

HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY  
FACULTY OF COMPUTER SCIENCE AND ENGINEERING



## COMPUTER NETWORKS

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### Lab 1

# Behavior of the TCP protocol

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Ho Chi Minh City, August 2019



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?

**Answer:** Ở đây chúng ta có hai cách xác định IP address và TCP port của máy client.

- Cách dễ nhất là dựa vào HTTP message mà server phản hồi
- Cách thứ hai là dựa vào cơ chế của three-way handshake

Địa chỉ IP và TCP port của máy client:

- ID address: 192.168.1.102
- TCP port: 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?

**Answer:** Tương tự câu 1 ta có IP address của gaia.cs.umass.edu:

- ID address: 128.119.245.12
- TCP port: 80

Port mà gaia.cs.umass.edu truyền và nhận TCP segment: 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?

No.	Time	Source	Destination	Protocol	Length	Info
199	5.297341	192.168.1.102	128.119.245.12	HTTP	104	POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
203	5.461175	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)

▶	Frame 203: 784 bytes on wire (6272 bits), 784 bytes captured (6272 bits)
▶	Ethernet II, Src: LinksysG_da:af:73 (08:06:25:da:af:73), Dst: Actionte_8a:70:1a (08:20: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: 164091, Len: 730
▶	Hypertext Transfer Protocol
▶	Line-based text data: text/html (11 lines)

**Answer:** Theo như hình trên, IP address và TCP port của máy client là:

- IP address: 192.168.137.55
- TCP port: 59964

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

**Answer:**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5940 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of
8	0.054699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of

- Sequence number của TCP SYN segment được dùng để bắt đầu kết nối TCP giữa máy khách và gaia.cs.umass.edu là 0.
- Dựa vào [SYN] flag bên trong cột Info hoặc dựa vào thông tin header ta có thể nhận biết đó là TCP 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?

**Answer:**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5940 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment

Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
Ethernet II, Src: LinksysG_da:af:73 (00:06:25:da:af:73), Dst: Actionte_8a:70:1a (00:20:e0:8a:70:1a)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102
Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 0, Ack: 1, Len: 0
Source Port: 80
Destination Port: 1161
[Stream index: 0]
TCP Segment Len: 0
Sequence number: 0 (relative sequence number)
[Next sequence number: 0 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
0111 .... = Header Length: 28 bytes (7)
Flags: 0x012 (SYN, ACK)
0000 .... = Reserved: Not set
.... 0... = Nonce: Not set
.... 0... = Congestion Window Reduced (CWR): Not set
.... 0... = ECN-Echo: Not set
.... 0... = Urgent: Not set
.... 0... = Push: Not set
.... 0... = Reset: Not set
.... 0... = SYN: Set
.... 0... = FIN: Not set
[TCP Flags: .....A..S.]

- Sequence number của SYNACK segment được gửi bởi gaia.cs.umass.edu đến máy khách để trả lời cho SYN là 0.
- Giá trị của Acknowledgement field trong SYNACK segment là 1.
- Do lúc này hai bên vẫn chưa thực hiện xong quá trình handshark nên sequence number bằng 0 (vì đây là gói đầu tiên của nó trong phiên TCP, chưa có dữ liệu nào được gửi). Khi máy client gửi TCP SYN segment sang gaia.cs.umass.edu, lúc này gaia.cs.umass.edu phải gửi lại một phản hồi xác nhận SYN flag từ client (Acknowledgement = 1).
- Dựa vào [SYN,ACK] flag bên trong cột Info hoặc dựa vào thông tin header ta có thể nhận biết đó là TCP SYNACK segment.



6. What is the sequence number of the TCP segment containing the HTTP POST command?

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of

Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)  
Ethernet II, Src: Actionte\_8a:70:1a (08:20:e0:8a:70:1a), Dst: Linksys6\_da:af:73 (08:06:25: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

0000 f5 0c 04 89 00 50 0d d6 01 f5 34 a2 74 1a 50 18 ...P...4.t.P.  
0000 44 70 1f bd 00 00 00 00 00 00 00 00 00 00 00 00 Op...P...4.t.P.  
0000 72 05 01 0c 2d 0c 01 02 73 2f 0c 01 02 33 2d 31 ...real-lab s/lab3-1  
0000 2d 72 05 70 0c 79 2e 08 74 6d 20 48 54 54 50 2f ...-reply.h tm HTTP/  
0000 31 2e 31 0d 0a 48 6f 73 74 3a 20 67 61 69 61 2e ...1.1..Host: gaia.  
0000 03 73 2e 75 0d 01 73 75 2e 05 64 75 0d 0a 55 73 ...cs.umass.edu.US  
0000 03 72 2d 41 67 65 74 3a 20 4d 6f 7a 09 6e 6c 6a ...er-Agent: Mozilla  
0000 01 2f 35 2e 30 20 28 57 69 6e 64 6f 77 73 3b 20 ...a/5.0 (Windows;  
0000 55 3b 20 57 69 6e 64 6f 77 73 20 4e 54 20 35 2e ...U; Windows NT 5.  
0000 31 3b 20 65 6e 2d 55 53 3b 20 72 76 3a 31 2e 30 ...1; en-US; rv:1.0  
0000 20 32 30 20 47 65 03 0b 6f 2f 32 30 33 30 32 ...2) Gecko/200302  
0000 30 38 20 4e 65 74 73 63 61 70 65 2f 37 2e 30 32 ...88 Netscape/7.0.2  
0000 0d 0a 41 63 63 65 70 74 3a 20 74 65 78 74 2f 78 ...-Accept: text/x  
0000 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78 ...ml,application/x  
0000 6d 6c 2c 61 70 70 6c 69 63 61 74 69 6f 6e 2f 78 ...ml,application/x  
0000 09 74 6d 6c 2b 70 70 6c 6e 2c 74 65 78 74 2f 68 74 ...html+xml;text/h  
0000 6d 6c 3b 71 3d 30 2e 39 2c 74 65 78 74 2f 70 6c ...ml;q=0.9;text/pl  
0000 61 69 6e 3b 71 3d 30 2e 38 2c 76 69 64 65 6f 2f ...ain;q=0.8;video/  
0000 78 2d 6d 6e 67 2c 69 6d 61 67 65 2f 70 6e 67 2c ...x-mng,image/png;  
0000 69 6d 61 67 65 2f 6a 78 65 67 2c 69 6d 61 67 65 ...image/jpeg,image

**Answer:** Theo hình trên ta thấy sequence number của TCP segment gồm HTTP POST command là 1.

7. 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 after the receipt of each ACK?

No.	Time	Source	Destination	Protocol	Length	Info
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of
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	0.077495	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment
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	0.267892	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.394897	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0

Frame 22: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)  
Ethernet II, Src: Actionte\_8a:70:1a (08:20:e0:8a:70:1a), Dst: Linksys6\_da:af:73 (08:06:25: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: 14853, Ack: 1, Len: 1460

0000 f5 0c 04 89 00 50 0d d6 3b f9 34 a2 74 1a 50 18 ...P...4.t.P.  
0000 44 70 49 63 00 00 0f 77 6e 2c 20 64 6f 77 6e 2c Op...low n, down,  
0000 20 64 6f 77 6e 2c 20 20 57 6f 75 0c 64 20 74 68 ...down. Would th  
0000 05 20 66 61 0c 6c 20 4e 45 50 45 20 63 6f 6d 6d ...e fail N EVER con  
0000 65 20 74 6f 20 61 6e 20 65 6e 64 21 20 20 60 49 ...e to an end! I  
0000 3d 0a 77 6f 6e 64 05 72 20 08 6f 77 20 6d 61 6e ...-wonder how man  
0000 70 20 6d 69 6e 65 73 20 49 27 70 65 20 66 61 6e ...y miles. I've fal  
0000 6c 65 6e 20 62 79 20 74 68 69 73 20 74 09 6d 65 ...len by t his time  
0000 3f 27 20 73 68 65 20 73 61 69 64 20 61 6c 6f 75 ...?' she s aid alou  
0000 64 2e 6d 0a 69 49 20 6d 75 73 74 20 62 65 20 67 ...d... I m ust be g  
0000 05 74 74 69 6e 67 20 73 6f 6d 65 77 68 65 72 65 ...etting s omewhere  
0000 20 6e 65 61 72 20 74 68 65 20 63 65 6e 74 72 65 ...near th e centre

**Answer:**

Sequence number của first six segments trong TCP connection (bao gồm segment chứa HTTP POST) là 1, 566, 2026, 3486, 4946, 6406



8. What is the length of each of the first six TCP segments? **Answer:** Length của sáu

No.	Time	Source	Destination	Protocol	Length	Info
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment
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	0.054826	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment
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	0.267892	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

Frame 22: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0  
Ethernet II, Src: Actiote 8a:78:1a (08:20:e0:8a:78:1a), Dst: LinksysG da:af:73 (08:00:2d: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: 14853, Ack: 1, Len: 1460

0020 f5 0c 04 89 00 50 0d d6 3b f9 34 a2 74 1a 50 10 .....P...:4.t.P.  
0030 44 70 49 63 00 00 6f 77 0e 2c 20 64 6f 77 0e 2c DpIc...ow n, down,  
0040 20 64 6f 77 0e 2e 20 29 57 6f 75 6c 64 29 74 68 down. Would th  
0050 55 20 65 61 6c 6c 20 4e 45 56 45 52 20 63 6f 6d e Fall N EVER con  
0060 55 20 74 6f 20 61 6e 20 65 6e 64 21 20 29 60 45 e to an endl I  
0070 94 9a 77 6f 6e 64 65 72 20 69 6f 77 20 6d 61 6e ..wonder how man  
0080 79 20 6d 69 6c 65 73 20 49 27 76 65 20 66 61 6c y miles I've fal  
0090 6c 65 6e 20 62 79 20 74 68 69 73 20 74 69 6d 65 len by t his time  
00a0 3f 27 6d 78 68 65 20 73 73 69 64 20 61 6c 6f 75 P' she s aid alou  
00b0 94 2e 6d 9a 69 49 20 6d 75 73 74 20 62 65 20 67 d...I m ust be g  
00c0 65 74 74 69 6e 67 20 73 6f 6d 65 77 68 65 72 65 etting s omewhere  
00d0 20 6e 65 61 72 20 74 68 65 20 63 65 6e 74 72 65 near th e centre

TCP segments đầu lần lượt là: 565, 1460, 1460, 1460, 1460, 1460

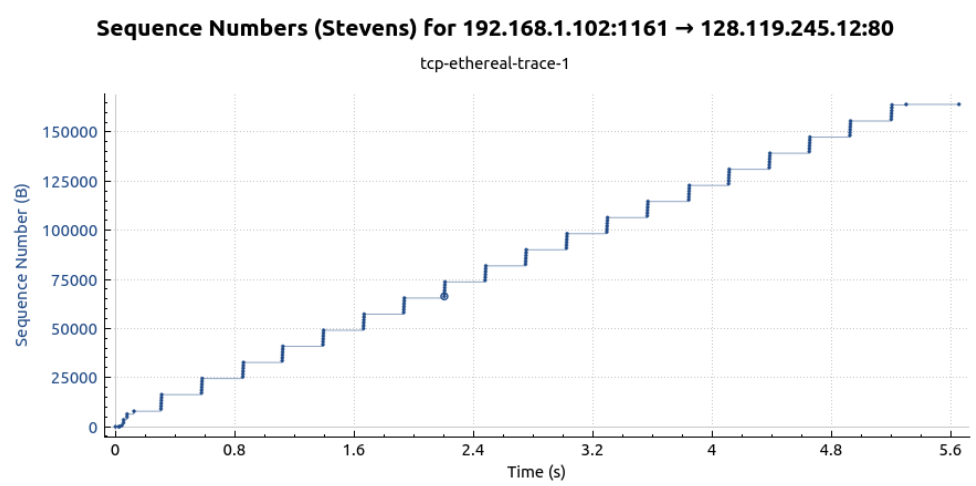
9. What is the minimum amount of available buffer space advertised at the received for the entire trace? Does the lack of receiver buffer space ever throttle the sender?

**Answer:**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=8 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment
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	0.054826	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment
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	0.267892	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
18	0.305040	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460 [TCP segment of
19	0.305813	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of
20	0.306692	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of
21	0.307571	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=13393 Ack=1 Win=17520 Len=1460 [TCP segment of
22	0.308699	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=14853 Ack=1 Win=17520 Len=1460 [TCP segment of
23	0.309553	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=16313 Ack=1 Win=17520 Len=892 [TCP segment

- Lượng buffer space có sẵn tối thiểu được quảng cáo ở mức nhận được cho entire trace là 5840 bytes (Window size tăng dần cho đến 62780 thì do tràn buffer nên không thể tăng nữa).
- Sender sẽ không bao giờ throttle bởi vì thiếu buffer space nhận.

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



**Answer:** Không có segment truyền lại trong tệp theo dõi. Có thể xác minh điều này bằng cách kiểm tra sequence numbers của các TCP segment trong tệp theo dõi. Trong Time Sequence(Stevens), tất cả sequence numbers từ nguồn (192.168.1.102) tới đích (128.119.245.12) tăng tỉ lệ thuận với thời gian. Nếu có một segment truyền lại, sequence numbers của segment truyền lại này phải nhỏ hơn các segment lân cận của nó.

11. How much data does the receiver typically acknowledge in an ACK?

	acknowledged	sequence
ACK1	566	566
ACK2	2026	1460
ACK3	3486	1460
ACK4	4946	1460
ACK5	6406	1460
ACK6	7866	1460
ACK7	9013	1147
ACK8	10473	1460
ACK9	11933	1460
ACK10	13393	1460
ACK11	14853	1460
ACK12	16313	1460
...	...	...
No.80	58165	2352
...	...	...

No.	Time	Source	Destination	Protocol	Length	Info
69	1.488313	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=44761 Win=62780 Len=0
70	1.584980	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=47621 Win=62780 Len=0
71	1.661513	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=49973 Win=62780 Len=0
72	1.661734	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=49973 Ack=1 Win=17520 Len=1460 [TCP segment of
73	1.662474	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=51433 Ack=1 Win=17520 Len=1460 [TCP segment of
74	1.663315	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=52893 Ack=1 Win=17520 Len=1460 [TCP segment of
75	1.664198	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=54353 Ack=1 Win=17520 Len=1460 [TCP segment of
76	1.665254	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=55813 Ack=1 Win=17520 Len=1460 [TCP segment of
77	1.666151	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=57273 Ack=1 Win=17520 Len=892 [TCP segmen
78	1.758227	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=52893 Win=62780 Len=0
79	1.860063	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=55813 Win=62780 Len=0
80	1.930880	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=58165 Win=62780 Len=0
81	1.931099	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=58165 Ack=1 Win=17520 Len=1460 [TCP segment of
82	1.931879	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=59625 Ack=1 Win=17520 Len=1460 [TCP segment of
83	1.932757	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=61085 Ack=1 Win=17520 Len=1460 [TCP segment of

**Answer:** Sự khác biệt giữa các sequence numbers được thừa nhận của hai ACK liên tiếp cho biết dữ liệu mà server nhận được giữa hai ACK này. Bằng cách kiểm tra lượng dữ liệu được xác nhận theo từng ACK, có những trường hợp receiver đang ACKing các phân khúc khác. Ví dụ: segment của No. 80 được acknowledged data với 2920 bytes = 1460\*2 bytes.

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

**Answer:** Tính toán thông lượng phụ thuộc rất nhiều vào việc ta chọn khoảng thời gian. Trong phần này ta chọn cả thời gian connect. Thông lượng trung bình sẽ được tính bằng tổng kích thước dữ liệu chia cho tổng thời gian transmit.

$$T = T_{last} - T_{first} = 5.455830 - 0.026477 = 5.4294(sec)$$

$$S = S_{last} - S_{first} = 164091 - 1 = 164090(bytes)$$

$$throughput = S/T = 164090/5.4294 = 30.222KB/sec$$

Trong đó, first ACK là No.4 và last ACK là No.202, T là time instant, S là acknowledged sequence number.