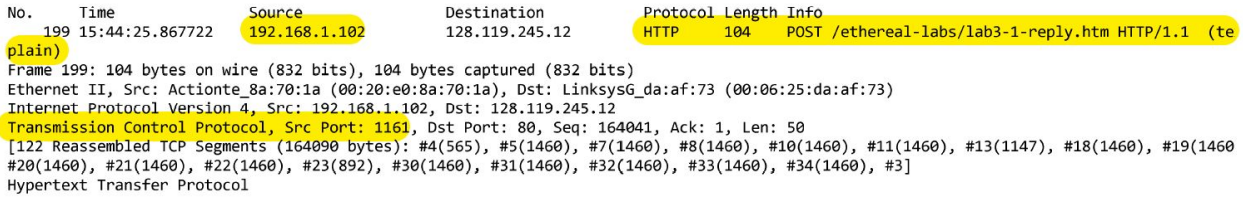
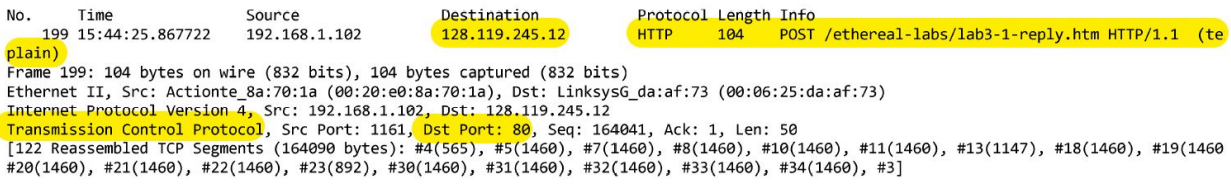
Name : Hazem Morsy Hassan
ID : 16

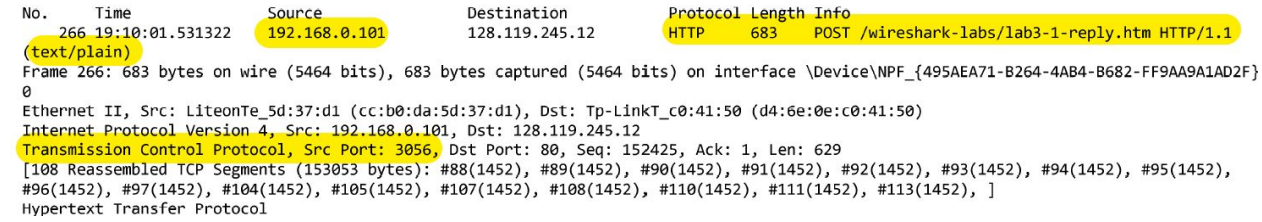
1) The IP address of the client(in trace file) is 192.168.1.102 and its port number is 1161.



2) The IP address of gaia.cs.umass.edu is 128.119.245.12 and its port number is 80.



3) The IP address of the client (my computer) is 192.168.0.101 and its port number is 3056.



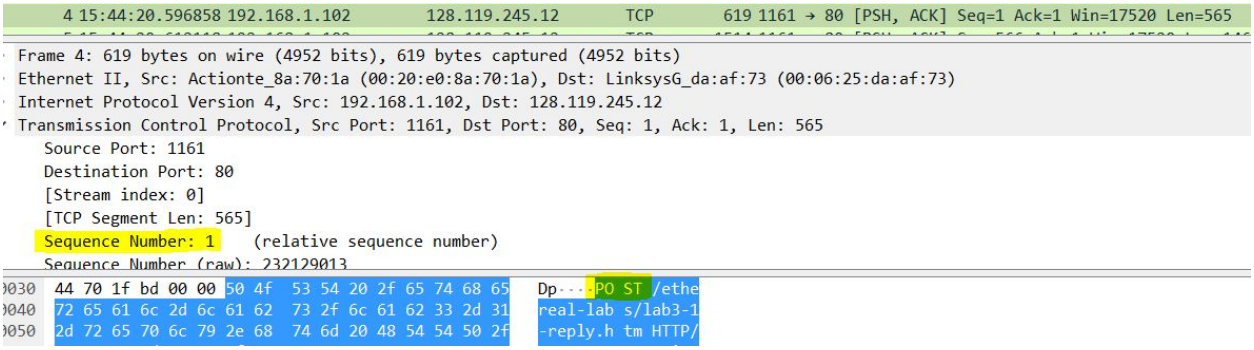
4) Sequence number of TCP SYN segment is (0) , the flag syn is set to (1) which identifies the SYN segment.

```
No.     Time              Source                Destination           Protocol Length Info
      1 15:44:20.570381    192.168.1.102         128.119.245.12        TCP      62     1161 → 80 [SYN] Seq=0 Win=16384
SACK_PERM=1
Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence Number: 0    (relative sequence number)
    Sequence Number (raw): 232129012
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 0
    Acknowledgment number (raw): 0
    0111 .... = Header Length: 28 bytes (7)
    Flags: 0x002 (SYN)
        000. .... .... = Reserved: Not set
        ...0 .... .... = Nonce: Not set
        .... 0... .... = Congestion Window Reduced (CWR): Not set
        .... .0.. .... = ECN-Echo: Not set
        .... ..0. .... = Urgent: Not set
        .... ...0 .... = Acknowledgment: Not set
        .... .... 0... = Push: Not set
        .... .... .0.. = Reset: Not set
        .... .... ..1. = Syn: Set
        .... .... ...0 = Fin: Not set
```

5) The sequence number of SYN ACK segment is (0) , Acknowledgment number is (1) which is the sequence number of previous message (SYN) + 1 = 0 + 1 = 1
, the syn flag and acknowledgment flags are both equal to (1) which identifies the SYN-ACK segment.

```
No.     Time              Source                Destination           Protocol Length Info
      2 15:44:20.593553    128.119.245.12        192.168.1.102         TCP      62     80 → 1161 [SYN, ACK] Seq=0 Ack=1
MSS=1460 SACK_PERM=1
Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: LinksysG_da:af: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: 0, Ack: 1, Len: 0
    Source Port: 80
    Destination Port: 1161
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence Number: 0    (relative sequence number)
    Sequence Number (raw): 883061785
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 1    (relative ack number)
    Acknowledgment number (raw): 232129013
    0111 .... = Header Length: 28 bytes (7)
    Flags: 0x012 (SYN, ACK)
        000. .... .... = Reserved: Not set
        ...0 .... .... = Nonce: Not set
        .... 0... .... = Congestion Window Reduced (CWR): Not set
        .... .0.. .... = ECN-Echo: Not set
        .... ..0. .... = Urgent: Not set
        .... ...1 .... = Acknowledgment: Set
        .... .... 0... = Push: Not set
        .... .... .0.. = Reset: Not set
        .... .... ..1. = Syn: Set
        .... .... ...0 = Fin: Not set
```

6) The sequence number of the HTTP post segment is (1).



7) -> Segments sent:

4 15:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565

Sequence number = 1 , time = 15:44:20.596858

5 15:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460

Sequence number = 566 , time = 15:44:20.612118

7 15:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460

Sequence number = 2026 , time = 15:44:20.624407

8 15:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460

Sequence number = 3486 , time = 15:44:20.625071

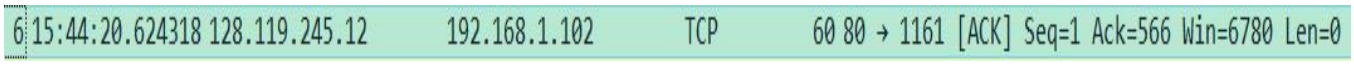
10 15:44:20.647786 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460

Sequence number = 4946 , time = 15:44:20.647786

11 15:44:20.648538 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460

Sequence number = 6406 , time = 15:44:20.648538

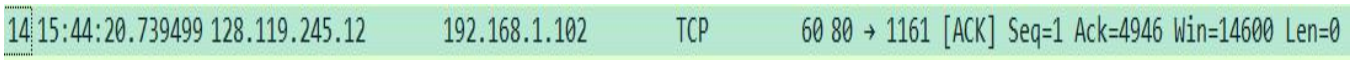
-> ACKS Segments:



time = 15:44:624318

time = 15:44:20.647675

time = 15:44:20.694466



time = 15:44:20.739499

time = 15:44:20.787680

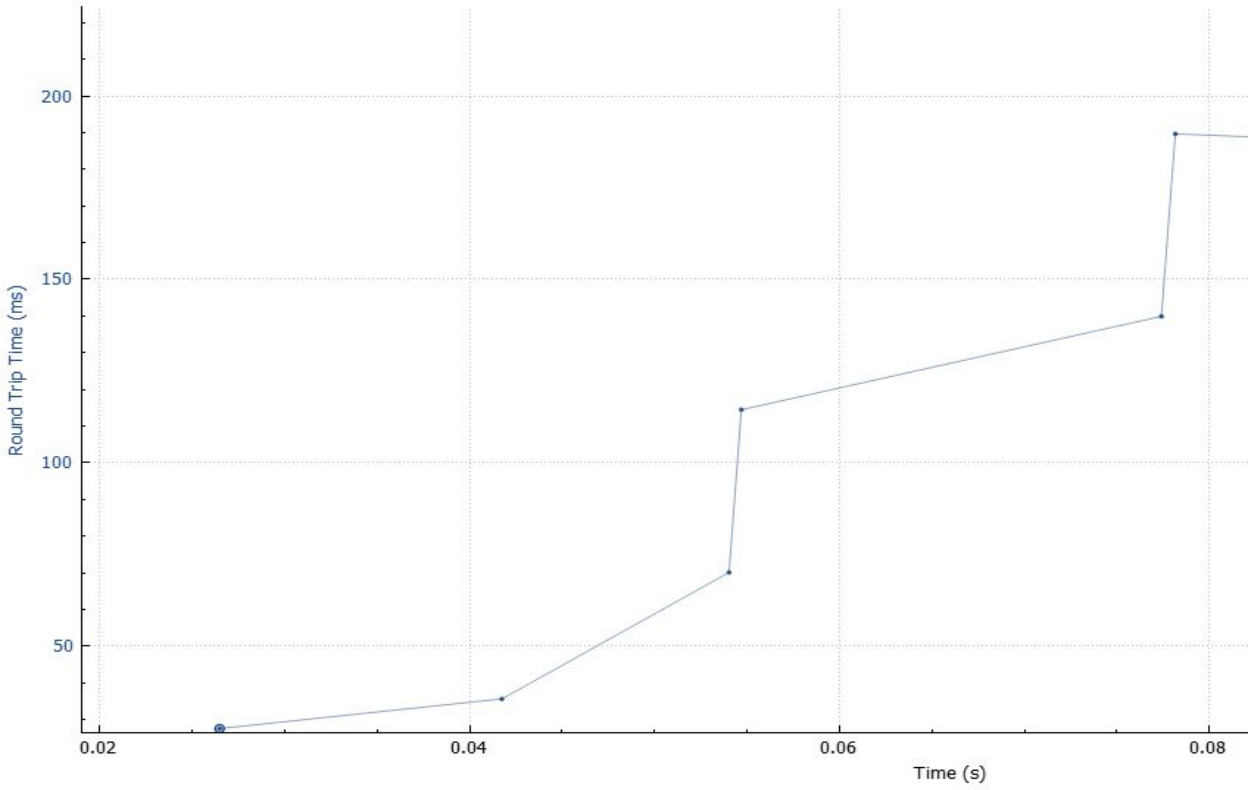
time = 15:44:20.838183

Segment	RTT (time ack - time of sent segment)
Seg 1	20.624318 - 20.596858 = 0.02746 sec
Seg 2	20.647675 - 20.612118 = 0.35557 sec
Seg 3	20.694466 - 20.624407 = 0.070059 sec
Seg 4	20.739499 - 20.625071 = 0.114428 sec
Seg 5	20.787680 - 20.647786 = 0.1398994 sec
Seg 6	20.838183 - 20.648538 = 0.189645 sec

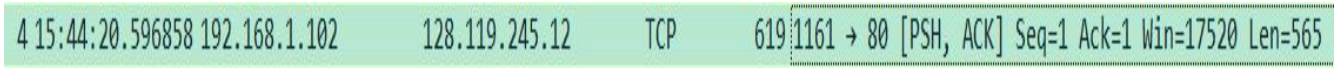
EstimatedRTT = (1 - 0.125) * EstimatedRTT(previous) + 0.125 * sampleRTT(current)

Segment	EstimatedRTT
Seg 1	0.02746 sec
Seg 2	0.875 * 0.2746 + 0.125 * 0.35557 = 0.28472 sec
Seg 3	0.875 * 0.28472 + 0.125 * 0.070059 = 0.25789 sec
Seg 4	0.875 * 0.25789 + 0.125 * 0.114428 = 0.23996 sec
Seg 5	0.875 * 0.23996 + 0.125 * 0.1398994 = 0.22745 sec
Seg 6	0.875 * 0.22745 + 0.125 * 0.189645 = 0.22272 sec

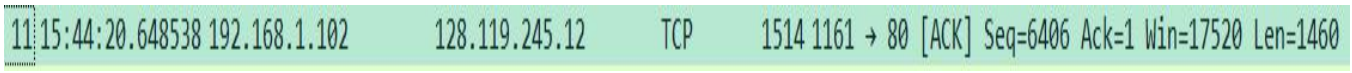
RTT plot for first six segments



8) -> Segments sent:

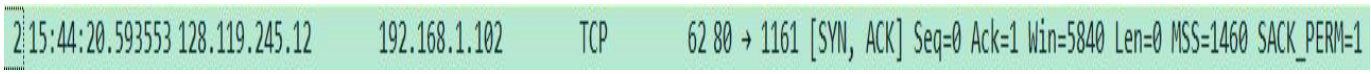


Length of First segment = 565 bytes

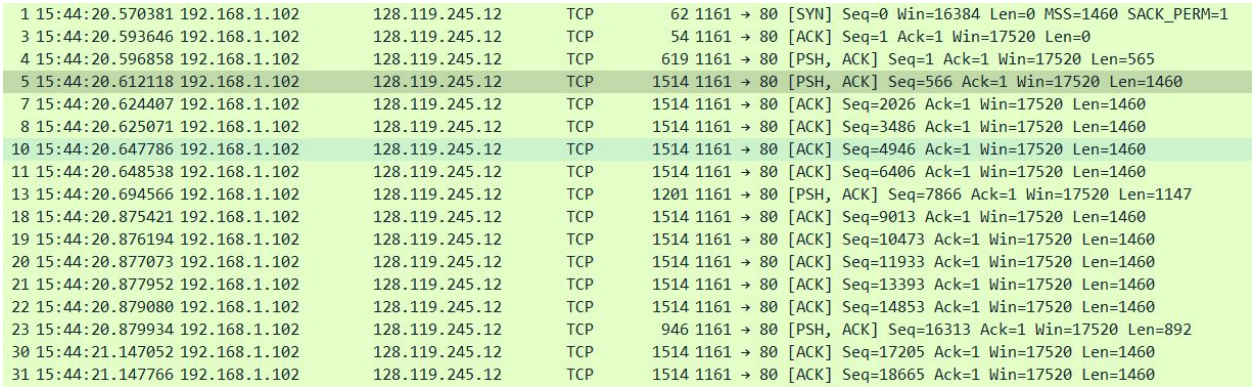


Length of next five segments = 1460 bytes

9) The minimum buffer is 5840 bytes , No , the sender is never throttled because each time the client sends data , the window size at the receiver is greater than it and able to hold it.



10) There are no retransmitted segments , by filtering on sent segments only , I found that all **sequence numbers** of sent segments are unique.



11) Data acknowledged for each ack is the current acknowledge number minus the previous acknowledge number , in this case the packet number no 52 the data received is (33589 - 31237) = 2352 bytes which is the sum of packets no 46 & 47 1460 + 892 = 2352 bytes

```
46 15:44:21.427183 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=31237 Ack=1 Win=17520 Len=1460
47 15:44:21.428064 192.168.1.102 128.119.245.12 TCP  946 1161 → 80 [PSH, ACK] Seq=32697 Ack=1 Win=17520 Len=892
48 15:44:21.469804 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=26857 Win=55480 Len=0
49 15:44:21.519926 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=28317 Win=58400 Len=0
50 15:44:21.565096 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=29777 Win=61320 Len=0
51 15:44:21.610201 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=31237 Win=62780 Len=0
52 15:44:21.687478 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=33589 Win=62780 Len=0
```

in the second case the packet number no 61 the data received is (40889 - 37969) = 2920 bytes which is the sum of packets no 56 & 57 --> 2 * 1460 = 2920 bytes

```
56 15:44:21.690239 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=37969 Ack=1 Win=17520 Len=1460
57 15:44:21.691283 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=39429 Ack=1 Win=17520 Len=1460
58 15:44:21.692272 192.168.1.102 128.119.245.12 TCP  946 1161 → 80 [PSH, ACK] Seq=40889 Ack=1 Win=17520 Len=892
59 15:44:21.770802 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=35049 Win=62780 Len=0
60 15:44:21.835407 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=37969 Win=62780 Len=0
61 15:44:21.932455 128.119.245.12 192.168.1.102 TCP   60 80 → 1161 [ACK] Seq=1 Ack=40889 Win=62780 Len=0
```

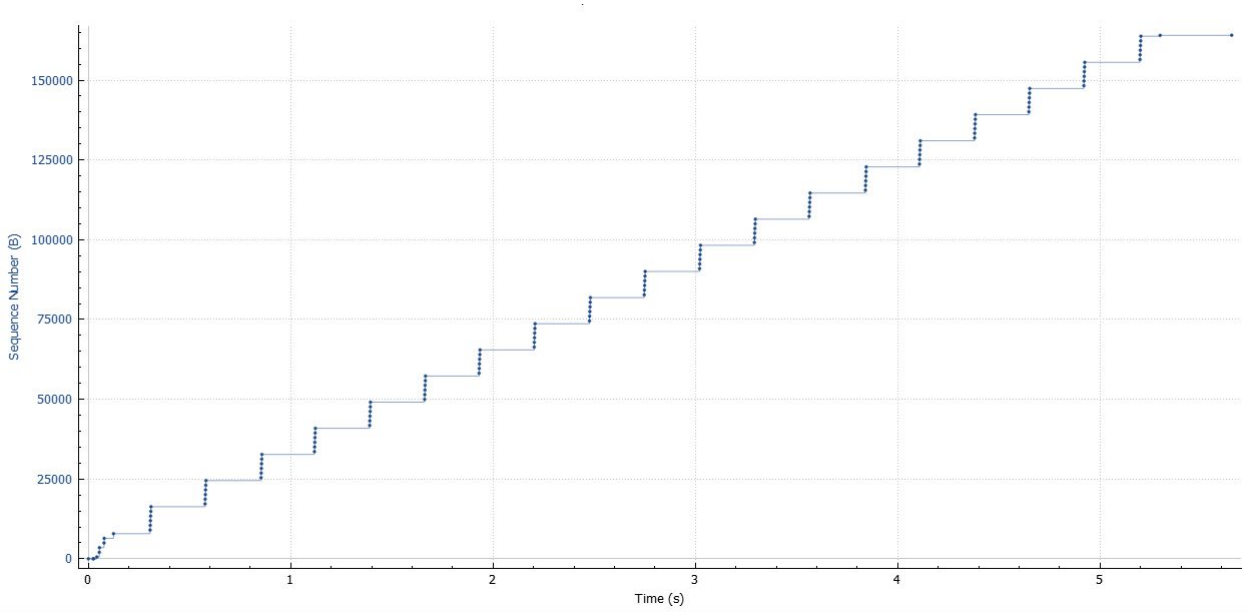
12) The file size(alice.txt) is 164090 bytes , the time for sending the first segment is 0.026477 sec and time for last ack is 5.45583 sec
So throughput is total size / average time to sent file
= 164090 / (5.45583 - 0.026477) = 30222.75 bytes / sec

```
No.     Time            Source          Destination     Protocol Length Info
    199 15:44:25.867722 192.168.1.102   128.119.245.12  HTTP     104    POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1  (te
plain)
Frame 199: 104 bytes on wire (832 bits), 104 bytes captured (832 bits)
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 164041, Ack: 1, Len: 50
[122 Reassembled TCP Segments (164090 bytes): #4(565), #5(1460), #7(1460), #8(1460), #10(1460), #11(1460), #13(1147), #18(1460), #19(1460
#20(1460), #21(1460), #22(1460), #23(892), #30(1460), #31(1460), #32(1460), #33(1460), #34(1460), #3]
```

```
No.     Time            Source          Destination     Protocol Length Info
      4 15:44:20.596858 192.168.1.102   128.119.245.12  TCP      619    1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 565
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 565]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 232129013
    [Next Sequence Number: 566    (relative sequence number)]
    Acknowledgment Number: 1    (relative ack number)
    Acknowledgment number (raw): 883061786
    0101 .... = Header Length: 20 bytes (5)
    Flags: 0x018 (PSH, ACK)
    Window: 17520
    [Calculated window size: 17520]
    [Window size scaling factor: -2 (no window scaling used)]
    Checksum: 0x1fbd [unverified]
    [Checksum Status: Unverified]
    Urgent Pointer: 0
    [SEQ/ACK analysis]
    [Timestamps]
        [Time since first frame in this TCP stream: 0.026477000 seconds]
        [Time since previous frame in this TCP stream: 0.003212000 seconds]
```

```
No.     Time              Source                Destination           Protocol Length Info
    202 15:44:26.026211    128.119.245.12        192.168.1.102         TCP      60     80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
Frame 202: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
Ethernet II, Src: LinksysG_da:af: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: 164091, Len: 0
    Source Port: 80
    Destination Port: 1161
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 883061786
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 164091    (relative ack number)
    Acknowledgment number (raw): 232293103
    0101 .... = Header Length: 20 bytes (5)
    Flags: 0x010 (ACK)
    Window: 62780
    [Calculated window size: 62780]
    [Window size scaling factor: -2 (no window scaling used)]
    Checksum: 0x44a8 [unverified]
    [Checksum Status: Unverified]
    Urgent Pointer: 0
    [SEQ/ACK analysis]
    [Timestamps]
        [Time since first frame in this TCP stream: 5.455830000 seconds]
        [Time since previous frame in this TCP stream: 0.007943000 seconds]
```

13) Slow start starts at 0 and ends nearly at 0.12 seconds , congestion avoidance starts at 0.3 sec . It seems that the slow start ends quickly and doesn't take a long time to switch to congestion avoidance stage.



14)

- Size of file on my computer is 155,648 bytes , time for sending first segment is 0.136477 sec and the time for last ack is 0.88386 sec so throughput is 155648 / (0.88386 - 0.136477) = 208257.346 bytes / sec

```
No.     Time              Source                Destination           Protocol Length Info
     88 19:10:01.018462    192.168.0.101         128.119.245.12        TCP      1506   3056 → 80 [ACK] Seq=1 Ack=1 Win=132096 Len=1452
Frame 88: 1506 bytes on wire (12048 bits), 1506 bytes captured (12048 bits) on interface \Device\NPF_{495AEA71-B264-4AB4-B682-FF9AA9A1A
id 0
Ethernet II, Src: LiteonTe_5d:37:d1 (cc:b0:da:5d:37:d1), Dst: Tp-LinkT_c0:41:50 (d4:6e:0e:c0:41:50)
Internet Protocol Version 4, Src: 192.168.0.101, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 3056, Dst Port: 80, Seq: 1, Ack: 1, Len: 1452
    Source Port: 3056
    Destination Port: 80
    [Stream index: 12]
    [TCP Segment Len: 1452]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 2277532093
    [Next Sequence Number: 1453    (relative sequence number)]
    Acknowledgment Number: 1    (relative ack number)
    Acknowledgment number (raw): 2183227511
    0101 .... = Header Length: 20 bytes (5)
    Flags: 0x010 (ACK)
    Window: 516
    [Calculated window size: 132096]
    [Window size scaling factor: 256]
    Checksum: 0x50c0 [unverified]
    [Checksum Status: Unverified]
    Urgent Pointer: 0
    [SEQ/ACK analysis]
    [Timestamps]
       [Time since first frame in this TCP stream: 0.136477000 seconds]
       [Time since previous frame in this TCP stream: 0.009771000 seconds]
    TCP payload (1452 bytes)
Data (1452 bytes)
0000  50 4f 53 54 20 2f 77 69 72 65 73 68 61 72 6b 2d  POST /wireshark-
```

```
No.     Time              Source                Destination           Protocol Length Info
    292 19:10:01.765845    128.119.245.12        192.168.0.101         TCP      54     80 → 3056 [ACK] Seq=1 Ack=153054 Win=183296 Len=0
Frame 292: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface \Device\NPF_{495AEA71-B264-4AB4-B682-FF9AA9A1AD2F}, id
Ethernet II, Src: Tp-LinkT_c0:41:50 (d4:6e:0e:c0:41:50), Dst: LiteonTe_5d:37:d1 (cc:b0:da:5d:37:d1)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.0.101
Transmission Control Protocol, Src Port: 80, Dst Port: 3056, Seq: 1, Ack: 153054, Len: 0
    Source Port: 80
    Destination Port: 3056
    [Stream index: 12]
    [TCP Segment Len: 0]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 2183227511
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 153054    (relative ack number)
    Acknowledgment number (raw): 2277685146
    0101 .... = Header Length: 20 bytes (5)
    Flags: 0x010 (ACK)
    Window: 1432
    [Calculated window size: 183296]
    [Window size scaling factor: 128]
    Checksum: 0x3d75 [unverified]
    [Checksum Status: Unverified]
    Urgent Pointer: 0
    [SEQ/ACK analysis]
    [Timestamps]
       [Time since first frame in this TCP stream: 0.883860000 seconds]
       [Time since previous frame in this TCP stream: 0.004879000 seconds]
```

14)

- Slow start starts at 7.7 sec and ends nearly at 7.8 seconds , congestion avoidance starts at 7.9 sec . It seems that the slow start ends quickly and doesn't take a long time to switch to congestion avoidance stage.