Network Technology and Programming Lab
Assignment 1

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Deadline: 8/03/2024 23:59

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Know your lab!

As this is the introductory assignment, the goal is for you to become familiar with the Commlab and its network. Examine the network - carefully and without tampering with the connections! - and take a close look at the networking devices i.e. the routers, the switches, the hub, and the connections between them. At the start of the assignment, please make sure you remember the state of the cabling at the networking devices (all ethernet cables originating from the computers and labeled comm1 to comm10, are plugged on the 24-port switch), and before you leave, plug the cables at their original ports so that the next groups that will use the lab, start from the same basis as you.

On the control panel of the lab you will find 7 routers (Ubiquity EdgeRouter X) and 2 switches (EdgeSwitch 24, EdgeSwitch 8). You have full access on the R2-R7 and on the EdgeSwitch 8. Access on the R1 and on EdgeSwitch24 is read-only and no configuration is allowed. For easily accessing the available equipment, a management VLAN (ID: 1000) is configured and accessible using the management port 24 of the EdgeSwitch 24. This port is configured to automatically apply VLAN tagging on all incoming untagged packets. Therefore, you can plug a PC on this port and access without any further configuration the available devices. For your convenience, a DHCP server runs on the management VLAN that will assign a proper IP address on the plugged host automatically.

The management ports are the *eth0* for the routers and the port 1 for the EdgeSwitch 8. In order to save time and possible problems due to misconfiguration, lets assume that the rule is to never change the configuration of these ports. If you do so, please reset the device and upload the default configuration, so other teams can access them easily. The assignments will not require to configure the management ports. At the end of your session, re-upload the default configuration on the devices and reset any changes in the interface parameters of the Comm hosts.

The IP addresses for accessing the WebUI of each device are listed in the table below:

Device	Address
R1	192.168.4.1
R2	192.168.4.2
R3	192.168.4.3
R4	192.168.4.4
R5	192.168.4.5
R6	192.168.4.6
R7	192.168.4.7
EdgeSwitch 24	192.168.4.8
EdgeSwitch 8	192.168.4.9

The username for the devices with full access is *hy435* and the password *hy435@csd*. For the R1 and the EdgeSwitch 24, a read only account with username *student* and password *hy435@csd* exists.

The lab also has 10 Linux workstations. In the table below you can see which ones you may use, and which are not available for the time being. Their corresponding IP

addresses can be found at the table below:

Host	Address
comm1	192.168.4.51
comm2	**DEAD**
comm3	192.168.4.53
comm4	**DEAD**
comm5	192.168.4.55
comm6	**DEAD**
comm7	**DEAD**
comm8	192.168.4.58
comm9	**DEAD**
comm10	**DEAD**

Feel free to play with the available equipment! Just remember to revert to the initial state whatever you play with!

1. Exercise 0: Check connectivity

All of the Ethernet cables from the computers should be plugged on the 24-port switch. Make sure this stands. Also check that the hosts comm1 to comm10 mentioned in the table above are available. [Tip] Be patient when turning on the PCs!

(i) First you can inspect and see if the ip addresses on the table correspond with the actual ones. You will need to setup **different** IPv4 addresses on four[4] of the PCs, using the *ip command*. We will label the four nodes A, B, C and D. The addresses should be of the form 192.168.4.x/24. Carefully choose which ones you will use! **Report** the addresses you assigned to each node.

(ii) Check the connectivity between your 4 nodes. How will you check if there is connectivity between them?

You can always use the command *ethtool* to get more information about the link capabilities.

2. Exercise 1: Single-Server Switch Topology

(i) Generate traffic between the nodes A and B. For this purpose you will use the **iperf3** tool. Go through the man page of the tool to see the available arguments and their use.

Four different scenarios will be used to evaluate the performance of the network:

(a) Generate TCP traffic letting the protocol adapt to the network conditions

(b) Generate UDP traffic with a bitrate of 5% of the link's theoretical maximum

(c) Generate UDP traffic with a bitrate of 50% of the link's theoretical maximum

(d) Generate UDP traffic with a bitrate of 99% of the link's theoretical maximum

Run iperf3 as server on node B , and as client on node A . Run each of the above scenarios between the two nodes for 60 seconds. The setup is depicted in Figure 1
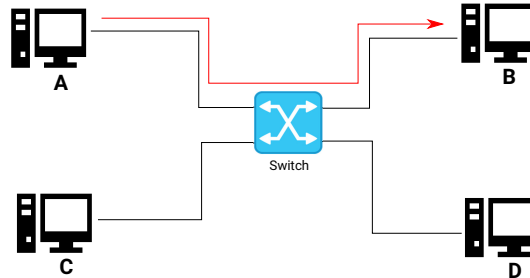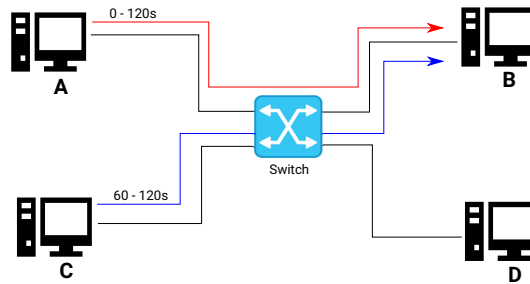

Figure 1: Single-server, single-flow scenario

Figure 2: Single-server, multiple-flow scenario

(a) Plot the results. TCP plots should contain the throughput, along with the congestion window size and the re-transmissions. On the other hand, for the UDP plot the throughput, along with the jitter and the packet loss percentage

(b) Report your findings

(c) For the TCP experiments, compare the re-transmissions and the size of the congestion window. What do you observe?

(d) For the UDP experiments, compare the throughput the jitter and packet loss. What do you observe?

(ii) For the next task you will also utilize node C. Run iperf as client on node A and on node C, and as server on node B. For each of task 1's scenarios, do the following: Execute the scenario between nodes A and B for 60 seconds. Then, and without killing the first flow, run the scenario for 60 more seconds between nodes C and B (the rationale behind this task is to observe what happens when a single flow is generated versus two simultaneous flows, and how the bitrate varies). Report the values observed and compare with the above task. The setup is depicted in Figure 2

(iii) Older versions of iperf did not provide the bandwidth option for TCP flows. Can you provide a possible explanation for that design decision?

3. Exercise 2: Single-Server Hub Topology

In this task you will use the hub instead of the switch. Unplug nodes A, B and C from the switch, and plug them on the hub. Repeat the experiments (i), (ii) of Exercise 1 and report your findings. Furthermore, comment on the differences you observed between the different topologies and explain them.

4. Multiple-Server Topology

In this last task you will repeat the above two scenarios, only this time we will also use the fourth node:

1. Plug again all nodes on the switch. This time, run iperf as client on nodes A and C, and as server on nodes B and D. Execute each of task 1's scenarios between nodes A and B, and then, again without killing the first flow, execute the scenario for 60 more seconds between nodes C and D. The setup is depicted in Figure 3

2. Now plug all nodes on the hub. Run again the above scenario.

Plot the results and report your findings. What is the difference of this topology compared to the star topology of the two first tasks?
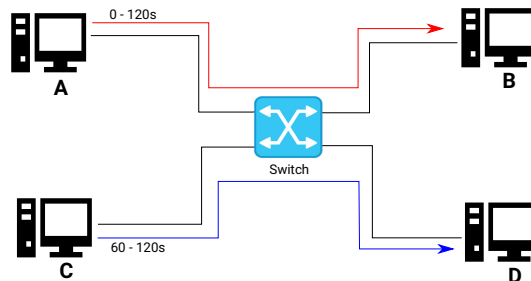

Figure 3: Multiple-server, multiple-flow scenario

* Remember to shutdown the PCs when leaving the lab and leave everything in place ! For the comms with no available UI, you can use the command *sudo shutdown now*.

Reporting

Your reports should include your answers to the above questions as well as the plots of the observed results. You are expected to show for each task, the variation of the bitrate

of each node in time, using plots. You can use the plotting tool of your choice for this purpose. For example you can find (and/or imporve if you want) implementations of iperf plotter on Github. Your reports should be in pdf format. Pay attention on the quality of your report. Plots should be easily readable and you are expected to comment on your findings. If something is wrong with your experiment, justify the approach you followed and provide possible reasons for the abnormal situation.

Submission

The submission of the assignments will be done through the **turnin** process. If needed, more info will be sent to the list prior to the deadline. You can turnin this assignment until **Friday 8/3 23:59**. Use the command below:
turnin assignment1@hy435 <dir>

Oral Examination

All the students who have submitted their exercises are requested to attend the oral exam session, in order to present their solutions. A short quiz will also take place during that time. You will need to choose a timeslot for the oral exam using Doodle. More details will be sent to you via email.

Attention

- Each team will only be examined during the timeslot choosed.

- During this session both the Assignments 1 and 2 will be examined.

- Both the timely submission and the oral exam session will contribute to the grading of the assignments.