



SeoulTech ITM Major

Wireshark: TCP

2025 Spring, Computer Networks

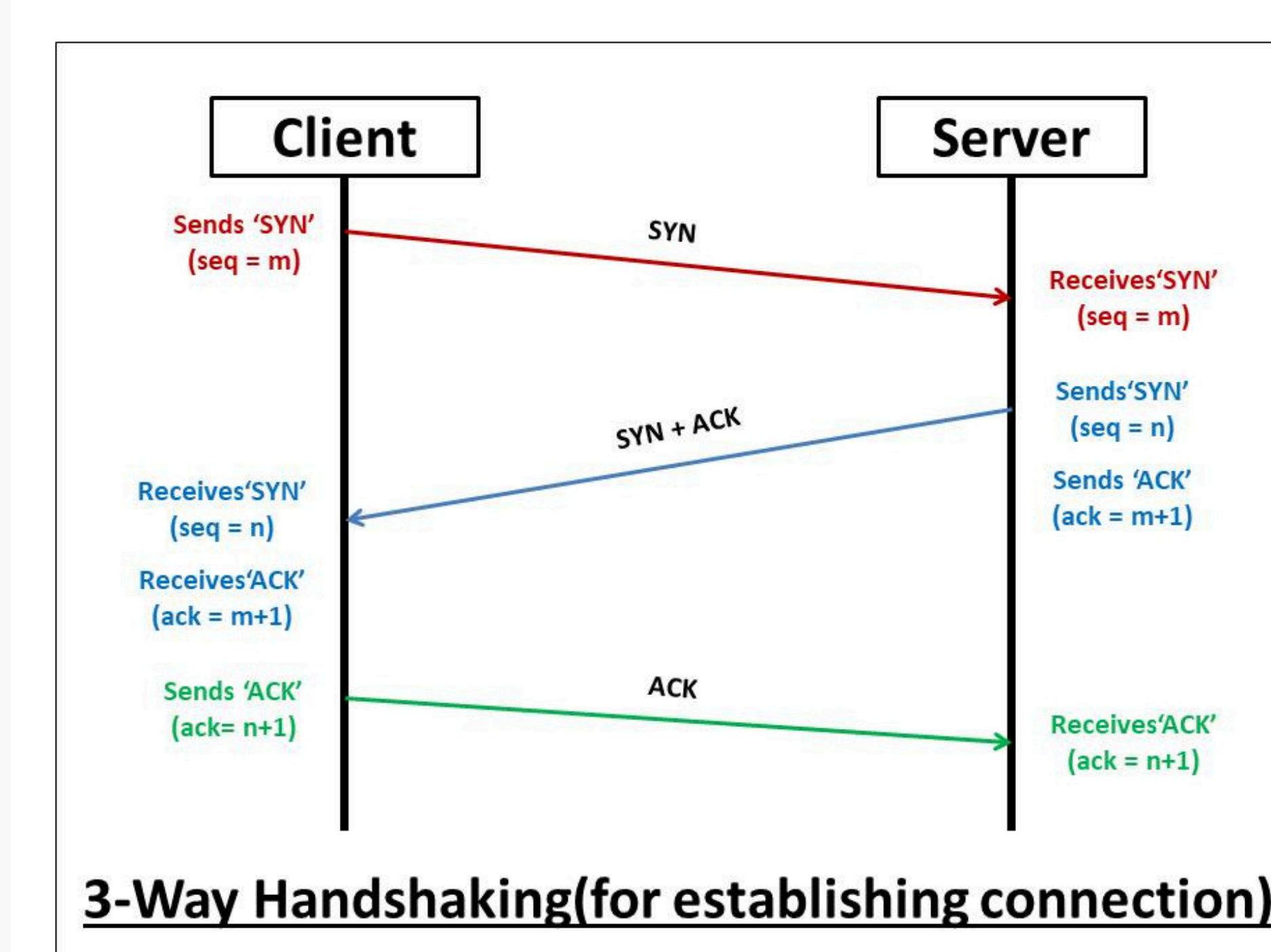
25170045 Teemu | 21102052 Jeongyun | 22102009 Jiwon
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Introduction to TCP

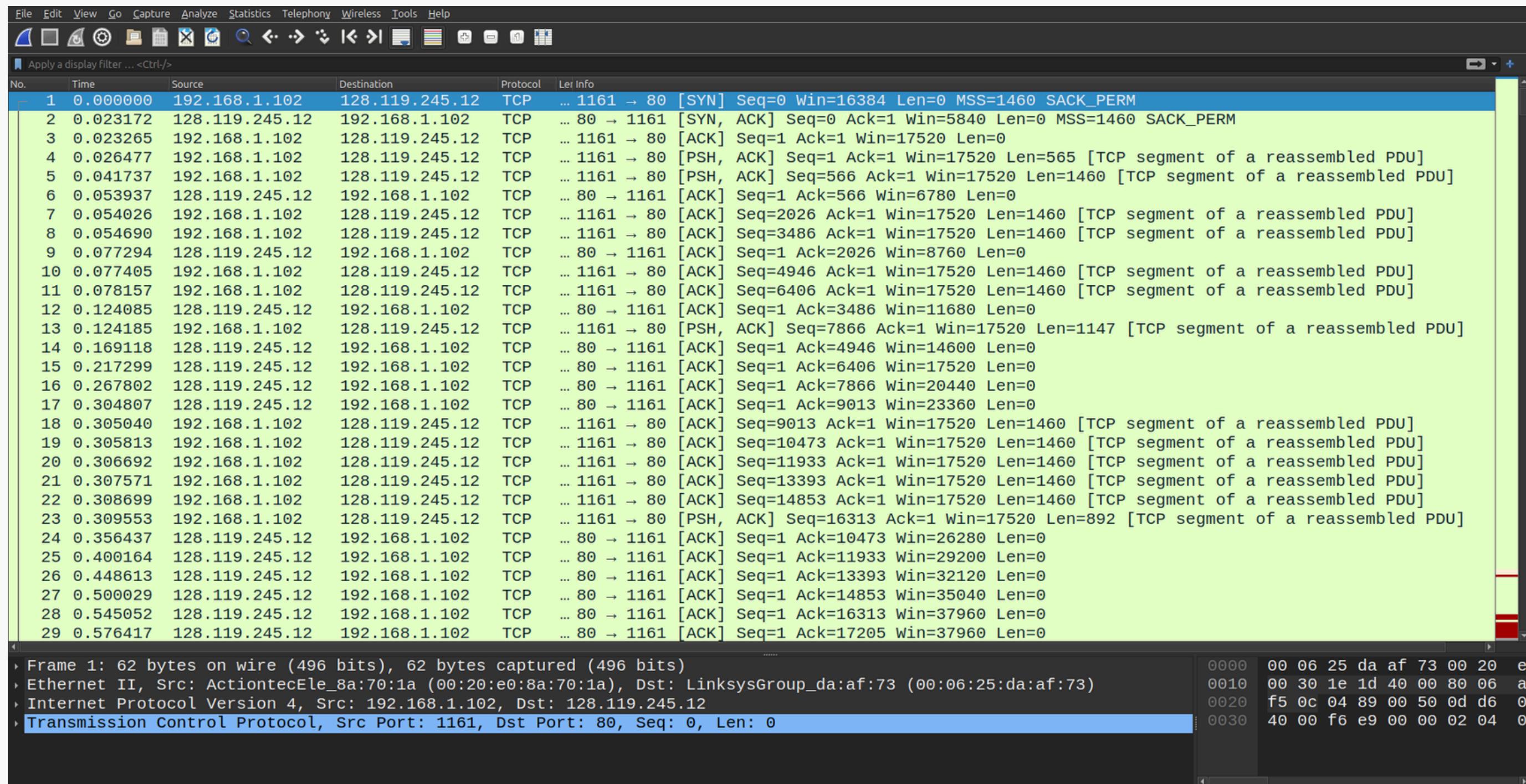
- *Layer 4 Protocol in TCP/IP Model*
- *Connection-oriented*
- *Three-Way Handshake*
- *Flow Control*
- *Congestion Control*

Introduction to TCP



Introduction to the problems

Investigate details of packets (frames) in TCP communication between client and server using Wireshark
Upload “alice.txt” to “gaia.cs.umass.edu”



Problem 1

What is the Source Address and Port Number used by the client? (sender)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	... 1161	→ 80 [SYN] Seq=0 Win=16384
2	0.023172	128.119.245.12	192.168.1.102	TCP	... 80 → 1161	[SYN, ACK] Seq=0 Ack=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	... 1161 → 80	[ACK] Seq=1 Ack=1 Win=:

Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: ActiontecEle_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysGroup_da:af:73
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
0100 = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
Total Length: 48
Identification: 0x1e1d (7709)
010. = Flags: 0x2, Don't fragment
...0 0000 0000 0000 = Fragment offset: 0
Time to Live: 128
Protocol: TCP (6)
Header Checksum: 0xa518 [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: 0, Len: 0
Source Port: 1161
Destination Port: 80

Problem 2

What is the Destination Address and Port Number of the server? (receiver)

No.	Time	Source	Destination	Protocol	Len Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [SYN] Seq=0 Win=16384
2	0.023172	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [SYN, ACK] Seq=0 Ack=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=1 Ack=1 Win=:

Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: ActiontecEle_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysGroup_da:af:73
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
 0100 = Version: 4
 0101 = Header Length: 20 bytes (5)
 Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
 Total Length: 48
 Identification: 0x1e1d (7709)
 010. = Flags: 0x2, Don't fragment
 ...0 0000 0000 0000 = Fragment offset: 0
 Time to Live: 128
 Protocol: TCP (6)
 Header checksum: 0xa518 [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: 0, Len: 0
 Source Port: 1161
 Destination Port: 80

Problem 3

What is the Source Address and Port Number used by the client in the personal trace? (sender)

No.	Time	Source	Destination	Protocol	Length	Info
76	10.26673...	10.50.34.243	128.119.245.12	TCP	... 38310 → 80	[SYN] Seq=0 Win=64240 L=0
79	10.57454...	128.119.245.12	10.50.34.243	TCP	... 80 → 38310	[SYN, ACK] Seq=0 Ack=1 L=0
80	10.57461...	10.50.34.243	128.119.245.12	TCP	... 38310 → 80	[ACK] Seq=1 Ack=1 Win=64240 L=0

Frame 76: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface wlp2s0,
Ethernet II, Src: ChongqingFug_2f:33:c9 (4c:d5:77:2f:33:c9), Dst: ArubaHewlett_8a:a7:00 (08:00:27:8a:a7:00)
Internet Protocol Version 4, Src: 10.50.34.243, Dst: 128.119.245.12
 0100 = Version: 4
 0101 = Header Length: 20 bytes (5)
 Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
 Total Length: 60
 Identification: 0xd1f0 (53744)
 010. = Flags: 0x2, Don't fragment
 ...0 0000 0000 0000 = Fragment offset: 0
 Time to Live: 64
 Protocol: TCP (6)
 Header Checksum: 0xc622 [validation disabled]
 [Header checksum status: Unverified]
 Source Address: 10.50.34.243
 Destination Address: 128.119.245.12
Transmission Control Protocol, Src Port: 38310, Dst Port: 80, Seq: 0, Len: 0
 Source Port: 38310
 Destination Port: 80

Problem 4

What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection

No.	Time	Source	Destination	Protocol	Len Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MS
2	0.023172	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=584
3	0.023265	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Le

Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: ActiontecEle_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysGroup_da:af:73 (00:0c:29:af:73:00)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0

Source Port: 1161
Destination Port: 80
[Stream index: 0]
[Conversation completeness: Incomplete, DATA (15)]
[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 = Accurate ECN: Not set
.... 0... = Congestion Window Reduced: 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.]

Problem 5

What is sequence number of SYNACK segment in reply to the SYN?

What is the value of Acknowledgement field in SYNACK segment, and how to determine the value?

What identifies the segment as SYNACK segment?

No.	Time	Source	Destination	Protocol	Layer Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MS
2	0.023172	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=584
3	0.023265	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0

Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: LinksysGroup_da:af:73 (00:06:25:da:af:73), Dst: ActiontecEle_8a:70:1a (00:2
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102
Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 0, Ack: 1, Len: 0

Source Port: 80
Destination Port: 1161
[Stream index: 0]
[Conversation completeness: Incomplete, DATA (15)]
[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)

000. = Reserved: Not set
...0 = Accurate ECN: Not set
.... 0... = Congestion Window Reduced: 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
[TCP Flags:A..S.]

Problem 5

What is sequence number of SYNACK segment in reply to the SYN?

What is the value of Acknowledgement field in SYNACK segment, and how to determine the value?

What identifies the segment as SYNACK 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=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

Frame 3: 54 bytes on wire (432 bits), 54 bytes captured (432 bits)
Ethernet II, Src: ActiontecEle_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysGroup_da:af:73 (00:06:25
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: 0
Source Port: 1161
Destination Port: 80
[Stream index: 0]
[Conversation completeness: Incomplete, DATA (15)]
[TCP Segment Len: 0]
Sequence Number: 1 (relative sequence number)
Sequence Number (raw): 232129013
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 883061786
0101 = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
000. = Reserved: Not set
...0 = Accurate ECN: Not set
.... 0.... = Congestion Window Reduced: Not set
.... .0.. = ECN-Echo: Not set
.... ..0. = Urgent: Not set
.... ...1 = Acknowledgment: Set
.... 0... = Push: Not set
....0.. = Reset: Not set
....0. = Syn: Not set
....0 = Fin: Not set
[TCP Flags:A....]

Problem 5

Reasoning for our answer:

Source: <https://www.ietf.org/rfc/rfc793.txt> [Cited: 2025/04/11]

The screenshot shows a dark-themed document page. In the top right corner, it says "[Page 15]" above the date "September 1981". In the top left corner, there is a small square icon containing the number "82". The main title "Transmission Control Protocol Functional Specification" is centered at the top. Below the title, there are two sections: "Sequence Number: 32 bits" and "Acknowledgment Number: 32 bits", each followed by a detailed description.

Sequence Number: 32 bits

The sequence number of the first data octet in this segment (except when SYN is present). If SYN is present the sequence number is the initial sequence number (ISN) and the first data octet is ISN+1.

Acknowledgment Number: 32 bits

If the ACK control bit is set this field contains the value of the next sequence number the sender of the segment is expecting to receive. Once a connection is established this is always sent.

Sequence numbers are used during **connection setup** even when no data is included (length =0)
ex) control packets(SYN, FIN, ACK)

Problem 6

What is the sequence number of TCP segment containing the HTTP POST?

40.026477 192.168.1.1... 128.119.245... TCP

619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565

```
[Stream index: 0]
[Stream Packet Number: 4]
[Conversation completeness: Incomplete, DATA (15)]
[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)
Window: 17520
[Calculated window size: 17520]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0x1fb9 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
[Timestamps]
[SEQ/ACK analysis]
TCP payload (565 bytes)
[Reassembled PDU in frame: 199]
```

Data Field

Dp....PO ST /ethe
real-lab s/lab3-1
-reply.h tm HTTP/
1.1..Hos t: gaia.
cs.umass .edu..Us
er-Agent : Mozill
a/5.0 (W indows;
U; Windo ws NT 5.
1; en-US ; rv:1.0
.2) Geck o/200302
08 Netsc ape/7.02
..Accept : text/x

Problem 6

What is the sequence number of TCP segment containing the HTTP POST?

40.026477 192.168.1.1... 128.119.245... TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565

5 0.041737	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=565
6 0.053937	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6784

- > Frame 5: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)
- > Ethernet II, Src: ActiontecEle_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysGroup_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: 566, Ack: 1, Len: 1460

Source Port: 1161

Destination Port: 80

[Stream index: 0]

[Stream Packet Number: 5]

> [Conversation completeness: Incomplete, DATA (15)]

[TCP Segment Len: 1460]

Sequence Number: 566 (relative sequence number)

Sequence Number (raw): 232129578

[Next Sequence Number: 2026 (relative sequence number)]

Acknowledgment Number: 1 (relative ack number)

Acknowledgment number (raw): 883061786

0101 = Header Length: 20 bytes (5)

Problem 7

Each First Six Segments: 1) sequence number, 2) transmission time, 3) ACK received time, 4) RTT, 5) EstimatedRTT

o.	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 SACK_PERM
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 MSS=1460
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
1	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP P]
2	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP P]
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
3	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP P]
4	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP P]
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 ACK=2026 Win=8/60 Len=0
5	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP P]
6	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP P]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 ACK=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP P]
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460 [TCP P]

Problem 7

Each First Six Segments: 1) sequence number, 2) transmission time, 3) ACK received time, 4) RTT, 5)

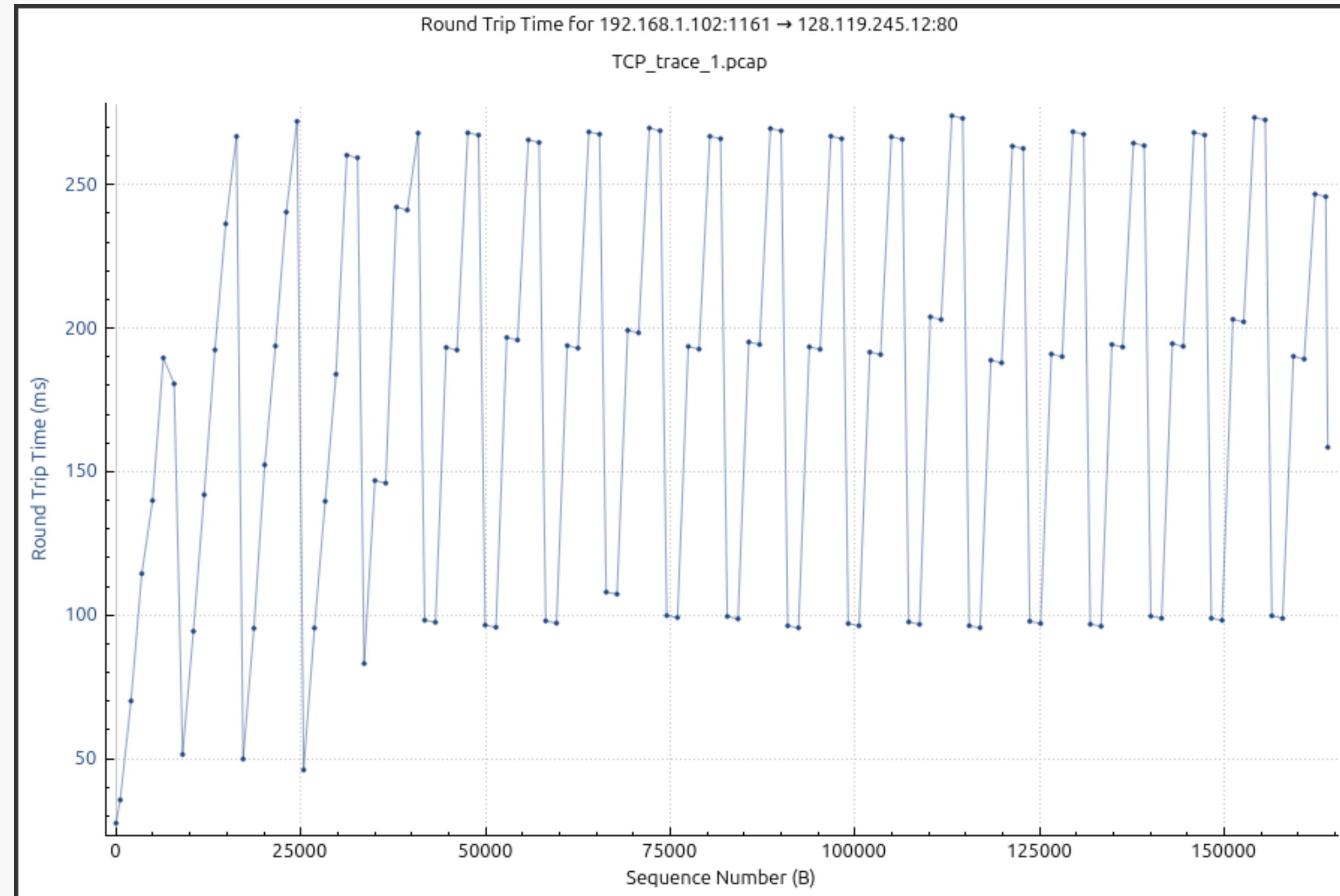
$$RTT = \text{ACK Time} - \text{Transmission Time}$$

$$\text{EstimatedRTT} = (1 - 0.125) * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$$

Packet Number	Sequence Number	Transmission Time	ACK Time	RTT	Estimated RTT
4	1	0.026477	0.053937	0.027460	0.027460
5	566	0.041737	0.077294	0.035557	0.028500
7	2026	0.054026	0.124085	0.070059	0.033700
8	3486	0.054690	0.169118	0.114428	0.043800
10	4946	0.077405	0.217299	0.139894	0.055800
11	6406	0.078157	0.267802	0.189645	0.072500

Problem 7

Each First Six Segments: 1) sequence number, 2) transmission time, 3) ACK received time, 4) RTT, 5) EstimatedRTT



Problem 8

Length of each of the first six TCP 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=0 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=0 Ack=1 Win=5840 Len=0 MSS=1460	
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=565 [TCP]	
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP]	
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=1460 [TCP]	
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP]	
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=17520 Len=1460 [TCP]	
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP]	
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0	
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147	

‣ [SEQ/ACK analysis]
TCP payload (1460 bytes)
[Reassembled PDU in frame: 199]
TCP segment data (1460 bytes)

1st segment : **565 bytes**

2nd ~ 6th segment : **1460 bytes** ← **MSS**

IP + TCP header = **40 bytes**

Problem 9

What is minimum amount of available buffer space advertised at the received for the entire trace?

Does the lack of receiver buffer space ever throttle the sender?

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 SACK_PERM
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 MSS=1460 SACK_PERM
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=565 [TCP PDU reassembled in 199]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP PDU reassembled in 199]
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=1460 [TCP PDU reassembled in 199]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP PDU reassembled in 199]
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=17520 Len=1460 [TCP PDU reassembled in 199]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP PDU reassembled in 199]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP PDU reassembled in 199]
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460 [TCP PDU reassembled in 199]

The minimum amount of buffer space : 5840bytes

5840 → 6780 → 8760 → 11680 → 14600 → 17520 → ... → 62780

The sender will not be throttled!

Problem 10.

Are there any retransmitted segments in the trace file? → **NO**

What did you check for (in the trace) in order to answer this question?

Manually Find Duplicate Ack or
Use “tcp.analysis.ack_lost_segment”

tcp.analysis.ack_lost_segment						
No.	Time	Source	Destination	Protocol	Length	Info
728	14.946780	108.177.125.188	172.30.1.83	TCP	66	[TCP ACKed unseen segment]

e.g., Wireshark will label the corresponding packet

344	10.755552	172.30.1.83	20.189.172.33	TLSv1...	631	Change Cipher Spec, Client Hello (SNI=westus-0.in.applicationinsights.azure.com)
345	10.757102	172.30.1.83	20.189.172.33	TLSv1...	560	Client Hello (SNI=westus-0.in.applicationinsights.azure.com)
346	10.961830	172.30.1.83	20.189.172.33	TCP	78	50588 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=4108230677 TSecr=0
347	10.961890	172.30.1.83	20.189.172.33	TCP	78	50589 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=3846396238 TSecr=0
348	10.963974	172.30.1.83	20.189.172.33	TCP	78	50590 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2587468617 TSecr=0
362	11.267393	172.30.1.83	20.189.172.33	TCP	78	[TCP Retransmission] 50586 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSva
363	11.267459	172.30.1.83	20.189.172.33	TCP	78	[TCP Retransmission] 50585 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSva
364	11.267484	172.30.1.83	20.189.172.33	TCP	560	[TCP Retransmission] 50577 → 443 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=494 TSval
365	11.269809	172.30.1.83	20.189.172.33	TCP	560	[TCP Retransmission] 50578 → 443 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=494 TSval
366	11.271003	172.30.1.83	20.189.172.33	TCP	560	[TCP Retransmission] 50580 → 443 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=494 TSval
367	11.298145	172.30.1.83	20.189.172.33	TCP	560	[TCP Retransmission] 50579 → 443 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=494 TSval
369	11.404778	20.189.172.33	172.30.1.83	TCP	74	443 → 50586 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1440 WS=256 SACK_PERM TSv
370	11.404780	20.189.172.33	172.30.1.83	TCP	74	443 → 50585 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1440 WS=256 SACK_PERM TSv
371	11.404971	172.30.1.83	20.189.172.33	TCP	66	50586 → 443 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=4046857563 TSecr=87500741
372	11.405089	172.30.1.83	20.189.172.33	TCP	66	50585 → 443 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=172757118 TSecr=89288222
373	11.414726	172.30.1.83	20.189.172.33	TLSv1...	560	Client Hello (SNI=westus-0.in.applicationinsights.azure.com)

Frame 364: 560 bytes on wire (4480 bits), 560 bytes captured (4480 bits) on interface e...
Section number: 1
> Interface id: 0 (en0)

0000 88 3c 1c 94 97 8f 14 14 7d 00 13 e9 08 00 45 00 <....
0010 02 22 00 00 40 00 40 06 ca 86 ac 1e 01 53 14 bd ..@@
0020 ac 21 c5 91 01 bb 4b bc 10 75 94 76 89 9c 80 18 !...K

Problem 11.

How much data does the receiver typically acknowledge in an ACK?

Can you identify cases where the receiver is ACKing every other received segment?

No.	Time	Source	Destination	Protocol	Len Info	
71	1.661513	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [ACK] Seq=1 Ack=49973 Win=62780 Len=0	
72	1.661734	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=49973 Ack=1 Win=17520 Len=1460 [TC]	
73	1.662474	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=51433 Ack=1 Win=17520 Len=1460 [TC]	
74	1.663315	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=52893 Ack=1 Win=17520 Len=1460 [TC]	
75	1.664198	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=54353 Ack=1 Win=17520 Len=1460 [TC]	
76	1.665254	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=55813 Ack=1 Win=17520 Len=1460 [TC]	
77	1.666151	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [PSH, ACK] Seq=57273 Ack=1 Win=17520 Len=892	
78	1.758227	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [ACK] Seq=1 Ack=52893 Win=62780 Len=0	
79	1.860063	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [ACK] Seq=1 Ack=55813 Win=62780 Len=0	
80	1.930880	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [ACK] Seq=1 Ack=58165 Win=62780 Len=0	
81	1.931099	192.168.1.102	128.119.245.12	TCP	... 1161 → 80 [ACK] Seq=58165 Ack=1 Win=17520 Len=1460 [TC]	

79	1.860063	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [ACK] Seq=1 Ack=55813	80	1.930880	128.119.245.12	192.168.1.102	TCP	... 80 → 1161 [ACK] Seq=1 Ack=58165
					[Window size scaling factor: -2 (no window scaling used)]						[Window size scaling factor: -2 (no window scaling used)]
					Checksum: 0xeb9f [unverified]						Checksum: 0xe26f [unverified]
					[Checksum Status: Unverified]						[Checksum Status: Unverified]
					Urgent Pointer: 0						Urgent Pointer: 0
					[Timestamps]						[Timestamps]
					- [SEQ/ACK analysis]						- [SEQ/ACK analysis]
					[This is an ACK to the segment in frame: 75]						[This is an ACK to the segment in frame: 77]

After the first 6,8192 byte PDUs are sent, the algorithm settles to a [6 Packet - 3 ACK pattern].
3 ACK = $(1460 + 1460) + (1460 + 1460) + (1460 + 892)$

Problem 12.

What is the throughput (bytes transferred per unit time) for the TCP connection?

Time	Source	Destination	Protocol	Length	Info
10.000000	192.168.1.1...	128.119.245...	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK
20.023172	128.119.245...	192.168.1.1...	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS
30.023265	192.168.1.1...	128.119.245...	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
40.026477	192.168.1.1...	128.119.245...	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
199.5.297341	192.168.1.1...	128.119.245...	HTTP	104	POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (1
200.5.389471	128.119.245...	192.168.1.1...	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201.5.447887	128.119.245...	192.168.1.1...	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202.5.455830	128.119.245...	192.168.1.1...	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203.5.461175	128.119.245...	192.168.1.1...	HTTP	784	HTTP/1.1 200 OK (text/html)

$$\text{Total Bytes Transmitted} = (164091 - 1)$$

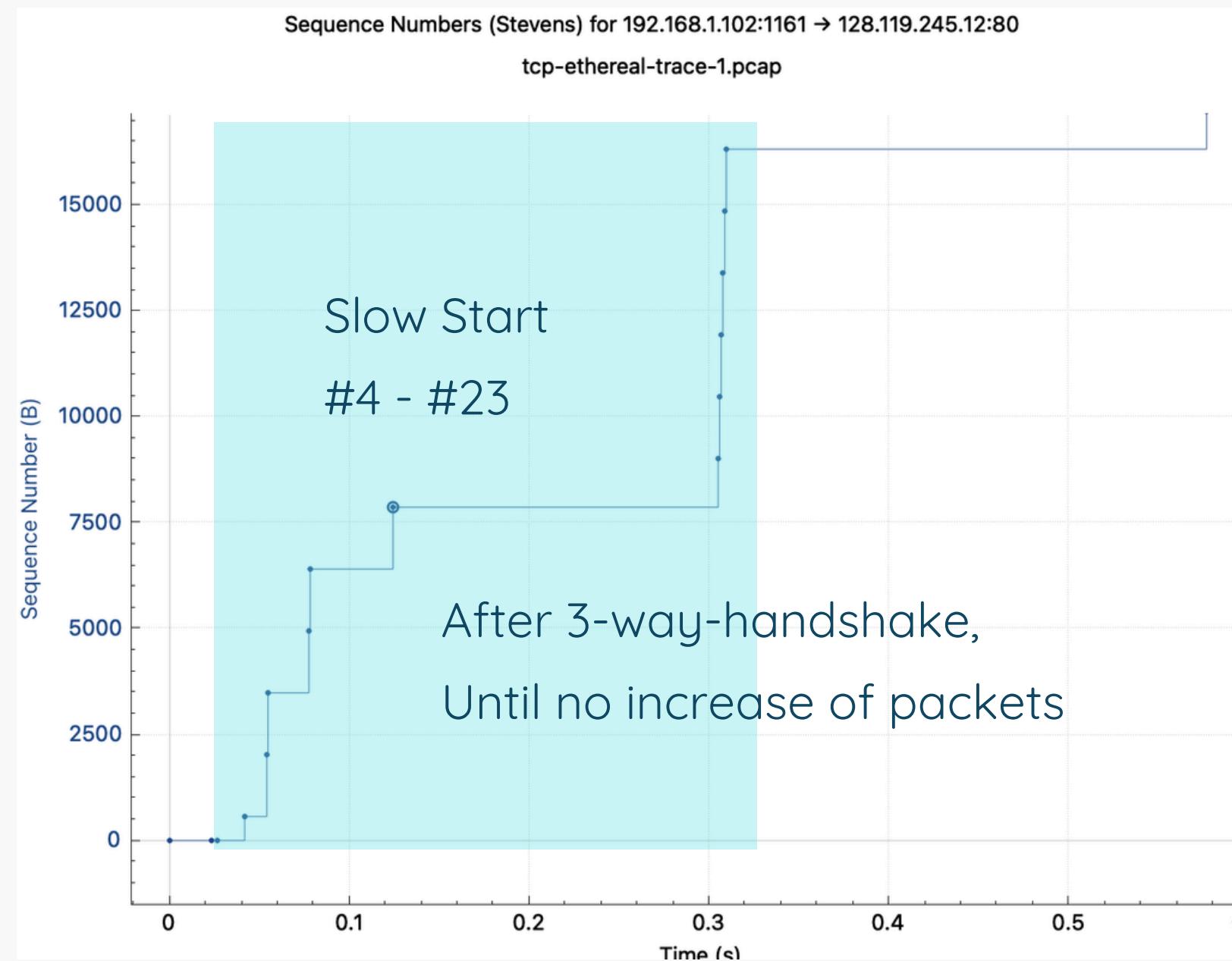
$$\text{Total Transmission Time} = (5.455830 - 0.026477)$$

$$\text{Throughput} = (164091 - 1) / (5.455830 - 0.026477) = 30222.754 \text{ bytes/sec}$$

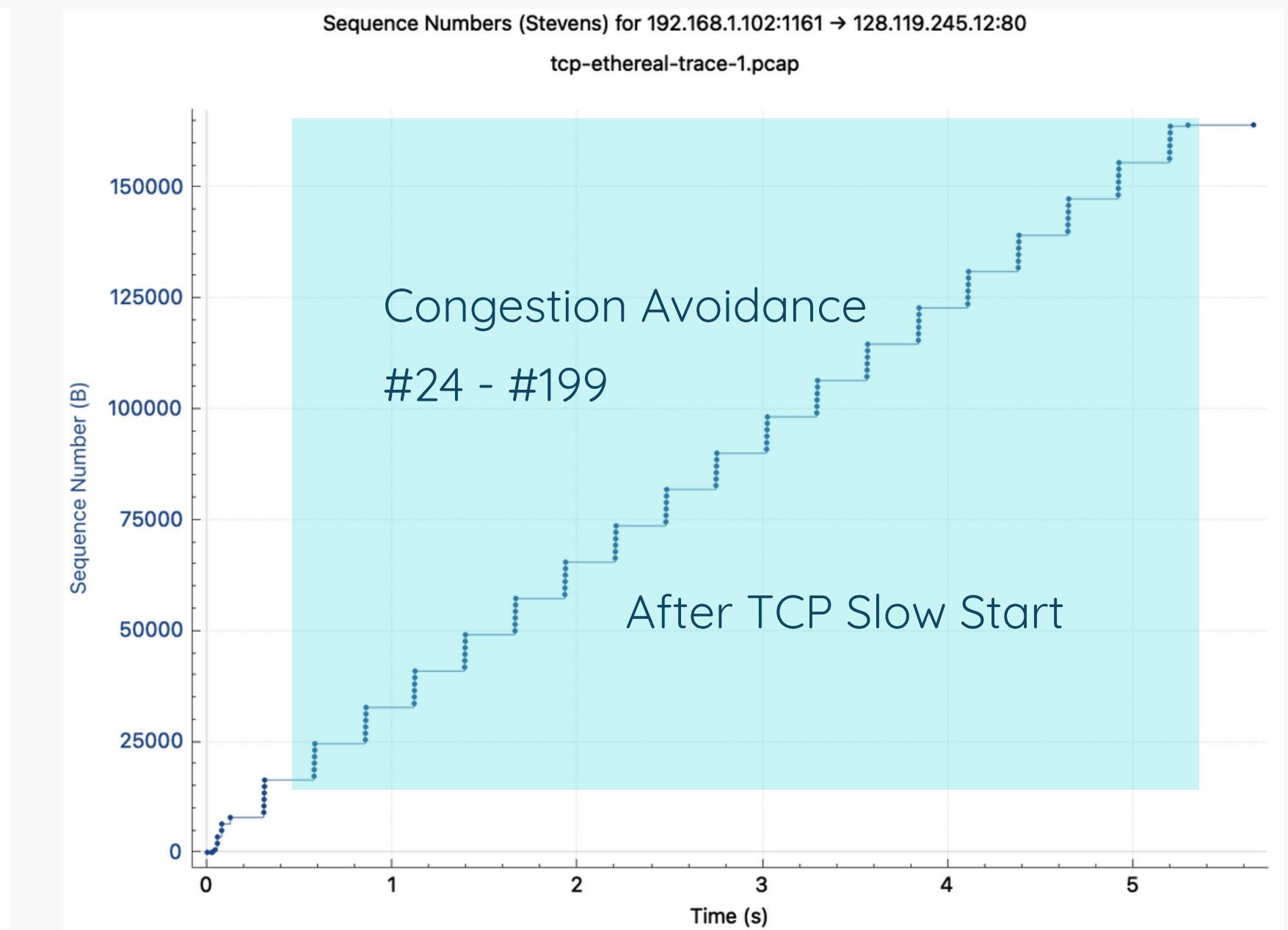
Problem 13.

Find begin and end point of “TCP Slow Start” and “TCP Congestion Avoidance” (provided trace)

Difference between textbook theory and practical case



No exponent increase of packets in Slow Start

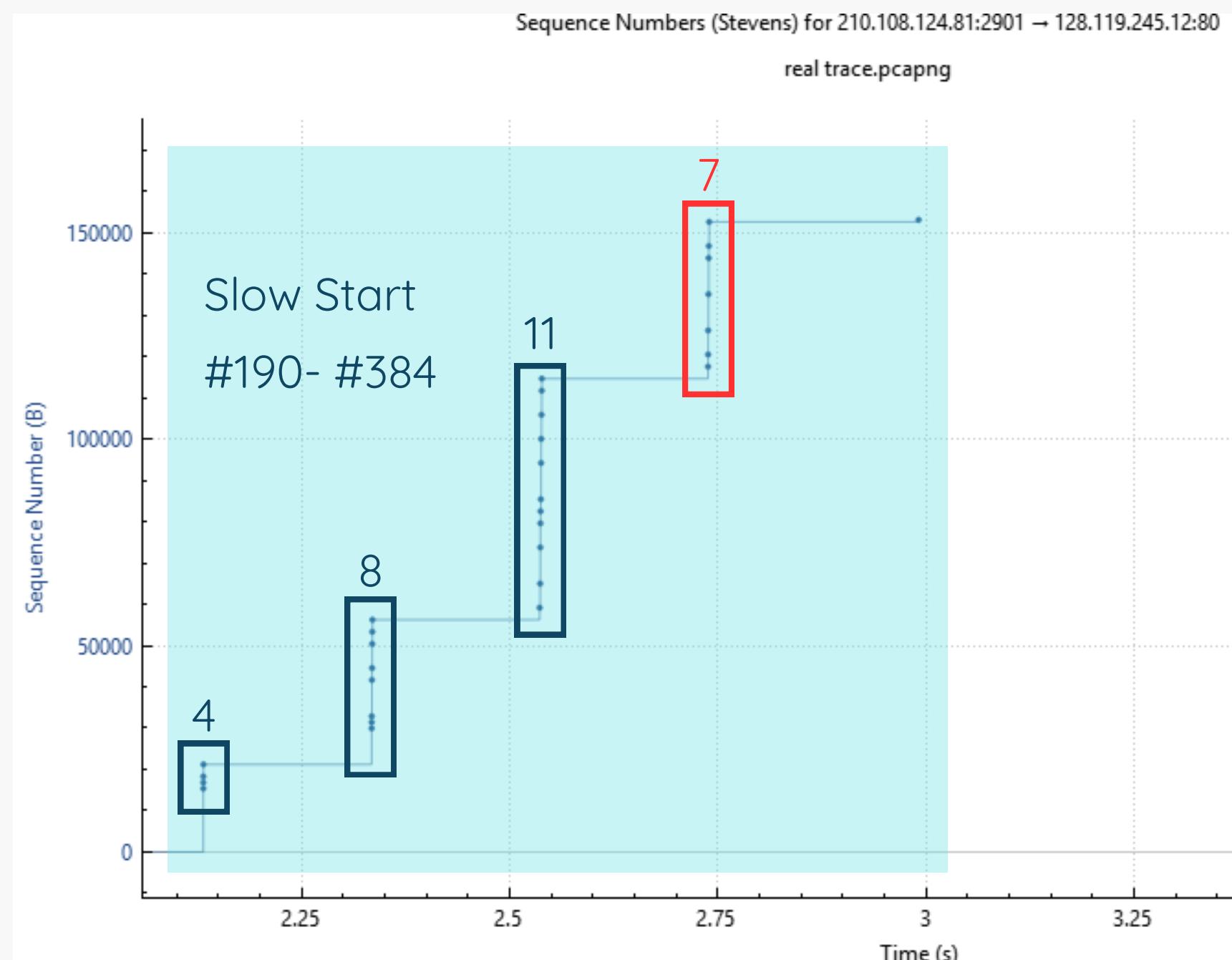


No linear increase of packets in Congestion Avoidance

Problem 14.

Find begin and end point of “TCP Slow Start” and “TCP Congestion Avoidance” (my own trace)

Difference between textbook theory and practical case



Like-exponent increase in Slow Start
→ No exact exponent increase.
“cwnd” is decreased because the message is end.
No room for exponent increase.

Congestion Avoidance is not occurred because data transfer is already ended in slow start phase.



Thank you

