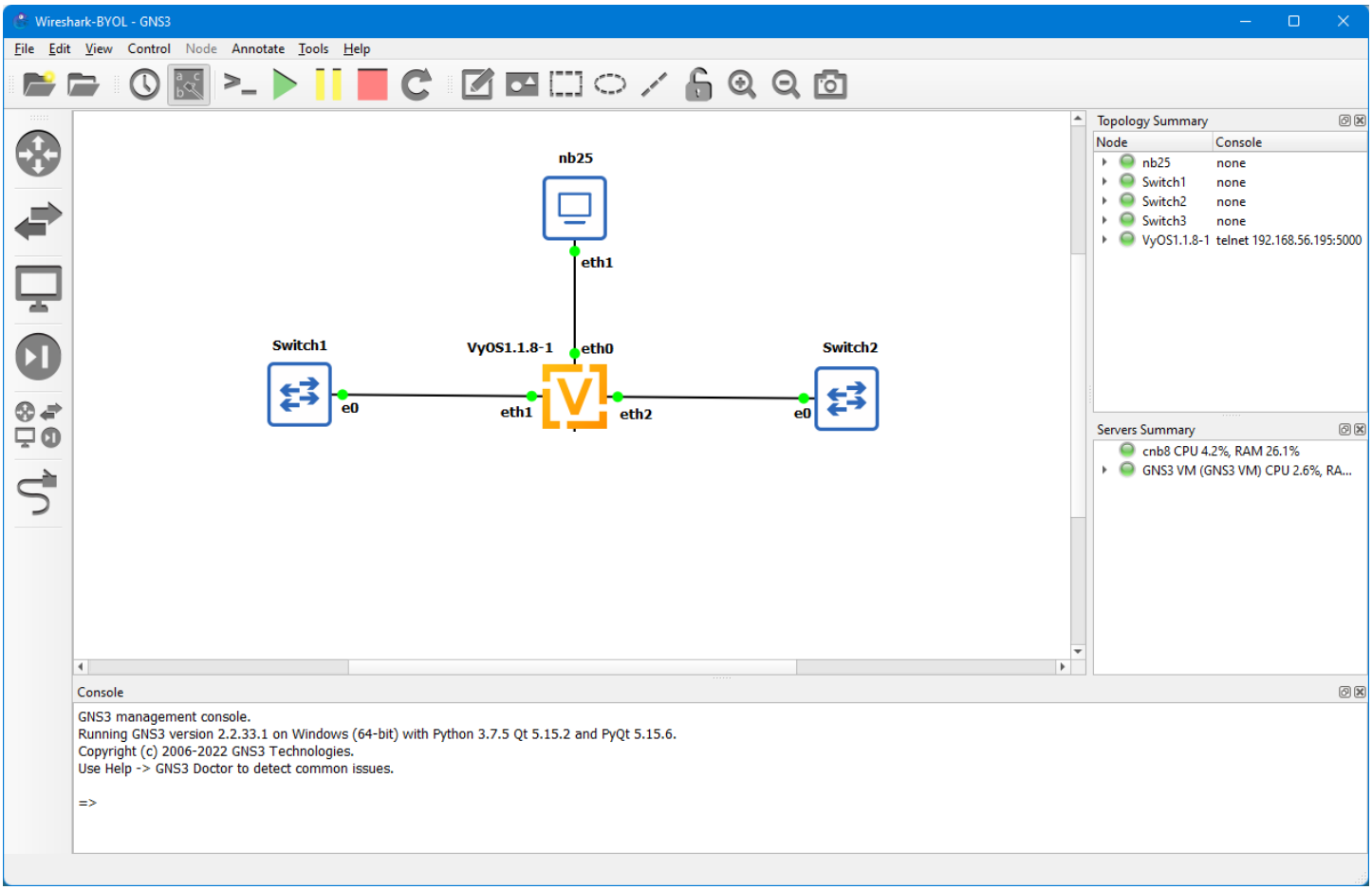
16. Adjust labels/icons as needed for viewing clarity)



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X. Create Rocky Linux VM's

Any Linux distro you would rather use is ok, basic directions to get such into the lab may be similar.

1. Start VirtualBox, then select "New" to create the new virtual machine

2. Set the "Name" field to "Rocky-8.5-1", the "Type" field to "Linux", and the "Version" field to "Other Linux (64 bit)"

3. Configure the "Memory size" setting of 2048MB

4. Verify the "Hard drive" setting is selected for "Create a virtual hard drive now", select Create

5. Configure the "File size" "16.00 GB"

6. Verify the "Hard drive file type" setting is selected for "Create a virtual disk now"

7. Verify the "Storage on physical hard drive" setting is selected for "Dynamically allocated", select Create

8. You should now see the newly created Rocky-8.5-1 VM in the "Oracle VM VirtualBox Manager" window

9. There are a few changes to be made before running/installing VyOS, select the "Settings" icon for the Rocky VM

    a) Select "Network" on the left side panel. In the Adapter 1 tab, change the "Attached to:" box to "Not attached"

    b) Select "Storage" on the left side panel, in the "Storage Devices" area, click the icon that looks like a CD and is labeled "Empty", then in the "Attributes" area, click the icon that looks like a CD/DVD, select "Choose a virtual CD/DVD disk file", navigate to where the Rocky Linux ISO is located and select Open

    c) Select "Display" on the left side panel. In the change the "Scale Factor:" box dependent on host video resolution, then select "OK"

        (1) FHD 1920 x 1080, leave display set to 100%

        (2) QHD 2560 x 1440, set display to 200%,

        (3) UHD 3840 x 2160, set display to 300%

10. In the "Oracle VM VirtualBox Manager" window, verify the Rocky Linux settings

11. Select the "Start" button to load the Rocky-8.5-1 VM

12. When the Rocky Linux 8 screen is presented, select "Install Rocky Linux 8", Follow the install prompt to configure and install Rocky Linus

    a) Select your language as appropriate

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b) Configure the Root Password" to be "password" (will require 2 Done to confirm)

c) Configure "Time & Date" as appropriate for your timezone

d) Choose "Installation Destination" and then select "Done"

e) Can create a new user if you want, not required

f) Select "Begin Installation" to complete the Rocky Linux installation process, may take 7-10 minutes to complete

g) When the installation has completed, select "Reboot System" in the lower-right of the screen

h) At the "INITIAL SETUP" screen, select "LICENSING", tic the "I accept the license agreement" box, select "Done", then select "FINISH CONFIGURATION"

i) At the "Welcome!" screen, select "Next"

j) Configure "Location Services" to "OFF", select Next

k) At the "Online Accounts" screen, select "Skip"

l) At the "About You" screen, configure as appropriate, then select "Start Using Rocky Linux"

13. After the installation process has completed, power down the Rocky-8.5-1 VM

14. Clone the Rocky-8.5-1 VM

a) In the "Oracle VM VirtualBox Manager" window, right-click the Rocky-8.5-1 VM and select "Clone"

b) Set Name: to Rocky-8.5-2, select "Next"

c) Verify the "Full clone" button is selected, select "Clone"

d) Observe the new Rocky-8.5-2 VM has been created

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XI. Configuring the IPv6-BYOL project, add the Rocky VMs

1. Add the Rocky VMs to the project: in the IPv6-BYOL – GNS3 window, select >Edit >Preferences >VirtualBox VMs

    a) Select New, in "Server" window select "Next", in VirtualBox Virtual Machine VM list select Rocky-8.5-1 then select "Finish"

    b) Select New, in "Server" window select "Next", in VirtualBox Virtual Machine VM list select Rocky-8.5-2 then select "Finish", then select "OK"

2. In the IPv6-BYOL – GNS3 window, select the "Browse End Devices" icon in the left-side navigation

3. Click and drag the Rocky-8.5-1 icon to the mid-upper-left of the projects main screen, above the left corner of the Switch1 icon

4. Click and drag the Rocky-8.5-2 icon to the mid-upper-right of the projects main screen, above the right corner of the Switch2 icon

    a) click the "Browse End Devices" icon again to close the window

5. Align icons as needed

6. Connect the Rocky VMs to the switch

    a) click the "Add a link" icon in the left-side navigation

    b) select the Rocky-8.5-1-1 icon, select eth0

    c) select the Switch1 icon, select eth1

    d) select the Rocky-8.5-2-1 icon, select eth0

    e) select the Switch2 icon, select eth1

    f) click the "Add a link" icon again to exit adding links

7. Adjust labels/icons as needed for viewing clarity

8. Add text above the VyOS1.1.8-1 and Switch1 link: in the IPv6-BYOL – GNS3 window, select the "Add a note" icon in the top toolbar, type "SLAAC" for the note

9. Add text above the VyOS1.1.8-1 and Switch2 link: in the IPv6-BYOL – GNS3 window, select the "Add a note" icon in the top toolbar, type "DHCPv6" for the note

10. Adjust labels/icons as needed for viewing clarity

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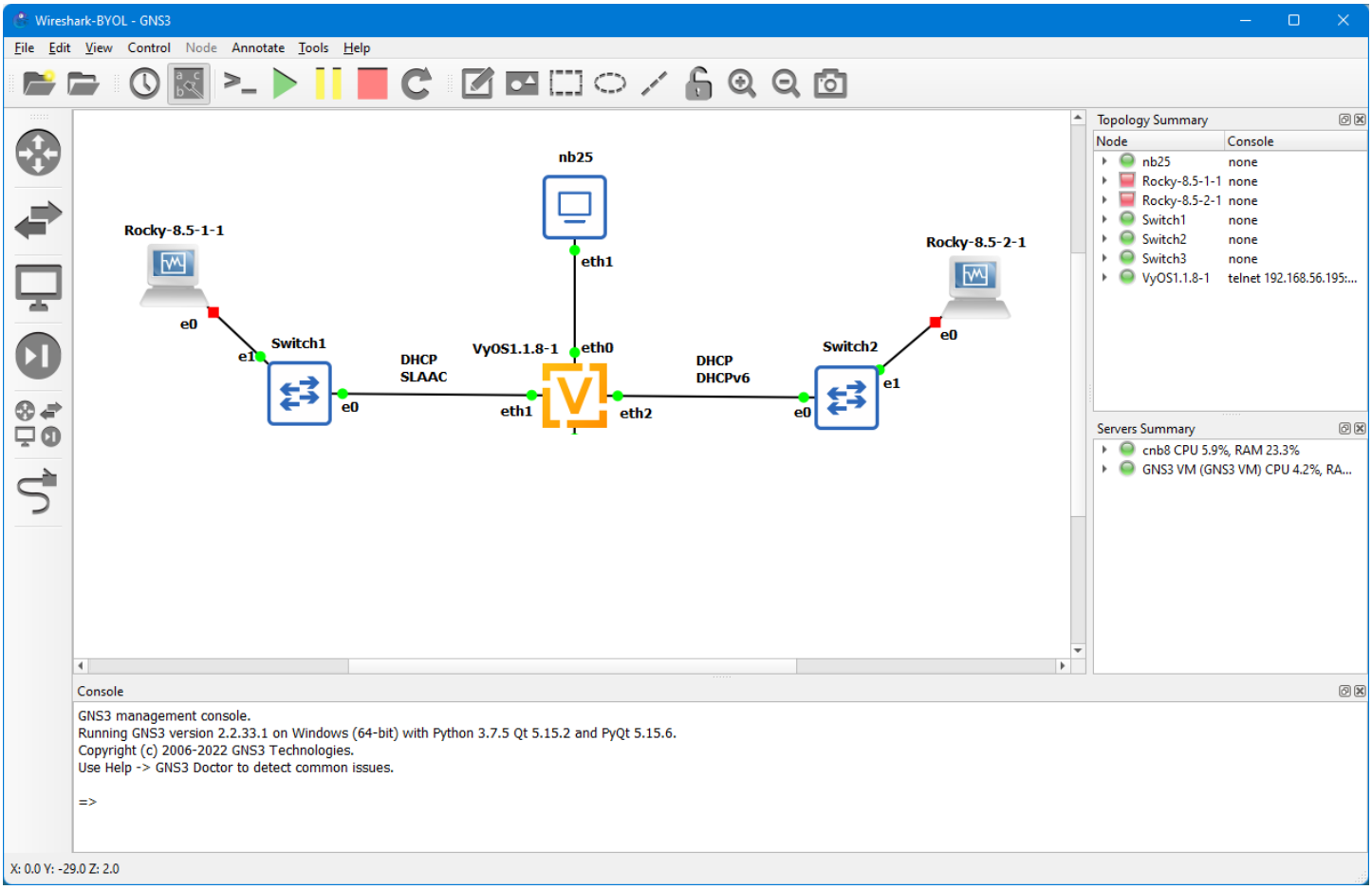

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XII. Create Windows 10 VM's

If you only have 8GB RAM in your host computer, you may not want to attempt Windows VMs, as there may not be enough resources in the host.

1. In VirtualBox, select "New" to create the new virtual machine

2. Set the "Name" field to "Win10-Ent-1" and the "Version" field to "Windows 10 (64 bit)"

3. Verify the "Memory size" setting of 2048MB

4. Verify the "Hard drive" setting is selected for "Create a virtual hard drive now", select Create

5. Configure the "File size" "20.00 GB"

6. Verify the "Hard drive file type" setting is selected for "VDI (VirtualBox Disk Image)"

7. Verify the "Storage on physical hard drive" setting is selected for "Dynamically allocated", select Create

8. You should now see the newly created Win10-Ent-1 VM in the "Oracle VM VirtualBox Manager" window

9. There are a few changes to be made before running/installing VyOS, select the "Settings" icon for the Windows VM

    a) Select "Network" on the left side panel. In the Adapter 1 tab, change the "Attached to:" box to "Not attached"

    b) Select "Storage" on the left side panel, in the "Storage Devices" area, click the icon that looks like a CD and is labeled "Empty", then in the "Attributes" area, click the icon that looks like a CD/DVD, select "Choose a virtual CD/DVD disk file", navigate to where the Windows 10 ISO is located and select Open

    c) Select "Display" on the left side panel. In the change the "Scale Factor:" box dependent on host video resolution, then select "OK"

        (1) FHD 1920 x 1080, leave display set to 100%

        (2) QHD 2560 x 1440, set display to 200%,

        (3) UHD 3840 x 2160, set display to 300%

10. In the "Oracle VM VirtualBox Manager" window, verify the Windows settings

11. Select the "Start" button to load the Win10-Ent-1 VM

12. When the Windows screen is presented, select "Next", then select "Install now". Follow the install prompts to configure and install Windows 10

    a) Tic the box for "I accept the license terms, select "Next"

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b) At “Which type of installation do you want?”, select the “Custom: Install Windows only (advanced)” section

c) At “Where do you want to install Windows”, select “Next”

d) Continue to follow prompts for installation configuration

e) At “Let’s connect you to a network”, select “I don’t have internet” in the lower-left corner

f) At “There’s more to discover when you connect to the internet”, select “Continue with limited setup” in the lower-left corner

g) Follow prompts to create user, password, and security questions

h) At “Choose privacy settings for you device”, select “No” for all options, select “Accept”

i) At “Let Cortana help you get things done”, select “Not now”

13. Once Windows has rebooted and completes the installation process, a few more changes are required

a) Select the >Start >Settings >System >About >Rename this PC, set “Current PC name” to “Win10-Ent-1, select “Next”, then select “Restart now”, then log into the Win10-Ent-1 VM

b) Select >Start, then start typing “advanced” and select “Windows Defender Firewall with Advanced Security”

c) Select “Inbound Rules” in the left window

d) Scroll down to the rules starting with “File and Printer Sharing (Echo Request – ICMPv4-In)” (there are 2 rules for IPv4 and 2 rules for IPv6)

e) Select all 4 rules and select “Enable Rule” in the right-side panel

f) Right-click on each rule that has “Private” in the “Profile” column and select “Properties” (there is 1 rule each for IPv4 and IPv6)

(1) Select the “Scope” tab, then select the “Any IP address” button in the “Remote IP address” section, then select “OK”. Close this window and the admin tools window.

g) Close the “Windows Defender Firewall with Advanced Security” window

14. Right-click the Windows Start button, select “Shut down or sign out”, select “Shut down”

15. Select the “Settings” icon for the Windows VM

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a) Select "Storage" on the left side panel, in the "Storage Devices" area, click the icon that looks like a CD and is labeled "19044.1288.211006-0501...", then in the "Attributes" area, click the icon that looks like a CD/DVD, select "Remove Disck from Virtual Drive"", select OK

16. Clone the Win10-Ent 1 VM

a) In the "Oracle VM VirtualBox Manager" window, right-click the Win10-Ent-1 VM and select “Clone”

b) Set Name: to Win10-Ent-2, select “Next”

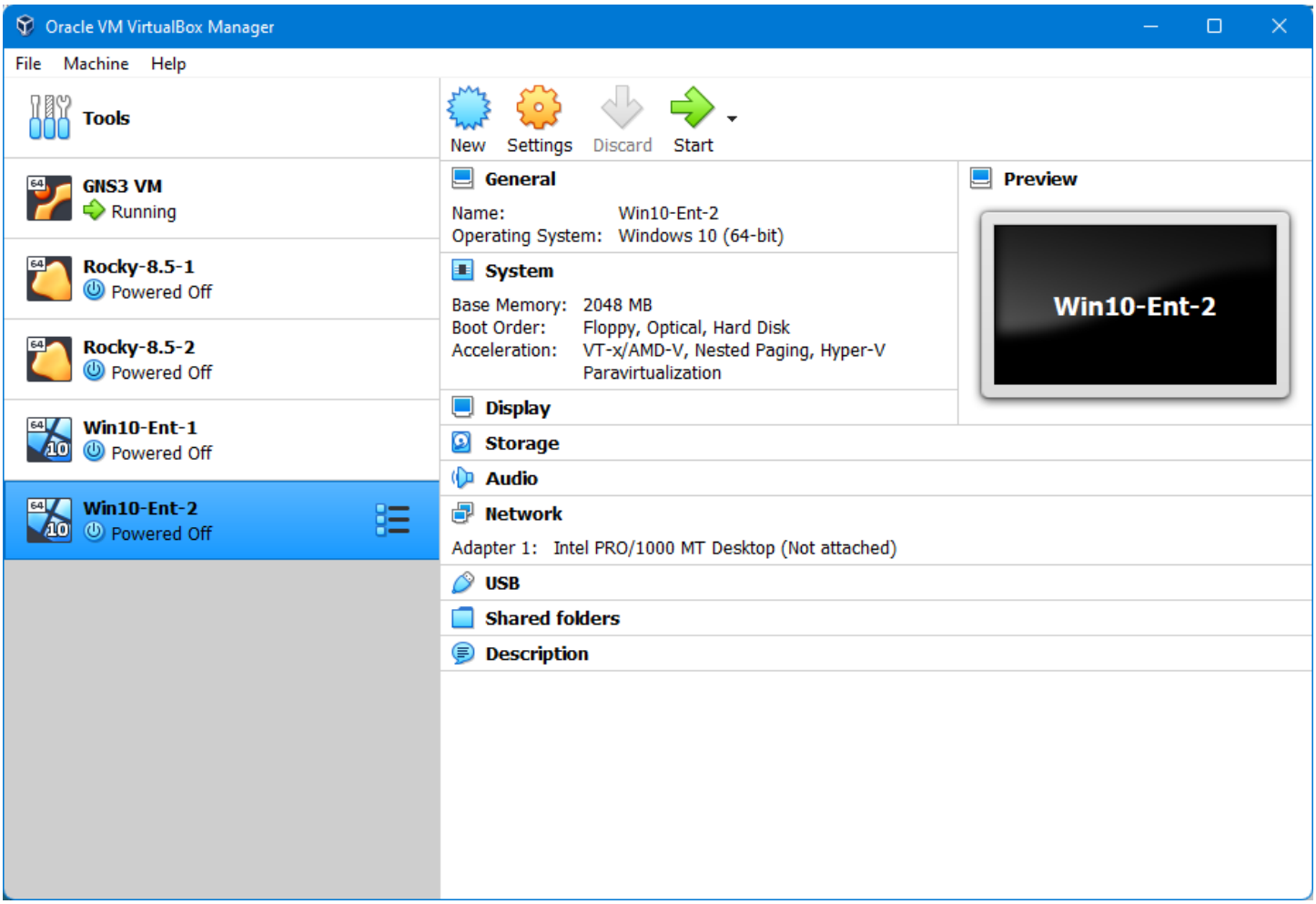
c) Verify the “Full clone” button is selected, select “Clone”

d) Observe the new Win10-Ent-2 VM has been created

17. Start the Win10-Ent-2 VM, login

a) Select the >Start >Settings >About >Rename this PC, set “Current PC name” to “Win10-Ent-2, select “Next”, then select “Restart now”, then log into the Win10-Ent-2 VM

18. Right-click the Windows Start button, select “Shut down or sign out”, select “Shut down”



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XIII. Configuring the IPv6-BYOL project, add the Windows 10 VMs

1. Add the windows 10 VMs to the project: in the IPv6-BYOL – GNS3 window, select >Edit >Preferences >VirtualBox VMs

    a) Select New, in "Server" window select "Next", in VirtualBox Virtual Machine VM list select Win10-Ent-1 then select "Finish"

    b) Select New, in "Server" window select "Next", in VirtualBox Virtual Machine VM list select Win10-Ent-2 then select "Finish", then select "OK"

2. In the IPv6-BYOL – GNS3 window, select the "Browse End Devices" icon in the left-side navigation

3. Click and drag the Win10-Ent-1 icon to the mid-lower-left of the projects main screen, below the left corner of the Switch1 icon

4. Click and drag the Win10-Ent-2 icon to the mid-lower-right of the projects main screen, below the right corner of the Switch2 icon

    a) click the "Browse End Devices" icon again to close the window

5. Align icons as needed

6. Connect the Windows VMs to the switch

    a) click the "Add a link" icon in the left-side navigation

    b) select the Win10-Ent-1-1 icon, select eth0

    c) select the Switch1 icon, select eth2

    d) select the Win10-Ent-2-1 icon, select eth0

    e) select the Switch2 icon, select eth2

    f) click the "Add a link" icon again to exit adding links

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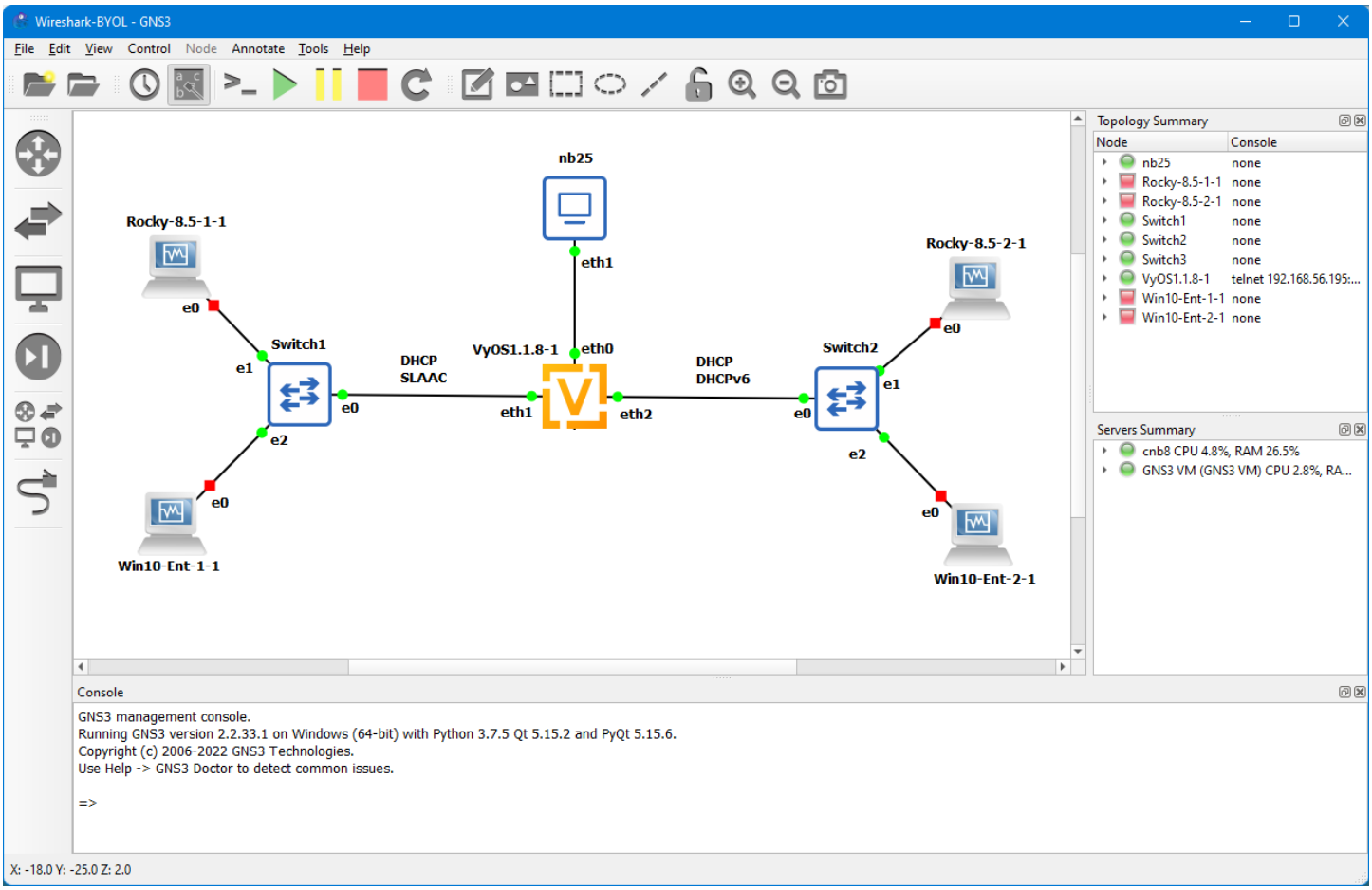
7. Adjust labels/icons as needed for viewing clarity



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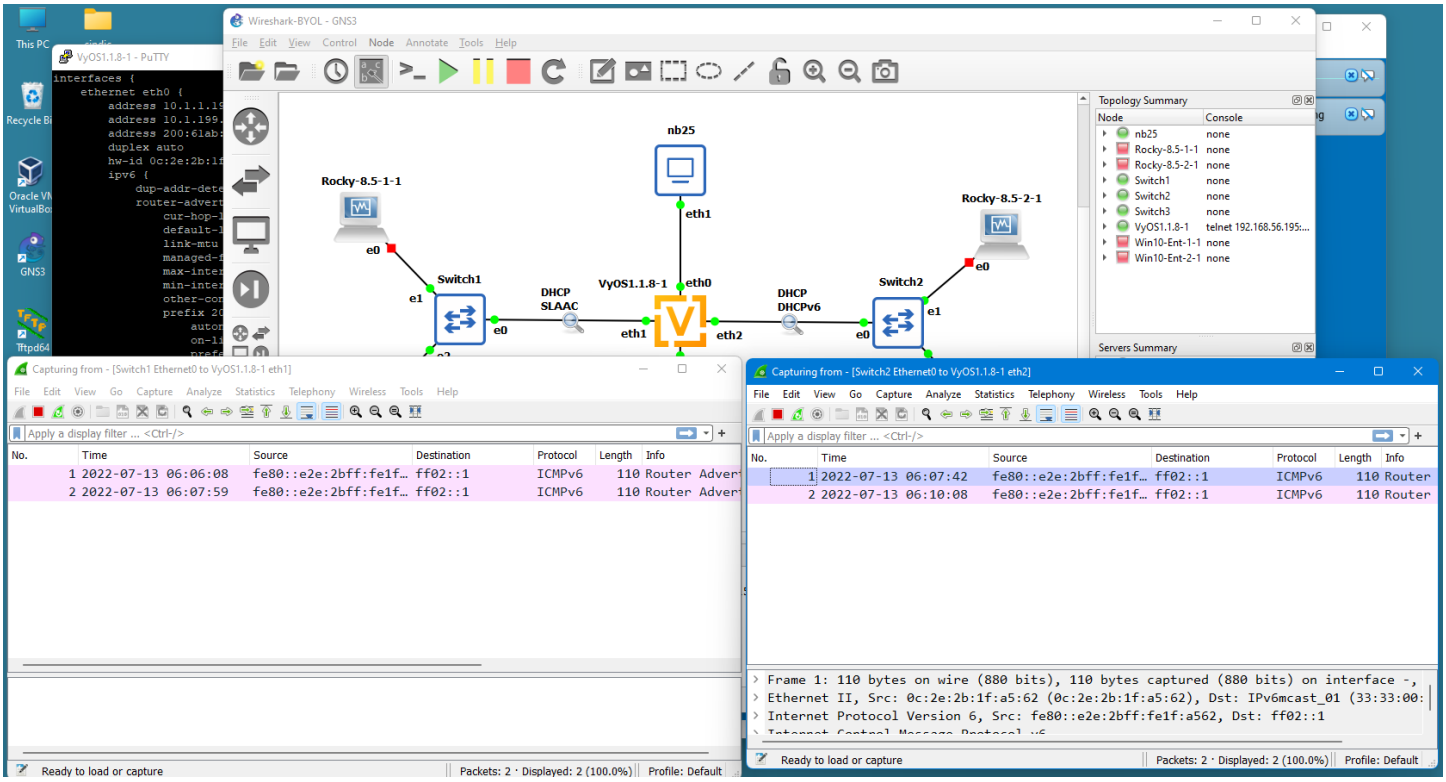
XIV. Start Captures and VMs

1. Start 2 capture sessions:

a) in the IPv6-BYOL – GNS3 window, right-click on the link between Switch1 and VyOS1.1.8-1, select “Start capture”, then select “OK”, this will launch a Wireshark capture. You will observe a small “magnifying icon on the link. Adjust the Wireshark application window to a smaller size in order to see additional windows.

b) in the IPv6-BYOL – GNS3 window, right-click on the link between Switch2 and VyOS1.1.8-1, select “Start capture”, then select “OK”, this will launch a Wireshark capture. You will observe a small “magnifying icon on the link. Adjust the Wireshark application window to a smaller size in order to see additional windows.

c) After a few minutes, you will observe traffic is occurring, at least you should see ICMPv6 Router Advertisements on both network segments



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2. Start Rocky-8.5-1-1 VM

a) In the IPv6-BYOL – GNS3 window, right-click the Rocky-8.5-1-1 and select “Start”. GNS3 will communicate to VirtualBox and start the VM, a new VirtualBox session window will also popup for the Rocky Linux VM access

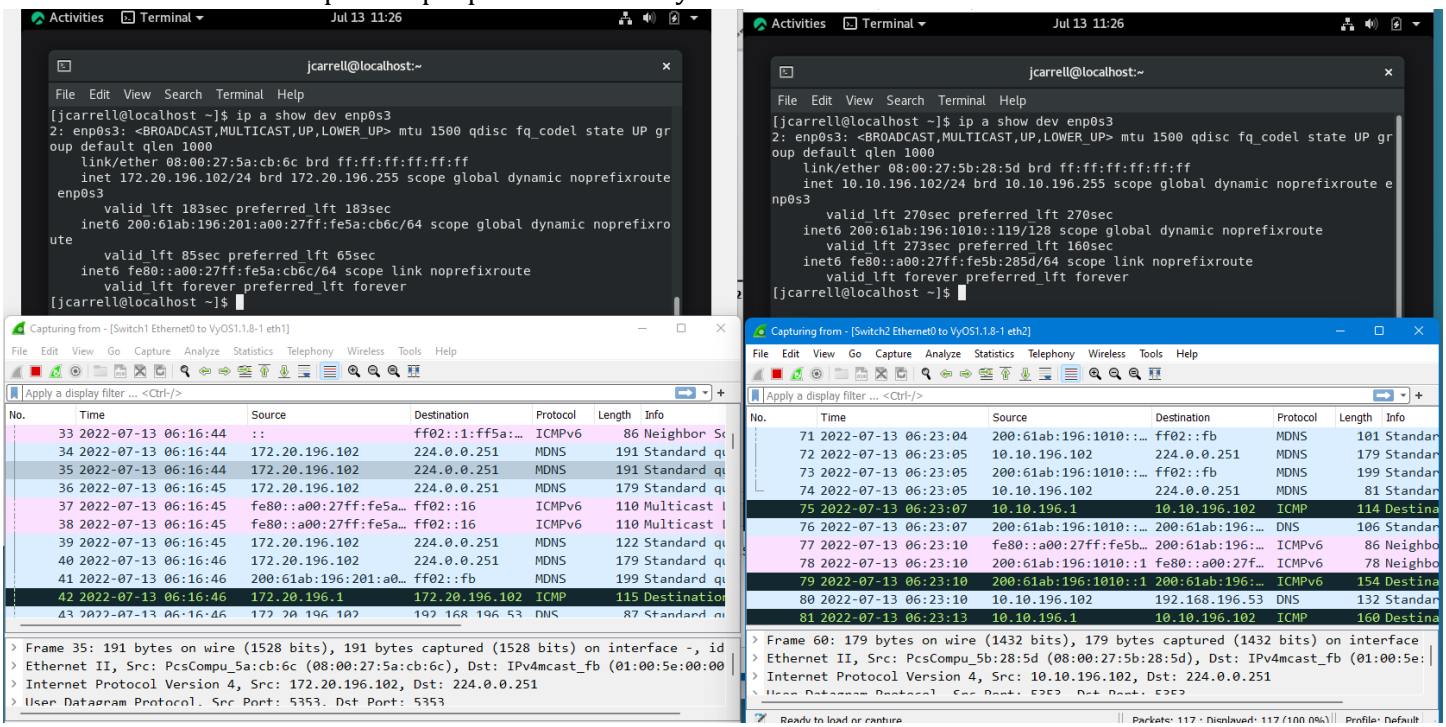
b) In the Rocky-8.5-1-1 [Running] – Oracle VM Virtual box window, login to the Rocky Linux VM

c) In the upper-right corner of the Rocky VM, select the “down arrow” button, select the right-facing arrow at Wired Off, select “connect”

d) Observe more traffic in the Wireshark capture window

e) Open a terminal session, enter “ip a show dev enp0s3”, observe the IPv4 and IPv6 addresses

3. Repeat step 2 process for Rocky-8.5-2-1



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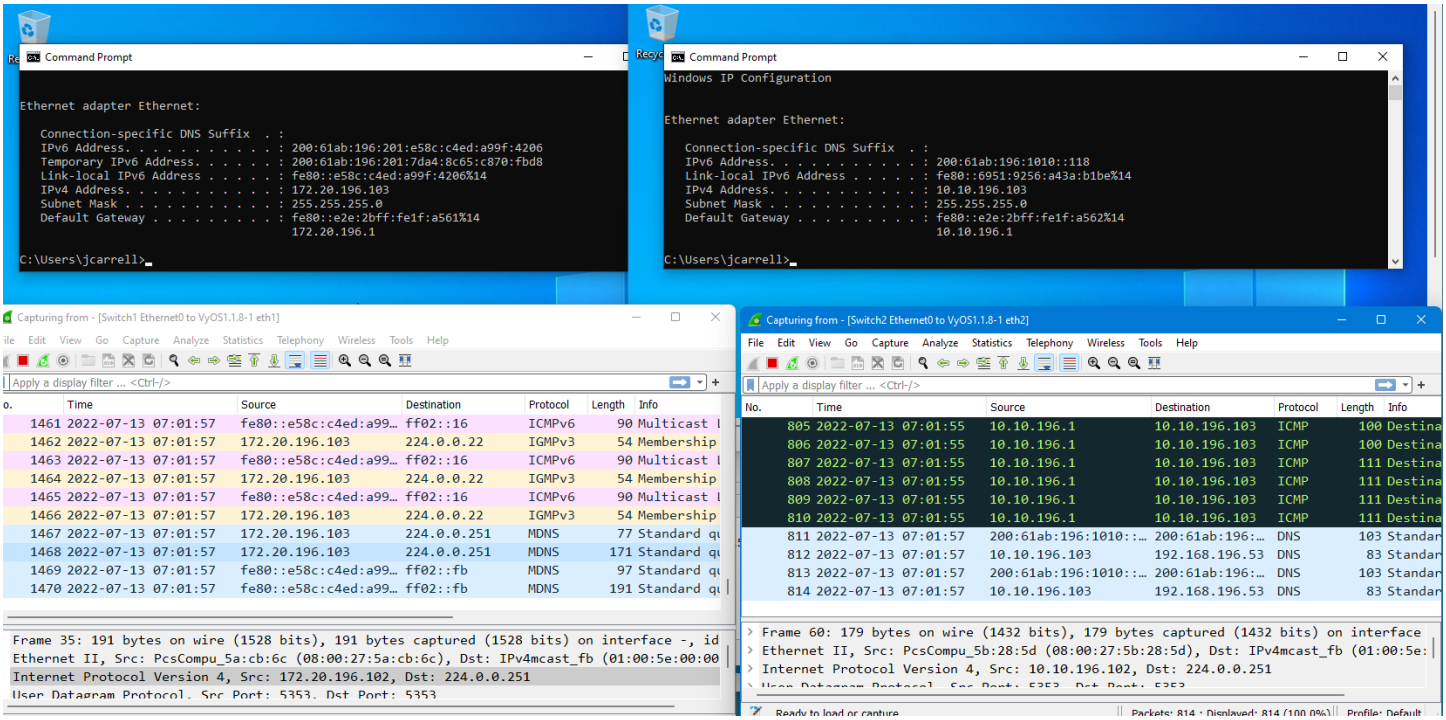
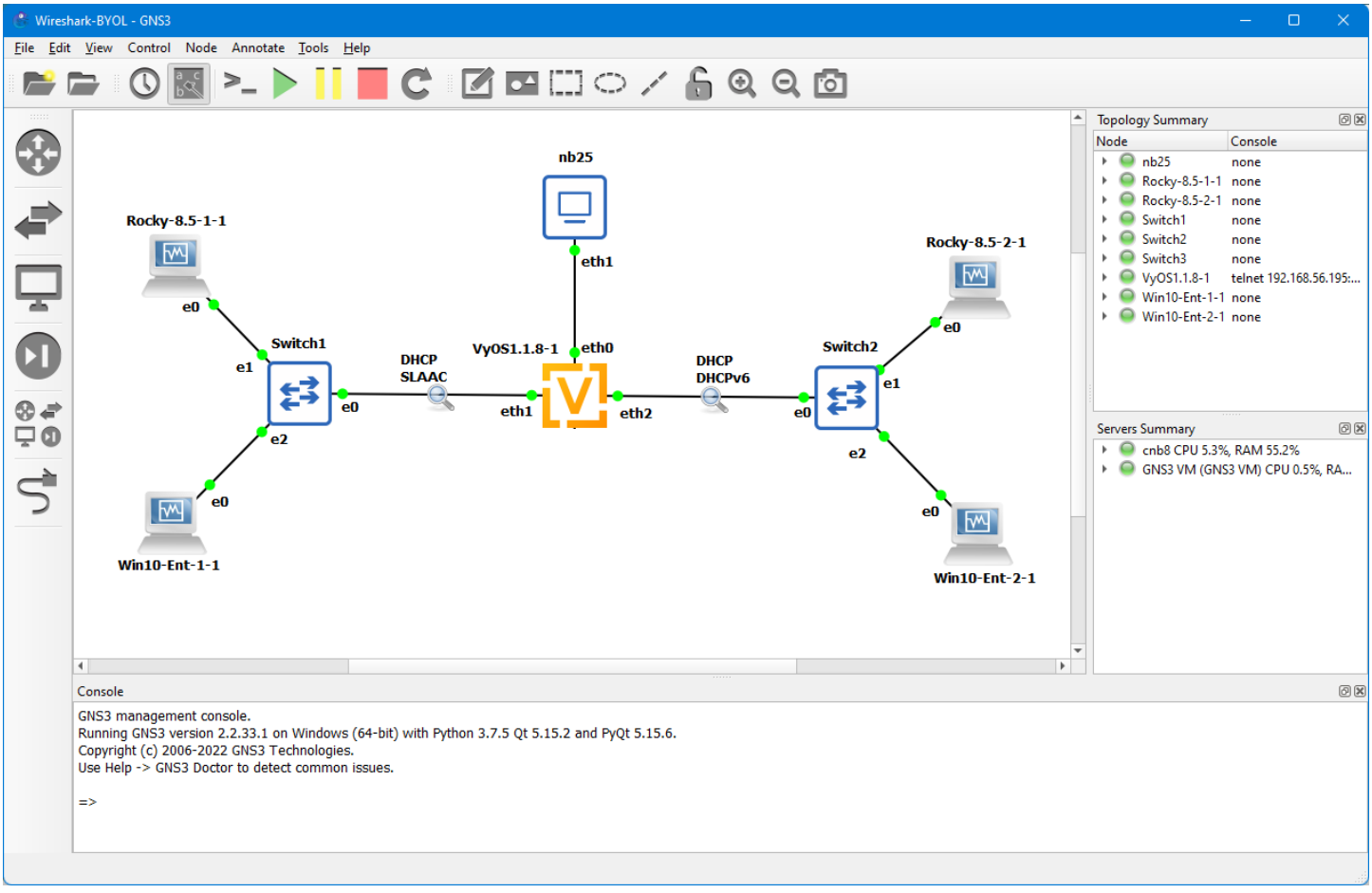
4. Can repeat similar process for Windows VMs





Congratulations, you are on the way for your IPv6 journey!

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XV. Appendix

A. IPv6 Essentials Reference Sheet

IPv6 Essentials Reference Sheet v1.8

IPv6 Addressing

Address Type	IPv6 Notation	Binary Prefix
Unspecified	::/128	0000...0 (128 bits)
Loopback	::1/128	0000...1 (128 bits)
Multicast	ff00::/8	1111 1111 xxxx xxxx
Link-Local	fe80::/10	1111 1110 1000 0000
Global Unicast (GUA)	2000::/3	001x xxxx xxxx xxxx
Unique Local (ULA)	fc00::/7	1111 110x xxxx xxxx
6to4 (tunnel)	2002::/16	
Teredo (tunnel)	2001:0000::/32	
IPv4-Mapped IPv6	0:0:0:0:0:ffff:a.b.c.d	
NAT64	64:ff9b::/96	
Documentation	2001:0db8::/32	

IPv6 Address Shorthand Notation

2001:0db8:0006:1ab5:0000:0000:0000:ba11
remove leading zeros to achieve
2001:db8:6:1ab5:0:0:0:ba11
additional reduction by replacing consecutive fields of zeros with double-colon "::" option (can only be done once) to achieve
2001:db8:6:1ab5::ba11

IPv6 Header

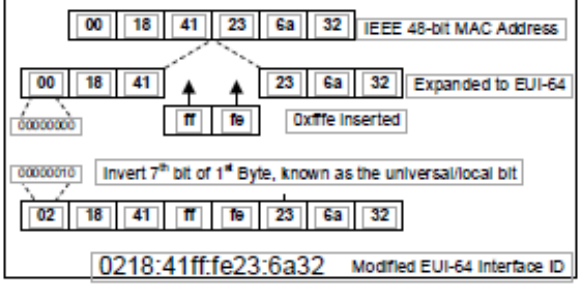
Version (4) | Traffic Class (8) | Flow Label (20)
Payload Length (16) | Next Header (8) | Hop Limit (8)
Source Address (128)
Destination Address (128)

Version : IP version number, 6 for IPv6
Traffic Class : Similar to IPv4 ToS field. Used by nodes to identify and distinguish between different classes or priorities of IPv6 packets
Flow Label : Used by a source to label sequences of packets for which it requests special handling by the IPv6 routers
Payload Length : Length of the IPv6 payload (may also include extension headers)
Next Header : Identifies the type of header following the IPv6 header
Hop Limit : Decremented by 1 by every router that forwards the packet
Source Address : IPv6 address of the originator of the packet, will be a unicast address
Destination Address : IPv6 address of the intended recipient or final destination of the packet, can be unicast or multicast address

Well Known Multicast Addresses

Address	Description	Scope
ff01::1	All Nodes Address	Interface-local
ff02::1	All Nodes Address	Link-local
ff01::2	All Routers Address	Interface-local
ff02::2	All Routers Address	Link-local
ff05::2	All Routers Address	Site-local
ff02::4	DVMRP Routers	Link-local
ff02::5	OSPF IGP Drothers	Link-local
ff02::6	OSPF IGP DRs	Link-local
ff02::9	RIPng Routers	Link-local
ff02::a	EIGRPv6 Routers	Link-local
ff02::c	Microsoft SSDP	Link-local
ff02::d	All PIM Routers	Link-local
ff02::12	VRRPv3	Link-local
ff02::16	All MLDv2 Routers	Link-local
ff02::1:2	DHCPv6 Servers/Agents	Link-local
ff05::1:3	DHCPv6 Servers/Agents	Site-local
ff0x::101	Network Time Protocol	Variable
ff02::1:ffxx:xxxx	Solicited-Node Address	Link-local

Interface ID from MAC Address



ICMPv6 Message Types

128	Echo Request
129	Echo Reply
130	Multicast Listener Query
131	Multicast Listener Report
132	Multicast Listener Done
133	Router Solicitation
134	Router Advertisement
135	Neighbor Solicitation
136	Neighbor Advertisement
137	Redirect Message
138	Router Renumbering
139	ICMP Node Information Query
140	ICMP Node Information Response
143	Multicast Listener Report (MLDv2)
144	Home Agent Discovery Request
145	Home Agent Discovery Reply
146	Mobile Prefix Solicitation
147	Mobile Prefix Advertisement

IPv6 Next Header Fields

(Extension Headers)

0	IPv6 Hop-byHop Option
41	IPv6 encapsulation
43	Routing Header for IPv6
44	Fragment Header for IPv6
50	Encap Security Payload (ESP)
51	Authentication Header (AH)
59	No Next Header for IPv6
60	Destination Options for IPv6

IPv6 Address Types

Link-Local – Automatically assigned per interface, not routable
Global Unicast Address (GUA) – Assigned by SLAAC, Stateful (DHCPv6), or manual, routable to Internet
Unique Local Address (ULA) – Assigned by SLAAC, Stateful (DHCPv6), or manual, not routable to Internet, is routable within enterprise (like private address)

Unicast – one-to-one (link-local, unique local, global)
Anycast – one-to-nearest (allocated from Unicast)
Multicast – one-to-many (also replaces broadcast)

Wireshark Display Filters for IPv6

ipv6 – all IPv6 traffic
icmpv6 – all IPv6 ICMPv6 traffic
dhcpv6 – all DHCPv6 traffic
icmpv6.type == 133 – all router solicitations
icmpv6.type == 134 – all router advertisements
icmpv6.type == 135 – all neighbor solicitations
icmpv6.type == 136 – all neighbor advertisements
icmpv6.type == 137 – all redirect messages

IPv6 Neighbor Discovery Protocol

Neighbor Solicitation (NS) – Neighbor address resolution (similar to IPv4 ARP)
Neighbor Advertisement (NA) – Response to Neighbor Solicitation requests
Router Solicitation (RS) – Sent by nodes "looking" for IPv6 routers on-link
Router Advertisements (RA) – Sent periodically by routers and in response to RS
Duplicate Address Detection (DAD) – Sent to own Solicited-Node Multicast Address

www.teachmeipv6.com jeff.carrell@teachmeipv6.com
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