**NET 562**

**Homework #2**

Winter 2022

Due by 11:59 pm on Sunday, January 30, 2022

50 points total

1. (28 points total)
   1. (2 pts) Open up a browser and go to <http://www.itu.int/rec/T-REC-G.102-198811-I/en>. This page will show you several files that you can download from the ITU site in Switzerland (i.e., freely available pdfs). Paste in a screen shot of the browser window.
   2. (2 pts) Open another browser window, go to <http://speedtest.net>. Choose the SIG-Telecom, Geneva, Switzerland server and do the test. Take a screenshot showing the location of the speedtest server, your round-trip time (RTT) or ‘ping time’, the download speed and the upload speed resulting from this test and paste it here.
   3. (2 pts) Assuming that your RTT and download bandwidth from the ITU site in Switzerland will be the same as your test in (b), calculate the Bandwidth Delay Product (BDP) for this download.
   4. (10 pts—2 pts each) Set up Wireshark to start capturing packets. Go back to the ITU site and click on the top “PDF (acrobat)” link to download the G.102 document in English in PDF format (size 81522 bytes). Complete the download. Stop the Wireshark capture.
      1. In the Wireshark trace, select the first TCP segment (with SYN flag only set) that your computer sends to the ITU server to open the TCP connection. Open up the packet detail information in the center part of Wireshark to show the initial window size and TCP options. Paste a screenshot here.
      2. What is the initial window size that your computer specifies in this segment? Is it greater or less than the BDP? Be sure to consider window scale factor.
      3. What TCP options does your computer specify? Include the values.
      4. Now click on the ITU server response (with SYN, ACK bits set). What TCP options are specified here? Include the values for each option.
      5. Total time to download the file (from TCP SYN to final packet in Wireshark)
   5. Click on one of the packets in Wireshark and use the “Follow TCP Stream” option under Analyze to **isolate the ITU download packets** (hint: this is the data stream from server to client). Then click on Statistics 🡺 TCP Stream Graph 🡪 Time/Sequence Graph (tcptrace) to get a graph of TCP Sequence Number vs. Time.
      1. (2 pts) Paste a screenshot of this Time/Sequence Graph window only here.
      2. (6 pts) Examine this graph and describe the performance information that you see. Does the Window size ever go to zero? How many separate “TCP Bursts” do you see in the download? Are there places where packets are lost?
   6. Click on one of the packets in Wireshark and use the “Follow TCP Stream” option under Analyze to **isolate the ITU ACK packets** (hint: this is the data stream from server to client).
      1. (2 pts) Paste a screenshot of this Time/Sequence Graph window only here.
      2. (2 pts) Examine this graph and describe what you see.
2. (22 points total) Open the wireless-download.pcap file in Wireshark. This file shows a file download to a PC over a wireless link.
   1. (4 pts) Create a Time/Sequence (tcptrace) graph for the download data packets. Paste a screenshot here. Examine this graph and describe what you see.
   2. (4 pts) There should be many TCP bursts in this graph. Calculate the burst download throughput in bits/sec for the burst that begins at time 0.405961 and ends at time 0.487695.
   3. (4 pts) Calculate the overall average download throughput in bits/sec for all data in the file.
   4. Click on packet #177 in this file, which is a TCP ACK with Selective ACK (SACK).
      1. (2 pts) Create a Time/Sequence (tcptrace) graph for the ACK packets. Paste a screenshot here.
      2. (4 pts) Based on this ACK and the SACK information in TCP Options, what are the sequence numbers of all bytes successfully received so far? You should list 3 separate ranges of bytes that have been received successfully, based on SACK information.
      3. (4 pts) Based on this ACK and assuming that all TCP data packets are full-sized (MSS) and either arrive in-order or have been lost in transit, how many packets have been lost and need to be retransmitted by the sender to fill in all “holes” in this transmission? How do you know?