

# CS-315 Computer Networks Lab-5 (TCP)

## **PART-2**

1434	20:55:17.072434	192.168.0.194	128.119.245.12	HTTP	1995 POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
1443	20:55:17.333281	128.119.245.12	192.168.0.194	HTTP	831 HTTP/1.1 200 OK (text/html)

```
Transmission Control Protocol, Src Port: 51133, Dst Port: 80, Seq: 15110
  Source Port: 51133
  Destination Port: 80
  [Stream index: 67]
  > [Conversation completeness: Incomplete (30)]
  [TCP Segment Len: 1941]
  Sequence Number: 151102 (relative sequence number)
  Sequence Number (raw): 3589631583
  [Next Sequence Number: 153043 (relative sequence number)]
  Acknowledgment Number: 1 (relative ack number)
  Acknowledgment number (raw): 480144611
  0101 .... = Header Length: 20 bytes (5)
```

1. Source IP address = 192.168.0.194  
TCP Port Number = 51133
2. Gaia.cs.umass.edu IP address = 128.119.245.112  
TCP Port Number = 80

## **PART-3**

1065	20:55:09.743236	192.168.0.194	128.119.245.12	TCP	66 [51165 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM
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Transmission Control Protocol, Src Port: 51165, Dst Port: 80, Seq: 0, Le
  Source Port: 51165
  Destination Port: 80
  [Stream index: 53]
  > [Conversation completeness: Incomplete, ESTABLISHED (7)]
  [TCP Segment Len: 0]
  Sequence Number: 0 (relative sequence number)
  Sequence Number (raw): 3654052047
  [Next Sequence Number: 1 (relative sequence number)]
  Acknowledgment Number: 0
  Acknowledgment number (raw): 0
  1000 .... = Header Length: 32 bytes (8)
  > Flags: 0x002 (SYN)
```

1. Sequence number of TCP SYN segment = 0(Relative) and 3654052047(raw).

The segment that identifies the segment as SYN is the SYN flag(0x002), as we can see from the screenshot above.

2. Sequence number of TCP SYNACK segment = 0(Relative) and 2783335425(raw).

The flags segment contains the SYN and ACK flags (0x012 – set to 1) which identify the TCP packet(from the screenshot) as the SYNACK.

```
Transmission Control Protocol, Src Port: 80, Dst Port: 51165, Seq: 0, Ac
Source Port: 80
Destination Port: 51165
[Stream index: 53]
> [Conversation completeness: Incomplete, ESTABLISHED (7)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 2783335425
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 3654052048
1000 .... = Header Length: 32 bytes (8)
> Flags: 0x012 (SYN, ACK)
Window: 29200
[Calculated window size: 29200]
Checksum: 0xc14f [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
```

Value of acknowledgement field = 1(relative) and 3654052048(raw).

By adding 1 to the initial sequence number of the SYN segment from the client computer, gaia.cs.umass.edu calculates the value of the Acknowledgement field in the SYNACK segment.

3. Sequence Number = 1(Relative) and 3589480482(raw).

TCP Payload contains 721 bytes of data.

No, all of the data in the transferred file alice.txt did not fit into this single segment. There are a total of 55 segments.

4. (i) Time = 7<sup>th</sup> Feb, 2024 20:55:14.415125 IST

```
1274 20:55:14.415125 192.168.0.194 128.119.245.12 TCP 775 51133 → 80 [PSH, ACK] Seq=1 Ack=1 Win=513 Len=721 [TCP segment of a reassembled PDU]
```

- (ii) Time = 7<sup>th</sup> Feb, 2024 20:55:14.699291 IST

1293 20:55:14.699291 128.119.245.12 192.168.0.194 TCP 54: 80 → 51133 [ACK] Seq=1 Ack=722 Win=30720 Len=0

1274 20:55:14.415125 192.168.0.194 128.119.245.12 TCP 775 [51133 → 80 [PSH, ACK] Seq=1 Ack=1 Win=513 Len=721 [TCP segment of a reassembled PDU]

Sequence Number: 1 (relative sequence number)  
Sequence Number (raw): 3589480482  
[Next Sequence Number: 722 (relative sequence number)]  
Acknowledgment Number: 1 (relative ack number)  
Acknowledgment number (raw): 480144611  
0101 .... = Header Length: 20 bytes (5)  
> Flags: 0x018 (PSH, ACK)  
Window: 513  
[Calculated window size: 513]  
[Window size scaling factor: -1 (unknown)]  
Checksum: 0x39da [unverified]  
[Checksum Status: Unverified]  
Urgent Pointer: 0  
✓ [Timestamps]  
[Time since first frame in this TCP stream: 3.180880000 seconds]  
[Time since previous frame in this TCP stream: 3.180818000 seconds]  
✓ [SEQ/ACK analysis]  
[Bytes in flight: 721]  
[Bytes sent since last PSH flag: 721]  
TCP payload (721 bytes)  
[Reassembled PDU in frame: 1434]  
TCP segment data (721 bytes)

0000 e0 1c fc ed 68 1e 20 c1 9b 1f 79 8a 08 00 45 00 ....h...y...E  
0010 02 f9 ee 10 40 00 00 06 00 00 c0 a8 00 c2 80 77 ....@.....w  
0020 f5 0c c7 bd 00 50 d5 f3 20 22 1c 9e 6c e3 50 18 ....P...".I.P  
0030 02 01 39 da 00 00 50 4f 53 54 20 2f 77 69 72 65 ..9...PO ST /wire  
0040 73 68 61 72 6b 2d 6c 61 62 73 2f 6c 61 62 33 2d shark-la bs/lab3-  
0050 31 2d 72 65 70 6c 79 2e 68 74 6d 20 48 54 54 50 1-reply. htm HTTP  
0060 2f 31 2e 31 0d 0a 48 6f 73 74 3a 20 67 61 69 61 /1.1..Ho st: gaia  
0070 2e 63 73 2e 75 6d 61 73 73 2e 65 64 75 0d 0a 43 .cs.umas s.edu..C  
0080 6f 6e 6e 65 63 74 69 6f 6a 3a 20 6b 65 65 70 2d connectio n: keep  
0090 61 6c 69 76 65 0d 0a 43 6f 6e 74 65 6e 74 2d 4c alive..C ontent-L  
00a0 65 6e 67 74 68 3a 20 31 35 32 33 32 31 0d 0a 43 length: 1 52321..C  
00b0 61 63 68 65 2d 43 6f 6e 74 72 6f 6c 3a 20 6d 61 ache-Con trol: ma  
00c0 78 2d 61 67 65 3d 30 0d 0a 55 70 67 72 61 64 65 x-age=0 ..Upgrade  
00d0 2d 49 6e 73 65 63 75 72 65 2d 52 65 71 75 65 73 -Insecur e-Request  
00e0 74 73 3a 20 31 0d 0a 4f 72 69 67 69 6e 3a 20 68 ts: 1..O rigin: h  
00f0 74 74 70 3a 2f 2f 67 61 69 61 2e 63 73 2e 75 6d ttp://ga ia.cs.um  
0100 61 73 73 2e 65 64 75 0d 0a 43 6f 6e 74 65 6e 74 ass.edu..Content  
0110 2d 54 79 70 65 3a 20 6d 75 6c 74 69 70 61 72 74 -Type: m ultipart  
0120 2f 66 6f 72 6d 2d 64 61 74 61 3b 20 62 6f 75 6e /form-da ta; boun  
0130 64 61 72 79 3d 2d 2d 2d 2d 57 65 62 4b 69 74 46 dary=--- -WebKitF  
0140 6f 72 6d 42 6f 75 6e 64 61 72 79 77 51 41 41 6e ormBound arywQAAn  
0150 4a 72 50 59 58 73 43 4b 57 7a 71 0d 0a 55 73 65 JrPYXsCK Wzq..Use  
0160 72 2d 41 67 65 6e 74 3a 20 4d 6f 7a 69 6c 6c 61 r-Agent: Mozilla  
0170 2f 35 2e 30 20 28 57 69 6a 64 6f 77 73 20 4a 54 /5.0 (Wi ndows NT  
0180 20 31 30 2e 30 3b 20 57 69 6e 36 34 3b 20 78 36 10.0; W in64; x6  
0190 34 29 20 41 70 70 6c 65 57 65 62 4b 69 74 2f 35 4) Apple WebKit/5  
01a0 33 37 2e 33 36 20 28 4b 48 54 4d 4c 2c 20 6c 69 37.36 (K HTML, li  
01b0 6b 65 20 47 65 63 6b 6f 29 20 43 68 72 6f 6d 65 ke Gecko ) Chrome

Bytes 54-774: TCP segment data (tcp.segment\_data) Packets: 8795 · Displayed: 126 (1.4%) · Dropped: 0 (0.0%) Profile:

(iii) RTT for this first data-containing segment = 0.284166 seconds

[The RTT to ACK the segment was: 0.284166000 seconds]

(iv) RTT for 2<sup>nd</sup> data-carrying TCP segment and its ACK = 0.284011 seconds

[The RTT to ACK the segment was: 0.284011000 seconds]

5.

[55 Reassembled TCP Segments (153042 bytes): #1274(721), #1276(13140), #1297(27740), #1304(1460), #1316(1460), #1308(1460), #1323(1460), #1309(1460), #1312(1460), #1313(1460), #1332(1460)]

[Frame: 1274, payload: 0-720 (721 bytes)]  
[Frame: 1276, payload: 721-13860 (13140 bytes)]  
[Frame: 1297, payload: 13861-41600 (27740 bytes)]  
> [Frame: 1304, payload: 13861-15320 (1460 bytes)]  
> [Frame: 1316, payload: 13861-15320 (1460 bytes)]  
> [Frame: 1308, payload: 15321-16780 (1460 bytes)]  
> [Frame: 1323, payload: 15321-16780 (1460 bytes)]  
> [Frame: 1309, payload: 18241-19700 (1460 bytes)]  
> [Frame: 1312, payload: 21161-22620 (1460 bytes)]  
> [Frame: 1313, payload: 22621-24080 (1460 bytes)]  
> [Frame: 1332, payload: 22621-24080 (1460 bytes)]

1274	20:55:14.415125	192.168.0.194	128.119.245.12	TCP	775 51133 → 80 [PSH, ACK] Seq=1 Ack=1 Win=513 Len=721 [TCP segment of a reassembled PDU]
1276	20:55:14.415280	192.168.0.194	128.119.245.12	TCP	13194 51133 → 80 [ACK] Seq=722 Ack=1 Win=513 Len=13140 [TCP segment of a reassembled PDU]
1293	20:55:14.699291	128.119.245.12	192.168.0.194	TCP	54 80 → 51133 [ACK] Seq=1 Ack=722 Win=30720 Len=0
1294	20:55:14.699291	128.119.245.12	192.168.0.194	TCP	54 80 → 51133 [ACK] Seq=1 Ack=2182 Win=33664 Len=0
1295	20:55:14.699291	128.119.245.12	192.168.0.194	TCP	54 80 → 51133 [ACK] Seq=1 Ack=6562 Win=42368 Len=0
1296	20:55:14.699291	128.119.245.12	192.168.0.194	TCP	54 80 → 51133 [ACK] Seq=1 Ack=13862 Win=56960 Len=0
1297	20:55:14.699331	192.168.0.194	128.119.245.12	TCP	27794 51133 → 80 [PSH, ACK] Seq=13862 Ack=1 Win=513 Len=27740 [TCP segment of a reassembled PDU]
1302	20:55:15.146816	128.119.245.12	192.168.0.194	TCP	66 [TCP Window Update] 80 → 51133 [ACK] Seq=1 Ack=13862 Win=59904 Len=0 SLE=16782 SRE=18242
1303	20:55:15.146860	192.168.0.194	128.119.245.12	TCP	1514 51133 → 80 [ACK] Seq=41602 Ack=1 Win=513 Len=1460 [TCP segment of a reassembled PDU]

Header length = 20 bytes

1<sup>st</sup> segment = 721 + 20 = 741 bytes

2<sup>nd</sup> segment = 13140 + 20 = 13160 bytes

3<sup>rd</sup> segment = 27740 + 20 = 27760 bytes

4<sup>th</sup> segment = 1460 + 20 = 1480 bytes

6. Minimum amount of available buffer space = 513 bytes [can be seen from the screenshot from win field: Win=513]. No, the lack of receiver buffer space never throttles the sender for these first four data-carrying segments.

7. Yes,

By typing "tcp.analysis.retransmission" in the filter field.

No.	Time	Source	Destination	Protocol	Length	Info
46	20:54:54.872162	192.168.0.194	142.250.196.174	TCP	1466	[TCP Retransmission] 50653 → 443 [PSH, ACK] Seq=9528 Ack=1 Win=507 Len=1412
55	20:54:55.069645	192.168.0.194	142.250.182.110	TCP	1466	[TCP Retransmission] 50646 → 443 [ACK] Seq=374 Ack=40 Win=512 Len=1412
57	20:54:55.133582	192.168.0.194	142.250.182.110	TCP	1466	[TCP Retransmission] 50646 → 443 [ACK] Seq=1786 Ack=40 Win=512 Len=1412
58	20:54:55.133687	192.168.0.194	142.250.182.110	TCP	626	[TCP Retransmission] 50646 → 443 [ACK] Seq=4610 Ack=40 Win=512 Len=572
59	20:54:55.188947	192.168.0.194	142.250.196.174	TCP	1466	[TCP Retransmission] 50653 → 443 [ACK] Seq=1 Ack=1 Win=507 Len=1412
60	20:54:55.337507	192.168.0.194	20.189.173.4	TCP	985	[TCP Retransmission] 50791 → 443 [PSH, ACK] Seq=1 Ack=1 Win=517 Len=931
70	20:54:55.337961	142.250.182.110	192.168.0.194	TCP	93	[TCP Spurious Retransmission] 443 → 50646 [PSH, ACK] Seq=1 Ack=6594 Win=1564 Len=39
77	20:54:55.338021	192.168.0.194	142.250.182.110	TCP	1466	[TCP Spurious Retransmission] 50646 → 443 [ACK] Seq=374 Ack=40 Win=512 Len=1412
78	20:54:55.338040	192.168.0.194	142.250.182.110	TCP	894	[TCP Spurious Retransmission] 50646 → 443 [ACK] Seq=5182 Ack=40 Win=512 Len=840
111	20:54:55.694706	192.168.0.194	20.189.173.4	TCP	985	[TCP Retransmission] 50791 → 443 [PSH, ACK] Seq=1 Ack=1 Win=517 Len=931
118	20:54:55.741782	142.250.196.174	192.168.0.194	TCP	93	[TCP Retransmission] 443 → 50653 [PSH, ACK] Seq=1166 Ack=10940 Win=2073 Len=39
124	20:54:55.829825	20.189.173.4	192.168.0.194	TCP	154	[TCP Spurious Retransmission] 443 → 50791 [PSH, ACK] Seq=1 Ack=932 Win=16385 Len=100
389	20:54:59.282659	192.168.0.194	142.250.193.174	TCP	1466	[TCP Retransmission] 51151 → 443 [PSH, ACK] Seq=17088 Ack=6948 Win=131072 Len=1412
390	20:54:59.313775	192.168.0.194	142.250.196.174	TCP	1466	[TCP Retransmission] 50653 → 443 [PSH, ACK] Seq=20214 Ack=1205 Win=512 Len=1412
403	20:54:59.388866	142.250.193.174	192.168.0.194	TCP	160	[TCP Retransmission] 443 → 51151 [PSH, ACK] Seq=9859 Ack=18500 Win=141056 Len=106
451	20:54:59.404501	142.250.193.174	192.168.0.194	TLSv1.3	1118	[TCP Fast Retransmission] , Application Data, Application Data
521	20:54:59.694703	35.186.224.25	192.168.0.194	TCP	138	[TCP Spurious Retransmission] 443 → 50673 [PSH, ACK] Seq=40 Ack=322 Win=426 Len=84
523	20:54:59.714770	35.186.224.13	192.168.0.194	TCP	93	[TCP Spurious Retransmission] 443 → 50708 [PSH, ACK] Seq=199 Ack=1814 Win=937 Len=39
525	20:54:59.741206	142.250.196.174	192.168.0.194	TCP	93	[TCP Spurious Retransmission] 443 → 50653 [PSH, ACK] Seq=2374 Ack=21626 Win=2162 Len=39
541	20:54:59.847529	35.186.224.25	192.168.0.194	TCP	93	[TCP Spurious Retransmission] 443 → 50714 [PSH, ACK] Seq=1327 Ack=6212 Win=1817 Len=39
614	20:55:00.014650	184.84.221.8	192.168.0.194	TCP	2974	[TCP Spurious Retransmission] 443 → 51157 [ACK] Seq=17466 Ack=1206 Win=64128 Len=2920 [TCP segment of a reassembled PDU]
615	20:55:00.014650	184.84.221.8	192.168.0.194	TCP	400	[TCP Spurious Retransmission] 443 → 51157 [PSH, ACK] Seq=20386 Ack=1206 Win=64128 Len=346
954	20:55:03.055752	142.250.196.174	192.168.0.194	TCP	93	[TCP Retransmission] 443 → 50653 [PSH, ACK] Seq=3583 Ack=40700 Win=2327 Len=39

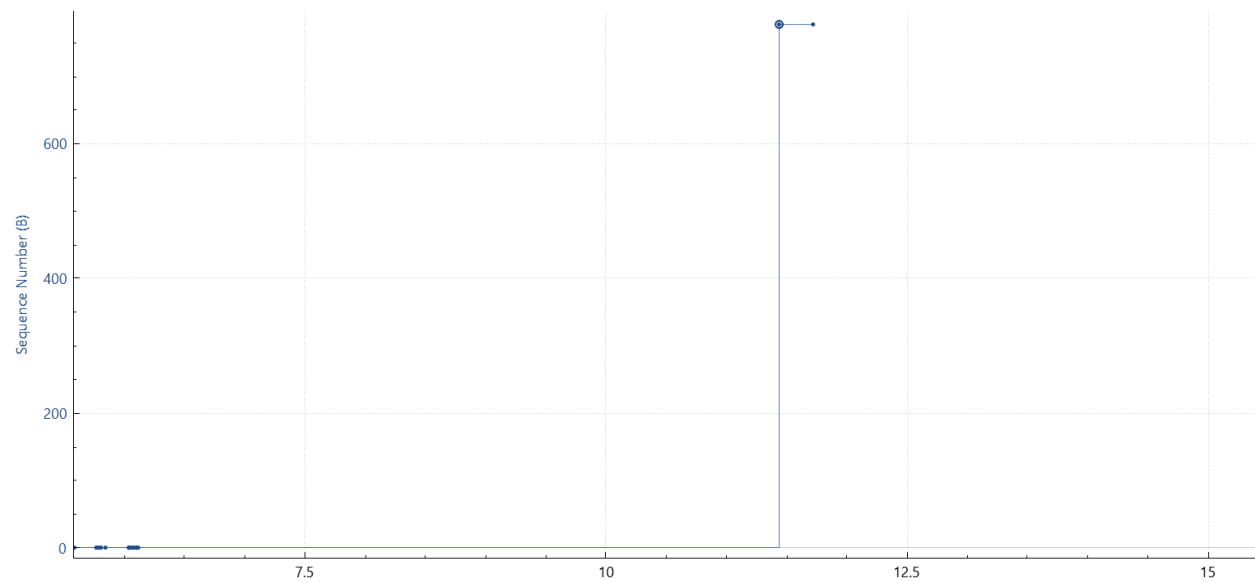
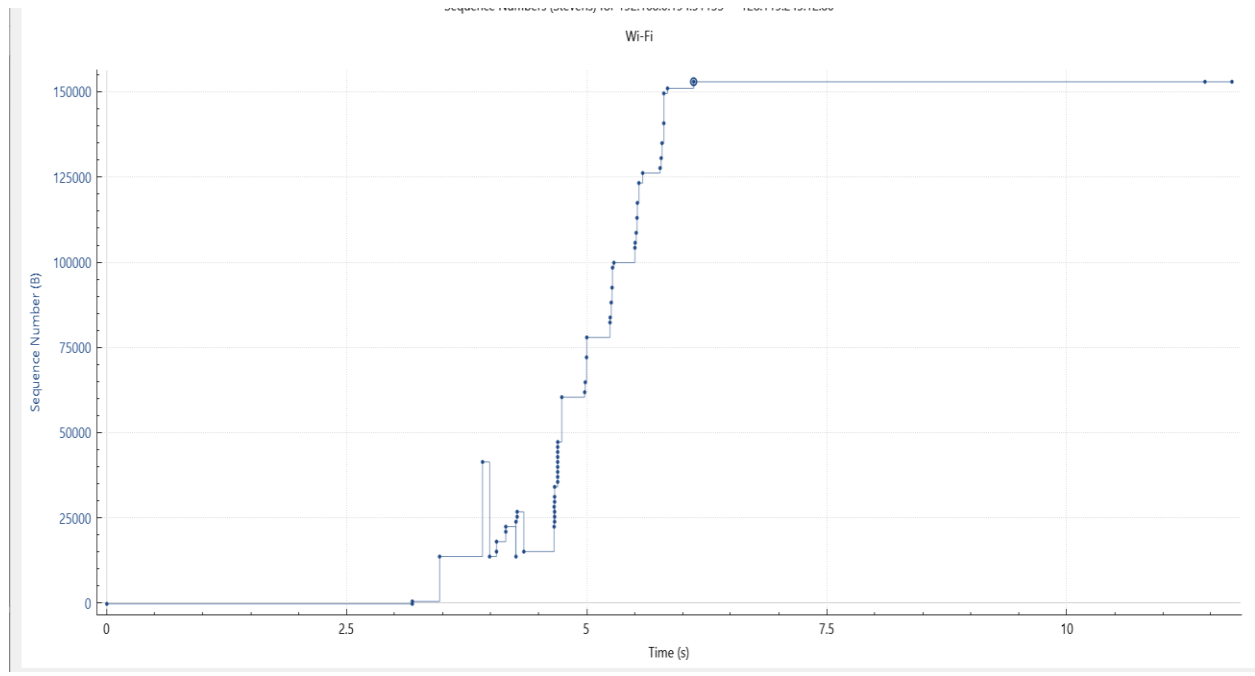
8. 1460 bytes,

Yes, the receiver is ACKing every other received segment among these first ten data-carrying segments. The difference between the acknowledged sequence numbers of two consecutive ACKs indicates the data received by the server between these two ACKs. By inspecting the amount of acknowledged data by each ACK, there are cases where the receiver is ACKing every other segment.

$$\begin{aligned} 9. \text{ Throughput} &= \text{Total data sent} / \text{Total time} \\ &= (152562-1) / (17.331907 - 14.415125) \\ &= 152561 / 2.916782 \\ &= 52,304.560299673 \text{ bytes per second} \\ &\sim 52.3 \text{ KB/s} \end{aligned}$$

To calculate this, find the total data transmitted which can be computed by the difference between the sequence number of the first TCP segment(=1) and the acknowledged sequence number of the last ACK(=152562). The time taken will be the time between the first segment and the last segment.

## **PART-4**



The slow start phase begins at  $t=0$  and ends at roughly  $t=11.5$  seconds  
So, congestion avoidance takes over at  $t=11.5$  seconds.