

Tyler Cope

CS372 Lab 2

1.
 - a. IP address of client: 192.168.1.102
 - b. Port number: 1161
2.
 - a. IP address of gaia.cs.umass.edu: 128.199.245.12
 - b. Port of gaia: 80

The image shows a Wireshark packet capture titled "tcp-ethereal-trace-1". The packet list pane displays 11 packets. The selected packet (No. 1) is a SYN packet from 192.168.1.102 to 128.199.245.12, port 1161 to 80. The packet details pane shows the Ethernet II, Internet Protocol Version 4, and Transmission Control Protocol (TCP) layers. The TCP layer shows Seq=0, Win=16384, Len=0, MSS=1460, SACK_PERM=1, and Window=0.

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.199.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1 Window=0
2	09:44:20.593553	128.199.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1 Window=0
3	09:44:20.593646	192.168.1.102	128.199.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.199.245.12	TCP	619	[TCP segment of a reassembled PDU]
5	09:44:20.612118	192.168.1.102	128.199.245.12	TCP	1514	[TCP segment of a reassembled PDU]
6	09:44:20.624318	128.199.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.199.245.12	TCP	1514	[TCP segment of a reassembled PDU]
8	09:44:20.625071	192.168.1.102	128.199.245.12	TCP	1514	[TCP segment of a reassembled PDU]
9	09:44:20.647675	128.199.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.199.245.12	TCP	1514	[TCP segment of a reassembled PDU]
11	09:44:20.648538	192.168.1.102	128.199.245.12	TCP	1514	[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: 128.199.245.12
> Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0

0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00 ..%..s. ..p...E.
0010 00 30 1e 1d 40 00 00 06 a5 18 c0 a8 01 66 80 77 .0..@... ..f.w
0020 f5 0c 04 89 00 50 0d d6 01 f4 00 00 00 70 02P... ..p..
0030 40 00 f6 e9 00 00 02 04 05 b4 01 01 04 02 @.....

Transmission Control Protocol (tcp), 28 bytes | Packets: 213 · Displayed: 202 (94.8%) · Load time: 0:0.5 | Profile: Default

3.
 - a. IP address of my computer: 23.3.97.175
 - b. Port of my computer: 58102

aliceUpload.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	14:02:39.254040	23.3.97.175	192.168.0.10	HTTP	199	HTTP/1.1 200 OK
2	14:02:39.254255	192.168.0.10	23.3.97.175	TCP	54	58102 → 80 [ACK] Seq=1 Ack=146 Win=32731 Len=0
3	14:02:39.781109	192.168.0.10	23.3.97.175	HTTP	248	POST /idle/iSvmx_06gvN4CNPZ/155 HTTP/1.1
4	14:02:39.851981	23.3.97.175	192.168.0.10	TCP	60	80 → 58102 [ACK] Seq=146 Ack=195 Win=16616 Len=0
5	14:02:40.364036	23.3.97.175	192.168.0.10	HTTP	199	HTTP/1.1 200 OK
6	14:02:40.364275	192.168.0.10	23.3.97.175	TCP	54	58102 → 80 [ACK] Seq=195 Ack=291 Win=32713 Len=0
8	14:02:40.892511	192.168.0.10	23.3.97.175	HTTP	248	POST /idle/iSvmx_06gvN4CNPZ/156 HTTP/1.1
9	14:02:40.957771	23.3.97.175	192.168.0.10	TCP	60	80 → 58102 [ACK] Seq=291 Ack=389 Win=16616 Len=0
10	14:02:41.470030	23.3.97.175	192.168.0.10	HTTP	199	HTTP/1.1 200 OK
11	14:02:41.470272	192.168.0.10	23.3.97.175	TCP	54	58102 → 80 [ACK] Seq=389 Ack=436 Win=32695 Len=0
12	14:02:42.002125	192.168.0.10	23.3.97.175	HTTP	248	POST /idle/iSvmx_06gvN4CNPZ/157 HTTP/1.1

> Frame 1: 199 bytes on wire (1592 bits), 199 bytes captured (1592 bits) on interface 0
 > Ethernet II, Src: ArrisGro_85:9b:e7 (5c:8f:e0:85:9b:e7), Dst: IntelCor_8c:97:04 (68:17:29:8c:97:04)
 > Internet Protocol Version 4, Src: 23.3.97.175, Dst: 192.168.0.10
 > Transmission Control Protocol, Src Port: 80, Dst Port: 58102, Seq: 1, Ack: 1, Len: 145
 > Hypertext Transfer Protocol

Offset	Hex	ASCII
0020	00 0a 00 50 e2 f6 a4 18 36 8e 89 05 b1 db 50 18	..P....6....P.
0030	40 e8 0e 0b 00 00 48 54 54 50 2f 31 2e 31 20 32	0....HT TP/1.1 2
0040	30 30 20 4f 4b 0d 0a 43 61 63 68 65 2d 43 6f 6e	00 OK..C ache-Con
0050	74 72 6f 6c 3a 20 6e 6f 2d 63 61 63 68 65 0d 0a	trol: no -cache..
0060	43 6f 6e 6e 65 63 74 69 6f 6e 3a 20 4b 65 65 70	Connecti on: Keep

Transmission Control Protocol (tcp), 20 bytes

Packets: 309 · Displayed: 226 (73.1%) · Load time: 0:0.6 · Profile: Default

4.

The segment of the TCP SYN segment to initiate the connection is 0. I referenced this thread <https://ask.wireshark.org/questions/230/displaying-all-tcp-connections-with-syn-packets> and this thread <https://ask.wireshark.org/questions/10640/how-to-find-syn-not-followed-by-a-synack> to answer the second part of the question. I believe what identifies it as SYN segment is that the SYN flag is set to 1.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp.flags.syn == 1

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
213	09:44:28.165938	192.168.1.102	199.2.53.206	TCP	62	1162 → 631 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	09:44:20.593553	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...

Header Length: 28 bytes

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

[Expert Info (Chat/Sequence): Connection establish request (SYN): server port 80]

```

0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00  ..%..s.  ..p...E.
0010 00 30 1e 1d 40 00 80 06 a5 18 c0 a8 01 66 80 77  .0...f.w
0020 f5 0c 04 89 00 50 0d d6 01 f4 00 00 00 00 70 02  ....P. ....p.
0030 40 00 f6 e9 00 00 02 04 05 b4 01 01 04 02      @.....

```

Don't fragment (ip.flags.df), 1 byte

Packets: 213 · Displayed: 3 (1.4%) · Load time: 0:0.7 · Profile: Default

5.

a. The sequence number of the SYNACK segment sent by gaia.cs.umass.edu in reply to the SYN is 0.

b. The value in the acknowledgment field is 1. gaia.cs.umass.edu determined that value by adding 1 to the sequence number of the SYN segment.

c. It is identified as a SYNACK segment because the Acknowledgment flag is set and the SYN flag is set.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp.flags.syn == 1

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
213	09:44:28.165938	192.168.1.102	199.2.53.206	TCP	62	1162 → 631 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	09:44:20.593553	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...

Header Length: 28 bytes

Flags: 0x012 (SYN, ACK)

- 000. = Reserved: Not set
- ...0 = Nonce: Not set
- 0... = Congestion Window Reduced (CWR): Not set
-0.. = ECN-Echo: Not set
-0. = Urgent: Not set
-1 = Acknowledgment: Set
- 0... = Push: Not set
-0.. = Reset: Not set
-1. = Syn: Set

[Expert Info (Chat/Sequence): Connection establish acknowledge (SYN+ACK): server port 80]

```

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00  . .p... %..s..E.
0010 00 30 00 00 40 00 37 06 0c 36 80 77 f5 0c c0 a8  .0..7. .6.w....
0020 01 66 00 50 04 89 34 a2 74 19 0d d6 01 f5 70 12  .f.P..4. t.....p.
0030 16 d0 77 4d 00 00 02 04 05 b4 01 01 04 02      ..wM.....

```

Don't fragment (ip.flags.df), 1 byte

Packets: 213 · Displayed: 3 (1.4%) · Load time: 0:0.7 | Profile: Default

6.

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

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PER...
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=146...
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460

> 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: 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)

Header Length: 20 bytes

```

0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00  ..%..s.  ..p...E.
0010 02 5d 1e 21 40 00 80 06 a2 e7 c0 a8 01 66 80 77  .].!@...  ....f.w
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....P0 ST /ethe
0040 72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 33 2d 31  real-lab s/lab3-1

```

Transmission Control Protocol: Protocol

Packets: 213 · Displayed: 202 (94.8%) · Load time: 0:0.6 | Profile: Default

7.

- The sequence number of the first six segments are: 1, 566, 2026, 3486, 4946, and 6406.
- All of the segment times that were sent start with 9:44:20, so I will only include the decimal. Just know that each segment is prefaced with 9:44:20 (check next screenshot to verify).

Segment 1: .596858

Segment 2: .612118

Segment 3: .624407

Segment 4: .625071

Segment 5: .647786

Segment 6: .648538

tcp-ethereal-trace-1							
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help							
tcp							
No.	Time	Source	Destination	Protocol	Length	Info	
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PER...	
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=146...	
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0	
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565	
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460	
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0	
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460	
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460	
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0	
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460	
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460	
[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)							
Header Length: 20 bytes							
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]							
0000	00 06 25 da af 73 00 20	e0 8a 70 1a 08 00 45 00	..%..s. ..p...E.				
0010	05 dc 1e 26 40 00 80 06	9f 63 c0 a8 01 66 80 77	...&@... ..c...f.w				
0020	f5 0c 04 89 00 50 0d d6	1a fa 34 a2 74 1a 50 10P... ..4.t.P.				
0030	44 70 95 83 00 00 20 55	6e 69 74 65 64 20 53 74	Dp.... U nited St				
0040	61 74 65 73 20 63 6f 70	79 72 69 67 68 74 0d 0a	ates cop yright..				
Transmission Control Protocol: Protocol							
Packets: 213 · Displayed: 202 (94.8%) · Marked: 6 (2.8%) · Load time: 0:0.6 Profile: Default							

c. Similarly, the acknowledgments all start with 9:44:20, so again I'll only include the decimal. The acknowledgments are:

Segment 1: .624318

Segment 2: .647675

Segment 3: .694466

Segment 4: .739499

Segment 5: .787680

Segment 6: .838183

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	09:44:20.694466	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	09:44:20.694566	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	09:44:20.739499	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	09:44:20.787680	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	09:44:20.838183	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0

[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 1 (relative sequence number)
Acknowledgment number: 7866 (relative ack number)
Header Length: 20 bytes
> Flags: 0x010 (ACK)
Window size value: 20440
[Calculated window size: 20440]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0x4c50 [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0

```

0000  00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00  . .p... %..s..E.
0010  00 28 58 77 40 00 37 06 b3 c6 80 77 f5 0c c0 a8  .(Xw@.7. ...w....
0020  01 66 00 50 04 89 34 a2 74 1a 0d d6 20 ae 50 10  .f.P..4. t... .P.
0030  4f d8 4c 50 00 00 93 c0 00 00 63 ed             O.LP.... ..c.

```

Transmission Control Protocol: Protocol | Packets: 213 · Displayed: 202 (94.8%) · Marked: 6 (2.8%) · Load time: 0:0.6 | Profile: Default

d. RTT value for each segment.

Segment 1: .624318 - .596858 = .02746

Segment 2: .647675 - .612118 = .035557

Segment 3: .694466 - .624407 = .070059

Segment 4: .739499 - .625071 = .114428

Segment 5: .787680 - .647786 = .139894

Segment 6: .838183 - .648538 = .189645

e. The formula for Estimated RTT is found on page 242 and is as follows:

$$\text{EstimatedRTT} = 0.875 * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$$

Segment 1: Same as measured RTT which is .02746

Segment 2: $0.875 * .02746 + 0.125 * .03557 = .02847375$

Segment 3: $0.875 * .02847375 + 0.125 * .070059 = .0336719063$

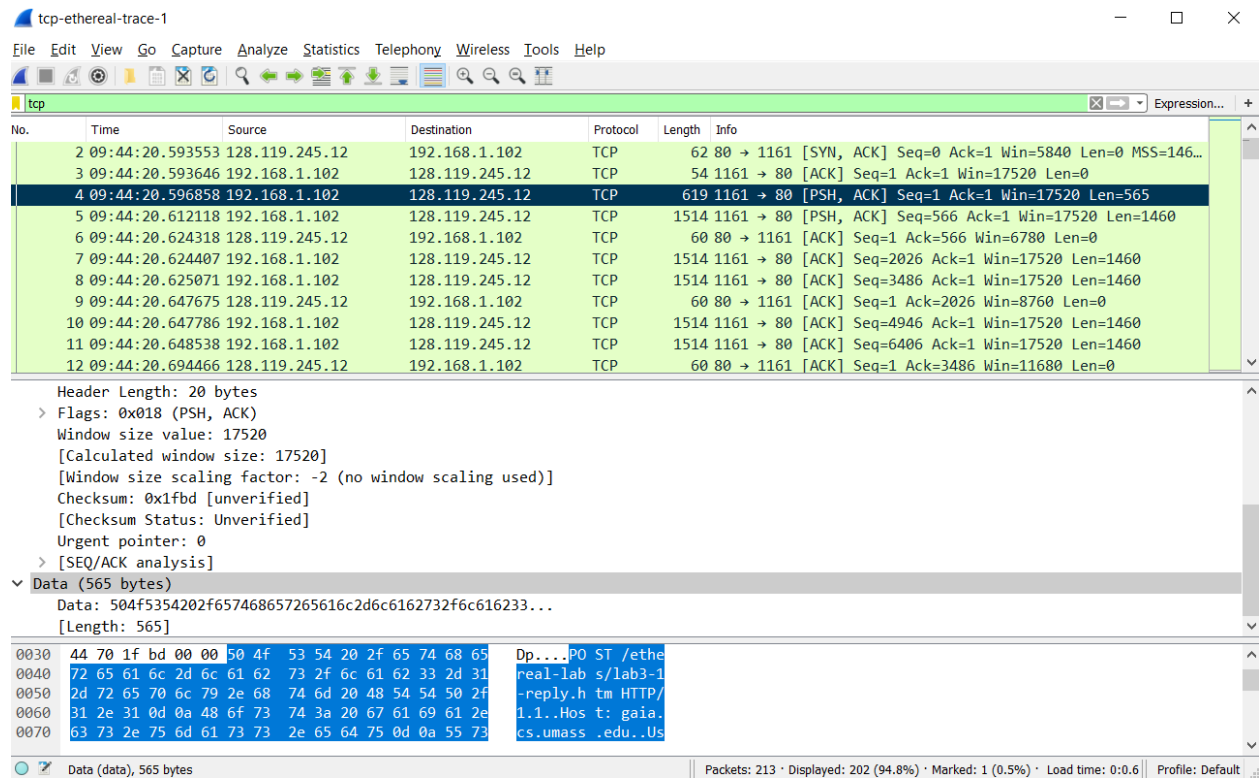
Segment 4: $0.875 * .0336719063 + 0.125 * .114428 = .043766418$

Segment 5: $0.875 * .043766418 + 0.125 * .139894 = .0557823658$

Segment 6: $0.875 * .0557823658 + 0.125 * .189645 = .0725151951$

8.

Segment 1: 565 bytes



The image shows a Wireshark packet capture analysis of Segment 1. The packet list pane displays a table of captured packets. Packet 4 is selected, showing its details and raw data.

No.	Time	Source	Destination	Protocol	Length	Info
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	09:44:20.694466	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0

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]

Data (565 bytes)
Data: 504f5354202f657468657265616c2d6c6162732f6c616223...
[Length: 565]

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 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

Data (data), 565 bytes | Packets: 213 · Displayed: 202 (94.8%) · Marked: 1 (0.5%) · Load time: 0:0.6 | Profile: Default

The length of the remaining segments is all 1460 bytes.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	09:44:20.694466	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0

Header Length: 20 bytes
 > 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]

▼ Data (1460 bytes)
 Data: 20556e697465642053746174657320636f70797269676874...
 [Length: 1460]

0030	44 70 95 83 00 00	20 55 6e 69 74 65 64 20 53 74	Dp.... U nited St
0040	61 74 65 73 20 63 6f 70	79 72 69 67 68 74 0d 0a	ates cop yright..
0050	6f 6e 20 6f 72 20 66 6f	72 20 74 68 69 73 20 77	on or fo r this w
0060	6f 72 6b 2c 20 73 6f 20	74 68 65 20 50 72 6f 6a	ork, so the Proj
0070	65 63 74 20 28 61 6e 64	20 79 6f 75 21 29 20 63	ect (and you!) c

Data (data), 1460 bytes

Packets: 213 · Displayed: 202 (94.8%) · Marked: 5 (2.3%) · Load time: 0:0.6 Profile: Default

9. The minimum amount of buffer space can be seen in the first acknowledgment from the server. It is 5840 bytes. It does not seem like the lack of receiver buffer space ever throttles the sender because the window grows as needed. In the next two screenshots, see how the first ACK shows 5408 bytes but the next window shows 6780.

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PER...
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=146...
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460

[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number)
Acknowledgment number: 1 (relative ack number)
Header Length: 28 bytes
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]

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00 . . . p . . . % . . . s . . . E .
0010 00 30 00 00 40 00 37 06 0c 36 80 77 f5 0c c0 a8 . 0 . . @ . 7 . . 6 . w
0020 01 66 00 50 04 89 34 a2 74 19 0d d6 01 f5 70 12 . f . P . . 4 . t p .
0030 16 d0 77 4d 00 00 02 04 05 b4 01 01 04 02 . w M

The window size value from the TCP header (tcp.window_size_value), 2 bytes

Packets: 213 · Displayed: 202 (94.8%) · Marked: 1 (0.5%) · Load time: 0:0.6 · Profile: Default

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PER...
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=146...
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460

[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]

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00 . . . p . . . % . . . s . . . E .
0010 00 28 58 72 40 00 37 06 b3 cb 80 77 f5 0c c0 a8 . (Xr@.7. . . w
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 04 2a 50 10 . f . P . . 4 . t * P .
0030 1a 7c 9e 30 00 00 da 12 00 00 47 a5 . . 0 G .

The window size value from the TCP header (tcp.window_size_value), 2 bytes

Packets: 213 · Displayed: 202 (94.8%) · Marked: 1 (0.5%) · Load time: 0:0.6 · Profile: Default

10. There are no retransmitted segments in the trace. In order to verify this, I looked at the sequence numbers of all the TCP segments. Whenever it got to a new segment, the acknowledgment number always increased, never decreasing.

11. Typically, the receiver is acknowledging 1460 bytes. There are a few times where the receiver is acknowledging every other received segment. I have a screenshot of an example.

The screenshot displays the Wireshark interface with a TCP trace. The packet list pane shows several TCP segments. Packet 71 is selected, and the details pane shows the following information:

- 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: 49973, Len: 0
 - Source Port: 80
 - Destination Port: 1161
 - [Stream index: 0]
 - [TCP Segment Len: 0]
 - Sequence number: 1 (relative sequence number)
 - Acknowledgment number: 49973 (relative ack number)
 - Header Length: 20 bytes
 - Flags: 0x010 (ACK)
 - Window size value: 62780

The packet bytes pane shows the raw data of the selected packet:

```
0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00  . . . p . . % . . s . . E .
0010 00 28 58 90 40 00 37 06 b3 ad 80 77 f5 0c c0 a8  . (X.@.7. . . . w . . . .
0020 01 66 00 50 04 89 34 a2 74 1a 0d d6 c5 29 50 10  . f . P . . 4 . t . . . . ) P .
0030 f5 3c 02 70 00 00 0e 6b 00 00 b9 f0  < . p . . . k . . . .
```

12. To get the throughput, we need to calculate the total amount of data transferred divided by the total transmission time. To get the total amount of data that was transferred we just need to go to the first sent packet, get the number of bytes sent, and subtract that from the final value of the last acknowledged segment. At the fourth segment we can see the first data being sent, with acknowledgment number 1. At the last segment for acknowledgment of sent data, segment 202, we can see the number is 164091. So $164091 - 1 = 164090$ (the total amount of data that was sent).

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
1	09:44:20.570381	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PER...
2	09:44:20.593553	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=146...
3	09:44:20.593646	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	09:44:20.596858	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	09:44:20.612118	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	09:44:20.624318	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	09:44:20.624407	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	09:44:20.625071	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	09:44:20.647675	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	09:44:20.647786	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	09:44:20.648538	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460

> 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)
Header Length: 20 bytes
Flags: 0x018 (PSH, ACK)
Window size value: 17520

0030 44 70 1f bd 00 00 50 4f 53 54 20 2f 65 74 68 65 Dg....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 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

The window size value from the TCP header (tcp.window_size_value), 2 bytes

Packets: 213 · Displayed: 202 (94.8%) · Marked: 1 (0.5%) · Load time: 0:0.6 Profile: Default

tcp-ethereal-trace-1

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

tcp

No.	Time	Source	Destination	Protocol	Length	Info
196	09:44:25.771531	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=162309 Ack=1 Win=17520 Len=1460
197	09:44:25.772405	192.168.1.102	128.119.245.12	TCP	326	1161 → 80 [PSH, ACK] Seq=163769 Ack=1 Win=17520 Len=272
198	09:44:25.867638	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
199	09:44:25.867722	192.168.1.102	128.119.245.12	TCP	104	1161 → 80 [PSH, ACK] Seq=164041 Ack=1 Win=17520 Len=50
200	09:44:25.959852	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201	09:44:26.018268	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202	09:44:26.026211	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	09:44:26.031556	128.119.245.12	192.168.1.102	TCP	784	80 → 1161 [PSH, ACK] Seq=1 Ack=164091 Win=62780 Len=730
206	09:44:26.221522	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0
213	09:44:28.165938	192.168.1.102	199.2.53.206	TCP	62	1162 → 631 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PE...

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

Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 164091, Len: 0

Source Port: 80
Destination Port: 1161
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 1 (relative sequence number)
Acknowledgment number: 164091 (relative ack number)
Header Length: 20 bytes
Flags: 0x010 (ACK)
Window size value: 62780
[Calculated window size: 62780]

0000 00 20 e0 8a 70 1a 00 06 25 da af 73 08 00 45 00 . .p... %..s..E.
0010 00 28 58 bb 40 00 37 06 b3 82 80 77 f5 0c c0 a8 .(X.@.7.w...
0020 01 66 00 50 04 89 3a a2 74 1a 0d d8 82 ef 50 10 .f.P..4. t.....P.
0030 f5 3c 44 a8 00 00 e5 e7 00 00 07 fb <0.....

The window size value from the TCP header (tcp.window_size_value), 2 bytes

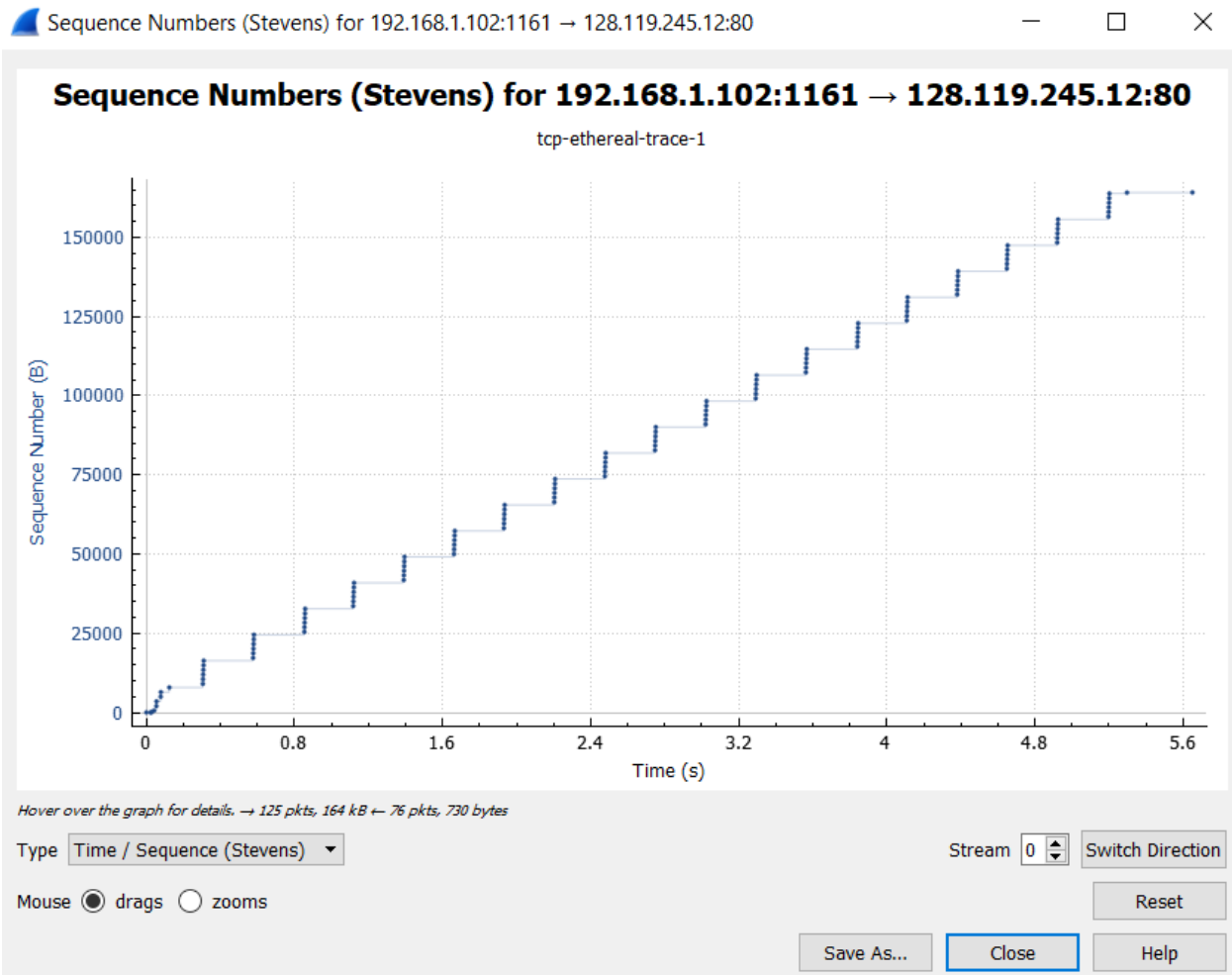
Packets: 213 · Displayed: 202 (94.8%) · Marked: 1 (0.5%) · Load time: 0:0.6 Profile: Default

Next, we need to calculate the total connection time. So, we start at the initial connection and get the time, then subtract that from the ending time (these times are verifiable in the screenshot above). $26.026211 - 20.596858 = 5.429353$ seconds. Finally, just divide to get the throughput: $164090 / 5.429353 = 30,222.75398192$ bytest/second.

13.

a. It looks like the slowstart phase begins at the initial TCP connection. After that however, the receiving is fairly smooth and the data coming in is never more than about 8200 bytes before it gets more data. This tells us that the sender is waiting for acknowledgment from the receiver before pushing more data, so I'm not sure there is any congestion avoidance at all.

b. Ideally, TCP will send quite a bit of data before waiting for acknowledgment. Here however, only a small amount of data was sent each time so there is never a worry about congestion control.



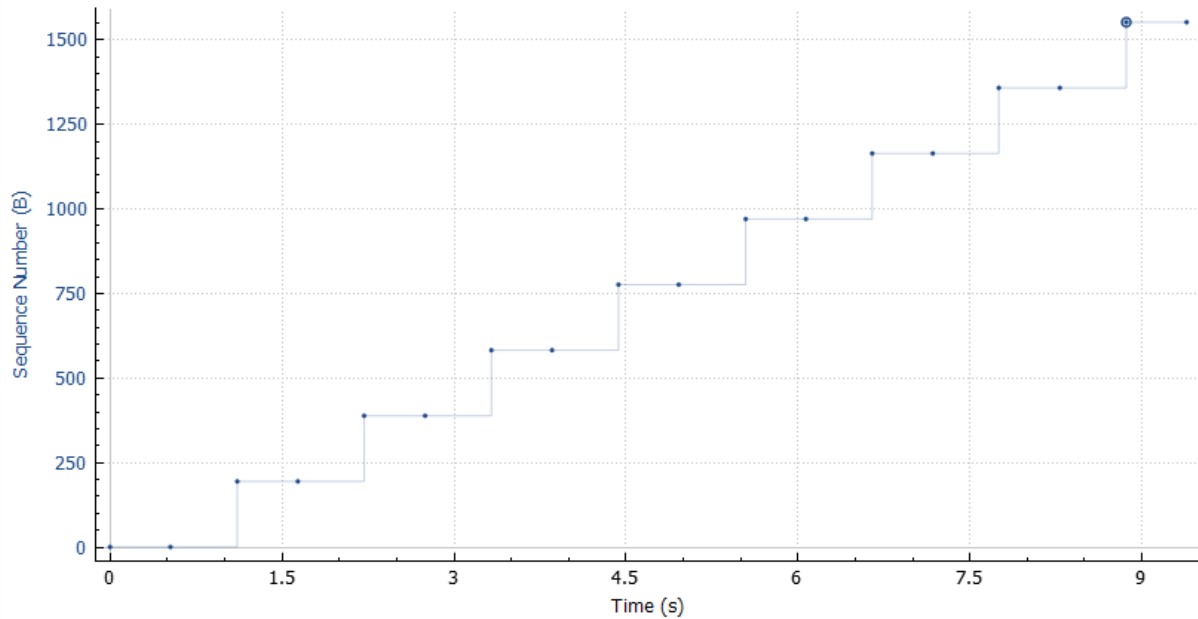
14.

a. It doesn't look like the slowstart phase ever ends. The window doesn't ever increase by too much.

b. This is similar to the idealized behavior that we have studied for TCP.

Sequence Numbers (Stevens) for 192.168.0.10:58102 → 23.3.97.175:80

aliceUpload.pcapng

*Click to select packet 294 (8.863s len 0 seq 1553 ack 1306 win 32586) → 18 pkts, 1746 bytes ← 19 pkts, 1450 bytes*Type **Time / Sequence (Stevens)** ▼

Stream 0 ▼

Switch Direction

Mouse ☒ drags ☐ zooms

Reset

Save As...

Close

Help