

## Exercise 1

**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 are the IP address and TCP port numbers used by the client computer (source) that is transferring the file to gaia.cs.umass.edu?**

1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80	[SYN] Seq=232129012 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=883061785 Ack=232129013 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=232129013 Ack=883061786 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80	[PSH, ACK] Seq=232129013 Ack=883061786 Win=17520 Len=565 [TCP segment of a reassembled

The IP address of gaia.cs.umass.edu is 128.119.245.12. It is sending and receiving on the port 80. The IP address of the source is 192.168.1.102 and the port number is 1161.

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

The sequence number is 232129013.

Destination Address: 128.119.245.12	0030	44 70 1f bd 00 00 50 4f	53 54 20 2f 65 74 68 65	Dp...PO ST /ethe
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129013, Ack:	0040	72 65 61 6c 2d 6c 61 62	73 2f 6c 61 62 33 2d 31	real-lab s/lab3-1
Source Port: 1161	0050	2d 72 65 70 6c 79 2e 68	74 6d 20 4b 54 54 50 2f	-reply.htm HTTP/
Destination Port: 80	0060	31 2e 31 0d 0a 48 6f 73	74 3a 20 67 61 69 61 2e	1.1..Host t: gaia.
[Stream index: 0]	0070	63 73 2e 75 6d 61 73 73	2e 65 64 75 0d 0a 55 73	cs.umass.edu..Us
[Conversation completeness: Incomplete, DATA (15)]	0080	65 72 2d 41 67 65 6e 74	3a 20 4d 6f 7a 69 6c 6c	er-Agent : Mozill
[TCP Segment Len: 565]	0090	61 2f 35 2e 30 20 28 57	69 6e 64 6f 77 73 3b 20	a/5.0 (W indows;
Sequence Number: 232129013	00a0	55 3b 20 57 69 6e 64 6f	77 73 20 4e 54 20 35 2e	Uy Windo ws NT 5.
[Next Sequence Number: 232129578]	00b0	31 3b 20 65 6e 2d 55 53	3b 20 72 76 3a 31 2e 30	1; en-US ; rv:1.0
Acknowledgment Number: 883061786	00c0	2e 32 29 20 47 65 63 6b	6f 2f 32 30 30 33 30 32	.2) Gecko o/200302
0010 .... = Header Length: 20 bytes (5)	00d0	30 38 20 4e 65 74 73 63	61 70 65 2f 37 2e 30 32	08 Netsc ape/7.02
Flags: 0x018 (PSH, ACK)	00e0	0d 0a 41 63 63 65 70 74	3a 20 74 65 78 74 2f 78	-Accept : text/x
Window: 17520	00f0	6d 6c 2c 61 70 70 6c 69	63 61 74 69 6f 6e 2f 78	ml,appli cation/x
[Calculated window size: 17520]	0100	6d 6c 2c 61 70 70 6c 69	63 61 74 69 6f 6e 2f 78	ml,appli cation/x
[Window size scaling factor: -2 (no window scaling used)]	0110	68 74 6d 6c 2b 78 6d 6c	2c 74 65 78 74 2f 68 74	html+xml ,text/ht
Checksum: 0x1fbd [unverified]	0120	6d 6c 3b 71 3d 30 2e 39	2c 74 65 78 74 2f 70 68	ml;q=0.9 ,text/pl
[Checksum Status: Unverified]	0130	61 69 6e 3b 71 3d 30 2e	38 2c 76 69 64 65 6f 2f	ain;q=0.8 ,video/
Urgent Pointer: 0	0140	78 2d 6d 6e 67 2c 69 6d	61 67 65 2f 70 6e 67 2c	x-mng,im age/png,
[Timestamps]	0150	69 6d 61 67 65 2f 6a 70	65 67 2c 69 6d 61 67 65	image/jp eg,image
[SEQ/ACK analysis]	0160	2f 67 69 66 3b 71 3d 30	2e 32 2c 74 65 78 74 2f	/gif;q=0.2 ,text/
TCP payload (565 bytes)	0170	63 73 73 2c 2a 2f 2a 3b	71 3d 30 2e 31 8d 0a 41	css,*/*; q=0.1..A
[Reassembled PDU in frame: 199]	0180	63 63 65 70 74 2d 4c 61	6e 67 75 61 67 65 3a 20	accept-La nguage:
TCP segment data (565 bytes)	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	20 64 65 66 6c 61 74 65	g: gzip, deflate
	01c0	2c 20 63 6f 6d 70 72 65	73 73 3b 71 3d 30 2e 39	, compre ss;q=0.9
	01d0	0d 0a 41 63 63 65 70 74	2d 43 68 61 72 73 65 74	-Accept -Charset

**Question 3. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection.**

(a) What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST) sent from the client to the webserver (Do not consider the ACKs received from the server as part of these six segments)?

(b) 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?

(c) What is the EstimatedRTT value (see relevant parts of Section 3.5 or lecture slides) after receiving each ACK? Assume that the initial value of EstimatedRTT is equal to the measured RTT ( SampleRTT ) for the first segment and then is computed using the EstimatedRTT equation for all subsequent segments. Set alpha to 0.125.

(d) What is the length of each of the first six TCP segments?

4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80	[PSH, ACK] Seq=232129013 Ack=883061786 Win=17520 Len=565 [TCP segment of a reassembled
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[PSH, ACK] Seq=232129578 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161	[ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=232131038 Ack=883061786 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=232132498 Ack=883061786 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=883061786 Ack=232131038 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=232133958 Ack=883061786 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=232135418 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU

Segment No.	Sequence No.	Time	ACK Received	RTT	Estimated RTT	Length
1(4)	232129013	0.026477	0.053937	0.053937 – 0.026477 = 0.02746	0.02746	565
2(5)	232129578	0.041737	0.077294	0.077294 – 0.041737 = 0.035557	(1-0.125)*0.02746 + 0.125*0.035557 = 0.02487	1460

3(7)	232131038	0.054026	0.124085	$0.124085 - 0.054026 = 0.070059$	$(1-0.125)*0.02487 + 0.125*0.070059 = 0.03367$	1460
4(8)	232132498	0.054690	0.169118	$0.169118 - 0.054690 = 0.114428$	$(1-0.125)* 0.03367 + 0.125*0.114428 = 0.04376$	1460
5(10)	232133958	0.077405	0.217299	$0.217299 - 0.077405 = 0.139894$	$(1-0.125)* 0.04376 + 0.125*0.139894 = 0.05578$	1460
6(11)	232135418	0.078157	0.267802	$0.267802 - 0.078157 = 0.189645$	$(1-0.125)* 0.05578 + 0.125*0.189645 = 0.07251$	1460

**Question 4. 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?**

The minimum amount of buffer space is 5840(line 2). The lack of receiver buffer space does not throttle the sender as the window grows larger to a maximum of 62780 bytes.

**Question 5. Are there any retransmitted segments in the trace file? To answer this question, what did you check for (in the trace)?**

There are not any retransmitted files in the tracefile. This was checked by using 'tcp.analysis.retransmission' in the filter field. No segments appeared, therefore there was no retransmissions



**Question 6. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (recall the discussion about delayed acks from the lecture notes or Section 3.5 of the text)?**

The receiver typically acknowledges 1460 bytes in an ACK.

**Question 7. What is the TCP connection's throughput (bytes transferred per unit of time during the connection)? Explain how you calculated this value.**

Looking at frame 199 we can see that all the reassembled TCP segments is 164090 bytes. This can also be shown by the last ACK – first Seq no.  $232293103 - 232129013 = 164090$  bytes.

Total transmission time = Last ACK time – first Seq time =  $5.455830 - 0.026477 = 5.429353$

Therefore, throughput =  $164090 / 5.429353 = 30222.75398$  bytes/sec.

## Exercise 2

No	Source IP	Destination IP	Protocol	Info
295	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [SYN] Seq=2818463618 win=8192 MSS=1460
296	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [SYN, ACK] Seq=1247095790 Ack=2818463619 win=262144 MSS=1460
297	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [ACK] Seq=2818463619 Ack=1247095791 win=65535
298	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [PSH, ACK] Seq=2818463619 Ack=1247095791 win=65535
301	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [ACK] Seq=1247095791 Ack=2818463652 win=262096
302	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [PSH, ACK] Seq=1247095791 Ack=2818463652 win=262144
303	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [ACK] Seq=2818463652 Ack=1247095831 win=65535
304	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [FIN, ACK] Seq=2818463652 Ack=1247095831 win=65535
305	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [FIN, ACK] Seq=1247095831 Ack=2818463652 win=262144
306	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [ACK] Seq=2818463652 Ack=1247095832 win=65535
308	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [ACK] Seq=1247095831 Ack=2818463653 win=262144

**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?**

The sequence number is 2818463618.

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

The sequence number is 1247095790. The ACK value is 2818463619. This ACK value is determined by the sequence number from the client + 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?**

The sequence number is 2818463619. The value of the ACK is 1247095791. This segment does not contain any data.

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

Both the client and the server have done active close. This can be determined as the client and server have both sent FINACK to each other. The type of closure used is simultaneous close. The sequence number of 304 is equal to the ACK of 305.

**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?**

Data bytes from the client to the server are  $2818463653 - 2818463618 - 2(\text{SYN}, \text{FIN}) = 33\text{bytes}$ .

Data bytes from the server to the client are  $1247095832 - 1247095790 - 2(\text{SYN}, \text{FIN}) = 40\text{bytes}$ .

The relationship between initial sequence number and the final ACK is the amount of bytes sent.