CSE3300/CSE5299: Computer Networking

Homework 1

Due Date: 9/10/2025, 11:59 pm, Wednesday. Submission through HuskyCT.
Full score: 100 for CSE3300 students; 120 for CSE5299 students (will be normalized to 100 when entering the grade in HuskyCT).

Note: Please start Problem 6 (on Mininet) as early as possible, as installing Mininet may take additional time on certain Mac systems.

1. **Packet-switched network and circuit-switched network (10 points).** Consider an application that transmits data at a steady state (e.g., the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions. Briefly justify your answers.

   a. (5 points) Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

      Circuit-switched network. Circuit-switched network can allocate dedicated network resource providing guaranteed bandwidth and predicable delay, since the application transmits the data at constant bit rate, the amount of network resource allocated will not be wasted.

   b. (5 points) Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Will the network be congested? Why?

      No. Since the sum of application data rates is less than the capacitities of each link, no queues will build up.

2. **Circuit switching and packet switching (25 points).** Suppose a group of users share a 1 Mbps link. Each user requires 100 Kbps when transmitting, but each user transmits only 20% of the time.

   a. (10 points) When circuit switching is used, how many users can be supported?

      Maximum users supported $= \left\lfloor \frac{1\,\text{Mbps}}{100\,\text{Kbps}} \right\rfloor = \lfloor 10 \rfloor = 10.$

   b. (15 points) Suppose packet-switching is used. If there are 50 users, use the binomial distribution to compute the probability that more than 10 of the 50 users are transmitting simultaneously at any given time. (Hint: You can write a program to compute this probability.)

$$\Pr[X > 10] \;=\; 1 - \Pr[X \le 10] \;=\; 1 - \sum_{k=0}^{10} \binom{50}{k} (0.2)^k (0.8)^{50-k} \;\approx\; \mathbf{0.4164}.$$

3. **Transmission delay and propagation delay (15 points).** Suppose two hosts, A and B, are connected by a 10 Mbps link. The length of a packet is 12 Kb (Kilobits, i.e., 12×10^3 bits or 1500 bytes). The length of the link is 10 km. Assume that signals propagate at the speed of light (i.e., the ideal speed of 3×10^8 m/s (meters per second)).

   a. (7 points) What is the propagation delay from A to B?

   $$\text{Propagation delay} = \frac{d}{s} = \frac{10{,}000}{3 \times 10^8}\ \text{s} \approx \mathbf{3.33 \times 10^{-5}}\ \text{s} = \mathbf{33.3}\ \boldsymbol{\mu}\mathbf{s}.$$

   b. (8 points) What is the transmission delay of the packet at A?

   $$\text{Transmission delay} = \frac{L}{R} = \frac{12{,}000\ \text{bits}}{10{,}000{,}000\ \text{bps}} = \mathbf{1.2 \times 10^{-3}}\ \text{s} = \mathbf{1.2}\ \text{ms}.$$

4. **Calculate the mean and the standard deviation of round-trip times (15 points).** In this problem, we will use a widely-used program, "ping". You may want to read about it if you are not already familiar with it (e.g., type "man ping" in Google).

   a. (5 points) Describe briefly the function of "ping". How does "ping" differ from "traceroute"?

      – ping: measures RTT to a destination
      – traceroute: tracks the hop-to-top path with per hop RTT.

   b. (5 points) Try using "ping" on your computer. Specifically, use 5 probes, each probe of 40 bytes, to obtain 5 samples of round-trip times from the machine you are using to a destination machine that you choose (e.g., `www.uconn.edu`). List the command you use and the results you get.

   `ping -c 5 -s 40 www.uconn.edu`

   results may vary.

   c. (5 points) Calculate the mean and the standard deviation of the round-trip times.

   results may vary.

5. **(10 points)** A student at UConn is working on a collaborative project with a team in Washington State University (WSU). He has 100 Gigabyte data, and his professor asked him to send the data to WSU as fast as possible. The student has two options, either to send it with a friend who will be traveling to WSU in one week (7 days), or use 1 Mbps dedicated link to transfer the data, which way would be faster (ignore propagation delay)? Explain why.

   Convert GB to bits:

   $$100\ \text{GB} = 100 \times 10^9\ \text{bytes} \approx 8 \times 10^{11}\ \text{bits}.$$

At a 1 Mbps link:

$$\frac{8 \times 10^{11} \text{ bits}}{1 \times 10^{6} \text{ bps}} = 8 \times 10^{5} \text{ s} \approx 222 \text{ hours} \approx 9.26 \text{ days} > 7 \text{ days.}$$

Therefore the friend will be faster.

6. **Mininet and Wireshark (25 points).**

We will use Mininet for project 2. Please follow the provided instructions (uploaded on huskyCT) to install Mininet and answer the questions outlined in the instruction document. The questions are also copied here.

In Mininet change the default configuration to have 4 hosts connected to a switch.

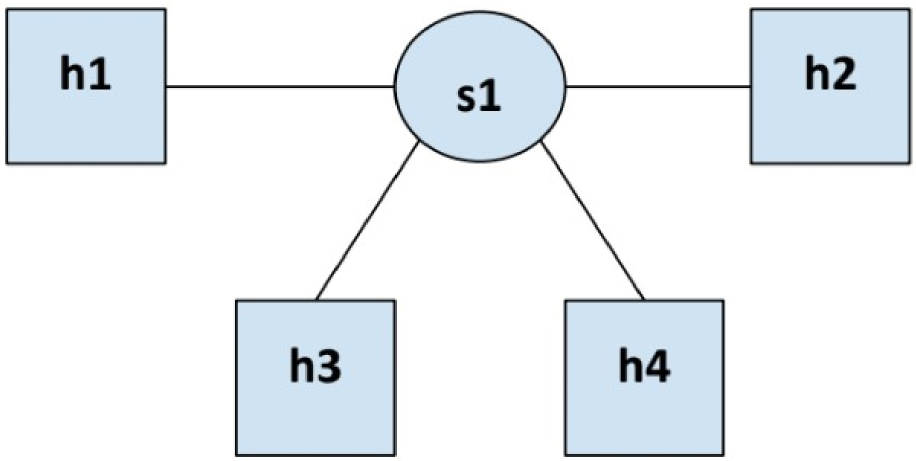


Figure 1: Mininet topology used in the experiment.

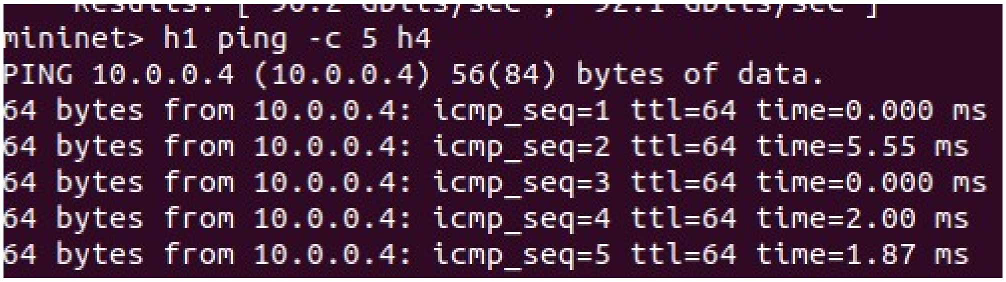
a. (5 pts) Show your screenshot of dump and pingall output.

```
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=3481>
<Host h2: h2-eth0:10.0.0.2 pid=3483>
<Host h3: h3-eth0:10.0.0.3 pid=3485>
<Host h4: h4-eth0:10.0.0.4 pid=3487>
<OVSSwitch s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None,s1-eth3:None,s1-eth4:None
pid=3492>
<Controller c0: 127.0.0.1:6653 pid=3474>
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 h4
h2 -> h1 h3 h4
h3 -> h1 h2 h4
h4 -> h1 h2 h3
*** Results: 0% dropped (12/12 received)
```

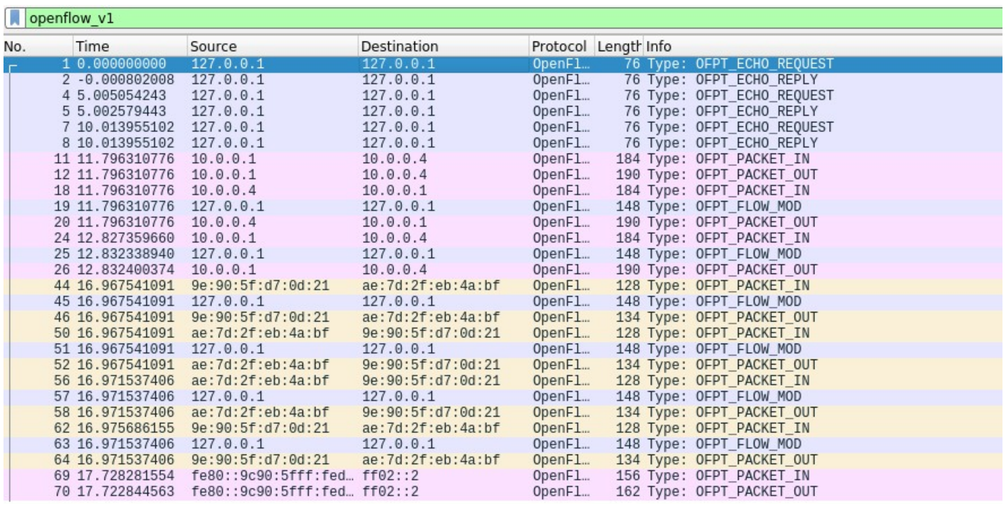
b. (10 pts) Run the iperf command as well, and screenshot the output, how fast is the connection?

```
mininet> iperf
*** Iperf: testing TCP bandwidth between h1 and h4
*** Results: ['90.2 Gbits/sec', '92.1 Gbits/sec']
```

c. (10pts) Work on Wireshark "Intro" to get familiar with Wireshark. Run wireshark, and using the display filter, filter for "openflow_v1". Note: When you run Wireshark, you should do so as "sudo wireshark". When you choose an interface to capture on, you should select "any". Run ping from a host to any other host using hX ping -c 5 hY. Show the screenshot on the Mininet terminal. And take a screenshot to show the captured related packets by Wireshark.



```
mininet> h1 ping -c 5 h4
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=0.000 ms
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=5.55 ms
64 bytes from 10.0.0.4: icmp_seq=3 ttl=64 time=0.000 ms
64 bytes from 10.0.0.4: icmp_seq=4 ttl=64 time=2.00 ms
64 bytes from 10.0.0.4: icmp_seq=5 ttl=64 time=1.87 ms
```



openflow_v1

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	127.0.0.1	127.0.0.1	OpenFl…	76	Type: OFPT_ECHO_REQUEST
2	-0.000802008	127.0.0.1	127.0.0.1	OpenFl…	76	Type: OFPT_ECHO_REPLY
4	5.005054243	127.0.0.1	127.0.0.1	OpenFl…	76	Type: OFPT_ECHO_REQUEST
5	5.002579443	127.0.0.1	127.0.0.1	OpenFl…	76	Type: OFPT_ECHO_REPLY
7	10.013955102	127.0.0.1	127.0.0.1	OpenFl…	76	Type: OFPT_ECHO_REQUEST
8	10.013955102	127.0.0.1	127.0.0.1	OpenFl…	76	Type: OFPT_ECHO_REPLY
11	11.796310776	10.0.0.1	10.0.0.4	OpenFl…	184	Type: OFPT_PACKET_IN
12	11.796310776	10.0.0.1	10.0.0.4	OpenFl…	190	Type: OFPT_PACKET_OUT
18	11.796310776	10.0.0.4	10.0.0.1	OpenFl…	184	Type: OFPT_PACKET_IN
19	11.796310776	127.0.0.1	127.0.0.1	OpenFl…	148	Type: OFPT_FLOW_MOD
20	11.796310776	10.0.0.4	10.0.0.1	OpenFl…	190	Type: OFPT_PACKET_OUT
24	12.827359660	10.0.0.1	10.0.0.4	OpenFl…	184	Type: OFPT_PACKET_IN
25	12.832338940	127.0.0.1	127.0.0.1	OpenFl…	148	Type: OFPT_FLOW_MOD
26	12.832400374	10.0.0.1	10.0.0.4	OpenFl…	190	Type: OFPT_PACKET_OUT
44	16.967541091	9e:90:5f:d7:0d:21	ae:7d:2f:eb:4a:bf	OpenFl…	128	Type: OFPT_PACKET_IN
45	16.967541091	127.0.0.1	127.0.0.1	OpenFl…	148	Type: OFPT_FLOW_MOD
46	16.967541091	9e:90:5f:d7:0d:21	ae:7d:2f:eb:4a:bf	OpenFl…	134	Type: OFPT_PACKET_OUT
50	16.967541091	ae:7d:2f:eb:4a:bf	9e:90:5f:d7:0d:21	OpenFl…	128	Type: OFPT_PACKET_IN
51	16.967541091	127.0.0.1	127.0.0.1	OpenFl…	148	Type: OFPT_FLOW_MOD
52	16.967541091	ae:7d:2f:eb:4a:bf	9e:90:5f:d7:0d:21	OpenFl…	134	Type: OFPT_PACKET_OUT
56	16.971537406	ae:7d:2f:eb:4a:bf	9e:90:5f:d7:0d:21	OpenFl…	128	Type: OFPT_PACKET_IN
57	16.971537406	127.0.0.1	127.0.0.1	OpenFl…	148	Type: OFPT_FLOW_MOD
58	16.971537406	ae:7d:2f:eb:4a:bf	9e:90:5f:d7:0d:21	OpenFl…	134	Type: OFPT_PACKET_OUT
62	16.975686155	9e:90:5f:d7:0d:21	ae:7d:2f:eb:4a:bf	OpenFl…	128	Type: OFPT_PACKET_IN
63	16.971537406	127.0.0.1	127.0.0.1	OpenFl…	148	Type: OFPT_FLOW_MOD
64	16.971537406	9e:90:5f:d7:0d:21	ae:7d:2f:eb:4a:bf	OpenFl…	134	Type: OFPT_PACKET_OUT
69	17.728281554	fe80::9c90:5fff:fed…	ff02::2	OpenFl…	156	Type: OFPT_PACKET_IN
70	17.722844563	fe80::9c90:5fff:fed…	ff02::2	OpenFl…	162	Type: OFPT_PACKET_OUT

7. **(For CSE5299 students only) (20 points)** Read the Request For Comments (RFC) titled "RFC 3724: The Rise of the Middle and the Future of End-to-End: Reflections on the Evolution of the Internet Architecture". Describe in your own words the evolution of the end-to-end architecture of the Internet. What does "the rise in the middle" mean? How do the changes affect you?

Answer may vary.