

Exercise 1 : TCP

| 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 0.026177 | 192.168.1.102 | 128.119.245.12 | TCP | 62 | 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0 |

Q1:

As the gaia.cs.umass.edu is the server, which should be the destination (128.119.245.12) in the 1st hand shake. And the port number relevant should be 80. The IP of the host is the source, which shows as 192.168.1.102

Q2:

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|--------------|-------------------|----------------|----------|--------|---|
| | 187 5.104175 | Intel_52:2b:23 | Broadcast | ARP | 42 | Who has 192.168.1.1? Tell 192.168.1.100 |
| | 188 5.105060 | LinksysG da:af:73 | Intel 52:2b:23 | ARP | 42 | 192.168.1.1 is at 00:06:25:da:af:73 |
| → | 199 5.297341 | 192.168.1.102 | 128.119.245.12 | HTTP | 104 | POST /etherreal-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) |

The seq of POST is

Q3:

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[122 Reassembled TCP Segments (164090 bytes): #4(565), #5(1460), #7(1460), #8(1460), #10(1460), #11(1460), #13(1147), #18(1460), #19(1460),  
[Frame: 4, payload: 0-564 (565 bytes)]  
[Frame: 5, payload: 565-2024 (1460 bytes)]  
[Frame: 7, payload: 2025-3484 (1460 bytes)]  
[Frame: 8, payload: 3485-4944 (1460 bytes)]  
[Frame: 10, payload: 4945-6404 (1460 bytes)]  
[Frame: 11, payload: 6405-7864 (1460 bytes)]
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| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|----------|----------------|----------------|----------|--------|---|
| 6 | 0.026477 | 192.168.1.102 | 128.119.245.12 | TCP | 619 | 1161 → 80 [PSH, ACK] Seq=232129813 Win=17520 Len=565 [TCP segment of a reassembled PDU] |
| 7 | 0.041737 | 192.168.1.102 | 128.119.245.12 | TCP | 1510 | 1161 → 80 [PSH, ACK] Seq=232129578 Win=17520 Len=1460 [TCP segment of a reassembled PDU] |
| 8 | 0.053193 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883861786 Ack=232129578 Win=6780 Len=0 |
| 9 | 0.054026 | 192.168.1.102 | 128.119.245.12 | TCP | 1510 | 1161 → 80 [ACK] Seq=232131038 Win=17520 Len=1460 [TCP segment of a reassembled PDU] |
| 10 | 0.054690 | 128.119.245.12 | 192.168.1.102 | TCP | 1510 | 1161 → 80 [ACK] Seq=883861786 Ack=232131038 Win=6780 Len=0 |
| 11 | 0.077294 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883861786 Ack=232131038 Win=6780 Len=0 |
| 12 | 0.077405 | 192.168.1.102 | 128.119.245.12 | TCP | 1510 | 1161 → 80 [ACK] Seq=232133958 Ack=8816786 Win=17520 Len=1460 [TCP segment of a reassembled PDU] |
| 13 | 0.078157 | 192.168.1.102 | 128.119.245.12 | TCP | 1510 | 1161 → 80 [ACK] Seq=232135418 Ack=8816786 Win=17520 Len=1460 [TCP segment of a reassembled PDU] |

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|----------|-------------------|----------------|----------|--------|---|
| 213 | 7.595557 | 192.168.1.102 | 199.2.53.206 | TCP | 62 | 1160 → 631 [SYN] Seq=234062521 Win=16384 Len=0 MSS=1460 SACK_PERM=1 |
| 188 | 5.105060 | Linksys_gd:a:f:73 | Intel_52:2b:23 | ARP | 42 | 192.168.1.1 is at 00:06:25:da:af:73 |
| 6 | 0.053937 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0 |
| 9 | 0.077294 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=8760 Len=0 |
| 12 | 0.124085 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0 |
| 14 | 0.169118 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883061786 Ack=232133958 Win=14600 Len=0 |
| 15 | 0.217799 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0 |
| 16 | 0.262802 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 → 1161 [ACK] Seq=883061786 Ack=232136878 Win=20440 Len=0 |

| No. | Seq | sentTime | receivedTime | SampleRTT | EstimatedRTT |
|-----|-----------|----------|--------------|-----------|--------------|
| 1 | 232129013 | 0.026477 | 0.053937 | 0.02746 | 0.02746 |
| 2 | 232129578 | 0.041737 | 0.077294 | 0.035557 | 0.028472125 |
| 3 | 232131038 | 0.054026 | 0.124085 | 0.070059 | 0.033670484 |
| 4 | 232132498 | 0.05469 | 0.169118 | 0.114428 | 0.043765174 |
| 5 | 232133958 | 0.077405 | 0.217299 | 0.139894 | 0.055781277 |
| 6 | 232135418 | 0.078157 | 0.267802 | 0.189645 | 0.072514242 |

Here, the first 6 segments are frame #4, #5, #7, #8, #10, #11. The seq, sentTime, receiveTime and SampleRTT as shown in the red squares above.

In order to calculate the EstimatedRTT, we need to use formula from lecture notes :

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

(PS. The EstimatedRTT are calculated in the excel file, which is posted inside the Lab04.tar)

Q4:

The length of these 6 segments are 565, 1460, 1460, 1460, 1460, 1460. (as the figure 1 in Q3

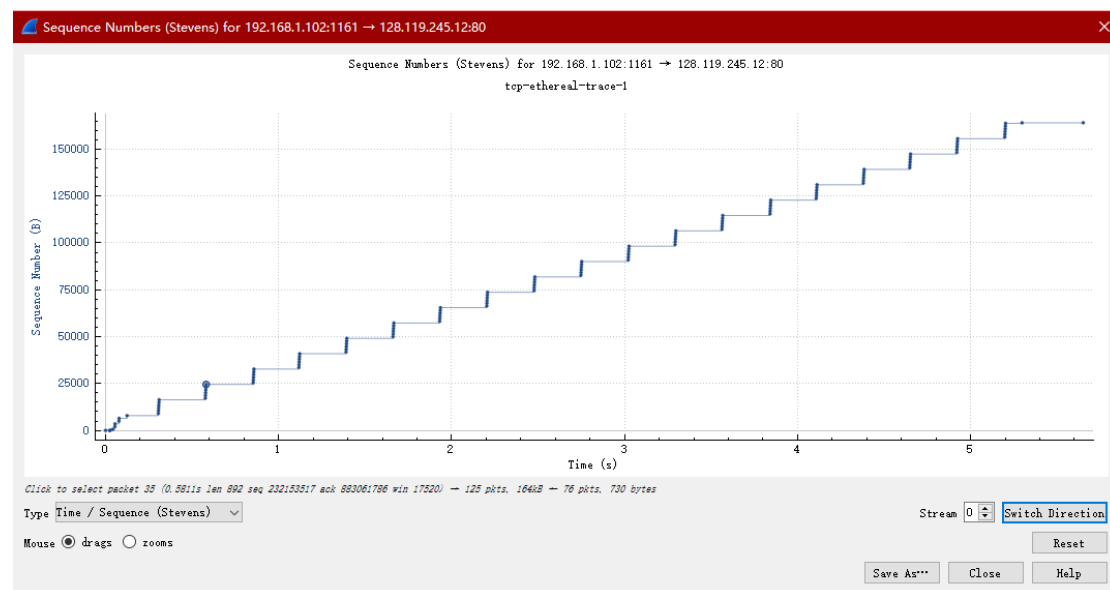
Q5:

| | 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 |

The SYN-ACK message gives out the minimum size of buffer space, which is 5840 bytes.

No, lack of receiver buffer space will not throttle the sender.

Q6:



There is no retransmitted segments in the trace file. The image resembles an ascending, equal-length staircase. If there are repeatedly sent segments, there will be cases where the retransmitted segment have a smaller seq than its neighboring segments.

Q7:

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[122 Reassembled TCP Segments (164090 bytes): #4(565), #5(1460), #7(1460), #8(1460), #9(1460), #10(1460), #11(1460), #12(1460), #13(1460), #14(1460), #15(1460), #16(1460), #17(1460), #18(1460), #19(1460), #20(1460), #21(1460), #22(1460), #23(892 bytes), #24(1460), #25(1460), #26(1460), #27(1460), #28(1460), #29(1460), #30(1460), #31(1460), #32(1460), #33(1460), #34(1460), #35(892 bytes), #36(1460), #37(1460), #38(1460), #39(1460), #40(1460), #41(1460), #42(1460), #43(1460), #44(1460), #45(1460), #46(1460), #47(1460), #48(1460), #49(1460), #50(1460), #51(1460), #52(1460), #53(1460), #54(1460), #55(1460), #56(1460), #57(1460), #58(1460), #59(1460), #60(1460), #61(1460), #62(1460), #63(1460), #64(1460), #65(1460), #66(1460), #67(1460), #68(1460), #69(1460), #70(1460), #71(1460), #72(1460), #73(1460), #74(1460), #75(1460), #76(1460), #77(1460), #78(1460), #79(1460), #80(1460), #81(1460), #82(1460), #83(1460), #84(1460), #85(1460), #86(1460), #87(1460), #88(1460), #89(1460), #90(1460), #91(1460), #92(1460), #93(1460), #94(1460), #95(1460), #96(1460), #97(1460), #98(1460), #99(1460)]
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The size of ACK is usually 1460 bytes.

| | | | | | | | | | | | | | |
|----|----------|----------------|----------------|-----|------|------|--------|------------|---------------|---------------|-----------|----------|------------------------------------|
| 42 | 0.853405 | 192.168.1.102 | 128.119.245.12 | TCP | 1514 | 1161 | - 80 | [ACK] | Seq=232154409 | ACK=883061786 | Win=17520 | Len=1460 | [TCP segment of a reassembled PDU] |
| 43 | 0.854076 | 192.168.1.102 | 128.119.245.12 | TCP | 1514 | 1161 | - 80 | [ACK] | Seq=232155869 | ACK=883061786 | Win=17520 | Len=1460 | [TCP segment of a reassembled PDU] |
| 44 | 0.853923 | 192.168.1.102 | 128.119.245.12 | TCP | 1514 | 1161 | - 80 | [ACK] | Seq=232157329 | ACK=883061786 | Win=17520 | Len=1460 | [TCP segment of a reassembled PDU] |
| 45 | 0.855878 | 192.168.1.102 | 128.119.245.12 | TCP | 1514 | 1161 | - 80 | [ACK] | Seq=232158789 | ACK=883061786 | Win=17520 | Len=1460 | [TCP segment of a reassembled PDU] |
| 46 | 0.856802 | 192.168.1.102 | 128.119.245.12 | TCP | 1514 | 1161 | - 80 | [ACK] | Seq=232160249 | ACK=883061786 | Win=17520 | Len=1460 | [TCP segment of a reassembled PDU] |
| 47 | 0.857683 | 192.168.1.102 | 128.119.245.12 | TCP | 926 | 161 | - 80 | [PSH, ACK] | Seq=232161709 | ACK=883061786 | Win=17520 | Len=92 | [TCP segment of a reassembled PDU] |
| 48 | 0.899423 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 | - 1161 | [ACK] | Seq=883061786 | ACK=232155869 | Win=65536 | Len=0 | |
| 49 | 0.949545 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 | - 1161 | [ACK] | Seq=883061786 | ACK=232157329 | Win=65536 | Len=0 | |
| 50 | 0.994715 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 | - 1161 | [ACK] | Seq=883061786 | ACK=232158789 | Win=65536 | Len=0 | |
| 51 | 1.039026 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 | - 1161 | [ACK] | Seq=883061786 | ACK=232160249 | Win=65536 | Len=0 | |
| 52 | 1.137097 | 128.119.245.12 | 192.168.1.102 | TCP | 60 | 80 | - 1161 | [ACK] | Seq=883061786 | ACK=232160249 | Win=65536 | Len=0 | |

As the diagram shows, these 4 server segments acknowledged to the relevant client segment. So the ack #232155869 is acknowledging #232154409 and #232155869, where the receiver send a cumulative ACK for 2 different segments.

| | | | | |
|---|----------|----------------|---------------|--|
| [122 Reassembled TCP Segments (164090 bytes): #4(565), #5(1460), #7(1460), #8(1460), #10(1460), #11(1460), #13(1147), #18(1460), #19(1460), [Frame: 4, payload: 0-564 (565 bytes)] [Frame: 5, payload: 565-2024 (1460 bytes)] [Frame: 7, payload: 2025-3484 (1460 bytes)] [Frame: 8, payload: 3485-4944 (1460 bytes)] [Frame: 10, payload: 4945-6404 (1460 bytes)] [Frame: 11, payload: 6405-7864 (1460 bytes)] | | | | |
| 202 | 5.455830 | 128.119.245.12 | 192.168.1.102 | TCP 60 80 → 1161 [ACK] Seq=883061786 Ack=232293103 Win=62780 Len=0 |
| 203 | 5.461175 | 128.119.245.12 | 192.168.1.102 | HTTP 784 HTTP/1.1 200 OK (text/html) |
| 204 | 5.598090 | 192.168.1.100 | 192.168.1.1 | SSDP 174 M-SEARCH * HTTP/1.1 |

Q8:

The average throughput of TCP is the ratio of the total transmission data to the total transmission time.

In this lab, there are 122 segments reassembled and the total size of them is 164090 bytes. As the time of last segment(#199) is 5.297341 sec, and the first segment(#4) is 0.026477 sec. the time cost of these 122 segments is (5.297341 - 0.026477) = 5.270864 sec. Therefore, the TCP average throughput is 164090 bytes / 5.270864 sec = 31.131 Kbyte/sec.

Exercise 2 : TCP

| No | Source IP | Destination IP | Protocol | Info |
|-----|-------------|----------------|----------|---|
| 295 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [SYN] Seq=2818463618 win=8192 MSS=1460 |
| 296 | 10.99.6.175 | 10.9.16.201 | TCP | 5000 > 50045 [SYN, ACK] Seq=1247095790 Ack=2818463619 win=262144 MSS=1460 |
| 297 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [ACK] Seq=2818463619 Ack=1247095791 win=65535 |

Q1:

As the table shows, the seq is 2818463618.

| No | Source IP | Destination IP | Protocol | Info |
|-----|-------------|----------------|----------|---|
| 295 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [SYN] Seq=2818463618 win=8192 MSS=1460 |
| 296 | 10.99.6.175 | 10.9.16.201 | TCP | 5000 > 50045 [SYN, ACK] Seq=1247095790 Ack=2818463619 win=262144 MSS=1460 |
| 297 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [ACK] Seq=2818463619 Ack=1247095791 win=65535 |

Q2:

Seq is 1247095790. ACK number is 2818463619.

This ACK is determined by adding 1 on the initial sequence number that received from client.

| No | Source IP | Destination IP | Protocol | Info |
|-----|-------------|----------------|----------|---|
| 295 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [SYN] Seq=2818463618 win=8192 MSS=1460 |
| 296 | 10.99.6.175 | 10.9.16.201 | TCP | 5000 > 50045 [SYN, ACK] Seq=1247095790 Ack=2818463619 win=262144 MSS=1460 |
| 297 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [ACK] Seq=2818463619 Ack=1247095791 win=65535 |

Q3:

Seq is 2818463619. ACK number is 1247095791.

There is no content data include in this message.

| | | | | |
|-----|-------------|-------------|-----|--|
| 302 | 10.99.6.175 | 10.9.16.201 | TCP | 5000 > 50045 [PSH, ACK] Seq=1247095791 Ack=2818463652 win=262144 |
| 303 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [ACK] Seq=2818463652 Ack=1247095831 win=65535 |
| 304 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [FIN, ACK] Seq=2818463652 Ack=1247095831 win=65535 |
| 305 | 10.99.6.175 | 10.9.16.201 | TCP | 5000 > 50045 [FIN, ACK] Seq=1247095831 Ack=2818463652 win=262144 |
| 306 | 10.9.16.201 | 10.99.6.175 | TCP | 50045 > 5000 [ACK] Seq=2818463652 Ack=1247095832 win=65535 |
| 308 | 10.99.6.175 | 10.9.16.201 | TCP | 5000 > 50045 [ACK] Seq=1247095831 Ack=2818463653 win=262144 |

Q4:

The conversation is closed by both client and server. In the FIN stage, client and server will both generated FINs based on previous-received ACK and Seq. The ACK will not increased.

Q5:

Client: (final ACK – Initial Seq) – SYN – FIN = 2818463653 – 2818463618 – 2 = 33 Bytes.

Client: (final ACK – Initial Seq) – SYN – FIN = 1247095832 – 1247095790 – 2 = 40 Bytes.