

1. What is the IP address and TCP port number used by the client computer (source) that is transferring the file to gaia.cs.umass.edu? To answer this question, it's probably easiest to select an HTTP message and explore the details of the TCP packet used to carry this HTTP message, using the “details of the selected packet header window” (refer to Figure 2 in the “Getting Started with Wireshark” Lab if you're uncertain about the Wireshark windows).

Answer:

The client IP address is *192.168.1.102*, TCP port number is *1161*

Screenshot

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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]

> Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)

> Ethernet II, Src: PremaxPe_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)

Acknowledgment number: 0

0111 = Header Length: 28 bytes (7)

> Flags: 0x002 (SYN)

Window size value: 16384

[Calculated window size: 16384]

Checksum: 0xf6e9 [unverified]

[Checksum Status: Unverified]

Urgent pointer: 0

> Options: (8 bytes), Maximum segment size, No-Operation (NOP), No-Operation (NOP), SACK permitted

source ip:192.168.1.102

source port:1161

Figure 1: SYN packet

2. What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection?

Answer:

gaia.cs.umass.edu's IP address is *128.119.245.12*, port number is *80*

Screenshot

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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]

> Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)

> Ethernet II, Src: LinksysG_da:af:73 (08:06:25:da:af:73), Dst: PremaxPe_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)
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]

gaia.cs.umass.edu ip: 128.119.245.12
gaia.cs.umass.edu port: 80

Figure 2: SYN ACK packet

4. What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu? What is it in the segment that identifies the segment as a SYN segment?

Answer: The sequence number of the TCP SYN segment is 0 since it is used to imitate the TCP connection between the client computer and gaia.cs.umass.edu. According to the screenshot below, in the Flags section, the SYN flag is set to 1 which indicates that this segment is a SYN segment.

Screenshot

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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]

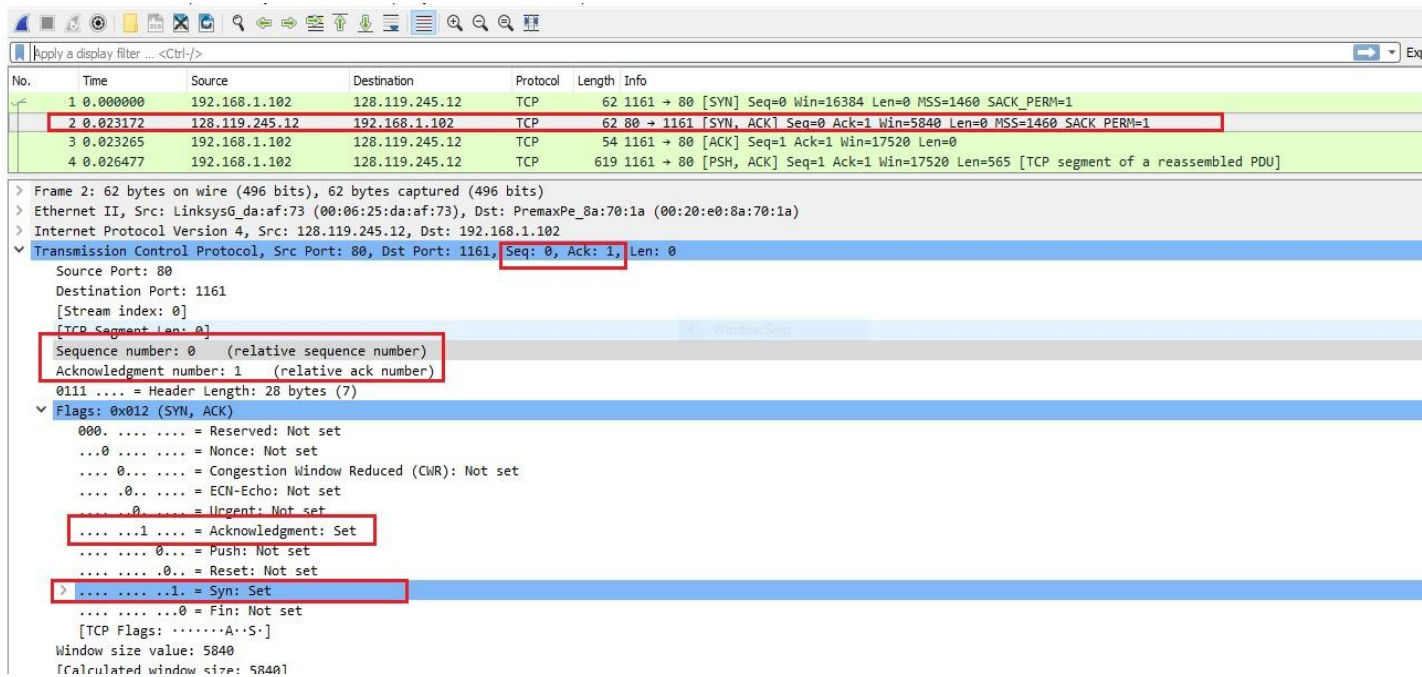
> Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
> Ethernet II, Src: PremaxPe_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
> Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
▼ Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0
Source Port: 1161
Destination Port: 80
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number)
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 SYN flag set to 1
...0... = Fin: Not set
[TCP Flags:S.]
Window size value: 16384
[Calculated window size: 16384]

Figure 3: SYN seq num + flag

5. What is the sequence number of the SYNACK segment sent by gaia.cs.umass.edu to the client computer in reply to the SYN? What is the value of the Acknowledgement field in the SYNACK segment? How did gaia.cs.umass.edu determine that value? What is it in the segment that identifies the segment as a SYNACK segment?

Answer: According to the screenshot below, the sequence number of the SYN_ACK segment sent by gaia.cs.umass.edu to the client computer in reply to the SYN is 0. The value of the acknowledgement field in the SYN_ACK segment is determined by the server gaia.cs.umass.edu. The server adds 1 to the initial sequence number of the SYN segment from the client computer. For this case, the initial sequence number of the SYN segment from the client computer is 0, thus the value of the acknowledgement field in the SYN_ACK segment is 1. A segment will be identified as a SYN_ACK segment if both SYN flag and ACKnowledgement flag in the segment are set to 1.

Screenshot



6. What is the sequence number of the TCP segment containing the HTTP POST command? Note that in order to find the POST command, you'll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with a "POST" within its DATA field.

Answer: The sequence number of the TCP segment containing the HTTP Post command is 1.

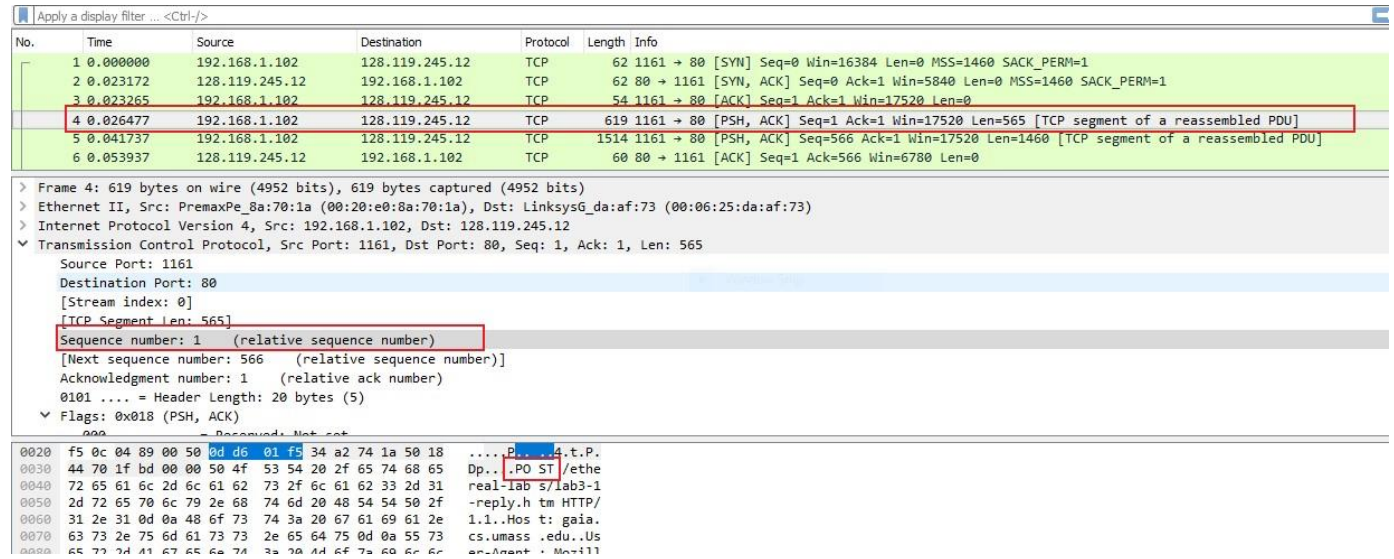
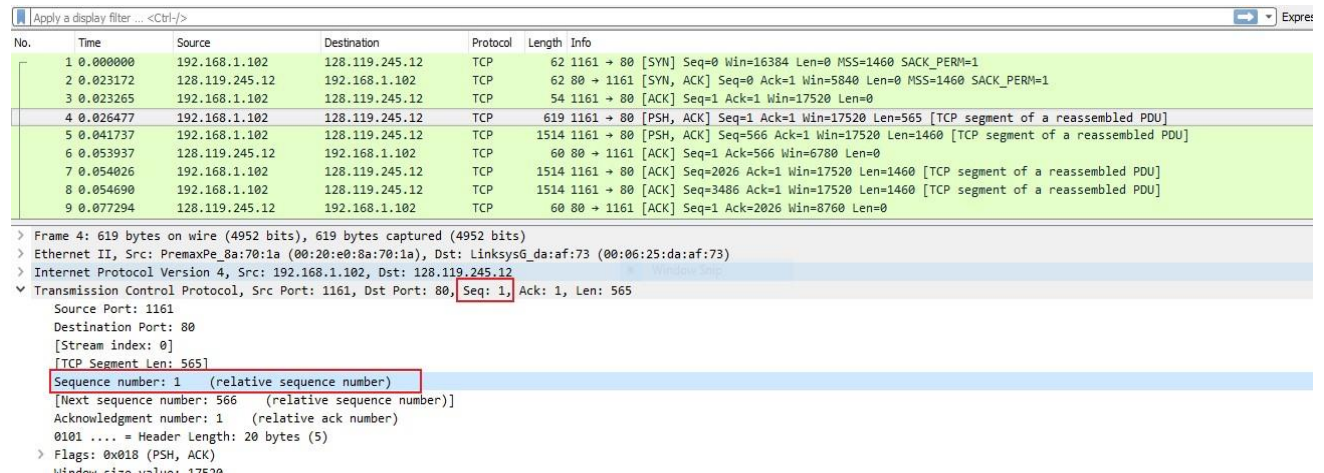


Figure 4: HTTP Post

7. Consider the TCP connection.
 - a. What are the sequence numbers of the first six segments in the TCP connection?

Answer: Sequence number for segment 1 is 1,
Sequence number for segment 2 is 566.
Sequence number of segment 3 is 2016.
Sequence number of segment 4 is 3486.
Sequence number of segment 5 is 4946.
Sequence number of segment 6 is 6406.

Screenshot:



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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

> Frame 5: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)
 > Ethernet II, Src: PremaxPe_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: 566, Ack: 1, Len: 1460

Source Port: 1161
 Destination Port: 80
 [Stream index: 0]
 [TCP Segment Len: 1460]
 Sequence number: 566 (relative sequence number)
 [Next sequence number: 2026 (relative sequence number)]
 Acknowledgment number: 1 (relative ack number)
 0101 = Header Length: 20 bytes (5)
 > Flags: 0x018 (PSH, ACK)
 Window size value: 17520
 [Calculated window size: 17520]

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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

> Frame 7: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)
 > Ethernet II, Src: PremaxPe_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: 2026, Ack: 1, Len: 1460

Source Port: 1161
 Destination Port: 80
 [Stream index: 0]
 [TCP Segment Len: 1460]
 Sequence number: 2026 (relative sequence number)
 [Next sequence number: 3486 (relative sequence number)]
 Acknowledgment number: 1 (relative ack number)
 0101 = Header Length: 20 bytes (5)
 > Flags: 0x010 (ACK)
 Window size value: 17520

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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

> Frame 8: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)
 > Ethernet II, Src: PremaxPe_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: 3486, Ack: 1, Len: 1460

Source Port: 1161
 Destination Port: 80
 [Stream index: 0]
 [TCP Segment Len: 1460]
 Sequence number: 3486 (relative sequence number)
 [Next sequence number: 4946 (relative sequence number)]
 Acknowledgment number: 1 (relative ack number)
 0101 = Header Length: 20 bytes (5)
 > Flags: 0x010 (ACK)
 Window size value: 17520
 [Calculated window size: 17520]
 [Window size scaling factor: -2 (no window scaling used)]

4	0.092365	128.168.1.102	128.119.245.12	TCP	54 → 1161	→ [ACK] Seq=1 Acl=1 Win=17520 Len=0	
4	0.026477	128.168.1.102	128.119.245.12	TCP	619 → 1161	→ 80 [PSH, ACK] Seq=1 Acl=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]	
5	0.041737	128.168.1.102	128.119.245.12	TCP	1514 → 1161	→ 80 [PSH, ACK] Seq=566 Acl=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	
6	0.053937	128.119.245.12	128.168.1.102	TCP	60 → 1161	[ACK] Seq=1 Acl=566 Win=6780 Len=0	
7	0.054026	128.168.1.102	128.119.245.12	TCP	1514 → 1161	→ 80 [ACK] Seq=2026 Acl=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	
8	0.054698	128.168.1.102	128.119.245.12	TCP	1514 → 1161	→ 80 [ACK] Seq=3486 Acl=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	
9	0.077294	128.168.1.102	128.119.245.12	TCP	60 → 1161	60 → 80 [ACK] Seq=1 Acl=2026 Win=9760 Len=0	
10	0.077405	128.168.1.102	128.119.245.12	TCP	1514 → 1161	→ 80 [ACK] Seq=4946 Acl=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	
11	0.078157	128.168.1.102	128.119.245.12	TCP	1514 → 1161	→ 80 [ACK] Seq=6406 Acl=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	

c. When was the ACK for each segment received?

3	0.823265	192.168.1.102	128.119.245.12	TCP	54	1161	> 80	[ACK] Seq=1 Ack=1 Win=17520 Len=0	
4	0.826477	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	0.841373	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	0.853937	128.119.245.12	192.168.1.102	TCP	60	80	> 1161	[ACK] Seq=1 Ack=566 Win=6780 Len=0	
7	0.854262	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	0.854690	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	0.877294	128.119.245.12	192.168.1.102	TCP	60	80	> 1161	[ACK] Seq=1 Ack=2026 Win=8768 Len=0	

> Frame 6: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)

> Ethernet II, Src: LinksysGda:af:73 (00:0e:25:da:af:73), Dst: PremaxPe_8a:70:1a (00:20:e0:8a:70:1a)

> Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102

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	0.054590	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=2926 Win=6780 Len=0	
10	0.077495	128.119.245.12	192.168.1.102	TCP	1514 1161 → 80 [ACK] Seq=6946 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	

> Frame 9: 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: PremaxPe Ba:70:1a (00:20:e0:8a:70:1a)

No.	Time	Source	Destination	Protocol	Length	Info
7	0.054036	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	0.054090	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=6760 Len=0
10	0.077485	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	1281	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	0.212799	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267892	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.308485	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.308490	128.119.245.12	192.168.1.102	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=7866 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

No.	Time	Source	Destination	Protocol	Length	Info
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	0.212799	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]

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	1281	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	0.267882	128.119.245.12	192.168.1.102	TCP	60	80	1161	[ACK]	Seq=1 Ack=7866 Win=20440 Len=0
17	0.304887	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]

No.	Time	Source	Destination	Protocol	Length	Info
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]

- d. Given the difference between when each TCP segment was sent, and when its acknowledgement was received, what is the RTT value for each of the six segments?

Answer:

RTT for segment 1 is 0.02746 seconds,
 RTT for segment 2 is 0.035557 seconds,
 RTT for segment 3 is 0.070059 seconds,
 RTT for segment 4 is 0.114428 seconds,
 RTT for segment 5 is 0.139894 seconds,
 RTT for segment 6 is 0.189645 seconds.

Segment	Packet Number	Sequence Number	Time Sent(s)	Time ACK received(s)	RTT(s)
1	4	1	0.026477	0.053937	0.02746
2	5	566	0.041737	0.077294	0.035557
3	7	2016	0.054026	0.124085	0.070059
4	8	3486	0.054690	0.169118	0.114428
5	10	4946	0.077405	0.217299	0.139894
6	11	6406	0.078157	0.267802	0.189645

8. What is the length of each of the first six TCP segments?

Answer:

The length of each of the first 6 TCP segments is 1400 bytes.

Segment	Packet Number	Sequence Number	Length(bytes)	Time Sent(s)	Time ACK received(s)	RTT(s)
1	4	1	565	0.026477	0.053937	0.02746
2	5	566	1400	0.041737	0.077294	0.035557
3	7	2016	1400	0.054026	0.124085	0.070059
4	8	3486	1400	0.054690	0.169118	0.114428
5	10	4946	1400	0.077405	0.217299	0.139894
6	11	6406	1400	0.078157	0.267802	0.189645

Screenshot:

No.	Time	Source	Destination	Protocol	Length	Info
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=6788 Len=0

> Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)

> Ethernet II, Src: PremaxPe_8a:70:1a (00:20:e0:8a:70:1a), Dst: Linksys6_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)

[Next sequence number: 566 (relative sequence number)]

Acknowledgment number: 1 (relative ack number)

0101 ... = Header Length: 20 bytes (5)

> Flags: 0x018 (PSH, ACK)

Window size value: 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]

TCP payload (565 bytes)

[Reassembled PDU in frame: 199]

TCP segment data (565 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

> Frame 5: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)

> Ethernet II, Src: PremaxPe_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: 566, Ack: 1, Len: 1460

Source Port: 1161
Destination Port: 80
[Stream index: 0]
[TCP Segment Len: 1460]
Sequence number: 566 (relative sequence number)
[Next sequence number: 2026 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
0101 ... = Header Length: 20 bytes (5)
Flags: 0x018 (PSH, ACK)
Window size value: 17520
[Calculated window size: 17520]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0x3be5 [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
[SEQ/ACK analysis]
TCP payload (1460 bytes)
Reassembled PDU in frame: 199
TCP segment data (1460 bytes)

No.	Time	Source	Destination	Protocol	Length	Info
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

> Frame 7: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)

> Ethernet II, Src: PremaxPe_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: 2026, Ack: 1, Len: 1460

Source Port: 1161
Destination Port: 80
[Stream index: 0]
[TCP Segment Len: 1460]
Sequence number: 2026 (relative sequence number)
[Next sequence number: 3486 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
0101 ... = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 17520
[Calculated window size: 17520]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0xb98e [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
[SEQ/ACK analysis]
TCP payload (1460 bytes)
Reassembled PDU in frame: 199
TCP segment data (1460 bytes)

No.	Time	Source	Destination	Protocol	Length	Info
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

> Frame 8: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)

> Ethernet II, Src: PremaxPe_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: 3486, Ack: 1, Len: 1460

Source Port: 1161
Destination Port: 80
[Stream index: 0]
[TCP Segment Len: 1460]
Sequence number: 3486 (relative sequence number)
[Next sequence number: 4946 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
0101 ... = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 17520
[Calculated window size: 17520]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0xdd01 [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
[SEQ/ACK analysis]
TCP payload (1460 bytes)
Reassembled PDU in frame: 199
TCP segment data (1460 bytes)

No.	Time	Source	Destination	Protocol	Length	Info
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]

> Frame 10: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)

> Ethernet II, Src: PremaxPe_8a:70:1a (00:20:e0:8a:70:1a), Dst: Linksys6_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: 4946, Ack: 1, Len: 1460

Source Port: 1161

Destination Port: 80

[Stream index: 0]

[TCP Segment Len: 1460]

Sequence number: 4946 (relative sequence number)

[Next sequence number: 6406 (relative sequence number)]

Acknowledgment number: 1 (relative ack number)

0101 = Header Length: 20 bytes (5)

> Flags: 0x010 (ACK)

Window size value: 17520

[Calculated window size: 17520]

[Window size scaling factor: -2 (no window scaling used)]

Checksum: 0x908e [unverified]

[Checksum Status: Unverified]

Urgent pointer: 0

> [SEQ/ACK analysis]

TCP payload (1460 bytes)

[Reassembled PDU in frame: 199]

TCP segment data (1460 bytes)

No.	Time	Source	Destination	Protocol	Length	Info
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]

> Frame 11: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)

> Ethernet II, Src: PremaxPe_8a:70:1a (00:20:e0:8a:70:1a), Dst: Linksys6_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: 6406, Ack: 1, Len: 1460

Source Port: 1161

Destination Port: 80

[Stream index: 0]

[TCP Segment Len: 1460]

Sequence number: 6406 (relative sequence number)

[Next sequence number: 7866 (relative sequence number)]

Acknowledgment number: 1 (relative ack number)

0101 = Header Length: 20 bytes (5)

> Flags: 0x010 (ACK)

Window size value: 17520

[Calculated window size: 17520]

[Window size scaling factor: -2 (no window scaling used)]

Checksum: 0x9583 [unverified]

[Checksum Status: Unverified]

Urgent pointer: 0

> [SEQ/ACK analysis]

TCP payload (1460 bytes)

[Reassembled PDU in frame: 199]

TCP segment data (1460 bytes)

9. What is the minimum amount of available buffer space advertised at the received for the entire trace? Does the lack of receiver buffer space ever throttle the sender?

Answer:

The minimum amount of available buffer space advertised at the received is 17536 bytes.

Segment	Available Buffer Space Advertised At The Received
1	6780
2	8760
3	11680
4	14600
5	17520
6	20440

Screenshot:

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	0.054025	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	0.064600	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=2486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

▼ Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 566, Len: 0

Source Port: 80
Destination Port: 1161
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 1 (relative sequence number)
Acknowledgment number: 566 (relative ack number)
0101 = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 6780
[Calculated window size: 6780]
[Window size scaling factor: -2 (no window scaling used)]

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]

▼ Frame 9: 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: PremaxPe_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: 2026, Len: 0

Source Port: 80
Destination Port: 1161
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 1 (relative sequence number)
Acknowledgment number: 2026 (relative ack number)
0101 = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 8760
[Calculated window size: 8760]

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	0.124105	192.168.1.102	128.119.245.12	TCP	1281	1161 → 80	[PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
14	0.160910	192.168.1.102	128.119.245.12	TCP	60	80 → 1161	[ACK] Seq=1 Ack=7866 Win=17520 Len=0

▼ Frame 12: 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: PremaxPe_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: 3486, Len: 0

Source Port: 80
Destination Port: 1161
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 1 (relative sequence number)
Acknowledgment number: 3486 (relative ack number)
0101 = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 11680
[Calculated window size: 11680]

13	0.124185	192.168.1.102	128.119.245.12	TCP	1281	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	0.306603	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80	[ACK] Seq=11033 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

▼ Frame 14: 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: PremaxPe_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: 4946, Len: 0

Source Port: 80
Destination Port: 1161
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 1 (relative sequence number)
Acknowledgment number: 4946 (relative ack number)
0101 = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 14600
[Calculated window size: 14600]
[Window size scaling factor: -2 (no window scaling used)]

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	0.306593	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80	[ACK] Seq=11032 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	
> Frame 15: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0 > Ethernet II, Src: LinksysG_da:af:73 (00:06:25:da:af:73), Dst: PremaxPe_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: 6406, Len: 0 Source Port: 80 Destination Port: 1161 [Stream index: 0] [TCP Segment Len: 0] Sequence number: 1 (relative sequence number) Acknowledgment number: 6406 (relative ack number) 0101 = Header Length: 20 bytes (5) > Flags: 0x010 (ACK) Window size value: 17520 [Calculated window size: 17520] [Window size scaling factor: -2 (no window scaling used)]							

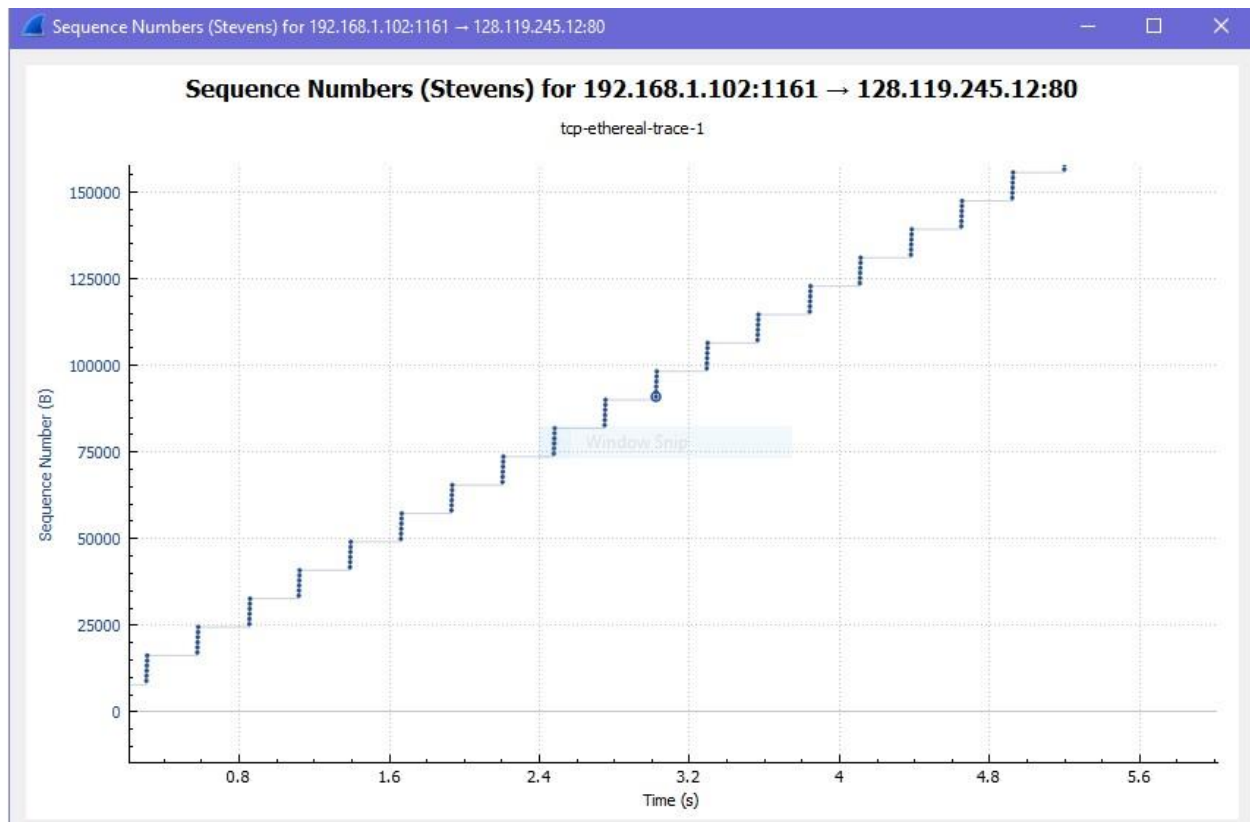
14	0.169118	128.119.245.12	192.168.1.102	TCP	60 80 → 1161	[ACK] Seq=1 Ack=4946 Win=14600 Len=0	
15	0.217299	128.119.245.12	192.168.1.102	TCP	60 80 → 1161	[ACK] Seq=1 Ack=6406 Win=17520 Len=0	
16	0.267802	128.119.245.12	192.168.1.102	TCP	60 80 → 1161	[ACK] Seq=1 Ack=7866 Win=20440 Len=0	
17	0.304807	128.119.245.12	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	0.306593	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80	[ACK] Seq=11032 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]	
> Frame 16: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0 > Ethernet II, Src: LinksysG_da:af:73 (00:06:25:da:af:73), Dst: PremaxPe_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: 7866, Len: 0 Source Port: 80 Destination Port: 1161 [Stream index: 0] [TCP Segment Len: 0] Sequence number: 1 (relative sequence number) Acknowledgment number: 7866 (relative ack number) 0101 = Header Length: 20 bytes (5) > Flags: 0x010 (ACK) Window size value: 20440 [Calculated window size: 20440] [Window size scaling factor: -2 (no window scaling used)]							

10. Are there any retransmitted segments in the trace file? What did you check for (in the trace) in order to answer this question?

Answer:

No there is no retransmitted segments in the trace file. This can be explained by packets with same sequence number at different time is not found.

Screenshot:



11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 247 in the text).

Answer: According to the screenshot below, we can see that the ACK numbers increase in the sequence of 566, 2026, 3486, and so on. The ACK numbers increase by 1460 each time, indicating that the receiver is acknowledging 1460 bytes.

Screenshot:

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	0.305048	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=26280 Len=0
25	0.400164	128.119.245.12	192.168.1.102	TCP	60	80 → 1161	[ACK] Seq=1 Ack=11933 Win=29280 Len=0

12. What is the throughput (bytes transferred per unit time) for the TCP connection?
Explain how you calculated this value.

Answer:

$$\text{Throughput} = \frac{\text{Amount of data transmitted}}{\text{time incurred}}$$

Amount of data transmitted = 150,965 bytes

Time incurred = 6.32201300 – 2.02610500 = 4.295908 s

$$\text{Throughput} = \frac{150965}{4.295908}$$

Throughput = 35.141 kbytes/sec

Screenshot:

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=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	128.119.245.12	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	128.119.245.12	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

Time Send First Segment

196	5.201150	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 reassembled PDU]
197	5.202024	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 reassembled PDU]
198	5.297257	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
199	5.297341	192.168.1.102	128.119.245.12	HTTP	104	POST /etherreal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
200	5.389471	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201	5.447887	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202	5.455830	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	5.461175	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)

> Frame 199: 104 bytes on wire (832 bits), 104 bytes captured (832 bits)
 > Ethernet II, Src: PremaxPe_8a:70:1a (00:20:e0:8a:70:1a), Dst: Linksys6_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
 Source Port: 1161
 Destination Port: 80
 [Stream index: 0]

Time Send Last Segment

Here, amount of data transmitted = 164041

Time incurred = 5.297341 – 0.023265 = 5.274076

Throughput = (164041 / 5.274076) = 31103.26814 bytes/sec
= 30.37 kbytes/sec

13. Use the Time-Sequence-Graph(Stevens) plotting tool to view the sequence number versus time plot of segments being sent from the client to the gaia.cs.umass.edu server. Can you identify where TCP's slow start phase begins and ends, and where congestion avoidance takes over? Comment on ways in which the measured data differs from the idealized behaviour of TCP that we've studied in the text.

Answer:

By observing the plot, we can see that the slow-start phase only lasts for first 0.2-0.8 second. Afterwards, it seems that the TCP session is always in congestion avoidance state. In this case, we do not observe the expected linear increase behaviour, i.e. the TCP transmit window does not grow linearly during this phase. This does not seem to be caused by flow control since the receiver advertised window is significantly larger than 5 packets. The reason for this behaviour might be due to the fact that the HTTP server has enforced a rate-limit of some sort.

Screenshot:

