COM-407: TCP/IP NETWORKING

LAB EXERCISES (TP) 2
L2 V.S. L3, NAT, PHYSICAL CONNECTION, AND TROUBLESHOOTING

October 20th, 2022
Deadline: November 2nd, 2022 at 23.55 PM

Abstract

In this lab you will work with the virtual environment introduced in Lab 1. First you will see the different behaviors of networking devices that work on layer 2 and layer 3; then you will configure your virtual network to be able to access the Internet; and finally you will connect one physical machine to another one and use its Internet connection.

1 PREPARING THE LAB

1.1 LAB REPORT

Answer questions on Moodle.

The deadline is Wednesday, November 2nd, 23:55

1.2 SET UP

Copy the **lab2 resources** folder from Moodle into the shared folder of your VM before starting the lab.

2 LAYER 2 VS. LAYER 3 NETWORKING

The aim of this section is to illustrate the difference between networking devices that work at layer 2 and layer 3.

2.1 USING A SWITCH AS A NETWORKING DEVICE

ANALYZE and ANSWER: For this part, answer the quiz **Lab2 - Part 1.1** on Moodle.

A switch is a MAC-layer device which expands a LAN by making forwarding decision based on destination MAC-address. In this section you will learn how they work.

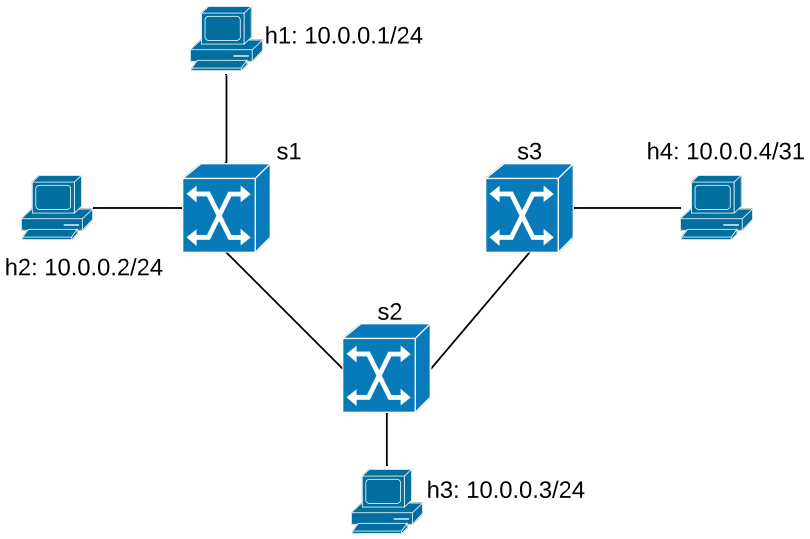

Figure 1: Loop-free network configuration with three switches

Open a terminal in your VM and run the script `topo1.py` as root (*password: lca2*), which should be located in the shared folder on the Desktop. If not, refer to Section 1.2.

```
# sudo python topo1.py
```

This will create the network described in Figure 1, and redirect you to the Mininet Command Line. Additionally, one terminal will appear for each of the four hosts. The four new terminals will be labeled (`h1, h2, h3, h4`) for convenience. `h1, h2` and `h3` should be configured with the `10.0.0.0/24` subnet with the fourth byte of their IP address being `1, 2` and `3`, respectively. Also, `h4` should have the IP address 10.0.0.4 with the subnet mask of `255.255.255.254`. Additionally, every host is automatically assigned an IPv6 address.

Warning! In the questions that follow, be careful when you copy-paste your answer from the mininet terminal to moodle. There might be some hidden characters and your answer will be marked wrong.

Q1/ Answer **Lab2 - Part 1.1** on Moodle.

Exit Mininet and clean up the topology before going to next subsection:

```
mininet> exit
# mn -c
```

2.2 CONFIGURE A SWITCH TO HANDLE LOOPS

ANALYZE and ANSWER: For this part, answer the quiz **Lab2 - Part 1.2** on Moodle.

The goal of this subsection is to configure a LAN with loops. Similarly to the previous subsection, there are four hosts connected through three switches. The switches are forming a loop.

Run `topo2.py`. It creates the topology depicted in Figure 2.

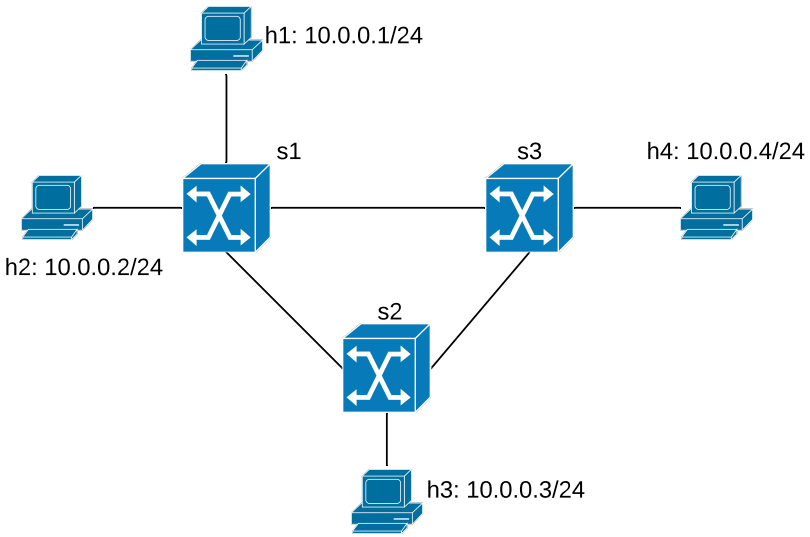

Figure 2: Network configuration with switches forming a loop

Now, perform a reachability test in Mininet using IPv4. A reachability test is a test to determine which hosts can 'reach' one another. This is performed by having each host ping all other hosts using its IPv4 address. A quick way to do this test in Mininet is by running the following command:

```
mininet> pingall
```

Q2/ Answer **Lab2 - Part 1.2** on Moodle.

Exit Mininet and clean up the topology before going to next subsection:

```
mininet> exit
# mn -c
```

2.3 USING A ROUTER AS A NETWORKING DEVICE

ANALYZE and ANSWER: For this part, answer the quiz **Lab2 - Part 1.3** on Moodle.

We have already configured a router in Lab 1, but we did not address how it worked. In this section we learn

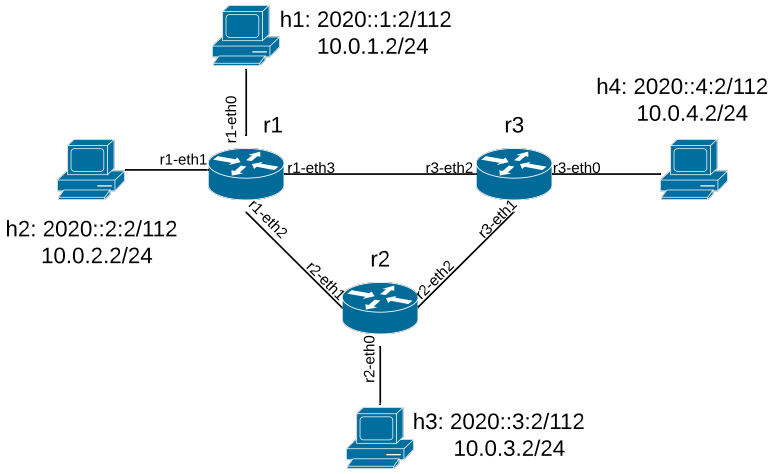

Figure 3: Network configuration with routers

about the process of routing a packet. To do so, run the script `topo3.py`. It creates the network topology with four hosts and three routers as shown in Figure 3.

Q3/ Answer **Lab2 - Part 1.3** on Moodle.

Now, exit Mininet and clean up the topology before going to next section:

```
mininet> exit
# mn -c
```

3 Connecting Virtual Environment to the Real World Using Network Address Translation (NAT)

ANALYZE and ANSWER: For this part, answer the quiz **Lab2 - Part 2** on Moodle.

Please read carefully! In Lab0, we asked you to connect the VM to the host machine using a "Network Adapter" of type "**NAT Network**". This was done to enable IPV6 connectivity inside the VM. However, we have noticed that this part of the lab does not work correctly with this type of adapter. For this part, please make sure you configure a "Network Adapter" of type "**NAT**". Please refer back to Lab0 to check how to change the adapter. In case IPV6 connectivity is needed in a future lab, we will remind you to change the network adapter again.

In this section we will use what we learned from Lab1 about manipulating the `iptables` filter. The purpose of the section is to connect an isolated virtual network that we have deployed so far, to the Internet.

Look at the Figure 4. The NAT in the box "Physical Machine" is the one created by VirtualBox. It connects the network interface of "LCA2 VM" to the physical interface of your laptop (**Note that in the network setting of the VM, there should be one Network Adapter which is set to "NAT"**).

As soon as you turn on the VM, remove the IP configuration of the interface connected to the NAT, as it is going to be used by Mininet. Get the list of interfaces in the VM and use the following command to flush the interface of the VM connected to NAT:

```
# sudo ip addr flush dev <interface name of VM connected to NAT>
```

Remember that the root password is `lca2`. Run the script `topo4.py`. This creates the network described in the box "Network in Mininet" shown in Figure 4. In this network, `h1` and `h2` are hosts, `r1` is also a host but configured to act as a perimeter router where we will have our connection to the real world. The goal of the switch `s3` is connecting `r1-eth1` to the network interface of the LCA2 VM. However, we know that LCA2 VM interface is used by the virtual machine itself. Therefore, we add a port to `s3` and connect it the network interface of LCA2 VM.

Q4/ Answer **Lab2 - Part 2** on Moodle

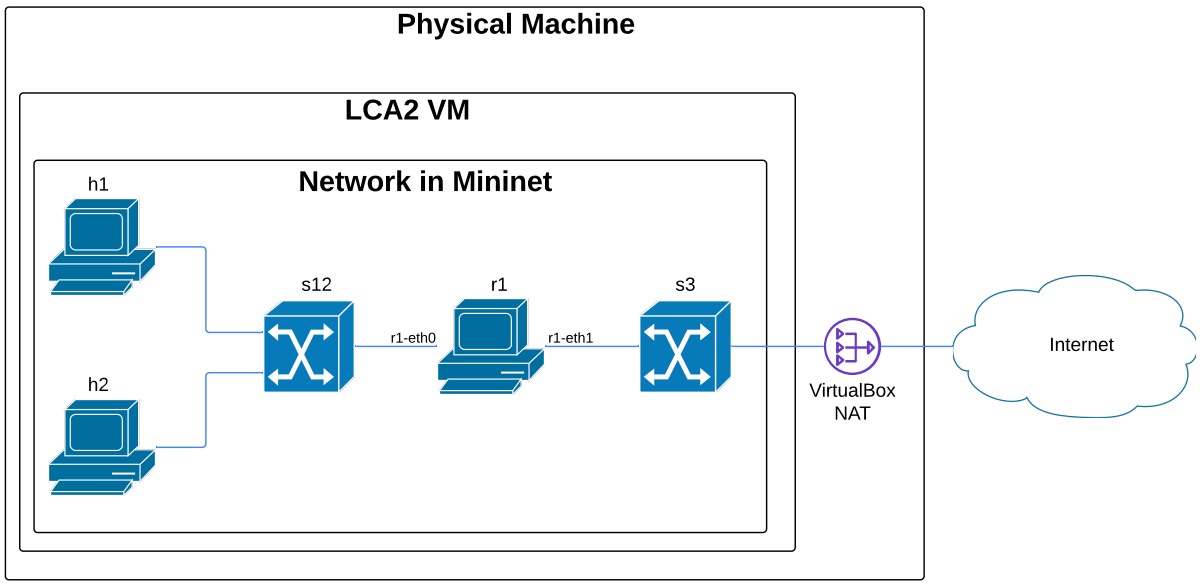

Figure 4: Network configuration with a connection to the real world

RESEARCH EXERCISES (OPTIONAL)

4 POINT-TO-POINT WIRED CONNECTION OF TWO PHYSICAL MACHINES

ANALYZE and ANSWER: For this part, answer the quiz **Lab2 - Bonus - Part 1** on Moodle.

In this section, you will connect two physical machines via an Ethernet cable. The goal of this section is to give you a feel about the communication between physical machines.

To accomplish this section, you are required to have access over two physical machines, e.g. your laptop and your friend's, and an Ethernet cable. If you need an Ethernet cable or a USB-to-Ethernet adapter, you can borrow one INF015.

Figure 5: Point-to-point wired connection of two physical machines

Q5/ Answer **Lab2 - Bonus - Part 1** on Moodle.

4.1 SHARING INTERNET ACCESS

ANALYZE and ANSWER: For this part, answer either the quiz **Lab2 - Bonus - Part 2 for Linux** or **Lab2 - Bonus - Part 2 for Windows/Mac**, depending on your operating system, on Moodle.

The goal of this subsection is to allow `M1` to access the Internet via `M2`. This is similar to "tethering", when you share a mobile phone's internet access with other devices that do not have Internet access.

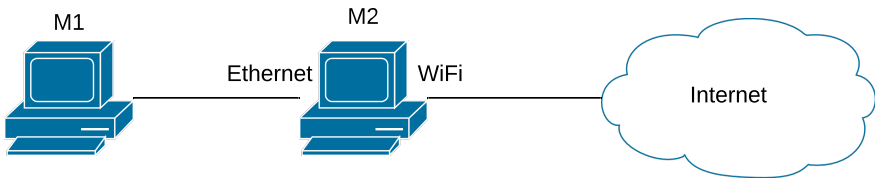

Figure 6: Sharing Internet with a friend!

Assume the configuration is as in Figure 6. We want to connect `M1` via `M2` to the Internet. We could setup `M2` as a bridge, a router, or a NAT.

The process depends on the OS that M2 runs. Please complete the quiz on moodle that corresponds to your case (Linux or Windows/Mac).

Q6/ Answer **Lab2 - Bonus - Part 2 for Linux** or **Lab2 - Bonus - Part 2 for Windows/Mac**, depending on your operating system, on Moodle.

One application of such configuration is to share your own Internet access with other people who are not connected to the Internet. Suppose a friend of you visits Switzerland and would like to have Internet access; however, the cost of Roaming is too much for him/her. Therefore, you would like to do him/her a favor and share your own Internet with him/her. This can be done by the practical experience you have obtained in this section.

Disclaimer: You may think of sharing your EPFL Internet connection using your GASPAR credentials and give Internet access to your friend. We would like to warn you that this generous behavior is unfortunately forbidden.

Note: If you borrowed any Ethernet cable or USB-to-Ethernet adapter, please return them to INF015; as otherwise, your submission will not be graded.

Note: If you are using a Windows machine, turn on the Windows Firewall again.