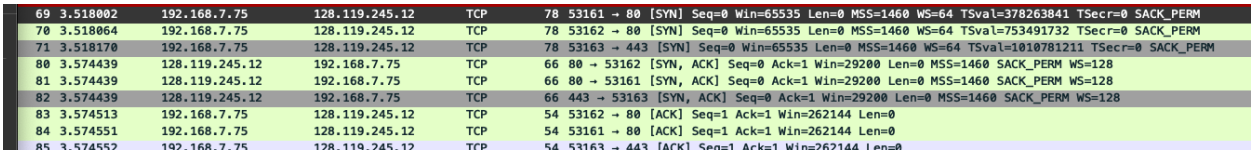
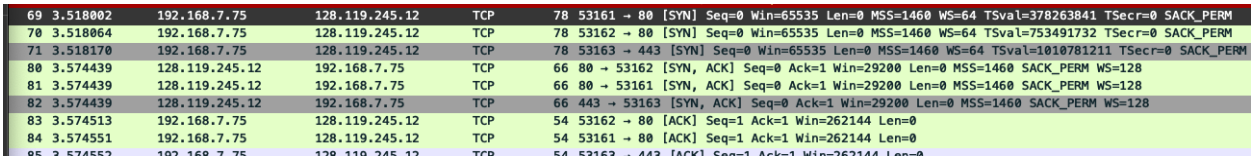
Marcos Ondruska
Student id: 2685885
Project 2

2) The IP address of gaia.cs.umass.edu is 128.119.245.12, and the port numbers are Port 80 for HTTP and Port 443 for HTTPS.



69	3.518002	192.168.7.75	128.119.245.12	TCP	78 53161 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=378263841 TSecr=0 SACK_PERM
70	3.518064	192.168.7.75	128.119.245.12	TCP	78 53162 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=753491732 TSecr=0 SACK_PERM
71	3.518170	192.168.7.75	128.119.245.12	TCP	78 53163 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=1010781211 TSecr=0 SACK_PERM
80	3.574439	128.119.245.12	192.168.7.75	TCP	66 80 → 53162 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
81	3.574439	128.119.245.12	192.168.7.75	TCP	66 80 → 53161 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
82	3.574439	128.119.245.12	192.168.7.75	TCP	66 443 → 53163 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
83	3.574513	192.168.7.75	128.119.245.12	TCP	54 53162 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0
84	3.574551	192.168.7.75	128.119.245.12	TCP	54 53161 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0

3) The IP address of my client computer is 192.168.7.75, and the port numbers used are Port 80 for HTTP and Port 443 for HTTPS.



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71	3.518170	192.168.7.75	128.119.245.12	TCP	78 53163 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=1010781211 TSecr=0 SACK_PERM
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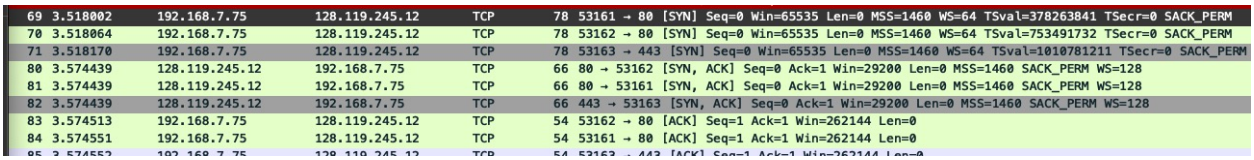
81	3.574439	128.119.245.12	192.168.7.75	TCP	66 80 → 53161 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
82	3.574439	128.119.245.12	192.168.7.75	TCP	66 443 → 53163 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
83	3.574513	192.168.7.75	128.119.245.12	TCP	54 53162 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0
84	3.574551	192.168.7.75	128.119.245.12	TCP	54 53161 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0

4) The sequence number of the TCP SYN that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu is “0”. The [SYN} in the info section identifies the SYN segment.



69	3.518002	192.168.7.75	128.119.245.12	TCP	78 53161 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=378263841 TSecr=0 SACK_PERM
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81	3.574439	128.119.245.12	192.168.7.75	TCP	66 80 → 53161 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
82	3.574439	128.119.245.12	192.168.7.75	TCP	66 443 → 53163 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
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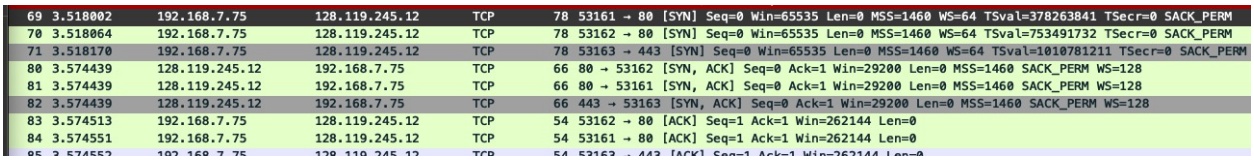
84	3.574551	192.168.7.75	128.119.245.12	TCP	54 53161 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0

5) The sequence number of the SYNACK segment sent by gaia.cs.umass.edu is “0”. The value of the acknowledgement field in the SYNACK segment is “1”. Gaia.cs.umass.edu determined the acknowledgement value from the client sequence number (mine) and then adds 1 (0 + 1 = 1). The item that identifies the SYNACK is the [SYN, ACK] in the info section



69	3.518002	192.168.7.75	128.119.245.12	TCP	78 53161 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=378263841 TSecr=0 SACK_PERM
70	3.518064	192.168.7.75	128.119.245.12	TCP	78 53162 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=753491732 TSecr=0 SACK_PERM
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81	3.574439	128.119.245.12	192.168.7.75	TCP	66 80 → 53161 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128
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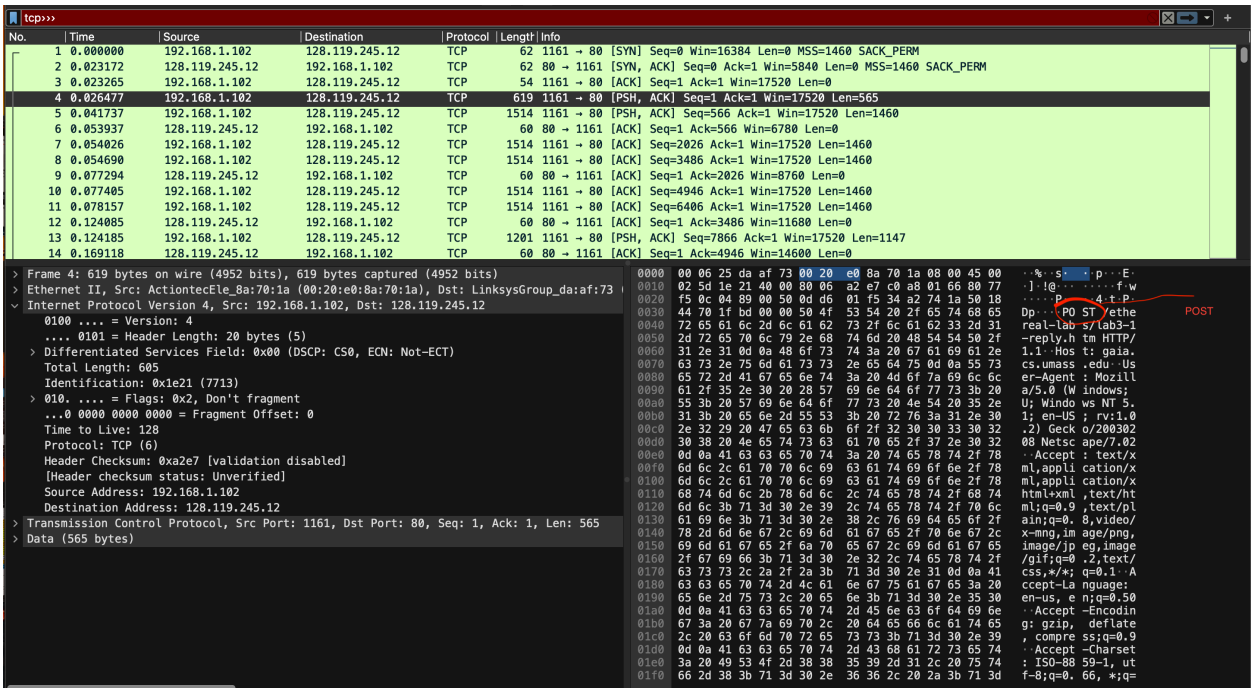
83	3.574513	192.168.7.75	128.119.245.12	TCP	54 53162 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0
84	3.574551	192.168.7.75	128.119.245.12	TCP	54 53161 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0

6) The sequence number of the TCP segment containing the HTTP POST is “1”.



7) The sequence numbers of the first six segments starting with the HTTP POST are (1, 566, 2026, 3486, 4946, 6406). Each of the segments was sent at the following times (0.026477, 0.041737, 0.054026, 0.054690, 0.077405, 0.078157). Each ACK was received as follows respectively (0.053937, 0.077294, 0.124085, 0.124185, 0.169118, 0.217299). RTT for each of the 6 segments is as follows (0.053937-0.026477=0.02746, 0.077294-0.041737 = 0.035557, 0.124085-0.054026=0.070059, 0.124185-0.054690=0.069495, 0.169118-0.077405=0.091713, 0.217299-0.078157=0.139142).

The equation on Page 242 of the textbook for Estimated Round Trip Time is:

EstimatedRTT = (1 – alpha) * EstimatedRTT + (alpha * sample RTT)

The sample value for alpha in the book is 0.125, therefore I will use the same value as per instructions. Estimated RTT for the first segment will equal its RTT, all others are EstimatedRTT.

Therefore Estimated RTT for the segments are (0.027460,

(1-0.125) * 0.027460 + 0.125*0.035557 = 0.028498,

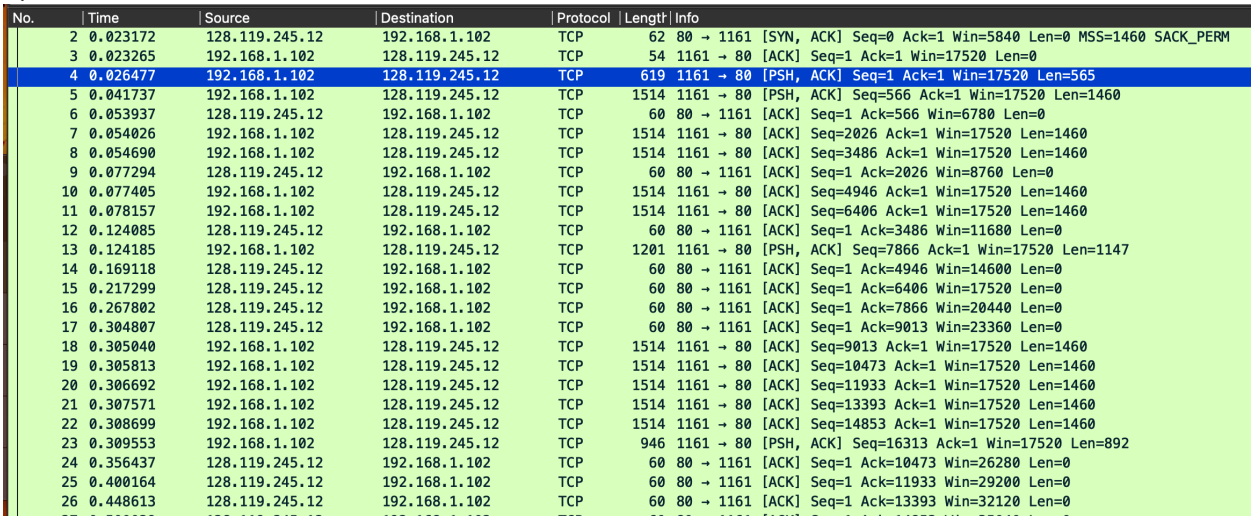
(1-0.125) * 0.028498 + 0.125*0.070059 = 0.0.033607,

(1-0.125) * 0.033607 + 0.125*0.069495 = 0.037684,

(1-0.125) * 0.037684 + 0.125*0.0.091713 = 0.044731,

(1-0.125) * 0.0.044731 + 0.125*0.0.139142 = 0.0.056836)

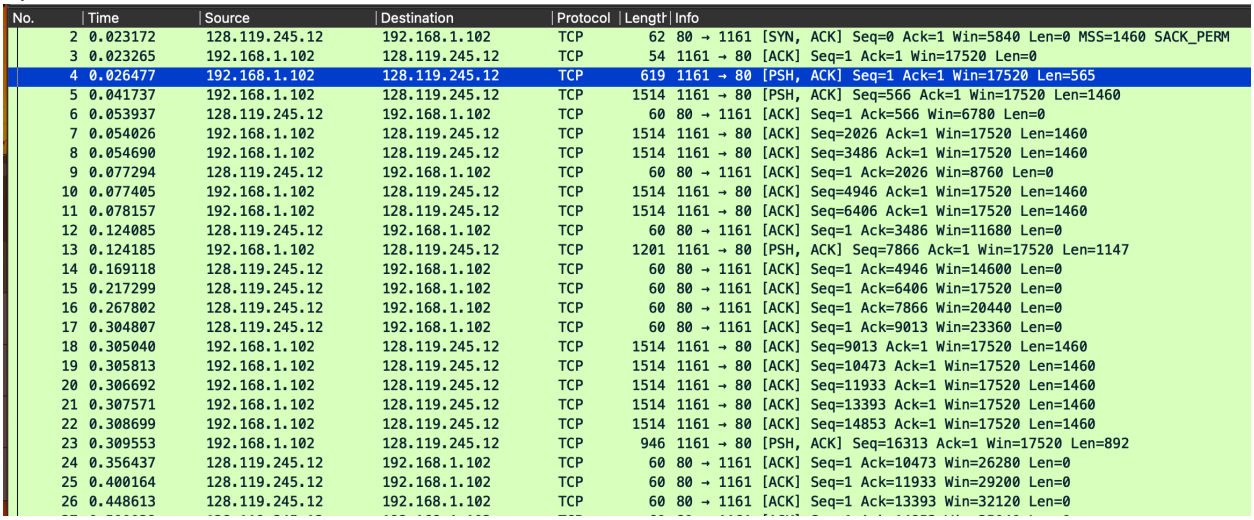
8)



No.	Time	Source	Destination	Protocol	Length	Info
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460
21	0.307571	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=13393 Ack=1 Win=17520 Len=1460
22	0.308699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=14853 Ack=1 Win=17520 Len=1460
23	0.309553	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=16313 Ack=1 Win=17520 Len=892
24	0.356437	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=10473 Win=26280 Len=0
25	0.400164	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=11933 Win=29200 Len=0
26	0.448613	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=13393 Win=32120 Len=0

The lengths of the first six segments are:
(565, 1460, 1460, 1460, 1460, 1460)

9)



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6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
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25	0.400164	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=11933 Win=29200 Len=0
26	0.448613	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=13393 Win=32120 Len=0

The initial window size is initially advertised as 5840 bytes in packet no 2. This 5840 looks to be the minimum amount of available buffer space advertised.
It does not seem that there is throttling due to a lack of available buffer space. The Advertised window space starts at 5840 bytes and steadily increases to a maximum of 62780 over time. There don't seem to be any instances where the window size drops to a very low value or zero, and the client doesn't seem to be affected as they continue to send full sized segments (1460 bytes) all the way through the trace. There also don't seem to be any long pauses in the data transmission.

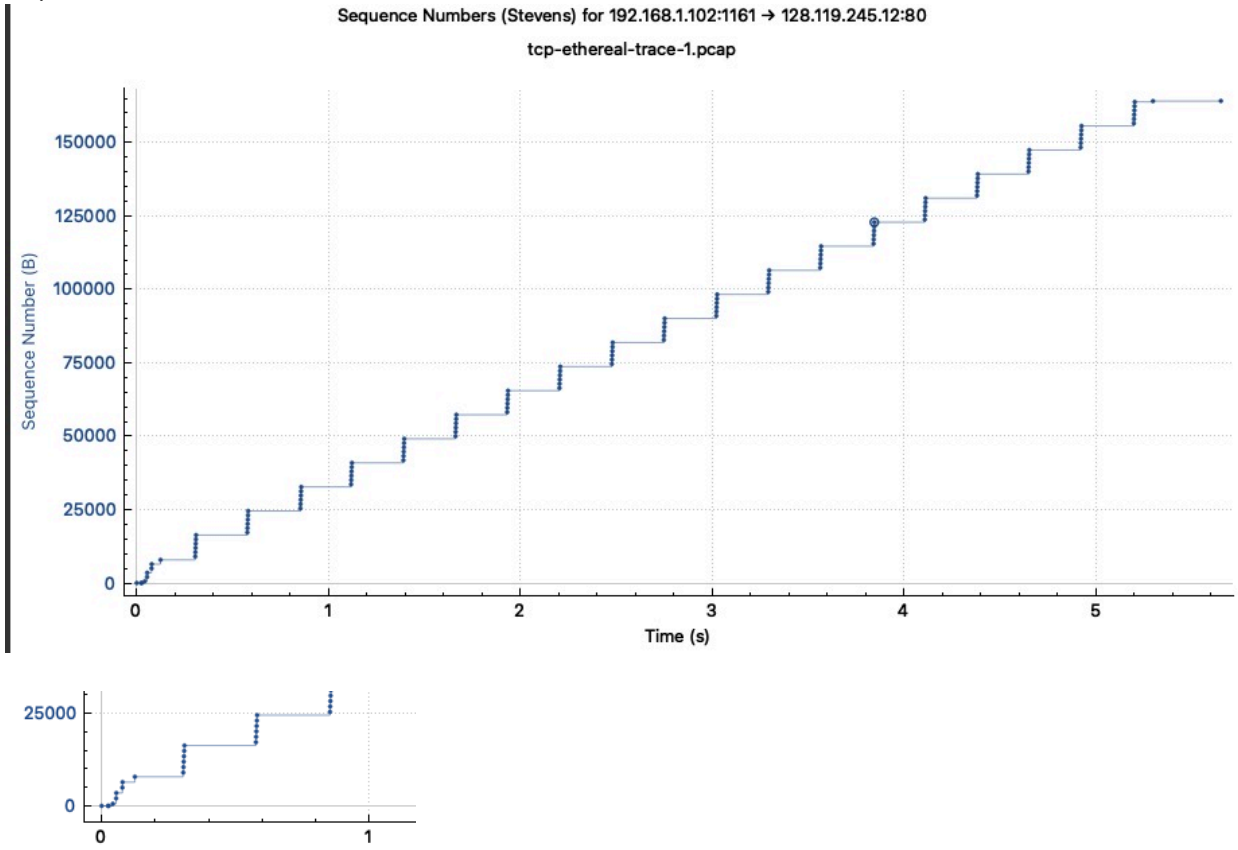
10) There seem to be no duplicate sequence numbers in any of the transmissions, there also seem to be no duplicate ACKs that might seem like packet loss. I have also checked

Wireshark for retransmissions at Analyze-> Expert information, and there seem to be no retransmissions there. So in short, I checked for Duplicate Sequence numbers, Duplicate ACK's, and Wireshark's Expert Analysis for any flags.

11) The receiver typically acknowledges 1460 bytes in an ACK, which represents the MSS (maximum segment size) of the sender's packets. I don't see any cases where the receiver is ACKing every other received segment.

12) Packet 202 shows that the seq ends with a total of 164091 bytes of data sent. The total time of the transfer would be calculated by taking the time at packet 202 of 5.45583 and subtracting the start time in packet 4 of 0.026477. So total time would be 5.45583-0.026477 =5.429353 seconds. To calculate throughput you would use the formula:
Throughput = total data transferred / total time
= 164091 / 5.429353
= approx 30223 bytes/second

13)



Given the graph and the zoom in of the graph, the slow start phase starts at 0 seconds and seems to end just before 0.1 seconds. This is where the sequence

numbers increase in smaller sizes initially and then end up increasing quickly. The congestion window increases exponentially during this phase.
When slow start ends (just before 0.1 seconds) congestion avoidance takes over.
The biggest differences from the idealized behavior of TCP that is in the material is that all examples seemed to have a situation where there was packet loss and then the congestion window was reset. There doesn't seem to be a reset at all and potentially another slow start. The graph itself also seem very linear, which probably shows that the MSS of the client doesn't overwhelm the server at all.