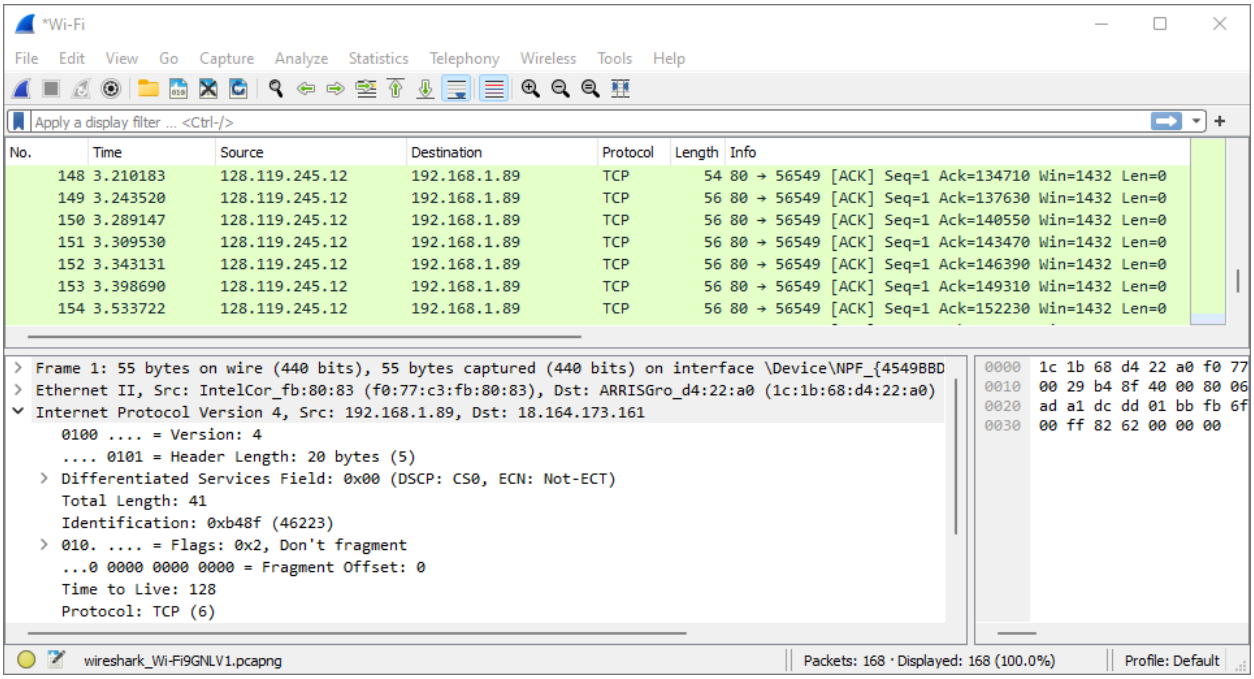
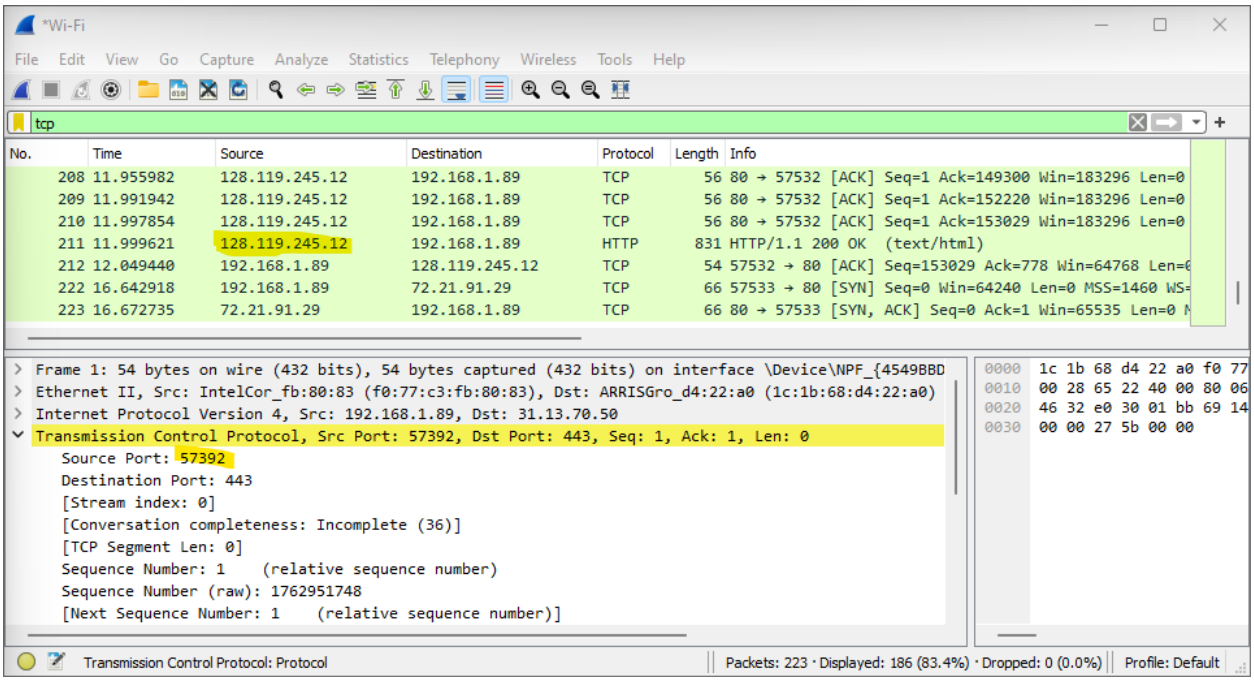
Lab 2: TCP

1. Capturing a bulk TCP transfer from your computer to a remote server.

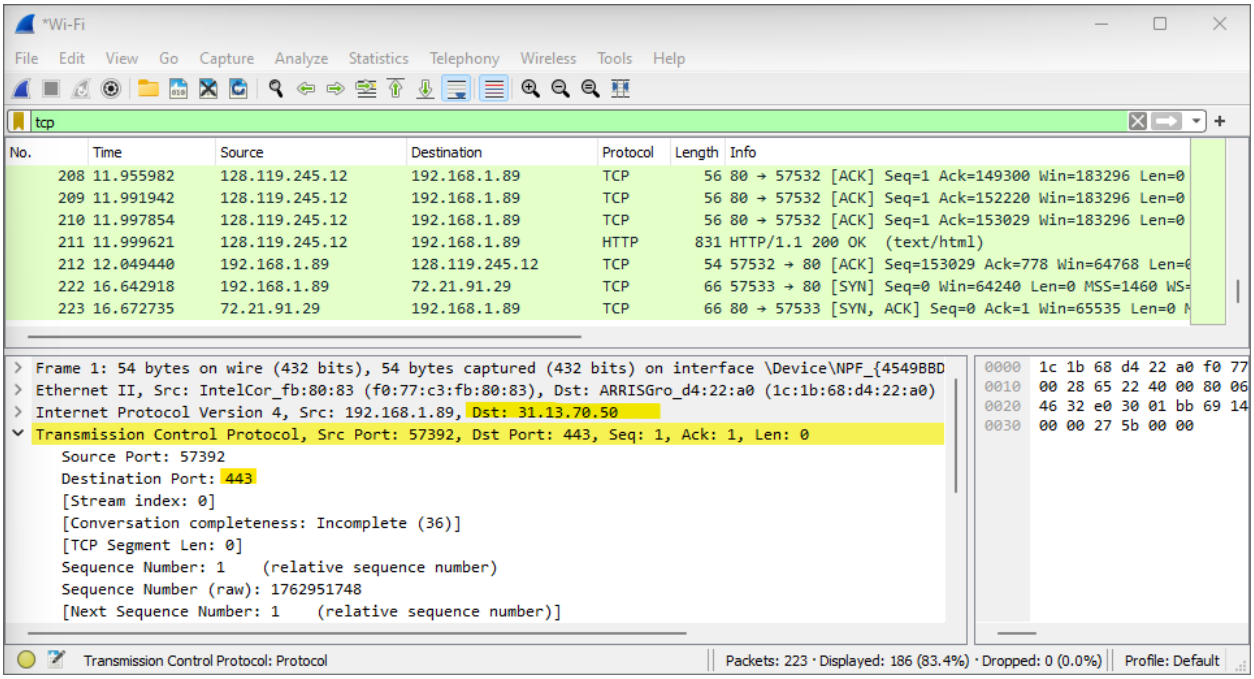


2. A first look at the captured trace.

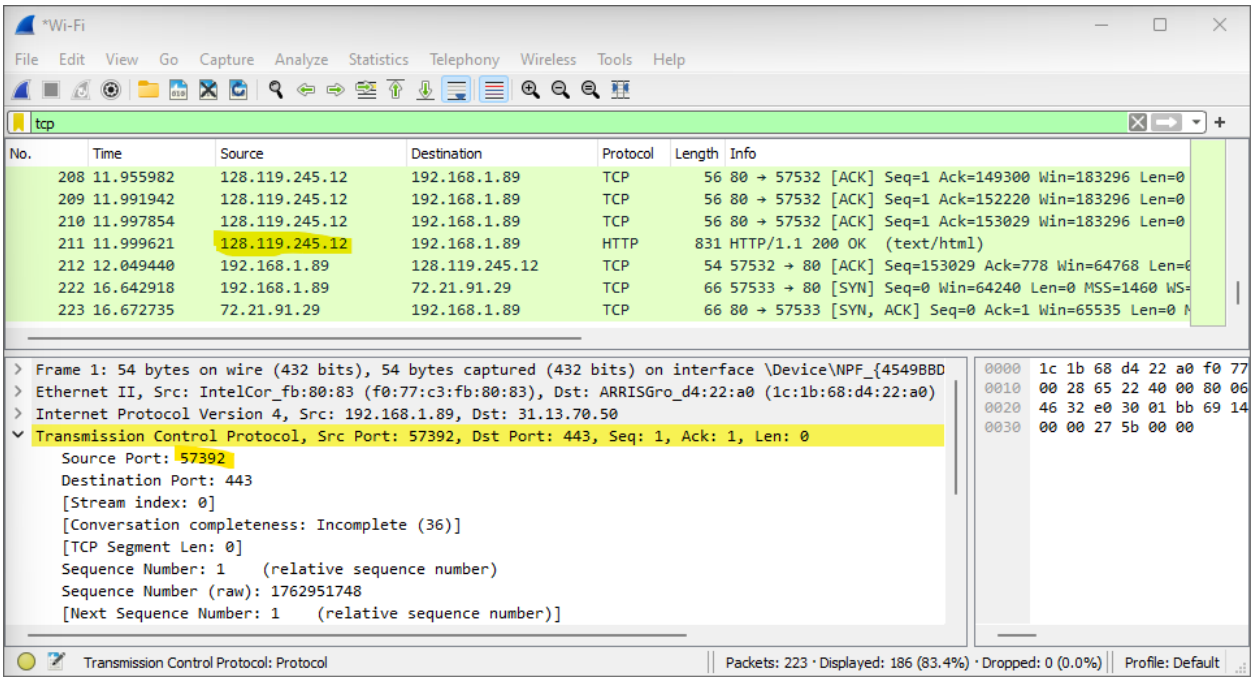
1. Computer (source) IP address: 192.168.1.89 and TCP port number: 57392



2. Destination computer: gaia.cs.umass.edu IP address: 31.13.70.50 and TCP port number: 443.

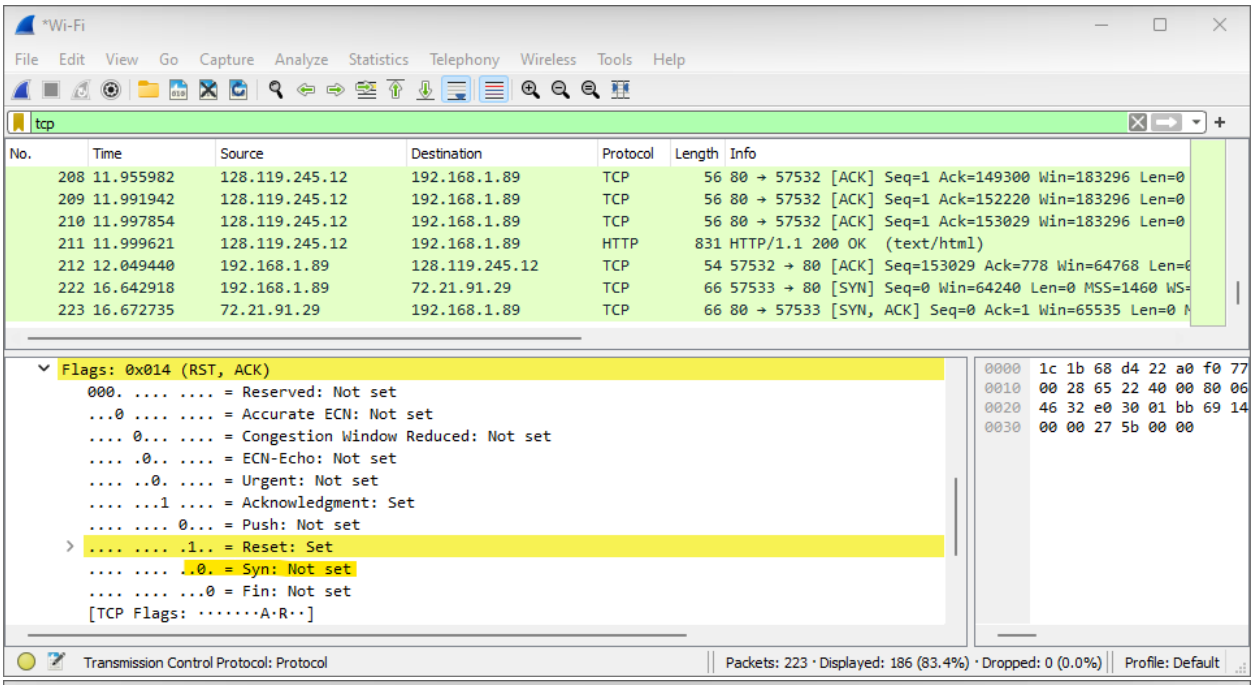


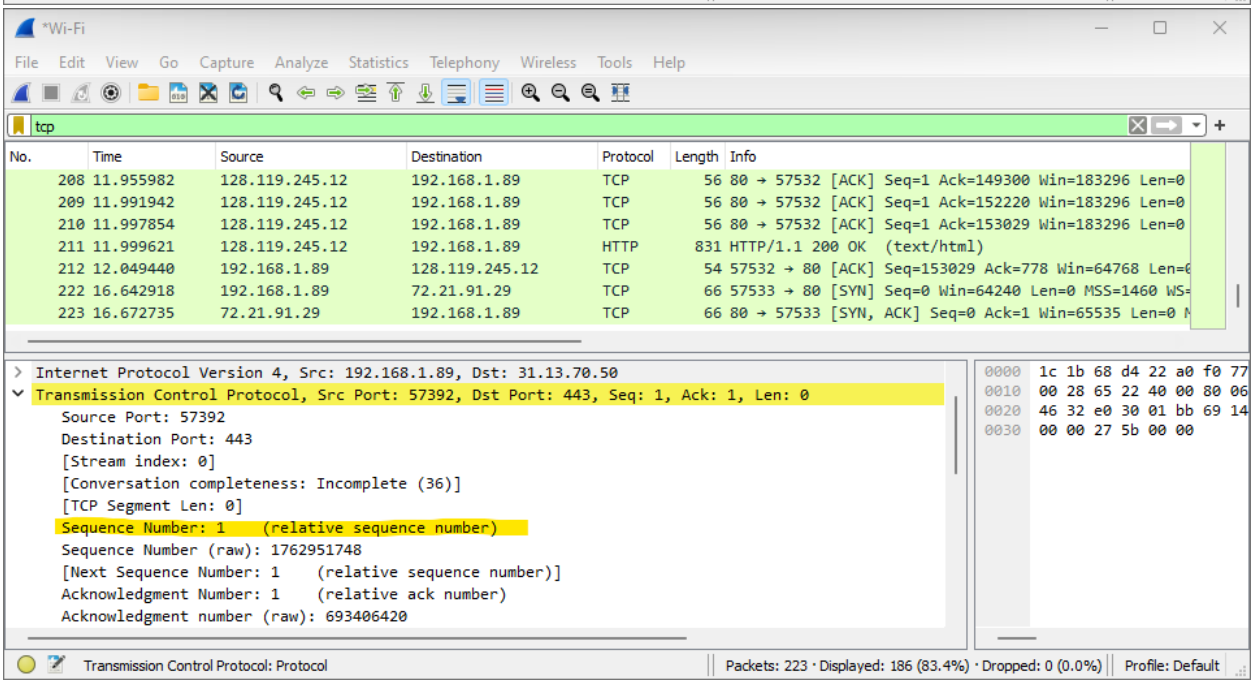
3. IP address: 192.168.1.89 and TCP port number: 57392



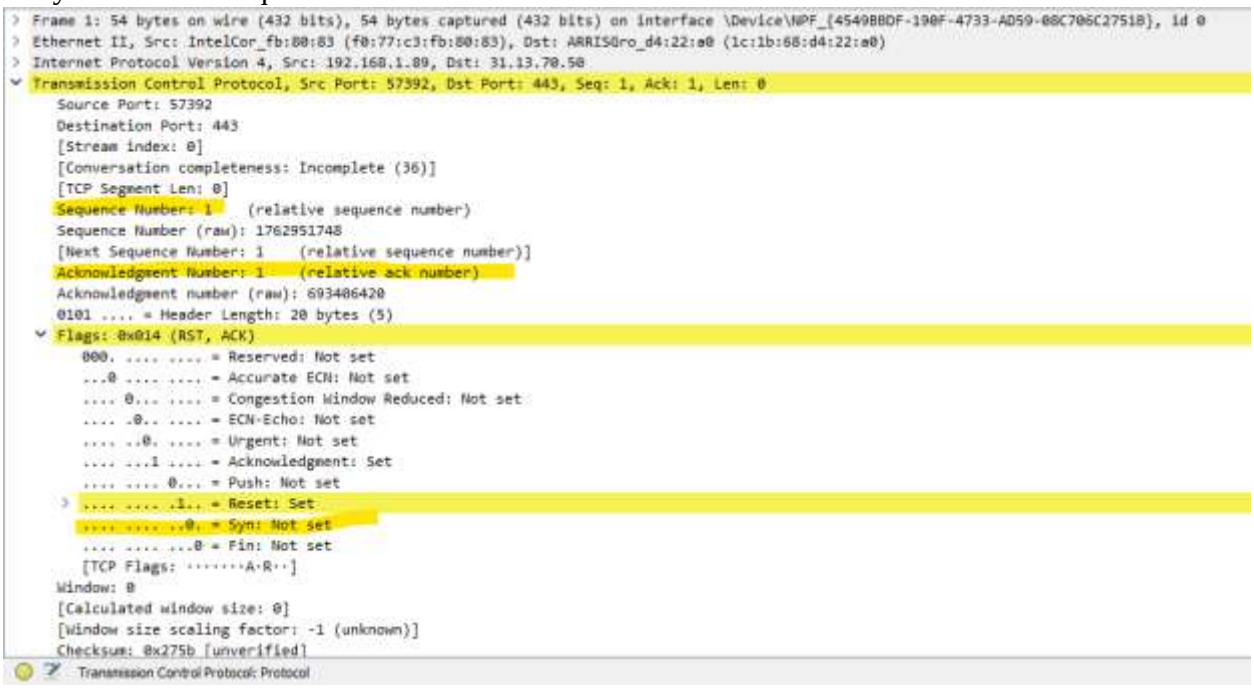
3. TCP Basics

4. Sequence number of the TCP SYN segment is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu. The value is 1 in this trace. The SYN flag is set to 1 and it indicates that this segment is a SYN segment.

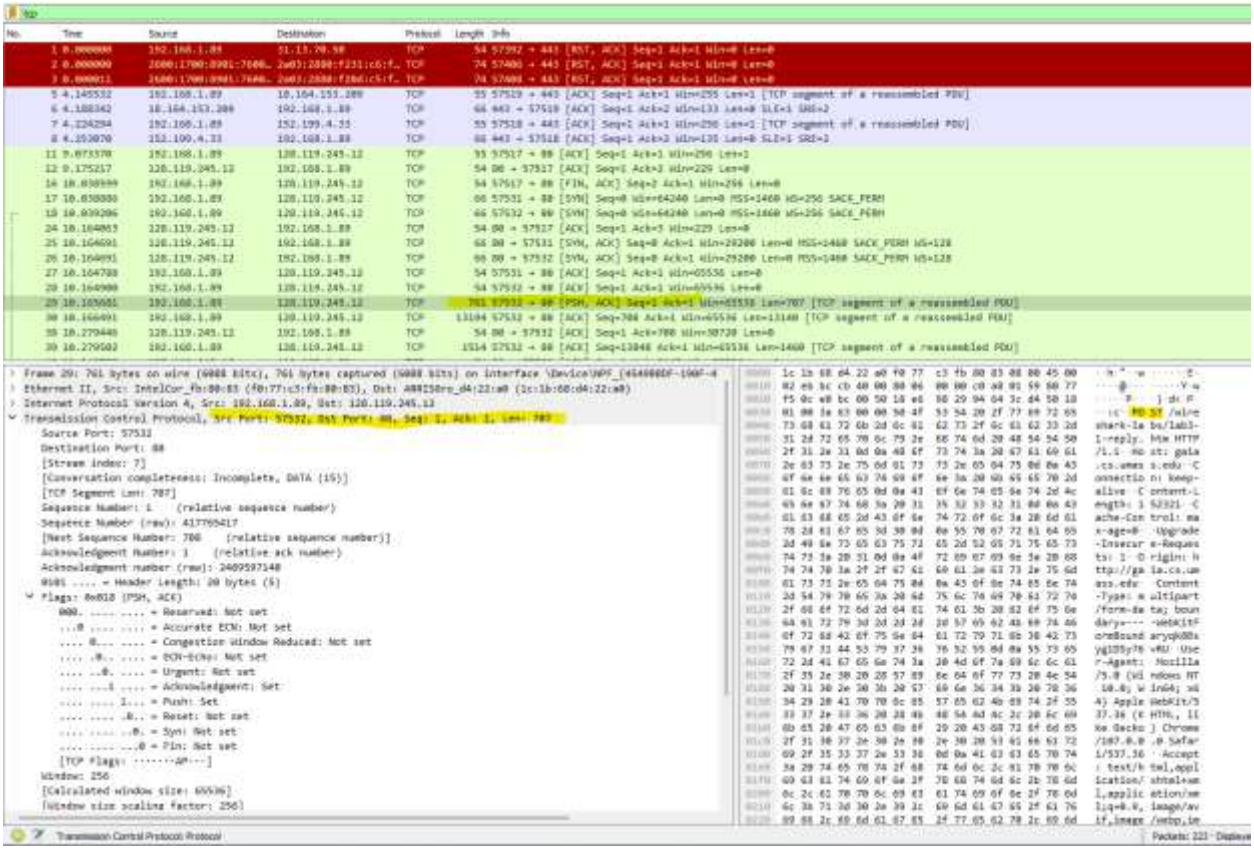




5. Syn: 0 Ack: 1 Seq: 1



6. Segment:29 and sequence number : 1 POST



7. Segment 1: seq number: 1, segment 2: seq number: 579, segment 3: seq number: 716, segment 4: seq number: 2164, segment 5: seq number: 362, segment 6: seq number: 5060.

Recording the sending time and received time of ACKs:

	Sent time	ACK received time	RTT
Segment 1	0.271257000	0.366931000	0.095674
Segment 2	0.271425000	0.367289000	0.095864
Segment 3	0.271797000	0.368617000	0.09682
Segment 4	0.271798000	0.369952000	0.098154
Segment 5	0.367081000	0.479965000	0.112884
Segment 6	0.368711000	0.482492000	0.113781

According to the formula: EstimatedRTT = 0.875 * EstimatedRTT + 0.125 * SampleRTT

EstimatedRTT after the receipt of the ACK of segment 1:

EstimatedRTT = RTT for Segment 1 = 0.095674 s

EstimatedRTT after the receipt of the ACK of segment 2:

EstimatedRTT = 0.875 * 0.095674 + 0.125 * 0.095864= 0.09569775 s

EstimatedRTT after the receipt of the ACK of segment 3:

EstimatedRTT = 0.875 * 0.09569775 + 0.125 * 0.09682= 0.09583803125 s

EstimatedRTT after the receipt of the ACK of segment 4:

EstimatedRTT = 0.875 * 0.09583803125 + 0.125 * 0.098154= 0.09612752734 s

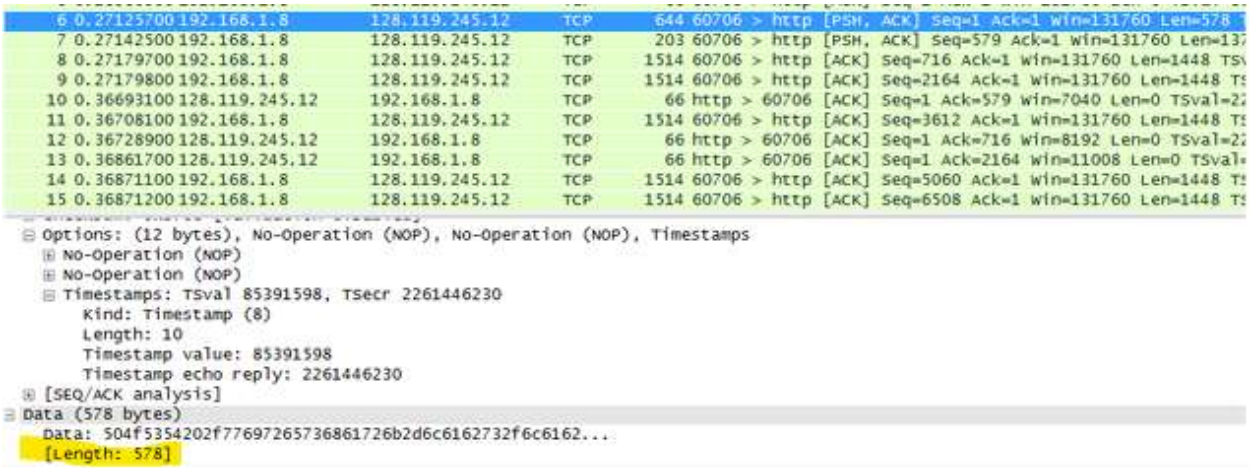
EstimatedRTT after the receipt of the ACK of segment 5:

EstimatedRTT = 0.875 * 0.09612752734 + 0.125 * 0.112884= 0.09822208642 s

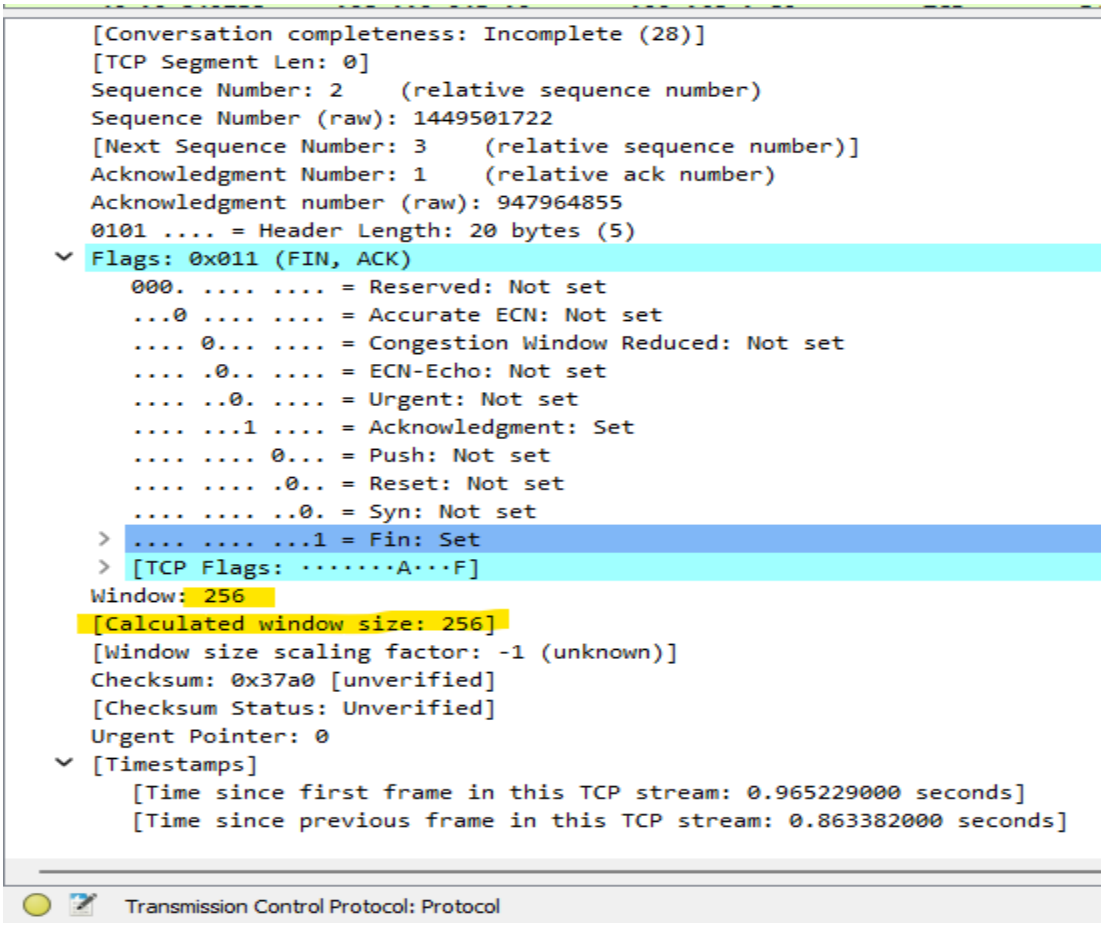
EstimatedRTT after the receipt of the ACK of segment 6:

EstimatedRTT = 0.875 *0.09822208642 + 0.125 * 0.113781= 0.10016695061 s

8. length: 578 bytes



9. Window: 256

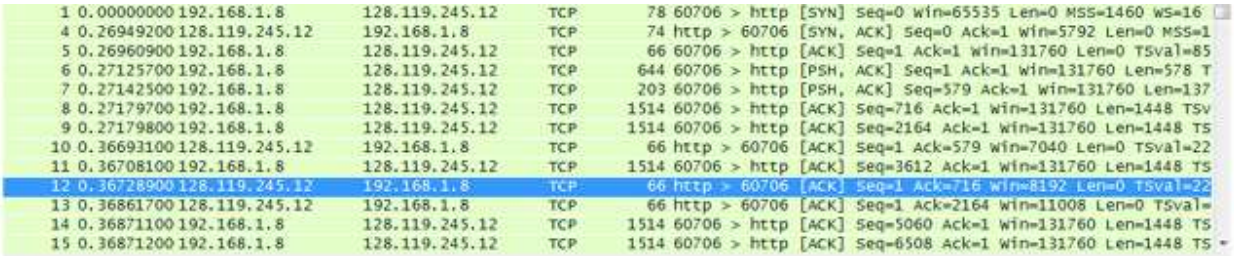


10.

There are no retransmitted segments in the trace file. We can verify this by checking the sequence numbers of the TCP segments in the trace file. In the Time Sequence-Graph (Stevens) of this trace, all sequence numbers from the source (192.168.1.89) to the destination (31.13.70.50) are increasing monotonically with respect to time. If there is a retransmitted segment, the sequence number of this retransmitted segment should be smaller than those of its neighboring segments.

11.

The difference between the acknowledged sequence numbers of two consecutive ACKs indicates the data received by the server between these two ACKs. The receiver is ACKing every other se gment. For example, segment of No. 13 acknowledged data with 1430 bytes.



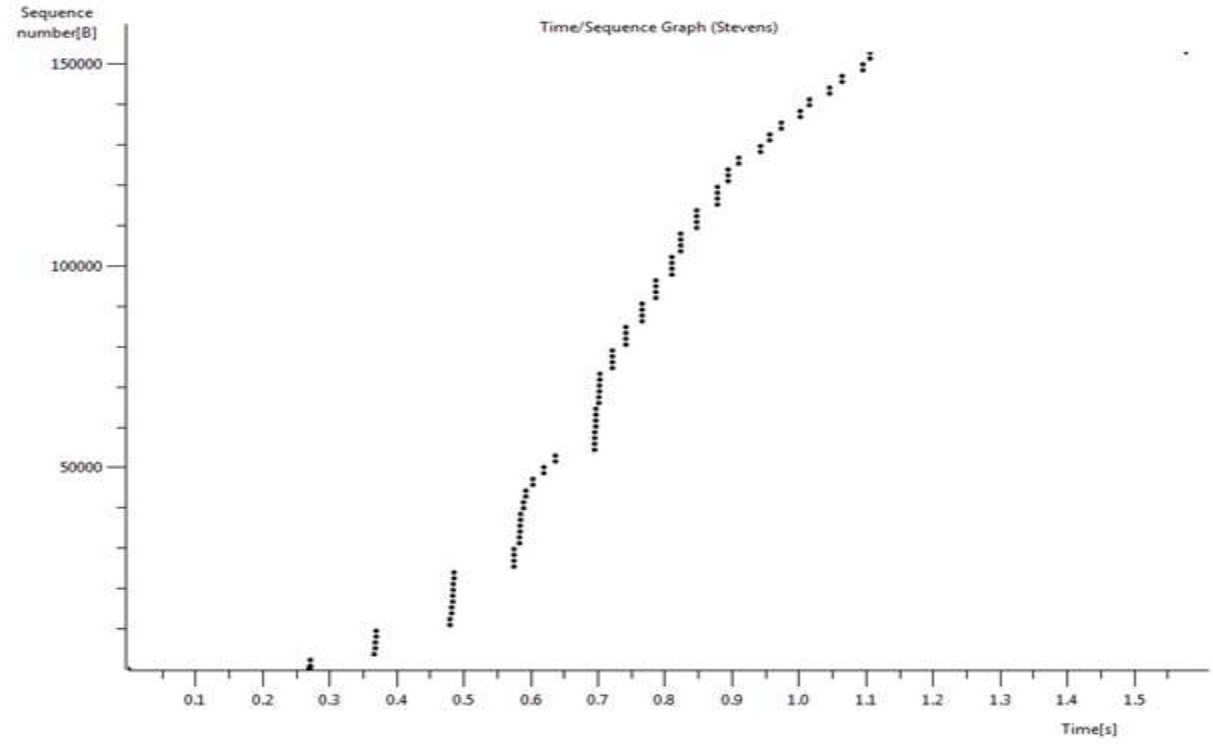
1	0.00000000	192.168.1.8	128.119.245.12	TCP	78 60706 > http [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16
4	0.26949200	128.119.245.12	192.168.1.8	TCP	74 http > 60706 [SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS=1
5	0.26960900	192.168.1.8	128.119.245.12	TCP	66 60706 > http [ACK] Seq=1 Ack=1 Win=131760 Len=0 TSval=85
6	0.27125700	192.168.1.8	128.119.245.12	TCP	644 60706 > http [PSH, ACK] Seq=1 Ack=1 Win=131760 Len=578 T
7	0.27142500	192.168.1.8	128.119.245.12	TCP	203 60706 > http [PSH, ACK] Seq=579 Ack=1 Win=131760 Len=137
8	0.27179700	192.168.1.8	128.119.245.12	TCP	1514 60706 > http [ACK] Seq=716 Ack=1 Win=131760 Len=1448 TSv
9	0.27179800	192.168.1.8	128.119.245.12	TCP	1514 60706 > http [ACK] Seq=2164 Ack=1 Win=131760 Len=1448 TS
10	0.36693100	128.119.245.12	192.168.1.8	TCP	66 http > 60706 [ACK] Seq=1 Ack=579 Win=7040 Len=0 TSval=22
11	0.36708100	192.168.1.8	128.119.245.12	TCP	1514 60706 > http [ACK] Seq=3612 Ack=1 Win=131760 Len=1448 TS
12	0.36728900	128.119.245.12	192.168.1.8	TCP	66 http > 60706 [ACK] Seq=1 Ack=716 Win=8192 Len=0 TSval=22
13	0.36861700	128.119.245.12	192.168.1.8	TCP	66 http > 60706 [ACK] Seq=1 Ack=2164 Win=11008 Len=0 TSval=
14	0.36871100	192.168.1.8	128.119.245.12	TCP	1514 60706 > http [ACK] Seq=5060 Ack=1 Win=131760 Len=1448 TS
15	0.36871200	192.168.1.8	128.119.245.12	TCP	1514 60706 > http [ACK] Seq=6508 Ack=1 Win=131760 Len=1448 TS

12.

The alice.txt on the hard drive is 152,138 bytes, and the download time is 1.578736000 (First TC P segment) - 0.271257000 (last ACK) = 1.307479 second. Therefore, the throughput for the TCP connection is computed as 152,138/1.307479=116359.803867 bytes/second.

4. TCP congestion control in action

13. The slow start of the TCP seems to begin at about 0.27 seconds and then ends at about 0.35 seconds. Congestion avoidance takes over at about 0.7 seconds because it cut down the amount being sent.



14. It is answered above.