

Assignment 3: Wireshark With TCP

PART-A

Question-1

Source IP Address: 172.19.126.54

Source Port Number: 57526

http							
No.	Time	Time Stamp	Source	Destination	Protocol	Length	Info
155	3.931957840	17:12:17.6337193...	172.19.126.54	128.119.245.12	HTTP	1192	POST /wires
172	4.182524114	17:12:17.8842856...	128.119.245.12	172.19.126.54	HTTP	833	HTTP/1.1 20

```
Frame 155: 1192 bytes on wire (9536 bits), 1192 bytes captured (9536 bits) on interface any, id 0
Linux cooked capture v1
Internet Protocol Version 4, Src: 172.19.126.54, 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: 1176
    Identification: 0x1636 (5686)
  ▶ 010. .... = Flags: 0x2, Don't fragment
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 64
    Protocol: TCP (6)
    Header Checksum: 0x805c [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 172.19.126.54
    Destination Address: 128.119.245.12
Transmission Control Protocol, Src Port: 57526, Dst Port: 80, Seq: 151841, Ack: 1, Len: 1136
  Source Port: 57526
  Destination Port: 80
  [Stream index: 0]
  [Conversation completeness: Incomplete, DATA (15)]
  [TCP Segment Len: 1136]
  Sequence Number: 151841 (relative sequence number)
```

figure 1

Question-2

Destination IP Address: 128.119.245.12

Destination Port Number: 80

Reference: *figure 1*

Question-3

- Sequence Number: 2924159282
- It has set its Flag Field value as 0x0002 [SYN] that sets the SYN Flag bit which will ultimately make it identified as SYN Segment
- Yes, it will allow receiver to selectively acknowledge the out of order packages and specify which segments are missing as it allows SACK, it can be inspected by observing the TCP Options of TCP headers of Packets Exchanged during HandShake i.e. Kind: SACK Permitted (4) as of the current example. [figure 2.2]

No.	Time	Time Stamp	Source	Destination	Protocol	Length	Info
8	2.919843629	17:12:16.6216051...	172.19.126.54	128.119.245.12	TCP	76	57526 → 80 [SYN]
10	3.164974229	17:12:16.8667357...	128.119.245.12	172.19.126.54	TCP	68	80 → 57526 [SYN, ACK]
11	3.165035401	17:12:16.8667969...	172.19.126.54	128.119.245.12	TCP	56	57526 → 80 [ACK]
12	3.165439916	17:12:16.8672014...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
13	3.165456311	17:12:16.8672178...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
14	3.165587773	17:12:16.8673492...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
15	3.165593503	17:12:16.8673550...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
16	3.165736668	17:12:16.8674981...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
17	3.165750668	17:12:16.8675121...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
18	3.165880495	17:12:16.8676420...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
19	3.165887144	17:12:16.8676486...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
20	3.165998327	17:12:16.8677598...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
21	3.166004159	17:12:16.8677656...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
22	3.420139232	17:12:17.1219007...	128.119.245.12	172.19.126.54	TCP	56	80 → 57526 [ACK]
23	3.420202445	17:12:17.1219639...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
24	3.420217821	17:12:17.1219793...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
25	3.420368166	17:12:17.1221296...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
26	3.420375997	17:12:17.1221375...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
27	3.420506283	17:12:17.1222677...	128.119.245.12	172.19.126.54	TCP	56	80 → 57526 [ACK]
28	3.420543114	17:12:17.1223046...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
29	3.420550381	17:12:17.1223118...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]
30	3.420680922	17:12:17.1224424...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [ACK]
31	3.420689152	17:12:17.1224506...	172.19.126.54	128.119.245.12	TCP	1516	57526 → 80 [PSH, ACK]


```

...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 64
Protocol: TCP (6)
Header Checksum: 0x8522 [validation disabled]
[Header checksum status: Unverified]
Source Address: 172.19.126.54
Destination Address: 128.119.245.12
Transmission Control Protocol, Src Port: 57526, Dst Port: 80, Seq: 0, Len: 0
Source Port: 57526
Destination Port: 80
[Stream index: 0]
[Conversation completeness: Incomplete, DATA (15)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 2924159282
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 0
Acknowledgment number (raw): 0
1010 .... = Header Length: 40 bytes (10)
Flags: 0x002 (SYN)
Window: 64240
[Calculated window size: 64240]
Checksum: 0x822c [unverified]

```

Figure 2.1

- ```

Urgent Pointer: 0
Options: (20 bytes), Maximum segment size:
 TCP Option - Maximum segment size: 1
 TCP Option - SACK permitted
 Kind: SACK Permitted (4)
 Length: 2
 TCP Option - Timestamps
 TCP Option - No-Operation (NOP)

```

Figure 2.2

#### Question-4

- a) Sequence Number: 2495720350
- b) Flag: 0x0012 (SYN, ACK)
- c) Acknowledgement Number: 2924159283
- d) As gaia.cs.umass.edu recieved a TCP Connection Request with a Squence Number 2924159282 and Length 0, from that it can understand that the next packet it must expect would be next Byte in Sequence Number. So it sends that as ACK Number.

| No. | Time        | Time Stamp          | Source         | Destination    | Protocol | Length | Info             |
|-----|-------------|---------------------|----------------|----------------|----------|--------|------------------|
| 8   | 2.919843629 | 17:12:16.6216051... | 172.19.126.54  | 128.119.245.12 | TCP      | 76     | 57526 → 80 [SYN] |
| 10  | 3.164974229 | 17:12:16.8667357... | 128.119.245.12 | 172.19.126.54  | TCP      | 68     | 80 → 57526 [SYN, |
| 11  | 3.165035401 | 17:12:16.8667969... | 172.19.126.54  | 128.119.245.12 | TCP      | 56     | 57526 → 80 [ACK] |
| 12  | 3.165439916 | 17:12:16.8672014... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 13  | 3.165456311 | 17:12:16.8672178... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 14  | 3.165587773 | 17:12:16.8673492... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 15  | 3.165593503 | 17:12:16.8673550... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 16  | 3.165736668 | 17:12:16.8674981... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 17  | 3.165750668 | 17:12:16.8675121... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 18  | 3.165880495 | 17:12:16.8676420... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 19  | 3.165887144 | 17:12:16.8676486... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 20  | 3.165998327 | 17:12:16.8677598... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 21  | 3.166004159 | 17:12:16.8677656... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 22  | 3.420139232 | 17:12:17.1219007... | 128.119.245.12 | 172.19.126.54  | TCP      | 56     | 80 → 57526 [ACK] |
| 23  | 3.420202445 | 17:12:17.1219639... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 24  | 3.420217821 | 17:12:17.1219793... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 25  | 3.420368166 | 17:12:17.1221296... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 26  | 3.420375997 | 17:12:17.1221375... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 27  | 3.420506283 | 17:12:17.1222677... | 128.119.245.12 | 172.19.126.54  | TCP      | 56     | 80 → 57526 [ACK] |
| 28  | 3.420543114 | 17:12:17.1223046... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 29  | 3.420550381 | 17:12:17.1223118... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |
| 30  | 3.420680922 | 17:12:17.1224424... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] |
| 31  | 3.420689152 | 17:12:17.1224506... | 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, |

Destination Address: 172.19.126.54

Transmission Control Protocol, Src Port: 80, Dst Port: 57526, Seq: 0, Ack: 1, Len: 0

Source Port: 80

Destination Port: 57526

[Stream index: 0]

[Conversation completeness: Incomplete, DATA (15)]

[TCP Segment Len: 0]

Sequence Number: 0 (relative sequence number)

Sequence Number (raw): 2495720350

[Next Sequence Number: 1 (relative sequence number)]

Acknowledgment Number: 1 (relative ack number)

Acknowledgment number (raw): 2924159283

1000 .... = Header Length: 32 bytes (8)

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

Figure 3

#### Question-5

- a) Sequence Number: 2924311123
- b) Payload: 1136
- c) The size of file is 152.1 kB (1,52,138 bytes) which is much less then tha TCP Payload so all the data of the transferred file can't sit and fit into a single TCP packet.

```

Destination Address: 172.19.126.54
Transmission Control Protocol, Src Port: 57526, Dst Port: 80, Seq: 151841, Ack: 1, Len: 1136
Source Port: 57526
Destination Port: 80
[Stream index: 0]
[Conversation completeness: Incomplete, DATA (15)]
[TCP Segment Len: 1136]
Sequence Number: 151841 (relative sequence number)
Sequence Number (raw): 2924311123
[Next Sequence Number: 152977 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 2495720351
0101 = Header Length: 20 bytes (5)

```

Figure 4

### Question-6

- 17:12:16.867201424 (or) 3.165439916 (s) after the TCP SYN Segment was sent [figure 6.1]
- 17:12:17.121900740 [figure 6.2]
- It Actually didn't Recieved ACK for the First Packet sent [figure 6.2]
- RTT for this Second data-containing segment: 0.254682921 (s)
- As I didn't recieved ACK for the First Packet, considering results of my friend's wireshark capture. He got the following result:

RTT for this first data-containing segment is **0.000705242** seconds.

RTT value of the second data-carrying TCP segment and its ACK is **0.003076674** seconds.

Estimated RTT after the ACK for the second data-carrying segment is received is **0.001001671** seconds

|                |                    |                |                |     |                                                                                                 |
|----------------|--------------------|----------------|----------------|-----|-------------------------------------------------------------------------------------------------|
| 10 3.164974229 | 17:12:16.866735737 | 128.119.245.12 | 172.19.126.54  | TCP | 68 80 → 57526 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM WS=128                  |
| 11 3.165035401 | 17:12:16.866796909 | 172.19.126.54  | 128.119.245.12 | TCP | 56 57526 → 80 [ACK] Seq=1 Ack=1 Win=64256 Len=0                                                 |
| 12 3.165439916 | 17:12:16.867201424 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 → 80 [ACK] Seq=1 Ack=1 Win=64256 Len=1460 [TCP segment of a reassembled PDU]         |
| 13 3.165456311 | 17:12:16.867217819 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 → 80 [PSH, ACK] Seq=1461 Ack=1 Win=64256 Len=1460 [TCP segment of a reassembled PDU] |

figure 6.1

|                |                    |                |                |     |            |
|----------------|--------------------|----------------|----------------|-----|------------|
| 12 3.165439916 | 17:12:16.867201424 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 13 3.165456311 | 17:12:16.867217819 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 14 3.165587773 | 17:12:16.867349281 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 15 3.165593503 | 17:12:16.867355011 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 16 3.165736668 | 17:12:16.867498176 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 17 3.165750668 | 17:12:16.867512176 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 18 3.165880495 | 17:12:16.867642003 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 19 3.165887144 | 17:12:16.867648652 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 20 3.165998327 | 17:12:16.867759835 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 21 3.166004159 | 17:12:16.867765667 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 22 3.420139232 | 17:12:17.121900740 | 128.119.245.12 | 172.19.126.54  | TCP | 56 80 → 5  |
| 23 3.420202445 | 17:12:17.121963953 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 24 3.420217821 | 17:12:17.121979329 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 25 3.420368166 | 17:12:17.122129674 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 26 3.420375997 | 17:12:17.122137505 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 27 3.420506283 | 17:12:17.122267791 | 128.119.245.12 | 172.19.126.54  | TCP | 56 80 → 5  |
| 28 3.420543114 | 17:12:17.122304622 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 29 3.420550381 | 17:12:17.122311889 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 30 3.420680922 | 17:12:17.122442430 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |
| 31 3.420689152 | 17:12:17.122450660 | 172.19.126.54  | 128.119.245.12 | TCP | 1516 57526 |

```

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....]
Window: 274
[Calculated window size: 35072]
[Window size scaling factor: 128]
Checksum: 0x12a6 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
- [Timestamps]
- [SEQ/ACK analysis]
 [This is an ACK to the segment in frame: 13]
 [The RTT to ACK the segment was: 0.254682921 seconds]
 [iRTT: 0.245191772 seconds]

```

figure 6.2

### Question-7

Each one of four has Total: 1480 (Talking just at TCP Level)

| Source         | Destination    | Protocol | Length | Info                                                       |
|----------------|----------------|----------|--------|------------------------------------------------------------|
| 172.19.126.54  | 128.119.245.12 | TCP      | 76     | 57526 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM  |
| 128.119.245.12 | 172.19.126.54  | TCP      | 68     | 80 → 57526 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 |
| 172.19.126.54  | 128.119.245.12 | TCP      | 56     | 57526 → 80 [ACK] Seq=1 Ack=1 Win=64256 Len=0               |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=1 Ack=1 Win=64256 Len=1460 [TCP segme |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=1461 Ack=1 Win=64256 Len=1460 [T |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=2921 Ack=1 Win=64256 Len=1460 [TCP se |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=4381 Ack=1 Win=64256 Len=1460 [T |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=5841 Ack=1 Win=64256 Len=1460 [TCP se |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=7301 Ack=1 Win=64256 Len=1460 [T |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=8761 Ack=1 Win=64256 Len=1460 [TCP se |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=10221 Ack=1 Win=64256 Len=1460 [ |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=11681 Ack=1 Win=64256 Len=1460 [TCP s |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=13141 Ack=1 Win=64256 Len=1460 [ |
| 128.119.245.12 | 172.19.126.54  | TCP      | 56     | 80 → 57526 [ACK] Seq=1 Ack=2921 Win=35072 Len=0            |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=14601 Ack=1 Win=64256 Len=1460 [TCP s |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=16061 Ack=1 Win=64256 Len=1460 [ |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=17521 Ack=1 Win=64256 Len=1460 [TCP s |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=18981 Ack=1 Win=64256 Len=1460 [ |
| 128.119.245.12 | 172.19.126.54  | TCP      | 56     | 80 → 57526 [ACK] Seq=1 Ack=5841 Win=40960 Len=0            |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=20441 Ack=1 Win=64256 Len=1460 [TCP s |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=21901 Ack=1 Win=64256 Len=1460 [ |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [ACK] Seq=23361 Ack=1 Win=64256 Len=1460 [TCP s |
| 172.19.126.54  | 128.119.245.12 | TCP      | 1516   | 57526 → 80 [PSH, ACK] Seq=24821 Ack=1 Win=64256 Len=1460 [ |

figure 7

### Question-8

- Window: 275 with Scaling Factor: 128
- No it won't throttle the sender for the first five data carrying segment as the buffer space is not sufficiently small (e.g., is not close to zero or significantly smaller than the sender's congestion window)

```

[TCP Flags:A....]
Window: 274
[Calculated window size: 35072]
[Window size scaling factor: 128]
Checksum: 0x12a6 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
- [Timestamps]

```

figure 8



### Question-9

Its same accross all the Data Carrying Packets, Window: 502, with Window Scaling Factor: 128. It is the case because the sender is not receiving and payload packets from the reciever, its only being acknowledged for the packets its has send. So there won't be any case of throttling or congestion at sender by reciever as recievers ACK packets are of length 0.

```
[TCP Flags:AP...]
Window: 502
[Calculated window size: 64256]
[Window size scaling factor: 128]
Checksum: 0x9d26 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
▶ [Timestamps]
```

*figure 9*

### Question-10

No there aren't any retransmitted segments in the trace file. For this conclusion I observed for non-duplicacy of acknowledge number in the TCP-ACK Packets from the reciever.

### Question-11

- a) For the First 10 data-carrying Segemnts it Acknowledged 5 packets where the bytes acknowledged are 2920,1460,1460,1460 giving an average of 1752 bytes
- b) No, as it showed comulativce acknowldegements

|    |             |                    |                |                |
|----|-------------|--------------------|----------------|----------------|
| 11 | 3.165035401 | 17:12:16.866796909 | 172.19.126.54  | 128.119.245.12 |
| 12 | 3.165439916 | 17:12:16.867201424 | 172.19.126.54  | 128.119.245.12 |
| 13 | 3.165456311 | 17:12:16.867217819 | 172.19.126.54  | 128.119.245.12 |
| 14 | 3.165587773 | 17:12:16.867349281 | 172.19.126.54  | 128.119.245.12 |
| 15 | 3.165593503 | 17:12:16.867355011 | 172.19.126.54  | 128.119.245.12 |
| 16 | 3.165736668 | 17:12:16.867498176 | 172.19.126.54  | 128.119.245.12 |
| 17 | 3.165750668 | 17:12:16.867512176 | 172.19.126.54  | 128.119.245.12 |
| 18 | 3.165880495 | 17:12:16.867642003 | 172.19.126.54  | 128.119.245.12 |
| 19 | 3.165887144 | 17:12:16.867648652 | 172.19.126.54  | 128.119.245.12 |
| 20 | 3.165998327 | 17:12:16.867759835 | 172.19.126.54  | 128.119.245.12 |
| 21 | 3.166004159 | 17:12:16.867765667 | 172.19.126.54  | 128.119.245.12 |
| 22 | 3.420139232 | 17:12:17.121900740 | 128.119.245.12 | 172.19.126.54  |
| 23 | 3.420202445 | 17:12:17.121963953 | 172.19.126.54  | 128.119.245.12 |
| 24 | 3.420217821 | 17:12:17.121979329 | 172.19.126.54  | 128.119.245.12 |
| 25 | 3.420368166 | 17:12:17.122129674 | 172.19.126.54  | 128.119.245.12 |
| 26 | 3.420375997 | 17:12:17.122137505 | 172.19.126.54  | 128.119.245.12 |
| 27 | 3.420506283 | 17:12:17.122267791 | 128.119.245.12 | 172.19.126.54  |
| 28 | 3.420543114 | 17:12:17.122304622 | 172.19.126.54  | 128.119.245.12 |
| 29 | 3.420550381 | 17:12:17.122311889 | 172.19.126.54  | 128.119.245.12 |
| 30 | 3.420680922 | 17:12:17.122442430 | 172.19.126.54  | 128.119.245.12 |
| 31 | 3.420689152 | 17:12:17.122450660 | 172.19.126.54  | 128.119.245.12 |

```

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....]
Window: 274
[Calculated window size: 35072]
[Window size scaling factor: 128]
Checksum: 0x12a6 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
► [Timestamps]
▼ [SEQ/ACK analysis]
 [This is an ACK to the segment in frame: 13]
 [The RTT to ACK the segment was: 0.254682921 seconds]
 [iRTT: 0.245191772 seconds]

```

figure 11: Its the first ACK from the reciever and its showing comutativeness which can be observed from its ACK feild which shows that the reciever is expecting packet 3

## Question-12

Total Message Size: 1,52,138 Bytes

First Packet Time-Stamp: 2.919843629...(a)

Last Packet Time-Stamp: 4.182574266...(b)

Throughput = Transfer Size/ Transfer Time  
 = 1,52,138/((b)-(a))  
 = 1,52,138/1.262730637  
 = **120483.336304764 bytes/sec**

|     | Time        | Time Stamp         | Source         | Destination    |
|-----|-------------|--------------------|----------------|----------------|
| 8   | 2.919843629 | 17:12:16.621605137 | 172.19.126.54  | 128.119.245.12 |
| 10  | 3.164974229 | 17:12:16.866735737 | 128.119.245.12 | 172.19.126.54  |
| 11  | 3.165035401 | 17:12:16.866796909 | 172.19.126.54  | 128.119.245.12 |
| 170 | 4.179798151 | 17:12:17.881559659 | 128.119.245.12 | 172.19.126.54  |
| 171 | 4.179798232 | 17:12:17.881559740 | 128.119.245.12 | 172.19.126.54  |
| 172 | 4.182524114 | 17:12:17.884285622 | 128.119.245.12 | 172.19.126.54  |
| 173 | 4.182574266 | 17:12:17.884335774 | 172.19.126.54  | 128.119.245.12 |

figure 12

## PART-B

### Question-1

Source IP Address: 172.19.126.253

Source Port Number: 54570

```
[Header checksum status: Unverified]
Source Address: 172.19.126.253
Destination Address: 35.185.44.232
Transmission Control Protocol, Src Port: 54570, Dst Port: 443, Seq: 1, Ack: 1, Len:
Source Port: 54570
Destination Port: 443
[Stream index: 0]
[Conversation completeness: Incomplete DATA (15)]
```

*figure 1*

### Question-2

Destination IP Address: 35.185.44.232

Destination Port Number: 443

Reference: *figure 1*

### Question-3

- a) Sequence Number: 2833411430 [*figure 2.2*]
- b) It has set its Flag Field value as 0x0002 [SYN] that sets the SYN Flag bit which will ultimately make it identified as SYN Segment [*figure 2.2*]
- c) Yes, it will allow receiver to selectively acknowledge the out of order packages and specify which segments are missing as it allows SACK, it can be inspected by observing the TCP Options of TCP headers of Packets Exchanged during HandShake i.e. Kind: SACK Permitted (4) as of the current example. [*figure 2.1*]

|    |             |                    |                |                |
|----|-------------|--------------------|----------------|----------------|
| 34 | 3.210988927 | 17:13:37.262092745 | 172.19.126.253 | 35.185.44.232  |
| 35 | 3.217414099 | 17:13:37.268517917 | 35.185.44.232  | 172.19.126.253 |
| 36 | 3.217463004 | 17:13:37.268566822 | 172.19.126.253 | 35.185.44.232  |
| 37 | 3.219711472 | 17:13:37.270815290 | 172.19.126.253 | 35.185.44.232  |
| 38 | 3.226177204 | 17:13:37.277281022 | 172.19.126.253 | 35.185.44.232  |
| 39 | 3.459231175 | 17:13:37.510334993 | 35.185.44.232  | 172.19.126.253 |

  

|                                    |                                               |  |  |  |
|------------------------------------|-----------------------------------------------|--|--|--|
| Wireshark · Packet 35 · Assignment |                                               |  |  |  |
| ▶                                  | TCP Option - Maximum segment size: 1420 bytes |  |  |  |
| ▼                                  | TCP Option - SACK permitted                   |  |  |  |
|                                    | Kind: SACK Permitted (4)                      |  |  |  |
|                                    | Length: 2                                     |  |  |  |
| ▼                                  | TCP Option - Timestamps                       |  |  |  |
|                                    | Kind: Time Stamp Option (8)                   |  |  |  |

*figure 2.2 IITH@CSE to Host*



| Io. | Time        | Time Stamp         | Source         | Destination    |
|-----|-------------|--------------------|----------------|----------------|
| 30  | 2.931354203 | 17:13:36.982458021 | 172.19.126.253 | 35.185.44.232  |
| 31  | 2.932244729 | 17:13:36.983348547 | 172.19.126.253 | 35.185.44.232  |
| 32  | 3.182827243 | 17:13:37.233931061 | 172.19.126.253 | 35.185.44.232  |
| 33  | 3.210923202 | 17:13:37.262027020 | 35.185.44.232  | 172.19.126.253 |
| 34  | 3.210988927 | 17:13:37.262092745 | 172.19.126.253 | 35.185.44.232  |
| 35  | 3.217414099 | 17:13:37.268517917 | 35.185.44.232  | 172.19.126.253 |
| 36  | 3.217463004 | 17:13:37.268566822 | 172.19.126.253 | 35.185.44.232  |
| 37  | 3.219711472 | 17:13:37.270815290 | 172.19.126.253 | 35.185.44.232  |
| 38  | 3.226177204 | 17:13:37.277281022 | 172.19.126.253 | 35.185.44.232  |
| 39  | 3.459231175 | 17:13:37.510334993 | 35.185.44.232  | 172.19.126.253 |

Source Port: 54570

Destination Port: 443

[Stream index: 0]

[Conversation completeness: Incomplete, DATA (15)]

[TCP Segment Len: 0]

Sequence Number: 0 (relative sequence number)

Sequence Number (raw): 2833411430

[Next Sequence Number: 1 (relative sequence number)]

Acknowledgment Number: 0

Acknowledgment number (raw): 0

1010 .... = Header Length: 40 bytes (10)

#### 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.]

Window: 64240

[Calculated window size: 64240]

Checksum: 0xcaa8 [unverified]

[Checksum Status: Unverified]

Urgent Pointer: 0

#### Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (

▸ TCP Option - Maximum segment size: 1460 bytes

▾ TCP Option - SACK permitted

Kind: SACK Permitted (4)

Length: 2

figure 2.2 Host to [IIT@CSE](mailto:IIT@CSE)

### Question-4

a) Sequence Number: 1186615147

b) Flag: 0x0012 (SYN, ACK)

c) Acknowledgement Number: 2833411431

d) As gaia.cs.umass.edu recieved a TCP Connection Request with a Squence Number 2833411430 and Length 0, from that it can understand that the next packet it must expect would be next Byte in Sequence Number. So it sends that as ACK Number.

|    |             |                    |                |                |         |                  |            |
|----|-------------|--------------------|----------------|----------------|---------|------------------|------------|
| 33 | 3.210923202 | 17:13:37.262027020 | 35.185.44.232  | 172.19.126.253 | TCP     | 76 443 → 54570   | [SYN, ACK] |
| 34 | 3.210988927 | 17:13:37.262092745 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443   | [ACK] Seq= |
| 35 | 3.217414099 | 17:13:37.268517917 | 35.185.44.232  | 172.19.126.253 | TCP     | 76 443 → 54578   | [SYN, ACK] |
| 36 | 3.217463004 | 17:13:37.268566822 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54578 → 443   | [ACK] Seq= |
| 37 | 3.219711472 | 17:13:37.270815290 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 730 Client Hello |            |
| 38 | 3.226177204 | 17:13:37.277281022 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 730 Client Hello |            |
| 39 | 3.459231175 | 17:13:37.510334993 | 35.185.44.232  | 172.19.126.253 | TCP     | 76 443 → 54582   | [SYN, ACK] |

  

|                                                                                       |  |      |          |
|---------------------------------------------------------------------------------------|--|------|----------|
| Destination Address: 172.19.126.253                                                   |  | 0000 | 00 00 00 |
| Transmission Control Protocol, Src Port: 443, Dst Port: 54570, Seq: 0, Ack: 1, Len: 0 |  | 0010 | 45 00 00 |
| Source Port: 443                                                                      |  | 0020 | ac 13 7e |
| Destination Port: 54570                                                               |  | 0030 | a0 12 fd |
| [Stream index: 0]                                                                     |  | 0040 | a1 25 5c |
| [Conversation completeness: Incomplete, DATA (15)]                                    |  |      |          |
| [TCP Segment Len: 0]                                                                  |  |      |          |
| Sequence Number: 0 (relative sequence number)                                         |  |      |          |
| Sequence Number (raw): 1186615147                                                     |  |      |          |
| [Next Sequence Number: 1 (relative sequence number)]                                  |  |      |          |
| Acknowledgment Number: 1 (relative ack number)                                        |  |      |          |
| Acknowledgment number (raw): 2833411431                                               |  |      |          |
| 1010 .... = Header Length: 40 bytes (10)                                              |  |      |          |
| 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.]                                                               |  |      |          |

Figure 4

## Question-5

- Sequence Number: 1186615148
- Payload: 5168
- No, in this case if considering Web Objects from [IITH@CSE](#)

S

|     |             |                    |                |                |         |                                                           |  |
|-----|-------------|--------------------|----------------|----------------|---------|-----------------------------------------------------------|--|
| 44  | 3.517223644 | 17:13:37.568327462 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 5236 Server Hello, Change Cipher Spec, Application Data   |  |
| 45  | 3.517279575 | 17:13:37.568383393 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443 [ACK] Seq=663 Ack=5169 Win=61696 Len=0     |  |
| 63  | 3.570983812 | 17:13:37.622087630 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 1476 Server Hello, Change Cipher Spec, Application Data   |  |
| 64  | 3.571020856 | 17:13:37.622124674 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54578 → 443 [ACK] Seq=663 Ack=1409 Win=64128 Len=0     |  |
| 65  | 3.571398588 | 17:13:37.622502406 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 3828 Application Data, Application Data, Application Data |  |
| 66  | 3.571424488 | 17:13:37.622528306 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54578 → 443 [ACK] Seq=663 Ack=5169 Win=61568 Len=0     |  |
| 82  | 3.744618759 | 17:13:37.795722577 | 35.185.44.232  | 172.19.126.253 | TCP     | 68 443 → 54582 [ACK] Seq=1 Ack=663 Win=64512 Len=0 TS     |  |
| 83  | 3.761234894 | 17:13:37.812338712 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 2884 Server Hello, Change Cipher Spec, Application Data   |  |
| 84  | 3.761275529 | 17:13:37.812379347 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54582 → 443 [ACK] Seq=663 Ack=2817 Win=63488 Len=0     |  |
| 85  | 3.762224490 | 17:13:37.813328308 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 2420 Application Data, Application Data, Application Data |  |
| 86  | 3.762262075 | 17:13:37.813365893 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54582 → 443 [ACK] Seq=663 Ack=5169 Win=61568 Len=0     |  |
| 102 | 3.821511424 | 17:13:37.872615242 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 132 Change Cipher Spec, Application Data                  |  |
| 103 | 3.822582710 | 17:13:37.873686528 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 238 Application Data                                      |  |
| 104 | 3.822616231 | 17:13:37.873729049 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 499 Application Data                                      |  |
| 107 | 3.838996447 | 17:13:37.890100265 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 132 Change Cipher Spec, Application Data                  |  |
| 108 | 3.839274220 | 17:13:37.890428057 | 172.19.126.253 | 35.185.44.232  | TLSv1.3 | 255 Application Data                                      |  |

  

|                                                                                                    |  |      |                                     |
|----------------------------------------------------------------------------------------------------|--|------|-------------------------------------|
| Frame 44: 5236 bytes on wire (41888 bits), 5236 bytes captured (41888 bits) on interface any, id 0 |  | 0020 | ac 13 7e fd 01 bb d5 2a 46 ba 4f 6c |
| Linux cooked capture v1                                                                            |  | 0030 | 80 18 00 7e 90 08 00 00 01 01 08 0a |
| Internet Protocol Version 4, Src: 35.185.44.232, Dst: 172.19.126.253                               |  | 0040 | 82 90 08 15 16 03 03 00 7a 02 00 00 |
| Transmission Control Protocol, Src Port: 443, Dst Port: 54570, Seq: 1, Ack: 663, Len: 5168         |  | 0050 | dc a2 4a 40 ce 8f f8 30 71 17 79 10 |
| Source Port: 443                                                                                   |  | 0060 | 64 03 00 6b 21 01 3a 48 27 96 43 89 |
| Destination Port: 54570                                                                            |  | 0070 | be 57 7b 5a 2f 78 cb 7e e4 2f d7 0b |
| [Stream index: 0]                                                                                  |  | 0080 | bf 23 82 9d 26 3a 63 3c 72 d3 a0 78 |
| [Conversation completeness: Incomplete, DATA (15)]                                                 |  | 0090 | 13 01 00 00 2e 00 2b 00 02 03 04 00 |
| [TCP Segment Len: 5168]                                                                            |  | 00a0 | 1d 00 20 cb 77 2f 98 36 cb 60 9c 31 |
| Sequence Number: 1 (relative sequence number)                                                      |  | 00b0 | c9 bf c6 f9 50 d5 1e 1f 3e 6c 37 a4 |
| Sequence Number (raw): 1186615148                                                                  |  | 00c0 | 66 52 1c 14 03 03 00 01 01 17 03 03 |
| [Next Sequence Number: 5169 (relative sequence number)]                                            |  | 00d0 | ed 6d 92 e6 29 84 fb 4d 56 80 ba 83 |
| Acknowledgment Number: 663 (relative ack number)                                                   |  | 00e0 | c9 e6 41 7f 4e 91 e0 d3 f0 1f 49 6b |
| Acknowledgment number (raw): 2833412093                                                            |  | 00f0 | 03 10 91 c1 b6 d3 58 69 91 ce 32 40 |
| 1000 .... = Header Length: 32 bytes (8)                                                            |  | 0100 | 47 08 2c b8 54 87 d9 7b 15 9a 7e b2 |
| Flags: 0x018 (PSH, ACK)                                                                            |  | 0110 | 1d d8 bb c0 05 73 75 bf 5e ed 26 dc |
| 000. .... = Reserved: Not set                                                                      |  | 0120 | 0f 3a f9 cd f4 70 75 64 e3 03 92 4f |
| ...0 .... = Accurate ECN: Not set                                                                  |  | 0130 | d1 9f 0b 4f 43 a0 be b3 b6 b8 56 c8 |
|                                                                                                    |  | 0140 | 5f eb a1 98 7d 99 86 ca 21 12 c9 47 |

figure 5

## Question-6

- 17:13:38.208885094 (or) 4.157781276 (s) after the TCP SYN Segment was sent
- 17:13:38.208897969
- 0.000012875

d) Here for the second packet my host didn't sent the ACK to [IITH@CSE](mailto:IITH@CSE) rather it was a comutative in ACK of Packet 3. So due to this insufficient data I won't be able to calculate EstimatedRRT.

|                 |                    |                |                |         |                                                                        |
|-----------------|--------------------|----------------|----------------|---------|------------------------------------------------------------------------|
| 131 4.157499249 | 17:13:38.208803058 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 298 Application Data                                                   |
| 132 4.157781276 | 17:13:38.208885094 | 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=5526 Ack=1328 Win=64512 Len=1408 TSval=1328 |
| 133 4.157794151 | 17:13:38.208897969 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443 [ACK] Seq=1359 Ack=6934 Win=64128 Len=0 TSval=1328      |
| 134 4.157917135 | 17:13:38.209020953 | 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=6934 Ack=1328 Win=64512 Len=1408 TSval=1328 |
| 135 4.167545397 | 17:13:38.218649215 | 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=8342 Ack=1328 Win=64512 Len=1408 TSval=1328 |
| 136 4.167562491 | 17:13:38.218666309 | 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443 [ACK] Seq=1359 Ack=9750 Win=64128 Len=0 TSval=1328      |
| 137 4.177202015 | 17:13:38.228305833 | 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=9750 Ack=1328 Win=64512 Len=1408 TSval=1328 |
| 138 4.182532879 | 17:13:38.233636697 | 35.185.44.232  | 172.19.126.253 | TCP     | 68 443 → 54578 [ACK] Seq=5169 Ack=727 Win=64512 Len=0 TSval=1328       |
| 139 4.183321165 | 17:13:38.234424983 | 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 129 Application Data                                                   |

figure 6.1

### Question-7

Each one of four has Total: 1408 (Talking just at TCP Level)

|                |                |         |                                                                         |
|----------------|----------------|---------|-------------------------------------------------------------------------|
| 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=5526 Ack=1328 Win=64512 Len=1408 TSval=1328  |
| 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443 [ACK] Seq=1359 Ack=6934 Win=64128 Len=0 TSval=1328       |
| 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=6934 Ack=1328 Win=64512 Len=1408 TSval=1328  |
| 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=8342 Ack=1328 Win=64512 Len=1408 TSval=1328  |
| 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443 [ACK] Seq=1359 Ack=9750 Win=64128 Len=0 TSval=1328       |
| 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=9750 Ack=1328 Win=64512 Len=1408 TSval=1328  |
| 35.185.44.232  | 172.19.126.253 | TCP     | 68 443 → 54578 [ACK] Seq=5169 Ack=727 Win=64512 Len=0 TSval=1328        |
| 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 129 Application Data                                                    |
| 172.19.126.253 | 35.185.44.232  | TCP     | 56 54578 → 443 [RST] Seq=727 Win=0 Len=0                                |
| 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 173 Application Data, Application Data, Application Data                |
| 172.19.126.253 | 35.185.44.232  | TCP     | 56 54578 → 443 [RST] Seq=914 Win=0 Len=0                                |
| 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 1476 Application Data                                                   |
| 172.19.126.253 | 35.185.44.232  | TCP     | 68 54570 → 443 [ACK] Seq=1359 Ack=12566 Win=64128 Len=0 TSval=1328      |
| 35.185.44.232  | 172.19.126.253 | TLSv1.3 | 92 Application Data                                                     |
| 172.19.126.253 | 35.185.44.232  | TCP     | 56 54578 → 443 [RST] Seq=939 Win=0 Len=0                                |
| 35.185.44.232  | 172.19.126.253 | TCP     | 1476 443 → 54570 [ACK] Seq=12566 Ack=1328 Win=64512 Len=1408 TSval=1328 |

figure 7

### Question-8

a) Window: 501 with Scaling Factor: 128

b) No it won't throttle the sender for the first five data carrying segment as the *buffer space is not sufficiently small (e.g., is not close to zero or significantly smaller than the sender's congestion window)*

```

.....
[TCP Flags:A....]
Window: 501
[Calculated window size: 64128]
[Window size scaling factor: 128]
Checksum: 0x3570 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0

```

figure 8

### Question-9

Its same accross all the Data Carrying Packets, Window: 502, with Window Scaling Factor: 128. It is the case because the server is not receiving and payload packets from the sender, its only being acknowledged for the packets its has send. So there won't be any case of throttling or congestion at sender by reciever as recievers ACK packets are of length 0.

```

... ..
[TCP Flags:A....]
Window: 126
[Calculated window size: 64512]
[Window size scaling factor: 512]
Checksum: 0x6cb0 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0

```

*figure 9*

### **Question-10**

No there aren't any retransmitted segments in the trace file. For this conclusion I observed for non-duplicacy of acknowledge number in the TCP-ACK Packets from the receiver.

### **Question-11**

- a) 1408 Bytes, tho some were cumulative ACK
- b) No, as it showed cumulative acknowledgements

### **Question-12**

Throughput = Transfer size / Transfer Time

Transfer size = Sequence Number of Last Data carrying segment + Its Length – Sequence Number of First Data Carrying segment  
 $= 1217808 + 2186 - 5526$   
 $= 1214468 \text{ Bytes}$

First Packet Time-Stamp: 2.931354203...(a)  
 Last Packet Time-Stamp: 7.002261345...(b)  
 Transfer Time = (b) – (a)  
 $= 4.070907142 \text{ (s)}$

So,

Throughput =  $1214468 / 4.070907142$   
 $= 298328.593022965 \text{ bytes/sec}$