

Zachary Waters

Ellen Zegura

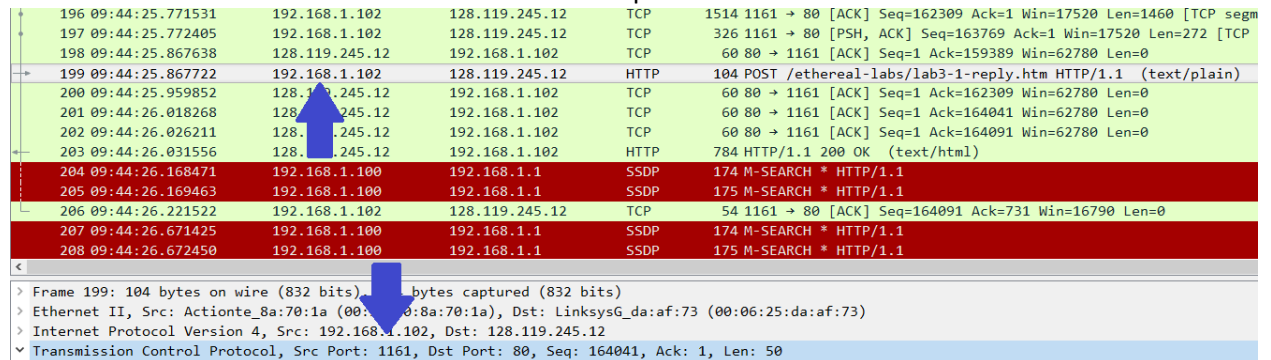
4/22/2019

CS 3251

## Homework 4:

### Wireshark Lab:

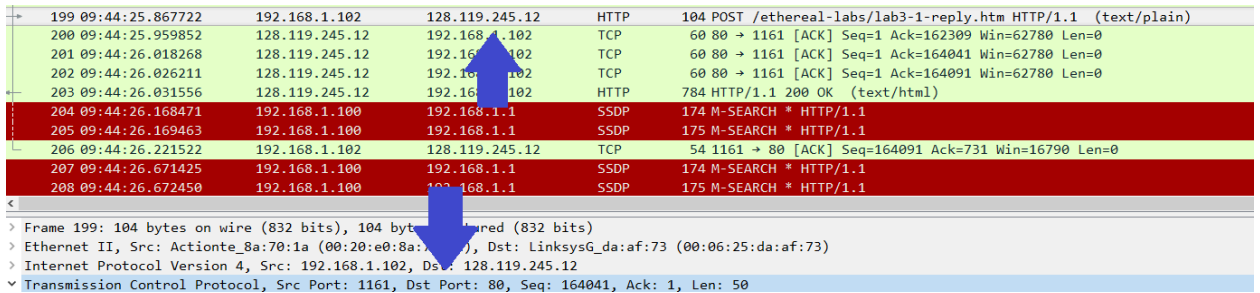
1. The client's IP address is 192.168.1.102 and the TCP port number is 1161.



No.	Time	Source	Destination	Protocol	Length	Info
196	09:44:25.771531	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=162309 Ack=1 Win=17520 Len=1460 [TCP segment of a flow already captured: (previous Seq=162309, Len=1460)]
197	09:44:25.772405	192.168.1.102	128.119.245.12	TCP	326	1161 → 80 [PSH, ACK] Seq=163769 Ack=1 Win=17520 Len=272 [TCP segment of a flow already captured: (previous Seq=162309, Len=1460)]
198	09:44:25.867638	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
199	09:44:25.867722	192.168.1.102	128.119.245.12	HTTP	104	POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
200	09:44:25.959852	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201	09:44:26.018268	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202	09:44:26.026211	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	09:44:26.031556	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)
204	09:44:26.168471	192.168.1.100	192.168.1.1	SSDP	174	M-SEARCH * HTTP/1.1
205	09:44:26.169463	192.168.1.100	192.168.1.1	SSDP	175	M-SEARCH * HTTP/1.1
206	09:44:26.221522	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0
207	09:44:26.671425	192.168.1.100	192.168.1.1	SSDP	174	M-SEARCH * HTTP/1.1
208	09:44:26.672450	192.168.1.100	192.168.1.1	SSDP	175	M-SEARCH * HTTP/1.1

< Frame 199: 104 bytes on wire (832 bits) captured (832 bits) on 0  
> Ethernet II, Src: Actionte\_8a:70:1a (00:08:0a:70:1a:00), 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  
v Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 164041, Ack: 1, Len: 50

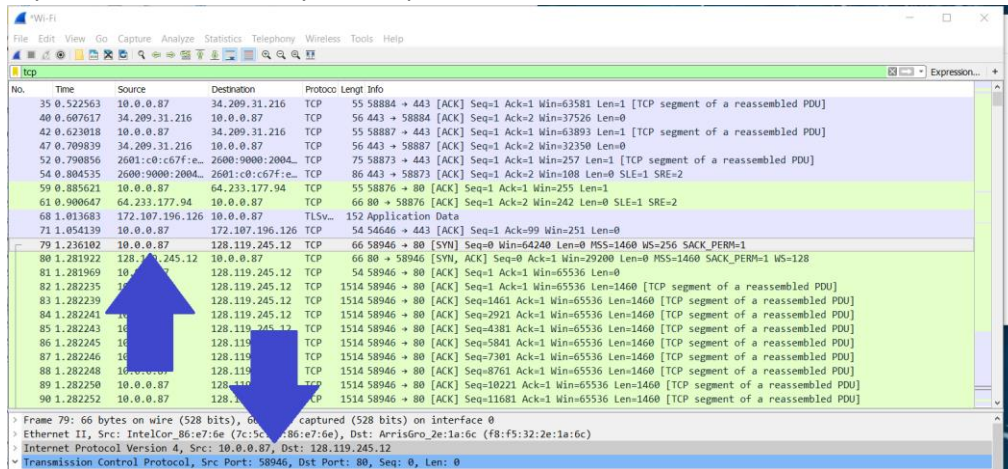
2. the IP address of gaia.cs.umass.edu is 128.119.245.12 and the port number is 80.



No.	Time	Source	Destination	Protocol	Length	Info
199	09:44:25.867722	192.168.1.102	128.119.245.12	HTTP	104	POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
200	09:44:25.959852	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201	09:44:26.018268	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202	09:44:26.026211	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	09:44:26.031556	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)
204	09:44:26.168471	192.168.1.100	192.168.1.1	SSDP	174	M-SEARCH * HTTP/1.1
205	09:44:26.169463	192.168.1.100	192.168.1.1	SSDP	175	M-SEARCH * HTTP/1.1
206	09:44:26.221522	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0
207	09:44:26.671425	192.168.1.100	192.168.1.1	SSDP	174	M-SEARCH * HTTP/1.1
208	09:44:26.672450	192.168.1.100	192.168.1.1	SSDP	175	M-SEARCH * HTTP/1.1

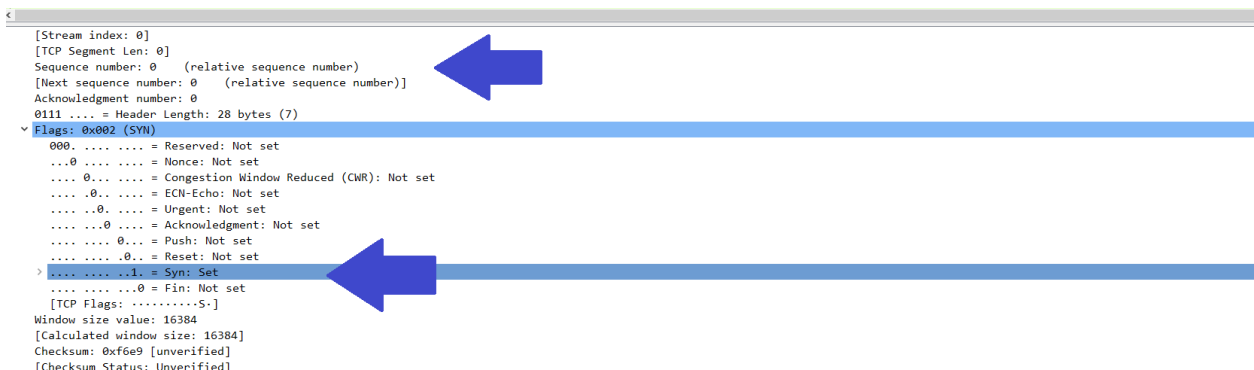
< Frame 199: 104 bytes on wire (832 bits) captured (832 bits) on 0  
> Ethernet II, Src: Actionte\_8a:70:1a (00:08:0a:70:1a:00), Dst: LinksysG\_da:af:73 (00:06:25:da:af:73)  
> Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12  
v Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 164041, Ack: 1, Len: 50

3. My IP is 10.0.0.87 and my source port is 58946



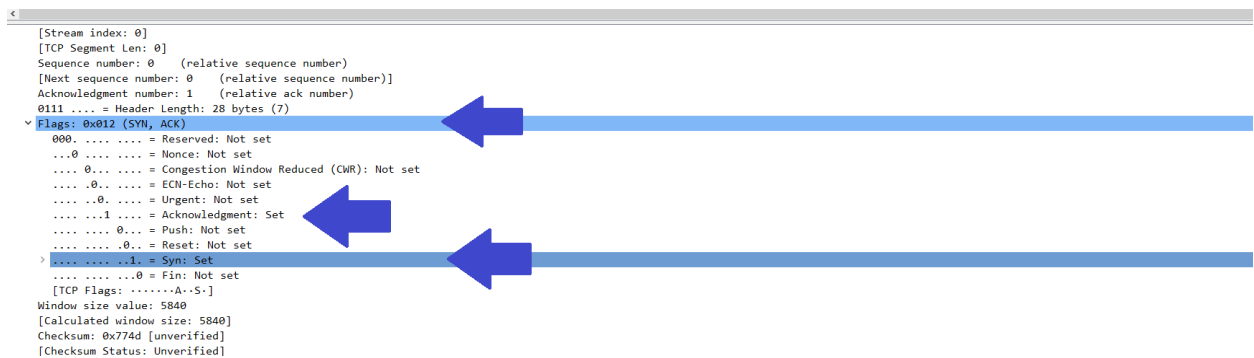
No.	Time	Source	Destination	Protocol	Length	Info
35	0.522563	10.0.0.87	34.209.31.216	TCP	55	58884 → 443 [ACK] Seq=1 Ack=1 Win=63581 Len=1 [TCP segment of a reassembled PDU]
40	0.607617	34.209.31.216	10.0.0.87	TCP	56	443 → 58884 [ACK] Seq=1 Ack=2 Win=37526 Len=0
42	0.623018	10.0.0.87	34.209.31.216	TCP	55	58887 → 443 [ACK] Seq=1 Ack=1 Win=63893 Len=1 [TCP segment of a reassembled PDU]
47	0.709839	34.209.31.216	10.0.0.87	TCP	56	443 → 58887 [ACK] Seq=1 Ack=2 Win=32350 Len=0
52	0.790856	2601:00:c67f::e	2600:9000:2004::	TCP	75	58873 → 443 [ACK] Seq=1 Ack=1 Win=257 Len=1 [TCP segment of a reassembled PDU]
54	0.804535	2600:9000:2004::	2601:00:c67f::e	TCP	86	443 → 58873 [ACK] Seq=1 Ack=2 Win=108 Len=0 SLE=1 SRE=2
59	0.885621	10.0.0.87	64.233.177.94	TCP	55	58876 → 80 [ACK] Seq=1 Ack=1 Win=255 Len=1
61	0.900647	64.233.177.94	10.0.0.87	TCP	66	80 → 58876 [ACK] Seq=1 Ack=2 Win=242 Len=0 SLE=1 SRE=2
68	1.013683	172.107.196.126	10.0.0.87	TLSv...	152	Application Data
71	1.054139	10.0.0.87	172.107.196.126	TCP	54	54646 → 443 [ACK] Seq=1 Ack=99 Win=251 Len=0
79	1.236102	10.0.0.87	128.119.245.12	TCP	66	58946 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
80	1.281922	128.119.245.12	10.0.0.87	TCP	66	80 → 58946 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM=1 WS=128
81	1.281969	10.0.0.87	128.119.245.12	TCP	54	58946 → 80 [ACK] Seq=1 Ack=1 Win=65536 Len=0
82	1.282235	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=1 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
83	1.282239	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=1461 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
84	1.282241	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=2921 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
85	1.282243	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=4381 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
86	1.282245	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=5841 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
87	1.282246	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=7301 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
88	1.282248	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=8761 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
89	1.282250	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=10221 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]
90	1.282252	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=11681 Ack=1 Win=65536 Len=1460 [TCP segment of a reassembled PDU]

4. The sequence number is 0 and the Syn flag is set to 1 which identifies the segment as a SYN segment.



[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number)
[Next sequence number: 0 (relative sequence number)]
Acknowledgment number: 0
0111 .... = Header Length: 28 bytes (7)
▼ Flags: 0x002 (SYN)
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
▼ ....0... = Syn: Set
....0... = Fin: Not set
[TCP Flags: .....S.]
Window size value: 16384
[Calculated window size: 16384]
Checksum: 0xf6e9 [unverified]
[Checksum Status: Unverified]

5. The sequence number of the SYNACK segment is 0, the value of the acknowledgment field is 1, this value is determined by simply adding 1 to the client's original field value. The Syn flag is set to 1 which identifies the segment as a SYN segment.



[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number)
[Next sequence number: 0 (relative sequence number)]
Acknowledgment number: 1 (relative sequence number)
0111 .... = Header Length: 28 bytes (7)
▼ 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
▼ ....0... = Syn: Set
....0... = Fin: Not set
[TCP Flags: .....A.S.]
Window size value: 5840
[Calculated window size: 5840]
Checksum: 0x774d [unverified]
[Checksum Status: Unverified]

6. the segment No.4 contains the HTTP POST command, the sequence number of this segment is 1.

4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

Destination Port: 80  
[Stream index: 0]  
[TCP Segment Len: 565]  
Sequence number: 1 (relative sequence number)  
[Next sequence number: 566 (relative sequence number)]  
Acknowledgment number: 1 (relative ack number)  
0101 .... = Header Length: 20 bytes (5)  
Flags: 0x018 (PSH, ACK)  
000. .... = Reserved: Not set

44 70 1f bd 00 00 50 4f 53 54 20 2f 65 74 68 65  
72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 33 2d 31  
2d 72 65 70 6c 79 2e 68 74 6d 20 48 54 54 50 2f

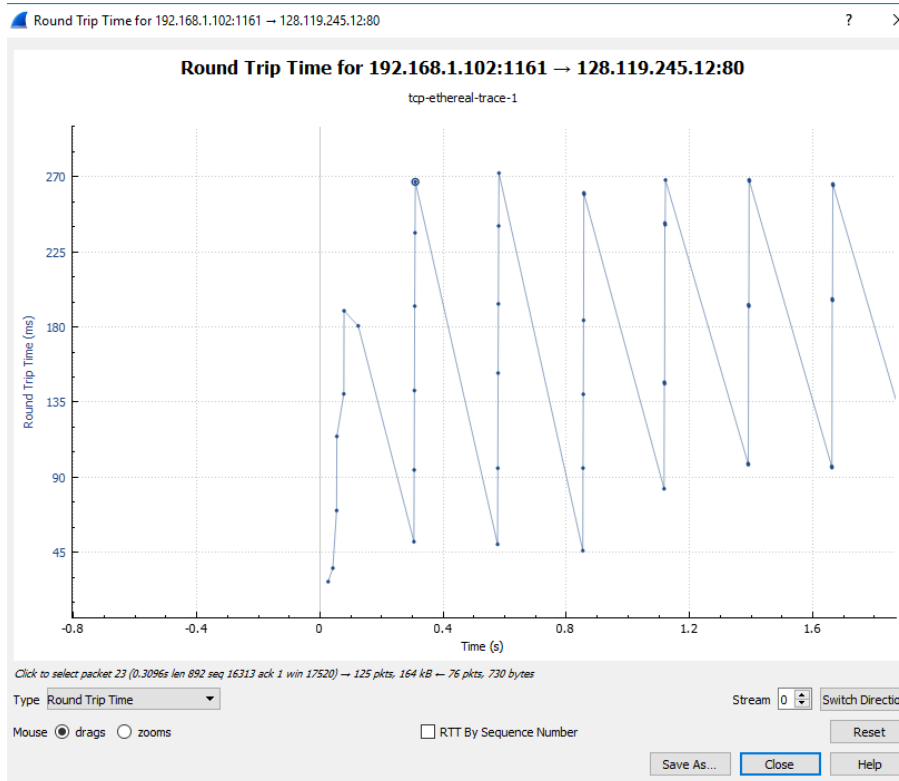
Dp...PO 5f /ethn  
real-lab s/lab3-1  
-reply.h tm HTTP/

7.

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=1
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=1
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK]	Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK]	Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
21	0.307571	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK]	Seq=13393 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
22	0.308699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK]	Seq=14853 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
23	0.309553	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK]	Seq=16313 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]

Solution Table:

Segment Number	Wireshark NO.	Sequence Number	Time Sequence	ACK Arrival Time	RTT time	Estimated RTT Value
1	4	1	0.026477	0.053937	0.02746	0.02646
2	5	566	0.041737	0.077294	0.035557	0.0285
3	7	2026	0.054026	0.124085	0.070059	0.0337
4	8	3486	0.05469	0.169118	0.11443	0.0438
5	10	4946	0.077405	0.217299	0.13989	0.0558
6	11	6406	0.078157	0.267802	0.18964	0.0725



8. The Length of the first TCP segment is 565 bytes, the length of the other 5 segments is 1460 bytes.

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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
21	0.307571	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=13393 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
22	0.308699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=14853 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
23	0.309553	192.168.1.102	128.119.245.12	TCP	946	1161 → 80	[PSH, ACK] Seq=16313 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
24	0.356437	128.119.245.12	192.168.1.102	TCP	60	80 → 1161	[ACK] Seq=1 Ack=10473 Win=26380 Len=0

> 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 (00:15:5d: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

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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
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 segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
21	0.307571	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=13393 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
22	0.308699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=14853 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
23	0.309553	192.168.1.102	128.119.245.12	TCP	946	1161 → 80	[PSH, ACK] Seq=16313 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
24	0.356437	128.119.245.12	192.168.1.102	TCP	60	80 → 1161	[ACK] Seq=1 Ack=10473 Win=26380 Len=0

> Frame 5: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)  
> Ethernet II, Src: Actionte\_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG\_da:af:73 (00:15:5d: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

9. The minimum amount of buffer space is 5840 bytes, the sender is never throttled.

Time	Source	Destination	Protocol	Length	Info
2.023172	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=1
3.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
5.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
6.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
8.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
9.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
11.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
12.0124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13.0124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
14.0169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15.0217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16.0267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17.0304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18.0305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
19.0305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
20.0306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
21.0307571	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=13393 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
22.0308699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=14853 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
23.0309553	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=16313 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]

Time to live: 55  
Protocol: TCP (6)  
Header checksum: 0x0c36 [validation disabled]  
[Header checksum status: Unverified]  
Source: 128.119.245.12  
Destination: 192.168.1.102

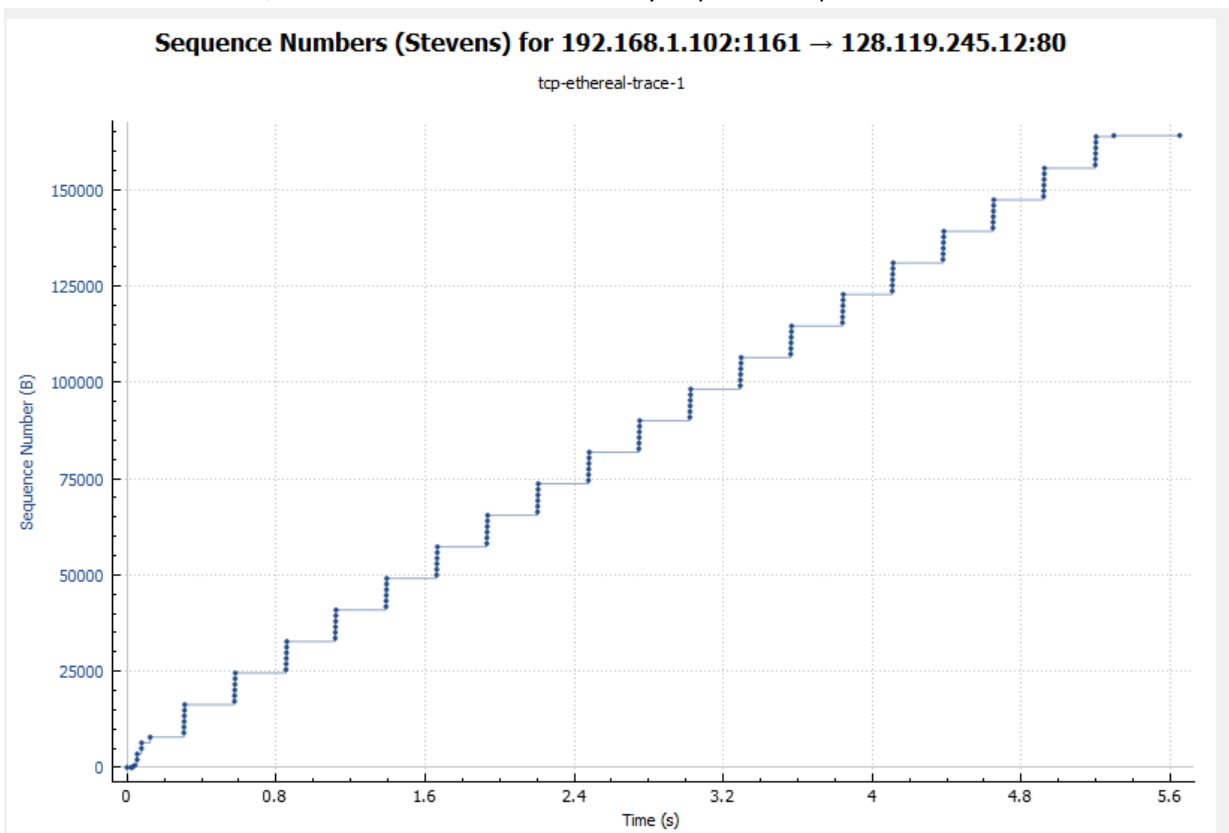
Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 0, Ack: 1, Len: 0

Source Port: 80  
Destination Port: 1161  
[Stream index: 0]  
[TCP Segment Len: 0]  
Sequence number: 0 (relative sequence number)  
[Next sequence number: 0 (relative sequence number)]  
Acknowledgment number: 1 (relative ack number)  
0111 .... = Header Length: 28 bytes (7)

Flags: 0x012 (SYN, ACK)  
Window size value: 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]

10. There are none, I checked to see if there are any duplicate sequence numbers.



11. The receiver typically acknowledges 1460 bytes of data in an ACK. You can see an example where the receiver acknowledges two segments simultaneously, because packet No. 80 acknowledges 2920 bytes of data.

No.	Time	Source	Destination	Protocol	Length	Info
74	1.663315	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=52893 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
75	1.664198	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=54353 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
76	1.665254	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=55813 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
77	1.666151	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=57273 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
78	1.758227	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=52893 Win=62780 Len=0
79	1.860063	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=55813 Win=62780 Len=0
80	1.930880	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=58165 Win=62780 Len=0
81	1.931099	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=58165 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
82	1.931879	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=59625 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
83	1.932757	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=61085 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
84	1.933636	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=62545 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
85	1.934770	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=64005 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
86	1.935586	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=65465 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
87	2.029069	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=61085 Win=62780 Len=0
88	2.126682	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=64005 Win=62780 Len=0
89	2.203195	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=66357 Win=62780 Len=0
90	2.203411	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=66357 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
91	2.204125	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=67817 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
92	2.204962	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=69277 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
93	2.205836	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=70737 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
94	2.206824	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=72197 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
95	2.207746	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=73657 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
96	2.311413	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=69277 Win=62780 Len=0
97	2.404338	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=73107 Win=62780 Len=0

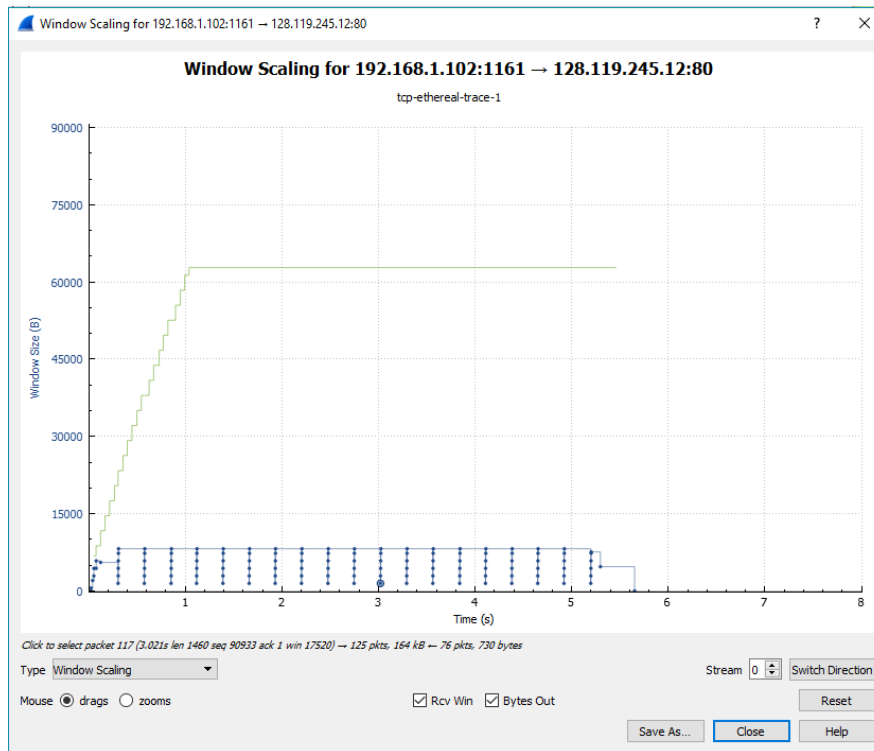
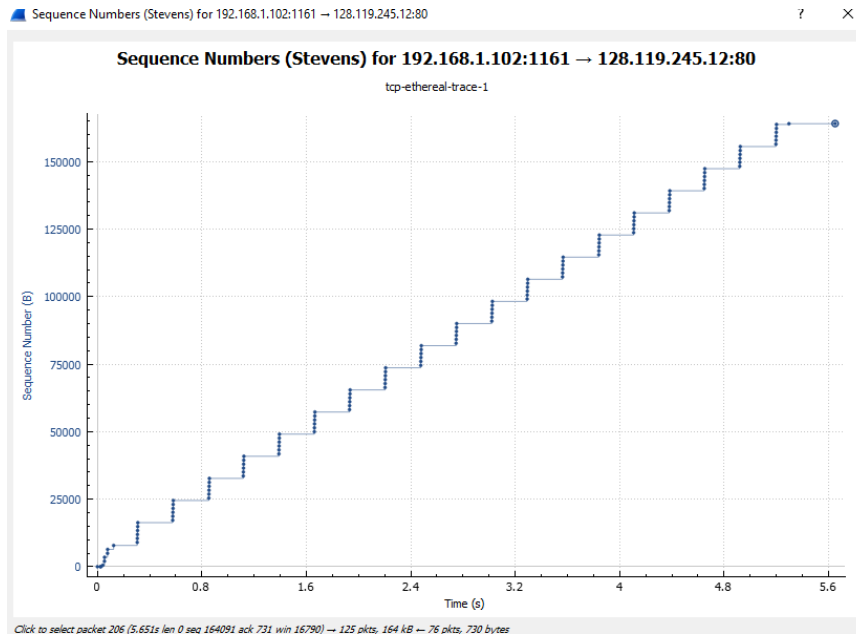
```

> Frame 80: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
> Ethernet II, Src: Linksys_G_daf:73 (00:06:25:da:af:73), Dst: Actionte_8a:70:1a (00:20:e0:8a:70:1a)
> Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102
✓ Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 58165, Len: 0
  Source Port: 80
  Destination Port: 1161
  [Stream index: 0]
  [TCP Segment Len: 0]
  Sequence number: 1 (relative sequence number)
  [Next sequence number: 1 (relative sequence number)]
  Acknowledgment number: 58165 (relative ack number)
  0101 .... = Header Length: 20 bytes (5)
  > Flags: 0x010 (ACK)
  Window size value: 62780
  [Calculated window size: 62780]
  [Window size scaling factor: -2 (no window scaling used)]
  Checksum: 0xe26f [unverified]
  [Checksum Status: Unverified]
  Urgent pointer: 0
  > [SEQ/ACK analysis]
  > [Timestamps]

```

12. The TCP connection starts at No. 4 and ENDS at No. 202. So total time is  $5.455830 - 0.026477 = 5.429353$ . the total bytes sent is No.202's Acknowledgment number - No.4's Sequence number:  $164091 - 1 = 164090$  bytes. So, the throughput is 30222.7706816 bytes per second.

13. TCP's slow start phase begins at time=0 and ends at time=0.1242. the congestion avoidance takes over at time 0.1242 and continues till time 1.03982. and it differs from the idealized behavior due to the "staircase effect" because of the transmission time delays.





14.

12) the TCP connection starts with packet NO. 82 Time 1.282235 Sequence number 1 and ends with packet No. 246 Time 1.511660 Sequence number 1. This means a total time of  $1.511660 - 1.282235 = 0.229425$  seconds. Packet NO. 246 had an acknowledgment number of 152873, which when you subtract the final ack by the first sequence number to get the total number of bytes,  $152873 - 1 = 152872$  bytes. Which mean 666326.686 bytes per second.

Io.	Time	Source	Destination	Protocol	Length	Info
71	1.054139	10.0.0.87	172.107.196.126	TCP	54	54646 → 443 [ACK] Seq=1 Ack=
79	1.236102	10.0.0.87	128.119.245.12	TCP	66	58946 → 80 [SYN] Seq=0 Win=6
80	1.281922	128.119.245.12	10.0.0.87	TCP	66	80 → 58946 [SYN, ACK] Seq=0
81	1.281969	10.0.0.87	128.119.245.12	TCP	54	58946 → 80 [ACK] Seq=1 Ack=1
82	1.282235	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=1 Ack=1
83	1.282239	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=1461 Ac
84	1.282241	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=2921 Ac
85	1.282243	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=4381 Ac
86	1.282245	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=5841 Ac
87	1.282247	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=7301 Ac
88	1.282249	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=8761 Ac
89	1.282251	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=10221 Ac
90	1.282253	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=11681 Ac
91	1.282255	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=13141 Ac
92	1.282257	128.119.245.12	10.0.0.87	TCP	56	80 → 58946 [ACK] Seq=1 Ack=2
93	1.334969	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=14601 Ac
94	1.334972	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=16061 Ac
95	1.334974	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=17521 Ac
96	1.334976	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=18981 Ac
97	1.335993	128.119.245.12	10.0.0.87	TCP	56	80 → 58946 [ACK] Seq=1 Ack=7
98	1.336004	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=20441 Ac
99	1.336006	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=21901 Ac
100	1.336008	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=23361 Ac
101	1.336009	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=24821 Ac
102	1.336011	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=26281 Ac
103	1.336012	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=27741 Ac
104	1.339430	128.119.245.12	10.0.0.87	TCP	56	80 → 58946 [ACK] Seq=1 Ack=1
105	1.339430	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=1 Ack=1
106	1.339442	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=29201 Ac
107	1.339444	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=30661 Ac
108	1.339446	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [PSH, ACK] Seq=32
109	1.339447	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=33581 Ac
110	1.339448	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=35041 Ac
111	1.339449	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=36501 Ac
112	1.339450	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=37961 Ac
113	1.339452	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=39421 Ac
114	1.339453	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=40881 Ac
115	1.339454	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=42341 Ac
118	1.383368	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=1 Ack=1
119	1.383368	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=1 Ack=2

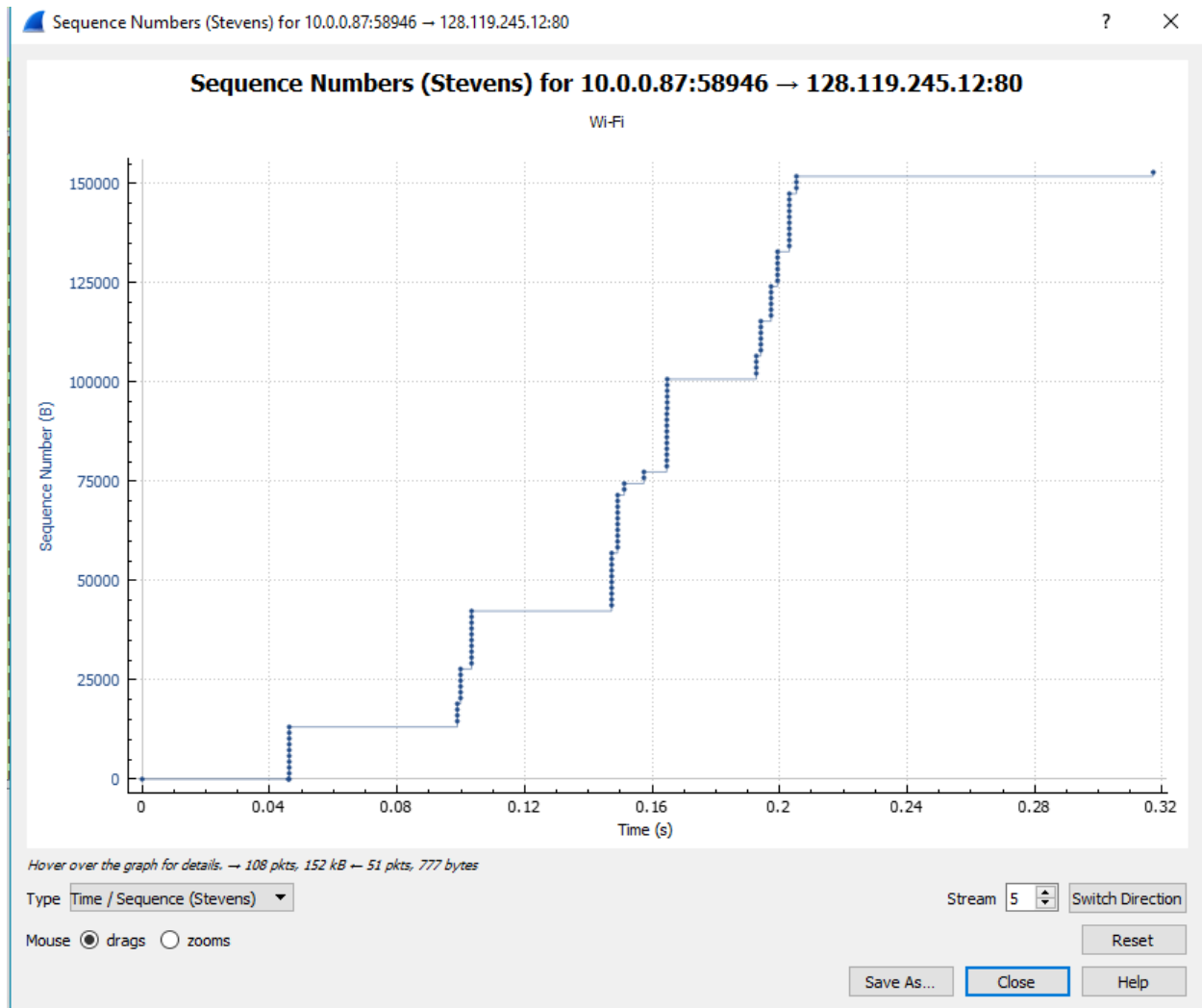
Destination Port: 80  
[Stream index: 5]  
[TCP Segment Len: 1460]  
Sequence number: 1 (relative sequence number)  
[Next sequence number: 1461 (relative sequence number)]  
Acknowledgment number: 1 (relative ack number)  
0101 .... = Header Length: 20 bytes (5)  
▼ Flags: 0x010 (ACK)  
0000 .... = 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  
...0 .... = Syn: Not set  
...0 .... = Fin: Not set

0030	01 00 bf 64 00 00 50 4f	53 54 20 2f 77 69 72 65	...d..PO St/wire
0040	73 68 61 72 6b 2d 6c 61	62 73 2f 6c 61 62 33 2d	shark-lab/lab3-
0050	31 2d 72 65 70 6c 79 2e	68 74 6d 20 48 54 5a 50	1-reply.htm HTTP
0060	2f 31 2e 31 0d 0a 48 6f	73 74 3a 20 67 61 69 61	/1.1..Host: gaia
0070	2e 63 73 2e 75 6d 61 73	73 2e 65 64 75 0d 0a 55	.cs.umass.edu..U
0080	73 65 72 2d 41 67 65 6e	74 3a 20 4d 6f 7a 69 6d	ser-Agent: Mozill
0090	6c 61 2f 35 2e 30 20 28	57 69 6e 64 6f 77 73 20	la/5.0 ( Windows
00a0	4e 54 20 31 30 2e 30 3b	20 57 69 6e 36 34 3b 20	NT 10.0; Win64;
00b0	78 36 34 3b 20 72 76 3a	36 36 2e 30 29 20 47 65	x64; rv: 66.0) Ge
00c0	63 6b 6f 2f 32 30 31 30	30 31 30 31 20 46 69 72	cko/2010 0101 Fir
00d0	65 66 6f 78 2f 36 36 2e	30 0d 0a 41 63 63 65 70	efox/66.0..Accep
00e0	74 3a 20 74 65 78 74 2f	68 74 6d 6c 2c 61 70 70	t: text/html,app
00f0	6c 69 63 61 74 69 6f 6e	2f 78 68 74 6d 6c 2b 78	lication/xhtml1-x
0100	6d 6c 2c 61 70 70 6c 69	63 61 74 69 6f 6e 2f 78	ml,application/x
0110	6d 6c 3b 71 3d 30 2e 39	2c 2a 2f 2a 3b 71 3d 30	ml;q=0.9,*/*;q=0
0120	2e 38 0d 0a 41 63 63 65	70 74 2d 4c 61 6e 6f 75	.8..Acce pt-Langu
0130	61 67 65 3a 20 65 6e 2d	55 53 2c 65 6e 3b 71 3d	age: en-US,en;q=

211	1.441353	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
212	1.441361	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=
213	1.441363	10.0.0.87	128.119.245.12	TCP	1514	58946 → 80 [ACK] Seq=
214	1.441365	10.0.0.87	128.119.245.12	HTTP	1086	POST /wireshark-lab3-
215	1.442182	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
216	1.442721	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
217	1.446080	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
218	1.446080	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
219	1.447091	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
220	1.448110	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
222	1.450680	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
223	1.451992	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
224	1.452736	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
225	1.471907	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
227	1.478787	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
228	1.480353	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
229	1.484560	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
230	1.484560	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
231	1.487026	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
232	1.489481	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
233	1.489481	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
234	1.489481	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
236	1.491906	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
237	1.491907	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
238	1.494699	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
239	1.494699	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
240	1.495709	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
241	1.500687	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
242	1.505545	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
244	1.511660	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
245	1.511660	128.119.245.12	10.0.0.87	TCP	60	80 → 58946 [ACK] Seq=
246	1.511660	128.119.245.12	10.0.0.87	HTTP	831	HTTP/1.1 200 OK (text/html)
249	1.558316	10.0.0.87	128.119.245.12	TCP	54	58946 → 80 [ACK] Seq=
255	1.558317	10.0.0.87	13.249.107.62	TCP	55	58883 → 443 [ACK] Seq=
256	1.558317	13.249.107.62	10.0.0.87	TCP	66	443 → 58883 [ACK] Seq=
257	1.558317	10.0.0.87	172.107.196.126	TLSv1.2	135	Application Data
261	1.558317	172.107.196.126	10.0.0.87	TCP	60	443 → 54646 [ACK] Seq=
265	1.558317	10.0.0.87	35.160.92.193	TCP	55	58931 → 443 [ACK] Seq=
268	1.558317	10.0.0.87	35.160.92.193	TCP	55	58917 → 443 [ACK] Seq=
271	1.558317	10.0.0.87	35.160.92.193	TCP	55	58927 → 443 [ACK] Seq=

Destination Port: 58946  
[Stream index: 5]  
[TCP Segment Len: 777]  
Sequence number: 1 (relative sequence number)  
[Next sequence number: 778 (relative sequence number)]  
Acknowledgment number: 152873 (relative ack number)  
0101 .... = Header Length: 20 bytes (5)  
▼ Flags: 0x018 (PSH, ACK)  
0000 .... = 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  
...1 .... = Push: Set  
...0 .... = Reset: Not set  
...0 .... = Syn: Not set  
...0 .... = Fin: Not set  
[TCP Flags: .....AP...]  
Window size value: 2207

13) I cannot identify where my slow start phase begins or ends, using this graph, in addition to the staircase like affect my graph differs from the ideal because it also lacks a slow start phase.



**P36:**

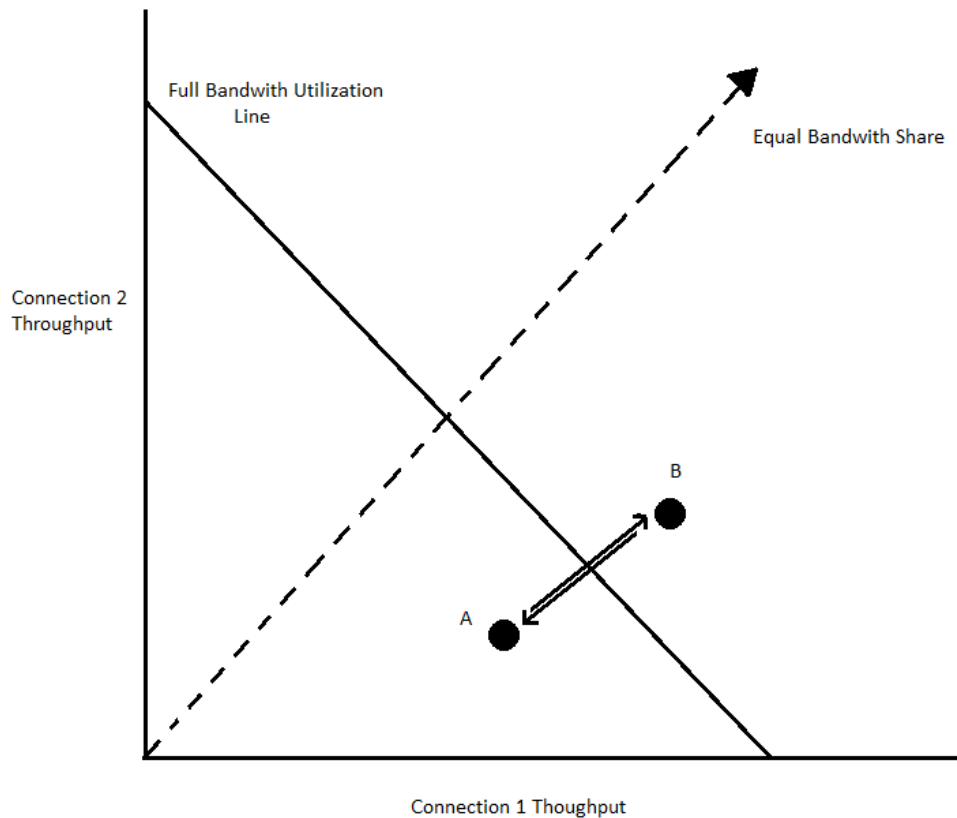
If the receiver receives a packet with a sequence number that is higher than anticipated, meaning it “missed” a packet, due to packet reordering. In response to detecting this gap, the receiver sends an ack for the initial packet again, and not the out of order one it just received. This continues till it receives the proper in-order packet. TCP is designed to take 3 duplicate acknowledgements to perform a fast retransmission because if waiting to make sure that the in-order packet is actually lost, and not just delayed before retransmitting. This is to prevent the sender from clogging the network with redundant packet.

**P40:**

- a) The TCP slow start is operating between rounds 1-6 and 23-26 because you can see the congestion window size start to ramp up rapidly.
- b) The TCP congestion avoidance is operating between rounds 6-16 and 17-22 because you can see the congestion window size increasing linearly.
- c) Because the window size was reduced but not all the way dropped to 1, then the loss is due to a triple-duplicate-acknowledgment
- d) Because the window size was dropped all the way to 1, then the loss is due to a timeout
- e) The value of ssthresh after the first transmission round is 32, since this is the window size reached before switching from slow-start-stop to congestion avoidance.
- f) the ssthresh value at round 18 is 21 this is because it is set to half of its size when there is a detected segment loss, and it was recently divided in half from its peak at 42, at round 15, so half of its value is 21.
- g) the ssthresh value at round 24 is 14 this is because it is set to half of its size when there is a detected segment loss, and it was recently divided in half from 28, at round 21, so half of its value is 14.
- h) the 70<sup>th</sup> segment was sent during round 7. You can calculate this by summing up the congestion window size of all previous rounds.
- i) the congestion window size and the ssthresh value would halve to 4.
- j) the congestion window size would be reset to 1, then regrow to 4 by the 19<sup>th</sup> round. The ssthresh value would remain the same and be 21.
- k) There would be a total of 63 packets, because in round 17, 1 packet is sent. Round 18, 2 packets are sent. Round 19, 4 packets are sent. Round 20, 8 packets are sent. Round 21, 16 packets are sent, and then round 22, 21 packets. So, you have a total of 52.

**P41:**

It would not converge to an equal share algorithm, simply because if the bandwidth increases and decreases with constant size, then if they began at point a, increase by constant size C to point B, on the graph, where they would result in packet lost, and then it would decrease by a constant amount back down to point A. this cycle would continue with the throughput constantly oscillating, thus it would never converge.



**P54:**

The advantage is that TCP would not have to go through slow start, saving time to ramp up to the throughput value obtained at t1. The disadvantage of using these values is that they may no longer be accurate, because of the delay between t1 and t2 that the sender spends idling. An alternative could be starting a timer for cwnd and ssthresh values, and when this expires, they are reset to their initial values.