

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](http://gaia.cs.umass.edu)?

client的ip为192.168.1.102, tcp端口号为1161.

2. What is the IP address of [gaia.cs.umass.edu](http://gaia.cs.umass.edu)? On what port number is it sending and receiving TCP segments for this connection?

gaia.cs.umass.edu的ip地址为128.119.245.152, tcp端口号为80

截图来自tcp-ethereal-trace-1

**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**

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](http://gaia.cs.umass.edu)?

在自己的trace当中client的ip为192.168.1.101, tcp端口号为60692.

截图来自自己的trace文件alice\_catch.pcapng

No.	Time	Source	Destination	Protocol	Length	Leftover Cap	Info
75	2.739016	192.168.1.101	128.119.245.12	TCP	78		60692 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2265982278 TSecr=0 SACK_...
76	2.990397	192.168.1.101	128.119.245.12	TCP	78		60693 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2265982278 TSecr=0 SACK_...
77	2.998199	128.119.245.12	192.168.1.101	TCP	74		80 → 60692 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK_PERM=1 TSval=3373489...
78	2.998201	128.119.245.12	192.168.1.101	TCP	74		80 → 60691 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK_PERM=1 TSval=3373489...
79	2.998331	192.168.1.101	128.119.245.12	TCP	66		60692 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2265982537 TSecr=3373489576
80	2.998404	192.168.1.101	128.119.245.12	TCP	66		60691 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2265982537 TSecr=3373489586
81	2.998952	192.168.1.101	128.119.245.12	TCP	829		60692 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=763 TSval=2265982537 TSecr=33734895...
82	2.999261	192.168.1.101	128.119.245.12	TCP	1494		60692 → 80 [ACK] Seq=764 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576...
83	2.999266	192.168.1.101	128.119.245.12	TCP	1494		60692 → 80 [ACK] Seq=2192 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=337348957...
84	2.999269	192.168.1.101	128.119.245.12	TCP	1494		60692 → 80 [ACK] Seq=3620 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=337348957...
85	2.999271	192.168.1.101	128.119.245.12	TCP	1494		60692 → 80 [ACK] Seq=5048 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=337348957...
86	2.999273	192.168.1.101	128.119.245.12	TCP	1494		60692 → 80 [ACK] Seq=6476 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=337348957...
87	2.999276	192.168.1.101	128.119.245.12	TCP	1494		60692 → 80 [ACK] Seq=7904 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=337348957...

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](http://gaia.cs.umass.edu)? What is it in the segment that identifies the segment as a SYN segment?

sequence number为0, segment中的flag标记出了SYN segment

### 截图来自自己的trace文件alice\_catch.pcapng

Conversation completeness: Incomplete, ESTABLISHED (7)

[TCP Segment Len: 0]

Sequence Number: 0 (relative sequence number)

Sequence Number (raw): 2551907190

[Next Sequence Number: 1 (relative sequence number)]

Acknowledgment Number: 0

Acknowledgment number (raw): 0

101 .... = Header Length: 44 bytes (11)

> Flags: 0x002 (SYN)

Window: 65535

No. | Time | Source | Destination | Protocol | Length | Leftover Cap| Info

73	1.430618	192.168.1.101	52.98.70.130	TCP	66	64383 → 443 [ACK] Seq=7093 Ack=5582 Win=2048 Len=0 TSval=1190284136 TSecr=483971480
74	2.738893	192.168.1.101	128.119.245.12	TCP	78	60691 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2525884513 TSecr=0 SACK\_...
75	2.739016	192.168.1.101	128.119.245.12	TCP	78	60692 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2265982278 TSecr=0 SACK\_...
76	2.990397	192.168.1.101	128.119.245.12	TCP	78	60693 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2624089043 TSecr=0 SACK\_...
77	2.998199	128.119.245.12	192.168.1.101	TCP	74	80 → 60692 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK\_PERM=1 TSval=3373489...
78	2.998201	128.119.245.12	192.168.1.101	TCP	74	80 → 60691 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK\_PERM=1 TSval=3373489...
79	2.998331	192.168.1.101	128.119.245.12	TCP	66	60692 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2265982537 TSecr=3373489576
80	2.998404	192.168.1.101	128.119.245.12	TCP	66	60691 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2525884772 TSecr=3373489576
81	2.998952	192.168.1.101	128.119.245.12	TCP	829	60692 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=763 TSval=2265982537 TSecr=3373489576
82	2.999261	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=764 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
83	2.999266	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=2192 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
84	2.999269	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=3620 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
85	2.999271	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=5048 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
  

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..0	.... = Acknowledgment: Not set
....0...0	.... = Push: Not set
....0...0..	.... = Reset: Not set
....0...0..1	.... = Syn: Set

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?

SYNACK segment的sequence number为0。Acknowledgement field的值为1，这个值是SYN segment的sequence number加1得到的。segment中的flag标记出了SYNACK segment。

### 截图来自自己的trace文件alice\_catch.pcapng

Conversation completeness: Incomplete, DATA (15)

[TCP Segment Len: 0]

Sequence Number: 0 (relative sequence number)

Sequence Number (raw): 3185251176

[Next Sequence Number: 1 (relative sequence number)]

Acknowledgment Number: 1 (relative ack number)

Acknowledgment number (raw): 3832589712

1010 .... = Header Length: 40 bytes (10)

> Flags: 0x012 (SYN, ACK)

Window: 28960

Timestamp: 1601111111.000000000, 1601111111.000000000

No. | Time | Source | Destination | Protocol | Length | Leftover Cap| Info

73	1.430618	192.168.1.101	52.98.70.130	TCP	66	64383 → 443 [ACK] Seq=7093 Ack=5582 Win=2048 Len=0 TSval=1190284136 TSecr=483971480
74	2.738893	192.168.1.101	128.119.245.12	TCP	78	60691 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2525884513 TSecr=0 SACK\_...
75	2.739016	192.168.1.101	128.119.245.12	TCP	78	60692 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2265982278 TSecr=0 SACK\_...
76	2.990397	192.168.1.101	128.119.245.12	TCP	78	60693 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2624089043 TSecr=0 SACK\_...
77	2.998199	128.119.245.12	192.168.1.101	TCP	74	80 → 60692 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK\_PERM=1 TSval=3373489...
78	2.998201	128.119.245.12	192.168.1.101	TCP	74	80 → 60691 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK\_PERM=1 TSval=3373489...
79	2.998331	192.168.1.101	128.119.245.12	TCP	66	60692 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2265982537 TSecr=3373489576
80	2.998404	192.168.1.101	128.119.245.12	TCP	66	60691 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2525884772 TSecr=3373489576
81	2.998952	192.168.1.101	128.119.245.12	TCP	829	60692 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=763 TSval=2265982537 TSecr=3373489576
82	2.999261	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=764 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
83	2.999266	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=2192 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
84	2.999269	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=3620 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
85	2.999271	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=5048 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576

No.	Time	Source	Destination	Protocol	Length	Leftover Cap  Info
73	1.430618	192.168.1.101	52.98.70.130	TCP	66	64383 → 443 [ACK] Seq=7093 Ack=5582 Win=2048 Len=0 TSval=1190284136 TSecr=483971480
74	2.738893	192.168.1.101	128.119.245.12	TCP	78	60691 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2525884513 TSecr=0 SACK_...
75	2.739016	192.168.1.101	128.119.245.12	TCP	78	60692 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2265982278 TSecr=0 SACK_...
76	2.739037	192.168.1.101	128.119.245.12	TCP	78	60693 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2624089043 TSecr=0 SACK_...
77	2.998199	128.119.245.12	192.168.1.101	TCP	74	80 → 60692 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK_PERM=1 TSval=33734895...
78	2.998201	128.119.245.12	192.168.1.101	TCP	74	80 → 60691 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK_PERM=1 TSval=33734895...
79	2.998331	192.168.1.101	128.119.245.12	TCP	66	60692 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2265982537 TSecr=3373489576
80	2.998404	192.168.1.101	128.119.245.12	TCP	66	60691 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2525884772 TSecr=3373489586
81	2.998952	192.168.1.101	128.119.245.12	TCP	829	60692 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=763 TSval=2265982537 TSecr=3373489576
82	2.999261	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=764 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
83	2.999266	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=2192 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
84	2.999269	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=3620 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
85	2.999271	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=5048 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
						0000. .... . = 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 > ....0. .... .1. = Syn: Set ....0. .... .0 = Fin: Not set [TCP_Elapse: 0.000000 A.c.1]

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.

【】 TCP segment containing the HTTP POST command的sequence number为1.

截图来自自己的trace文件alice\_catch.pcapng

No.	Time	Source	Destination	Protocol	Length	Leftover Cap  Info
73	126.75.90.10	192.168.1.101	128.119.245.12	TCP	78	60692 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1400 WS=0 TSval=2265982278 TSecr=0 SACK_...
76	2.990397	192.168.1.101	128.119.245.12	TCP	78	60693 → 80 [SYN, ACK] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=2624089043 TSecr=0 SACK_...
77	2.998199	128.119.245.12	192.168.1.101	TCP	74	80 → 60692 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK_PERM=1 TSval=33734895...
78	2.998201	128.119.245.12	192.168.1.101	TCP	74	80 → 60691 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1440 SACK_PERM=1 TSval=33734895...
79	2.998331	192.168.1.101	128.119.245.12	TCP	66	60692 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2265982537 TSecr=3373489576
80	2.998404	192.168.1.101	128.119.245.12	TCP	66	60691 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=2525884772 TSecr=3373489586
81	2.998952	192.168.1.101	128.119.245.12	TCP	829	60692 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131328 Len=763 TSval=2265982537 TSecr=3373489576
82	2.999261	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=764 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
83	2.999266	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=2192 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
84	2.999269	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=3620 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
85	2.999271	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=5048 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
86	2.999273	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=6476 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
87	2.999276	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=7904 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
88	2.999279	192.168.1.101	128.119.245.12	TCP	1494	60692 → 80 [ACK] Seq=9332 Ack=1 Win=131328 Len=1428 TSval=2265982537 TSecr=3373489576
						Transmission Control Protocol, Src Port: 60692, Dst Port: 80, Seq: 1, Ack: 1, Len: 763 Source Port: 60692 Destination Port: 80 [Stream index: 3] [Conversation completeness: Incomplete, DATA (15)] [TCP Segment Len: 763] Sequence Number: 1 (relative sequence number) Sequence Number (raw): 3832589712 [Next Sequence Number: 764 (relative sequence number)] Acknowledgment Number: 1 (relative ack number)
0040	5d a8 50 4f 53 54 20 2f 77 69 72 65 73 68 61 72 1 POST / wireshar...					
0050	6b 2d 61 62 73 2f 6c 61 62 33 2d 31 2d 72 65 k:\lbs\l ab3-1-re...					
0060	70 6c 79 2e 68 74 6d 20 48 54 56 2f 31 2e 73 2e ply.htm HTTP/1.1...					
0070	0d 04 48 6f 73 74 2a 20 67 61 69 61 2e 63 73 2e 7: Host: gaia.cs...					
0080	75 6d 61 73 73 2d 65 64 75 0d 0a 43 6f 6e 66 65 umass.ed u-Conne...					
0090	63 74 69 6f 6e 3a 20 6b 65 67 70 2d 61 6c 69 76 ction: k eep-aliv...					
00a0	65 0d 0a 43 6f 6e 74 65 6e 74 2d 4c 65 66 67 74 e::Content-nt-Leng...					
00b0	68 3a 20 31 35 32 33 32 31 0d 0a 43 61 63 68 65 ht: 15232 1-Cache...					
00c0	2d 43 6f 6e 74 72 6f 6c 3a 28 6d 61 78 2d 61 67 -Control : max-ag...					
00d0	65 3d 30 0d 0a 4f 72 69 67 69 6e 3a 20 68 74 74 es=0 -Orin gin: htt...					
00e0	70 3a 2f 67 61 69 61 2e 63 73 2e 75 6d 61 73 p://gaia.cs.umass...					
00f0	73 6c 65 64 75 0d 0a 55 70 67 72 61 64 65 2d 49 s://upgrade-I...					
0100	67 63 75 65 73 72 65 2d 52 65 71 75 65 73 73 nsecure - Requests...					
0110	3a 20 31 0d 0a 44 54 3a 20 31 0d 0a 43 6f 6e 1 - 1-DNT 1-Con...					
0120	74 65 66 74 2d 54 79 70 65 69 20 6d 75 6d 74 69 tent-Typ e: multi...					
0130	70 61 72 74 2f 66 6f 72 6d 2d 64 61 74 61 2b 20 part/for m-data:...					
0140	62 6f 75 6e 64 61 72 79 3d 2d 2d 2d 2d 57 65 62 boundary ==_Web...					
0150	4b 69 74 46 6f 72 6d 42 6f 75 6e 64 61 72 79 4 KitFormy boundary]					
0160	4b 64 36 58 52 75 44 72 52 75 37 39 38 36 0d K06XR0d rR7996...					
0170	0a 55 73 65 72 2d 41 67 65 6e 74 3a 20 4d 61 7a -User-Ag ent: Moz...					
0180	69 6c 6c 61 2f 35 26 30 20 28 4d 61 63 69 6e 74 illa/5.0 (Macint...					
0190	6f 73 68 3b 20 49 6e 74 65 6c 20 4d 61 63 20 4f osh; Int el Mac O...					

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.

这道题自己的trace有点问题，ack会缺几个，所以用的是给出的tcp-ethereal-trace-1里的数据

No.	Time	Source	Destination	Protocol	Length	Leftover Cw	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62		1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62		80 → 1161 [SYN, ACK] Seq=1 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54		1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619		1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	0.053937	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	0.124085	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201		1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460

number	Time(s)	Seq Num	ACK Num
4	0.026477	1	
5	0.041737	566	
6	0.053937		566
7	0.054026		2026
8	0.054690		3486
9	0.077294		2026
10	0.077405		4946
11	0.078157		6406
12	0.124085		3486
13	0.124185		7866
14	0.169118		4946
15	0.217299		6406
16	0.267802		7866

number	Send Time(s)	ACK Time(s)	RTT(s)
1	0.026477	0.053937	0.02746
2	0.041737	0.077294	0.035557
3	0.054026	0.124085	0.070059
4	0.054690	0.169118	0.114428
5	0.077405	0.217299	0.139894
6	0.078157	0.267802	0.189654

$$EstimatedRTT_1 = 0.02746s$$

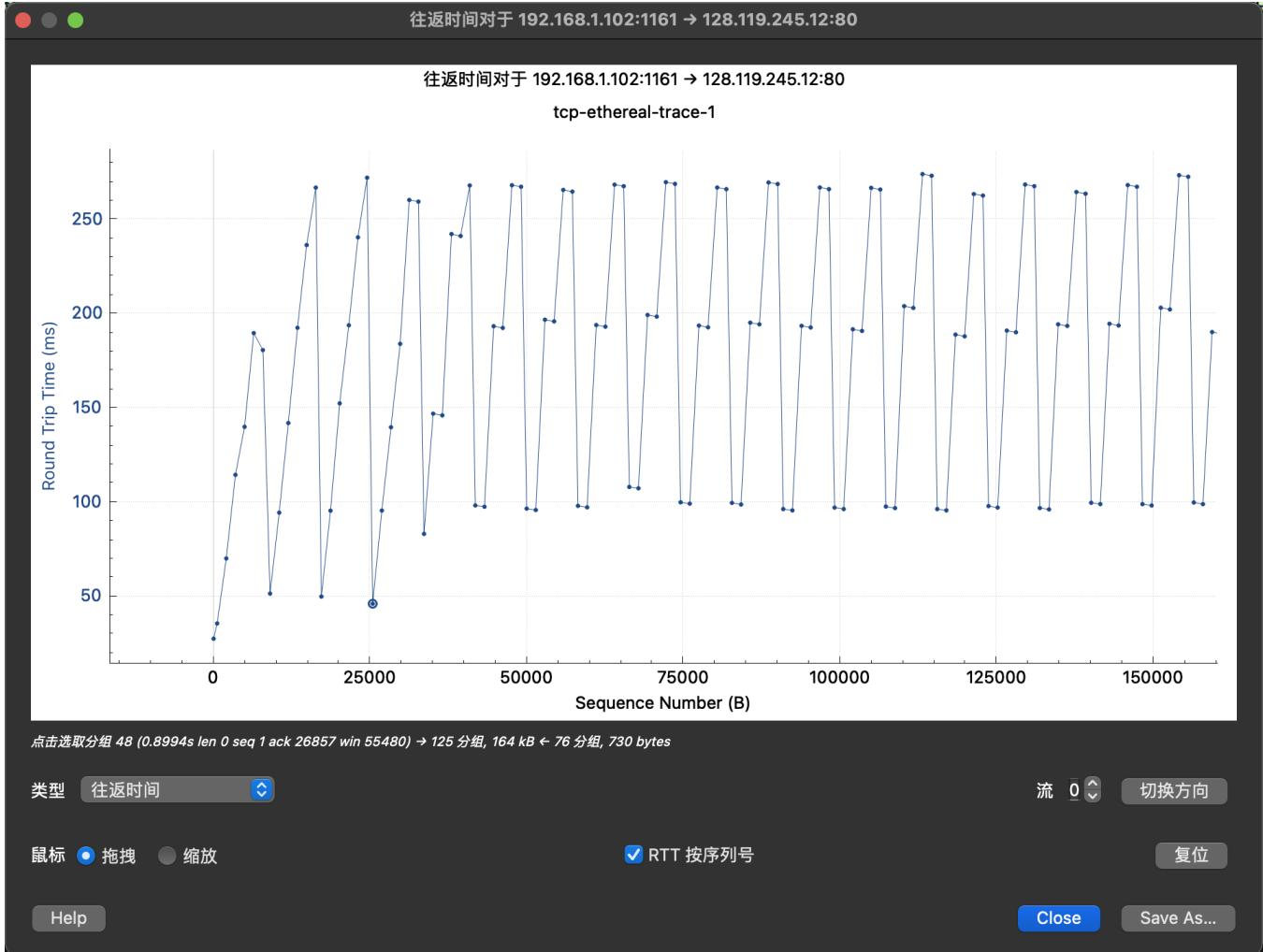
$$EstimatedRTT_2 = 0.875 * 0.02746 + 0.125 * 0.035557 = 0.0285s$$

$$EstimatedRTT_3 = 0.875 * 0.0285 + 0.125 * 0.070059 = 0.0337s$$

$$EstimatedRTT_4 = 0.875 * 0.0337 + 0.125 * 0.114428 = 0.0438s$$

$$EstimatedRTT_5 = 0.875 * 0.0438 + 0.125 * 0.139894 = 0.0558s$$

$$EstimatedRTT_6 = 0.875 * 0.0558 + 0.125 * 0.189654 = 0.0725s$$



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

截图来自tcp-ethereal-trace-1

No.	Time	Source	Destination	Protocol	Length	Leftover Cap	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62		1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62		80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54		1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619		1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=0
6	0.053937	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=6486 Ack=1 Win=17520 Len=1460
12	0.124985	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201		1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.212799	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60		80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460

第一个TCP segment (包含post的那个) 的长度为565，其他5个为1460

## 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?

截图来自tcp-ethereal-trace-1

No.	Time	Source	Destination	Protocol	Length	Leftover Cap	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62		1161 -> 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 -> 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1	
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 -> 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0	
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 -> 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565	
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460	
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0	
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460	
8	0.054698	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460	
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	0.077485	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460	
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=6486 Ack=1 Win=17520 Len=1460	
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0	
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 -> 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147	
14	0.169918	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0	
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=6486 Win=17520 Len=0	
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0	
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0	
18	0.305804	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460	

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

| 从第一个收到的ack可以看到缓冲区空间的最小值（接收方的窗口）为5840字节

No.	Time	Source	Destination	Protocol	Length	Leftover Cap	Info
41	0.853188	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=25397 Win=52380 Len=0
42	0.853405	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=25397 Ack=1 Win=17520 Len=1460	
43	0.854076	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=26857 Ack=1 Win=17520 Len=1460	
44	0.855036	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=28317 Ack=1 Win=17520 Len=1460	
45	0.855878	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=29777 Ack=1 Win=17520 Len=1460	
46	0.856802	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=31237 Ack=1 Win=17520 Len=1460	
47	0.857683	192.168.1.102	128.119.245.12	TCP	946	1161 -> 80 [PSH, ACK] Seq=32697 Ack=1 Win=17520 Len=892	
48	0.899423	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=26857 Win=55480 Len=0	
49	0.949545	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=28317 Win=58400 Len=0	
50	0.994715	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=29777 Win=61320 Len=0	
51	1.039820	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=31237 Win=62780 Len=0	
52	1.117097	128.119.245.12	192.168.1.102	TCP	60	80 -> 1161 [ACK] Seq=1 Ack=33580 Win=62780 Len=0	
53	1.117333	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=33589 Ack=1 Win=17520 Len=1460	
54	1.118133	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=35049 Ack=1 Win=17520 Len=1460	
55	1.119029	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=36509 Ack=1 Win=17520 Len=1460	
56	1.119858	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=37969 Ack=1 Win=17520 Len=1460	
57	1.120902	192.168.1.102	128.119.245.12	TCP	1514	1161 -> 80 [ACK] Seq=39429 Ack=1 Win=17520 Len=1460	
58	1.121891	192.168.1.102	128.119.245.12	TCP	946	1161 -> 80 [PSH, ACK] Seq=40889 Ack=1 Win=17520 Len=892	

> Frame 51: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)

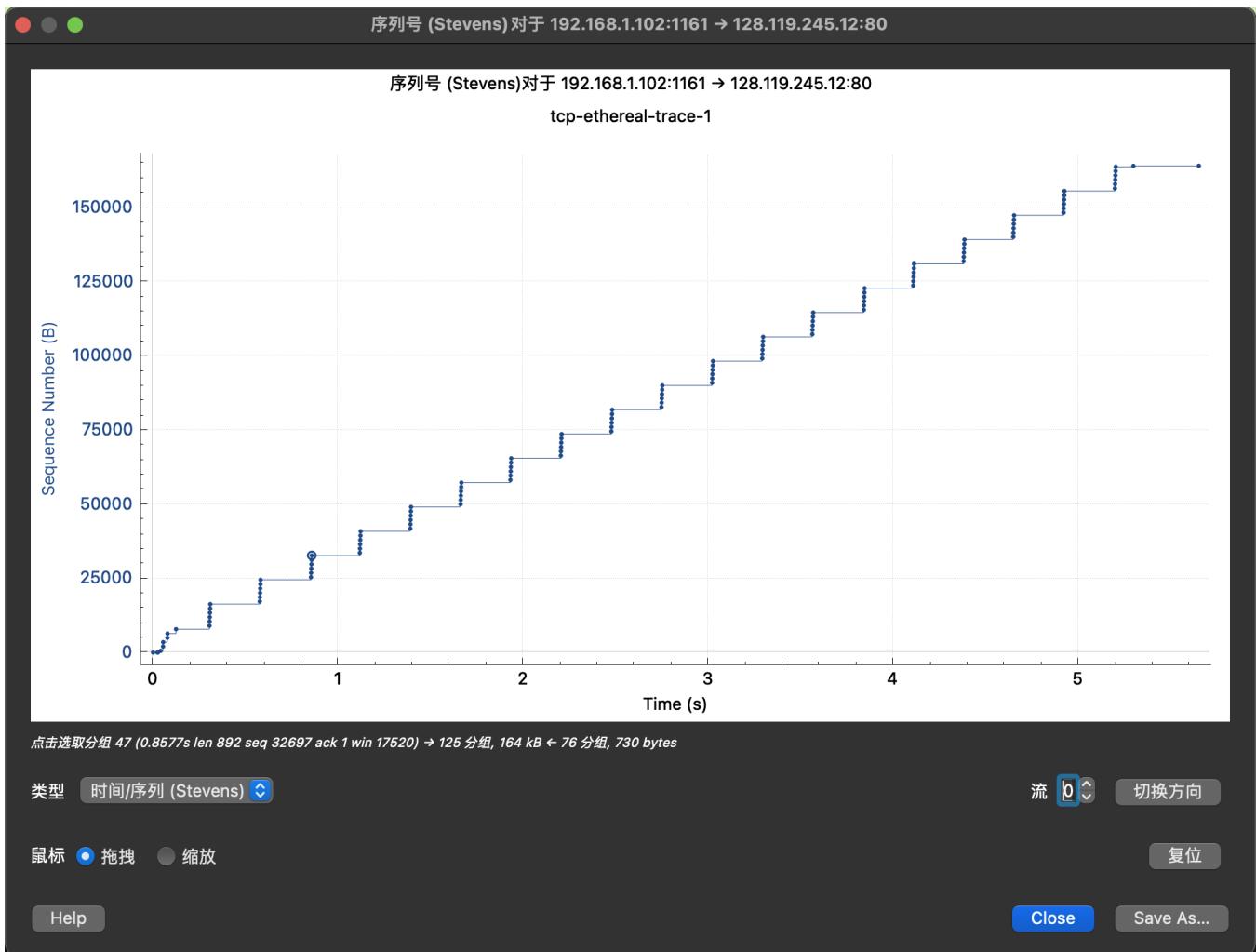
> Ethernet II, Src: Linksys\_G\_d:af:73 (00:06:25:d:af:73), Dst: Actionte\_8a:70:1a (00:20:e0:8a:70:1a)

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

| 在整个trace中可以看到窗口大小稳定增长到过62780字节，整个trace中没有看到发送方被窗口大小限制的情况

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

截图来自tcp-ethereal-trace-1



从TCP流形图的时间序列 (stevens) 可以看到随着时间增长, sequence number也保持单调增长, 如果存在重传的话, 会出现 sequence number减小的情况, 所以可以判断没有发生重传。

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).

截图来自tcp-ethereal-trace-1

No.	Time	Source	Destination	Protocol	Length	Leftover Cap	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 - 80	[SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 - 1161	[SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 - 80	[ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 - 80	[PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 - 80	[PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
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	0.054926	192.168.1.102	128.119.245.12	TCP	1514	1161 - 80	[ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 - 80	[ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 - 1161	[ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 - 80	[ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 - 80	[ACK] Seq=6496 Ack=1 Win=17520 Len=1460
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 - 1161	[ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 - 80	[PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 - 1161	[ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.212799	128.119.245.12	192.168.1.102	TCP	60	80 - 1161	[ACK] Seq=1 Ack=6496 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 - 1161	[ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304887	128.119.245.12	192.168.1.102	TCP	60	80 - 1161	[ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 - 80	[ACK] Seq=0013 Ack=1 Win=17520 Len=1460

#### ACK sequence number    data len

ACK1	566	566
ACK2	2026	1460
ACK3	3486	1460
ACK4	4946	1460

	ACK sequence number	data len
ACK5	6406	1460
ACK6	7866	1460

还有很多ack，但是对于多数ack而言，收到的data基本都是1460bytes

但是也有特殊情况。如下两个ack之间,相差  $2920 \text{ bytes} = 1460 * 2 \text{ bytes}$ , ack了两个segment。

Detailed Network Traffic Analysis - Port 12345									
Sequence	Source IP	Source Port	Destination IP	Destination Port	Protocol	Length	Timestamp	ACK Seq	ACK Len
75	1.664198	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=54353 Ack=1 Win=17520 Len=1460	
76	1.665254	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=55811 Ack=1 Win=17520 Len=1460	
77	1.666151	192.168.1.102	128.119.245.12	12345	TCP	946	2023-10-20 14:55:30.000	1161 -> 80 [PSH, ACK] Seq=57273 Ack=1 Win=17520 Len=892	
78	1.758227	128.119.245.12	192.168.1.102	12345	TCP	60	2023-10-20 14:55:30.000	80 -> 1161 [ACK] Seq=1 Ack=52893 Win=62780 Len=0	
79	1.860063	128.119.245.12	192.168.1.102	12345	TCP	60	2023-10-20 14:55:30.000	80 -> 1161 [ACK] Seq=1 Ack=55813 Win=62780 Len=0	
80	1.938880	128.119.245.12	192.168.1.102	12345	TCP	60	2023-10-20 14:55:30.000	80 -> 1161 [ACK] Seq=1 Ack=58165 Win=62780 Len=0	
81	1.931899	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=58165 Ack=1 Win=17520 Len=1460	
82	1.931879	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=59625 Ack=1 Win=17520 Len=1460	
83	1.932757	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=61083 Ack=1 Win=17520 Len=1460	
84	1.933636	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=62541 Ack=1 Win=17520 Len=1460	
85	1.934770	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=64005 Ack=1 Win=17520 Len=1460	
86	1.935586	192.168.1.102	128.119.245.12	12345	TCP	946	2023-10-20 14:55:30.000	1161 -> 80 [PSH, ACK] Seq=65465 Ack=1 Win=17520 Len=892	
87	2.029069	128.119.245.12	192.168.1.102	12345	TCP	60	2023-10-20 14:55:30.000	80 -> 1161 [ACK] Seq=1 Ack=61083 Win=62780 Len=0	
88	2.126682	128.119.245.12	192.168.1.102	12345	TCP	60	2023-10-20 14:55:30.000	80 -> 1161 [ACK] Seq=1 Ack=64005 Win=62780 Len=0	
89	2.203195	128.119.245.12	192.168.1.102	12345	TCP	60	2023-10-20 14:55:30.000	80 -> 1161 [ACK] Seq=1 Ack=66357 Win=62780 Len=0	
90	2.292411	192.168.1.102	128.119.245.12	12345	TCP	1514	2023-10-20 14:55:30.000	1161 -> 80 [ACK] Seq=66357 Ack=1 Win=17520 Len=1460	

12. What is the throughput (bytes transferred per unit time) for the TCP connection?

Explain how you calculated this value.

截图来自tcp-ethereal-trace-1

考虑整个传输过程的时间作为平均时间，需要计算整个传输中的数据量和传输时间。

186	5.019189	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=151197 Win=62780 Len=0
190	5.125019	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=154117 Win=62780 Len=0
191	5.197286	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=156469 Win=62780 Len=0
192	5.197508	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=156469 Ack=1 Win=17520 Len=1460
193	5.198388	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=157929 Ack=1 Win=17520 Len=1460
194	5.199275	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=159389 Ack=1 Win=17520 Len=1460
195	5.200252	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=160849 Ack=1 Win=17520 Len=1460
196	5.201150	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=162309 Ack=1 Win=17520 Len=1460
197	5.202024	192.168.1.102	128.119.245.12	TCP	326	1161 → 80 [PSH, ACK] Seq=163769 Ack=1 Win=17520 Len=272
198	5.297257	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
199	5.297341	192.168.1.102	128.119.245.12	TCP	104	1161 → 80 [PSH, ACK] Seq=164041 Ack=1 Win=17520 Len=50
200	5.389471	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201	5.447887	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202	5.455830	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	5.461175	128.119.245.12	192.168.1.102	TCP	784	80 → 1161 [PSH, ACK] Seq=1 Ack=164091 Win=62780 Len=730
206	5.651141	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0
233	3.605E7	192.160.1.102	100.2.53.295	TCP	63	1162 → 671 [SYN] Seq=0 Win=17304 Len=0 MSS=1460 SACK_RDM=1

可以看到最后一个ack记录到的sequence number为164091，减去第一个tcp segment的sequence number（即1）， $164091 - 1 = 164090$ bytes

tcp

No.	Time	Source	Destination	Protocol	Length	Leftover Cap Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305000	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460

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

> Flags: 0x0108 (PSH, ACK)

Window: 17520

[Calculated window size: 17520]

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

Csum: 0x1fb0 [unverified]

[Checksum Status: Unverified]

Urgent Pointer: 0

▼ [Timestamps]

[Time since first frame in this TCP stream: 0.026477000 seconds]

[Time since previous frame in this TCP stream: 0.003212000 seconds]

> [SEQ/ACK analysis]

TCP payload (565 bytes)

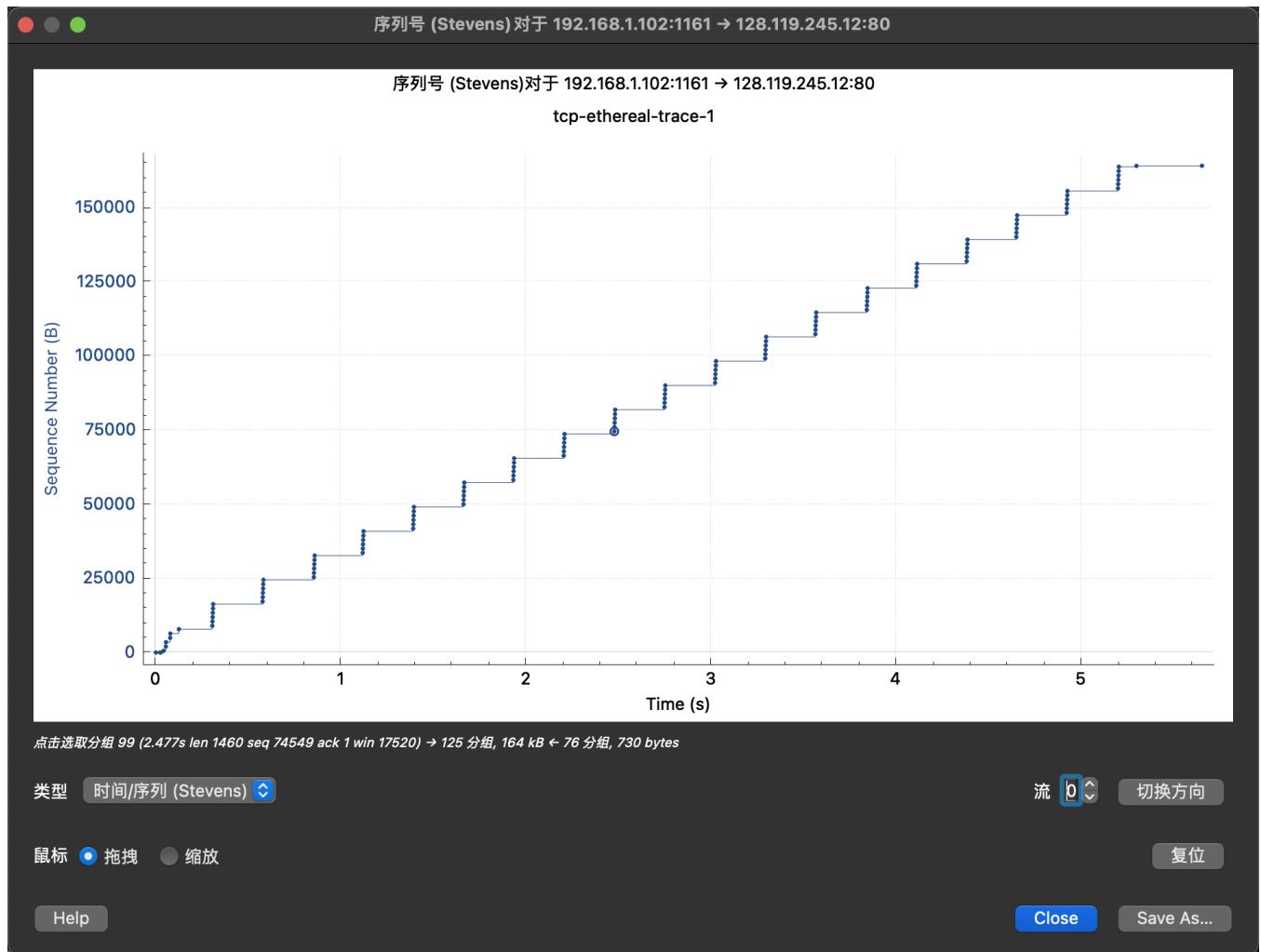
No.	Time	Source	Destination	Protocol	Length	Leftover Cwr	Info
186	5.019189	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=151197 Win=62780 Len=0
190	5.125019	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=154117 Win=62780 Len=0
191	5.197286	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=156469 Win=62780 Len=0
192	5.197508	192.168.1.102	128.119.245.12	TCP	1514		1161 -> 80 [ACK] Seq=156469 Ack=1 Win=17520 Len=1460
193	5.198388	192.168.1.102	128.119.245.12	TCP	1514		1161 -> 80 [ACK] Seq=157929 Ack=1 Win=17520 Len=1460
194	5.199275	192.168.1.102	128.119.245.12	TCP	1514		1161 -> 80 [ACK] Seq=159389 Ack=1 Win=17520 Len=1460
195	5.200252	192.168.1.102	128.119.245.12	TCP	1514		1161 -> 80 [ACK] Seq=160849 Ack=1 Win=17520 Len=1460
196	5.201150	192.168.1.102	128.119.245.12	TCP	1514		1161 -> 80 [ACK] Seq=162389 Ack=1 Win=17520 Len=1460
197	5.202024	192.168.1.102	128.119.245.12	TCP	326		1161 -> 80 [PSH, ACK] Seq=163789 Ack=1 Win=17520 Len=272
198	5.297257	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
199	5.297341	192.168.1.102	128.119.245.12	TCP	104		1161 -> 80 [PSH, ACK] Seq=164041 Ack=1 Win=17520 Len=50
200	5.389471	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201	5.447887	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202	5.455830	128.119.245.12	192.168.1.102	TCP	60		80 -> 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203	5.461175	128.119.245.12	192.168.1.102	TCP	784		80 -> 1161 [PSH, ACK] Seq=1 Ack=164091 Win=62780 Len=730
206	5.651141	192.168.1.102	128.119.245.12	TCP	54		1161 -> 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0
213	7.595557	192.168.1.102	199.2.53.206	TCP	62		1162 -> 631 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1

Acknowledgment Number: 164091 (relative ack number)  
 Acknowledgment number (raw): 232293103  
 0101 .... = Header Length: 20 bytes (5)  
 > Flags: 0x010 (ACK)  
 Window: 62780  
 [Calculated window size: 62780]  
 [Window size scaling factor: -2 (no window scaling used)]  
 Checksum: 0x44a8 [unverified]  
 [Checksum Status: Unverified]  
 Urgent Pointer: 0  
 < [Timestamps]  
 [Time since first frame in this TCP stream: 5.455830000 seconds]  
 [Time since previous frame in this TCP stream: 0.007943000 seconds]  
 > [SEQ/ACK analysis]

传输时间为第一个TCP segment的时间减去最后一个ack的时间  $5.455830 - 0.026477 = 5.4294s$

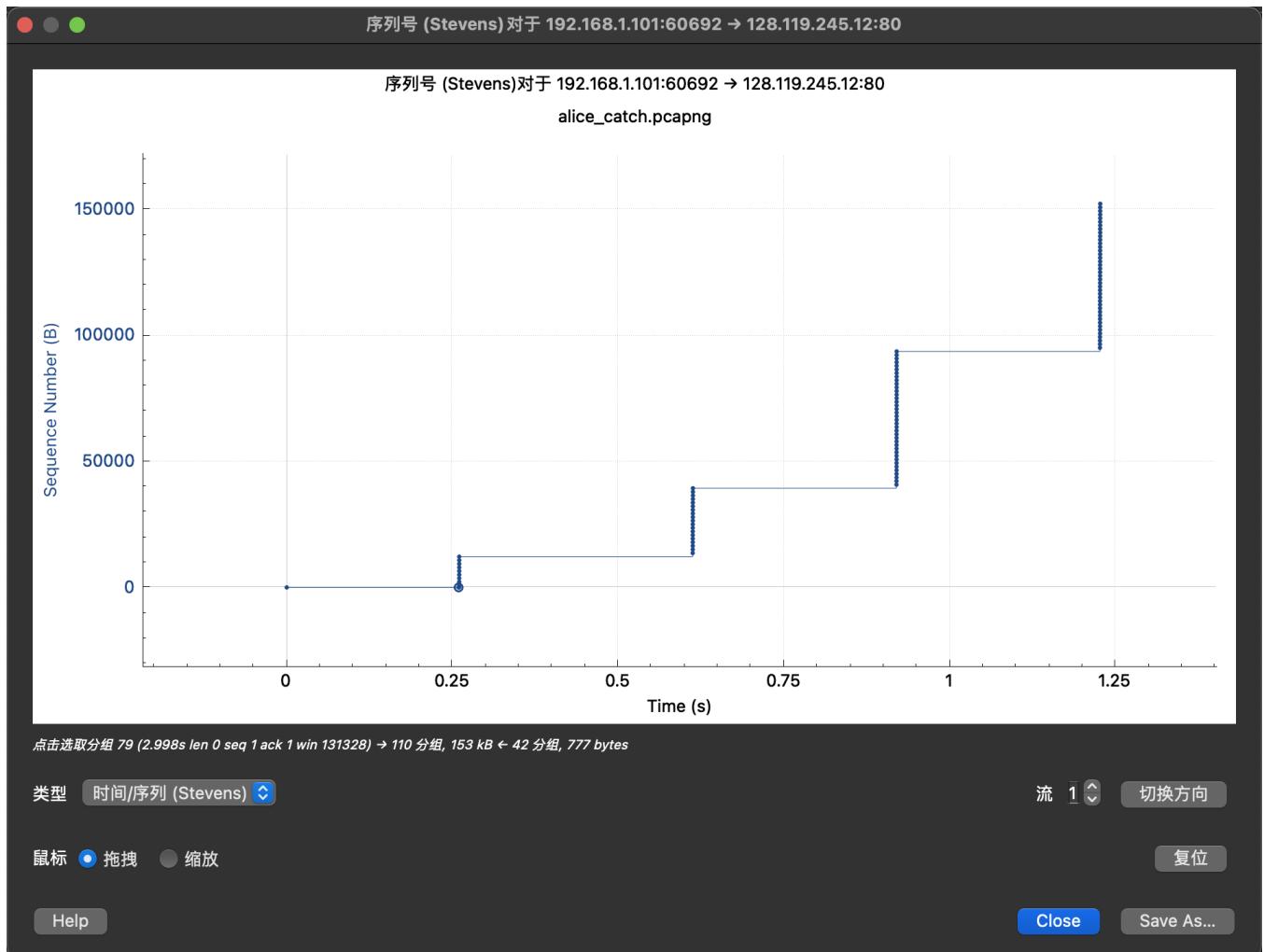
所以吞吐量为  $164090 / 5.4294 = 30.22 \text{ kb/sec}$

13. Use the Time-Sequence-Graph(Stevens) plotting tool to view the sequence number versus time plot of segments being sent from the client to the [gaia.cs.umass.edu](http://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.



从图上看慢启动大概开始于0秒时刻，结束于大概0.15秒时刻之前，之后就是拥塞控制开始接管，但是没有观测到明显的传输窗口线性增长。发送方似乎是以6个为批次传输数据包，这似乎不是由流量控制引起的，因为接收窗口明显大于5个包。

14. Answer each of two questions above for the trace that you have gathered when you transferred a file from your computer to [gaia.cs.umass.edu](http://gaia.cs.umass.edu)



在自己的trace当中看不到慢启动的情况，似乎从一开始就是拥塞控制开始接管，但是不同于13题，可以观测到明显的传输窗口线性增长。发送方每个批次发送的数据包数量也趋于固定，应该是流量控制引起的，数据量和窗口大小接近。