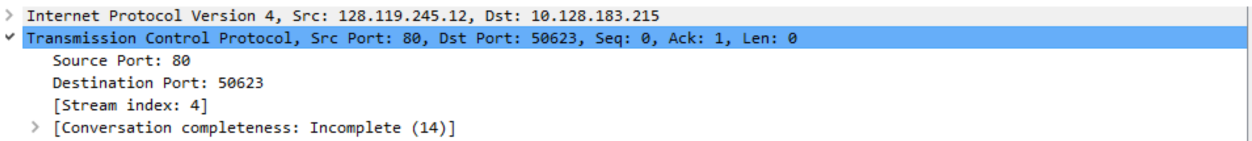
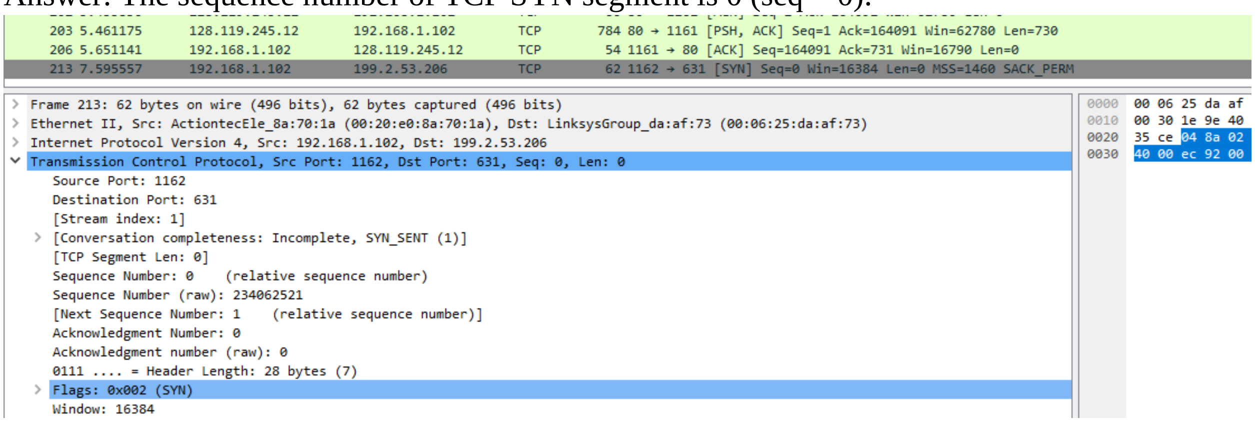
1. What is the IP address and TCP port number used by the client computer (source) that is transferring the file to gaia.cs.umass.edu? To answer this question, it's probably easiest to select an HTTP message and explore the details of the TCP packet used to carry this HTTP message, using the "details 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: IP Address: 192.168.1.102 – TCP Port: 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: IP Address: 128.119.245.12 – TCP Port: 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: From my trace
   The IP Address: 192.168.1.102
   The TCP Port: 50623




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 of TCP SYN segment is 0 (seq = 0).



We can identify this segment as a SYN segment because the flag header has SYN hexadeximal number (0x002) this flag set to 1.

```
Flags: 0x002 (SYN)
    000. .... .... = Reserved: Not set
    ...0 .... .... = Accurate ECN: Not set
    .... 0... .... = Congestion Window Reduced: Not set
    .... .0.. .... = ECN-Echo: Not set
    .... ..0. .... = Urgent: Not set
    .... ...0 .... = Acknowledgment: Not set
    .... .... 0... = Push: Not set
    .... .... .0.. = Reset: Not set
    .... .... ..1. = Syn: Set
```

5. What is the sequence number of the SYN ACK 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 of the SYN ACK segment is 0 (seq = 0)

   The value of the Acknowledgement field is 1 (in raw is 3852961089).

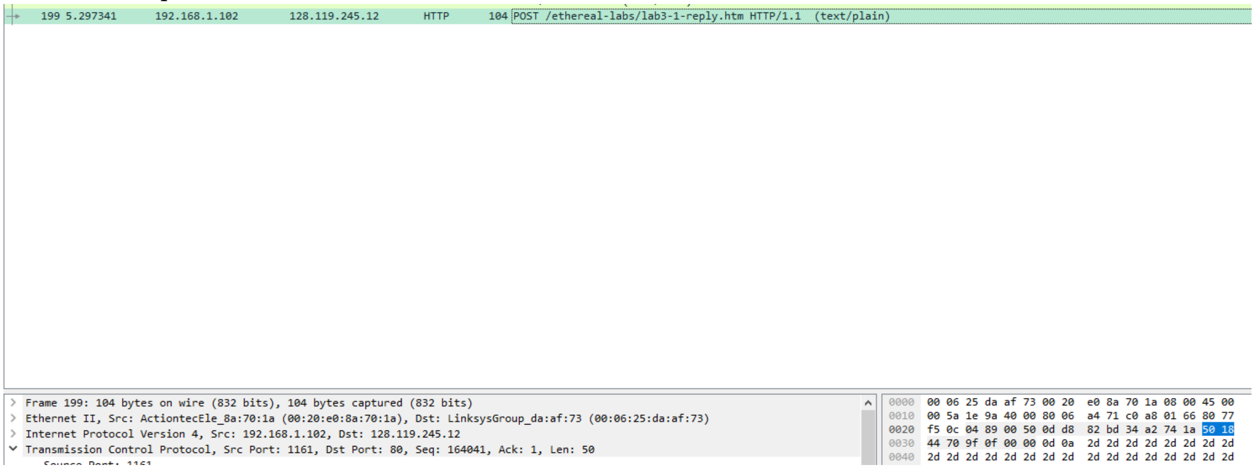
```
Acknowledgment Number: 1    (relative ack number)
Acknowledgment number (raw): 232129013
```

   The Acknowledgement is determined by adding 1 to initial seq number of SYN segment from client computer (0 + 1 = 0).

```
Flags: 0x012 (SYN, ACK)
    000. .... .... = Reserved: Not set
    ...0 .... .... = Accurate ECN: Not set
    .... 0... .... = Congestion Window Reduced: Not set
    .... .0.. .... = ECN-Echo: Not set
    .... ..0. .... = Urgent: Not set
    .... ...1 .... = Acknowledgment: Set
    .... .... 0... = Push: Not set
    .... .... .0.. = Reset: Not set
    .... .... ..1. = Syn: Set
    .... .... ...0 = Fin: Not set
    [TCP Flags: ·······A··S·]
```

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: SeqNum = 164041



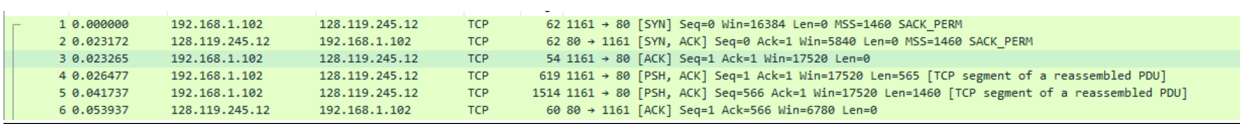

7. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection. What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST)?
   At what time was each segment sent? When was the ACK for each segment received?

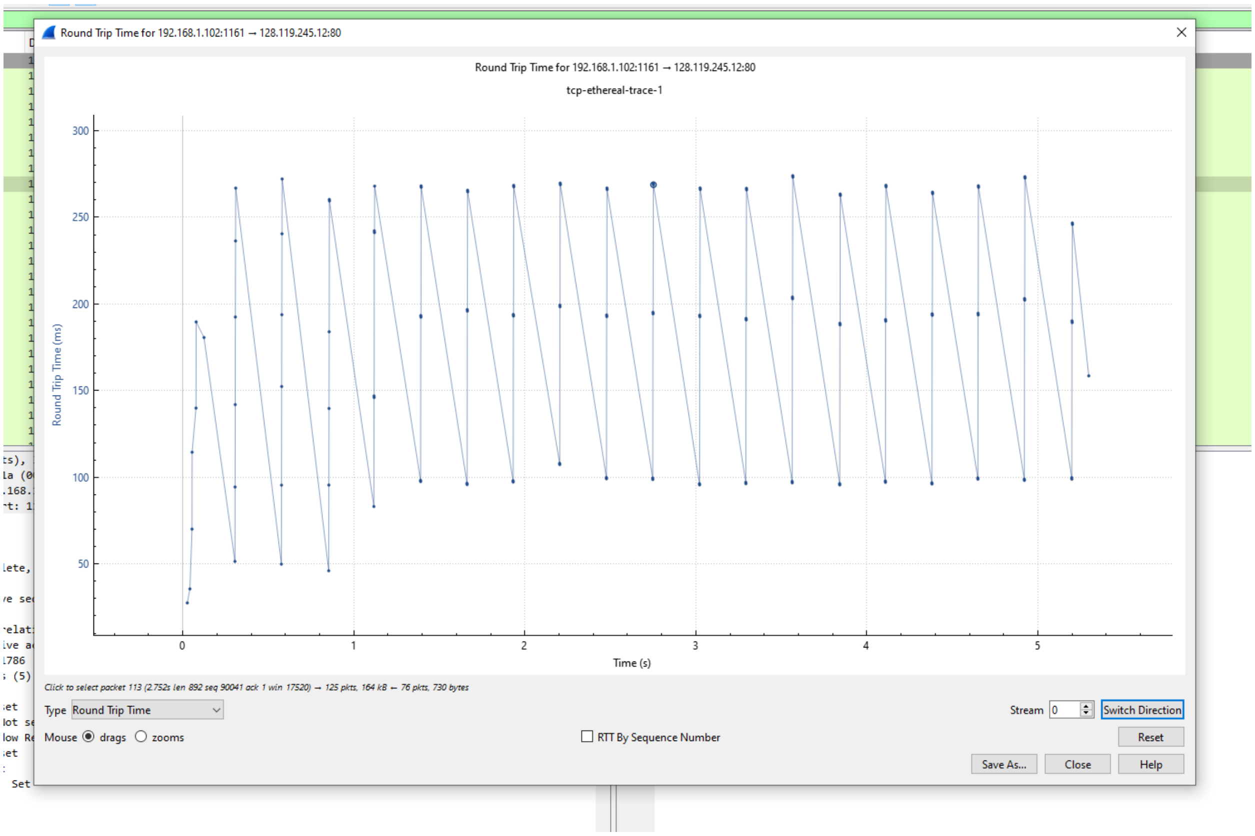
   Given the difference between when each TCP segment was sent, and when its acknowledgement was received, what is the RTT value for each of the six segments?

   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.

   Answer: The sent time of each segment you can see in time column






8. What is the length of each of the first six TCP segments ?
   Answer: The length is shown below

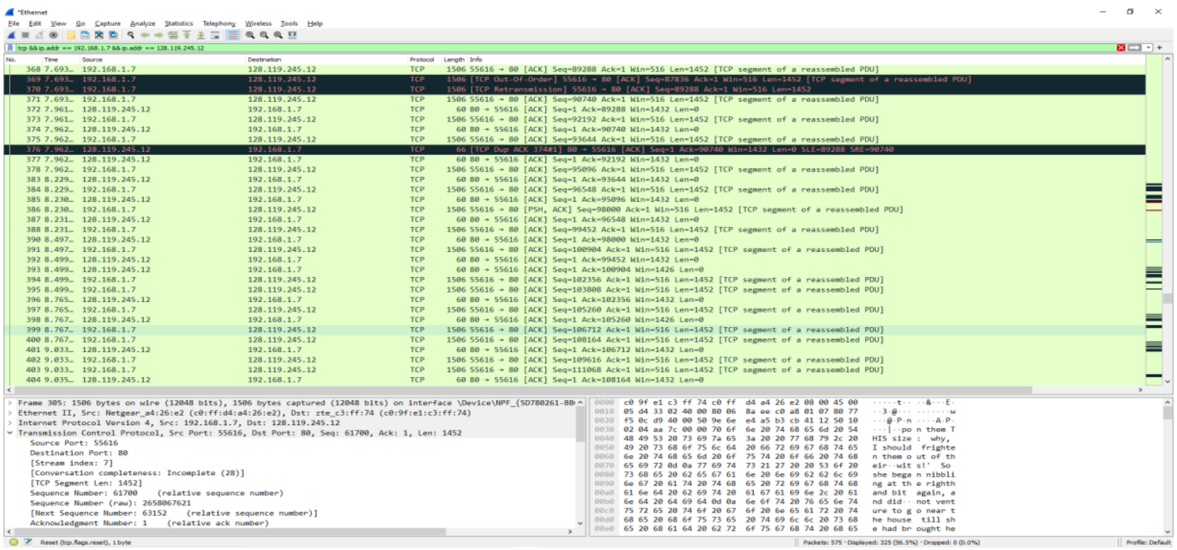
| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1 | 0.000000 | 192.168.1.102 | 128.119.245.12 | TCP | 62 | 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM |
| 2 | 0.023172 | 128.119.245.12 | 192.168.1.102 | TCP | 62 | 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 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 [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 |

9. What is the minimum amount of available buffer space advertised at the received for the entire trace? Does the lack of receiver buffer space ever throttle the sender?
   Answer:
   The minimum amount of available buffer space (receiver window) is 5840 bytes.
   The sender is never throttled because we never reach full capacity of the window (62780 bytes).
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: There are retransmitted segments in trace file. Because the sequence number do not increases or decrease by time no duration has inceased sequence number.

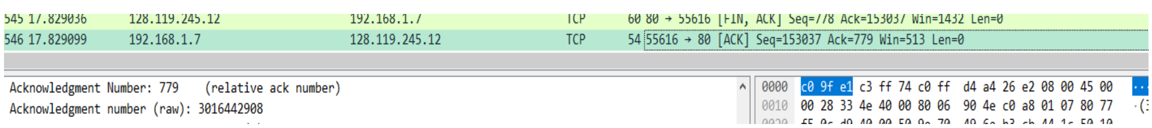
11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 250 in the text).

Answer: Each ACK has different lengths of data. But you can see in my case the length of 0 and 1460 usually appear in ACKs. There are cases where the receivers is ACKing every other segment. According to table 3.2 segment 80 with 2920 bytes = 1460 * 2.



12. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

Answer: The throughput can be calculated by using seq of last ack – the first seq number and divide by time since first frame : (153037 – 1) / 11.829099 = 12937.07 (byte per second)




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.

Answer: The TCP slow start begins at the start of the connection (when HTTP POST segment was sent out). TCP slow start phase and congestion avoidance phase can be identified by the value of window size of TCP sender. However, the value of the congestion window size cannot be obtained directly from the Time-Sequence-Graph (Stevens) graph. Nevertheless, we can estimate the lower bound of the TCP window size by the amount of outstanding data because the outstanding data is the amount of data without acknowledgement. We also know that TCP window is constrained by the receiver window size and the receiver buffer can act as the upper bound of the TCP window size. In this trace, the receiver buffer is not the bottleneck; therefore, this upper bound is not quite useful to infer the TCP window size. Hence, we focus on the lower bound of the TCP window size.