

Source and destination IP addresses and TCP port numbers

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?

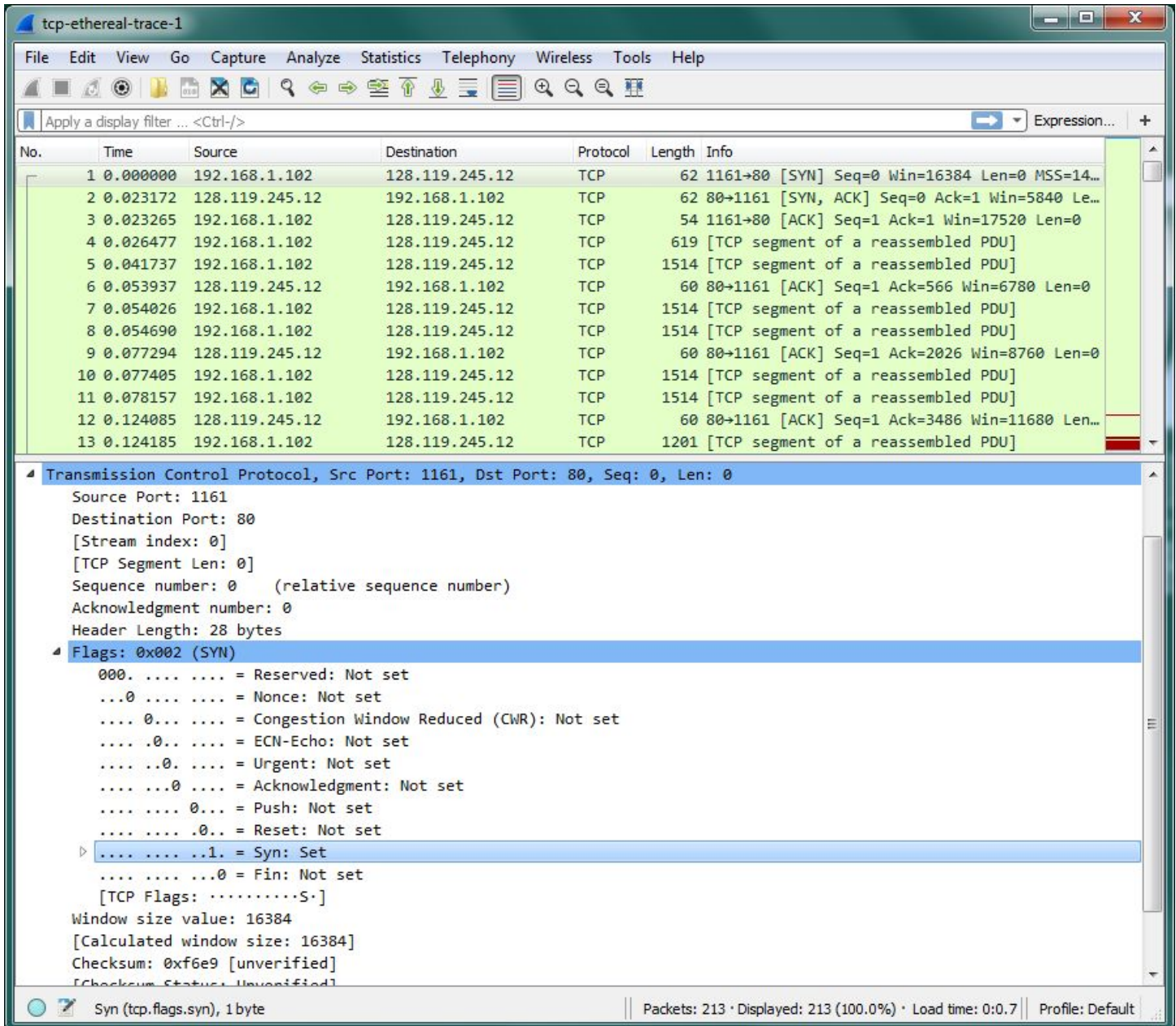
The client computer has the IP address **192.168.1.102** and TCP port number **1161**.

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?

The gaia.cs.umass.edu server has the IP address **128.119.245.12** and TCP port number **80**.

3. If you have been able to create your own trace, what is the IP address and TCP port number used by your client computer (source) to transfer the file to gaia.cs.umass.edu?

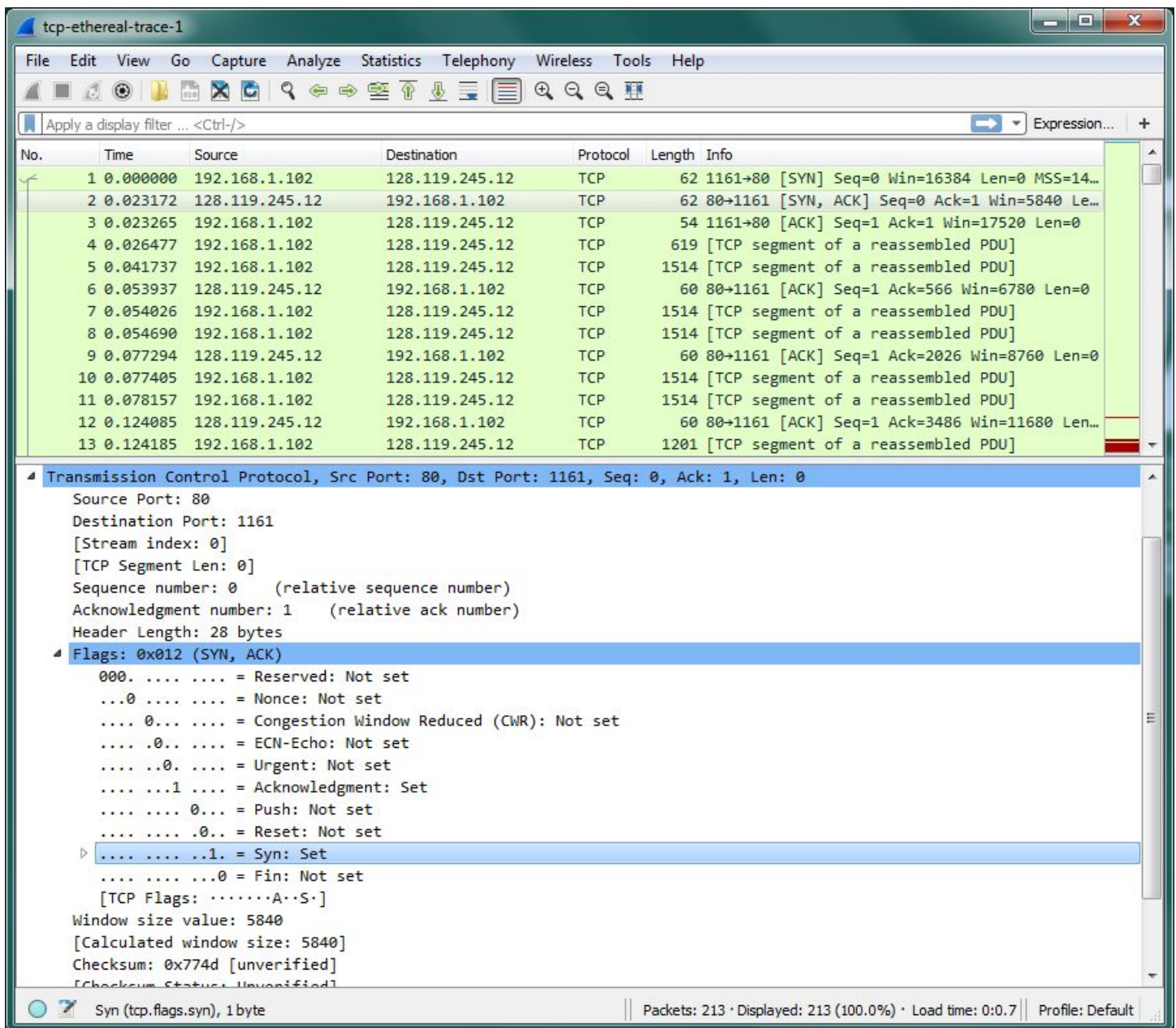
We have used the trace found at <http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip>.



TCP SYN segment

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?

The sequence number **0** is used to initiate the TCP connection between the client and server. The **SYN** flag is set (value of **1**), indicating that this is a **SYN** segment.



TCP SYNACK segment

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?

The **SYNACK** segment has sequence number **0** (like the **SYN** segment above) and an acknowledgement value of **1**. This value is determined by incrementing the sequence number from the **SYN** segment. The **SYN** and **Acknowledgement** flags identify this as a **SYNACK** segment.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Apply a display filter ... <Ctrl-/> Expression...

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=14...
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80→1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Le...
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]

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)
Header Length: 20 bytes
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 segment data (565 bytes)

0030 44 70 1f bd 00 00 50 4f 53 54 20 2f 65 74 68 65 Dp...PO ST /ethe
0040 72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 33 2d 31 real-lab s/lab3-1
0050 2d 72 65 70 6c 79 2e 68 74 6d 20 48 54 54 50 2f -reply.h tm HTTP/
0060 31 2e 31 0d 0a 48 6f 73 74 3a 20 67 61 69 61 2e 1.1..Host: gaia.
0070 63 73 2e 75 6d 61 73 73 2e 65 64 75 0d 0a 55 73 cs.umass .edu..Us
0080 65 72 2d 41 67 65 6e 74 3a 20 4d 6f 7a 69 6c 6c er-Agent : Mozill

A data segment used in reassembly of a [...I] protocol (tcp.segment_data), 565 bytes | Packets: 213 · Displayed: 213 (100.0%) · Load time: 0:0.7 | Profile: Default

Segment containing HTTP POST command

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 View window, looking for a segment with a "POST" within its DATA field.

The TCP segment containing the HTTP POST command has sequence number 1.

The image shows a Wireshark packet capture window titled 'tcp-ethereal-trace-1'. The main display area shows a list of 20 captured packets. The first three packets are SYN, ACK, and ACK segments. The subsequent packets are TCP segments of a reassembled PDU. The packet details pane for packet 4 is expanded, showing the TCP header information.

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=14...
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80→1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Le...
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[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...
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	[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...
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=6406 Win=17520 Len...
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=7866 Win=20440 Len...
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=9013 Win=23360 Len...
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]

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)
- Header Length: 20 bytes
- 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

Transmission Control Protocol (tcp), 20 bytes | Packets: 213 · Displayed: 213 (100.0%) · Marked: 6 (2.8%) · Load time: 0:0.7 | Profile: Default

Segments 1 through 6

The image shows a Wireshark packet capture window titled 'tcp-ethereal-trace-1'. The main display area shows a list of 20 captured packets. Packets 1 through 6 are SYN and ACK segments from 192.168.1.102 to 128.119.245.12. Packets 7 through 20 are TCP segments of a reassembled PDU from 128.119.245.12 to 192.168.1.102. The packet details pane for packet 6 is expanded, showing the Transmission Control Protocol header with Source Port 80, Destination Port 1161, Sequence number 1, Acknowledgment number 566, and Flags set to ACK. The status bar at the bottom indicates 213 packets displayed, with 6 marked (2.8%) and a load time of 0:0.7.

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=14...
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80→1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Le...
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[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...
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	[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...
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=6406 Win=17520 Len...
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=7866 Win=20440 Len...
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=9013 Win=23360 Len...
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	[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)
- Header Length: 20 bytes
- Flags: 0x010 (ACK)
- Window size value: 6780
- [Calculated window size: 6780]
- [Window size scaling factor: -2 (no window scaling used)]
- Checksum: 0x9e30 [unverified]
- [Checksum Status: Unverified]
- Urgent pointer: 0
- [SEQ/ACK analysis]

Transmission Control Protocol (tcp), 20 bytes | Packets: 213 · Displayed: 213 (100.0%) · Marked: 6 (2.8%) · Load time: 0:0.7 | Profile: Default

Acknowledgements of segments 1 through 6

7. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection. What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST)? At what time was each segment sent? When was the ACK for each segment received? 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? What is the EstimatedRTT value (see Section 3.5.3, page 239 in text) after the receipt of each ACK? Assume that the value of the EstimatedRTT is equal to the measured RTT for the first segment, and then is computed using the EstimatedRTT equation on page 239 for all subsequent segments.

Number	Packet Number		Sequence Number		Time Segment Sent	Time ACK Received	RTT
	Segment	ACK	Segment	ACK			
1	4	6	1	566	0.026477	0.053937	0.027460
2	5	9	566	2026	0.041737	0.077294	0.035557
3	7	12	2026	3486	0.054026	0.124085	0.070059
4	8	14	3486	4946	0.054690	0.169118	0.114430
5	10	15	4946	6406	0.077405	0.217299	0.139890
6	11	16	6406	7866	0.078157	0.267802	0.189640

$$EstimatedRTT = (0.875 \times EstimatedRTT) + (0.125 \times SampleRTT)$$

EstimatedRTT after **ACK 1**

$$= RTT \text{ for Segment 1} = 0.02746 \text{ seconds}$$

EstimatedRTT after **ACK 2**

$$= (0.875 \times 0.02746) + (0.125 \times 0.035557) = 0.0285 \text{ seconds}$$

EstimatedRTT after **ACK 3**

$$= (0.875 \times 0.0285) + (0.125 \times 0.070059) = 0.0337 \text{ seconds}$$

EstimatedRTT after **ACK 4**

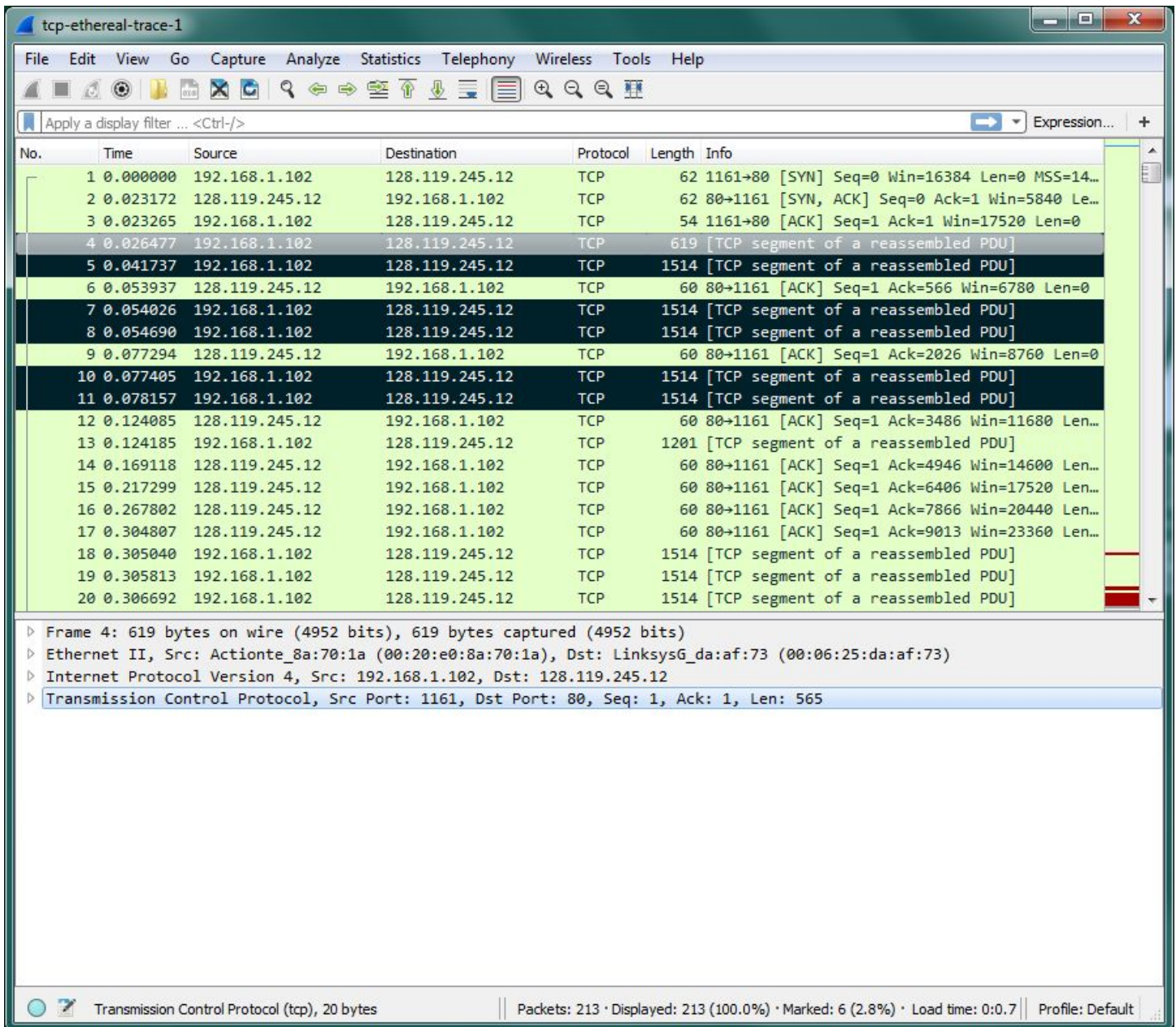
$$= (0.875 \times 0.0337) + (0.125 \times 0.11443) = 0.0438 \text{ seconds}$$

EstimatedRTT after **ACK 5**

$$= (0.875 \times 0.0438) + (0.125 \times 0.13989) = 0.0558 \text{ seconds}$$

EstimatedRTT after **ACK 6**

$$= (0.875 \times 0.0558) + (0.125 \times 0.18964) = 0.0725 \text{ seconds}$$



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=14...
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80→1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Le...
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[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...
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	[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...
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=6406 Win=17520 Len...
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=7866 Win=20440 Len...
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=9013 Win=23360 Len...
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]

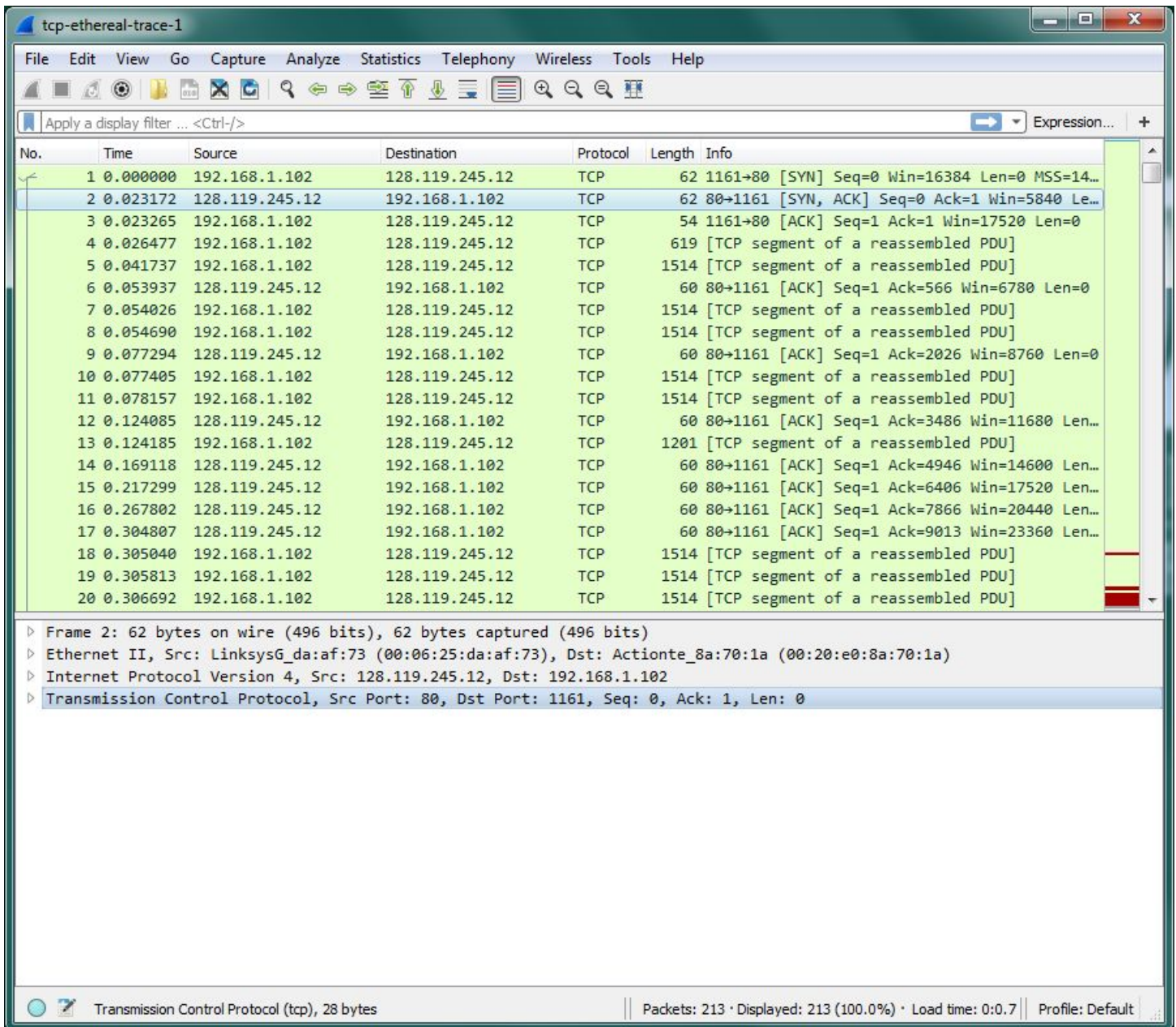
Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 565

Transmission Control Protocol (tcp), 20 bytes | Packets: 213 · Displayed: 213 (100.0%) · Marked: 6 (2.8%) · Load time: 0:0.7 | Profile: Default

Length of first TCP segment

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

Segment 1 is 565 bytes long while segments 2 through 6 are 1460 bytes long.



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=14...
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80→1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Le...
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	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[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...
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	[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...
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=6406 Win=17520 Len...
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=7866 Win=20440 Len...
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=9013 Win=23360 Len...
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	[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 (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

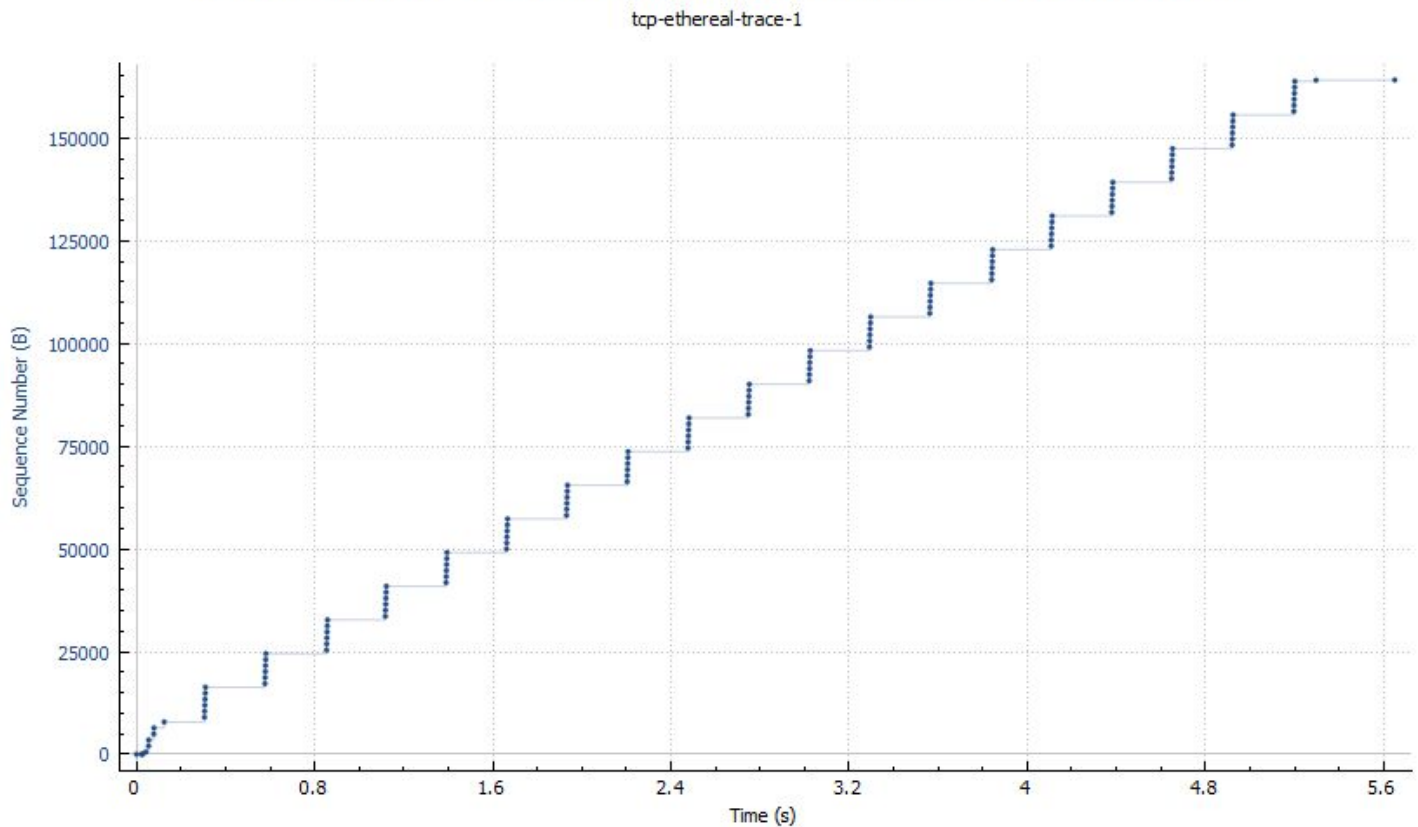
Transmission Control Protocol (tcp), 28 bytes | Packets: 213 · Displayed: 213 (100.0%) · Load time: 0:0.7 | Profile: Default

Minimum buffer space

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

The minimum amount of available buffer space is advertised in the first acknowledgement from the server as 5840 bytes. The sender is never throttled by the lack of receiver buffer space.

Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80



Time-sequence graph for the trace

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

There are no retransmitted segments in the trace file. The time-sequence graph reveals that each successive sequence number is greater than those before it, meaning that no segment was ever sent again.

No.	Time	Source	Destination	Protocol	Length	Info
74	1.663315	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
75	1.664198	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
76	1.665254	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
77	1.666151	192.168.1.102	128.119.245.12	TCP	946	[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 Le...
79	1.860063	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=55813 Win=62780 Le...
80	1.930880	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=58165 Win=62780 Le...
81	1.931099	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
82	1.931879	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
83	1.932757	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
84	1.933636	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
85	1.934770	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
86	1.935586	192.168.1.102	128.119.245.12	TCP	946	[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 Le...
88	2.126682	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=64005 Win=62780 Le...
89	2.203195	128.119.245.12	192.168.1.102	TCP	60	80→1161 [ACK] Seq=1 Ack=66357 Win=62780 Le...
90	2.203411	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
91	2.204125	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
92	2.204962	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
93	2.205836	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]

▶ Frame 88: 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: 64005, Len: 0

Transmission Control Protocol (tcp), 20 bytes Packets: 213 · Displayed: 213 (100.0%) · Marked: 4 (1.9%) · Load time: 0:0.7 Profile: Default

ACKing every other segment

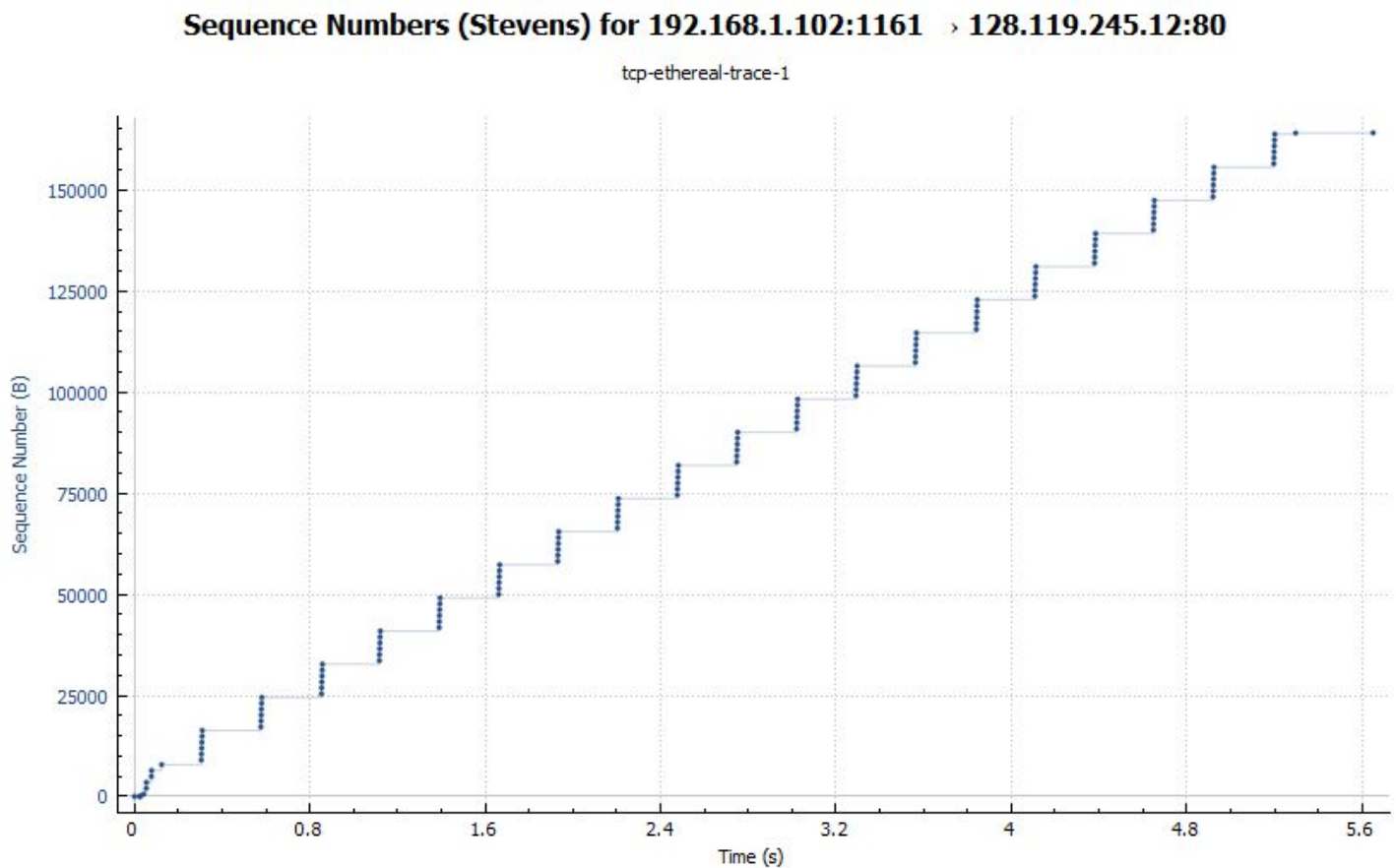
11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 247 in the text).

The receiver typically acknowledges **1460** bytes of data. **10** out of **12** acknowledgements were of this size; of the remaining two, one acknowledged **566** bytes and the other **1147**. If you inspect the acknowledged data of each ACK, there are cases where the receiver is ACKing every other segment. For example, segment **80** acknowledges **2920** bytes of data, or **2 × 1460** bytes.

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

The throughput of the TCP connection may be calculated by taking the total amount of data transferred and dividing it by the total time the connection was open. In doing this, we can calculate an average throughput for the duration of the connection. The total amount of data transferred can be calculated by finding the difference between the sequence number of the first segment (1 byte) and last ACK (164091 bytes). The total amount of time can be calculated by finding the difference between the time the first segment was sent (0.026477 seconds) and the time the last ACK was received (5.455830 seconds).

$$\text{Throughput} = \frac{\text{total bytes}}{\text{total time}} = \frac{164091 - 1}{5.455830 - 0.026477} = \frac{164090}{5.429353} = 30.222 \text{ bytes/second}$$



Time-Sequence graph for the trace

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 behavior of TCP that we've studied in the text.

TCP's slow start phase begins when the connection starts, when the HTTP POST segment is sent. According to the graph, the slow start ends at approximately time 0.18.