

TCP

No.	Time	Source	Destination	Protocol	Length	Time	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	0.054690	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
▶ Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)							
▶ Ethernet II, Src: PremaPe_8a:70:1a (00:20:e0:8a:70:1a), Dst: Linksys_0a: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: 0, Len: 0							
Source Port: 1161							
Destination Port: 80							
[Stream index: 0]							
[TCP Segment Len: 0]							
Sequence number: 0 (relative sequence number)							
Acknowledgment number: 0							
0111 = Header Length: 28 bytes (7)							
▼ 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...1. = Syn: Set							
....0...0 = Fin: Not set							
[TCP Flags:S.]							
Window size value: 16384							
[calculated window size: 16384]							
Checksum: 0xf6e9 [unverified]							
[checksum status: Unverified]							
Urgent pointer: 0							
▶ Options: (8 bytes), Maximum segment size, No-operation (NOP), No-operation (NOP), SACK permitted							

Figure 1: IP addresses and TCP port numbers of the client computer and gaia.cs.umass.edu

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 : IP address is 192.168.1.102 and TCP port number is 1161

2. What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection?

Answer : IP address is 128.119.245.12 and TCP port number is 80

3. 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 : Sequence number of the TCP SYN segment is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu. The **value is 0** in this trace. The **SYN flag is set to 1** and it indicates that this segment is a SYN segment.

No.	Source	Destination	Protocol	Length	Info
1	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	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	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	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 a
5	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a
6	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0

▶ 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: 128.119.245.12
 ▼ Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0
 Source Port: 1161
 Destination Port: 80
 [Stream index: 0]
 [TCP Segment Len: 0]
 Sequence number: 0 (relative sequence number)
 Acknowledgment number: 0
 0111 = Header Length: 28 bytes (7)
 ▼ 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...1. = Syn: Set
 0... = Fin: Not set
 [TCP Flags:S.]

Figure 2: Sequence number of the TCP SYN segment

2. 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 : Sequence number of the SYNACK segment from `gaia.cs.umass.edu` to the client computer in reply to the **SYN** has the value of **0** in this trace. The value of the **ACKnowledgement field** in the **SYNACK segment** is **1**. The value of the ACKnowledgement field in the SYNACK segment is determined by `gaia.cs.umass.edu` by adding 1 to the initial sequence number of SYN segment from the client computer (i.e.the sequence number of the SYN segment initiated by the client computer is 0.). The **SYN flag and Acknowledgement flag in the segment are set to 1** and they indicate that this segment is a SYNACK segment.

No.	Source	Destination	Protocol	Length	Info
1	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	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	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	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 a
5	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a
6	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0

▶ 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: 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: 0, Ack: 1, Len: 0
 Source Port: 80
 Destination Port: 1161
 [Stream index: 0]
 [TCP Segment Len: 0]
 Sequence number: 0 (relative sequence number)
 Acknowledgment number: 1 (relative ack number)
 0111 = Header Length: 28 bytes (7)
 ▼ 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
 0...1. = Acknowledgment: Set
 0... = Push: Not set
 0... = Reset: Not set
 ▶0...1. = Syn: Set
 0... = Fin: Not set
 [TCP Flags:A..S.]
 Window size value: 5840

Figure 3: Sequence number and Acknowledgement number of the TCP SYNACK segment

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

Answer : No. 4 segment is the TCP segment containing the HTTP POST command. The **sequence number** of this segment has the value of **1**.

No.	Time	Source	Destination	Protocol	Length	Time	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	0.054690	192.168.1.102	128.119.245.12	TCP	1514		1161 → 80 [ACK] Seq=3486 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)
0101 = Header Length: 20 bytes (5)
[TCP Flags: 0x018 (PSH, ACK)]
0000 = Reserved: Not set
...0 = Nonce: Not set
....0 = Congestion Window Reduced (CWR): Not set
....0 = ECH-Echo: Not set
....0 = Urgent: Not set
.....1 = Acknowledgment: Set
.....1 = Push: Set
....0 = Reset: Not set
....0 = Syn: Not set
....0 = Fin: Not set
[TCP Flags:AP...]
Window size value: 17520
[Calculated window size: 17520]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0x1fbd [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
[SEQ/ACK analysis]
TCP payload (565 bytes)
Data (565 bytes)

Figure 4: Sequence number of the TCP segment containing the HTTP POST command

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

Answer : Length of the **first TCP segment** (containing the HTTP POST): **565 bytes** and length of each of the **other five TCP segments: 1460 bytes (MSS)**.

No.	Source	Destination	Protocol	Length	Info
1	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	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	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565
5	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460
8	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
9	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460

Figure 5: Lengths of segments 1 - 6

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

Answer : The minimum amount of buffer space (receiver window) advertised at gaia.cs.umass.edu for the entire trace is **5840 bytes**, which shows in the **first acknowledgement** from the server. This receiver window grows steadily until a **maximum receiver buffer size of 62780 bytes**. The sender is **never throttled** due to lacking of receiver buffer space by inspecting this trace.

No.	Source	Destination	Protocol	Length	Info
1	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	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	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	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 a reassembled data segment]
5	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled data segment]
6	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0

Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0
 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: 0, Ack: 1, Len: 0

Figure 6: Minimum receive window advertised at gaia.cs.umass.edu

No.	Source	Destination	Protocol	Length	Info
47	192.168.1.102	128.119.245.12	TCP	946	1161 → 80 [PSH, ACK] Seq=32697 Ack=1 Win=17520 Len=892
48	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=26857 Win=55480 Len=0
49	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=28317 Win=58400 Len=0
50	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=29777 Win=61320 Len=0
51	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=31237 Win=62780 Len=0
52	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=33589 Win=62780 Len=0

Figure 7: Maximum receive window advertised at *gaia.cs.umass.edu*

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

Answer : There are no retransmitted segments in the trace file. We can verify this by checking the sequence numbers of the TCP segments in the trace file. In the **Time-Sequence-Graph (Stevens)** of this trace, **all sequence numbers** from the source (192.168.1.102) to the destination (128.119.245.12) are **increasing monotonically with respect to time**. If there is a retransmitted segment, the sequence number of this retransmitted segment should be smaller than those of its neighboring segments

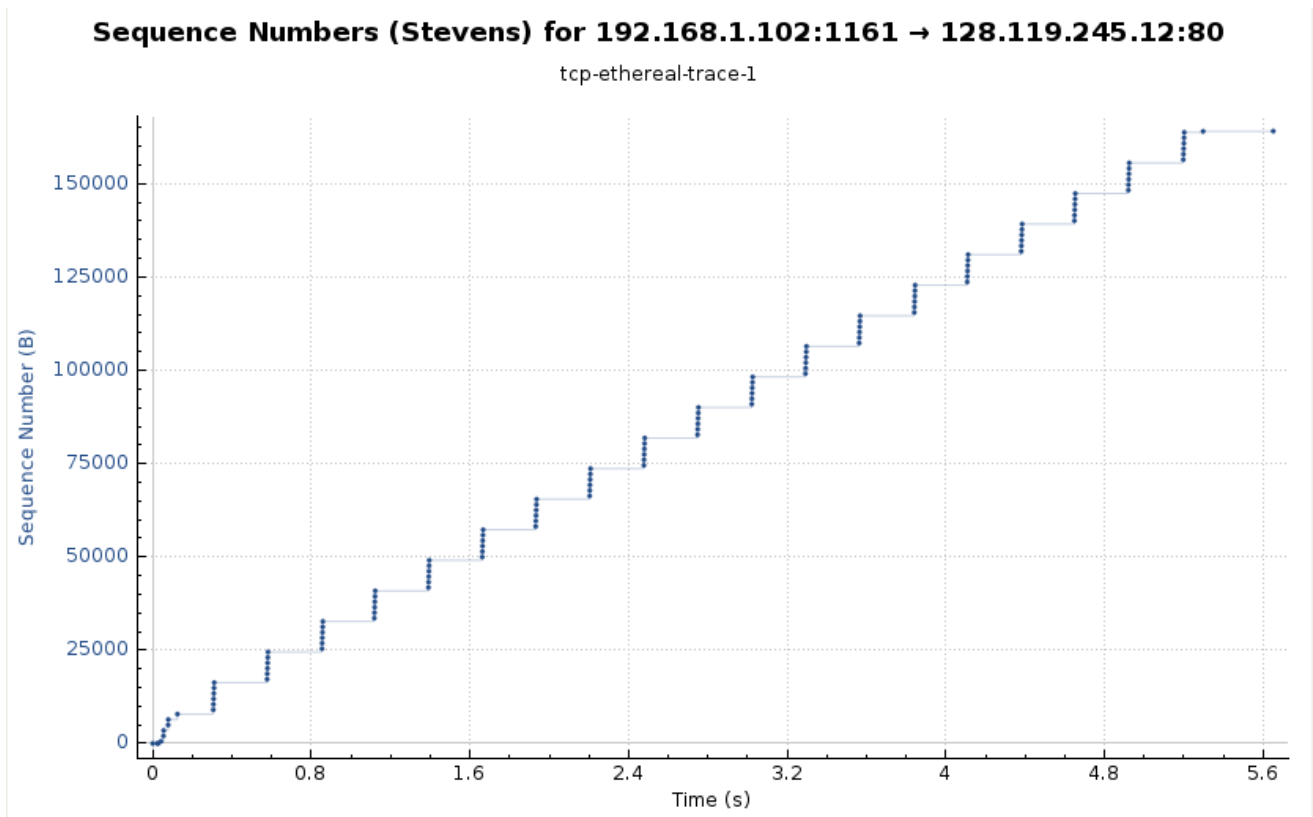


Figure 8: Sequence numbers of the segments from the source (192.168.1.102) to the destination (128.119.245.12)