

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?

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [SYN, ACK] Seq=1161 Win=0 Len=0
2	0.023172	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [SYN, ACK] Seq=80 Ack=1161 Win=175
3	0.023265	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [PSH, ACK] Seq=1161 Ack=80 Win=0 Len=0
5	0.041737	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [PSH, ACK] Seq=1161 Ack=80 Win=0 Len=0
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
7	0.054826	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
8	0.054990	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
11	0.078157	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
12	0.124985	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
17	0.304897	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=80 Ack=1161 Win=0 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
19	0.305813	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0
20	0.306692	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=1161 Ack=80 Win=0 Len=0

0100	Version: 4															
0101	Header Length: 20 bytes (5)															
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)																
Total Length: 40																
Identification: 0x1e1d (7769)																
Flags: 0x2, Don't fragment																
Fragment Offset: 0																
Time to Live: 128																
Protocol: TCP (6)																
Header checksum: 0x5a18 [validation disabled]																
[Header checksum status: Unverified]																
Source Address: 192.168.1.102																
Destination Address: 128.119.245.12																
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0																
Source Port: 1161																
Destination Port: 80																
[Stream index: 0]																
[Conversation completeness: Incomplete, DATA (15)]																
[TCP Segment Len: 0]																
Sequence Number: 0 (relative sequence number)																
Sequence Number (raw): 232129012																
[Next Sequence Number: 1 (relative sequence number)]																
Acknowledgment Number: 0																
Acknowledgment number (raw): 0																
0111 = Header Length: 28 bytes (7)																

The IP address of gaia.cs.umass.edu should be the destination IP address which is given by 128.119.245.12. The corresponding port number is used for this connection is 80.

The IP address of client computer is the source address which is given by 192.168.1.102 this is a private IP address, and the corresponding port number used is 1161.

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

	Source	Destination	Protocol	Length	Info
	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN, ACK] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM
	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
	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
	128.119.245.12	192.168.1.102	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
	128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=2028 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
	128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
	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]
	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
	192.168.1.102	128.119.245.12	TCP	1261	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14680 Len=0
	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
	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]
	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]
	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=1 Ack=11933 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
Protocol: TCP (6)					
Header checksum: 0xa2e7 [validation disabled]					
[Header checksum status: Unverified]					
Source Address: 192.168.1.102					
Destination Address: 128.119.245.12					
Source Port: 1161					
Destination Port: 80					
[Stream index: 0]					
[Conversation completeness: Incomplete, DATA (15)]					
[TCP Segment Len: 565]					
Sequence Number: 1 (relative sequence number)					
Next Sequence Number: 566 (relative sequence number)					
Acknowledgment Number: 1 (relative ack number)					
Acknowledgment number (raw): 803961786					
0101 = Header Length: 20 bytes (5)					
Flags: 0x018 (PSH, ACK)					
Window: 17520					
[Calculated window size: 17520]					
[Window size scaling factor: -2 (no window scaling used)]					
Checksum: 0xf1bd [unverified]					
[Checksum Status: Unverified]					
Urgent Pointer: 0					
[Timestamps]					

The fourth segment of the trace is the first TCP segment containing the HTTP POST command where you can find in the right.

The sequence number is 232129013

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)?

192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN]	Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM
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
192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK]	Seq=1 Ack=1 Win=17520 Len=0
128.119.245.12	192.168.1.102	TCP	619	1161 → 80 [PSH, ACK]	Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK]	Seq=1 Ack=566 Win=6780 Len=0
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK]	Seq=2028 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK]	Seq=2028 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK]	Seq=1 Ack=2026 Win=8760 Len=0
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]
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK]	Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK]	Seq=1 Ack=3486 Win=11680 Len=0
128.119.245.12	192.168.1.102	TCP	1261	1161 → 80 [PSH, ACK]	Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK]	Seq=1 Ack=4946 Win=14680 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK]	Seq=1 Ack=7866 Win=20440 Len=0
192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK]	Seq=1 Ack=9013 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK]	Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
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]
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]
Protocol: TCP (6)					
Header checksum: 0xf1bd [validation disabled]					
[Header checksum status: Unverified]					
Source Address: 192.168.1.102					
Destination Address: 128.119.245.12					
Source Port: 1161					
Destination Port: 80					
[Stream index: 0]					
[Conversation completeness: Incomplete, DATA (15)]					
[TCP Segment Len: 1460]					
Sequence Number: 566 (relative sequence number)					
Next Sequence Number: 2028 (relative sequence number)					
Acknowledgment Number: 1 (relative ack number)					
Acknowledgment number (raw): 803961786					
0101 = Header Length: 20 bytes (5)					
Flags: 0x018 (PSH, ACK)					
Window: 17520					
[Calculated window size: 17520]					
[Window size scaling factor: -2 (no window scaling used)]					
Checksum: 0xb8b5 [unverified]					
[Checksum Status: Unverified]					
Urgent Pointer: 0					
[Timestamps]					

Source	Destination	Protocol	Length	Info	Source	Destination	Protocol	Length	Info
192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM	0020	f5 0c 84 09 00 50 0d 0f 09 02 34 a2 74 1a 50 10	...	P...4 t.p.	
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	0030	4a 70 78 65 76 74 0a 68 66 0c 65 73 20 67 08	...	t text - files pe	
192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=0	0040	54 1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=0	...	r month: thus u	
192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]	0050	70 78 69 66 67 20 67 08 72 20 78 72 67 64 75 63	...	pping our produc	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0060	74 69 76 69 74 79 20 68 72 67 68 20 24 32 26 6d	...	tivity f from s2 m	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0070	69 66 6c 69 6f 20 67 08 0d 04 68 65 65 65 67	...	llyon: The G	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0080	6f 61 6c 69 6f 20 67 08 0d 04 68 65 65 65 67	...	oal of P roject o	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0090	75 74 65 6c 62 65 72 67 20 69 73 20 74 67 20 6f	...	utenberg is to G	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00a0	6c 6c 69 6f 62 65 71 77 61 79 20 4f 6c 62 20 54 72 69	...	lly Away One Tri	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	00b0	6c 6c 69 6f 62 65 71 77 61 79 20 4f 6c 62 20 54 72 69	...	llyon et oct - Fil	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00c0	65 73 20 62 79 31 2c 32 30 39 31 2c 30 39 31 2c	...	by the 9 Decembe	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	00d0	65 72 20 33 31 2c 32 30 39 31 2c 30 39 31 2c	...	er 31, 2 9001 [
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00e0	30 2c 30 39 31 2c 32 30 39 31 2c 30 39 31 2c	...	0,000 x 100,000,	
128.119.245.12	192.168.1.102	TCP	1201	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]	00f0	68 69 73 20 69 73 20 67 08 6c 69 6f 6e 5d 62 68	...	his is t en thous	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0100	61 6e 64 29 74 69 74 6c 65 73 20 65 61 63 68 20	...	and t illes s ech	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0110	6f 20 6f 20 65 65 65 65 65 65 65 65 65 65 65 65	...	o one hundred	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0120	69 6c 6c 69 6f 6e 20 67 08 65 64 72 65 65 73 2c 6d	...	llyon r readers,	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0130	74 6f 20 6f 6e 65 65 65 65 65 65 65 65 65 65 65	...	d if the e year 2	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0140	69 6c 6c 69 6f 6e 20 67 08 65 64 72 65 65 73 2c 6d	...	hich is 10% of	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0150	84 77 68 69 63 68 20 69 73 2c 31 30 29 29 29 29	...	member of comput	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0160	20 75 74 68 65 20 65 70 65 74 68 65 64 20 65 70	...	users by the en	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0170	6d 62 65 72 20 6f 66 20 63 6f 67 70 75 64 65 72	...	d of the e year 2	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0180	20 75 74 68 65 20 65 70 65 74 68 65 64 20 65 70	...	001... We need	
128.119.245.12	192.168.1.102	TCP	15						

Protocol: TCP (6)

Header checksum: 0x9f65 [validation disabled]

Header checksum status: Unverified

Source Address: 192.168.1.102

Destination Address: 128.119.245.12

Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 2026, Ack: 1, Len: 1460

Source Port: 1161

Destination Port: 80

[Stream index: 0]

[Conversation completeness: Incomplete, DATA (15)]

[TCP Segment Len: 1460]

Sequence Number: 2026 (relative sequence number)

Sequence Number (raw): 232131830

[Next Sequence Number: 3486 (relative sequence number)]

Acknowledgment Number: 1 (relative ack number)

Acknowledgment Number (raw): 883661786

0101... = Header Length: 20 bytes (5)

Flags: 0x010 (ACK)

Window: 17520

[Calculated window size: 17520]

[Window size scaling factor: -2 (no window scaling used)]

Checksum: 0x00d1 [unverified]

[Checksum Status: Unverified]

Urgent Pointer: 0

[Timestamps]

File data first frame in this TCP stream: 0x00000000 (empty)

Source	Destination	Protocol	Length	Info	Source	Destination	Protocol	Length	Info
192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM	0020	f5 0c 84 09 00 50 0d 0f 09 02 34 a2 74 1a 50 10	...	P...4 t.p.	
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	0030	4a 70 78 65 76 74 0a 68 66 0c 65 73 20 67 08	...	t text - files pe	
192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=0	0040	54 1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=0	...	r month: thus u	
192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]	0050	70 78 69 66 67 20 67 08 72 20 78 72 67 64 75 63	...	pping our produc	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0060	74 69 76 69 74 79 20 68 72 67 68 20 24 32 26 6d	...	tivity f from s2 m	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0070	69 66 6c 69 6f 20 67 08 0d 04 68 65 65 65 67	...	llyon: The G	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0080	6f 61 6c 69 6f 20 67 08 0d 04 68 65 65 65 67	...	oal of P roject o	
128.119.245.12	192.168.1.102	TCP	1201	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]	0090	75 74 65 6c 62 65 72 67 20 69 73 20 74 67 20 6f	...	utenberg is to G	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00a0	6c 6c 69 6f 62 65 71 77 61 79 20 4f 6c 62 20 54 72 69	...	lly Away One Tri	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	00b0	6c 6c 69 6f 62 65 71 77 61 79 20 4f 6c 62 20 54 72 69	...	llyon et oct - Fil	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00c0	65 73 20 62 79 31 2c 32 30 39 31 2c 30 39 31 2c	...	by the 9 Decembe	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	00d0	65 72 20 33 31 2c 32 30 39 31 2c 30 39 31 2c	...	er 31, 2 9001 [
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00e0	30 2c 30 39 31 2c 32 30 39 31 2c 30 39 31 2c	...	0,000 x 100,000,	
128.119.245.12	192.168.1.102	TCP	1201	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]	00f0	68 69 73 20 69 73 20 67 08 6c 69 6f 6e 5d 62 68	...	his is t en thous	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0100	61 6e 64 29 74 69 74 6c 65 73 20 65 61 63 68 20	...	and t illes s ech	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0110	6f 20 6f 20 65 65 65 65 65 65 65 65 65 65 65 65	...	o one hundred	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0120	69 6c 6c 69 6f 6e 20 67 08 65 64 72 65 65 73 2c 6d	...	llyon r readers,	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0130	74 6f 20 6f 6e 65 65 65 65 65 65 65 65 65 65 65	...	d if the e year 2	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0140	69 6c 6c 69 6f 6e 20 67 08 65 64 72 65 65 73 2c 6d	...	hich is 10% of	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0150	84 77 68 69 63 68 20 69 73 2c 31 30 29 29 29 29	...	member of comput	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0160	20 75 74 68 65 20 65 70 65 74 68 65 64 20 65 70	...	users by the en	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0170	6d 62 65 72 20 6f 66 20 63 6f 67 70 75 64 65 72	...	d of the e year 2	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0180	20 75 74 68 65 20 65 70 65 74 68 65 64 20 65 70	...	001... We need	
128.119.245.12	192.168.1.102	TCP	15						

Protocol: TCP (6)

Header checksum: 0x9f65 [validation disabled]

Header checksum status: Unverified

Source Address: 192.168.1.102

Destination Address: 128.119.245.12

Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 3486, Ack: 1, Len: 1460

Source Port: 1161

Destination Port: 80

[Stream index: 0]

[Conversation completeness: Incomplete, DATA (15)]

[TCP Segment Len: 1460]

Sequence Number: 3486 (relative sequence number)

Sequence Number (raw): 232131830

[Next Sequence Number: 4946 (relative sequence number)]

Acknowledgment Number: 1 (relative ack number)

Acknowledgment Number (raw): 883661786

0101... = Header Length: 20 bytes (5)

Flags: 0x010 (ACK)

Window: 17520

[Calculated window size: 17520]

[Window size scaling factor: -2 (no window scaling used)]

Checksum: 0x00d1 [unverified]

[Checksum Status: Unverified]

Urgent Pointer: 0

[Timestamps]

File data first frame in this TCP stream: 0x00000000 (empty)

Source	Destination	Protocol	Length	Info	Source	Destination	Protocol	Length	Info
192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM	0020	f5 0c 84 09 00 50 0d 0f 09 02 34 a2 74 1a 50 10	...	P...4 t.p.	
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	0030	4a 70 78 65 76 74 0a 68 66 0c 65 73 20 67 08	...	t text - files pe	
192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=0	0040	54 1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=0	...	r month: thus u	
192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]	0050	70 78 69 66 67 20 67 08 72 20 78 72 67 64 75 63	...	pping our produc	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0060	74 69 76 69 74 79 20 68 72 67 68 20 24 32 26 6d	...	tivity f from s2 m	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0070	69 66 6c 69 6f 20 67 08 0d 04 68 65 65 65 67	...	llyon: The G	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0080	6f 61 6c 69 6f 20 67 08 0d 04 68 65 65 65 67	...	oal of P roject o	
128.119.245.12	192.168.1.102	TCP	1201	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]	0090	75 74 65 6c 62 65 72 67 20 69 73 20 74 67 20 6f	...	utenberg is to G	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00a0	6c 6c 69 6f 62 65 71 77 61 79 20 4f 6c 62 20 54 72 69	...	lly Away One Tri	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	00b0	6c 6c 69 6f 62 65 71 77 61 79 20 4f 6c 62 20 54 72 69	...	llyon et oct - Fil	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00c0	65 73 20 62 79 31 2c 32 30 39 31 2c 30 39 31 2c	...	by the 9 Decembe	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	00d0	65 72 20 33 31 2c 32 30 39 31 2c 30 39 31 2c	...	er 31, 2 9001 [
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	00e0	30 2c 30 39 31 2c 32 30 39 31 2c 30 39 31 2c	...	0,000 x 100,000,	
128.119.245.12	192.168.1.102	TCP	1201	1161 → 80 [PSH, ACK] Seq=0 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]	00f0	68 69 73 20 69 73 20 67 08 6c 69 6f 6e 5d 62 68	...	his is t en thous	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0100	61 6e 64 29 74 69 74 6c 65 73 20 65 61 63 68 20	...	and t illes s ech	
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=0 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	0110	6f 20 6f 20 65 65 65 65 65 65 65 65 65 65 65 65	...	o one hundred	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0120	69 6c 6c 69 6f 6e 20 67 08 65 64 72 65 65 73 2c 6d	...	llyon r readers,	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0130	74 6f 20 6f 6e 65 65 65 65 65 65 65 65 65 65 65	...	d if the e year 2	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0140	69 6c 6c 69 6f 6e 20 67 08 65 64 72 65 65 73 2c 6d	...	hich is 10% of	
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=0 Ack=566 Win=8780 Len=0	0150	84 77 68 69 63 68 20 69 73 2c 31			

Source	Destination	Protocol	Length	Info
192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM
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
192.168.1.102	128.119.245.12	TCP	64	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
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]
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]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=8760 Len=0
192.168.1.102	128.119.245.12	TCP	1512	1161 → 80 [ACK] Seq=2826 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
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]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2826 Win=8760 Len=0
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]
128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=1680 Len=0
192.168.1.102	128.119.245.12	TCP	1261	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=1460 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6486 Win=17520 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9813 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
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]
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]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=11933 Win=23360 Len=0

Protocol: TCP (6)	0020 f5 0c 04 89 08 50 d6 1a fa 3a a2 74 1a 50 10P.....4 t P
Header Checksum: 0x9f63 [validation disabled]	0030 44 70 95 83 08 00 20 55 6e 60 74 65 64 20 53 74	Op...U nited St
[Header checksum status: Unverified]	0040 18 7f 13 32 32 33 3f 70 79 72 69 67 68 74 80 0a	ites copy right
Source Address: 192.168.1.102	0050 6f 6e 20 6f 72 20 66 6f 72 20 74 68 69 73 20 77	on or fo r this w
Destination Address: 128.119.245.12	0060 6f 72 60 2c 20 73 6f 20 74 68 65 20 50 72 6f 6a	ork, so (the Proj
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 6486, Ack: 1, Len: 1460	0070 65 63 74 20 70 61 6e 64 20 79 6f 75 21 29 20 63	ect (and you'll s
Source Port: 1161	0080 61 6e 20 63 6f 70 79 20 61 6e 64 6d 8a 64 69 73	an copy and-dis
Destination Port: 80	0090 74 72 69 62 75 74 65 20 69 74 60 6e 69 74 68	tribute it in the
[Stream index: 0]	00a0 60 20 55 6e 69 74 65 64 20 53 74 61 74 65 73 20	United States
Conversation completeness: Incomplete, DATA (15)]	00b0 7f 69 74 68 6f 75 74 20 70 65 72 6d 69 73 73 69	Without permis
[TCP Segment Len: 1460]	00c0 60 20 55 6e 69 74 65 64 20 53 74 61 74 65 73 20	on and- without
Sequence Number: 6486 (relative sequence number)	00d0 79 61 73 69 6e 6f 20 63 6f 70 79 72 69 67 88 74	aving c opyright
Sequence Number: 232129013 (relative sequence number)	00e0 20 72 6f 79 61 6c 74 69 65 73 2e 20 53 70 65	royalti es. Sup
Acknowledgment Number: 1 (relative ack number)	00f0 60 20 55 6e 69 74 65 64 20 53 74 61 74 65 73 20	trial fol ew, we
Acknowledgment number (raw): 883961786	0100 64 6f 72 74 68 6d 8a 62 65 6c 6f 77 2c 20 61 70	forth- b elow, an
0101 = Header Length: 20 bytes (5)	0110 70 65 73 20 69 66 20 79 6f 75 20 77 69 73 68 20	ily if y ou wish
Flags: 0x018 (ACK)	0120 74 6f 20 63 6f 70 79 20 61 6e 64 20 64 69 72 74	to copy and dist
Window: 17520	0130 72 69 62 75 74 65 20 74 68 69 73 20 65 74 65 70	tribute it in the
[Calculated window size: 17520]	0140 74 60 8a 75 6e 64 65 72 20 74 68 65 20 50 72 6f	t- under the Pro
[Window size scaling factor: -2 (no window scaling used)]	0150 6e 63 74 27 71 20 22 6e 62 4f 64 45 43 54 20	ject's - PROJE
Checksum: 0x05b8 [unverified]	0160 47 55 54 45 4e 4e 42 45 52 47 22 20 74 72 61 64 65	SUTENER G' trade
[Checksum Status: Unverified]	0170 60 61 72 60 2e 6d 8a 0d 6a 64 6f 20 63 72 65 61	mark.... To crea
Urgent Pointer: 0	0180 74 65 20 74 68 65 73 65 20 65 74 65 70 74 72 62	is these statu
[Timestamps]	0190 20 74 68 65 20 50 72 6f 6a 65 63 74 20 65 70 79	the Pro ject exp
	01a0 69 6e 64 74 20 63 6f 6e 73 69 64 65 72 61 62 65	ends con siderabl
	01b0 65 60 8a 65 6e 68 6f 72 74 73 20 74 6f 20 69 64	o- offer its to th

The sequence numbers are: 232129013 232129578 232131038 232132498 232133958 and 232135418

(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?

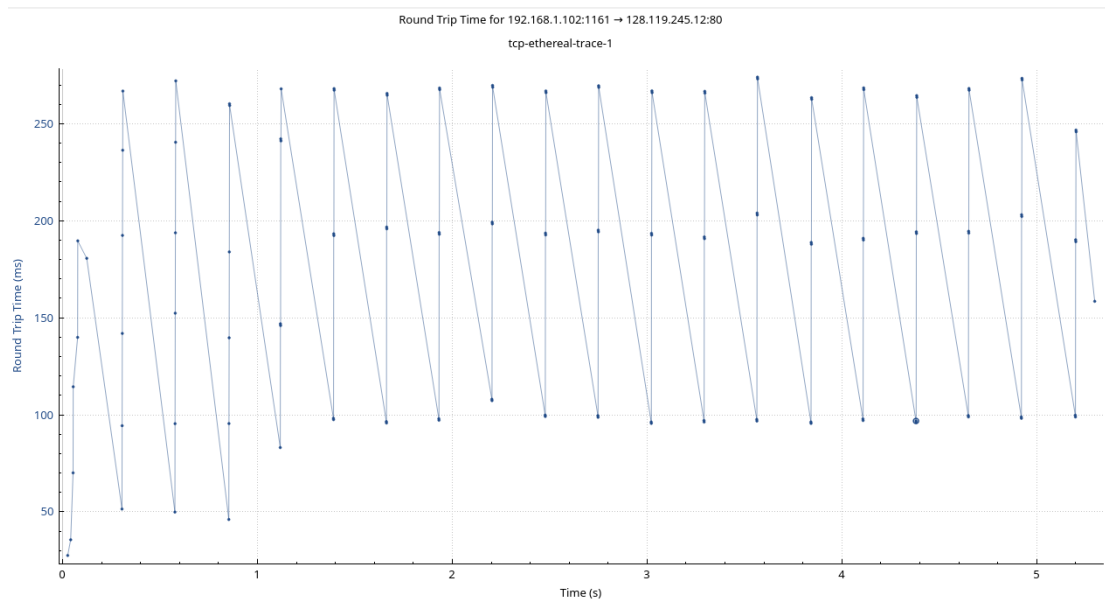
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000990	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0
3	0.023265	192.168.1.102	128.119.245.12	TCP	64	1161 → 80 [ACK] Seq=1 Ack=1 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
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
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=8760 Len=0
7	0.054926	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2826 Ack=1 Win=17520 Len=1460
8	0.054990	128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2826 Win=8760 Len=0
10	0.077485	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.124085	128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=566 Ack=1 Win=17520 Len=1460
12	0.124185	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=1680 Len=0
13	0.124185	128.119.245.12	192.168.1.102	TCP	1261	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=1460 Len=0
15	0.177299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6486 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	0.304897	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9813 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9813 Ack=1 Win=17520 Len=1460
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460

The segments were sent at time 0.026477 0.041737 0.054026 0.054690 0.077405 0.078157

The ACKs were received at time 0.053937 0.077294 0.124085 0.169118 0.217299 0.267802

RTT value can be calculated by taking the difference shown in the following table

(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.



Sequence Number	Segment sent time	ACK receive time	RTT	EstimatedRTT	Length
232129013	0.026477	0.053937	0.027460	0.027460	565
232129578	0.041737	0.077294	0.035557	0.028472	1460
232131038	0.054026	0.124085	0.070059	0.033670	1460
232132498	0.054690	0.169118	0.114428	0.043765	1460
232133958	0.077405	0.217299	0.139894	0.055781	1460
232135418	0.078157	0.267802	0.189645	0.072514	1460

Estimated RTT = (1 - alpha) * Estimated RTT + alpha * SampleRTT

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

The lengths are: 565 1460 1460 1460 1460 1460 correspondingly

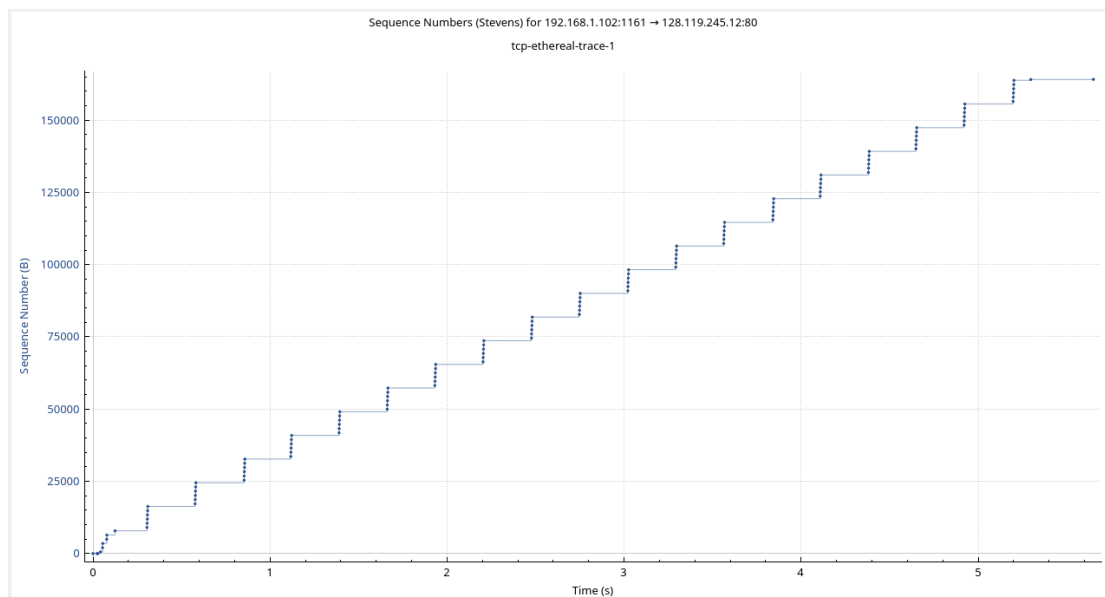
Question 4. What is the minimum amount of available buffer space advertised at the receiver for the entire trace? Does the lack of receiver buffer space ever throttle the sender?

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		
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	192	1161	→	80	[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]	
21	0.307571	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=13393	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
22	0.308699	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=14853	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
23	0.309553	192.168.1.102	128.119.245.12	TCP	946	1161	→	80	[PSH, ACK]	Seq=16313	Ack=1	Win=17520	Len=892	[TCP segment of a reassembled PDU]	
24	0.356437	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=10473	Win=26280	Len=0		
25	0.400164	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=11933	Win=29200	Len=0		
26	0.440613	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=13393	Win=32120	Len=0		
27	0.500029	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=14853	Win=35040	Len=0		
28	0.545052	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=16313	Win=37960	Len=0		
29	0.576417	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=17205	Win=37960	Len=0		
30	0.576671	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=17205	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
31	0.577385	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=18665	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
32	0.578329	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=20125	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
33	0.579195	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=21585	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
34	0.580149	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=23045	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	

169	0.737038	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=137951	Win=62700	Len=0		
170	0.740887	128.119.245.12	192.168.1.102	TCP	60	80	→	1161	[ACK]	Seq=1	Ack=140881	Win=62700	Len=0		
171	0.740904	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
172	0.740906	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
173	0.740909	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
174	0.740909	192.168.1.102	128.119.245.12	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
175	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
176	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
177	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
178	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
179	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
180	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
181	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
182	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
183	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
184	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
185	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
186	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
187	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
188	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
189	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
190	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
191	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
192	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
193	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
194	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
195	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
196	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
197	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
198	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
199	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
200	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
201	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
202	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
203	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
204	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
205	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
206	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
207	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
208	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
209	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
210	0.740910	128.119.245.12	192.168.1.102	TCP	1514	1161	→	80	[ACK]	Seq=140881	Ack=1	Win=17520	Len=1460	[TCP segment of a reassembled PDU]	
211	0.740910	128.119.245.12													

The minimum window size is 5840 bytes during the entire trace, the maximum buffer space is 62780 bytes. It is not likely to throttle the sender, as the buffer space is much bigger than the actual segment size.

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



The sequence number kept increasing all the time, therefore, no retransmitted segments.

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)?

Source	Destination	Protocol	Length	Info
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=87121 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=88501 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=90841 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=85661 Win=62780 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=85501 Win=62780 Len=0
192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=1 Ack=98933 Win=62780 Len=0
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=98933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=92393 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=93853 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=95313 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=96773 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=98233 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=93853 Win=62780 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=95773 Win=62780 Len=0
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=99125 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=100585 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=102045 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=103595 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=104965 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

The receiver typically acknowledges 1460 bytes of data in an ACK, as we can see the length of the data sent by the sender is mostly 1460 bytes. In the picture above. We can find that Seq 95313 and seq 96773 are combined in the Acknowledgement 96773 sent from the receiver.

Question 7. What is the TCP connection's throughput (bytes transferred per unit of time during the connection)?

183 4.922820	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=152657 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
184 4.923863	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=154117 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
185 4.924667	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=155577 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
186 5.019189	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=151197 Win=62780 Len=0
198 5.125919	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=154117 Win=62780 Len=0
191 5.197286	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=1 Ack=156469 Win=62780 Len=0
192 5.197588	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=156469 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
193 5.198388	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=157929 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
194 5.199276	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=159389 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
195 5.200252	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=160849 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
196 5.201150	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=162309 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
197 5.202024	192.168.1.102	128.119.245.12	TCP	326	1161 → 80 [PSH, ACK] Seq=163769 Ack=1 Win=17520 Len=270 [TCP segment of a reassembled PDU]
198 5.297257	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
199 5.297341	192.168.1.102	128.119.245.12	HTTP	104	POST /etherreal-labs/Lab3-1-reply.htm
200 5.389471	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201 5.447087	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202 5.455830	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164991 Win=62780 Len=0
203 5.461175	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)
203.5.451115	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [ACK] Seq=1 Ack=164991 Win=62780 Len=0
213 7.595557	192.168.1.102	199.2.53.206	TCP	62	1162 → 681 [SYN] Seq=0 Win=16384 Len=0

We can find that the total amount of data transmitted is 164090 bytes

Total time used to transfer the data is 5.455830-0.026477 = 5.429353s (from the HTTP POST request to the time finish the transmission)

Throughput = amount of data transmitted/ time used = 164090/5.429353 = 30222.75 bytes/s

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?

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?

Sequence number of the SYNACK segment sent by the server is 1247095790, the Acknowledgement field is 2818463619, which is the sequence number from the sender add 1 bit of SYN segment

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 of the ACK segment sent by the client computer in response to the SYNACK is 2818463619, the value of the Acknowledgment field in this ACK segment is 1247095791. It contains $2818463652 - 2818463619 = 33$ bytes of the data

Question 4. Who has done the active close? Is it the 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 the client and server did the active close, in No 304 and 305, we can find both client and server sent a FIN ACK segment to other side while the sequence number and Ack number correspond to each other.

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?

The amount of data transferred can be determined by the difference of first sequence number and the last ACK number.

Client: $2818463652 - 2818463619 = 33\text{bytes}$

Server: $1247095831 - 1247095791 = 40\text{ bytes}$

The Initial Sequence Number + 2 + total data transferred = final ACK received from the other side. Where the extra 2 is the SYN bit and FIN bit.