

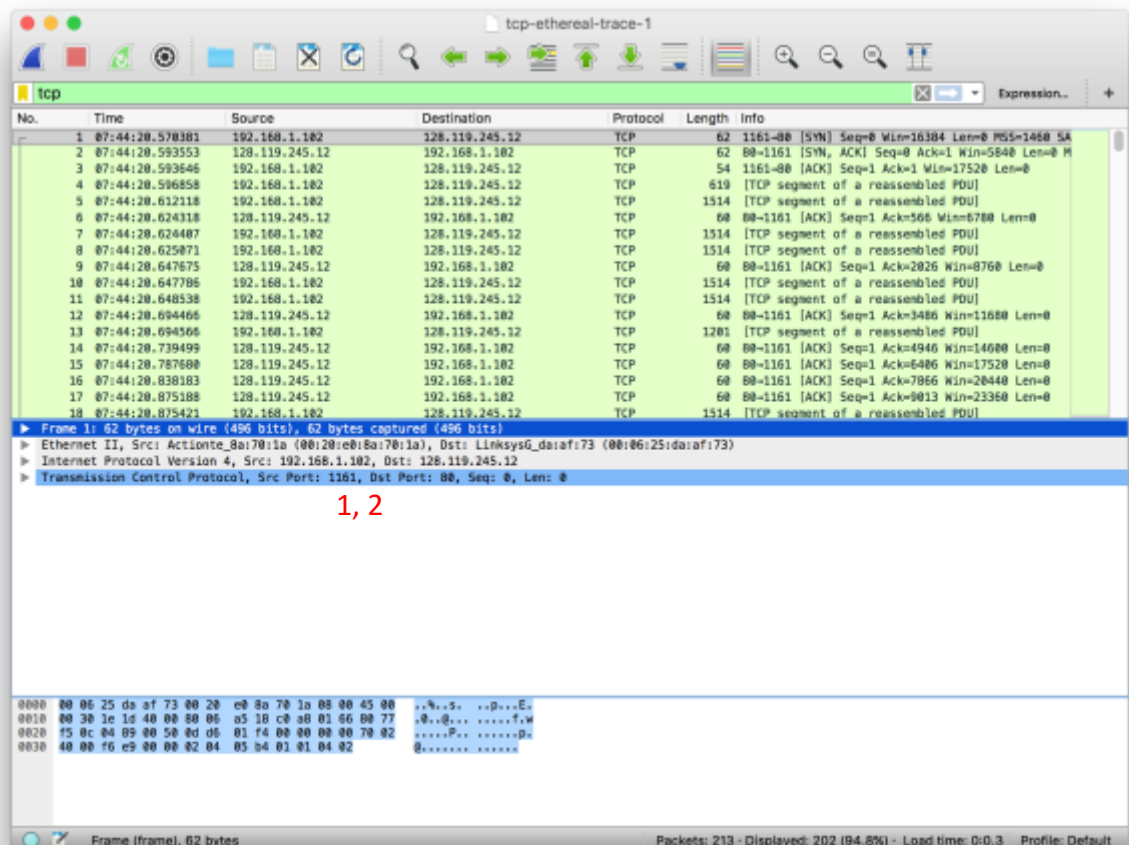
### LAB 3

1. What is the IP address and TCP port number used by the client computer (source) that is transferring the file to gaia.cs.umass.edu? To answer this question, it's probably easiest to select an HTTP message and explore the details of the TCP packet used to carry this HTTP message, using the "details of the selected packet header window" (refer to Figure 2 in the "Getting Started with Wireshark" Lab if you're uncertain about the Wireshark windows).

Answer: The client IP address is 192.168.1.102 and the TCP port is 1161

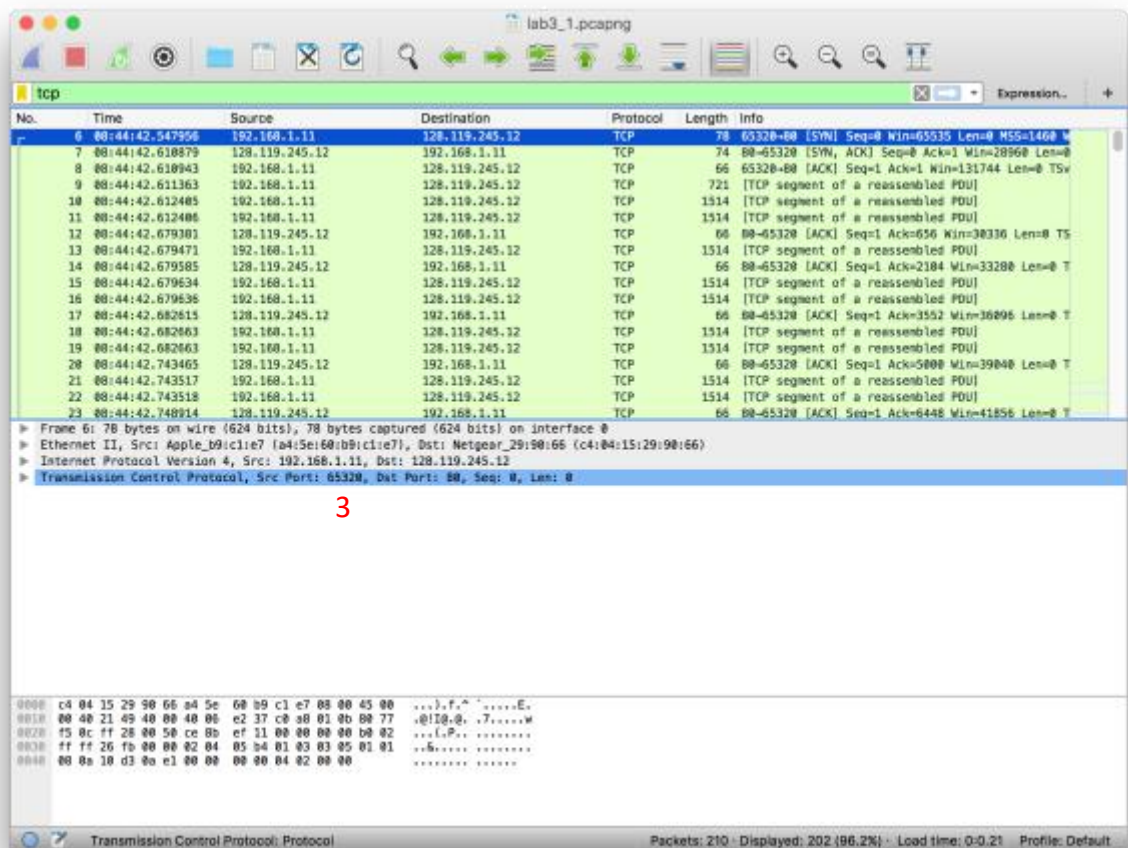
2. What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection?

Answer: The IP address of gaia.cs.umass.edu is 128.119.245.12 and the TCP port is 80.



3. What is the IP address and TCP port number used by your client computer (source) to transfer the file to gaia.cs.umass.edu?

Answer: The IP of my client is 192.168.1.11 and the TCP port is 65320.



No.	Time	Source	Destination	Protocol	Length	Info
6	00:44:42.547956	192.168.1.11	128.119.245.12	TCP	78	65320->0 [SYN] Seq=0 Win=65535 Len=0 MSS=1460
7	00:44:42.618879	128.119.245.12	192.168.1.11	TCP	74	80->65320 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0
8	00:44:42.618943	192.168.1.11	128.119.245.12	TCP	66	65320->80 [ACK] Seq=1 Ack=1 Win=131744 Len=0 TSv
9	00:44:42.611363	192.168.1.11	128.119.245.12	TCP	721	[TCP segment of a reassembled PDU]
10	00:44:42.612485	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
11	00:44:42.612486	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
12	00:44:42.679381	128.119.245.12	192.168.1.11	TCP	66	80->65320 [ACK] Seq=1 Ack=656 Win=38336 Len=0 TS
13	00:44:42.679471	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
14	00:44:42.679585	128.119.245.12	192.168.1.11	TCP	66	80->65320 [ACK] Seq=1 Ack=2184 Win=33280 Len=0 T
15	00:44:42.679634	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
16	00:44:42.679636	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
17	00:44:42.682615	128.119.245.12	192.168.1.11	TCP	66	80->65320 [ACK] Seq=1 Ack=3552 Win=16896 Len=0 T
18	00:44:42.682663	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
19	00:44:42.682663	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
20	00:44:42.743465	128.119.245.12	192.168.1.11	TCP	66	80->65320 [ACK] Seq=1 Ack=5000 Win=39040 Len=0 T
21	00:44:42.743517	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
22	00:44:42.743518	192.168.1.11	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
23	00:44:42.748914	128.119.245.12	192.168.1.11	TCP	66	80->65320 [ACK] Seq=1 Ack=6448 Win=41856 Len=0 T

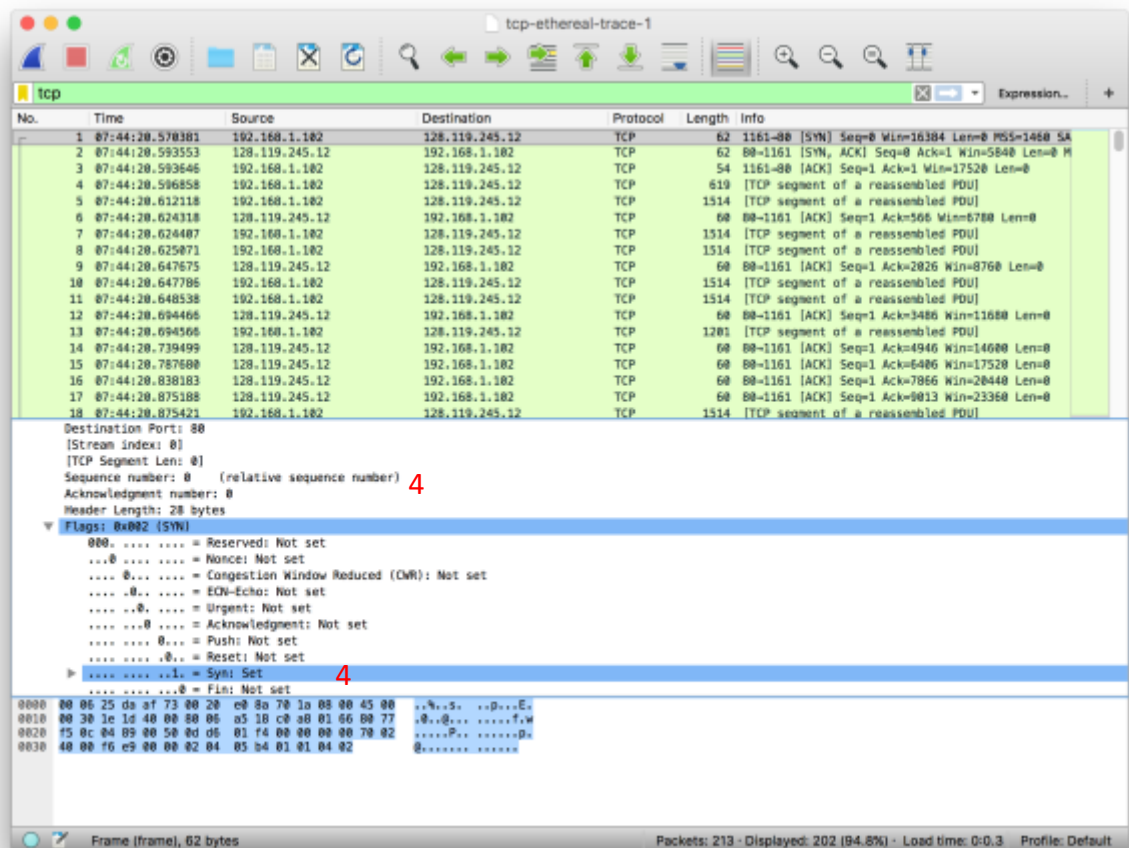
Frame 6: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface 0  
Ethernet II, Src: Apple\_b0ic1e7 (a4:5e:60:b0:ic1e7), Dst: Netgear\_29:90:66 (c4:04:15:29:90:66)  
Internet Protocol Version 4, Src: 192.168.1.11, Dst: 128.119.245.12  
Transmission Control Protocol, Src Port: 65320, Dst Port: 80, Seq: 0, Len: 0

3

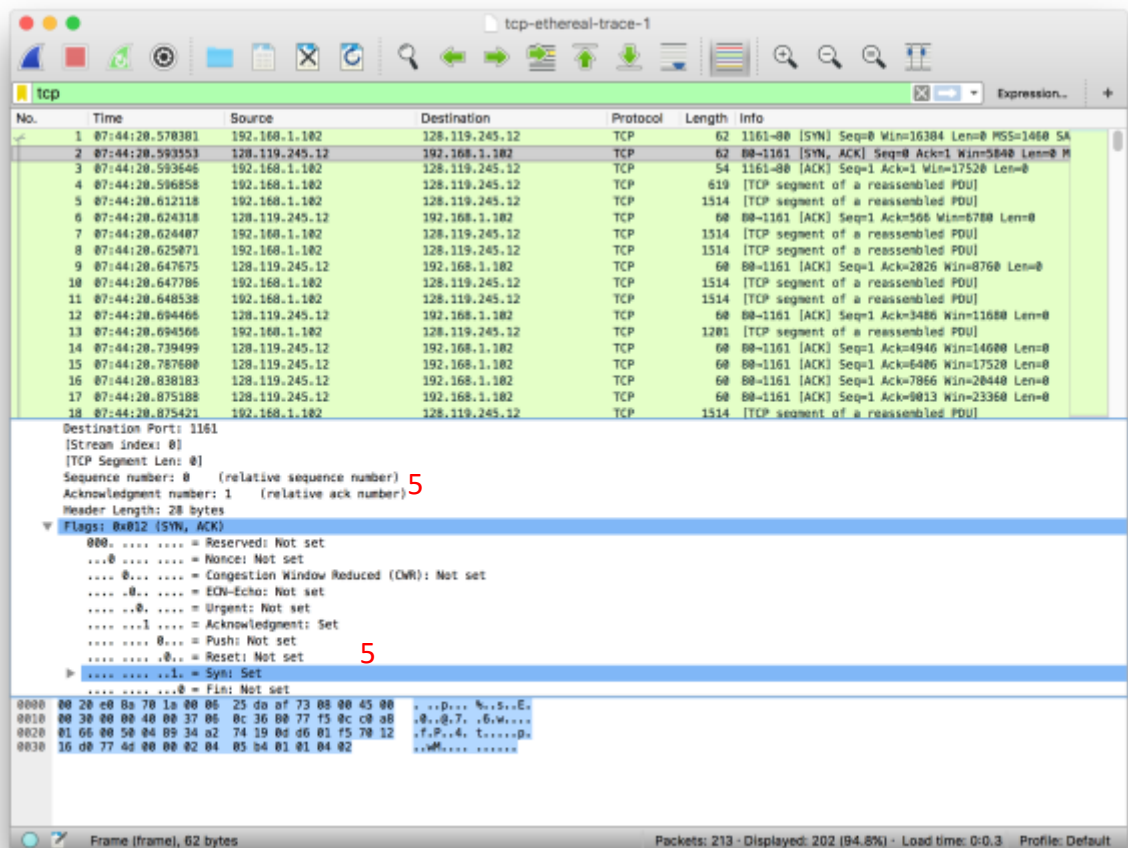
0000 c4 04 15 29 90 66 a4 5e 60 b0 c1 e7 05 00 45 00 ... .F.^ .....E.  
0010 00 40 21 49 40 00 40 06 e2 37 c0 a8 01 0b 00 77 ... @!Q@. .7.....W  
0020 f5 0c ff 28 00 50 ce 8b ef 11 00 00 00 00 00 02 ... .L.P. ....  
0030 ff ff 26 fb 00 00 02 04 05 04 01 03 03 05 01 01 ... &.....  
0040 00 0a 10 d3 0a e1 00 00 00 00 04 02 00 00 ..... .....

Transmission Control Protocol, Protocol Packets: 210 · Displayed: 202 (96.2%) · Load time: 0-0:21 Profile: Default

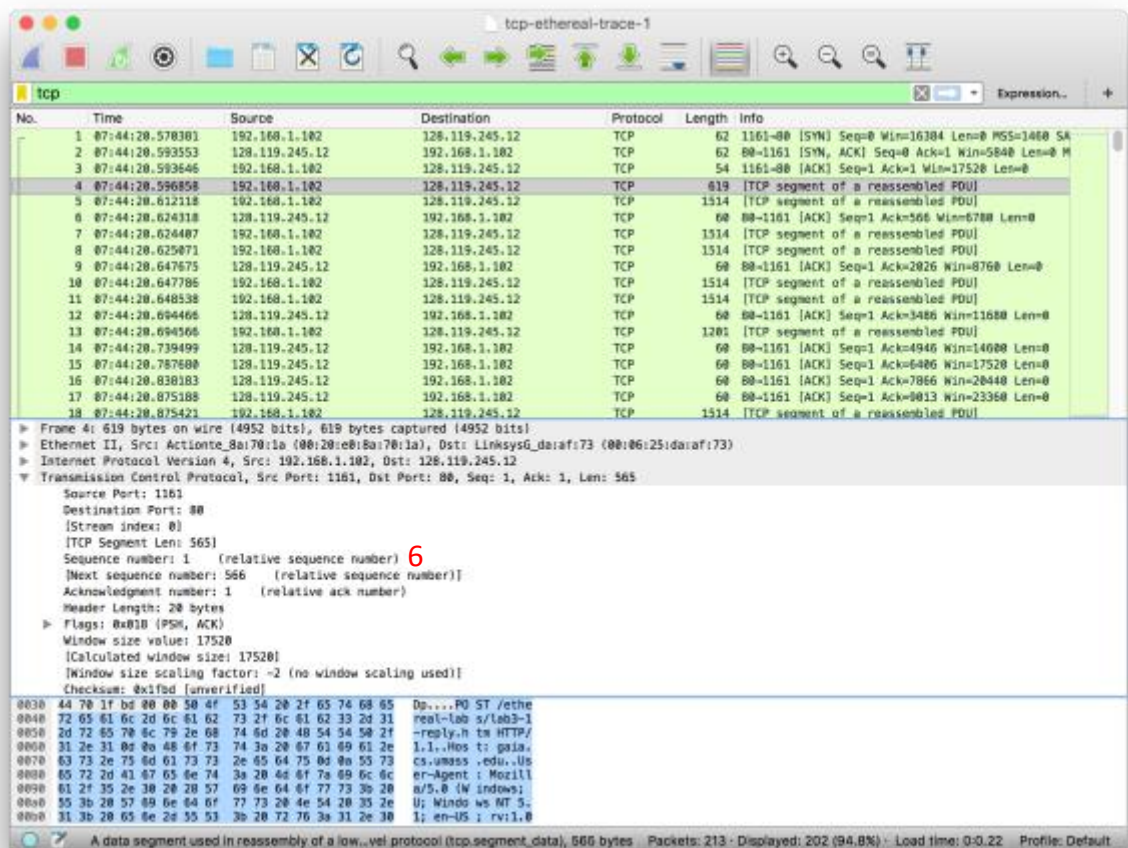
4. What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu? What is it in the segment that identifies the segment as a SYN segment?
- Answer: The sequence number is 0 for this segment. It is identified by the SYN flag being set to 1.



5. What is the sequence number of the SYNACK segment sent by gaia.cs.umass.edu to the client computer in reply to the SYN? What is the value of the Acknowledgement field in the SYNACK segment? How did gaia.cs.umass.edu determine that value? What is it in the segment that identifies the segment as a SYNACK segment?
- Answer: The sequence number is 1 for this segment. The value of the acknowledgment field is 1. This number was determined by gaia.cs.umass.edu by adding 1 to the sequence number. The sequence is identified as SYNACK because both the SYN and Acknowledgement flags are set to 1.



6. What is the sequence number of the TCP segment containing the HTTP POST command? Note that in order to find the POST command, you'll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with a "POST" within its DATA field.  
Answer: The sequence number is 1.



- Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection. What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST)? At what time was each segment sent? When was the ACK for each segment received? Given the difference between when each TCP segment was sent, and when its acknowledgement was received, what is the RTT value for each of the six segments? What is the EstimatedRTT value (see Section 3.5.3, page 242 in text) after the receipt of each ACK? Assume that the value of the EstimatedRTT is equal to the measured RTT for the first segment, and then is computed using the EstimatedRTT equation on page 242 for all subsequent segments.

Note: Wireshark has a nice feature that allows you to plot the RTT for each of the TCP segments sent. Select a TCP segment in the “listing of captured packets” window that is being sent from the client to the gaia.cs.umass.edu server. Then select: Statistics->TCP Stream Graph- >Round Trip Time Graph.

Answer: If the segment containing the HTTP POST is considered to be the first segment, the following table displays the data asked for above:

	Sequence Number	Time Sent	Ack Received	RTT
Segment 1	1	.026477	.053937	0.02746
Segment 2	566	.041737	.077294	0.035557
Segment 3	2026	.054026	.124085	0.070059
Segment 4	3486	.054690	.169118	0.114428
Segment 5	4946	.077405	.217299	0.139894
Segment 6	6406	.078157	.267802	0.189645

$\text{EstimatedRTT} = 0.875 * \text{EstimatedRTT} + 0.125 * \text{sampleRTT}$

Initial EstimatedRTT = .02746

After	EstimatedRTT (seconds)
Segment 1	.02746
Segment 2	.02847
Segment 3	.03367
Segment 4	.04376
Segment 5	.05578
Segment 6	.07251



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161->80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=
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
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	610	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=566 Win=6788 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
8	0.054090	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=1486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	[TCP segment of a reassembled PDU]
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=5406 Win=17520 Len=0
16	0.267882	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304887	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=8013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]

Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 565

Source Port: 1161  
Destination Port: 80  
[Stream index: 0]  
[TCP Segment Len: 565]

Sequence number: 1 (relative sequence number)  
Next sequence number: 566 (relative sequence number)  
Acknowledgment number: 1 (relative ack number)  
Header Length: 20 bytes  
Flags: 0x018 (PSH, ACK)  
Window size value: 17520  
[Calculated window size: 17520]  
[Window size scaling factor: -2 (no window scaling used)]  
Checksum: 0x1fbd [unverified]  
[Checksum Status: Unverified]  
Urgent pointer: 0  
[SEQ/ACK analysis]

0020 15 0c 04 09 00 50 0d d6 01 f5 34 a2 74 1a 50 18 .....P...4.t.P.  
0030 44 70 1f bd 00 00 50 4f 53 54 20 2f 65 74 68 65 Dp....P0 ST /ethe  
0040 72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 33 2d 31 real-lab s/lab3-1  
0050 2d 72 65 70 6c 79 2e 68 74 8d 20 48 54 54 50 2f -reply.h tn HTTP/  
0060 31 2e 31 08 0a 48 6f 73 74 3a 20 67 61 69 61 2e 1.1..Pos ti gala.  
0070 63 73 2e 75 60 61 73 73 2e 65 64 75 0a 0a 53 73 cs.umass .edu..Us  
0080 65 72 2d 41 87 65 6e 74 3a 20 4d 6f 7a 09 6c 6c er-Agent : Morill  
0090 61 2f 35 2e 30 20 20 57 69 6e 64 6f 77 73 30 20 a/5.8 (W indows;  
00a0 55 3b 20 57 69 6e 64 6f 77 73 20 4e 54 20 35 2e U; Windo ws NT 5.

TCP Segment Len (tcp.len), 1 byte

Packets: 213 · Displayed: 202 (94.8%) · Marked: 6 (2.8%) · Load time: 0:0.22 Profile: Default

8. What is the length of each of the first six TCP segments?  
Answer: The length of the first segment is 565 bytes (see screenshot above) and each segment after that is 1460 bytes.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161->80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=
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
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=566 Win=6788 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
8	0.054090	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=1468 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	[TCP segment of a reassembled PDU]
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=5406 Win=17520 Len=0
16	0.267882	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304887	128.119.245.12	192.168.1.102	TCP	60	80->1161 [ACK] Seq=1 Ack=8013 Win=23360 Len=0
18	0.305840	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]

Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 566, Ack: 1, Len: 1468

Source Port: 1161  
Destination Port: 80  
[Stream index: 0]  
[TCP Segment Len: 1468] 8  
Sequence number: 566 (relative sequence number)  
[Next sequence number: 2026 (relative sequence number)]  
Acknowledgment number: 1 (relative ack number)  
Header Length: 20 bytes  
Flags: 0x018 (PSH, ACK)  
Window size value: 17520  
[Calculated window size: 17520]  
[Window size scaling factor: -2 (no window scaling used)]  
Checksum: 0x3be5 [unverified]  
[Checksum Status: Unverified]  
Urgent pointer: 0  
[SEQ/ACK analysis]

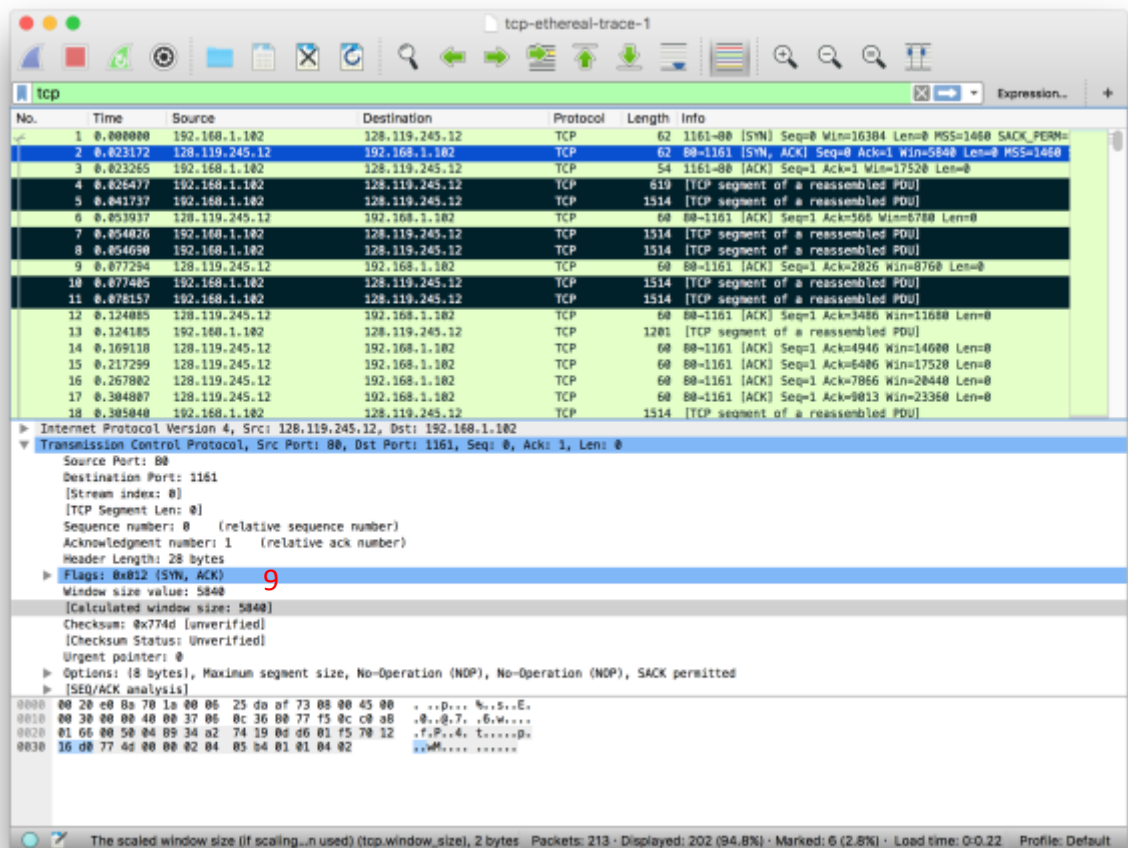
0020 15 0c 04 09 00 50 0d d5 04 20 34 a2 74 1a 50 18 .....P...4.t.P.  
0030 44 70 3b e5 00 00 43 6f 6e 74 65 6e 74 2d 54 79 Daj...Co ntent-Ty  
0040 70 65 3a 20 6d 75 6c 74 69 70 61 72 74 2f 66 6f pe: mult ipart/fo  
0050 72 66 2d 64 61 74 61 3b 20 62 6f 75 6e 64 61 72 m-data: boundar  
0060 79 36 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d ys-----  
0070 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 32 36 35 -----265  
0080 30 30 31 39 31 36 39 31 35 37 32 34 0d 0a 43 6f 00191091 3724..Co  
0090 6e 74 65 6e 74 2d 4c 65 6e 07 74 00 3a 20 31 36 ntent-Le ngth: 16  
00a0 33 34 31 31 0d 0a 0d 0a 2d 2d 2d 2d 2d 2d 2d 2d 3411.....

TCP Segment Len (tcp.len), 1 byte

Packets: 213 · Displayed: 202 (94.8%) · Marked: 6 (2.8%) · Load time: 0:0.22 Profile: Default

9. What is the minimum amount of available buffer space advertised at the receiver for the entire trace? Does the lack of receiver buffer space ever throttle the sender?  
Answer: The minimum amount of buffer space is 5840 bytes, which can be seen in the initial ACK from the server. After reviewing the trace, I did not notice any evidence of the receiver ever throttling the sender. The window size grows throughout the entire transmission process.

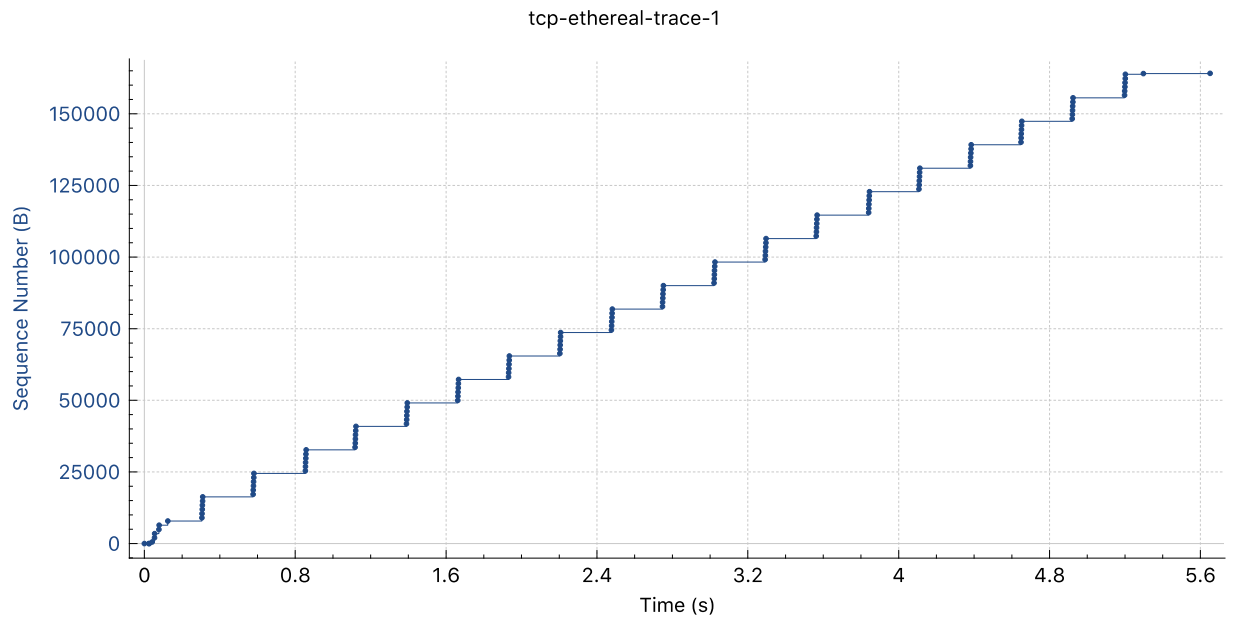




10. Are there any retransmitted segments in the trace file? What did you check for (in the trace) in order to answer this question?

Answer: I did not notice any retransmitted segments in the trace file. I confirmed this by reviewing all of the sequence numbers for all the TCP segments. I also reviewed the time-sequence-graph.

### Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80



11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 250 in the text).

Answer: Initially the receiver is acknowledging data the size of 1460 bytes. As time goes on though I do see data being acknowledge every other segment. For example, segment 69 acknowledge 2920 bytes.

No.	Time	Source	Destination	Protocol	Length	Info
59	07:44:21.778882	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=35849 Win=62780 Len=0
60	07:44:21.835487	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=37969 Win=62780 Len=0
61	07:44:21.932455	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=48889 Win=62780 Len=0
62	07:44:21.958267	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=41781 Win=62780 Len=0
63	07:44:21.958491	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=41781 Ack=1 Win=17520 Len=146
64	07:44:21.951285	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=43241 Ack=1 Win=17520 Len=146
65	07:44:21.952864	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=44781 Ack=1 Win=17520 Len=146
66	07:44:21.962975	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=46161 Ack=1 Win=17520 Len=146
67	07:44:21.963771	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=47621 Ack=1 Win=17520 Len=146
68	07:44:21.964583	192.168.1.182	128.119.245.12	TCP	946	1161->80 [PSH, ACK] Seq=48881 Ack=1 Win=17520 Len=146
69	07:44:22.058594	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=44781 Win=62780 Len=0
70	07:44:22.155161	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=47621 Win=62780 Len=0
71	07:44:22.231894	128.119.245.12	192.168.1.182	TCP	60	80->1161 [ACK] Seq=1 Ack=49973 Win=62780 Len=0
72	07:44:22.232115	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=49973 Ack=1 Win=17520 Len=146
73	07:44:22.232855	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=51433 Ack=1 Win=17520 Len=146
74	07:44:22.233696	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=52893 Ack=1 Win=17520 Len=146
75	07:44:22.234579	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=54353 Ack=1 Win=17520 Len=146
76	07:44:22.235635	192.168.1.182	128.119.245.12	TCP	1514	1161->80 [ACK] Seq=55813 Ack=1 Win=17520 Len=146

Frame 69: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0  
 Ethernet II, Src: LinksysG\_dai:af:73 (08:06:25:da:af:73), Dst: Actionte\_Ba:70:1a (00:20:e0:8a:70:1a)  
 Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.182  
 Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 44781, Len: 0

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00 ...P...%..S...E..  
 0010 00 20 50 8e 40 00 37 06 b3 af 00 77 f5 0c c0 a8 ...X...@.7...W....  
 0020 01 06 00 50 8e 40 09 34 a2 74 1a 06 d6 b0 91 50 10 ...f.P...@...t....P..  
 0030 f5 3c 17 08 00 00 7c 7d 00 00 0b 77 ...c....}...R..

12. What is the throughput (bytes transferred per unit time) for the TCP connection?

Explain how you calculated this value.

Answer: We can determine the throughput by determining the number of bytes transmitted and the total time it took to transmit. We then divide total transferred by time and we get our answer.

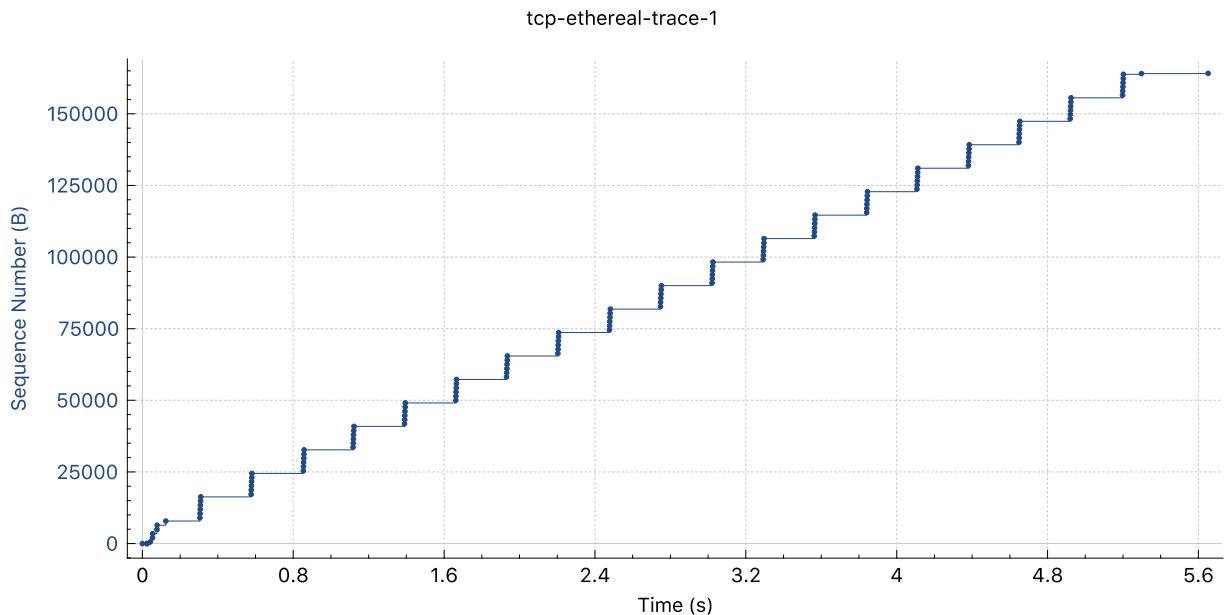
Total bytes transferred = 164090

Total Time = 5.455830 - .26477 = 5.4294

Throughput = total transferred/time = 164090/5.4294 = 30222.49 bytes/sec

13. Use the Time-Sequence-Graph(Stevens) plotting tool to view the sequence number versus time plot of segments being sent from the client to the gaia.cs.umass.edu server. Can you identify where TCP's slowstart phase begins and ends, and where congestion avoidance takes over? Comment on ways in which the measured data differs from the idealized behavior of TCP that we've studied in the text.

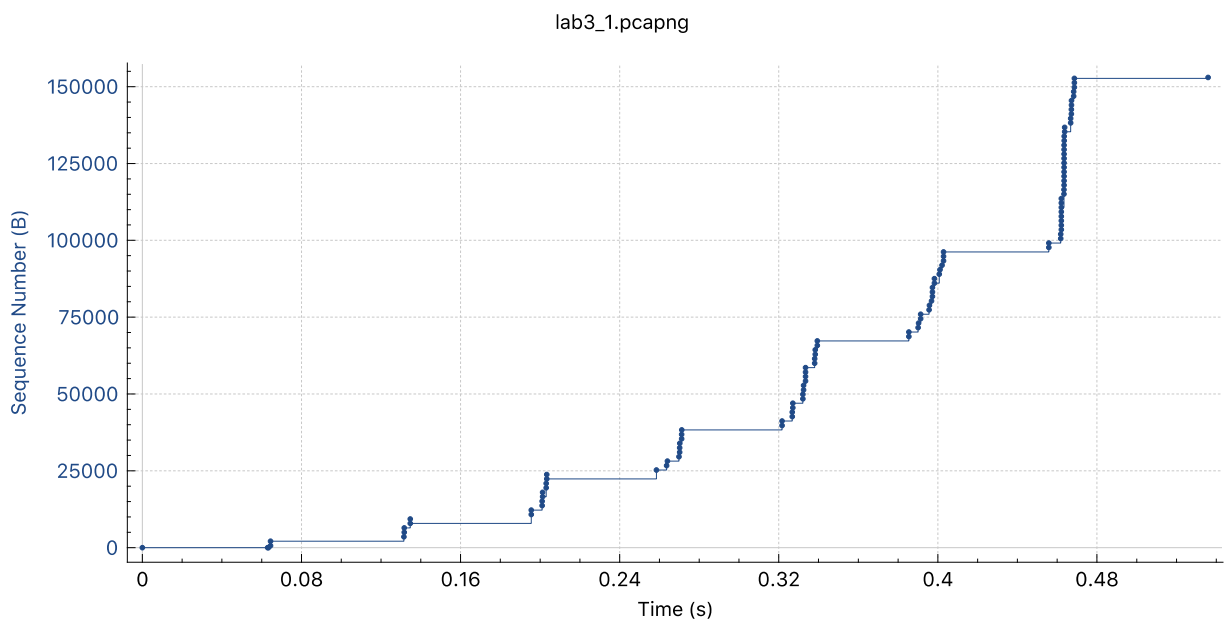
### Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80



The graph shows that the slow start phase lasts for roughly 0.1 seconds. It then appears that the TCP session is in some sort of congestion avoidance. The weird thing is that the TCP window does not grow at all. This appears to point that the sender is not sending data aggressively or they have some sort of limit on their end.

14. Answer Question 13 for the trace that you captured when you transferred a file from your own computer to gaia.cs.umass.edu

### Sequence Numbers (Stevens) for 192.168.1.11:65320 → 128.119.245.12:80



Answer: The slow start phase appears to be working the entire time of my TCP session.

Rob Navarro

CS 372

We can see this since the window size is continuously increasing during the entire transfer time. This is more of the expected behavior that we would expect to see for a transmission based on what I've read in the textbook. Since the transmission size never decreases, it does not appear that congestion control ever kicks in.