

## Exercise 1: Understanding TCP using Wireshark

**Question 1 . What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection? What 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 screenshot shows the Wireshark interface with a packet capture of a TCP connection. The packet list at the top shows a SYN segment from 192.168.1.102 to 128.119.245.12 on port 80. The packet details pane shows the TCP header for this segment.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN, Seq=232129012 Win=16384 Len=0 MSS=1460 S
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=883061785 Ack=232129013 Win=584
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=232129013 Ack=883061786 Win=17520 Le
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 Win=175
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=175
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Le
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232131038 Ack=883061786 Win=17520 Le
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17520 Le
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=8760 Le
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232133958 Ack=883061786 Win=17520 Le
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232135418 Ack=883061786 Win=17520 Le
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Le
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 Win=175

Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0  
 Ethernet II, Src: Actionte\_8a:70:1a (00:20:e0:8a:70:1a), Dst: Link-Local (01:00:5e:00:00:00)  
 Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12  
 Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129012  
 Source Port: 1161  
 Destination Port: 80  
 [Stream index: 0]  
 [Conversation completeness: Incomplete, DATA (15)]  
 [TCP Segment Len: 0]  
 Sequence Number: 232129012  
 [Next Sequence Number: 232129013]  
 Acknowledgment Number: 0  
 Acknowledgment number (raw): 0  
 0111 .... = Header Length: 28 bytes (7)  
 Flags: SYN

IP address of gaia.cs.umass.edu is 128.119.245.12

The port for the connection with source gaia.cs.umass is 80 for sending and receiving .

IP address of the source is 198.168.1.102, and the TCP Port for this port is 1161.

**Question 2 . What is the sequence number of the TCP segment containing the HTTP POST command? Note that to find the POST command, you'll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with a " POST " within its DATA field.**

No.	Time	Source	Destination	Protocol	Length	Info
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 PDU]
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 PDU]
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]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 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=883061786 Ack=232133958 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232136878 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232138025 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232138025 Ack=883061786 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=232139485 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

[Conversation completeness: Incomplete, DATA (15)]

[TCP Segment Len: 565]

Sequence Number: 232129013

[Next Sequence Number: 232129578]

Acknowledgment Number: 883061786

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

Flags: 0x018 (PSH, ACK)

Window: 17520

[Calculated window size: 17520]

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

Checksum: 0x1fbd [unverified]

[Checksum Status: Unverified]

Urgent Pointer: 0

[Timestamps]

[SEQ/ACK analysis]

TCP payload (565 bytes)

[Reassembled PDU in frame: 199]

TCP segment data (565 bytes)

0020 f5 0c 04 89 60 50 d0 d6 01 f5 34 a2 74 1a 50 18 .....P.....4.t.P.

0030 44 70 1f bd 00 00 50 4f 53 64 20 2f 65 74 68 65 Dp...SO ST /ethe

0040 72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 33 2d 31 real-lab s/lab3-1

0050 2d 72 65 70 6c 79 2e 08 74 6d 20 48 54 81 50 2f -reply.htm HTTP/

0060 31 2e 31 00 9a 48 6f 73 74 3a 20 6f 61 69 61 24 t1-Hos t: gaila.

0070 63 73 2e 75 6d 61 73 73 2e 65 64 75 0d 0a 55 73 cs.umass .edu~Us

0080 65 72 2d 41 67 65 6e 74 3a 20 4d 6f 7a 69 6c 6c er-Agent : Mozill

0090 61 2f 35 2e 30 20 28 5f 69 6e 64 6f 77 73 30 28 a/5.0 (w indows;

00a0 65 3b 20 57 69 6e 64 6f 77 73 20 4e 54 20 35 24 Uj Windo ws NT 5.

00b0 31 3b 20 65 6e 2d 55 53 3b 20 72 76 3a 31 2e 30 1; en-US ; rv:1.0

00c0 2e 32 29 29 47 65 63 6b 6f 2f 32 30 30 33 30 32 .2) Geck o/200302

00d0 30 38 20 4e 65 74 73 63 61 70 65 2f 37 2e 30 32 98 Netsc ape/7.02

00e0 8d 0a 41 63 63 65 70 74 3a 20 74 65 70 74 2f 78 -Accept : text/x

00f0 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78 ml,appli cation/x

0100 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78 ml,appli cation/x

0110 68 74 6d 6c 2b 78 6d 6c 2c 74 65 78 74 2f 68 74 html+xml ,text/ht

0120 6d 6c 3b 71 3d 30 2e 39 2c 74 65 78 74 2f 70 6d ml;type=0 ,text/pl

0130 61 69 6e 3b 71 3d 30 2e 38 2c 76 69 64 65 6f 2f ain;type=0 ,video/x

0140 78 2d 6d 6e 67 2c 69 6d 61 67 65 2f 70 6e 67 2c x-mng ,im age/png;

The sequence number is 232129013 for the TCP containing POST /ethereal-labslab3-1-reply.h HTTP

**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)?**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=232129012 Win=16384 L
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=883061785 Ack=23
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=232129013 Ack=8830617
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=232129013 Ack=88
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=232129578 Ack=88
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321295
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232131038 Ack=8830617
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232132498 Ack=8830617
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321310
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232133958 Ack=8830617
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232135418 Ack=8830617
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321324
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=232136878 Ack=88
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321339
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321354
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321368
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=2321386
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232138025 Ack=8830617
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232139485 Ack=8830617

1. 232129013
2. 232129578
3. 232131038
4. 232132498
5. 232133958

6. 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?

4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161	→ 80	[PSH,
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[PSH,
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK]
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161	→ 80	[PSH,
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK]
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK]

  

▼ Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)								
Encapsulation type: Ethernet (1)								
Arrival Time: Aug 21, 2004 23:44:20.596858000 AEST								
[Time shift for this packet: 0.000000000 seconds]								
Epoch Time: 1093095860.596858000 seconds								

  

1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161	→ 80	[SYN] Seq=232129012 Win=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80	→ 1161	[SYN, ACK] Seq=883061785
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161	→ 80	[ACK] Seq=232129013 Ack=8
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161	→ 80	[PSH, ACK] Seq=232129013
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[PSH, ACK] Seq=232129578
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK] Seq=232131038 Ack=8
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK] Seq=232132498 Ack=8
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK] Seq=232133958 Ack=8
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK] Seq=232135418 Ack=8
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161	→ 80	[PSH, ACK] Seq=232136878
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80	→ 1161	[ACK] Seq=883061786 Ack=2
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK] Seq=232138025 Ack=8
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161	→ 80	[ACK] Seq=232139485 Ack=8

  

▼ Frame 5: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)								
Encapsulation type: Ethernet (1)								
Arrival Time: Aug 21, 2004 23:44:20.612118000 AEST								
[Time shift for this packet: 0.000000000 seconds]								
Epoch Time: 1093095860.612118000 seconds								

1. 232129013 Sent at 23:44:20.596858, the ack was received at 23:44:20.624318 which gives us a RTT value of 27.460ms
2. 232129578 Sent at 23:44:20.612118, the ack was received at 23:44:20.624318 which gives us a RTT value of 12.200ms
3. 232131038 Sent at 23:44:20.624407, the ack was received at 23:44:20.647675 which gives us a RTT value of 23.268ms
4. 232132498 Sent at 23:44:20.625071, the ack was received at 23:44:20.694466 which gives us a RTT value of 69.395ms

5. 232133958 Sent at 23:44:20.647786, the ack was received at 23:44:20.739499 which gives us a RTT value of 91.713ms
6. 232135418 Sent at 23:44:20.648538, the ack was received at 23:44:20.787768 which gives us a RTT value of 139.142ms

(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.

If alpha is 0.125, then we can take the 1-alpha value as 0.875.

Hence we have: Estimated RTT = 0.875 x RTvalue + 0.125 x SampleRTT

1. 27.460 (same as sample)
2.  $(0.875 \times 27.460) + (0.125 \times 12.200) = 25.5525$  ms
3.  $(0.875 \times 25.5525) + (0.125 \times 23.268) = 25.2670$  ms
4.  $(0.875 \times 25.2670) + (0.125 \times 69.395) = 30.7839$  ms
5.  $(0.875 \times 30.7839) + (0.125 \times 91.713) = 38.3975$  ms
6.  $(0.875 \times 38.3975) + (0.125 \times 139.142) = 50.4906$  ms

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

**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 “win” is a representation of the minimum buffer space, so the minimum “win” is 5840 in line 2. This suggests that the receiver's buffer never limits the sender, since the buffer space stays at a minimum of 5840 and never reaches 0. Instead, the window size grows.

No.	Time	Source	Destination	Protocol	Length	Info
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	0.021172	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 PDU]
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 PDU]
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	0.054926	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=232132490 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	0.077495	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]
12	0.124885	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 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=883061786 Ack=232133958 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232136878 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232138025 Win=23360 Len=0
18	0.305840	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232138025 Ack=883061786 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=232139485 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

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



The trace file's absence of duplicate sequence numbers indicates that no segments were retransmitted. We check for duplicate sequence numbers.

**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)?**

Typically, the receiver issues ACKs after receiving the Maximum Segment Size (MSS). The first segment, at 565 bytes, doesn't prompt an immediate ACK, resulting in a delayed ACK on line 6 for segments 1 and 2. In contrast, the following segments are 1460 bytes—equal to the MSS—leading the receiver to send an ACK after every alternate segment in 3-6.

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

Explain how you calculated this value.

We must find total time and total bytes sent.

Total bytes is calculated by finding the difference of the numbers of the last ACK received on line 202 to the ISN (initial sequence number) on line 4. Last ACK is 232293103 and ISN is 232129013, meaning total bytes is 164090

199	5.297341	192.168.1.102	128.119.245.12	HTTP	104	POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
200	5.389471	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232291321 Win=62780 Len=0
201	5.447887	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232293053 Win=62780 Len=0
202	5.455830	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232293103 Win=62780 Len=0
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=232293103 Ack=883062516 Win=16790 Len=0
213	7.595557	192.168.1.102	199.2.53.206	TCP	62	1162 → 631 [SYN] Seq=234062521 Win=16384 Len=0 MSS=1460 SACK_PER

  

▶	Frame 202: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)	0000	00 20 e0 8a 70 1a 00 06 25 da af 73 08 0
▶	Ethernet II, Src: LinksysG da:af:73 (00:06:25:da:af:73), Dst: Actionte_8a:70:1a (00:	0010	00 28 58 bb 40 00 37 06 b3 82 80 77 f5 0
▶	Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102	0020	01 66 00 50 04 89 34 a2 74 1a 0d d8 82 e
▼	Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 883061786, Ack: 23	0030	f5 3c 44 a8 00 00 e5 e7 00 00 07 fb

  

Source Port:	80
Destination Port:	1161
[Stream index: 0]	
[Conversation completeness: Incomplete, DATA (15)]	
[TCP Segment Len: 0]	
Sequence Number:	883061786
[Next Sequence Number: 883061786]	
Acknowledgment Number:	232293103
0101 .... = Header Length: 20 bytes (5)	
Flags: 0x010 (ACK)	
Window:	62780

On the same TCP above, in row 202, we can look at frame 202 to see the time since reference or first frame: 5.45583 seconds. But since we only want throughput, we must take time since

first frame from frame 4 which has a time of 0.026477000 s.

No.	Time	Source	Destination	Protocol	Length	Info
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=1
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
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=619
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=17520 Len=1514
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
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17520 Len=1460
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
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232135418 Ack=883061786 Win=17520 Len=1460
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 Win=17520 Len=1201
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232133958 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232136878 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232138025 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232138025 Ack=883061786 Win=17520 Len=1460
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232139485 Ack=883061786 Win=17520 Len=1460

  

▼ Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits) on interface 0	0000	00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 00 00 00
Encapsulation type: Ethernet (1)	0010	02 5d 1e 21 40 00 80 06 a2 e7 c0 a8 01 00 00 00 00
Arrival Time: Aug 21, 2004 23:44:20.596858000 AEST	0020	f5 0c 04 89 00 50 0d d6 01 f5 34 a2 74 00 00 00 00
[Time shift for this packet: 0.000000000 seconds]	0030	44 70 1f bd 00 00 50 4f 53 54 20 2f 65 00 00 00 00
Epoch Time: 1093095860.596858000 seconds	0040	72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 00 00 00 00
[Time delta from previous captured frame: 0.003212000 seconds]	0050	2d 72 65 70 6c 79 2e 68 74 6d 20 48 54 00 00 00 00
[Time delta from previous displayed frame: 0.003212000 seconds]	0060	31 2e 31 0d 0a 48 6f 73 74 3a 20 67 61 00 00 00 00
[Time since reference or first frame: 0.026477000 seconds]	0070	63 73 2e 75 6d 61 73 73 2e 65 64 75 0d 00 00 00 00
Frame Number: 4	0080	65 72 2d 41 67 65 6e 74 3a 20 4d 6f 7a 00 00 00 00
Frame Length: 619 bytes (4952 bits)	0090	61 2f 35 2e 30 20 28 57 69 6e 64 6f 77 00 00 00 00
Capture Length: 619 bytes (4952 bits)	00a0	55 3b 20 57 69 6e 64 6f 77 73 20 4e 54 00 00 00 00

We subtract the two above values  $5.45583 - 0.026477 = 5.429353$  seconds.

Hence byte per unit of time we can divide as such:

**$164090 / 5.429353 = 30223.83$  bytes per second.**

## Exercise 2: TCP Connection Management

Consider the following TCP transaction between a client (10.9.16.201) and a server (10.99.6.175).

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?**

In the first row, which is Seq=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?**

In the second row, which is seq=1247095790. Value of Ack=2818463619. The server determined the acknowledgment number by taking the client's initial sequence number (2818463618) and adding 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?**

In the third row, Sequence number = 2818463619. ACK value is 1247095790 which is one plus the sequence number of the SYNACK response segment. No data is in this segment

**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?**

In row with No. 304 we can see that the client did the active close since it sent the first FIN (i.e. the source IP was 10.9.16.201 - the client's ip). The server (10.99.6.175) replies with FIN, ACK which is a passive close in packet No. 305. Packets no 306 and 308 are ACK from the client and then the server, respectively making it a 4-segment close:

1. Client to Server: FIN, ACK (packet 304)
2. Server to Client: ACK (packet 305 is FIN, ACK; ACK part is part 2)
3. Server to Client: FIN (same packet 305)
4. Client to Server: ACK (packet 306)

So, it is a proper 4-segment close (FIN / ACK / FIN / ACK)

**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 total data sent = Final ACK received from the other side – Initial Sequence Number (ISN) – 1 (for SYN)

which gives us:

From the client to the server:

Initial Seq: 2818463618 (from SYN in packet 295)

Final ACK received from server is 2818463653 (in packets 305 & 308)

Bytes transferred = 2818463653 - 2818463618 - 1 = 34 bytes

From the server to the client:

Initial Seq: 1247095790 (from SYN-ACK in packet 296)

Final Ack from client: 1247095832 (seen in packet 306)

Bytes transferred = 1247095832 - 1247095790 - 1 = 41 bytes