Lab 12
TCP

Prof. Kredo

Due: Start of lab Friday, May 1

Name:	
Name:	

Introduction

In this lab you will accomplish several goals:

- Examine a TCP connection and data transfer
- Evaluate how delay and packet loss affect TCP performance

Work in pairs for this lab using the equipment at your desk. Distribute the work evenly to make sure both group members know the material, as you will be required to know the material for evaluation.

1 Preliminary

Configure and connect your hosts so they can access the external network. There are several possible methods you can use from previous labs, but none require you to use a router. Test your setup by browsing a website from your hosts. Close your browser when you have verified your setup.

2 TCP Connections [30 Points]

As we mentioned in class, TCP is a common transport layer protocol. For this section it is helpful to know that Wireshark displays relative sequence and acknowledgment numbers, not actual numbers. To view the actual sequence number, select the packet in the upper pane, expand the TCP header in the middle window, select the sequence or ACK number field in the middle window, and examine the selected bytes in the lower window.

First, open your web browser. Start Wireshark and begin capturing on your Ethernet interface. Generate traffic for your capture by opening `http://farnsworth.ecst.csuchico.edu/file.html` in your browser. After you have downloaded the file, stop the packet trace and answer the following questions.

1. What is the (actual) initial sequence number used by your host?

2. Starting all TCP connections with the same sequence number can lead to problems. Describe one problem that could arise when initial sequence numbers are repeated.

3. What window size does the server advertise in its SYN packet? Does it use window size scaling?

4. Describe how your devices close the TCP connection. Include all packets used to close the connection in your answer. Who initiates the closing the connection?

5. Look at the SYN packets for the TCP connection. What TCP options do you see? Lookup and explain one option not discussed in class.

3 Network Simulation [10 Points]

The networks in lab are fairly fast and error-free due the small network size and low traffic intensity. This makes it difficult to evaluate protocols under real network conditions. Thankfully, we can instruct the kernel to simulate aspects of a real network, such as random delays and losses.

1. `ping` some Internet host. What is the average delay?

Lets add some delay to our "network." Enter the following command into your host.
`sudo tc qdisc add dev eth0 root netem delay 100ms` This command adds a delay of 100 ms to all packets sent by your host. You can read `tc(8)` and `netem(8)` for more information, if desired.

2. `ping` the same website as above. What is the average delay now?

You can also cause the kernel to randomly drop packets with the following command.
`sudo tc qdisc change dev eth0 root netem drop 30%` This command causes the kernel to randomly drop 30% of packets. Note the change from `add` to `change`. You can delay packets or drop packets with these simple commands, but not both. If you wish to return to normal operation on a host, enter the command `sudo tc qdisc del dev eth0 root`.

4 TCP with Delays [30 Points]

Lets study the effect of network delays on TCP performance. Use `iperf` to measure the TCP throughput between your hosts as you vary the delay. Only add delays to the host running the `iperf` client. Make sure the `iperf` server does not delay or drop any packets. Fill in the table below with your measurements. **Ensure your hosts have approximately a 1 Gbps connection, with no delay, for the data you collect.**

Delay	**Throughput**
0 ms	
5 ms	
10 ms	
25 ms	
50 ms	
75 ms	
100 ms	

1. At what delay do you estimate you would achieve half the throughput you achieve at a delay of 0 ms?

2. Based on your results, what throughput would you expect to the host you `ping`ed in the previous section? Assume losses are negligible and you have added no artificial delay.

5 TCP with Packet Losses [30 Points]

Lets now study the effect of packet losses on TCP performance. Use `iperf` to measure the TCP throughput between your hosts as you vary the percentage of packets that are dropped. **Ensure only the `iperf` client drops packets and that the `iperf` server does not drop or delay packets.** Fill in the table below with your measurements.

Loss Rate	**Throughput**
0 %	
0.1 %	
0.25 %	
0.5 %	
0.75 %	
1 %	
2 %	

1. Based on your results, at what loss rate do you estimate you would achieve half the throughput you achieve with no losses?

2. Based on your results, estimate at what delay you get a throughput equivalent to a loss rate of 0.5%.

3. Do you think TCP throughput is more sensitive to delay or packet losses? Why? Justify your answer with your data.