

Exercise 1: Understanding TCP using Wireshark

Question 1. What is the IP address of `gaia.cs.umass.edu`? On what port number is it sending and receiving TCP segments for this connection? 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`?

- IP address of `gaia.cs.umass.edu` : 128.119.245.12
- Source Port: 1161, Destination Port: 80
- Client Computer IP: 192.168.1.102
- TCP port number used by the client computer is Port 1161

Question 2. What is the sequence number of the TCP segment containing the HTTP POST command?

- sequence number: 232129013

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▶ Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)
▶ Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: Linksys_G:da:af:73 (00:06:25:da:af:73)
▶ Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
▼ Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129013, Ack: 883061786, Len: 565
  Source Port: 1161
  Destination Port: 80
  [Stream index: 0]
  [TCP Segment Len: 565]
  Sequence number: 232129013
  [Next sequence number: 232129578]
  Acknowledgment number: 883061786
  0101 .... = Header Length: 20 bytes (5)
  ▶ 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]
0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00  ..%..s...p...E-
0010 02 5d 1e 21 40 00 80 06 a2 e7 c0 a8 01 66 80 77  ..]!@...f.w
0020 f5 0c 04 89 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 7a 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 6d 20 48 54 54 50 2f  -reply.htm HTTP/
0060 31 2e 31 0d 0a 48 6f 73 74 3a 20 67 61 69 61 2e  1.1-Hos t: gaia.
0070 63 73 2e 75 6d 61 73 73 2e 65 64 75 00 0a 55 73  cs.umass .edu-Us
0080 65 72 2d 41 67 65 6e 74 3a 20 4d 6f 7a 69 6c 6c  er-Agent : Mozill
0090 61 2f 35 2e 30 20 28 57 69 6e 64 6f 77 73 3b 20  a/5.0 (W indows;
00a0 55 3b 20 57 69 6e 64 6f 77 73 20 4e 54 20 35 2e  U; Windo ws NT 5.
00b0 31 3b 20 65 6e 2d 55 53 3b 20 72 76 3a 31 2e 30  1; en-US ; rv:1.0
00c0 2e 32 29 20 47 65 63 6b 6f 2f 32 30 30 33 30 32  .2) Gecko /200302
00d0 30 38 20 4e 65 74 73 63 61 70 65 2f 37 2e 30 32  08 Netsc ape/7.02
00e0 0d 0a 41 63 63 65 70 74 3a 20 74 65 78 74 2f 78  -Accept : text/x
00f0 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78  ml,appli cation/x
0100 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78  ml,appli cation/x
0110 68 74 6d 6c 2b 78 6d 6c 2c 74 65 78 74 2f 68 74  html+xml ,text/ht
0120 6d 6c 3b 71 3d 30 2e 39 2c 74 65 78 74 2f 70 6c  ml;q=0.9 ,text/pl
0130 61 69 6e 3b 71 3d 30 2e 38 2c 76 69 64 65 6f 2f  ain;q=0.8,video/
0140 78 2d 6d 6e 67 2c 69 6d 61 67 65 2f 70 6e 67 2c  x-mng,image/png,
0150 69 6d 61 67 65 2f 6a 70 65 67 2c 69 6d 61 67 65  image/jpeg,image
0160 2f 67 69 66 3b 71 3d 30 2e 32 2c 74 65 78 74 2f  /gif;q=0.2,text/
0170 63 73 73 2c 2a 2f 2a 3b 71 3d 30 2e 31 0d 0a 41  css,*/*; q=0.1..A
0180 63 63 65 70 74 2d 4c 61 6e 67 75 61 67 65 3a 20  ccept-La nguage:
0190 65 6e 2d 75 73 2c 20 65 6e 3b 71 3d 30 2e 35 30  en-us, e n;q=0.50
01a0 0d 0a 41 63 63 65 70 74 2d 45 6e 63 6f 64 69 6e  -Accept -Encodin
01b0 67 3a 20 67 7a 69 70 2c 2d 64 65 6e 6c 61 74 65  g: gzip, deflate

No.: 4 - Time: 0.026477 - Source: 192.168.1.102 - Destination: 128.119.245.12 - Protocol: TCP - Length: 619 - Info: 1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 Win=17520 Len=565 [TCP segment of a reassembled PDU]
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Question 3 & Question 4.

	Sequence Numbers (From Client to Server)	Sent Time	ACK received Time	RTT	EstimateRTT	Length of TCP segment
1	232129013	0.026477	0.053937	0.027460	0.027460	565
2	232129578	0.041737	0.077294	0.035557	0.028472	1460
3	232131038	0.054026	0.124085	0.070059	0.033670	1460
4	232132498	0.054690	0.169118	0.114428	0.043765	1460
5	232133958	0.077405	0.217299	0.139894	0.055781	1460
6	232135418	0.078157	0.267802	0.189645	0.072514	1460

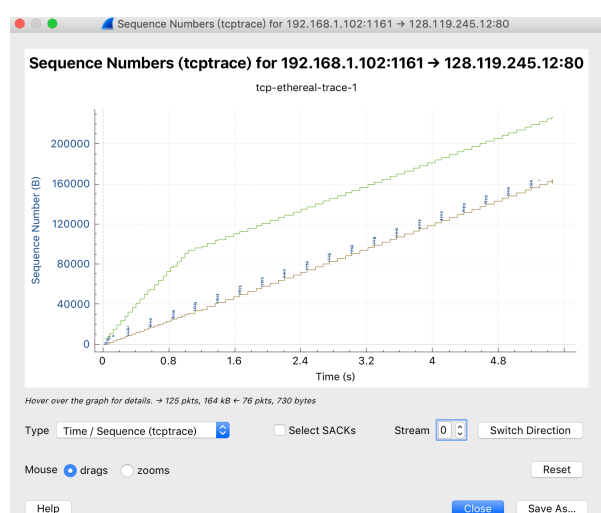
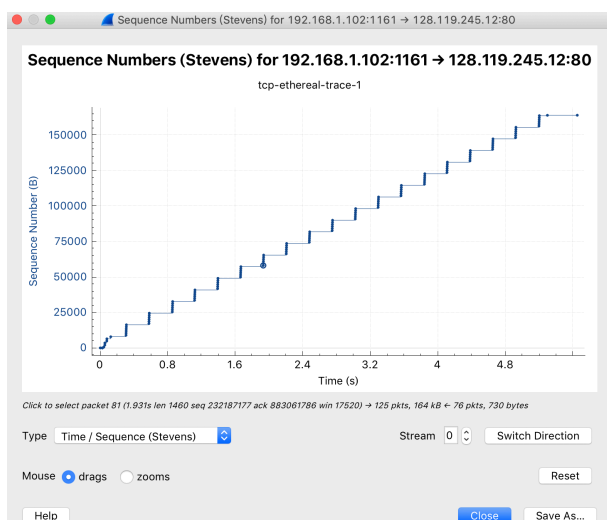
$$\text{EstimatedRTT} = 0.875 * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$$

Question 5. 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?

- Minimum amount of available buffer space at the receiver: 5840 bytes(windows size).
- It does not throttle the sender. The sender is never throttle due to lacking of receiver buffer space in this case, see that the buffer space is always larger than segment size.

Question 6. Are there any retransmitted segments in the trace file? What did you check for (in the trace) in order to answer this question?

- No, there is no retransmitted segments in the trace file.
- I check for if there are any packets with the same sequence number at different time. And did not find any. All sequence number of segment increasing respect to time.



Question 7. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment?

- Most of ACKs acknowledged 1460 bytes, so the receiver typically acknowledge in an ACK is 1460 bytes.
- The difference between the acknowledged sequence numbers of two consecutive ACKs indicates the amount of data received by the server between these 2 ACKs. By inspecting the amount of acknowledged data by each ACK, there are some cases where the receiver is ACKing every other segments. For example, segment of 80 acknowledged data with 2920 bytes = 1460 * 2 bytes.

Question 8. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

TCP throughput depends on the selection of average time period. TCP throughput is calculated as the ratio between the total amount data and the total transmission time. So $R = \text{TotalData} / \text{TotalTime}$.

Total data amount: the acknowledged sequence number of the last ACK(232293103) - the sequence number of the first TCP segment(232129013) = 164090 bytes.

Total time: the last ACK send time(5.455830) - the first time transmission(after TCP connection establishment 0.026477) = 5.429353 sec

Throughput R for the TCP connection = 164090 byte/5.429353 sec = **30222 bytes/sec**

Exercise 2: TCP Connection Management

Question 1. What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and server?

- sequence number of the TCP SYN segment is **2818463618**

Question 2. What is the sequence number of the SYN ACK segment sent by the server to the client computer in reply to the SYN? What is the value of the Acknowledgement field in the SYN ACK segment? How did the server determine that value?

- sequence number is 1247095790
- value of the Acknowledgement field: 2818463619
- This ACK value is determined by the client SYN seq number + 1

Question 3. What is the sequence number of the ACK segment sent by the client computer in response to the SYNACK? What is the value of the Acknowledgment field in this ACK segment? Does this segment contain any data?

- sequence number response to the SYNACK: **2818463619**
- value of the Acknowledgement field: **1247095791**
- No, this segment does not contain any data.

Question 4. Who has done the active close? client or the server? how you have determined this? What type of closure has been performed? 3 Segment (FIN/FINACK/ACK), 4 Segment (FIN/ACK/FIN/ACK) or Simultaneous close?

- Both Client and Server does the active close. Because in No.304 and No.305 contain FIN flag as well as ACK.
- The type of closure has been performed is Simultaneous close.

Question 5. How many data bytes have been transferred from the client to the server and from the server to the client during the whole duration of the connection? What relationship does this have with the Initial Sequence Number and the final ACK received from the other side?

- 33 bytes data transferred from the client to the server(1 byte SYN, 1 byte FIN), 40 bytes data transferred from the server to the client(1 byte SYN, 1 byte FIN).
- Data transferred equal to the difference of the Initial Sequence Number and the final ACK received from the other side. That is Final ACK received from the other side = ISN + SYN(1 byte) + The value of bytes transferred + FIN(1 byte)

	Client	Server
ISN	2818463618	1247095790
SYN	1	1
DATA	33	40
FIN	1	1
Total	281846353 (Final ACK of the Server)	1247095832 (Final ACK of the Client)