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Bill Pfeil

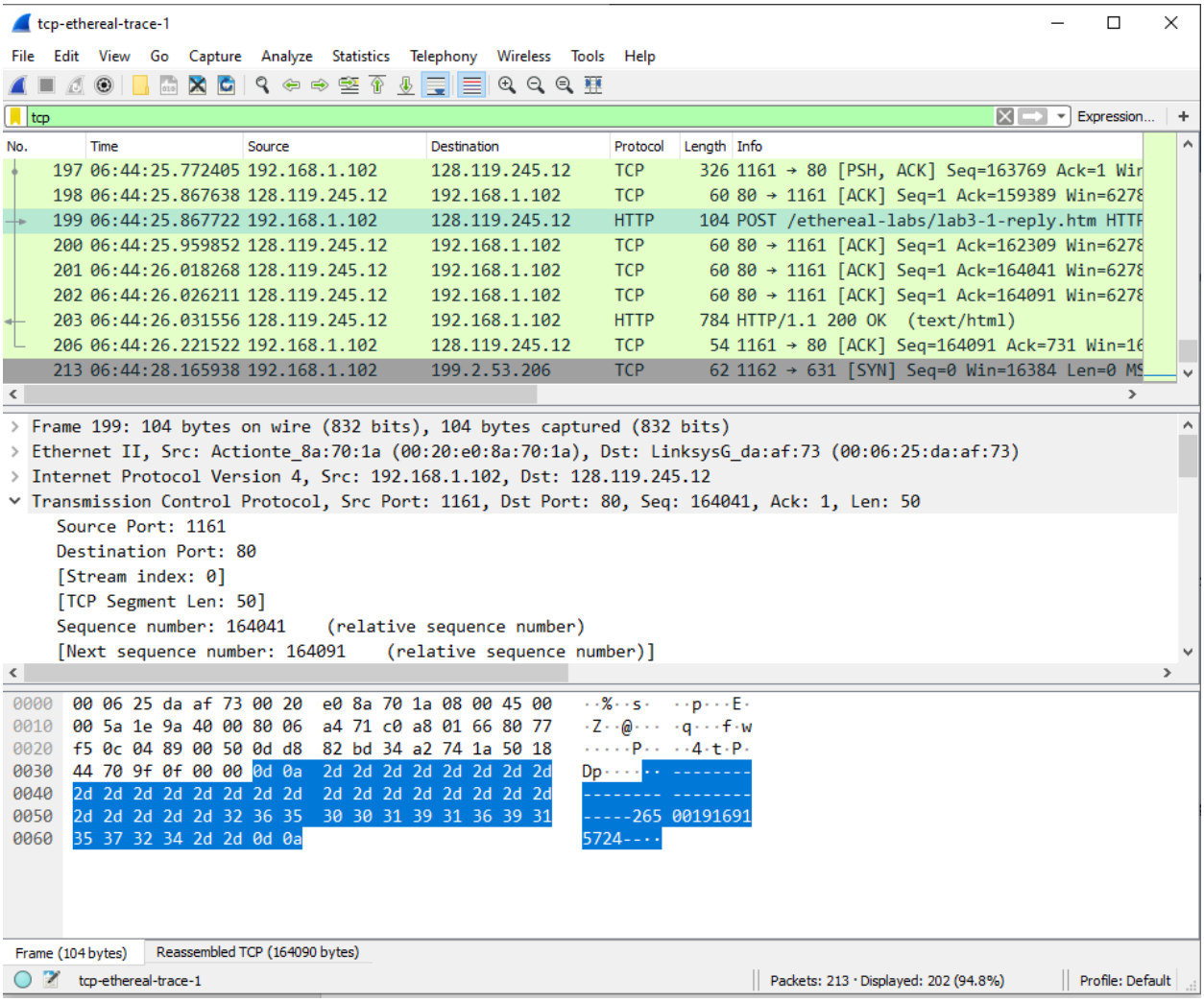
CS 372-X001

11/10/2019

Lab 3

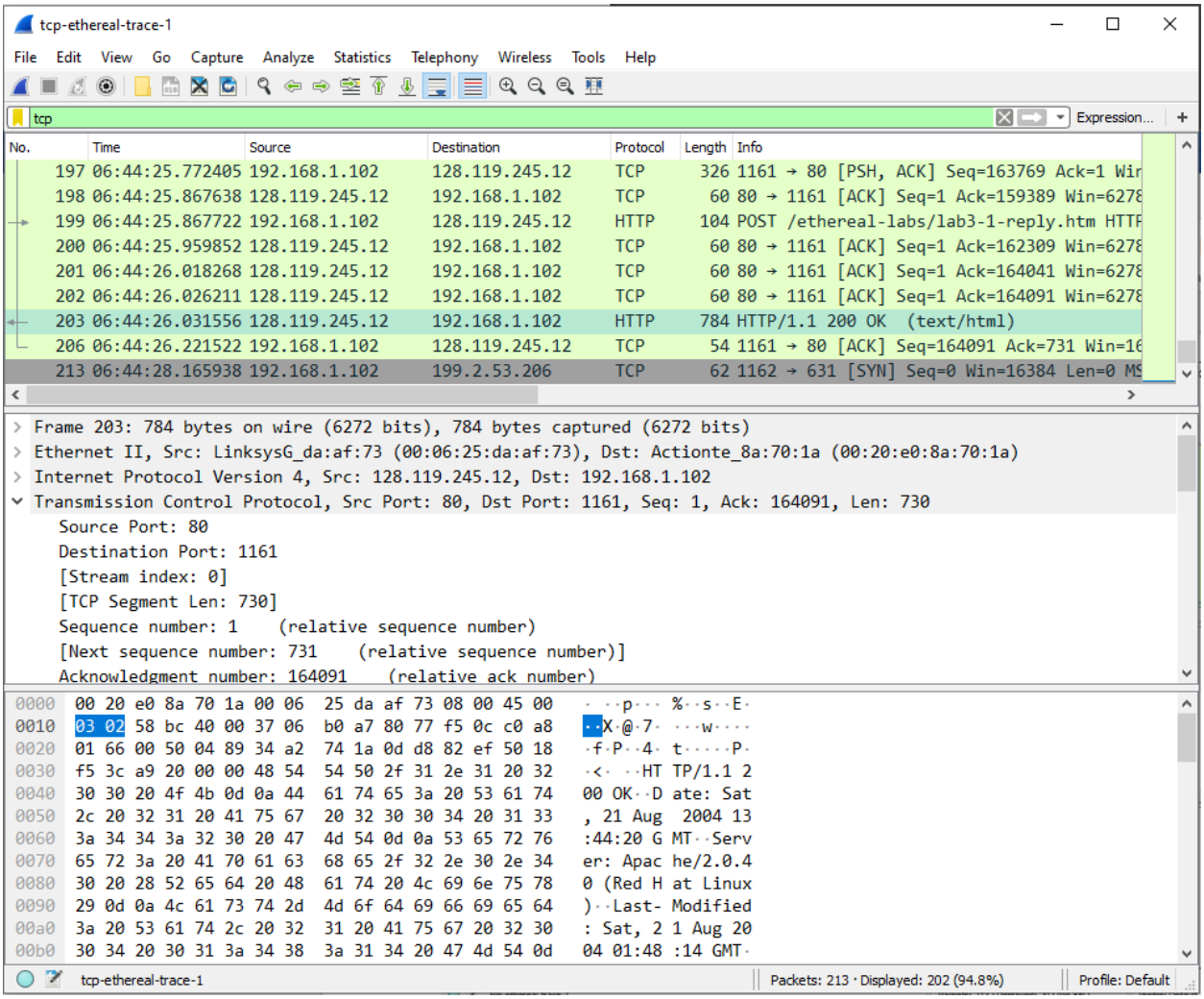
A first look at the captured trace

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.



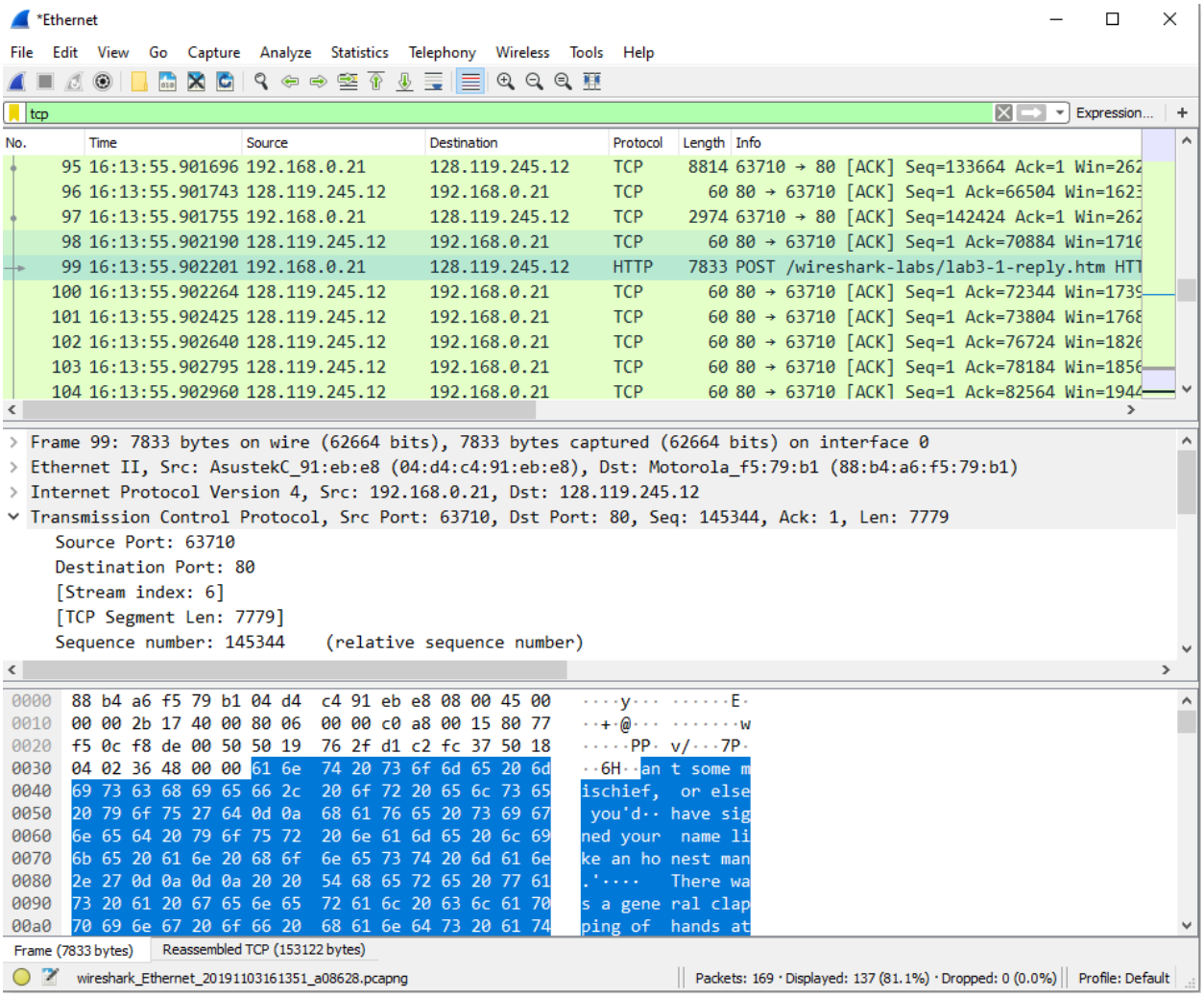
- The client IP address is 192.168.1.102 and TCP port number is 1161

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's IP address is 128.119.245.12 and port number is 80

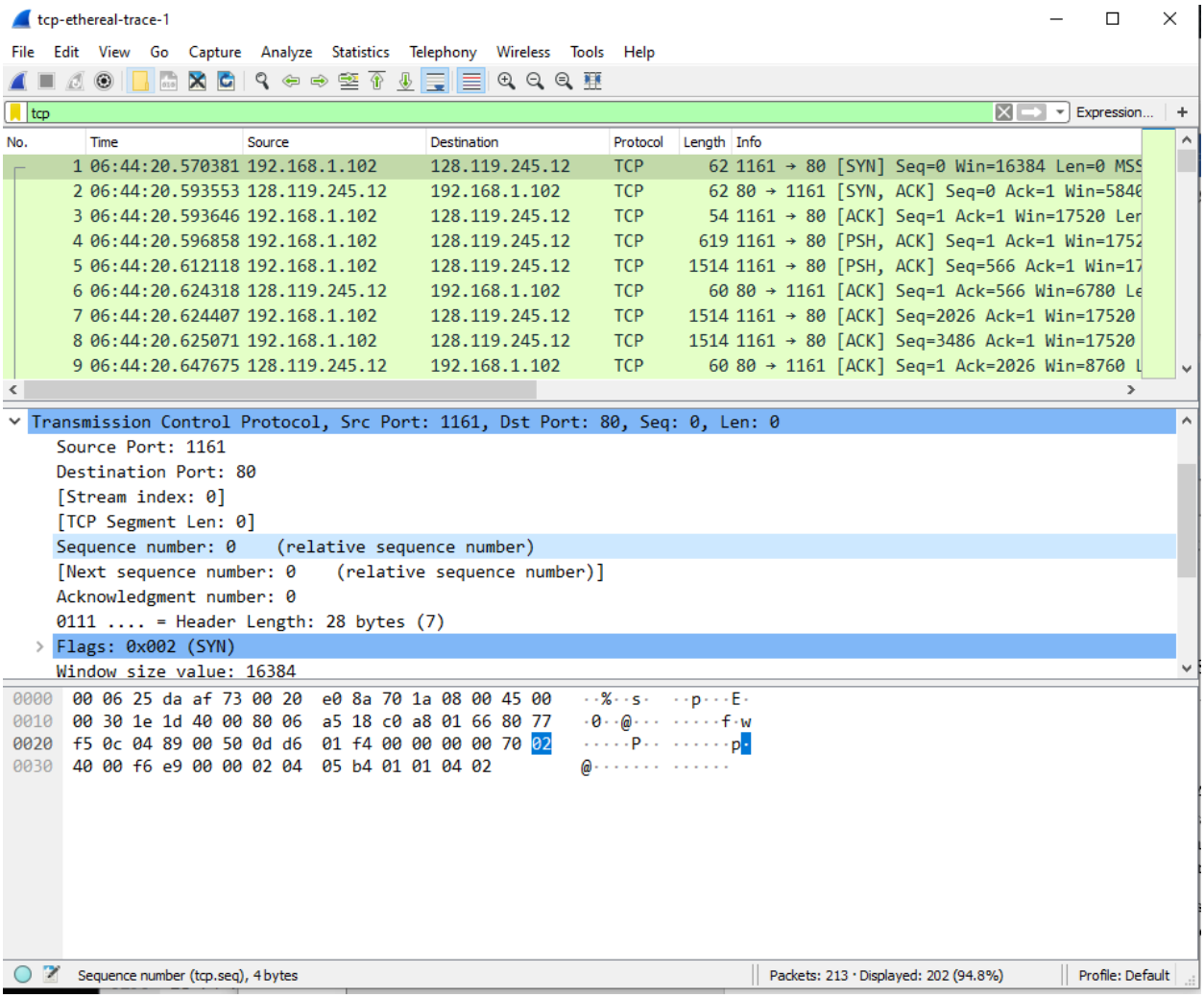
3. What is the IP address and TCP port number used by your client computer (source) to transfer the file to gaia.cs.umass.edu?



- The client IP address (my computer ethernet) is 192.168.0.21 and TCP port number is 63710

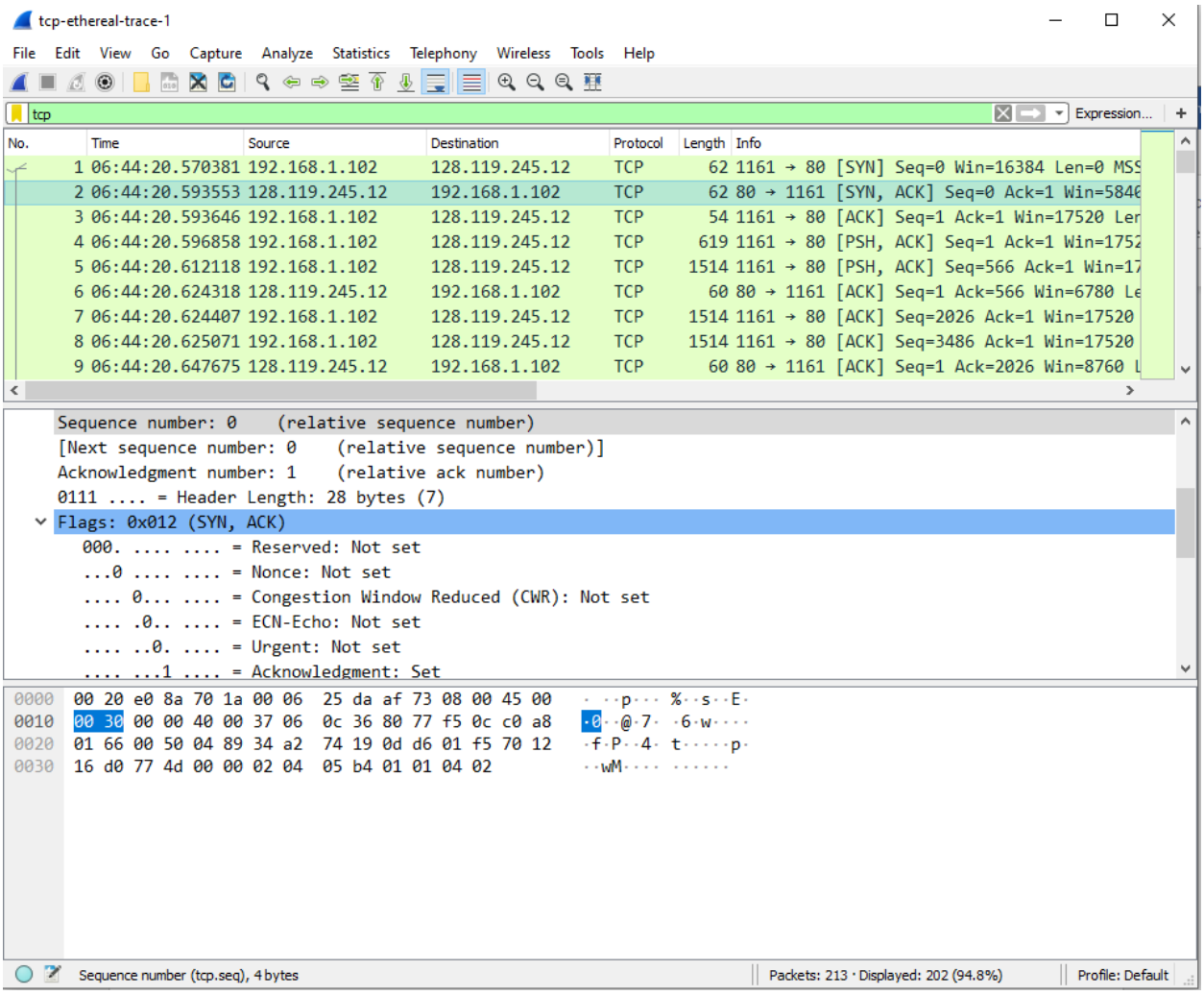
TCP Basics

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?



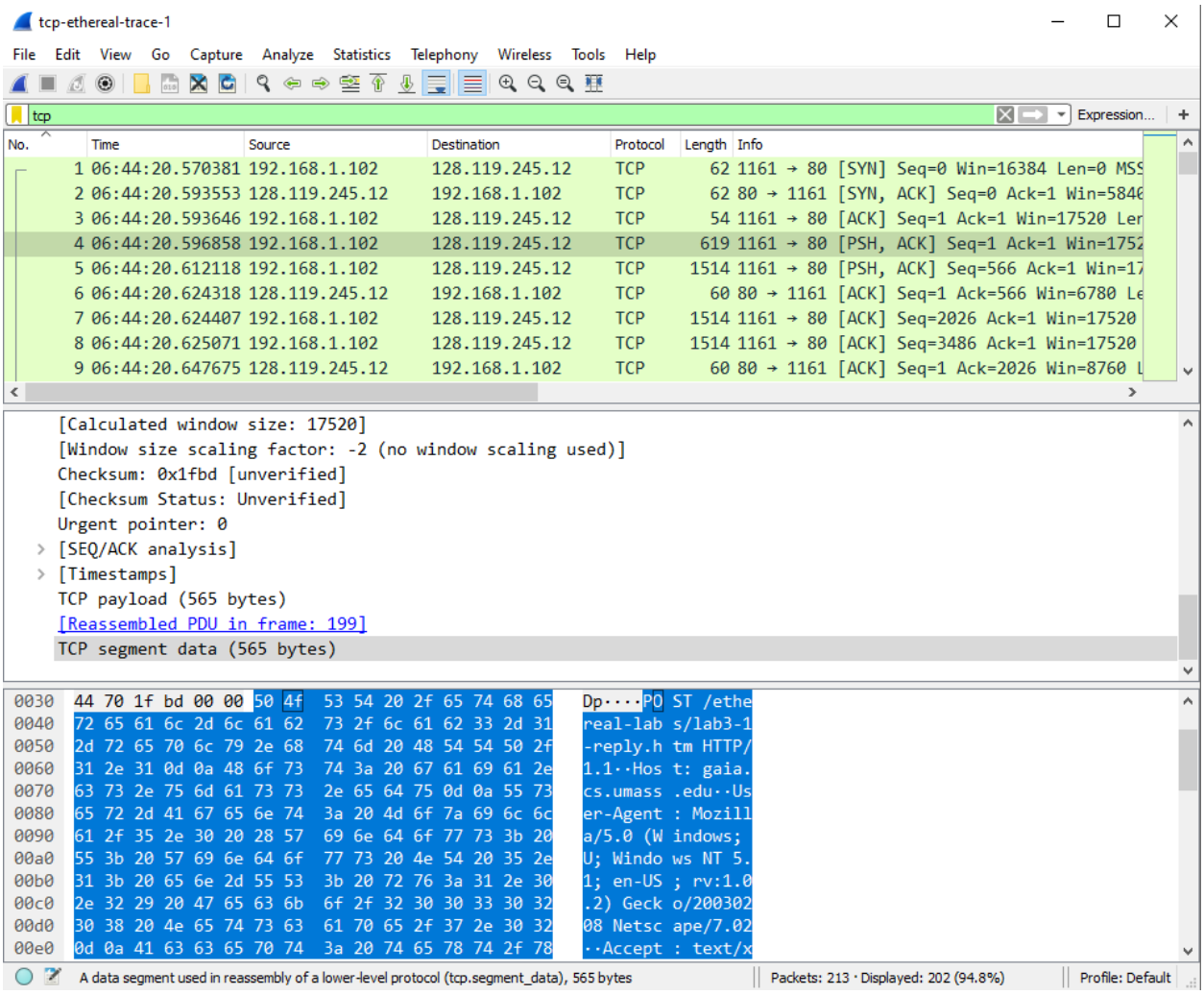
- The sequence number of TCP SYN segment is 0 because it is used for pretending the TCP connection between source client and gaia.cs.umass.edu. In addition, the flag for SYN set to 0x002 (SYN, 1) to identify the SYN segment

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?



- From the above screenshot, the sequence number of SYNACK 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 SYNACK segment is 1 because the value determined by the gaia.cs.umass.edu's server. The server adds 1 to the initial sequence number of the SYN segment from the client computer. When both SYN flag and ACK flag in the segment are set to 1, the segment will be identified as a SYNACK segment.

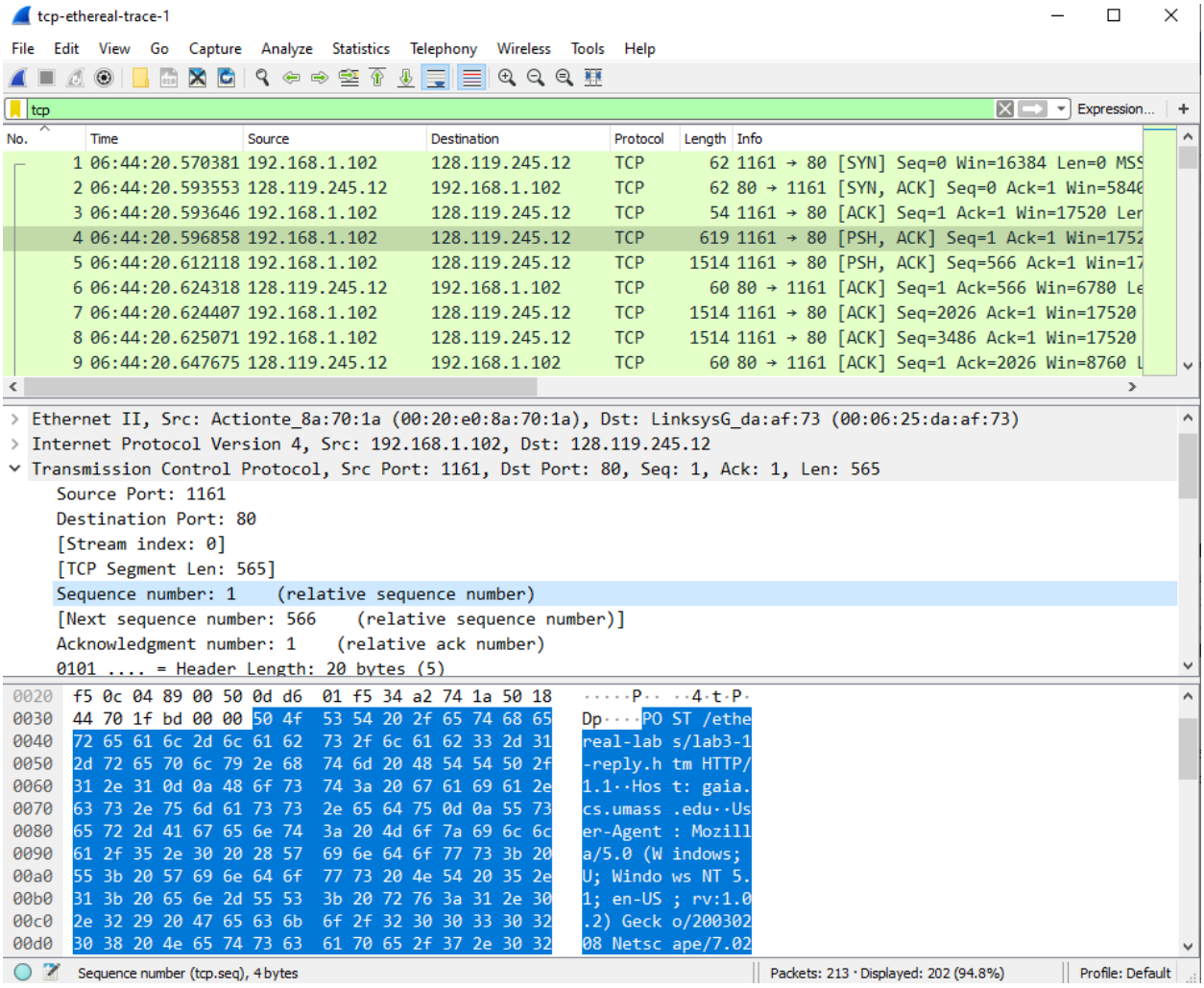
6. What is the sequence number of the TCP segment containing the HTTP POST command? Note that in order to find the POST command, you'll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with a "POST" within its DATA field.

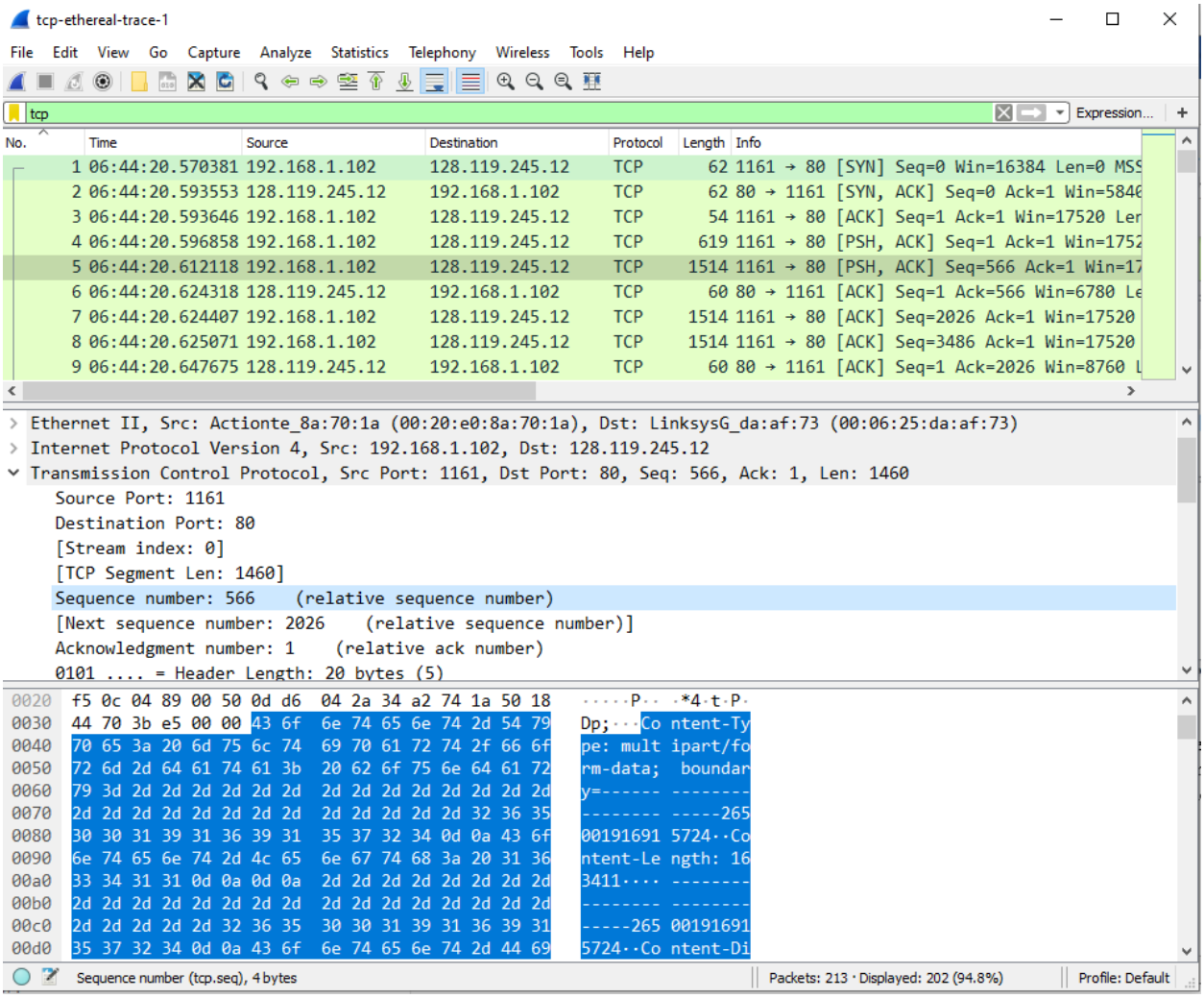


- The sequence number of the TCP segment containing the HTTP POST command is 1.

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 242 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 242 for all subsequent segments.

Note: Wireshark has a nice feature that allows you to plot the RTT for each of the TCP segments sent. Select a TCP segment in the "listing of captured packets" window that is being sent from the client to the gaia.cs.umass.edu server. Then select: Statistics->TCP Stream Graph- >Round Trip Time Graph.


tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
1 06:44:20.570381 192.168.1.102 128.119.245.12 TCP 62 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS
2 06:44:20.593553 128.119.245.12 192.168.1.102 TCP 62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840
3 06:44:20.593646 192.168.1.102 128.119.245.12 TCP 54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len
4 06:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=1752
5 06:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17
6 06:44:20.624318 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Le
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
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)
[Next sequence number: 566 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
0020 f5 0c 04 89 00 50 0d d6 01 f5 34 a2 74 1a 50 18 .....P.. ..4.t.P.
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..Hos t: 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
0090 61 2f 35 2e 30 20 28 57 69 6e 64 6f 77 73 3b 20 a/5.0 (W indows;
00a0 55 3b 20 57 69 6e 64 6f 77 73 20 4e 54 20 35 2e U; Windo ws NT 5.
00b0 31 3b 20 65 6e 2d 55 53 3b 20 72 76 3a 31 2e 30 1; en-US ; rv:1.0
00c0 2e 32 29 20 47 65 63 6b 6f 2f 32 30 30 33 30 32 .2) Geck o/200302
00d0 30 38 20 4e 65 74 73 63 61 70 65 2f 37 2e 30 32 08 Netsc ape/7.02
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default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File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
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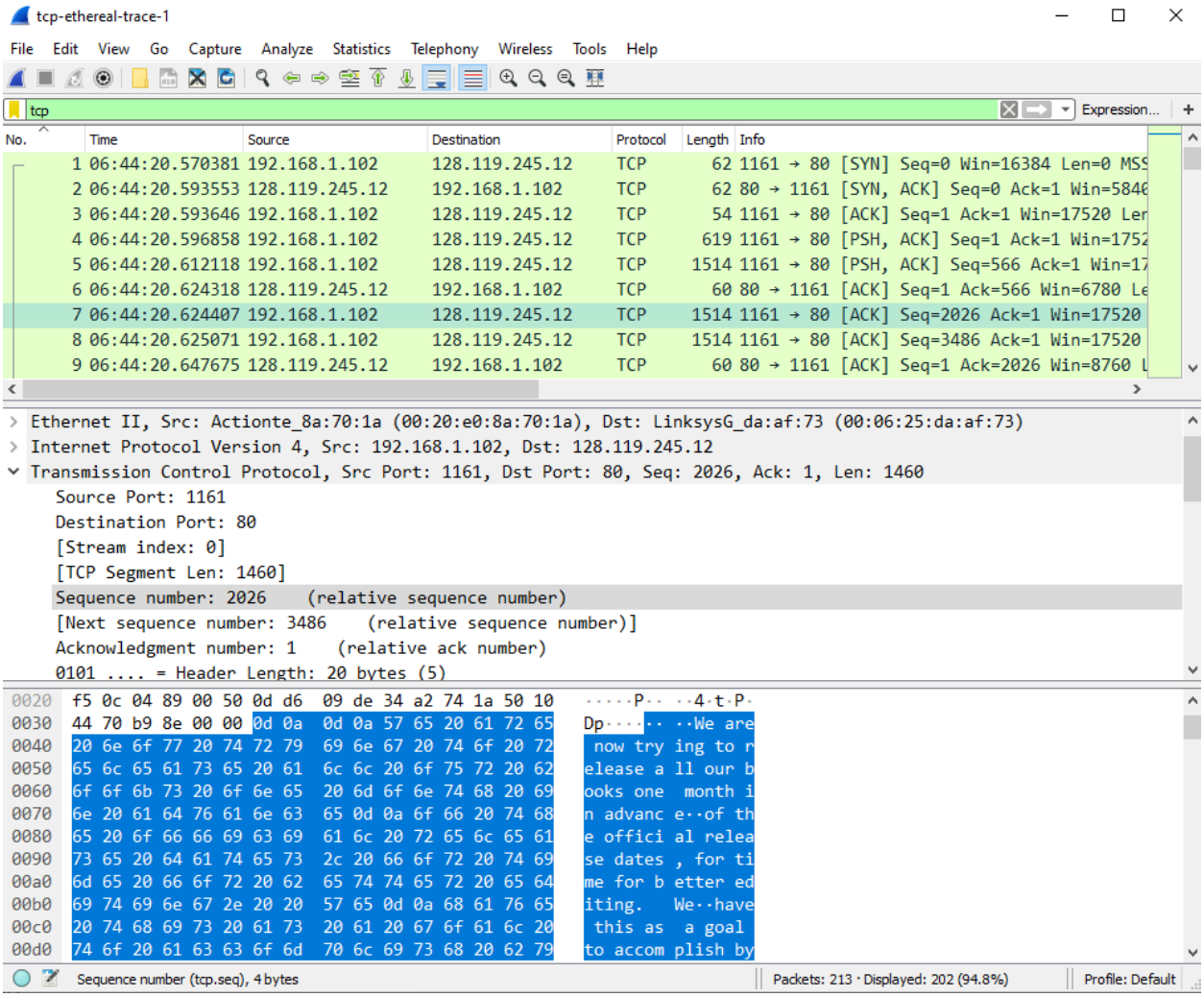
2 06:44:20.593553 128.119.245.12 192.168.1.102 TCP 62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840
3 06:44:20.593646 192.168.1.102 128.119.245.12 TCP 54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len
4 06:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=1752
5 06:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17
6 06:44:20.624318 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Le
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
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: 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)
0020 f5 0c 04 89 00 50 0d d6 04 2a 34 a2 74 1a 50 18 .....P... .*4.t.P.
0030 44 70 3b e5 00 00 43 6f 6e 74 65 6e 74 2d 54 79 Dp;...Co ntent-Ty
0040 70 65 3a 20 6d 75 6c 74 69 70 61 72 74 2f 66 6f pe: mult ipart/fo
0050 72 6d 2d 64 61 74 61 3b 20 62 6f 75 6e 64 61 72 rm-data; boundar
0060 79 3d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d y=------ --------
0070 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 32 36 35 -------- -----265
0080 30 30 31 39 31 36 39 31 35 37 32 34 0d 0a 43 6f 00191691 5724..Co
0090 6e 74 65 6e 74 2d 4c 65 6e 67 74 68 3a 20 31 36 ntent-Le ngth: 16
00a0 33 34 31 31 0d 0a 0d 0a 2d 2d 2d 2d 2d 2d 2d 2d 3411.... --------
00b0 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d 2d -------- --------
00c0 2d 2d 2d 2d 2d 32 36 35 30 30 31 39 31 36 39 31 -----265 00191691
00d0 35 37 32 34 0d 0a 43 6f 6e 74 65 6e 74 2d 44 69 5724..Co ntent-Di
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default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Expression...
No. Time Source Destination Protocol Length Info
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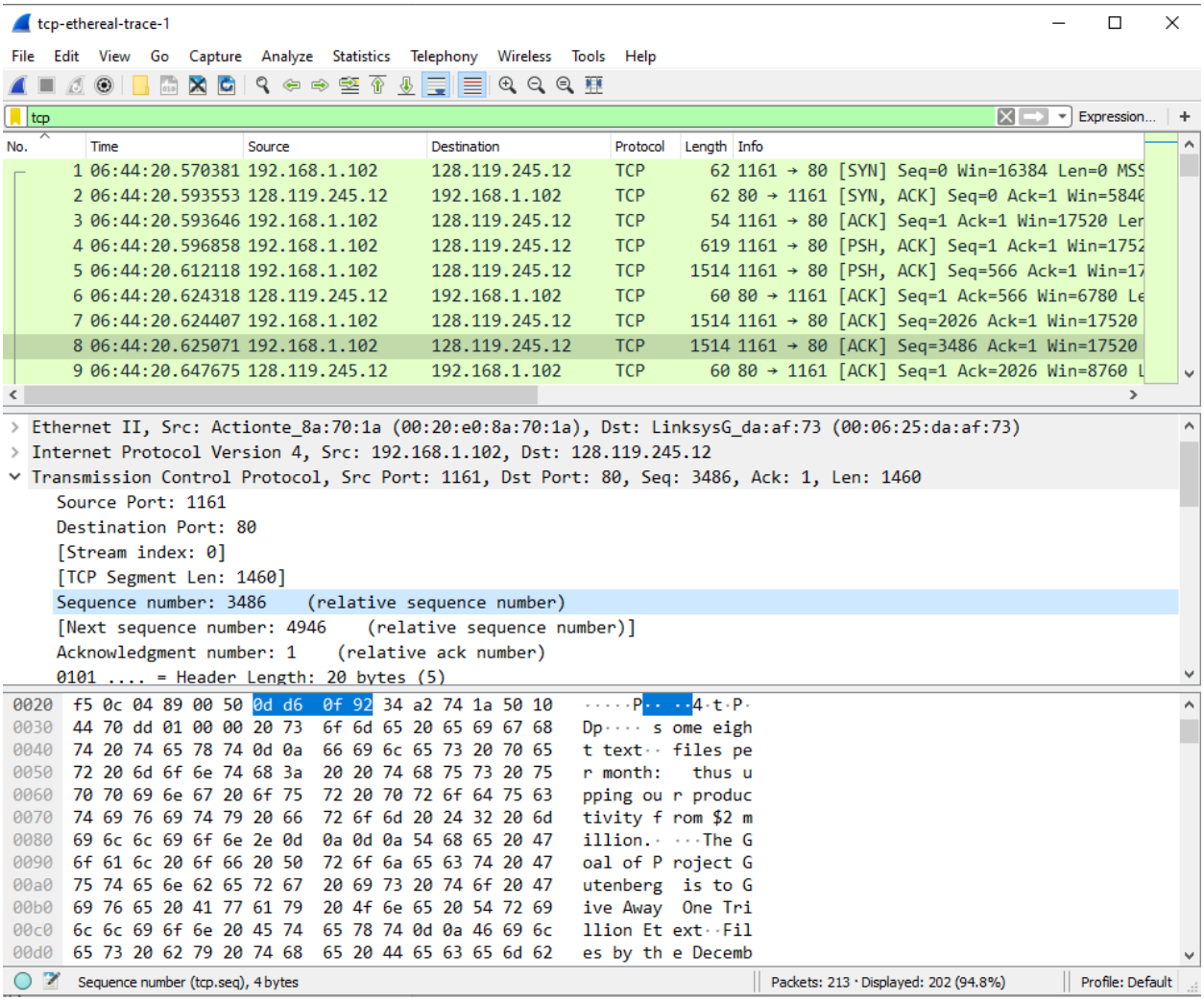
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 2026, Ack: 1, Len: 1460
Source Port: 1161
Destination Port: 80
[Stream 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)
0020 f5 0c 04 89 00 50 0d d6 09 de 34 a2 74 1a 50 10 ·····P·· ··4·t·P·
0030 44 70 b9 8e 00 00 0d 0a 0d 0a 57 65 20 61 72 65 Dp······ ··We are
0040 20 6e 6f 77 20 74 72 79 69 6e 67 20 74 6f 20 72 now try ing to r
0050 65 6c 65 61 73 65 20 61 6c 6c 20 6f 75 72 20 62 elease a ll our b
0060 6f 6f 6b 73 20 6f 6e 65 20 6d 6f 6e 74 68 20 69 ooks one month i
0070 6e 20 61 64 76 61 6e 63 65 0d 0a 6f 66 20 74 68 n advanc e··of th
0080 65 20 6f 66 66 69 63 69 61 6c 20 72 65 6c 65 61 e offici al relea
0090 73 65 20 64 61 74 65 73 2c 20 66 6f 72 20 74 69 se dates , for ti
00a0 6d 65 20 66 6f 72 20 62 65 74 74 65 72 20 65 64 me for b etter ed
00b0 69 74 69 6e 67 2e 20 20 57 65 0d 0a 68 61 76 65 iting. We··have
00c0 20 74 68 69 73 20 61 73 20 61 20 67 6f 61 6c 20 this as a goal
00d0 74 6f 20 61 63 63 6f 6d 70 6c 69 73 68 20 62 79 to accom plish by
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default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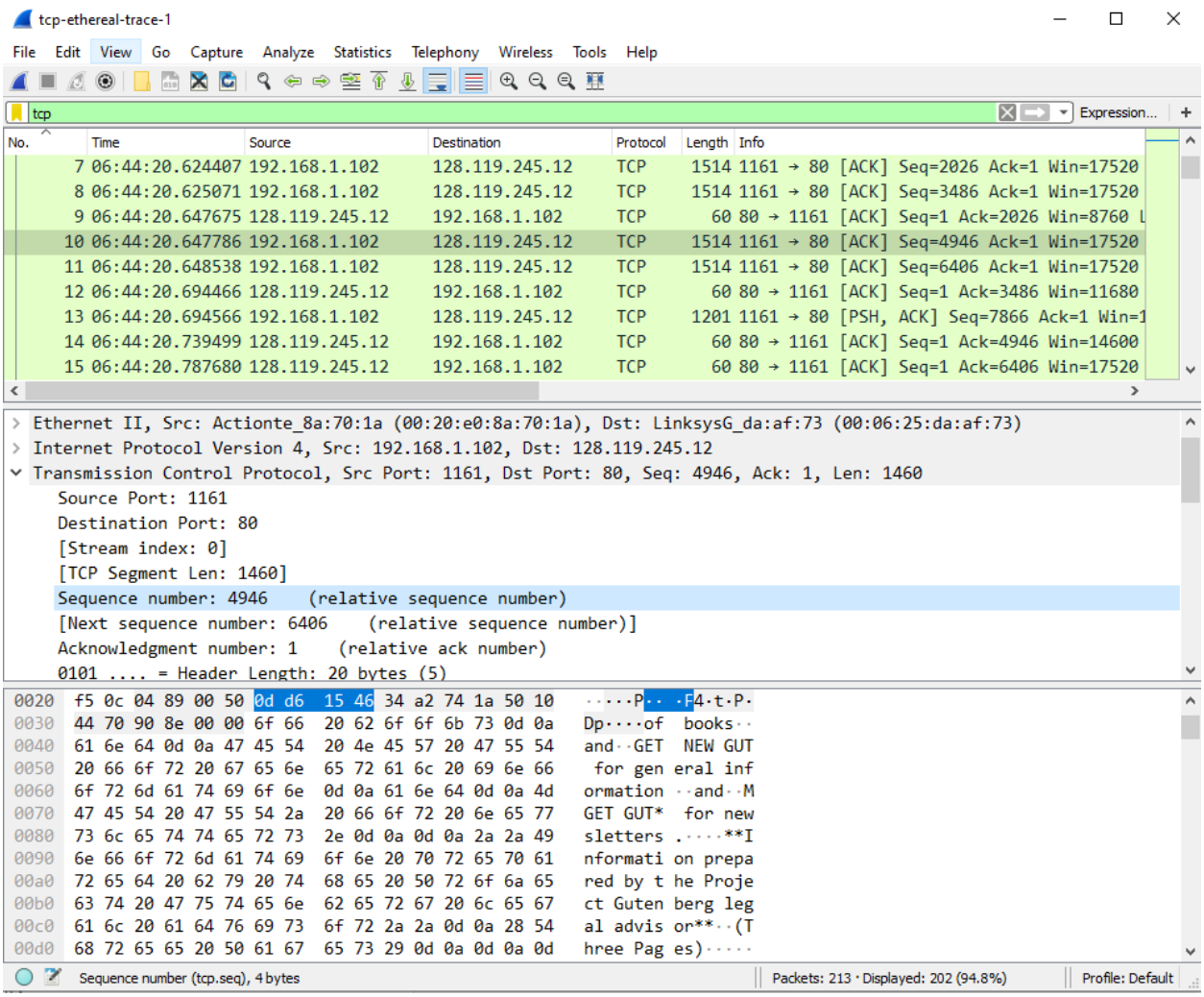
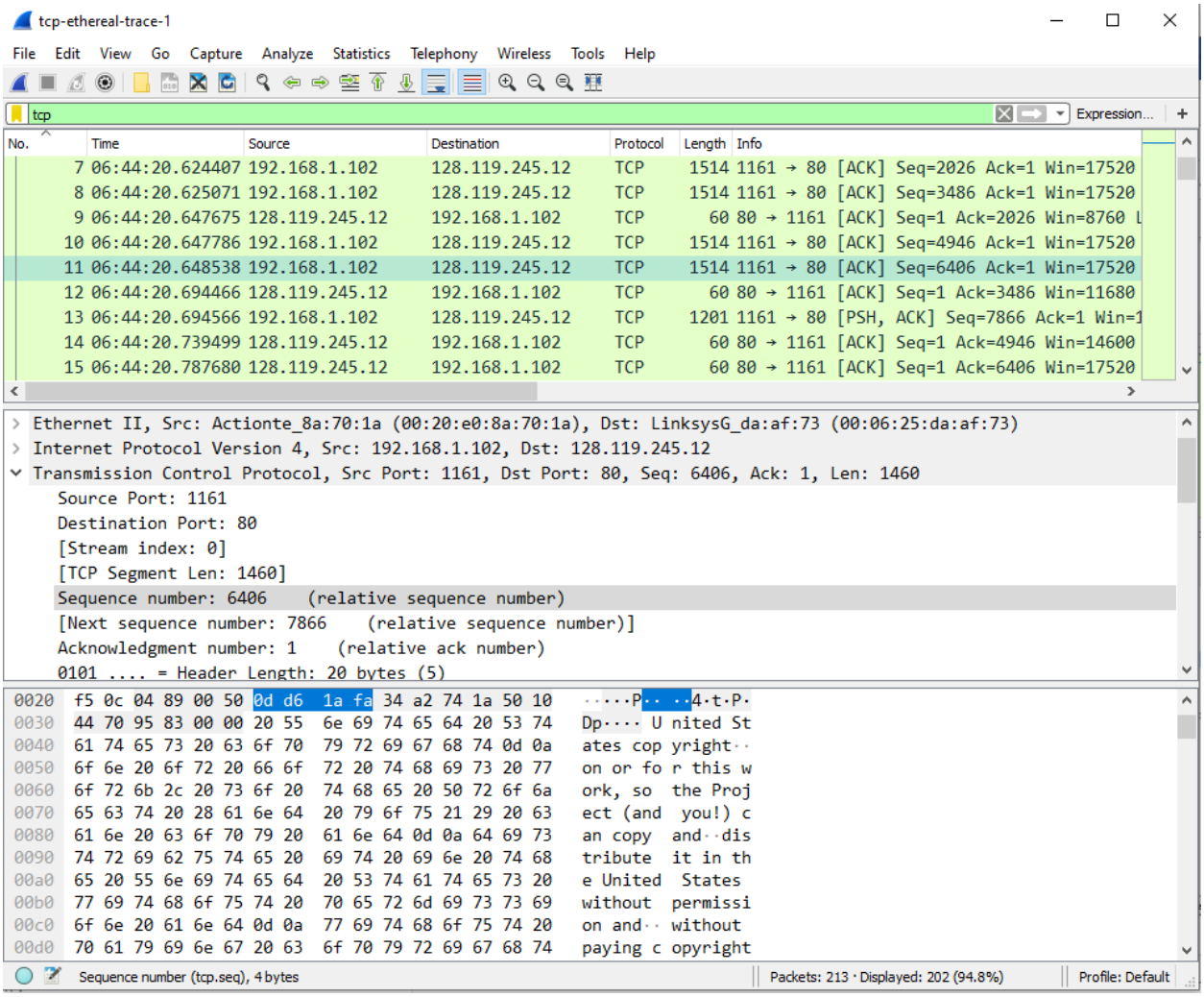
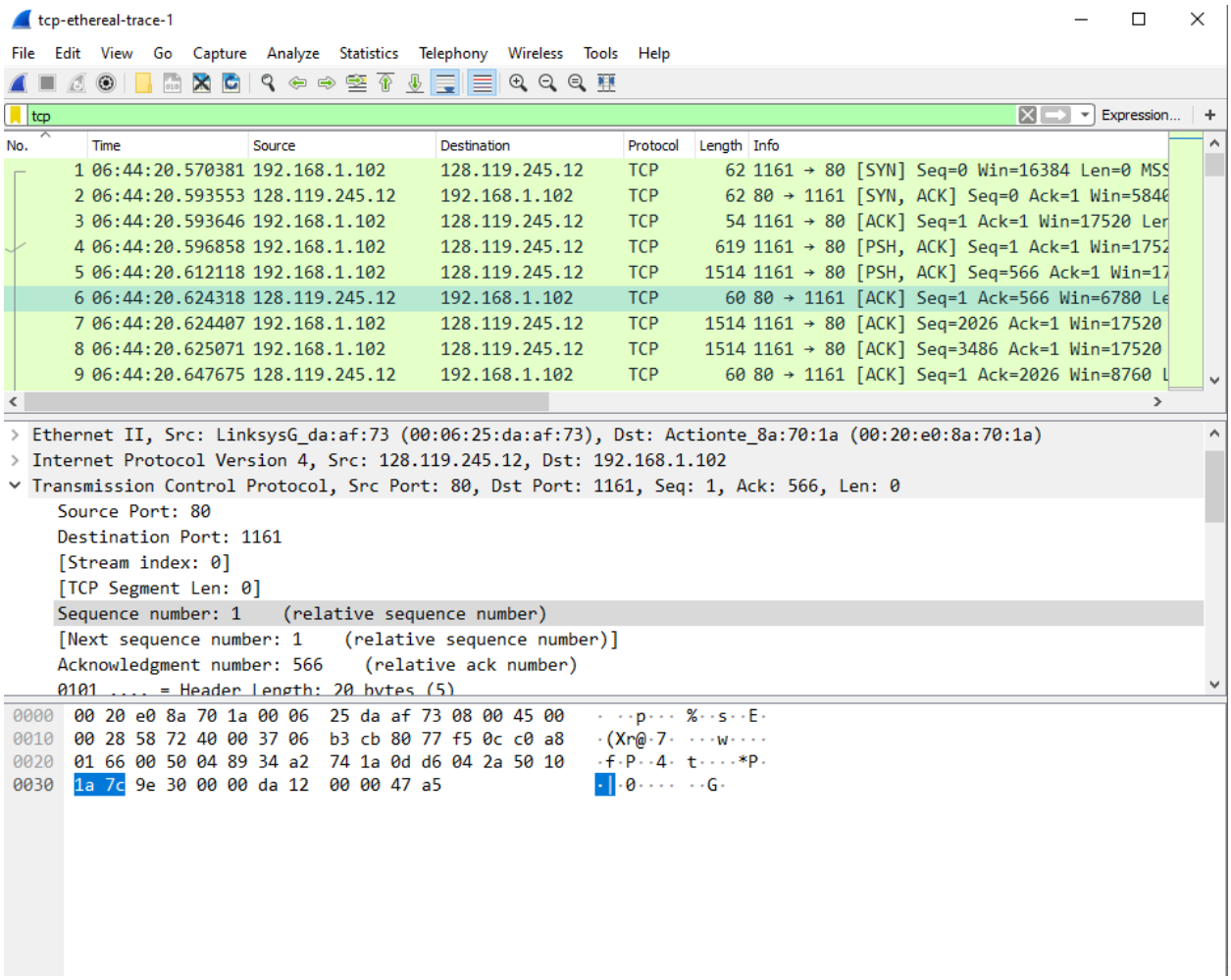
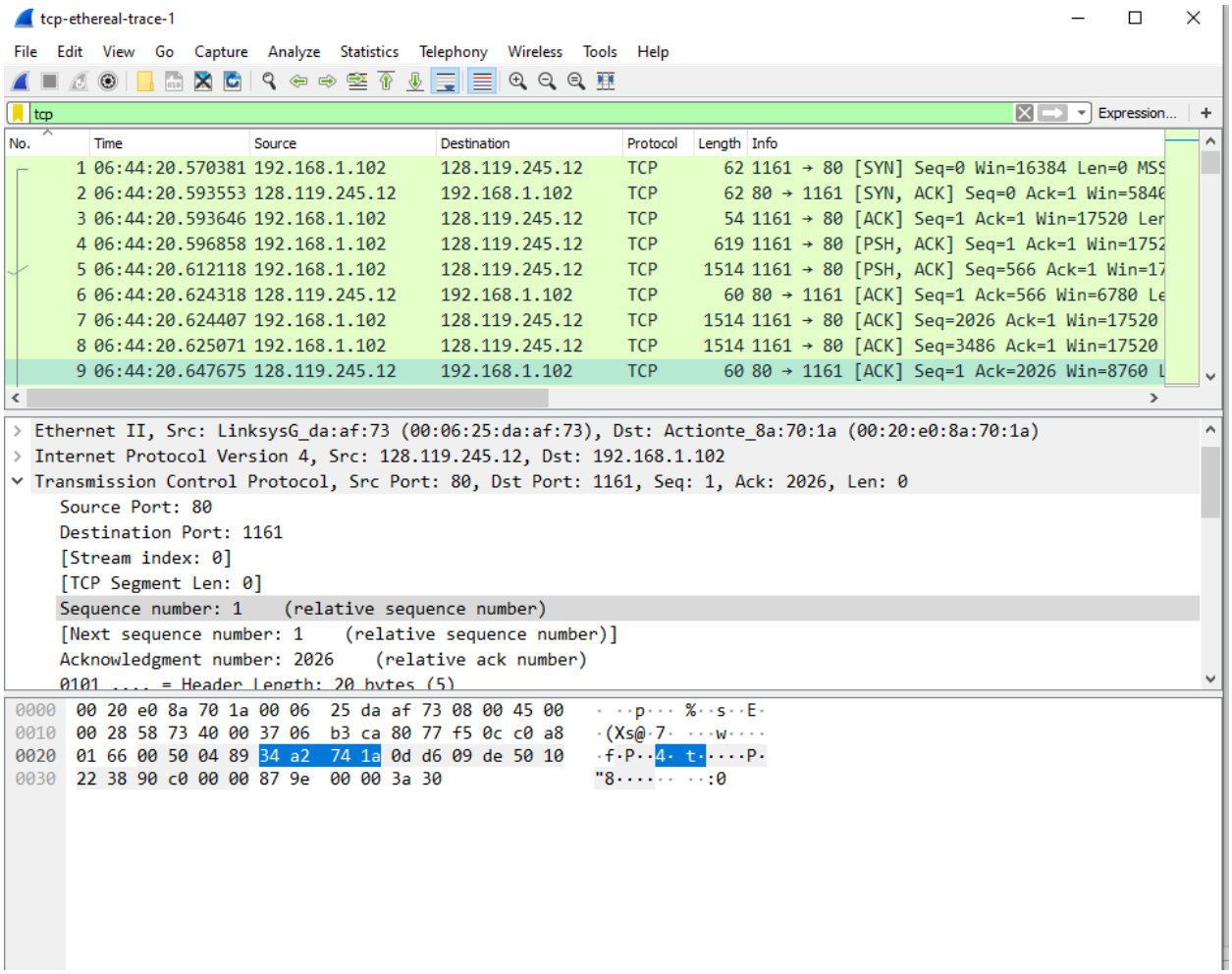
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 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)
0020 f5 0c 04 89 00 50 0d d6 0f 92 34 a2 74 1a 50 10
0030 44 70 dd 01 00 00 20 73 6f 6d 65 20 65 69 67 68
0040 74 20 74 65 78 74 0d 0a 66 69 6c 65 73 20 70 65
0050 72 20 6d 6f 6e 74 68 3a 20 20 74 68 75 73 20 75
0060 70 70 69 6e 67 20 6f 75 72 20 70 72 6f 64 75 63
0070 74 69 76 69 74 79 20 66 72 6f 6d 20 24 32 20 6d
0080 69 6c 6c 69 6f 6e 2e 0d 0a 0d 0a 54 68 65 20 47
0090 6f 61 6c 20 6f 66 20 50 72 6f 6a 65 63 74 20 47
00a0 75 74 65 6e 62 65 72 67 20 69 73 20 74 6f 20 47
00b0 69 76 65 20 41 77 61 79 20 4f 6e 65 20 54 72 69
00c0 6c 6c 69 6f 6e 20 45 74 65 78 74 0d 0a 46 69 6c
00d0 65 73 20 62 79 20 74 68 65 20 44 65 63 65 6d 62
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default

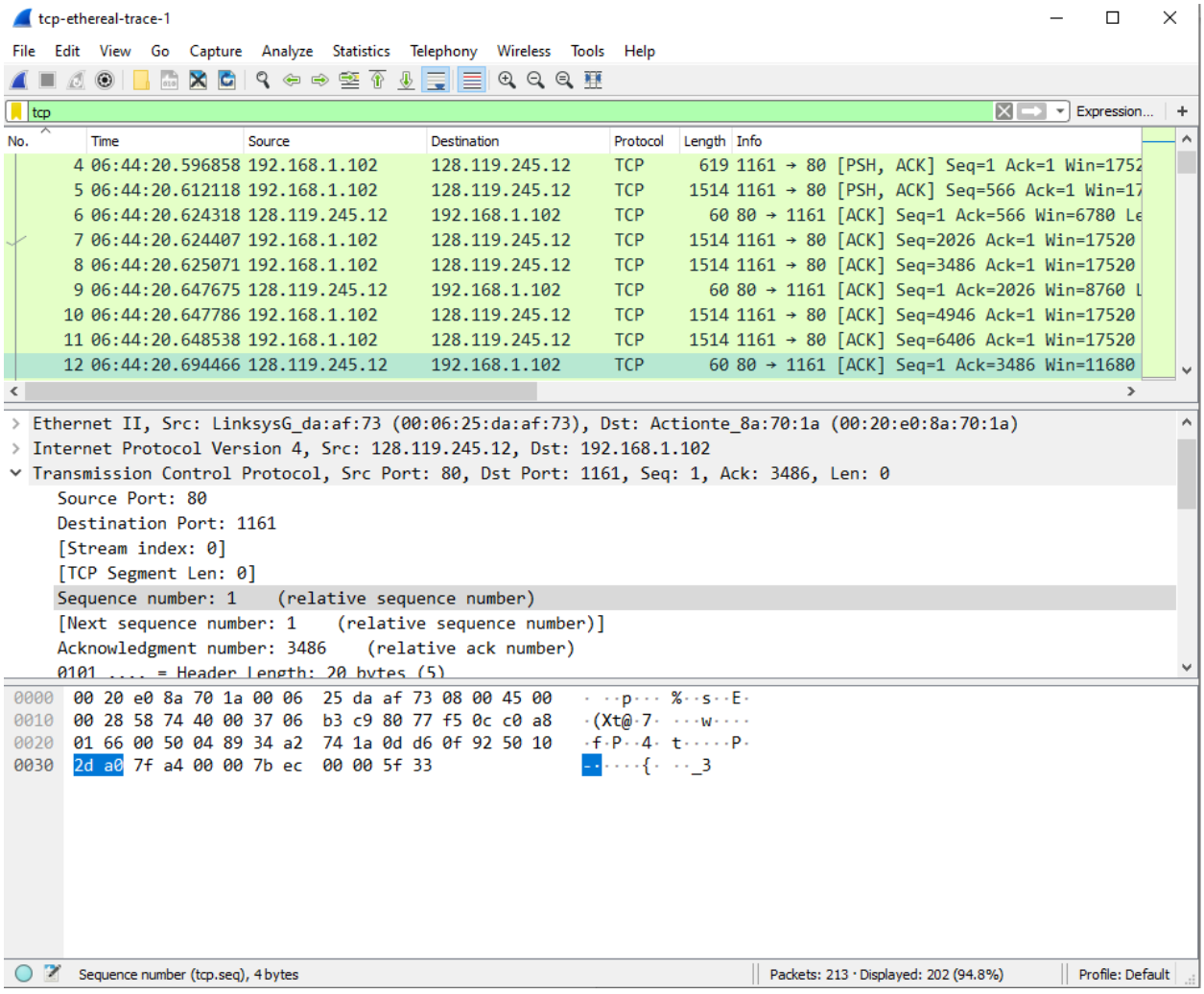

tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
10 06:44:20.647786 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520
11 06:44:20.648538 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520
12 06:44:20.694466 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680
13 06:44:20.694566 192.168.1.102 128.119.245.12 TCP 1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=1
14 06:44:20.739499 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600
15 06:44:20.787680 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520
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: 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)
0020 f5 0c 04 89 00 50 0d d6 15 46 34 a2 74 1a 50 10
0030 44 70 90 8e 00 00 6f 66 20 62 6f 6f 6b 73 0d 0a
0040 61 6e 64 0d 0a 47 45 54 20 4e 45 57 20 47 55 54
0050 20 66 6f 72 20 67 65 6e 65 72 61 6c 20 69 6e 66
0060 6f 72 6d 61 74 69 6f 6e 0d 0a 61 6e 64 0d 0a 4d
0070 47 45 54 20 47 55 54 2a 20 66 6f 72 20 6e 65 77
0080 73 6c 65 74 74 65 72 73 2e 0d 0a 0d 0a 2a 2a 49
0090 6e 66 6f 72 6d 61 74 69 6f 6e 20 70 72 65 70 61
00a0 72 65 64 20 62 79 20 74 68 65 20 50 72 6f 6a 65
00b0 63 74 20 47 75 74 65 6e 62 65 72 67 20 6c 65 67
00c0 61 6c 20 61 64 76 69 73 6f 72 2a 2a 0d 0a 28 54
00d0 68 72 65 65 20 50 61 67 65 73 29 0d 0a 0d 0a 0d
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default

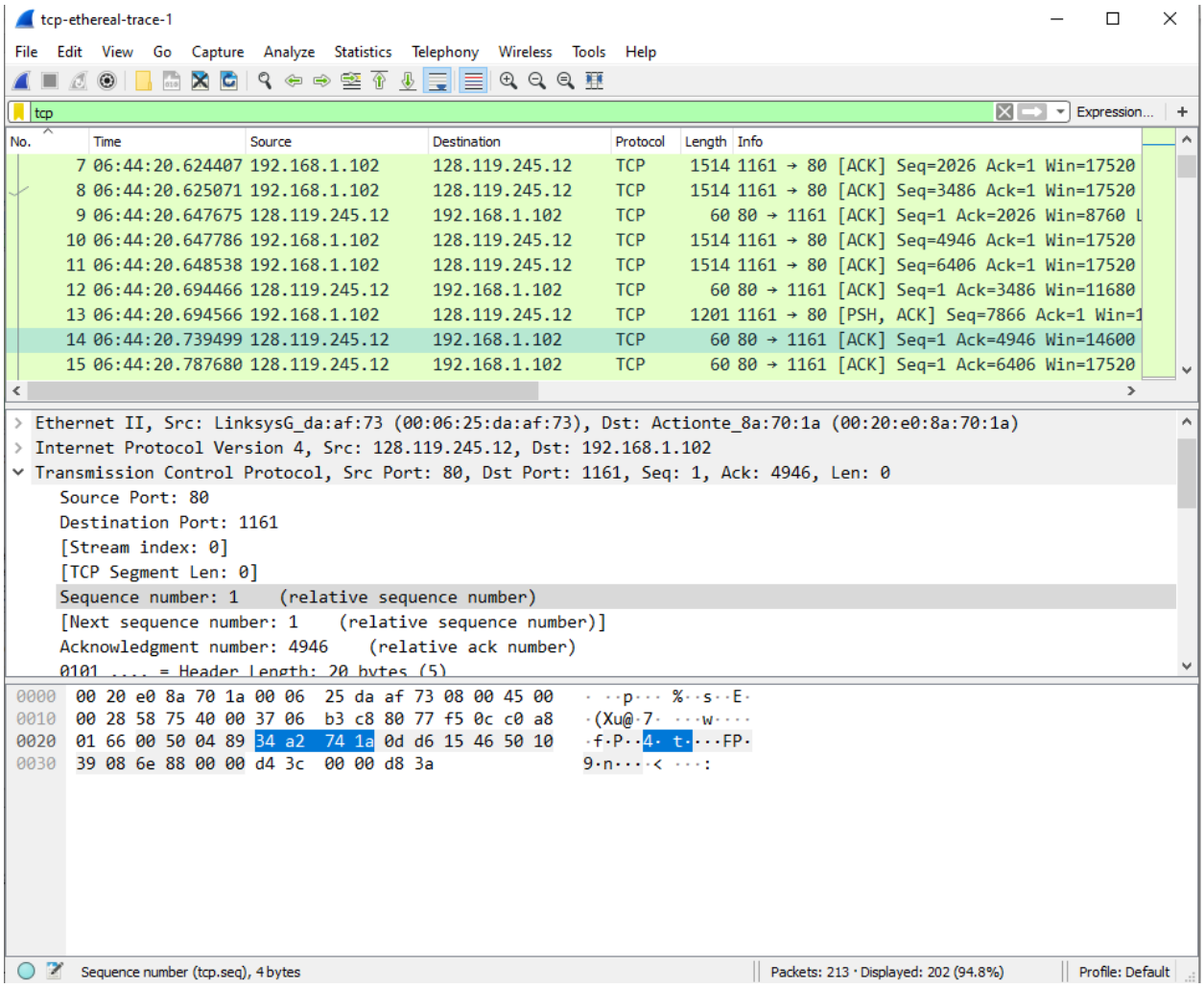


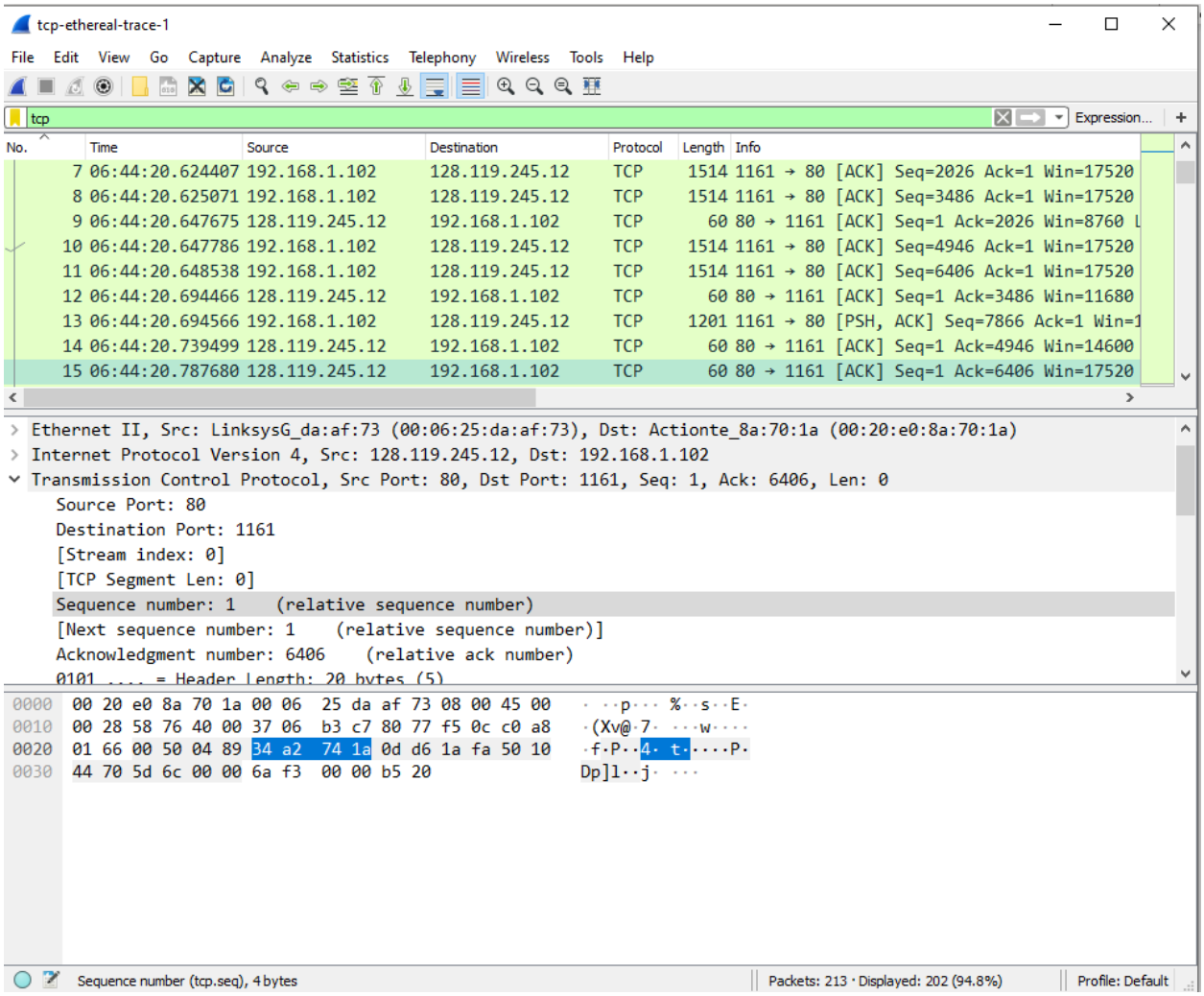
- The sequence numbers of the first six segments in the TCP connection are 1, 566, 2026, 3486, 4946, and 6406. The sent times for each segment are 6:44:20.596858, 6:44:20.612118, 6:44:20.624407, 6:44:20.625071, 6:44:20.647786, and 6:44:20.648538.

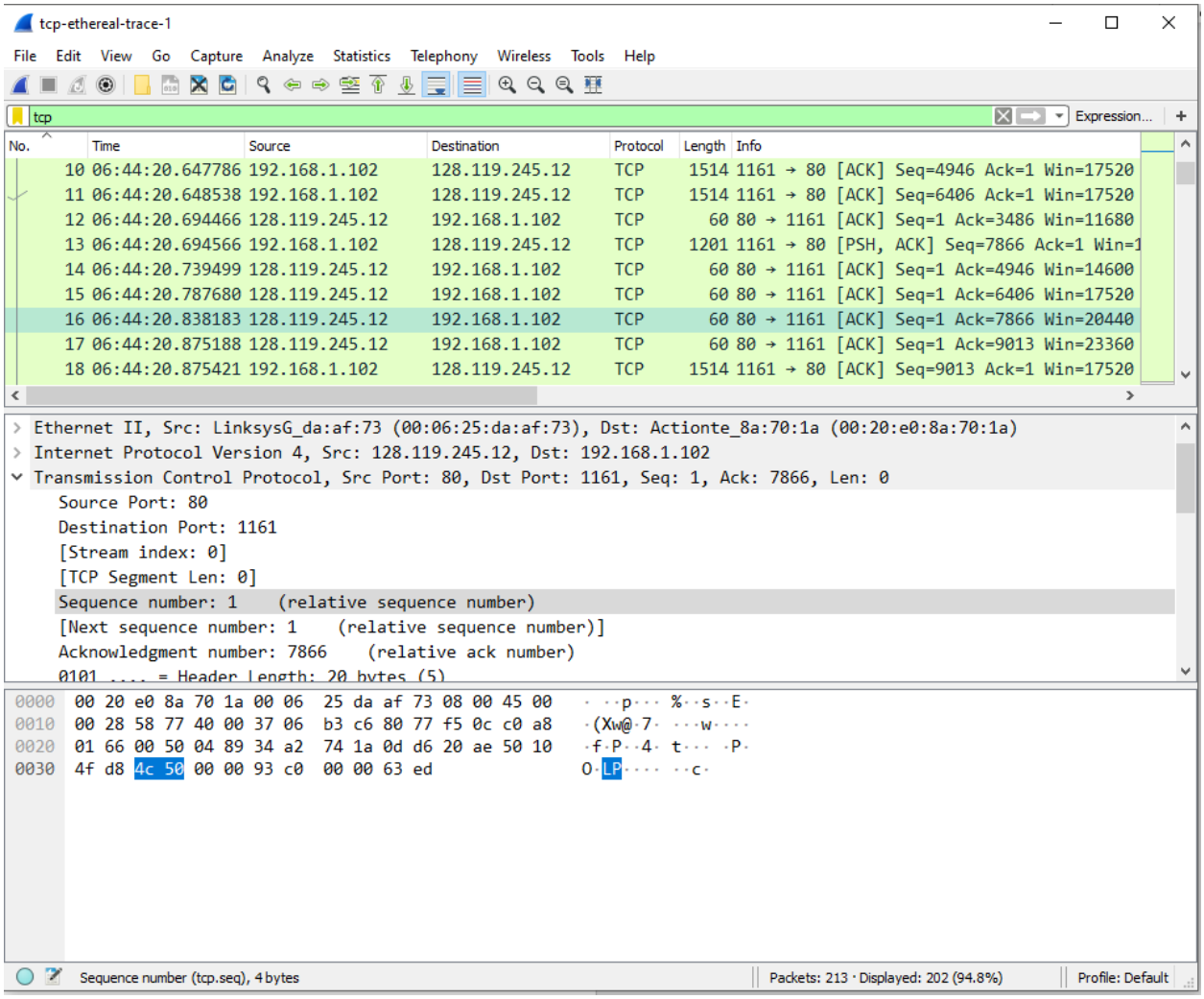

tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
1 06:44:20.570381 192.168.1.102 128.119.245.12 TCP 62 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS
2 06:44:20.593553 128.119.245.12 192.168.1.102 TCP 62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840
3 06:44:20.593646 192.168.1.102 128.119.245.12 TCP 54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len
4 06:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=1752
5 06:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17
6 06:44:20.624318 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Le
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760
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: 566, 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: 566 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00
0010 00 28 58 72 40 00 37 06 b3 cb 80 77 f5 0c c0 a8
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 04 2a 50 10
0030 1a 7c 9e 30 00 00 da 12 00 00 47 a5


tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
1 06:44:20.570381 192.168.1.102 128.119.245.12 TCP 62 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS
2 06:44:20.593553 128.119.245.12 192.168.1.102 TCP 62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840
3 06:44:20.593646 192.168.1.102 128.119.245.12 TCP 54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len
4 06:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=1752
5 06:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17
6 06:44:20.624318 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Le
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
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: 2026, 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: 2026 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00
0010 00 28 58 73 40 00 37 06 b3 ca 80 77 f5 0c c0 a8
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 09 de 50 10
0030 22 38 90 c0 00 00 87 9e 00 00 3a 30


tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
4 06:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=1752
5 06:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17
6 06:44:20.624318 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Le
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
10 06:44:20.647786 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520
11 06:44:20.648538 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520
12 06:44:20.694466 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680
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: 3486, 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: 3486 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00
0010 00 28 58 74 40 00 37 06 b3 c9 80 77 f5 0c c0 a8
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 0f 92 50 10
0030 2d a0 7f a4 00 00 7b ec 00 00 5f 33
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default


tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760
10 06:44:20.647786 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520
11 06:44:20.648538 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520
12 06:44:20.694466 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680
13 06:44:20.694566 192.168.1.102 128.119.245.12 TCP 1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=1
14 06:44:20.739499 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600
15 06:44:20.787680 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520
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: 4946, 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: 4946 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00
0010 00 28 58 75 40 00 37 06 b3 c8 80 77 f5 0c c0 a8
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 15 46 50 10
0030 39 08 6e 88 00 00 d4 3c 00 00 d8 3a
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default


tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760
10 06:44:20.647786 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520
11 06:44:20.648538 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520
12 06:44:20.694466 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680
13 06:44:20.694566 192.168.1.102 128.119.245.12 TCP 1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=1
14 06:44:20.739499 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600
15 06:44:20.787680 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520
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: 6406, 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: 6406 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00
0010 00 28 58 76 40 00 37 06 b3 c7 80 77 f5 0c c0 a8
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 1a fa 50 10
0030 44 70 5d 6c 00 00 6a f3 00 00 b5 20
Sequence number (tcp.seq), 4 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default



- The received times of each segment for ACK are 6:44:20.624318, 6:44:20.647675, 6:44:20.694466, 6:44:20.739499, 6:44:20.787680, and 6:44:20.838183
- The RTT values for each of the six segments are 0.02746, 0.035557, 0.070059, 0.114428, 0.139894, and 0.189645.
- EstimatedRTT = 0.875 * EstimatedRTT + 0.125 * SampleRTT

EstimatedRTT after the received the ACK of segment 1: EstimatedRTT = RTT for Segment 1 = 0.02746

EstimatedRTT after the received the ACK of segment 2: EstimatedRTT = (0.875 * 0.02746) + (0.125 * 0.035557) = 0.028472125

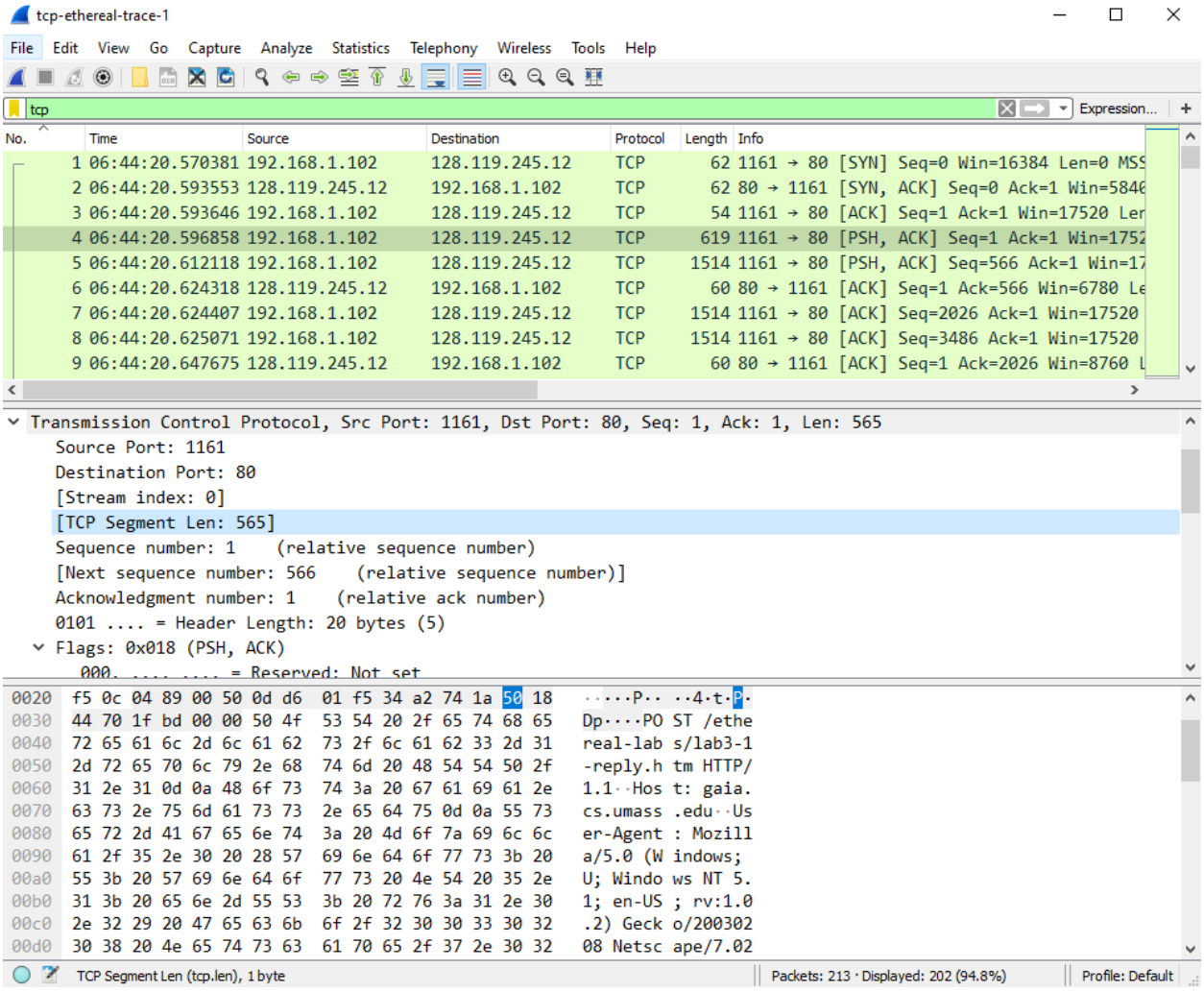
EstimatedRTT after the received the ACK of segment 3: EstimatedRTT = (0.875 * 0.028472125) + (0.125 * 0.070059) = 0.0367048437

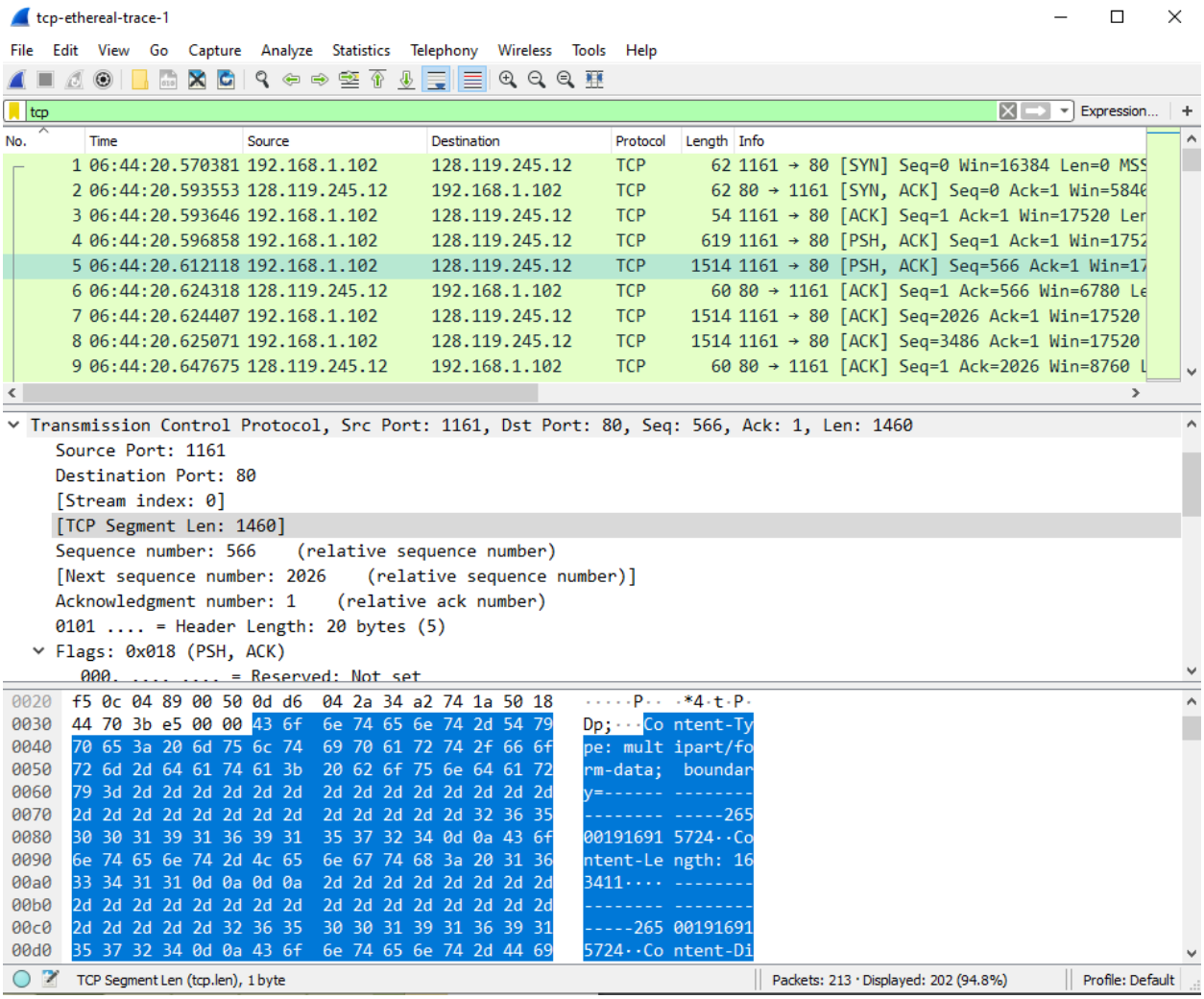
EstimatedRTT after the received the ACK of segment 4: EstimatedRTT = (0.875 * 0.0367048437) + (0.125 * 0.114428) = 0.04376517382

EstimatedRTT after the received the ACK of segment 5: EstimatedRTT = (0.875 * 0.04376517382) + (0.125 * 0.139894) = 0.05578127709

EstimatedRTT after the receipt of the ACK of segment 6: EstimatedRTT = (0.875 * 0.05578127709) + (0.125 * 0.189645) = 0.07251424246

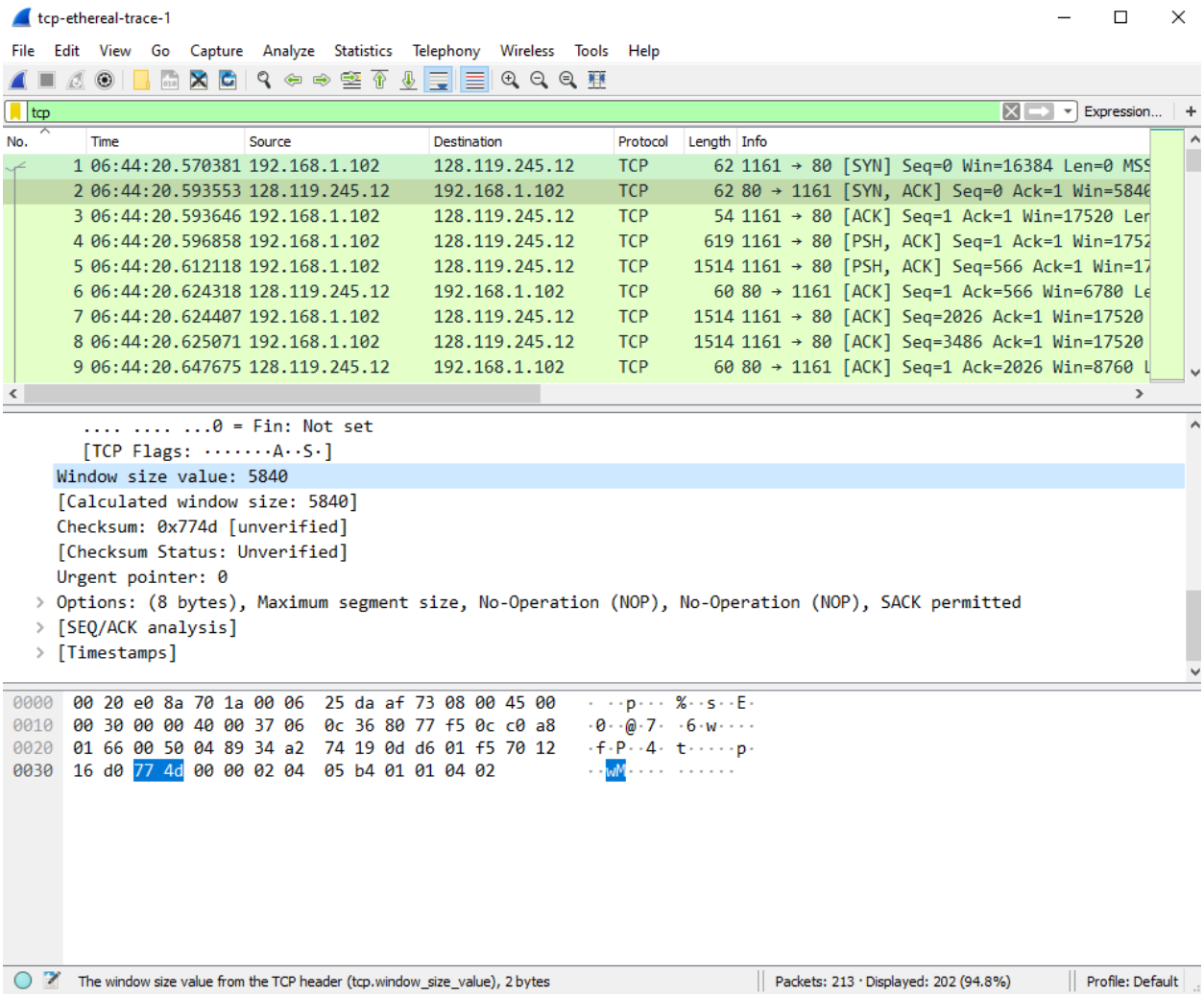
8. What is the length of each of the first six TCP segments?[3]

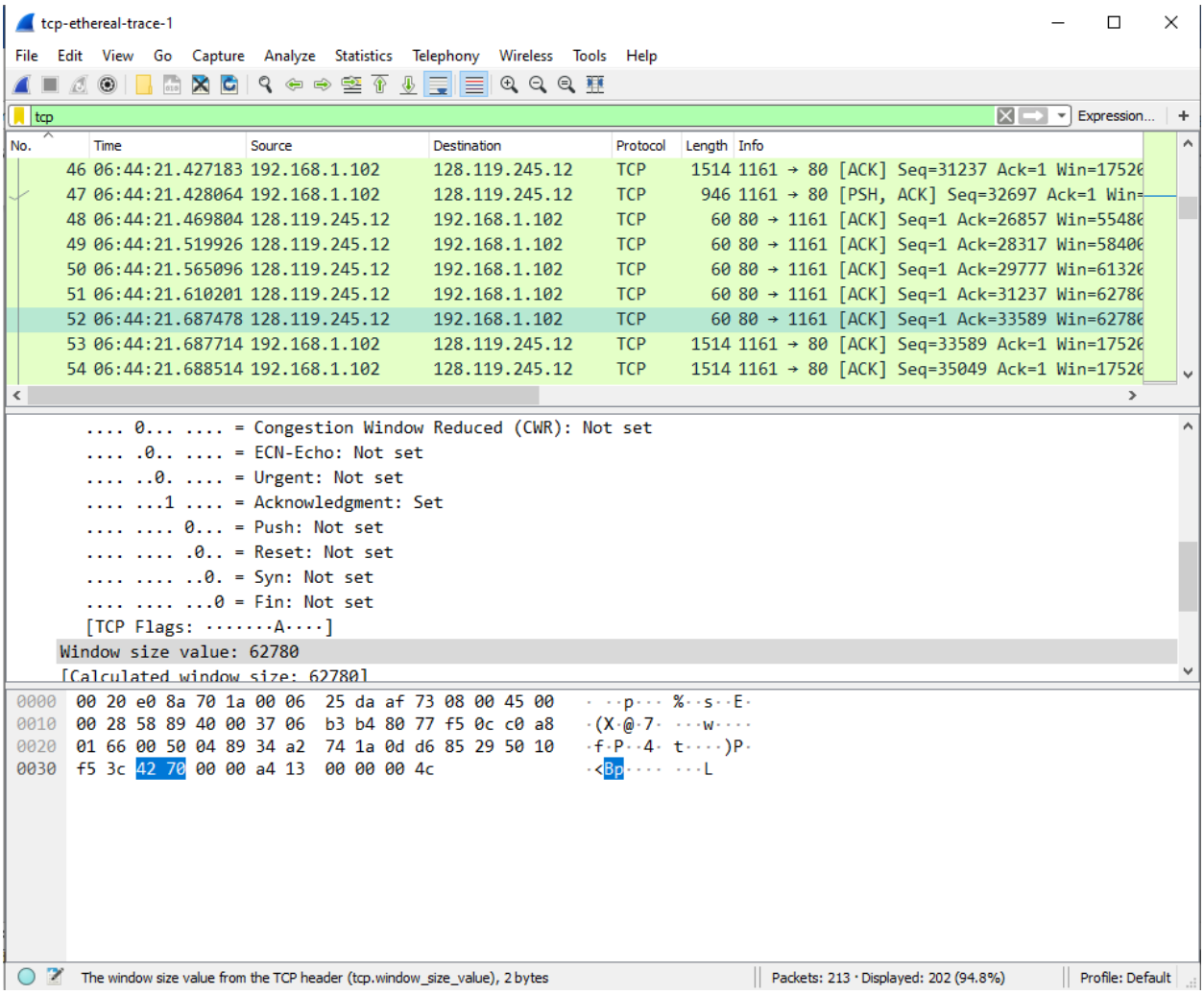




- The length of first of the six segment (HTTP POST) is only 565 byte and the rest of segments are 1460 bytes

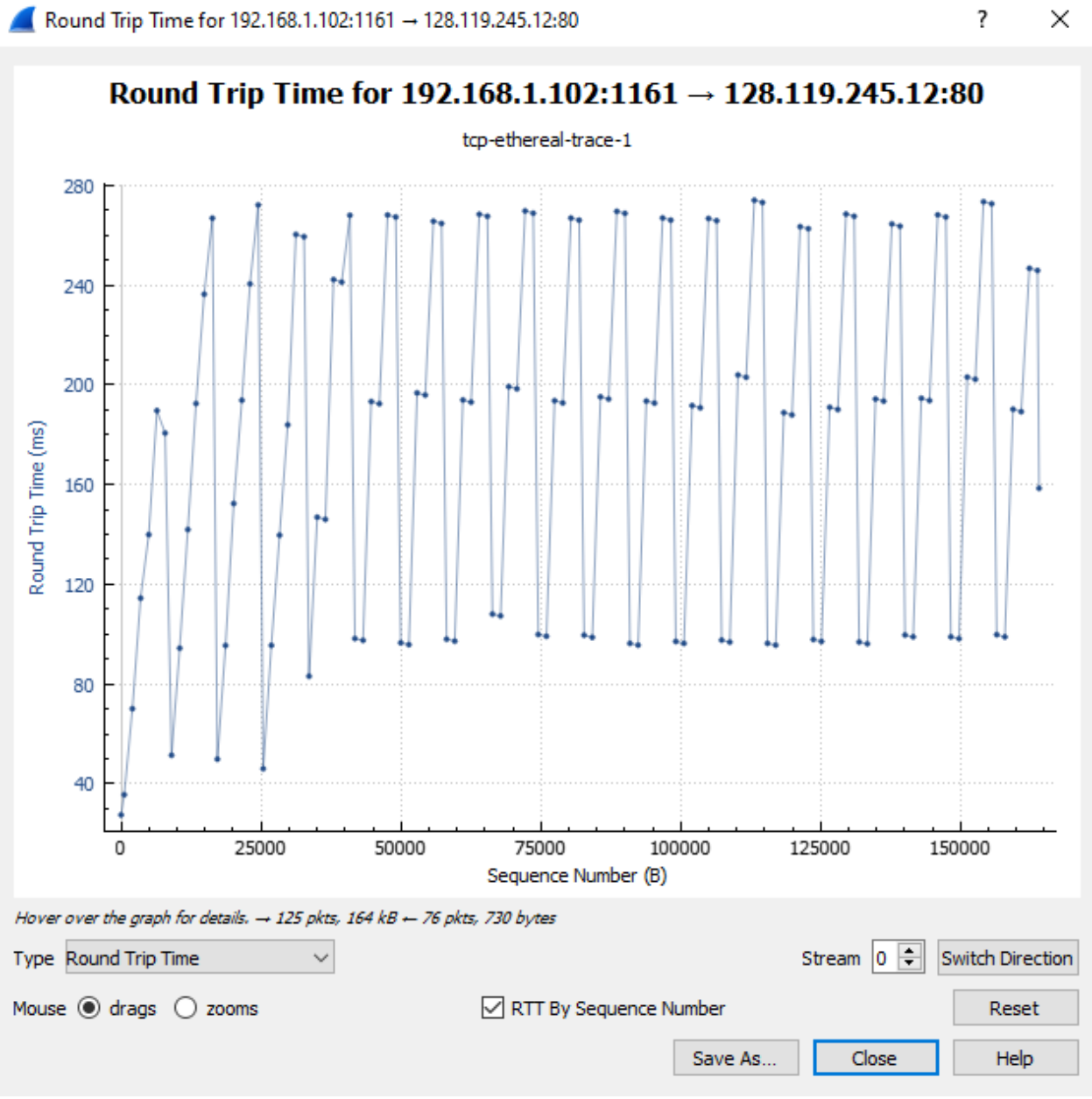
9. What is the minimum amount of available buffer space advertised at the received for the entire trace? Does the lack of receiver buffer space ever throttle the sender?

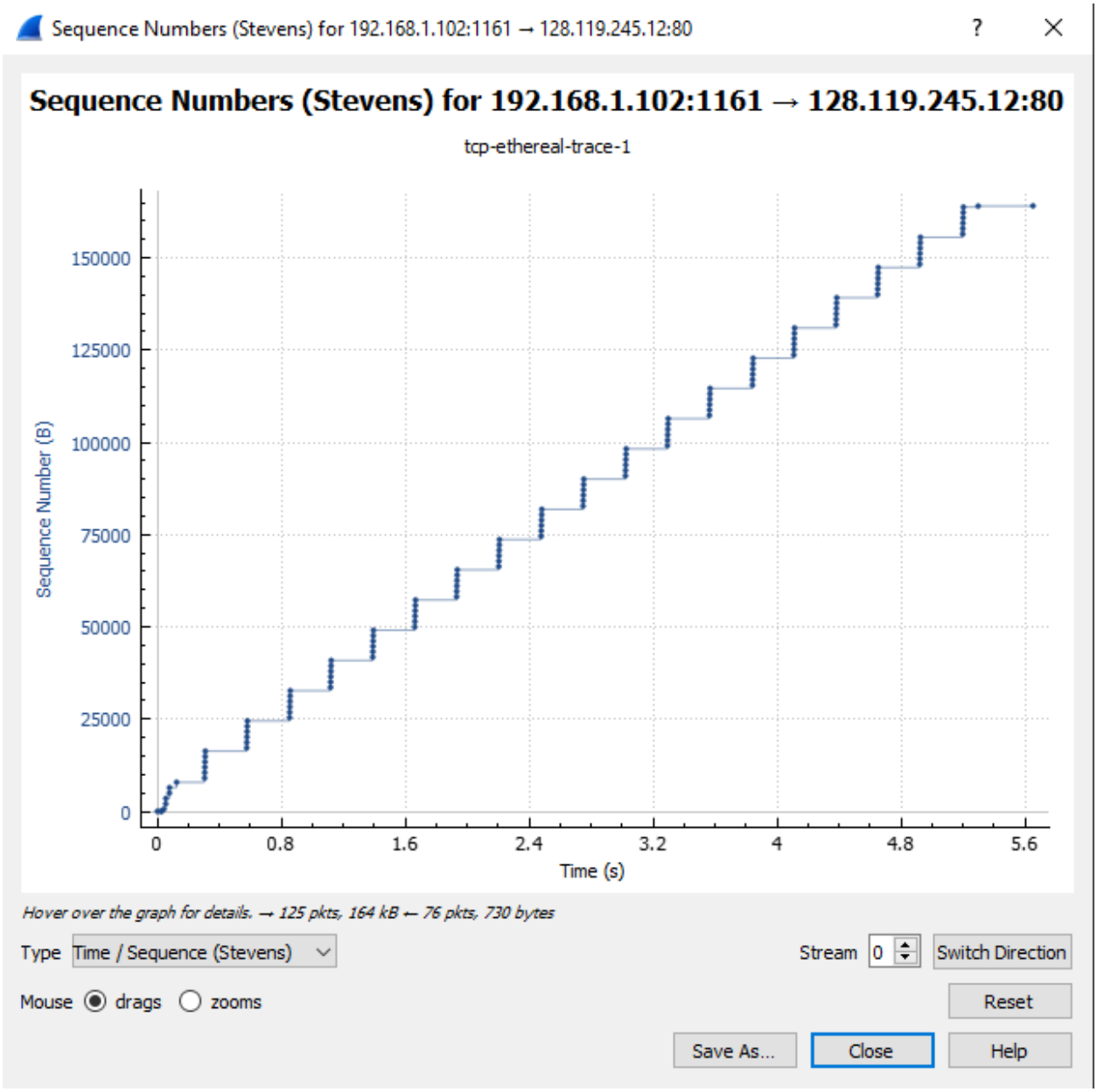

tcp-ethereal-trace-1
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
1 06:44:20.570381 192.168.1.102 128.119.245.12 TCP 62 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS
2 06:44:20.593553 128.119.245.12 192.168.1.102 TCP 62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840
3 06:44:20.593646 192.168.1.102 128.119.245.12 TCP 54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len
4 06:44:20.596858 192.168.1.102 128.119.245.12 TCP 619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=1752
5 06:44:20.612118 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17
6 06:44:20.624318 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Le
7 06:44:20.624407 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520
8 06:44:20.625071 192.168.1.102 128.119.245.12 TCP 1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520
9 06:44:20.647675 128.119.245.12 192.168.1.102 TCP 60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 L
....0 = Fin: Not set
[TCP Flags: ·····A··S·]
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]
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00
0010 00 30 00 00 40 00 37 06 0c 36 80 77 f5 0c c0 a8
0020 01 66 00 50 04 89 34 a2 74 19 0d d6 01 f5 70 12
0030 16 d0 77 4d 00 00 02 04 05 b4 01 01 04 02
The window size value from the TCP header (tcp.window_size_value), 2 bytes
Packets: 213 · Displayed: 202 (94.8%)
Profile: Default

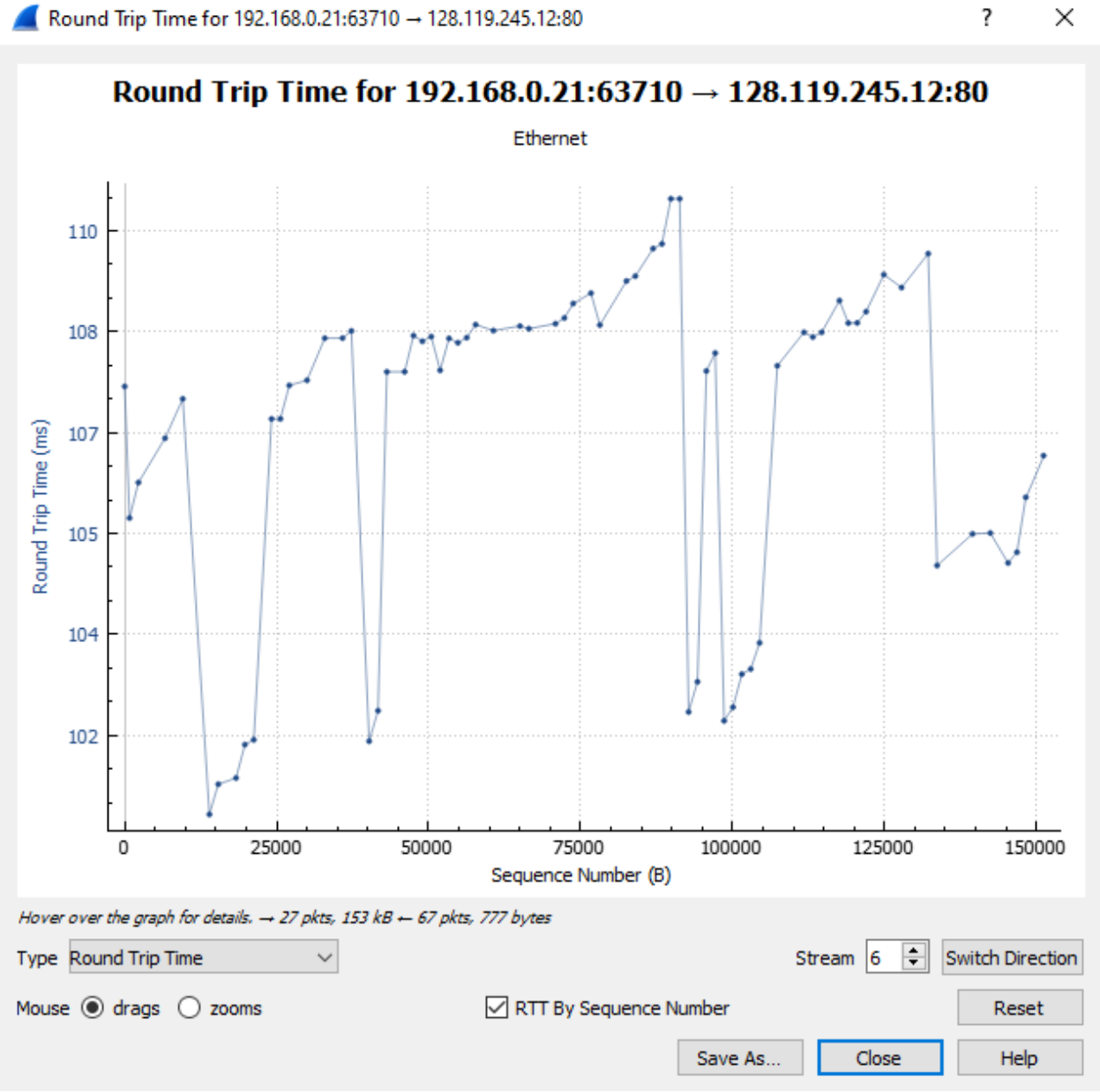


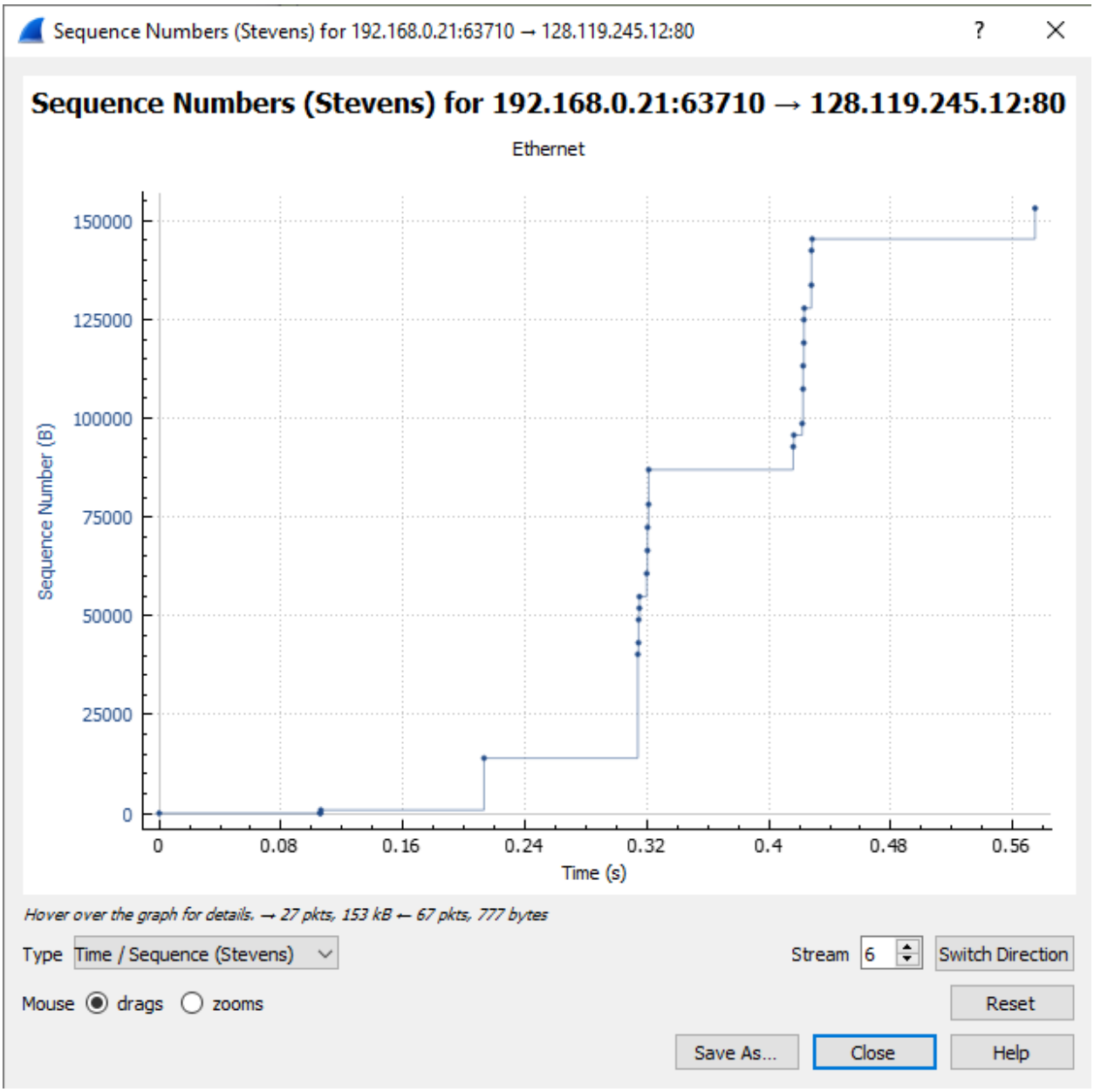
- The minimum amount of available buffer space advertised at the received for the entire trace is 5840 bytes as first acknowledgement from the server. The receiver window size gradually increased until the buffer size 62780 bytes. Therefore, the sender can't be throttled because of the lack of receiver buffer space.

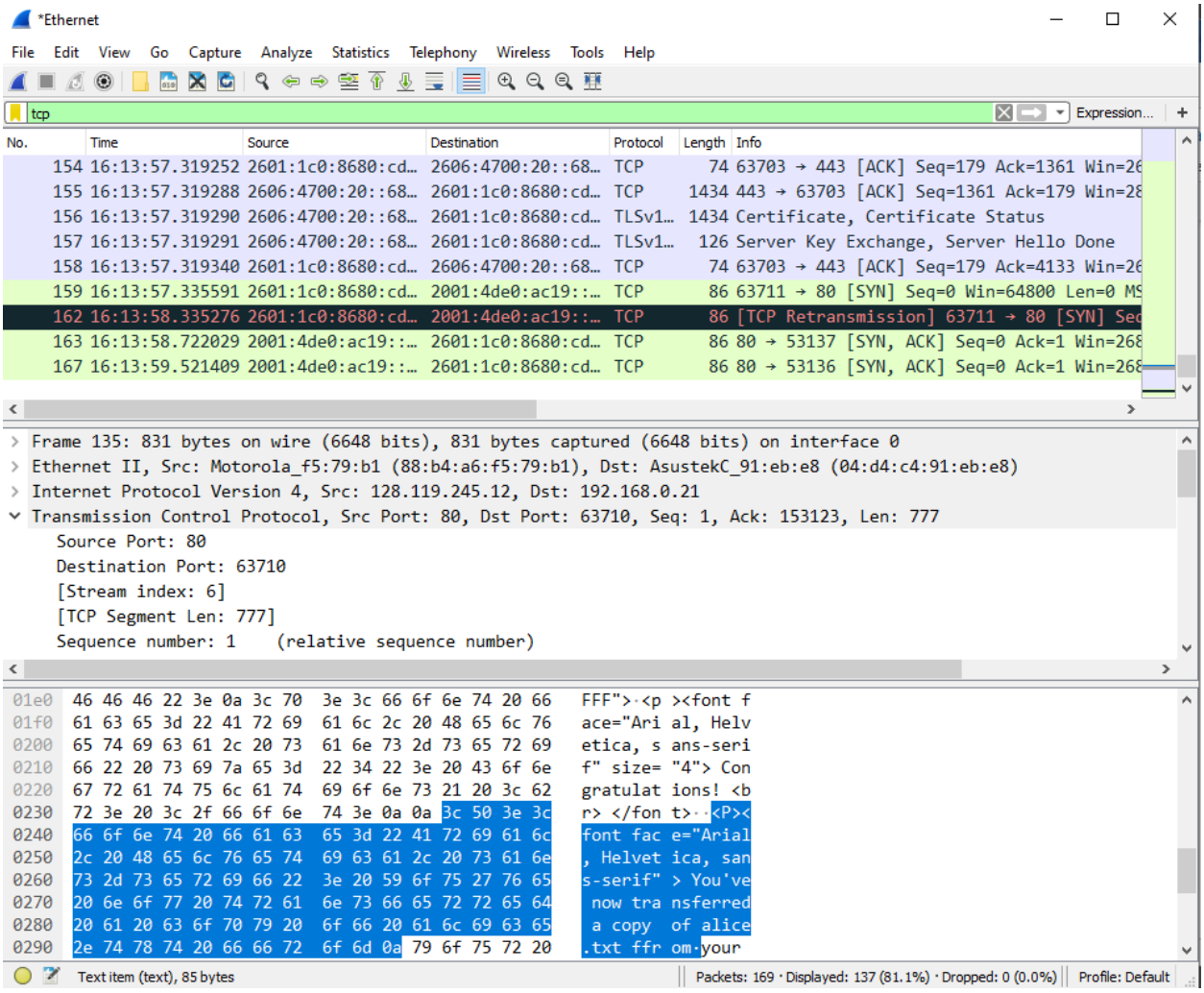
10. Are there any retransmitted segments in the trace file? What did you check for (in the trace) in order to answer this question?


Round Trip Time for 192.168.1.102:1161 → 128.119.245.12:80
Round Trip Time for 192.168.1.102:1161 → 128.119.245.12:80
tcp-ethereal-trace-1
Round Trip Time (ms)
280
240
200
160
120
80
40
0
25000
50000
75000
100000
125000
150000
Sequence Number (B)
Hover over the graph for details. → 125 pkts, 164 kB ← 76 pkts, 730 bytes
Type
Round Trip Time
Stream
0
Switch Direction
Mouse
drags
zooms
RTT By Sequence Number
Reset
Save As...
Close
Help


Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80
?
Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80
tcp-ethereal-trace-1
Sequence Number (B)
150000
125000
100000
75000
50000
25000
0
0
0.8
1.6
2.4
3.2
4
4.8
5.6
Time (s)
Hover over the graph for details. → 125 pkts, 164 kB ← 76 pkts, 730 bytes
Type
Time / Sequence (Stevens)
Stream
0
Switch Direction
Mouse
drags
zooms
Reset
Save As...
Close
Help


Round Trip Time for 192.168.0.21:63710 → 128.119.245.12:80
Round Trip Time for 192.168.0.21:63710 → 128.119.245.12:80
Ethernet
Round Trip Time (ms)
110
108
107
105
104
102
0
25000
50000
75000
100000
125000
150000
Sequence Number (B)
Hover over the graph for details. → 27 pkts, 153 kB ← 67 pkts, 777 bytes
Type
Round Trip Time
Stream
6
Switch Direction
Mouse
drags
zooms
RTT By Sequence Number
Reset
Save As...
Close
Help


Sequence Numbers (Stevens) for 192.168.0.21:63710 → 128.119.245.12:80
Sequence Numbers (Stevens) for 192.168.0.21:63710 → 128.119.245.12:80
Ethernet
150000
125000
100000
75000
50000
25000
0
Sequence Number (B)
0
0.08
0.16
0.24
0.32
0.4
0.48
0.56
Time (s)
Hover over the graph for details. → 27 pkts, 153 kB ← 67 pkts, 777 bytes
Type
Time / Sequence (Stevens)
Stream
6
Switch Direction
Mouse
drags
zooms
Reset
Save As...
Close
Help



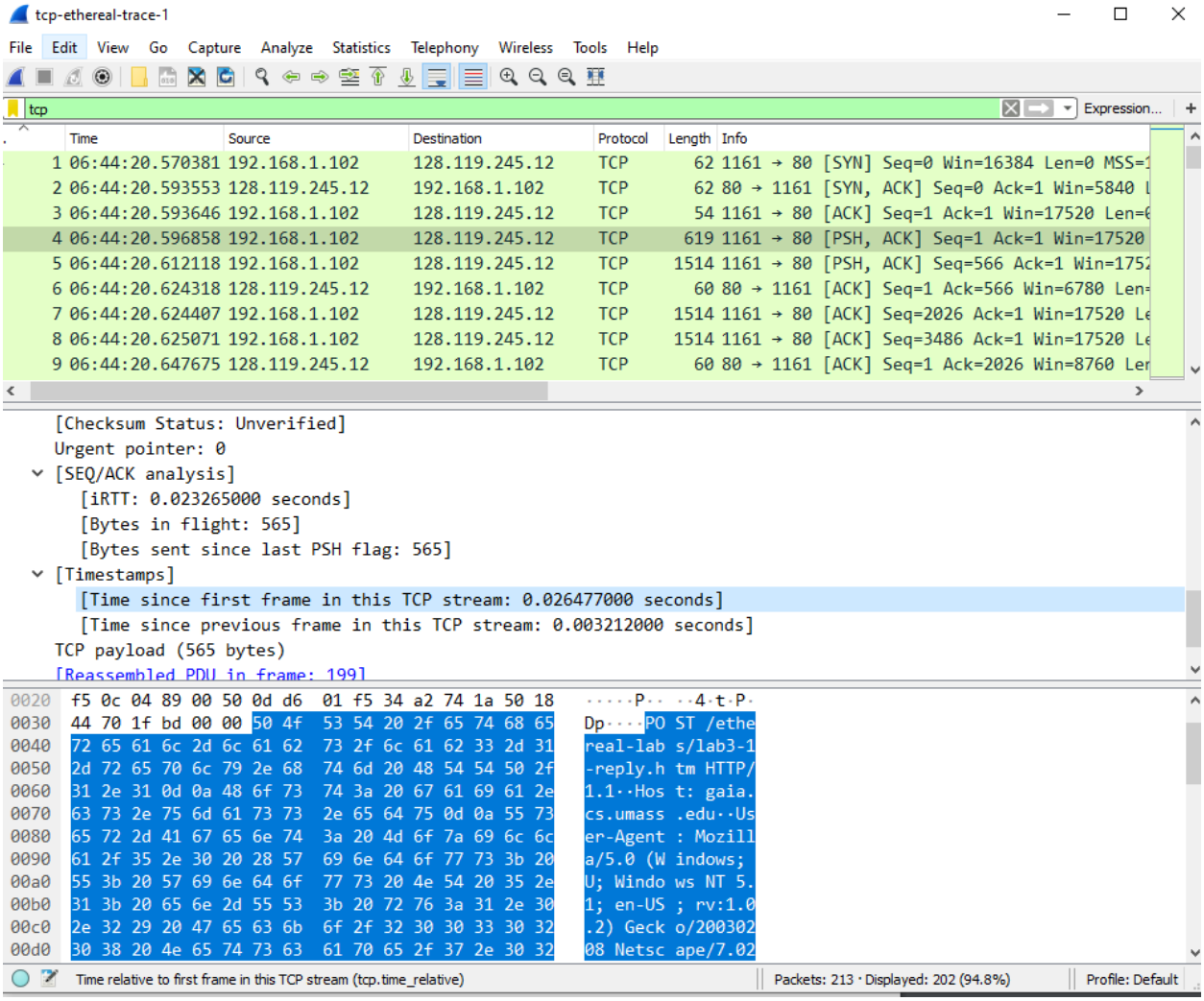
- There is no retransmitted segment in the trace file (tcp-ethereal-trace-1), but my computer ethernet's trace file has one retransmitted segment. I checked the packet list information for retransmitted segment.

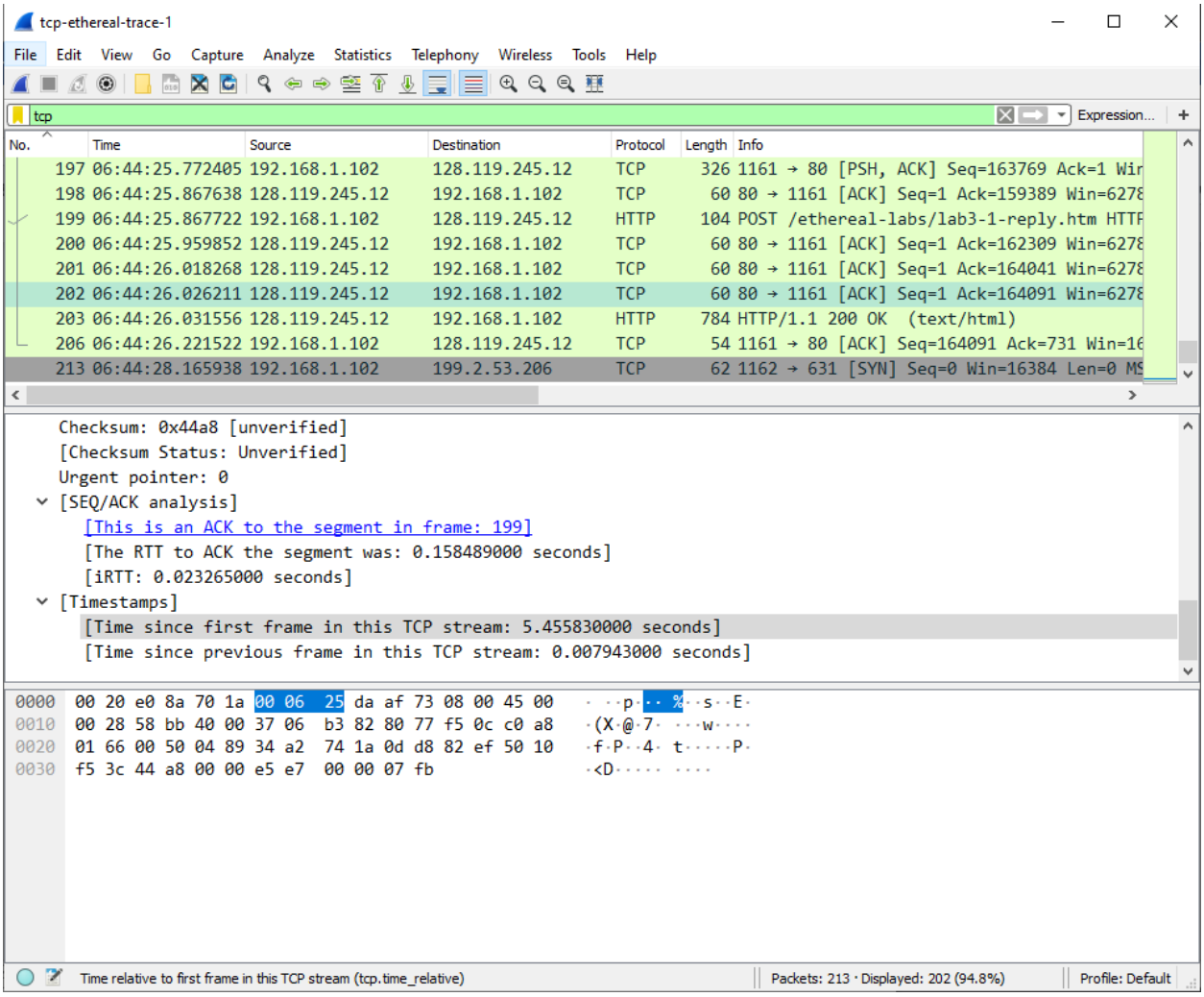
11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 250 in the text).

	ACK sequence number	ACKed data
ACK 1	566	566
ACK 2	2026	1460
ACK 3	3486	1460
ACK 4	4946	1460
ACK 5	6406	1460
ACK 6	7866	1460
ACK 7	9013	1147
ACK 8	10473	1460
ACK 9	11933	1460

- Typically, the data increased by 1460 each time except for the ACK 7. Therefore, it indicates that the receiver is ACKing 1460 bytes each time.

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





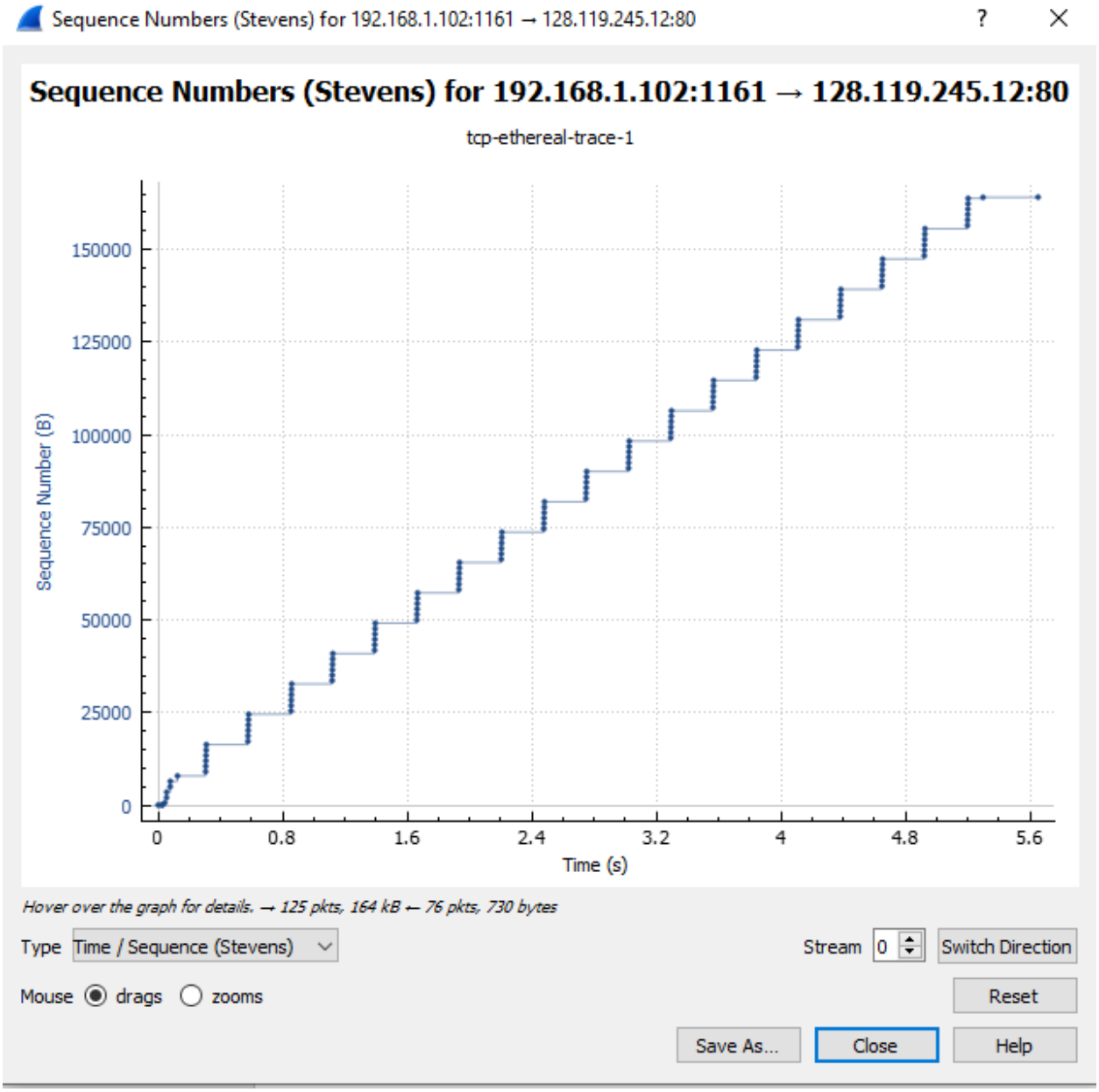
- To compute the throughput for the TCP connection, I need to calculate the amount of data transmitted and then divide it by time incurred. At this trace (tcp-ethereal-trace-1), the amount of data transmitted can be calculated by deducting the sequence number of first TCP segment (No.4) to the ACK sequence number of the last TCP segment (No.202) => 164091 – 1 = 164090 bytes. The incurred time can be calculated by deducting the time instant of the first TCP segment (0.026477) to the time instant of the last TCP segment (5.45583). Therefore, the incurred time for transmission is 5.45583 – 0.026477 = 5.429353

Then, 164090 / 5.429353 = about 30222.754 Byte/sec

TCP congestion control in action

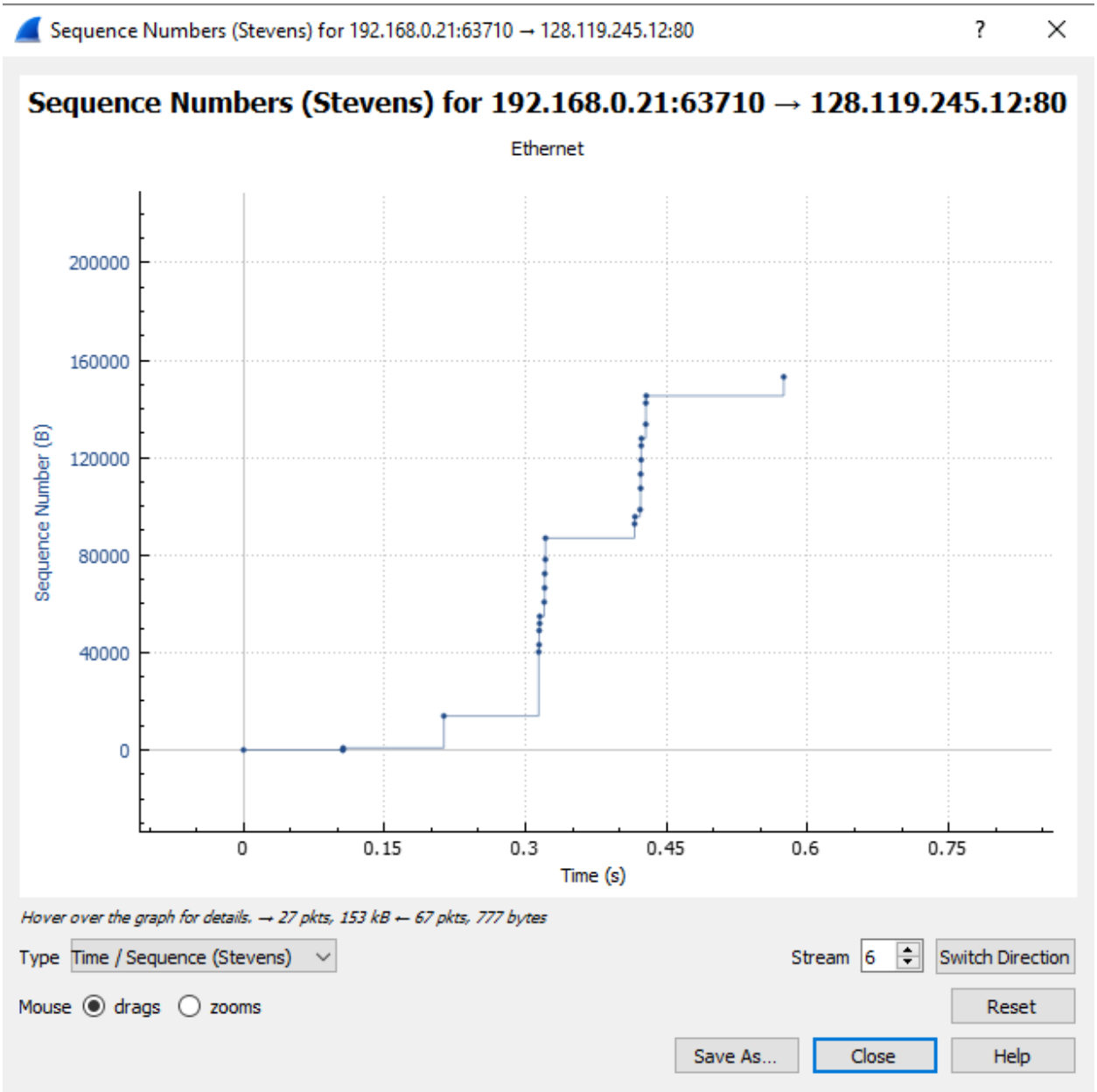
13. Use the Time-Sequence-Graph(Stevens) plotting tool to view the sequence number versus time plot of segments being sent from the client to the gaia.cs.umass.edu server. Can you identify where TCP's slowstart phase begins and ends, and where congestion avoidance takes over?

Comment on ways in which the measured data differs from the idealized behavior of TCP that we've studied in the text.



- From the plot, I can see the first 0.2 seconds have slow-start. After 0.2 seconds, the TCP is being stable and congestion avoidance state. The measured data is differed by using a fraction of the window size instead of the idealized 1/3 to a half.

14. Answer Question 13 for the trace that you captured when you transferred a file from your own computer to gaia.cs.umass.edu



- From the plot by my computer ethernet, I can see the first 0.2 seconds have slow-start. After 0.2 seconds, the TCP is being stable and congestion avoidance state. In contrast to the tcp-ethereal-trace-1 trace file, my computer trace shows that the measured data is differed by using bigger fraction than tcp-ethereal-trace-1 file's fraction and close to idealized window size.