

Lab4

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Exercise 1: Understanding TCP using Wireshark

Question 1.

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
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...]
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...]
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...]
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...]
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...]
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

Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits) on interface 0
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 0

1) the IP address of gaia.cs.umass.edu = destination IP address = 128.119.245.12.

2) the port number of gaia.cs.umass.edu = destination port number = 80

3) the client IP address = source IP address = 192.168.1.102

4) the client computer port number = source port number = 1161

Question 2.

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
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...]
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...]
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...]
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...]
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...]
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

Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits) on interface 0
Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 565
Source Port: 1161
Destination Port: 80
[Stream index: 0]
[TCP segment Len: 565]
Sequence Number: 1 (relative sequence number)
Sequence Number (raw): 232129013
[Next Sequence Number: 566 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 883061786
0101 ... = Header Length: 20 bytes (5)
Flags: 0x018 (PSH, ACK)
[Calculated window size: 17520]
[Window size scaling factor: -2 (no window scaling used)]
Checksum: 0x1fbd [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0

The sequence number of the TCP segment containing the POST method is 232129013.

Question 3.

The details of the first six segments containing the HTTP POST are provided below:

No	Seq #	Length(in Bytes)	Send time (seconds)	ACK received (seconds)	SampleRTT	EstimatedRTT
1	232129013	565	0.026477	0.053937	0.02746	0.02746
2	232129578	1460	0.041737000	0.077294000	0.035557000	0.028472
3	232131038	1460	0.054026000	0.124085000	0.070059000	0.03367
4	232132498	1460	0.054690000	0.169118000	0.114428000	0.043765
5	232133958	1460	0.077405000	0.217299000	0.139894000	0.055781
6	232135418	1460	0.078157000	0.267802000	0.189645000	0.072514

EstimatedRTT = $(1 - 0.125) * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$

Question 4.

No	Seq #	Length(in Bytes)
1	232129013	565
2	232129578	1460
3	232131038	1460
4	232132498	1460
5	232133958	1460
6	232135418	1460

Question 5.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	80 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=
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=
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=146
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 [T
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [T
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 [T
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [T

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

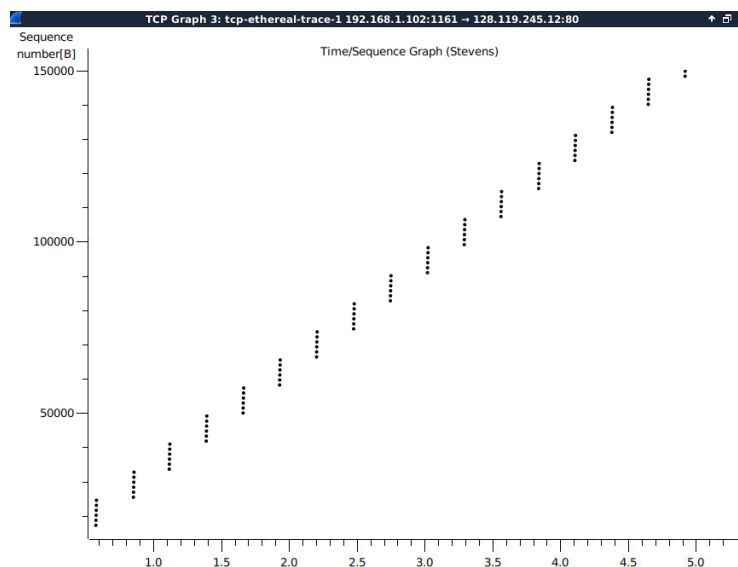
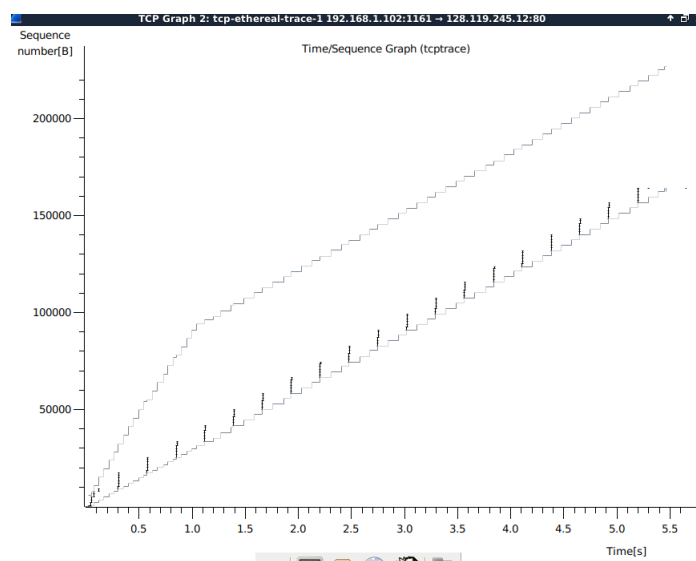
Source Port: 80
Destination Port: 1161
(Stream index: 0)
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 883061785
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 232129013
0111 = Header Length: 28 bytes (7)
[Flags: 0x02 - (SYN, ACK)]
Window: 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]
[This is an ACK to the segment in frame: 1]
[The RTT to ACK the segment was: 0.023172000 seconds]
[RTT: 0.023265000 seconds]
[Timestamps]
[Time since first frame in this TCP stream: 0.023172000 seconds]

The minimum available buff space is 5840 in the entire trace.

And receiver window does not seem to throttle the sender because the receiver window size is always more than 1460 bytes. Even when the receiver window is at its lowest ($5840 = 1460 \times 4$), the sender is constrained by congestion window rather than the flow control window.

Question 6.

There is no retransmitted segments in the trace file. First, in the entire trace file there haven't the repeat entry for the segment which is retransmitted with the same sequence number. Meanwhile, according to the Time-Sequence-Graph (Stevens and tcptrace) as below, all the sequence numbers 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 neighbouring segments. Therefore, there is no retransmitted segments in the trace file.



Question 7.

Time	Source	Destination	Protocol	Length	Info
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=33589 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 [TCP segmen...
54 1.118133	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=35049 Ack=1 Win=17520 Len=1460 [TCP segmen...
55 1.119829	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=36509 Ack=1 Win=17520 Len=1460 [TCP segmen...
56 1.119858	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=37969 Ack=1 Win=17520 Len=1460 [TCP segmen...
57 1.120902	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=39429 Ack=1 Win=17520 Len=1460 [TCP segmen...
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 [TCP se...
59 1.200421	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=35049 Win=62780 Len=0
60 1.265026	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=37969 Win=62780 Len=0
61 1.362074	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=40889 Win=62780 Len=0
62 1.389886	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=41781 Win=62780 Len=0
63 1.390110	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=41781 Ack=1 Win=17520 Len=1460 [TCP segmen...
64 1.390824	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=43241 Ack=1 Win=17520 Len=1460 [TCP segmen...
65 1.391683	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=44701 Ack=1 Win=17520 Len=1460 [TCP segmen...
66 1.392594	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=46161 Ack=1 Win=17520 Len=1460 [TCP segmen...
67 1.393390	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=47621 Ack=1 Win=17520 Len=1460 [TCP segmen...

Frame 59: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
 Ethernet II, Src: Linksys6_da:af:73 (00:06:25:da:af:73), Dst: Actionte_8a:70:1a (00:20:e0:8a:70:1a)
 Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102
 Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 35049, Len: 0
 Source Port: 80
 Destination Port: 1161

Typically, the receiver acknowledge in an ACK is 1460 bytes.

However, in segment #60, the receiver ACK number difference between # 59 and #60 is 2920. (2920 = 1460*2). This is because the time between the two packets sent by the sender is too short, and TCP uses Delayed ACKs where the receiver waits for up to 500 msec for the arrival of another in-order segment, and then sends a cumulative ACK for both of the received segments.

Question 8.

- 1) The total amount data transmitted = lackACK (based on No 202 segment) – firstSeqNum (based on No. 4 segment)

Specially, lackACK (raw) = 232293103, firstSeqNum = 232129013

- 2) Time = the time instant of the last ACK (No. 202 segment, 5.45583 seconds) - the time instant of the first TCP segment (No.4 segment, 0.026477 seconds)]
- 3) Therefore,

$$\text{Throughput} = \frac{\text{transmitted data}}{\text{time}} = \frac{\text{lastACK} - \text{firstSeqNum}}{\text{time}} = \frac{232293103 - 232129013}{5.45583 - 0.026477} \text{ Byte/sec} =$$

30222.904 byte/sec

Exercise 2: TCP Connection Management

Question 1.

The sequence number is 2818463618, which is used to initiate the TCP connection between the client computer and server.

Question 2.

- 1) The sequence number in SYNACK sent by the server to the client is 1247095790.

2)The ACK is 2818463619.

3)The ACK number sent by server is the result of adding 1 to the Sequence number. (ACK = SeqNum + 1, SYN occupies one byte.)

Question 3.

- 1) Sequence number = 2818463619 is sent by the client computer in response to the SYNACK,
- 2) and ACK= 1247095791.
- 3) There is no data included. Because the last segment of the three way handshake dose not contain any data transmission. Also, from the later segment No. 298, the seq number sent by the server to the client has the same Seq No 2818463619.

Question 4.

- 1) The close process is Simultaneous close.

From the last 4 segments (304, 305, 306, 308), it is easy to that their FINACK is sent by the client and server together (No 304 and 305 have crossed over in the network) through piggybacking, also the sequence numbers have no change.

Question 5.

- 1) Client,

the initial sequence number sent by client = 2818463618,

the lack ACK received by the client has ACK = 2818463653.

Data transformed form the client to server = lackACK - ISN – (1SYN + 1FIN) = 2818463653 – 2818463618 -2 = 33Bytes

- 2) Sever:

the initial Seq No = 1247095790,

the lack ACK received by server = 1247095832.

Data transformed form the server to client = lackACK - ISN – (1SYN + 1FIN) = 1247095832– 1247095790-2 = 40Bytes