ZID: z5230310 Name: Tian Liu Date: 09/07/2019

E1:

Q1:

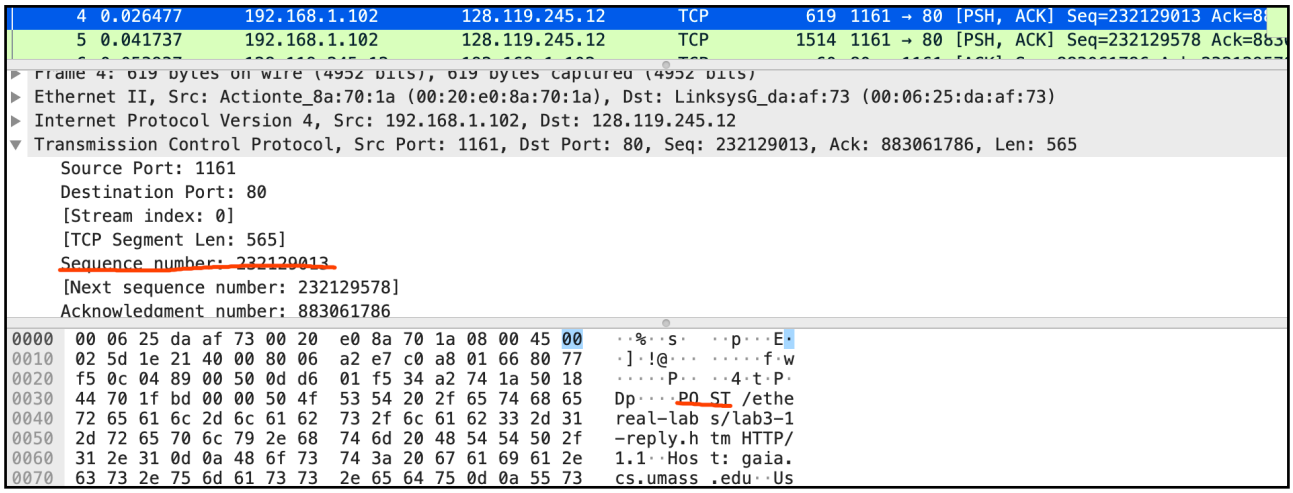
The IP address of gaia.cs.umass.edu is **128.119.245.12**

Port number **80** for to send and receive TCP segments for this connection

Source IP address is **192.168.1.102** and use Port number **1161** for transferring the file.

Q2:

Sequence number is: **232129013**. As the graph shows below.



Q3 & Q4:

As the table shows below:

$$EstimatedRTT = (1-\alpha) * EstimatedRTT + \alpha * SampleRTT \qquad (\alpha = 0.125)$$

1	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
2	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
1	6	0.053937	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0
3	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
4	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
2	9	0.077294	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=8760 Len=0
5	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
6	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
3	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
4	14	0.169118	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=883061786 Ack=232133958 Win=14600 Len=0
5	15	0.217299	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0
6	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

ZID: z5230310 Name: Tian Liu Date: 09/07/2019

Sequence No.	Sent Time	ACK receive time	RTT	Estimate RTT	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

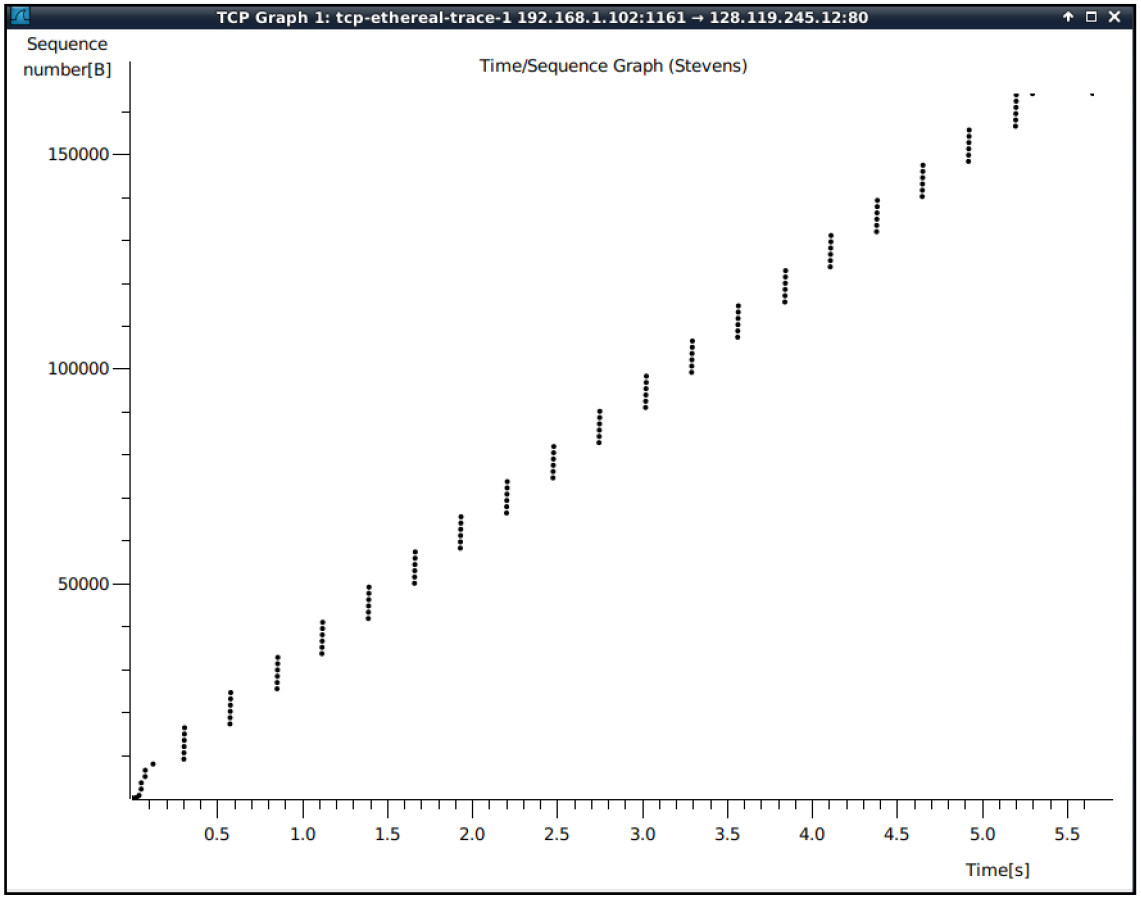
Q5:

As the picture shows below, the minimum amount of buffer space advertised at the receiver for the entire trace is 5840, the buffer space is always bigger than the TCP segment size, so it's not throttle the sender.

```
 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=
```

Q6:

No, there is no retransmitted segments in the trace file.

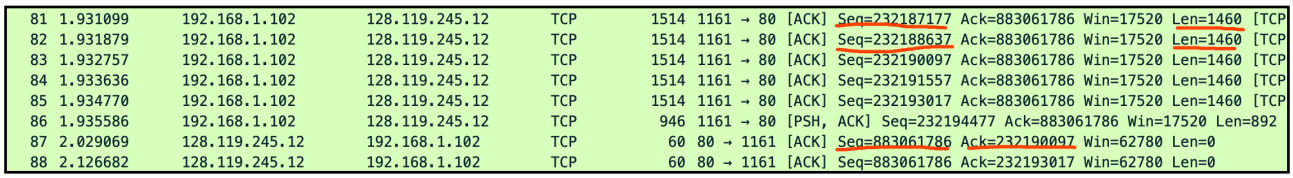


As this graph shows above, the sequence number increased by time, and no duplicate sequence number. Also, there is no duplicate ACK number segments.

Q7:

1460 bytes that the receiver typically acknowledge in an ACK.

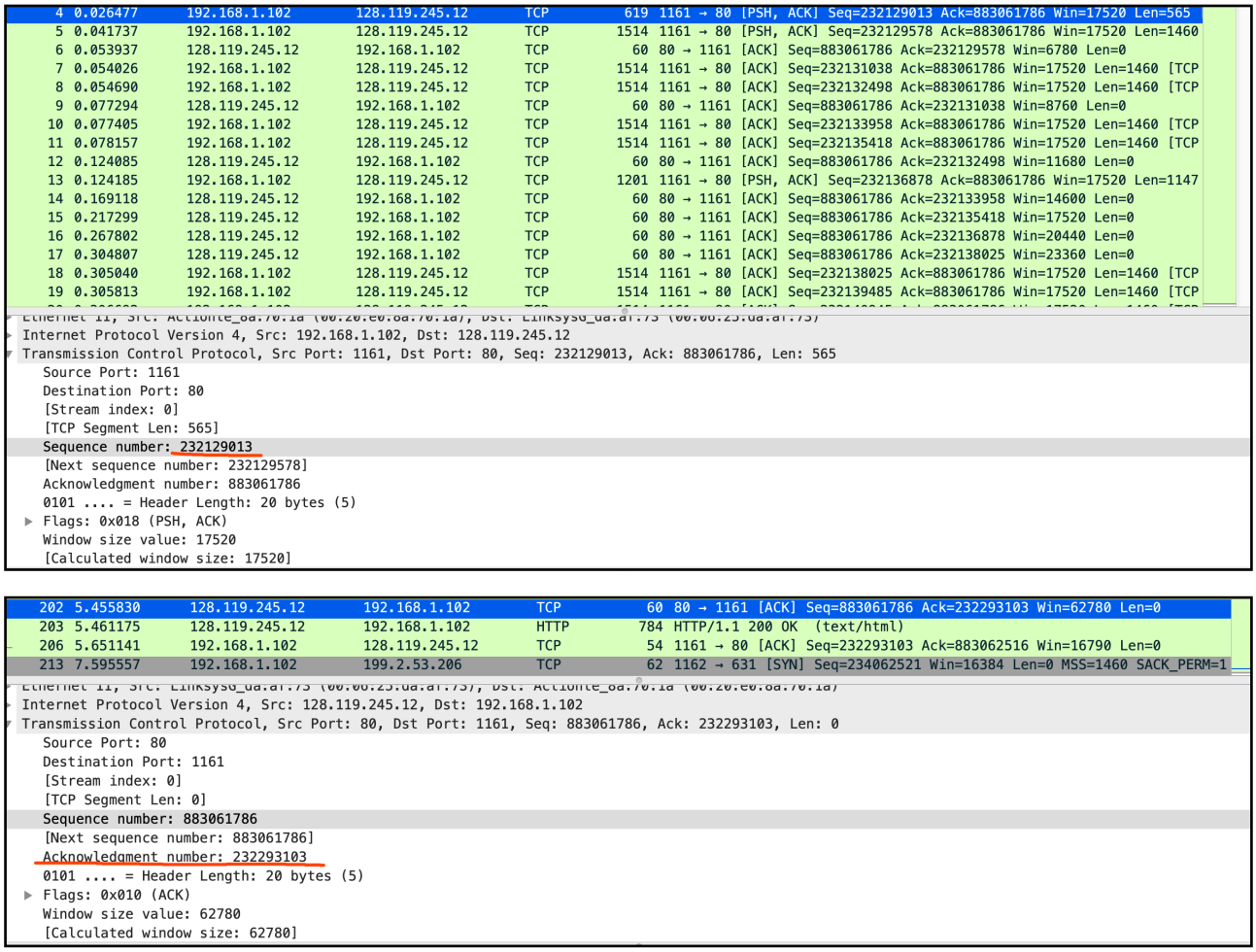
There are more cases that the receiver is ACKing every other received segment in trace file, for example:



```
 81 1.931099   192.168.1.102   128.119.245.12   TCP   1514 1161 → 80 [ACK] Seq=232187177 Ack=883061786 Win=17520 Len=1460 [TCP
 82 1.931879   192.168.1.102   128.119.245.12   TCP   1514 1161 → 80 [ACK] Seq=232188637 Ack=883061786 Win=17520 Len=1460 [TCP
 83 1.932757   192.168.1.102   128.119.245.12   TCP   1514 1161 → 80 [ACK] Seq=232190097 Ack=883061786 Win=17520 Len=1460 [TCP
 84 1.933636   192.168.1.102   128.119.245.12   TCP   1514 1161 → 80 [ACK] Seq=232191557 Ack=883061786 Win=17520 Len=1460 [TCP
 85 1.934770   192.168.1.102   128.119.245.12   TCP   1514 1161 → 80 [ACK] Seq=232193017 Ack=883061786 Win=17520 Len=1460 [TCP
 86 1.935586   192.168.1.102   128.119.245.12   TCP    946 1161 → 80 [PSH, ACK] Seq=232194477 Ack=883061786 Win=17520 Len=892
 87 2.029069   128.119.245.12   192.168.1.102   TCP     60 80 → 1161 [ACK] Seq=883061786 Ack=232190097 Win=62780 Len=0
 88 2.126682   128.119.245.12   192.168.1.102   TCP     60 80 → 1161 [ACK] Seq=883061786 Ack=232193017 Win=62780 Len=0
```

No.87 ACKing No.81 and No.82 together. And same to No.83 ,84 and 88.

Q8:



```
  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
  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
  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
  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
  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
 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
 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
 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
 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
Ethernet II, Src: Actionte_da:70:1a (00:20:e0:da:70:1a), Dst: Linksys6_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129013, Ack: 883061786, Len: 565
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [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 size value: 17520
    [Calculated window size: 17520]
```



```
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_PERM=1
Ethernet II, Src: Linksys6_da:af:73 (00:06:25:da:af:73), Dst: Actionte_da:70:1a (00:20:e0:da:70:1a)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102
Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 883061786, Ack: 232293103, Len: 0
    Source Port: 80
    Destination Port: 1161
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 883061786
    [Next sequence number: 883061786]
    Acknowledgment number: 232293103
    0101 .... = Header Length: 20 bytes (5)
  ▶ Flags: 0x010 (ACK)
    Window size value: 62780
    [Calculated window size: 62780]
```

$$Throughput = Numberofbytesreceived \div Costtime$$

(232293103 - 232129013) / (5.651141 - 0.026477) = **30222.754** bytes/s

E2:

Q1:

The sequence number of TCP SYN segment is **2818463618.**

Q2:

The sequence number of SYNACK segment sent by the sever to the server to the client computer is **1247095790**.

The Acknowledgement field in the SYNACK segment is **2818463619**.

This value is equal to **x + 1**, and **x** is the sequence number in the TCP SYN segment used to initiate the TCP connection.

Q3:

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

This value of the Acknowledgement field in this ACK segment is **1247095791**.

Yes, this segment contain 33 bytes data, which I can compute this by **2818463652(No.301) - 2818463619 = 33**.

Q4:

Both the client and sever done the active close, which can be found in No.304 and No.305 flag field **FIN**. They both send **FIN ACK** to the other side as their last segment. So this type is **Simultaneous close**.

Q5:

2818463652 - 2818463619 = 33 bytes for client to sever.

1247095831 - 124795791 = 40 bytes for server to client.

The relationship can be shown like:

(The final ACK Number - 1) - (The initial Sequence Number + 1) = total data transmitted.