Rules:

You are required to:

1. work either with only one partner or alone.
2. write name(s), ID(s) and date in the cover page OR you can use the latex file under our drive link.
3. avoid adding your answers/codes as snapshots; the credits of the answers will be zero.
4. discuss each part and add your codes/commands.
5. avoid cheating from other students and internet.
6. submit .pdf file (i.e. ID1_ID2.pdf) for the solution by accessing your RITAJ and replying on the assignment before the deadline, late submissions are not allowed.
7. do the submission by you or your partner, one submission per group is enough. If you submit twice or more, the last submission will be considered only.

Task 1 (Deadline is 26/01/2024)

This task has been adapted based on the labs of the Advanced Computer Networks course for the Vrije Universiteit Amsterdam.

1.1 Mininet

Mininet is a powerful network emulator and we will use it throughout the project tasks. **Mininet** is pre-installed in the VM you have just set up. Please complete the online **Mininet** walkthrough at http://mininet.org/walkthrough/. In some parts of the walkthrough, you may see software defined networks. We will discuss it later in this course, so you do not need to understand what they mean right now. You just need to know how to run and interact with **Mininet**.

1.2 Build a Customized Network Topology

Now using the **Mininet** APIs you have just learnt from the walkthrough, build the network topology illustrated in **Figure 1**. Hosts **h1 - h4** are represented by squares and switches **s1** and **s2** are represented by circles. The name of the devices you build in **Mininet** should match the names in the diagram. The hosts are assigned IP addresses 192.Y.0.X where Y should be the first two digits in your student ID (e.g. ID is 1190120, the IP is 192.20.0.X) and X should match the host number (1 − 4) (e.g. 192.Y.0.2 for **h2**). The properties (bandwidth, delay) of the links are specified as: (15Mbps, 10ms) for links **e1 - e4** and (20Mbps, 45ms) for link **e5**.

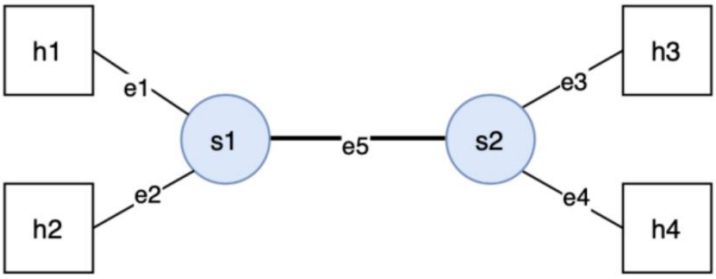

Figure 1: A simple bridge network topology.

Once you have completed the topology file, launch it in Mininet using the following command.

```
sudo mn –custom /path/to/topo/file –topo=topo name –link=tc
```

1.3 Measure the Performance of the Network

Use **Xterm** to start terminals for the hosts in the network.

```
mininet> xterm h1 h3
```

Now, please measure the **latency** and **throughput** between hosts **h1** and **h3** using **ping** and **iperf**, respectively. For **ping** you should send 20 or more packets and average the results and for **iperf**, you should measure for 20s or longer. Try to measure with both TCP and UDP connections.

```
h1$ iperf -s (-u)
h3$ iperf -c ip.to.server -t 20 (-u)
```

1.4 Effect of Multiplexing

In the above measurement we only have one connection going at the same time. Now, let us try with simultaneous connections where we let **h1** talk to **h3** and **h2** talk to **h4** at the same time. Try to predict the latency and throughput. Use ping and iperf to measure the latency and throughput of the two connections. Check if your predictions are correct and think about why or why not. What if we have two connections all destined to **h4** (i.e., **h1** - **h4** and **h2** - **h4**)?