Assignment 2 – Hands-On with the Transport Layer

Instructions:

Please complete this assignment by individuals. Both graduate and undergraduate students are expected to complete this assignment.

Getting Started

The objectives of this assignment are to gain hands-on experience with TCP.

Install Dependencies

Make sure that curl is installed.

```
$ sudo apt install curl
```

Update Cougarnet

Make sure you have the most up-to-date version of Cougarnet installed by running the following in your cougarnet directory:

```
$ git pull
$ python3 setup.py build
$ sudo python3 setup.py install
```

Remember that you can always get the most up-to-date documentation for Cougarnet here.

Start the Network

File h2-s1.cfg contains a configuration file that describes a network with two hosts, a and b, connected to switch s1.

Run the following command to create and start the network:

```
$ cougarnet --display --wireshark=a-s1 h2-s1.cfg
```

Begin Packet Capture

Now go to the open Wireshark window, click the "Capture Options" button (the gear icon). Select the s1-a interface for packet capture.

TCP Analysis of Large HTTP Response

This part is an exercise to help you understand SMTP.

Getting Started

Make sure the file jhu-y-mtn.jpg is in the current directory. Then run the following command on host b to start an HTTP server listening:

```
b$ python3 -m http.server
```

On host a run the following:

```
a$ curl -o /dev/null http://10.0.0.2:8000/jhu-y-mtn.jpg
```

This will request the file jhu-y-mtn.jpg from 10.0.0.2 (host b) port 8000 and store it to /dev/null (nowhere).

Now go to the wireshark output. You should see the control packets associated with a TCP three-way handshake, followed by a TCP segment from 10.0.0.1 containing an HTTP GET request, followed by a bunch of ACK packets from 10.0.0.2. Right-click on one of the packets, then hover over "Protocol Preferences" in the menu that appears, then "Transmission Control Protocol". Now uncheck the box that says "Allow subdissector to reassemble TCP streams. When "reassembling" is enabled, Wireshark combines all TCP segments associated with a single HTTP response, which behavior is confusing when analyzing TCP. Once unchecked, you should see the individual segments associated with separate packets.

Now select "Statistics" from the Wireshark menu. Then hover over "TCP Stream Graphs" in the menu that appears. Finally, click on "Time Sequence (Stevens").

In the graph, each dot represents a TCP segment being sent by b (the HTTP server responding to the HTTP request), the sequence number of which is the y-value of the dot. The almost-vertical stacks of dots represent TCP segments that are sent back-to-back. The "width" of a stack represents the time required to transmit those segments--that is, the xvalue of the last segment in the stack minus the x-value of the first segment in the stack. The horizontal lines in between stacks represent the time in which the host is waiting, idle, for inflight bytes to be acknowledged before sending more. Thus, initially, the length of these lines is very close to the round-trip time (RTT), i.e., the time it takes for the segments to propagate to their destination and the acknowledgments to propagate back to the sender.

Exercises

Answer the questions below:

1. Beginning at time 0, when the first stack of segments (i.e., round 1) is issued, through the time the eighth stack of segments (i.e., round 8) is issued, how does the send window grow? That is, how does the number of bytes (and segments) sent in round i compare to the number sent in round i - 1?

2. Based on your response to the previous problem, what congestion control state would you say that the sender is in during the sending of these first 8 rounds?

3. How does the idle time change as the rounds increase? Briefly explain why.

4. Explain what the graph will look like if the current pattern holds.

What to turn in:

Please note that you should submit your assignment on Gradescope. (We will not accept submissions on Canvas.)

Please prepare a PDF file including these sections:

1. Answers to the questions [5 points each, 20 points total]