

Haorui Zhang

10/30/2021

CS 455

No.	Time	Source	Destination	Protocol	Length	Info
157	8.001400	192.168.1.135	128.119.245.12	TCP	1448	62689 → 80 [ACK] Seq=1319
158	8.002128	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
159	8.002140	192.168.1.135	128.119.245.12	TCP	8418	62689 → 80 [PSH, ACK] Seq
160	8.003784	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
161	8.003784	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
162	8.003792	192.168.1.135	128.119.245.12	TCP	16782	62689 → 80 [PSH, ACK] Seq
163	8.109213	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
164	8.109249	192.168.1.135	128.119.245.12	TCP	5630	62689 → 80 [ACK] Seq=3967
165	8.109460	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
166	8.109468	192.168.1.135	128.119.245.12	TCP	8418	62689 → 80 [PSH, ACK] Seq
167	8.110736	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
168	8.110747	192.168.1.135	128.119.245.12	TCP	5630	62689 → 80 [ACK] Seq=5361
169	8.110784	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
170	8.110789	192.168.1.135	128.119.245.12	TCP	2842	62689 → 80 [ACK] Seq=5919
171	8.111009	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
172	8.111014	192.168.1.135	128.119.245.12	TCP	8418	62689 → 80 [PSH, ACK] Seq
173	8.112135	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
174	8.112139	192.168.1.135	128.119.245.12	TCP	8418	62689 → 80 [ACK] Seq=7034
175	8.115661	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
176	8.115667	192.168.1.135	128.119.245.12	TCP	5630	62689 → 80 [PSH, ACK] Seq
177	8.116963	128.119.245.12	192.168.1.135	TCP	60	80 → 62689 [ACK] Seq=1 Ac
178	8.116968	192.168.1.135	128.119.245.12	TCP	8418	62689 → 80 [ACK] Seq=8428

1.  
2.

- a. IP address: Source address: 192.169.1.102 Port Number: 1161 Destination Port number: 80

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80
			Destination			
			128.119.245.12			

- b. IP of gaia.cs.umass.edu: 128.119.245.12

Receiving port: 80

Sending port: 1161

80 → 1161

- c. My client IP: 192.168.1.135

TCP port: 62689

3.

- a. The sequence number counts the bytes of data into byte stream. It's 0 in this case. The SYN flag is set to 1

tcp-ethereal-trace-1

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tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK]
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK]
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4

[Stream index: 0]  
[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)  
▼ **Flags: 0x002 (SYN)**  
000. .... = Reserved: Not set  
...0 .... = Nonce: Not set

```

0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00  ..%.s.  .p...E.
0010 00 30 1e 1d 40 00 80 06 a5 18 c0 a8 01 66 80 77  .0..@...  ....f.w
0020 f5 0c 04 89 00 50 0d d6 01 f4 00 00 00 00 70 02  ....P...  ....p.
0030 40 00 f6 e9 00 00 02 04 05 b4 01 01 04 02      @.....  ....

```

Sequence Number (tcp.seq), 4 bytes | Packets: 213 · Displayed: 202 (94.8%) | Profile: Default

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK]
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK]
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4

000. .... = Reserved: Not set  
 ...0 .... = Nonce: Not set  
 .... 0... = Congestion Window Reduced (CWR): Not set  
 .... .0.. = ECN-Echo: Not set  
 .... ..0. = Urgent: Not set  
 .... ....0 = Acknowledgment: Not set  
 .... ....0... = Push: Not set  
 .... .... .0.. = Reset: Not set  
 > .... .... ..1. = Syn: Set  
 .... .... ...0 = Fin: Not set  
 [TCP Flags: .....S.]

0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00 ..%.s. .p...E.  
 0010 00 30 1e 1d 40 00 80 06 a5 18 c0 a8 01 66 80 77 .0..@... ..f.w  
 0020 f5 0c 04 89 00 50 0d d6 01 f4 00 00 00 00 70 02 .....P.....p  
 0030 40 00 f6 e9 00 00 02 04 05 b4 01 01 04 02 @.....

Syn (tcp.flags.syn), 1 byte

Packets: 213 · Displayed: 202 (94.8%) Profile: Default

b. The sequence number is 0.

The value of the ACK in the SYNACK segment is 1. Gaia server determines this value by adding 1 to the SYN segment's sequence number, which is 0. SYNACK is determined by ACK and SYN flags. Both are set to 1.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

Destination	Protocol	Length	Info
128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK...
128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segme...
128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP se...
192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segmen...
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segmen...
192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segmen...

Flags: 0x012 (SYN, ACK)

- 000. .... = Reserved: Not set
- ...0 .... = Nonce: Not set
- .... 0... = Congestion Window Reduced (CWR): Not set
- .... .0.. = ECN-Echo: Not set
- .... ..0. = Urgent: Not set
- .... ...1 .... = Acknowledgment: Set
- .... .... 0... = Push: Not set
- .... .... .0.. = Reset: Not set
- > .... .... ..1. = Syn: Set
- .... .... ...0 = Fin: Not set

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00 . . . p . . % . . s . . E .

0010 00 30 00 00 40 00 37 06 0c 36 80 77 f5 0c c0 a8 . 0 . . @ . 7 . . 6 . w . . . .

0020 01 66 00 50 04 89 34 a2 74 19 0d d6 01 f5 70 12 . f . P . . 4 . t . . . . . p .

0030 16 d0 77 4d 00 00 02 04 05 b4 01 01 04 02 . . w M . . . . .

Acknowledgment (tcp.flags.ack), 1 byte

Packets: 213 · Displayed: 202 (94.8%) Profile: Default

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

Destination	Protocol	Length	Info
128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK...
128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segme...
128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP se...
192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segmen...
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segmen...
192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segmen...

Destination Port: 1161  
 [Stream index: 0]  
 [TCP Segment Len: 0]  
 Sequence Number: 0 (relative sequence number)  
 Sequence Number (raw): 883061785  
 [Next Sequence Number: 1 (relative sequence number)]  
 Acknowledgment Number: 1 (relative ack number)  
 Acknowledgment number (raw): 232129013  
 0111 .... = Header Length: 28 bytes (7)  
 > Flags: 0x012 (SYN, ACK)  
 Window: 5840

```

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00  . . . p . . % . s . . E .
0010 00 30 00 00 40 00 37 06 0c 36 80 77 f5 0c c0 a8  . 0 . . @ . 7 . . 6 w . . .
0020 01 66 00 50 04 89 34 a2 74 19 0d d6 01 f5 70 12  . f . P . . 4 . t . . . . . p .
0030 16 d0 77 4d 00 00 02 04 05 b4 01 01 04 02      . . w M . . . . .
  
```

Sequence Number (tcp.seq), 4 bytes | Packets: 213 · Displayed: 202 (94.8%) | Profile: Default

Consider the TCP segment containing the HTTP POST as the first segment in the

- c. The sequence number is 1.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Current filter: tcp

Destination	Protocol	Length	Info
128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK...
128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segme...
128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP se...
192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segmen...
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segmen...
192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segmen...

Source Port: 1161  
Destination Port: 80  
[Stream index: 0]  
[TCP Segment Len: 565]  
Sequence Number: 1 (relative sequence number)  
Sequence Number (raw): 232129013  
[Next Sequence Number: 566 (relative sequence number)]  
Acknowledgment Number: 1 (relative ack number)  
Acknowledgment number (raw): 883061786  
0101 .... = Header Length: 20 bytes (5)  
Flags: 0x018 (PSH, ACK)

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

Sequence Number (tcp.seq), 4 bytes | Packets: 213 · Displayed: 202 (94.8%) | Profile: Default

- d. From the first to the sixth segment, the sequence numbers are: 1→566→2026→3486→4946→6406.

# Segment	Sent Time	Received Time	RTT
1	0.026477	0.053937	0.02746
2	0.041737	0.077294	0.035557
3	0.054026	0.124085	0.070059
4	0.054690	0.169118	0.114428
5	0.077405	0.217299	0.139894
6	0.078157	0.267802	0.189645

EstimatedRTT = 0.875\*EstimatedRTT+0.125\*SampleRTT

Estimated RTT for 1<sup>st</sup> segment: 0.02746

Estimated RTT for 2<sup>nd</sup> segment: 0.875\*0.02746+0.125\*0.035557 = 0.02847

Estimated RTT for 3<sup>rd</sup> segment: 0.875\*0.02847+0.125\*0.070059=0.0327775

Estimated RTT for 4<sup>th</sup> segment: 0.875\*0.0327775+0.125\*0.114428 = 0.0429838125

Estimated RTT for 5<sup>th</sup> segment: 0.875\*0.0429838125+0.125\*0.139894 = 0.05509

Estimated RTT for 6<sup>th</sup> segment: 0.875\*0.05509 + 0.125\*0.189645 = 0.071916

- e. Length:

# Segment	Length (byte)
1	565
2	1460
3	1460
4	1460
5	1460
6	1460

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Current filter: tcp

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=1
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...
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 segme...
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP se...
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 segmen...
192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segmen...
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 segmen...

< >

> 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, Dst: 128.119.245.12

> Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 565

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

Sequence Number (tcp.seq), 4 bytes

Packets: 213 · Displayed: 202 (94.8%)

Profile: Default



- f. Min buffer space (window size) is 5840 bytes. Since the window size increase to 62780 bytes eventually, the sender does not affected by the lack of receiver buffer space.

The image shows a Wireshark packet capture window titled 'tcp-ethereal-trace-1'. The packet list pane shows 10 packets. Packet 2 is a SYN, ACK from 128.119.245.12 to 192.168.1.102 with a window size of 5840. Packet 10 is an ACK from 192.168.1.102 to 128.119.245.12 with a window size of 62780. The packet details pane for packet 10 shows the 'Flags' field expanded, displaying 'Flags: 0x012 (SYN, ACK)' and 'Window: 5840'. The packet bytes pane shows the raw data of the packet, including the flags and window size fields.

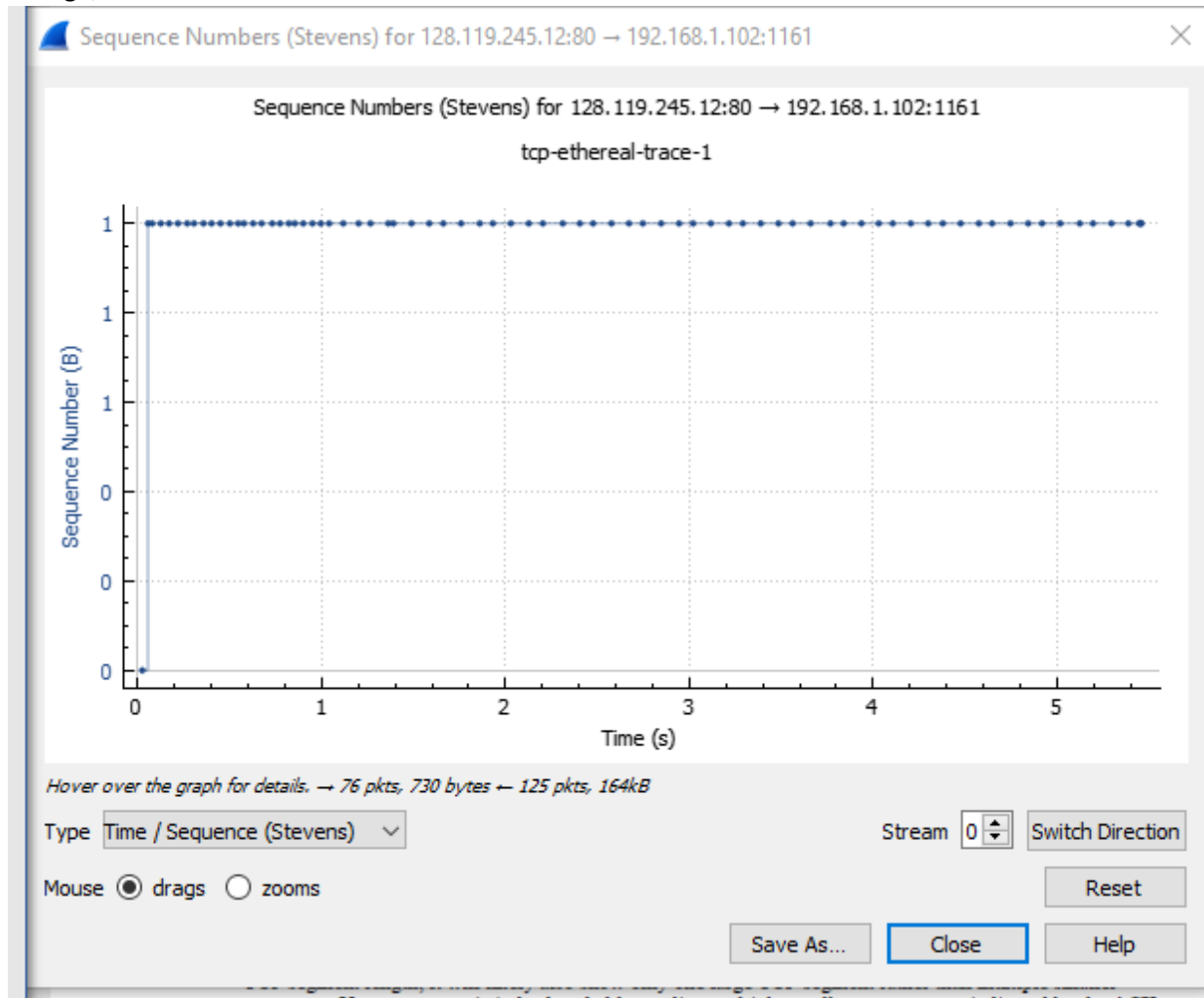
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] 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=615
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1510
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=1510
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1510
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=62780 Len=1510

Acknowledgment number (raw): 232129013  
 0111 .... = Header Length: 28 bytes (7)  
 > Flags: 0x012 (SYN, ACK)  
 Window: 5840  
 [Calculated window size: 5840]  
 Checksum: 0x774d [unverified]  
 [Checksum Status: Unverified]  
 Urgent Pointer: 0  
 > Options: (8 bytes), Maximum segment size, No-Operation (NOP), No-Operation (NOP), SACK permitted  
 > [SEQ/ACK analysis]  
 > [Timestamps]

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00 ..p...%..s..E.  
 0010 00 30 00 00 40 00 37 06 0c 36 80 77 f5 0c c0 a8 .@.7..6.w....  
 0020 01 66 00 50 04 89 34 a2 74 19 0d d6 01 f5 70 12 .f.P...4..t....p.  
 0030 16 d0 77 4d 00 00 02 04 05 b4 01 01 04 02 ..wM.....

Flags (12 bits) (tcp.flags), 2 bytes | Packets: 213 · Displayed: 202 (94.8%) | Profile: Default

- g. No, based on the sequence numbers graph, the transmission is stable and show no change, which means there is no retransmission.

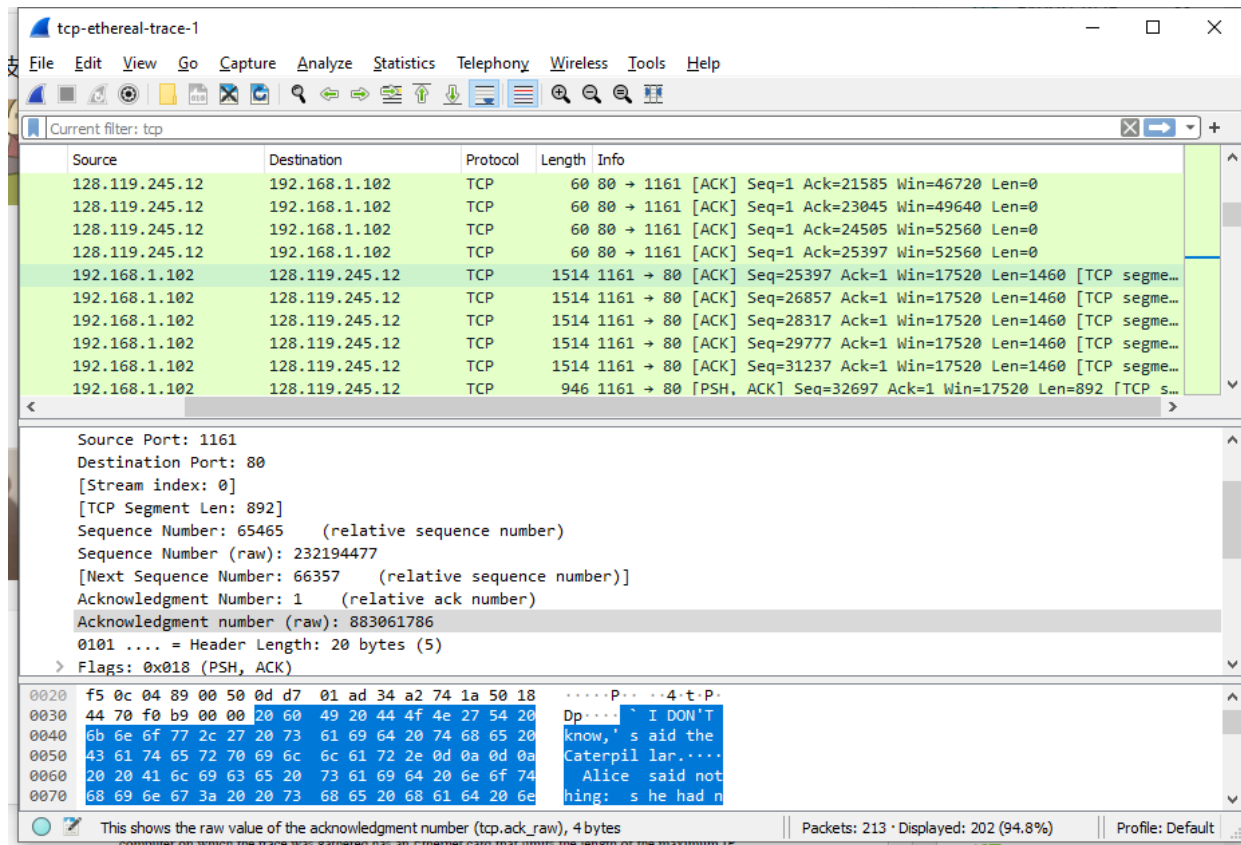


- h. We can calculate data size in an ACK by compare difference between this ACK seq number and next ACK sequence number.

# ACK	Cur sequence number	Data size
1	566	566
2	2026	1460
3	3486	1460
4	4946	1460
5	6406	1460

...

We can identify cases where the receiver is ACKing every other received segment based on data size. If the data size is different from others except the first one, then the receiver is ACKing every other received segment.



- i. The throughput of TCP is the amount of data being sent/received in a unit of time. To calculate the throughput, the total amount of data and the total time for the transmission need to be known. In this case, the total amount of data is determined by the difference between the final sequence number and the first sequence number, which is  $164091 - 1 = 164090$  bytes. The amount of time is determined by the difference between the first segment time and the final segment time, which is  $5.461175 - 0.026477 = 5.434698$ s. The total throughput is  $164090 \text{ bytes} / 5.434698 \text{ s} = 30193 \text{ bytes/second}$

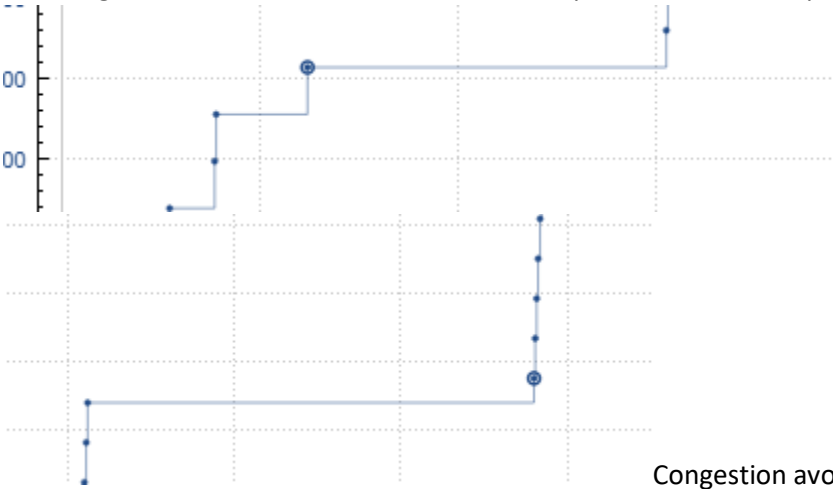
4.

- a. The slowstart phases starts as beginning and ends where the second phases of segments transmission start. Starts at 0.0 sec and ends by 0.1242 secs.



Slow start phases

The congestion avoidance takes over slow start phase as slow start phase ends:



Ideally TCP has the transmit as fast as possible as long as there is no congestion, and the window size after congestion is the half of the one before. But in this case, it's much less than the half of the threshold.

128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=25397 Win=52560 Len=0
128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=25397 Win=52560 Len=0
192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=25397 Ack=1 Win=17520 Len=1460 [TCP segme...
192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=26857 Ack=1 Win=17520 Len=1460 [TCP segme...
192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=28317 Ack=1 Win=17520 Len=1460 [TCP segme...
192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=29777 Ack=1 Win=17520 Len=1460 [TCP segme...
192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=31237 Ack=1 Win=17520 Len=1460 [TCP segme...
192.168.1.102	128.119.245.12	TCP	946 1161 → 80 [PSH, ACK] Seq=32697 Ack=1 Win=17520 Len=892 [TCP s...

The threshold is 52560 and the ideal window size should be 26280 but the actual one is only 17520

- b. My graph:
- Slow starts begins at 2.7s and ends at around 2.71s. After that the congestion phases start. Compare to ideal one, the window size is close to ideal case.

128.119.245.12	192.168.1.135	TCP	60 80 → 56298 [ACK] Seq=1 Ack=42465 Win=114432 Len=0
192.168.1.135	128.119.245.12	TCP	5630 56298 → 80 [ACK] Seq=92649 Ack=1 Win=263424 Len=5576 [TCP seg...
128.119.245.12	192.168.1.135	TCP	60 80 → 56298 [ACK] Seq=1 Ack=45253 Win=120064 Len=0

