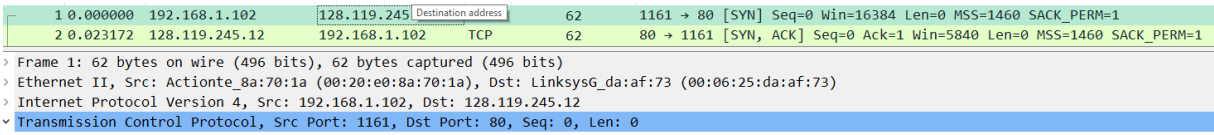
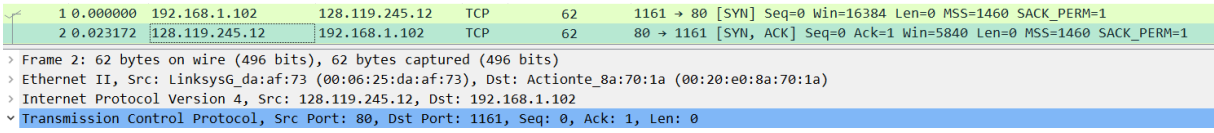
1. Client computer (source):

   IP address: 192.168.1.102
   TCP port number: 1161



2. Server (destination)

   IP address: 128.119.245.12
   TCP port number: 80

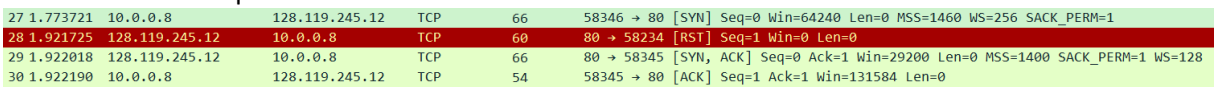


3. Client computer (source):

   IP address: 10.0.0.8
   TCP port number: 58345

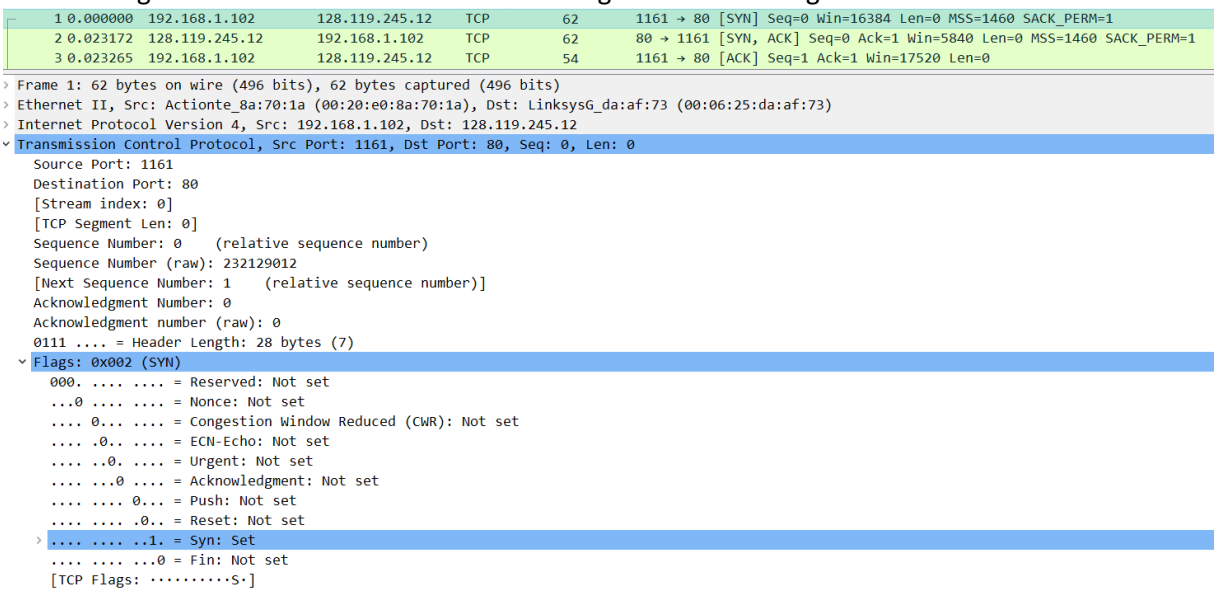
   Here we can see the 3 way handshake:

   1. SYN Seq=0
   2. SYN, ACK Seq=0 Ack=1
   3. ACK Seq=1 Ack=1

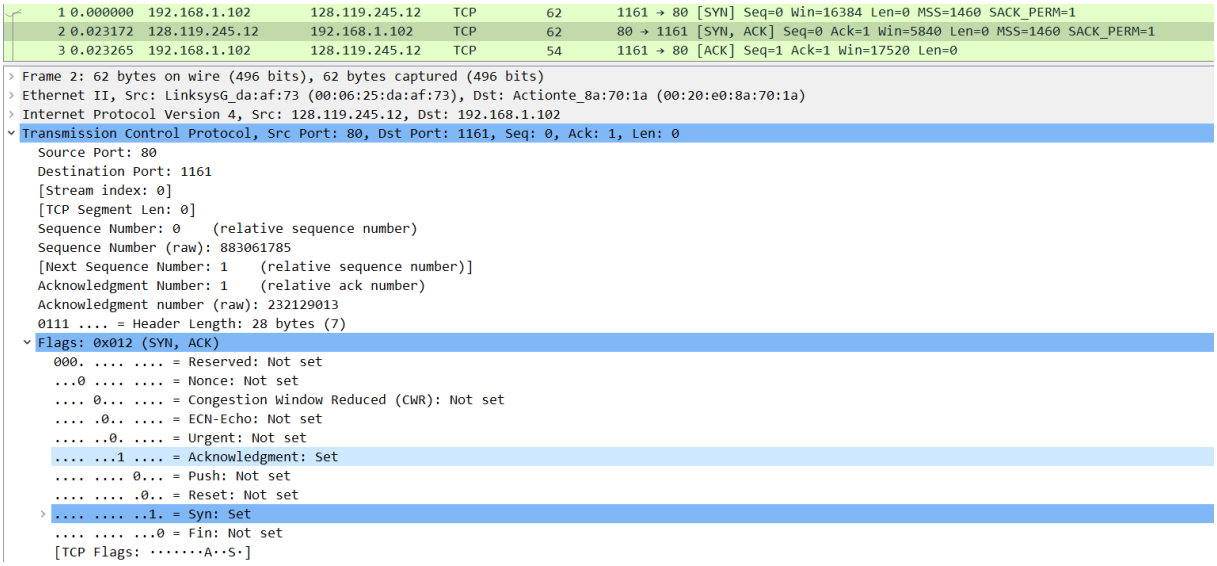


4. The sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu is 0.

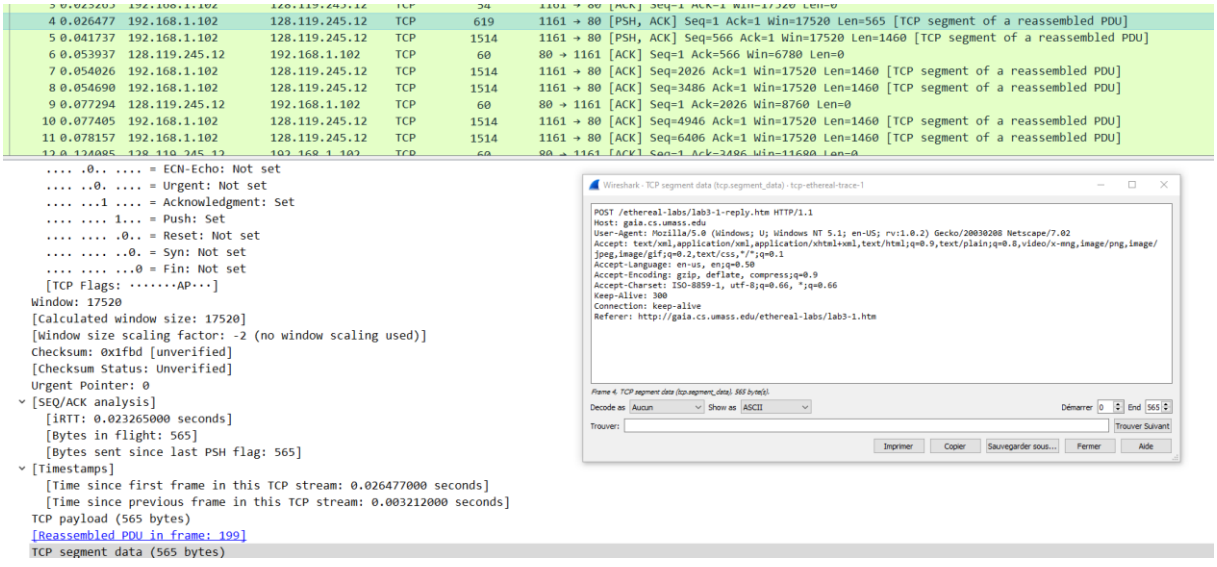
   The SYN flag is set to 1 and it indicates that this segment is a SYN segment.



5. The sequence number of the SYNACK segment from gaia.cs.umass.edu to the client computer in reply to the SYN has the value of 0.
   The value of the ACKnowledgement field in the SYNACK segment is 1.
   The value of the ACKnowledgement field in the SYNACK segment is determined by gaia.cs.umass.edu by adding 1 to the initial sequence number of SYN segment from the client computer (i.e. the sequence number of the SYN segment initiated by the client computer is 0).
   The SYN flag and Acknowledgement flag in the segment are set to 1 and they indicate that this segment is a SYNACK segment.



6. Sequence number : 1



7. The first six segments in the TCP connection including the segment containing the HTTP POST are: 4, 5, 7, 8, 10, 11.
   Segment 1: Sequence nb 1
   Segment 2: Sequence nb 566
   Segment 3: Sequence nb 2026
   Segment 4: Sequence nb 3486
   Segment 5: Sequence nb 4946
   Segment 6: Sequence nb 6406

   The ACKs segments numbers are: 6, 9, 12, 14, 15, 16.

   To calculate the RTT value for each of the six segments we will write the segment sent time, and the ACK received time and subtract the sent time from the ACK received time:

   The value of the time segments is sent/received is mentioned in the timestamps.
   Estimated RTT Value= 0.875*RTT+0.125*RTT Value

	Sent Time	ACK received	RTT Value	Estimated RTT Value
Segment 1	0.026477	0.053937	0.053937 - 0.026477 = **0.02746**	**0.02746**
Segment 2	0.041737	0.077294	0.077294 - 0.041737 = **0.035557**	**0.02847**
Segment 3	0.054026	0.124085	0.124085 - 0.054026 = **0.070059**	**0.03366**
Segment 4	0.05469	0.169118	0.169118 - 0.05469 = **0.114428**	**0.04375**
Segment 5	0.077405	0.217299	0.217299 - 0.077405 = **0.139894**	**0.055768**
Segment 6	0.078157	0.267802	0.267802 - 0.078157 = **0.189645**	**0.0725**

8. Segment 1 Length: 565
   Segment 2 Length: 1460
   Segment 3 Length: 1460
   Segment 4 Length: 1460
   Segment 5 Length: 1460
   Segment 6 Length: 1460

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 [TCP segment of a reassembled PDU]
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 [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=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 [TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [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	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [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=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 [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=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 [TCP segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

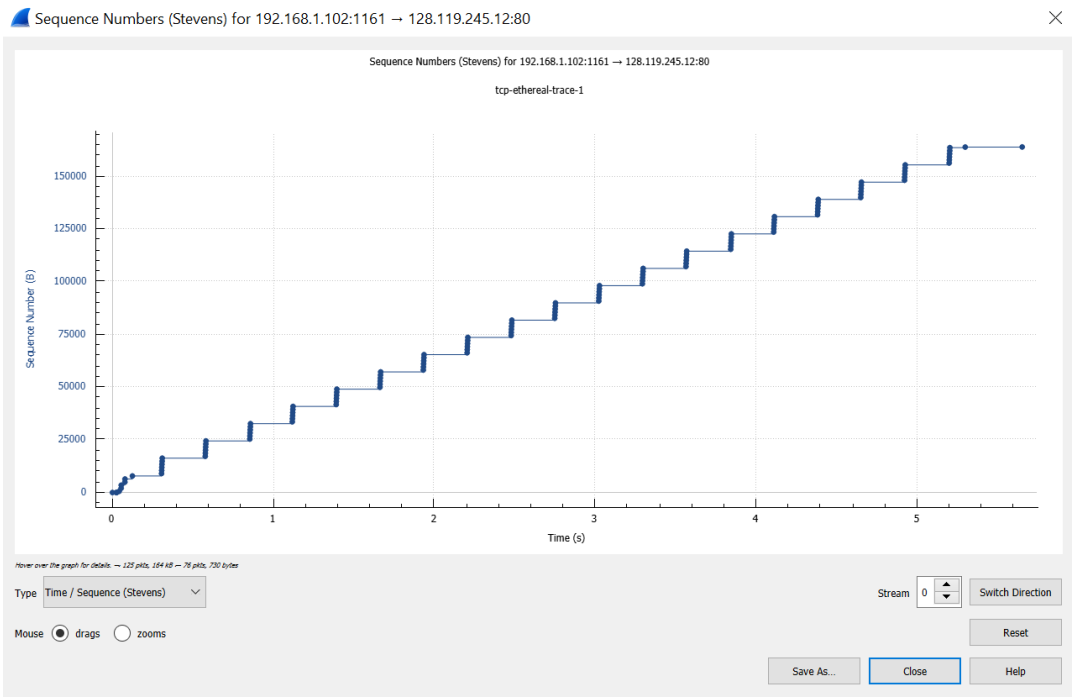
9. The minimum amount of available buffer space advertised at the received for the entire trace is 5840 bytes

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=1
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=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0

The lack of receiver buffer space never throttles the sender because the receiver window grows until the maximum receiver buffer size of 62780 bytes

202	5.455830	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	5.461175	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)

10. There are no retransmitted segments in the trace file.



All the sequence numbers from the source to the destination are increasing with respect to the time.
Therefore, there are no retransmitted segments (if any retransmitted segments exist, we would expect to see smaller sequence numbers from the right neighbors of the segments sequence numbers).

11. The receiver typically acknowledging 1460 bytes.
We can see that the ACK numbers are increasing in sequence of 1460 (the ACK sequence numbers are: 566, 2026, 3486, 4946, 6406, 7866

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 [TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [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	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [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=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 [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=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

12. The throughput for the TCP connection is defined as the amount of data to transmit divided by the transmission time.

    The amount of data to transmit: 164091 – 1 = 164090 bytes
    The first ACK for the first segment that was sent = 1.
    The last ACK of the last segment sent = 164091.

    The transmission time: 5.45583-0.026477 = 5.429353 sec
    (the last – the first TCP segment was received)

    The throughput is: 164090/5.429353 = 30222 bytes/sec = 30.222 Kbyte/sec

13. The TCP slow start phase begins and ends after 0.3 seconds (from 0 to 0.3 sec).
    The congestion avoidance takes over after those 0.3 seconds through the entire connection.
    The congestion does not seem to be caused by flow control (the receiver window size is larger than 5 packets). This might be caused because the HTTP server has enforced a rate-limit of some sort.