Exercise 1: Understanding TCP using Wireshark

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

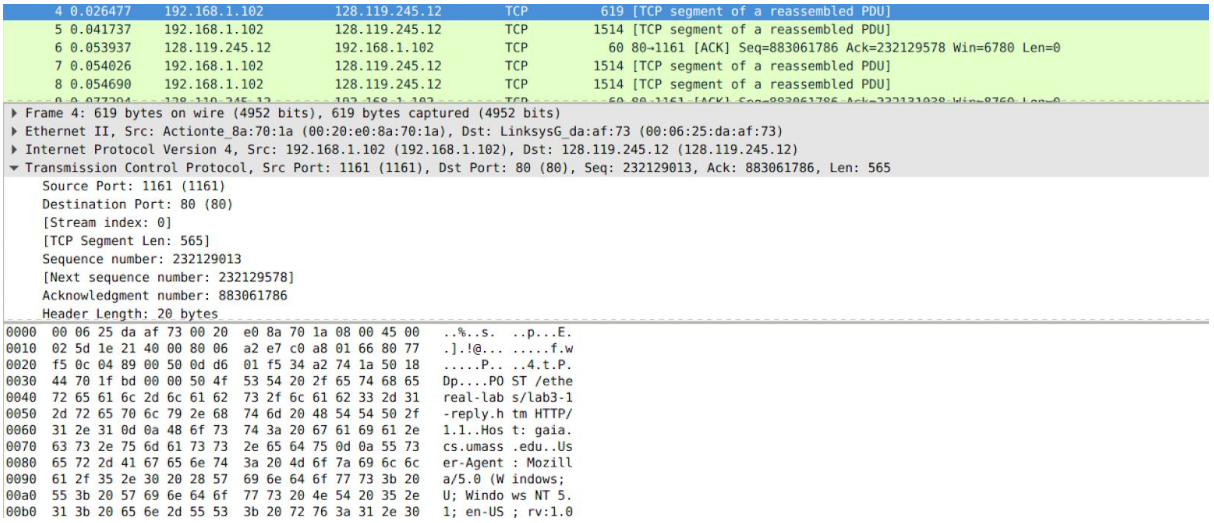
The IP address of gaia.cs.umass.edu is 128.119.245.12 . The port number it is sending and receiving TCP segments for this connection is port 80.

The IP address of the client computer is 192.168.1.102 and the TCP port is 1161.

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

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

The sequence number is 232129013.



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    4 0.026477   192.168.1.102   128.119.245.12   TCP    619 [TCP segment of a reassembled PDU]
    5 0.041737   192.168.1.102   128.119.245.12   TCP   1514 [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 [TCP segment of a reassembled PDU]
    8 0.054690   192.168.1.102   128.119.245.12   TCP   1514 [TCP segment of a reassembled PDU]
▸ Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)
▸ Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
▸ Internet Protocol Version 4, Src: 192.168.1.102 (192.168.1.102), Dst: 128.119.245.12 (128.119.245.12)
▾ Transmission Control Protocol, Src Port: 1161 (1161), Dst Port: 80 (80), Seq: 232129013, Ack: 883061786, Len: 565
    Source Port: 1161 (1161)
    Destination Port: 80 (80)
    [Stream index: 0]
    [TCP Segment Len: 565]
    Sequence number: 232129013
    [Next sequence number: 232129578]
    Acknowledgment number: 883061786
    Header Length: 20 bytes
0000  00 06 25 da af 73 00 20  e0 8a 70 1a 08 00 45 00   ..%..s.  ..p...E.
0010  02 5d 1e 21 40 00 80 06  a2 e7 c0 a8 01 66 80 77   .].!@... .....f.w
0020  f5 0c 04 89 00 50 0d d6  01 f5 34 a2 74 1a 50 18   .....P.. ..4.t.P.
0030  44 70 1f bd 00 00 50 4f  53 54 20 2f 65 74 68 65   Dp....PO ST /ethe
0040  72 65 61 6c 2d 6c 61 62  73 2f 6c 61 62 33 2d 31   real-lab s/lab3-1
0050  2d 72 65 70 6c 79 2e 68  74 6d 20 48 54 54 50 2f   -reply.h tm HTTP/
0060  31 2e 31 0d 0a 48 6f 73  74 3a 20 67 61 69 61 2e   1.1..Hos t: gaia.
0070  63 73 2e 75 6d 61 73 73  2e 65 64 75 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 57  69 6e 64 6f 77 73 3b 20   a/5.0 (W indows;
00a0  55 3b 20 57 69 6e 64 6f  77 73 20 4e 54 20 35 2e   U; Windo ws NT 5.
00b0  31 3b 20 65 6e 2d 55 53  3b 20 72 76 3a 31 2e 30   1; en-US ; rv:1.0
```

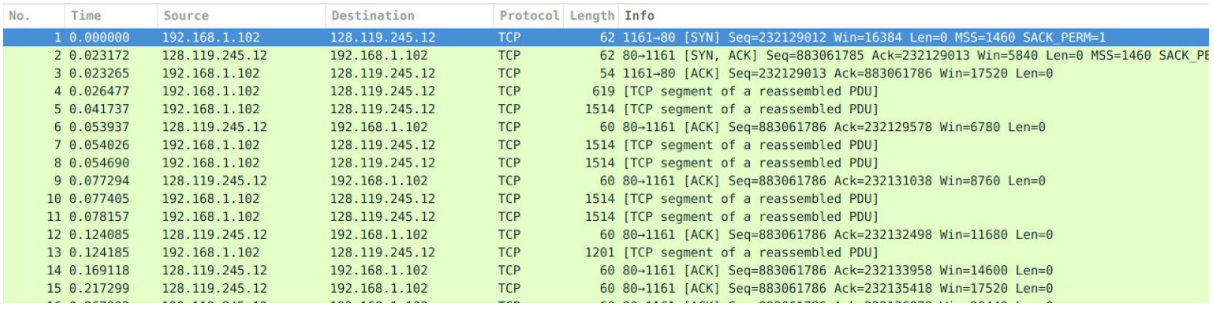
Question 3.

EstimatedRTT equation used:

Estimated RTT = (1 - 0.125) *estimatedRTT + 0.125 * sampleRTT

For the first segment, the initial value of EstimatedRTT is 0.02746

Sequence Numbers	Time each segment was sent	When the ACK for each segment was received	RTT	What is the estimatedRTT value?
232129013	0.026477	0.053937	0.02746	0.02746
232129578	0.041737	0.077294	0.035557	0.028472125
232131038	0.054026	0.124085	0.070059	0.03367048437
232132498	0.054690	0.169118	0.114428	0.04376517382
232133958	0.077405	0.217299	0.139894	0.05578127709
232135418	0.078157	0.267802	0.189645	0.07251424245



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 MSS=1460 SACK_PE
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[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	[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

Question 4. **What is the length of each of the first six TCP segments?**

1 - 565 bytes

2 - 1460 bytes

3 - 1460 bytes

4 - 1460 bytes

5 - 1460 bytes

6 - 1460 bytes

Question 5. **What is the minimum amount of available buffer space advertised at the receiver for the entire trace? Does the lack of receiver buffer space ever throttle the sender?**

The minimum amount of available buffer space advertised at the receiver for the entire trace is 5840.

The lack of receiver buffer space does not throttle the sender because the window size continues to expand and increases to prevent throttle.

```
Win=62780 Len=0
Win=62780 Len=0
Win=62780 Len=0
```

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

There are no retransmitted segments in the trace file. I checked for duplicate sequence numbers in the trace, and as there were none, it leads to the conclusion that there are no retransmitted segments in the trace file.

Question 7. **How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (recall the discussion about delayed acks from the lecture notes or Section 3.5 of the text).**

The typical amount of data that is acknowledged in an ACK is 1460 bytes.

There are multiple cases where the receiver is ACKing every other received segment such as 59 - 60 where the ACK is 2920, which is double the typical amount. Another case would be from 69 - 70.

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

The throughput for the TCP connection is 30222 bytes. The value was calculated by (total data / time).

Total data is calculated by subtracting the last ACK from the first sequence number from the client:

232293103 - 232129012 = 164091

The total transmission time is calculated by the time at the last segment minus the time at the first segment:

5.455830 - 0.026447 = 5.429383

Therefore, $\frac{164091}{5.429383}$ is equal to 30222.7711694 which is approximately 30222 bytes.

Exercise 2: TCP Connection Management

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

The sequence number of the TCP SYN segment that is used to initiate the TCP connection is 2818463618.

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

The sequence number of the SYNACK segment sent by the server to the client computer in reply to the SYN is 1247095790.

The value of the Acknowledgement field in the SYNACK segment is 2818463619.

The server determines the value by adding 1 to the because SYN segment accounts for one byte.

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

The sequence number of the ACK segment sent by the client computer in response to the SYNACK is 2818463619.

The value of the Acknowledgement field in this ACK segment 1247095791.

The segment contains no data.

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

Both client and server close the connection simultaneously.

Both send FINACK at the same time, which indicates it is a simultaneous close.

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

Initial sequence number: 2818463618

Final ACK received: 2818463653

2818463653 - 2818463618 = 35 bytes

The number of data bytes transferred from the client to server is determined by the final ACK minus the initial sequence number.