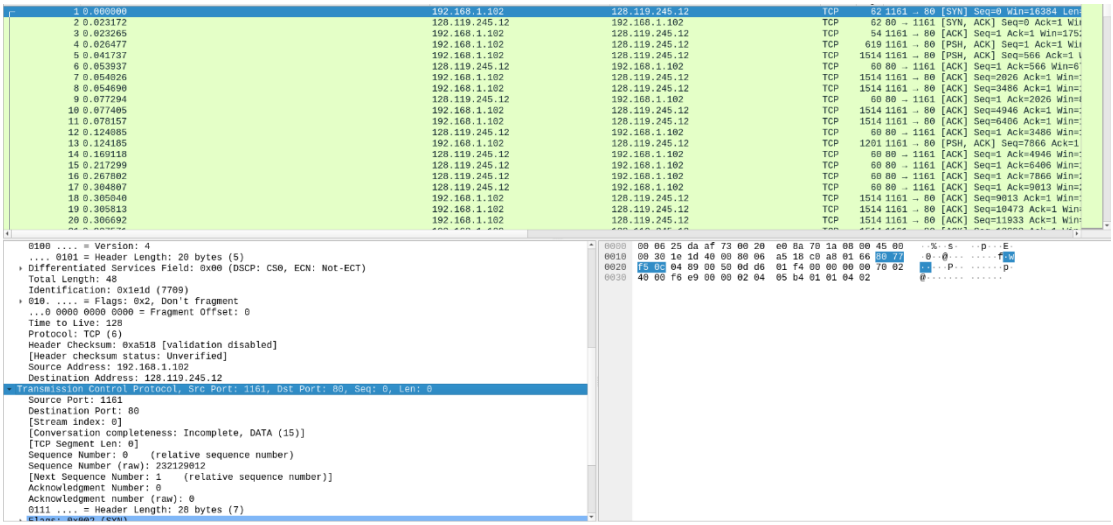
Exercise 1:

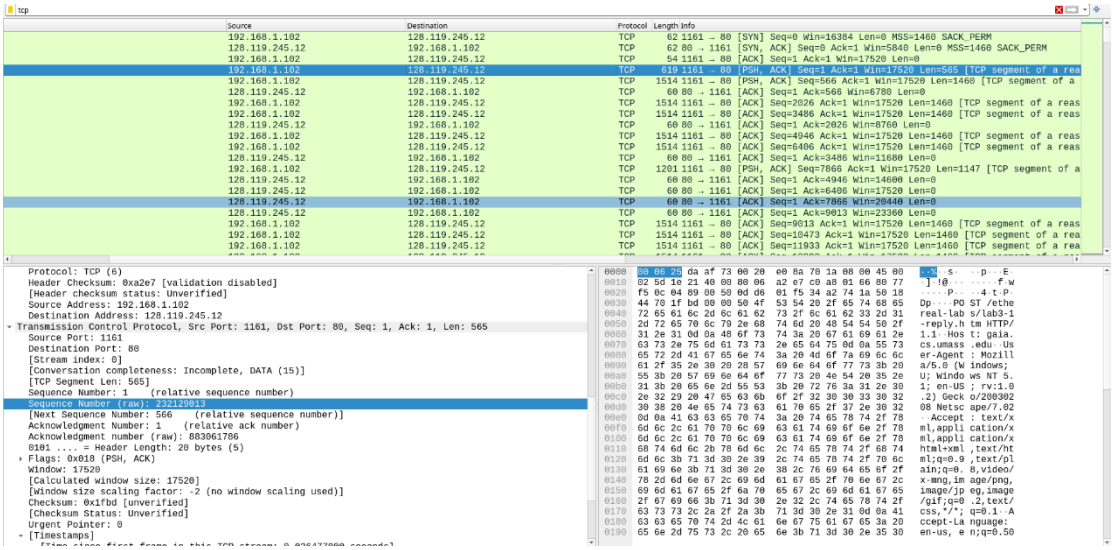
Question 1. What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection? What are the IP address and TCP port numbers used by the client computer (source) that is transferring the file to gaia.cs.umass.edu?



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?

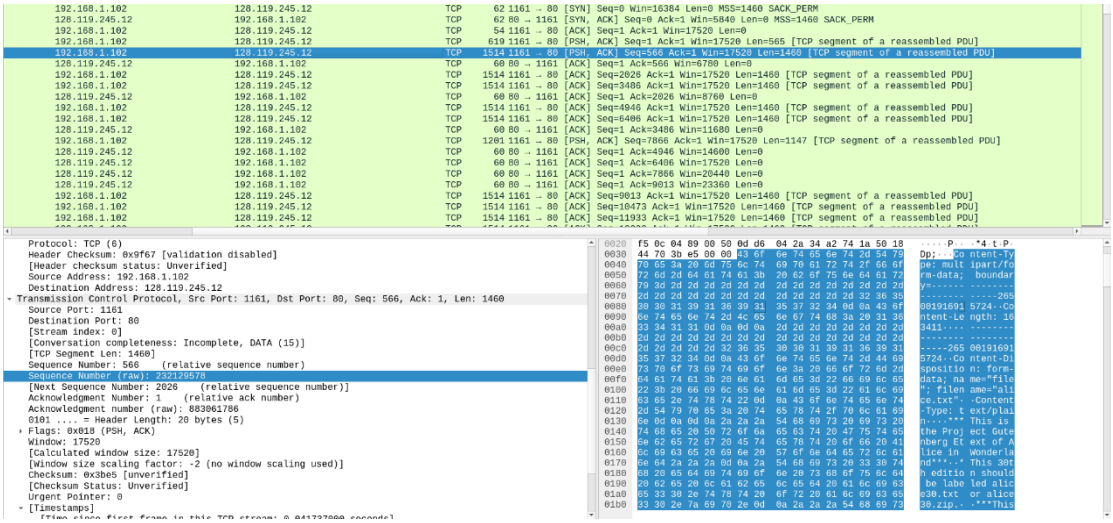


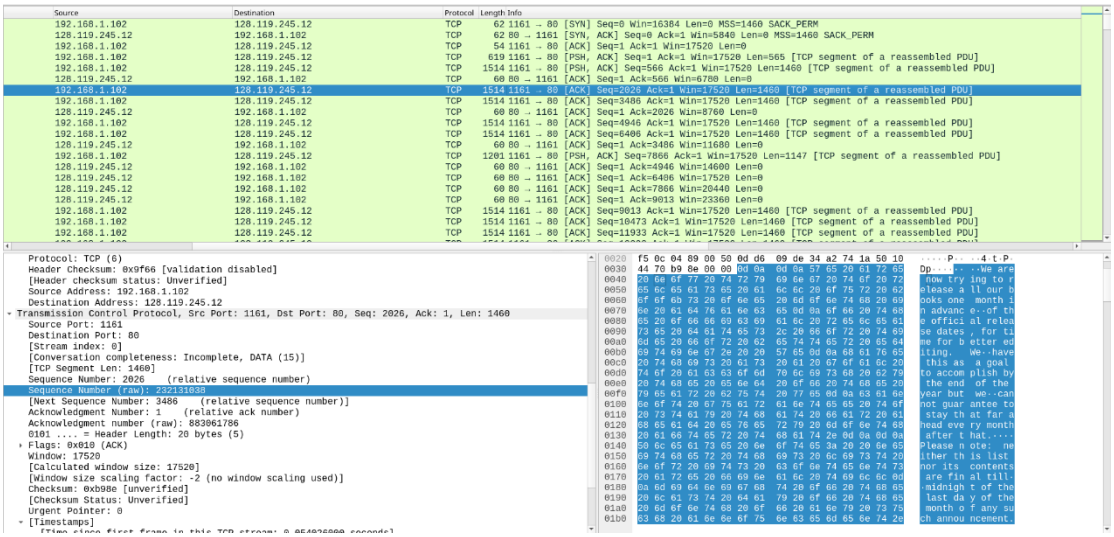
The fourth segment of the trace is the first TCP segment containing the HTTP POST command where you can find in the right.

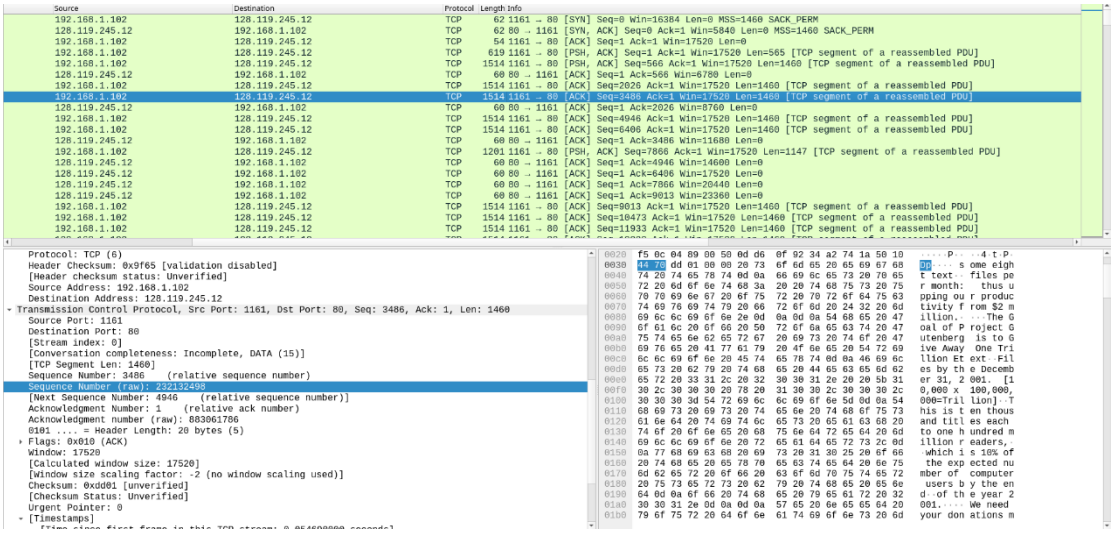
The sequence number is 232129013

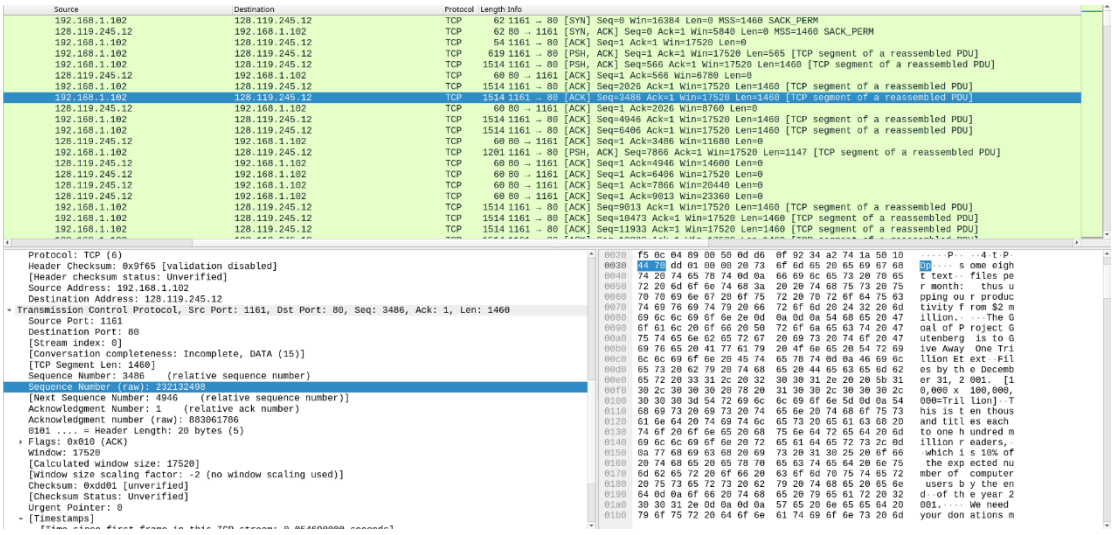
Question 3. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection.

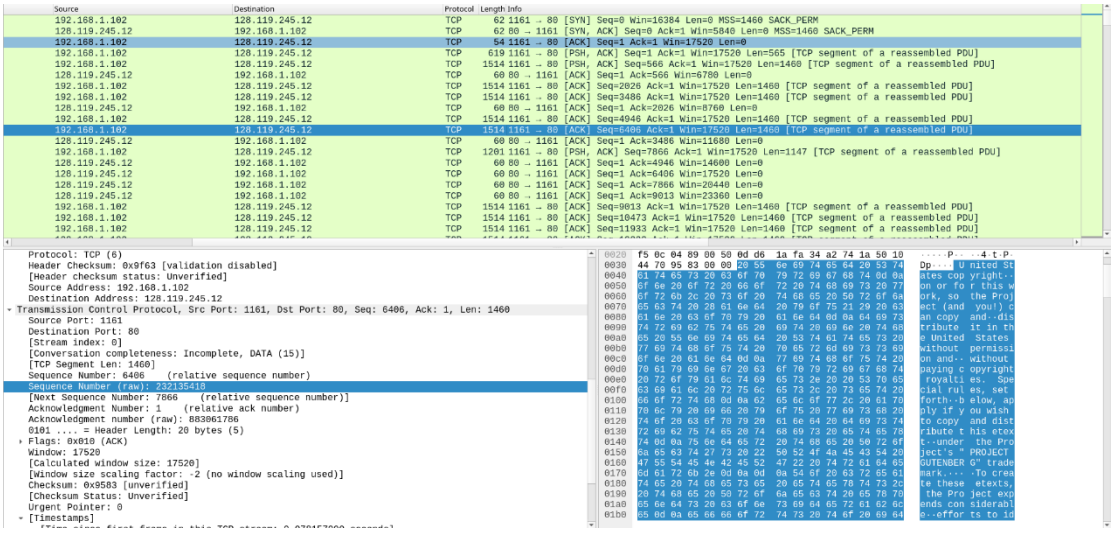
(a) What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST) sent from the client to the webserver (Do not consider the ACKs received from the server as part of these six segments)?




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 54 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=6780 Len=0
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]
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=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]
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]
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 1201 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=14600 Len=0
128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=6406 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=9013 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]
Protocol: TCP (6)
Header Checksum: 0x9f66 [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): 232131038
[Next Sequence Number: 3486 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 883061786
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: 0xb98e [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
[Timestamps]
0020 f5 0c 04 89 00 50 0d d6 09 de 34 a2 74 1a 50 10 .....P.. ..4.t.P.
0030 44 70 b9 8e 00 00 0d 0a 0d 0a 57 65 20 61 72 65 Dp...... ..We are
0040 20 6e 6f 77 20 74 72 79 69 6e 67 20 74 6f 20 72 now try ing to r
0050 65 6c 65 61 73 65 20 61 6c 6c 20 6f 75 72 20 62 elease a ll our b
0060 6f 6f 6b 73 20 6f 6e 65 20 6d 6f 6e 74 68 20 69 ooks one month i
0070 6e 20 61 64 76 61 6e 63 65 0d 0a 6f 66 20 74 68 n advanc e··of th
0080 65 20 6f 66 66 69 63 69 61 6c 20 72 65 6c 65 61 e offici al relea
0090 73 65 20 64 61 74 65 73 2c 20 66 6f 72 20 74 69 se dates , for ti
00a0 6d 65 20 6f 66 20 72 65 74 74 65 72 20 65 64 69 me for b etter edi
00b0 74 69 6e 67 2e 20 20 57 65 0d 0a 68 61 76 65 20 ting. We··have
00c0 20 74 68 69 73 20 61 73 20 61 20 67 6f 61 6c 20 this as a goal
00d0 74 6f 20 61 63 63 6f 6d 70 6c 69 73 68 20 62 79 to accom plish by
00e0 20 74 68 65 20 65 6e 64 20 6f 66 20 74 68 65 20 the end of the
00f0 79 65 61 72 20 62 75 74 20 77 65 0d 0a 63 61 6e year but we··can
0100 6e 6f 74 20 67 75 61 72 61 6e 74 65 65 20 74 6f not guar antee to
0110 20 73 74 61 79 20 74 68 61 74 20 66 61 72 20 61 stay th at far a
0120 68 65 61 64 20 65 76 65 72 79 20 6d 6f 6e 74 68 head eve ry month
0130 20 61 66 74 65 72 20 74 68 61 74 2e 0d 0a 0d 0a after t hat.····
0140 50 6c 65 61 73 65 20 6e 6f 74 65 3a 20 20 6e 65 Please n ote: ne
0150 69 74 68 65 72 20 74 68 69 73 20 6c 69 73 74 20 ither th is list
0160 6e 6f 72 20 69 74 73 20 63 6f 6e 74 65 6e 74 73 nor its contents
0170 20 61 72 65 20 66 69 6e 61 6c 20 74 69 6c 6c 0d are fin al till·
0180 0a 6d 69 64 6e 69 67 68 74 20 6f 66 20 74 68 65 ·midnigh t of the
0190 20 6c 61 73 74 20 64 61 79 20 6f 66 20 74 68 65 last da y of the
01a0 20 6d 6f 6e 74 68 20 6f 66 20 61 6e 79 20 73 75 month o f any su
01b0 63 68 20 61 6e 6e 6f 75 6e 63 65 6d 65 6e 74 2e ch annou ncement.

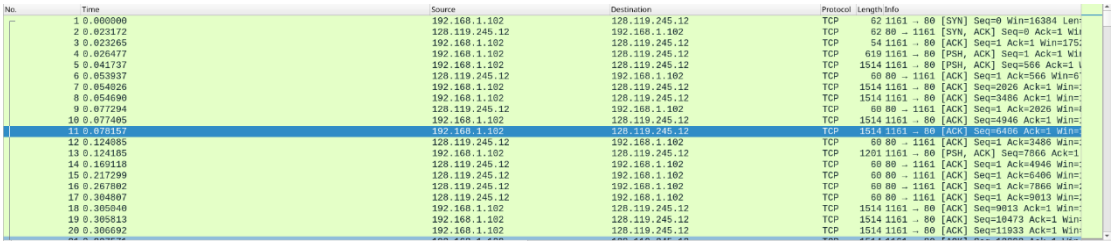

Source Destination Protocol Length Info
192.168.1.102 128.119.245.12 TCP 62 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM
128.119.245.12 192.168.1.102 TCP 62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM
192.168.1.102 128.119.245.12 TCP 54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 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=6780 Len=0
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]
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=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]
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]
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 1201 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=14600 Len=0
128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=6406 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=9013 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]
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): 232132498
[Next Sequence Number: 4946 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 883061786
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: 0xdd01 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
[Timestamps]
0020 f5 0c 04 89 00 50 0d d6 0f 92 34 a2 74 1a 50 10 .....P.. ..4.t.P.
0030 15 d4 dd 01 00 00 20 73 6f 6d 65 20 65 69 67 68 ...... s ome eigh
0040 74 20 74 65 78 74 0d 0a 66 69 6c 65 73 20 70 65 t text·· files pe
0050 72 20 6d 6f 6e 74 68 3a 20 20 74 68 75 73 20 75 r month: thus u
0060 70 70 69 6e 67 20 6f 75 72 20 70 72 6f 64 75 63 pping ou r produc
0070 74 69 76 69 74 79 20 66 72 6f 6d 20 24 32 20 6d tivity f rom $2 m
0080 69 6c 6c 69 6f 6e 2e 0d 0a 0d 0a 54 68 65 20 47 illion.· ···The G
0090 6f 61 6c 20 6f 66 20 50 72 6f 6a 65 63 74 20 47 oal of P roject G
00a0 75 74 65 6e 62 65 72 67 20 69 73 20 74 6f 20 47 utenberg is to G
00b0 69 76 65 20 41 77 61 79 20 4f 6e 65 20 54 72 69 ive Away One Tri
00c0 6c 6c 69 6f 6e 20 45 74 65 78 74 0d 0a 46 69 6c llion Et ext··Fil
00d0 65 73 20 62 79 20 74 68 65 20 44 65 63 65 6d 62 es by th e Decemb
00e0 65 72 20 33 31 2c 20 32 30 30 31 2e 20 20 5b 31 er 31, 2 001. [1
00f0 30 2c 30 30 30 2c 30 30 30 20 31 30 2c 30 30 30 0,000,x 100,000,
0100 30 30 30 3d 54 72 69 6c 6c 69 6f 6e 5d 0d 0a 54 000=Tril lion]··T
0110 68 69 73 20 69 73 20 74 65 6e 20 74 68 6f 75 73 his is t en thous
0120 61 6e 64 20 74 69 74 6c 65 73 20 65 61 63 68 20 and titl es each
0130 74 6f 20 6f 6e 65 20 68 75 6e 64 72 65 64 20 6d to one h undred m
0140 69 6c 6c 69 6f 6e 20 72 65 61 64 65 72 73 2c 0d illion r eaders,·
0150 0a 77 68 69 63 68 20 69 73 20 31 30 25 20 6f 66 ·which i s 10% of
0160 20 74 68 65 20 65 78 70 65 63 74 65 64 20 6e 75 the exp ected nu
0170 6d 62 65 72 20 6f 66 20 63 6f 6d 70 75 74 65 72 mber of computer
0180 20 75 73 65 72 73 20 62 79 20 74 68 65 20 65 6e users b y the en
0190 64 0d 0a 6f 66 20 74 68 65 20 79 65 61 72 20 32 d··of th e year 2
01a0 30 30 31 2e 0d 0a 0d 0a 57 65 20 6e 65 65 64 20 001.···· We need
01b0 79 6f 75 72 20 64 6f 6e 61 74 69 6f 6e 73 20 6d your don ations m


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 54 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=6780 Len=0
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]
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=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]
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]
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 1201 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=14600 Len=0
128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=6406 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=9013 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]
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): 232132498
[Next Sequence Number: 4946 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 883061786
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: 0xdd01 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
[Timestamps]
0020 f5 0c 04 89 00 50 0d d6 0f 92 34 a2 74 1a 50 10 .....P.. ..4.t.P.
0030 15 d4 dd 01 00 00 20 73 6f 6d 65 20 65 69 67 68 ...... s ome eigh
0040 74 20 74 65 78 74 0d 0a 66 69 6c 65 73 20 70 65 t text·· files pe
0050 72 20 6d 6f 6e 74 68 3a 20 20 74 68 75 73 20 75 r month: thus u
0060 70 70 69 6e 67 20 6f 75 72 20 70 72 6f 64 75 63 pping ou r produc
0070 74 69 76 69 74 79 20 66 72 6f 6d 20 24 32 20 6d tivity f rom $2 m
0080 69 6c 6c 69 6f 6e 2e 0d 0a 0d 0a 54 68 65 20 47 illion.· ···The G
0090 6f 61 6c 20 6f 66 20 50 72 6f 6a 65 63 74 20 47 oal of P roject G
00a0 75 74 65 6e 62 65 72 67 20 69 73 20 74 6f 20 47 utenberg is to G
00b0 69 76 65 20 41 77 61 79 20 4f 6e 65 20 54 72 69 ive Away One Tri
00c0 6c 6c 69 6f 6e 20 45 74 65 78 74 0d 0a 46 69 6c llion Et ext··Fil
00d0 65 73 20 62 79 20 74 68 65 20 44 65 63 65 6d 62 es by th e Decemb
00e0 65 72 20 33 31 2c 20 32 30 30 31 2e 20 20 5b 31 er 31, 2 001. [1
00f0 30 2c 30 30 30 2c 30 30 30 20 31 30 2c 30 30 30 0,000,x 100,000,
0100 30 30 30 3d 54 72 69 6c 6c 69 6f 6e 5d 0d 0a 54 000=Tril lion]··T
0110 68 69 73 20 69 73 20 74 65 6e 20 74 68 6f 75 73 his is t en thous
0120 61 6e 64 20 74 69 74 6c 65 73 20 65 61 63 68 20 and titl es each
0130 74 6f 20 6f 6e 65 20 68 75 6e 64 72 65 64 20 6d to one h undred m
0140 69 6c 6c 69 6f 6e 20 72 65 61 64 65 72 73 2c 0d illion r eaders,·
0150 0a 77 68 69 63 68 20 69 73 20 31 30 25 20 6f 66 ·which i s 10% of
0160 20 74 68 65 20 65 78 70 65 63 74 65 64 20 6e 75 the exp ected nu
0170 6d 62 65 72 20 6f 66 20 63 6f 6d 70 75 74 65 72 mber of computer
0180 20 75 73 65 72 73 20 62 79 20 74 68 65 20 65 6e users b y the en
0190 64 0d 0a 6f 66 20 74 68 65 20 79 65 61 72 20 32 d··of th e year 2
01a0 30 30 31 2e 0d 0a 0d 0a 57 65 20 6e 65 65 64 20 001.···· We need
01b0 79 6f 75 72 20 64 6f 6e 61 74 69 6f 6e 73 20 6d your don ations m



The sequence numbers are: 232129013 232129578 232131038 232132496 232132498 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?

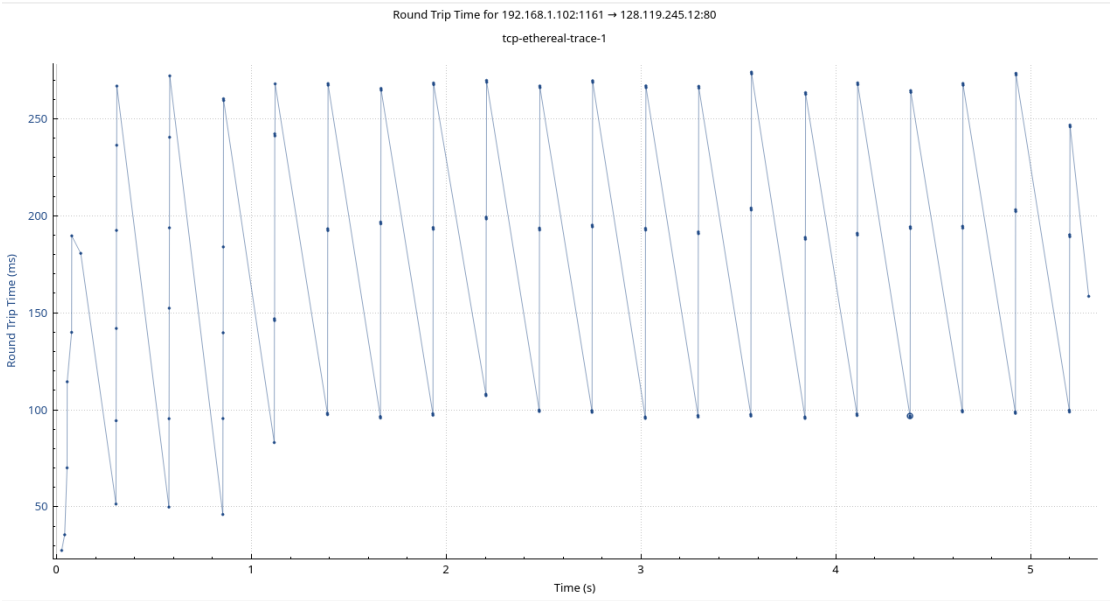


The segments were sent at time 0.026477 0.041737 0.054026 0.054690 0.077405 0.078157

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.



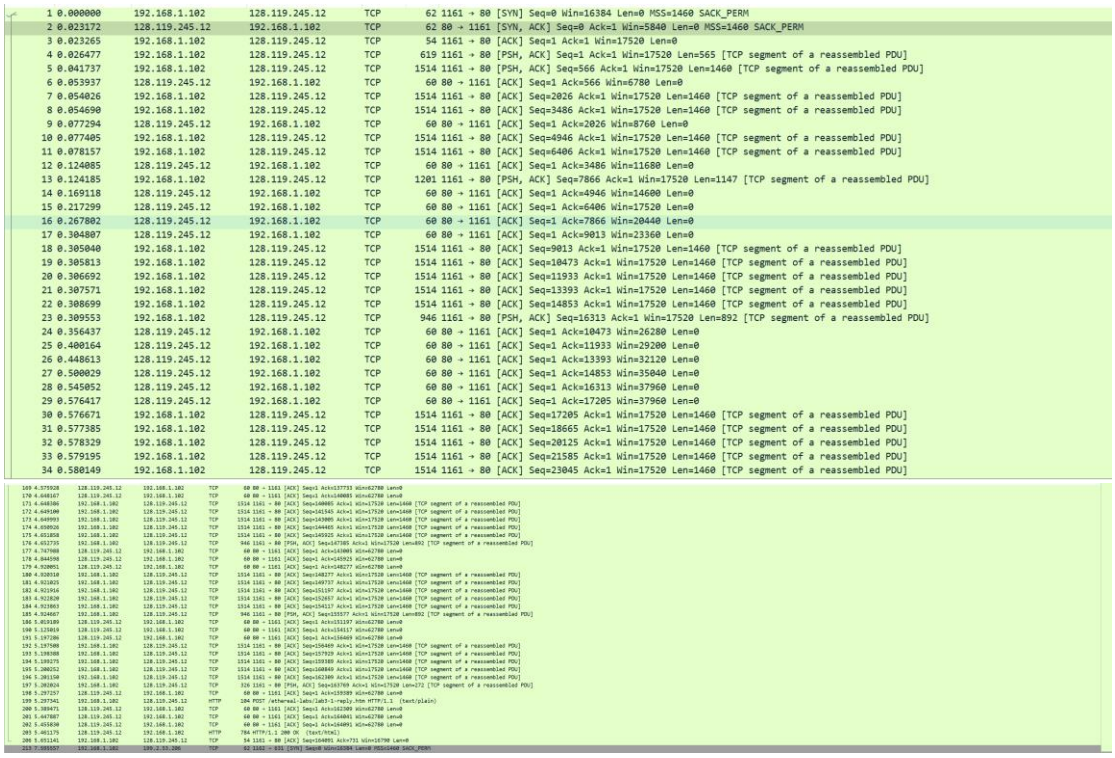
Sequence Number	Segment sent time	ACK receive time	RTT	EstimatedRTT	Length
232129013	0.026477	0.053937	0.027460	0.027460	565
232129578	0.041737	0.077294	0.035557	0.028472	1460
232131038	0.054026	0.124085	0.070059	0.033670	1460
232132496	0.054690	0.169118	0.114428	0.043765	1460
232132498	0.077405	0.217299	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?

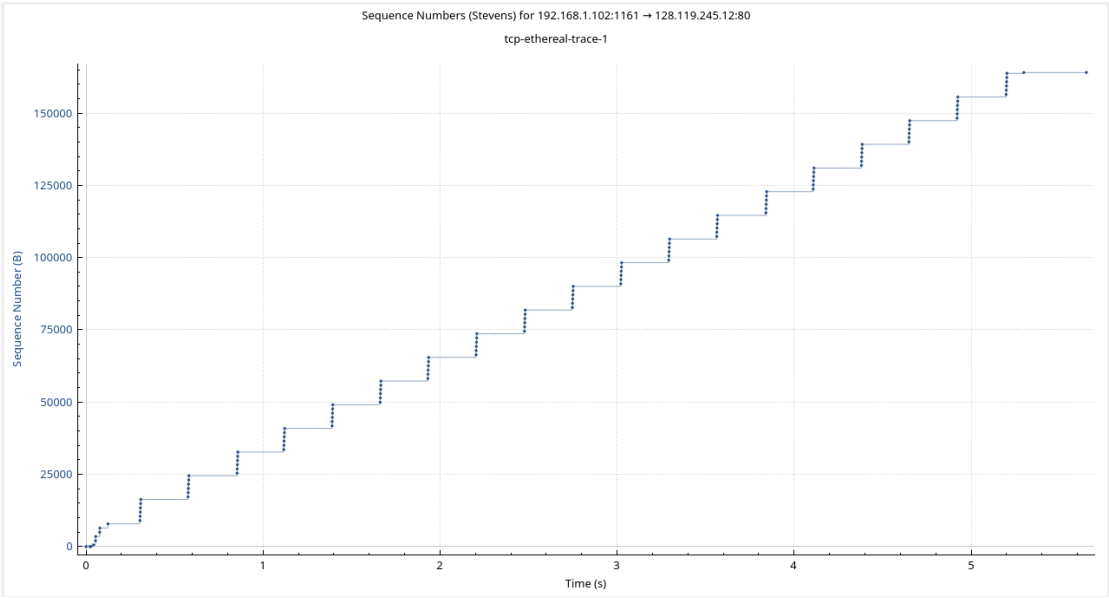
The lengths are: 565 1460 1460 1460 1460 1460 correspondingly

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?



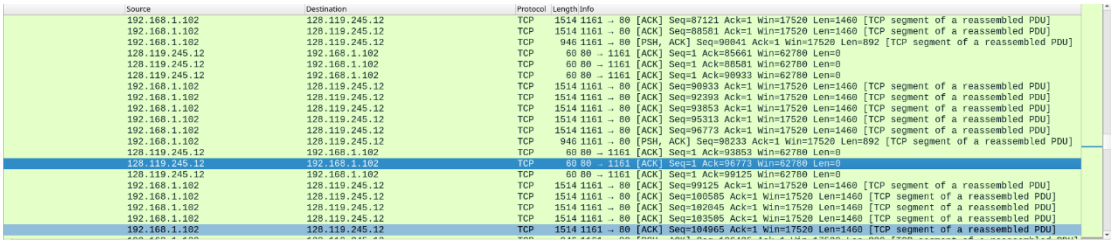
The minimum window size is 5840 bytes during the entire trace, the maximum buffer space is 62780 bytes. It is not likely to throttle the sender, as the buffer space is much bigger than the actual segment size.

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.

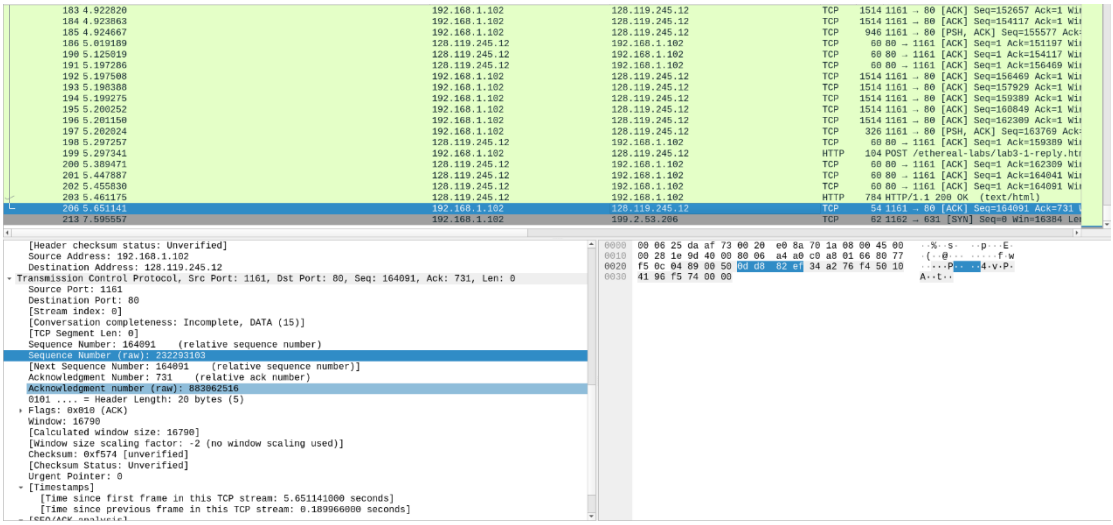
Question 6. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (recall the discussion about delayed acks from the lecture notes or Section 3.5 of the text)?



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=88581 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=90041 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=88581 Win=62780 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=90933 Win=62780 Len=0
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=90933 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=96773 Win=62780 Len=0
128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=99125 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=103505 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 Wi
184	4.923863	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=154117 Ack=1 Wi
185	4.924667	192.168.1.102	128.119.245.12	TCP	946 1161 → 80 [PSH, ACK] Seq=155577 Ack=
186	5.019189	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=151197 Wi
190	5.125019	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=154117 Wi
191	5.197286	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=156469 Wi
192	5.197508	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=156469 Ack=1 Wi
193	5.198388	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=157929 Ack=1 Wi
194	5.199275	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=159389 Ack=1 Wi
195	5.200252	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=160849 Ack=1 Wi
196	5.201150	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=162309 Ack=1 Wi
197	5.202024	192.168.1.102	128.119.245.12	TCP	326 1161 → 80 [PSH, ACK] Seq=163769 Ack=
198	5.297257	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=159389 Wi
199	5.297341	192.168.1.102	128.119.245.12	HTTP	104 POST /ethereal-labs/lab3-1-reply.ht
200	5.389471	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=162309 Wi
201	5.447887	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=164041 Wi
202	5.455830	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=164091 Wi
203	5.461175	128.119.245.12	192.168.1.102	HTTP	784 HTTP/1.1 200 OK (text/html)
206	5.651141	192.168.1.102	128.119.245.12	TCP	54 1161 → 80 [ACK] Seq=164091 Ack=731
213	7.595557	192.168.1.102	199.2.53.206	TCP	82 1162 → 631 [SYN] Seq=0 Win=16384 Le

```
[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: 164091, Ack: 731, Len: 0
  Source Port: 1161
  Destination Port: 80
  [Stream index: 0]
  [Conversation completeness: Incomplete, DATA (15)]
  [TCP Segment Len: 0]
  Sequence Number: 164091    (relative sequence number)
  Sequence Number (raw): 232293103
  [Next Sequence Number: 164091    (relative sequence number)]
  Acknowledgment Number: 731    (relative ack number)
  Acknowledgment number (raw): 883062516
  0101 .... = Header Length: 20 bytes (5)
  Flags: 0x010 (ACK)
  Window: 16790
  [Calculated window size: 16790]
  [Window size scaling factor: -2 (no window scaling used)]
  Checksum: 0xf574 [unverified]
  [Checksum Status: Unverified]
  Urgent Pointer: 0
  [Timestamps]
    [Time since first frame in this TCP stream: 5.651141000 seconds]
    [Time since previous frame in this TCP stream: 0.189966000 seconds]
```

```
0000  00 06 25 da af 73 00 20  e0 8a 70 1a 08 00 45 00   ··%··s· ··p···E·
0010  00 28 1e 9d 40 00 80 06  a4 a0 c0 a8 01 66 80 77   ·(··@··· ·····f·w
0020  f5 0c 04 89 00 50 0d d8  82 eb 34 a2 76 f4 50 10   ·····P·· ··4·v·P·
0030  41 96 f5 74 00 00                                 A··t··
```

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 = 33bytes

Server: 1247095831 – 1247095791 = 40 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.