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Section:5-B

TCP Work

1.

Client IP: 192.168.1.102

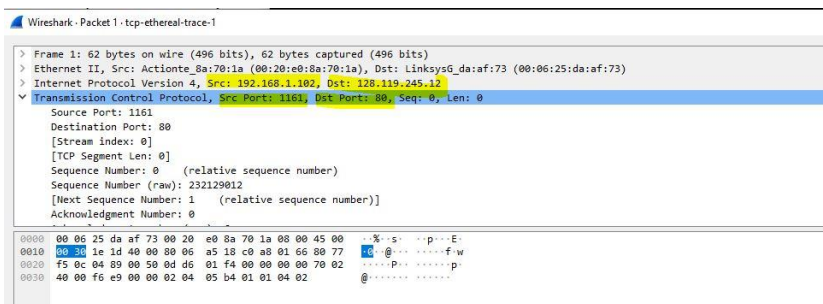
Port: 1161

2.

Server IP: 128.119.245.12

Port: 80

Since by checking through nslookup command, I found out that the IP address of gaia.cs.umass.edu. So the destination IP address matched the IP of the website and the source IP is of client.



Command Prompt

```
C:\Users\moham>nslookup gaia.cs.umass.edu
Server: UnKnown
Address: fe80::1

Non-authoritative answer:
Name:   gaia.cs.umass.edu
Address: 128.119.245.12

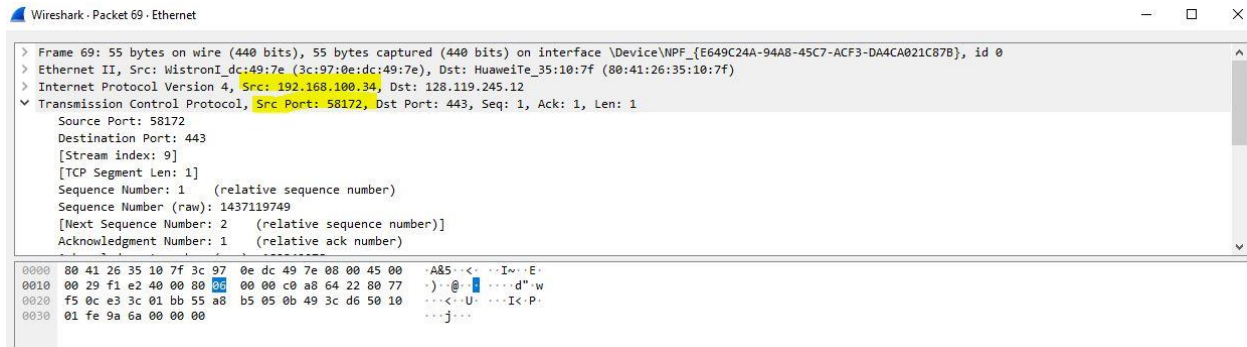
C:\Users\moham>
```

3.

My IP Address: 192.168.100.34

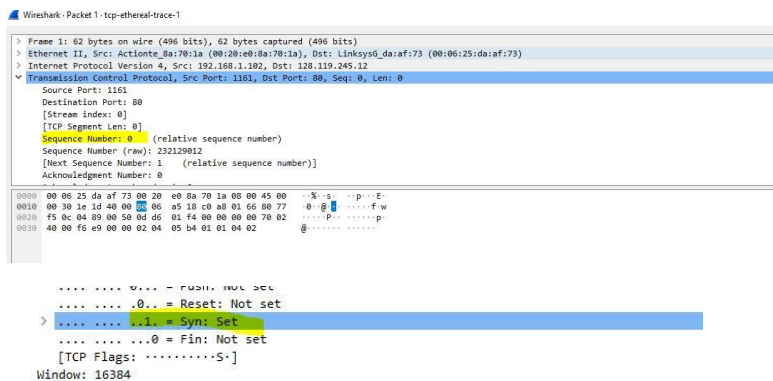
My port no: 58172

Confirmed my IP from ipconfig



4.

Sequence Number of TCP SYN segment is set to 0 as it is initializing the TCP connection. SYN flag is in this segment which identifies it as SYN segment as it's value is set to 1.



5.

The sequence of the SYNACK segment sent by source (gaia.cs.umass.edu) is 0. The Acknowledgment number is 1. This is determined by adding 1 to the sequence number sent by the initial sequence number in the SYN segment sent by the client.

As the initial sequence number was 0 so $0+1 = 1$.

The SYN and ACK flags are set to 1 making this segment as a SYNACK segment.

```
[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: 0x012 (SYN, ACK)
  000. .... = Reserved: Not set
  ...0 .... = Nonce: Not set
  .... 0... = Congestion Window Reduced (CWR): Not set
Acknowledgment number (raw): 232129013
0111 .... = Header Length: 28 bytes (7)
✓ Flags: 0x012 (SYN, ACK)
  000. .... = Reserved: Not set
  ...0 .... = Nonce: Not set
  .... 0... = Congestion Window Reduced (CWR):
  .... 0... = ECN-Echo: Not set
  .... 0... = Urgent: Not set
  .... 1... = Acknowledgment: Set
  .... 0... = Push: Not set
  .... 0... = Reset: Not set
  > .... 1... = Syn: Set
```

6.

Sequence number of packet containing POST command is 1.

```
Internet Protocol Version 4, Src: 192.168.1.102, Dst: 128.113.249.12
✓ 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)
  0000 00 06 25 da af 73 00 20 e0 8a 70 1a 08 00 45 00  ...%..s...p...E-
  0010 02 5d 1e 21 40 00 80 06 a2 e7 c0 a8 01 66 80 77  ...]!@...f.w
  0020 f5 0c 04 89 00 50 0d d6 01 f5 34 a2 74 1a 50 18  ...P...4.t.P
  0030 44 70 1f bd 00 00 50 4f 53 54 20 2f 65 74 68 65  Dp...PO ST /ethe
  0040 72 65 61 6c 2d 6c 61 62 73 2f 6c 61 62 33 2d 31  real-lab s/lab3-1
  0050 2d 72 65 70 6c 79 2e 68 74 6d 20 48 54 54 50 2f  -reply.htm HTTP/
  0060 31 2e 31 0d 0a 48 6f 73 74 3a 20 67 61 69 61 2e  1.1..Host: gaia.
  0070 63 73 3a 75 64 61 73 73 3a 65 64 75 64 61 73  63 umass.edu/
```

7.

First 6 Segments

3	0.025265	192.168.1.102	128.119.245.12	TCP	54 1161 → 80
4	0.026477	192.168.1.102	128.119.245.12	TCP	619 1161 → 80
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
6	0.053937	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
9	0.077294	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
12	0.124085	128.119.245.12	192.168.1.102	TCP	60 80 → 1161

The first 6 segments are 4,5,7,8,10 and 11

First 6 Acknowledgements

4	0.026477	192.168.1.102	128.119.245.12	TCP	619 1161 → 80
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
6	0.053937	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
9	0.077294	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80
12	0.124085	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201 1161 → 80
14	0.169118	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
15	0.217299	128.119.245.12	192.168.1.102	TCP	60 80 → 1161
16	0.267802	128.119.245.12	192.168.1.102	TCP	60 80 → 1161

The first 6 Acknowledgments are 6, 9, 12, 14, 15, 16

Sr no#	Sequence no	Sent Time	Ack time	RTT
1	1	0.026477	0.053937	0.027460
2	566	0.041737	0.077294	0.035557
3	2026	0.054026	0.124085	0.070059
4	3486	0.054690	0.169118	0.114428
5	4946	0.077405	0.217299	0.139894
6	6406	0.078157	0.267802	0.189645

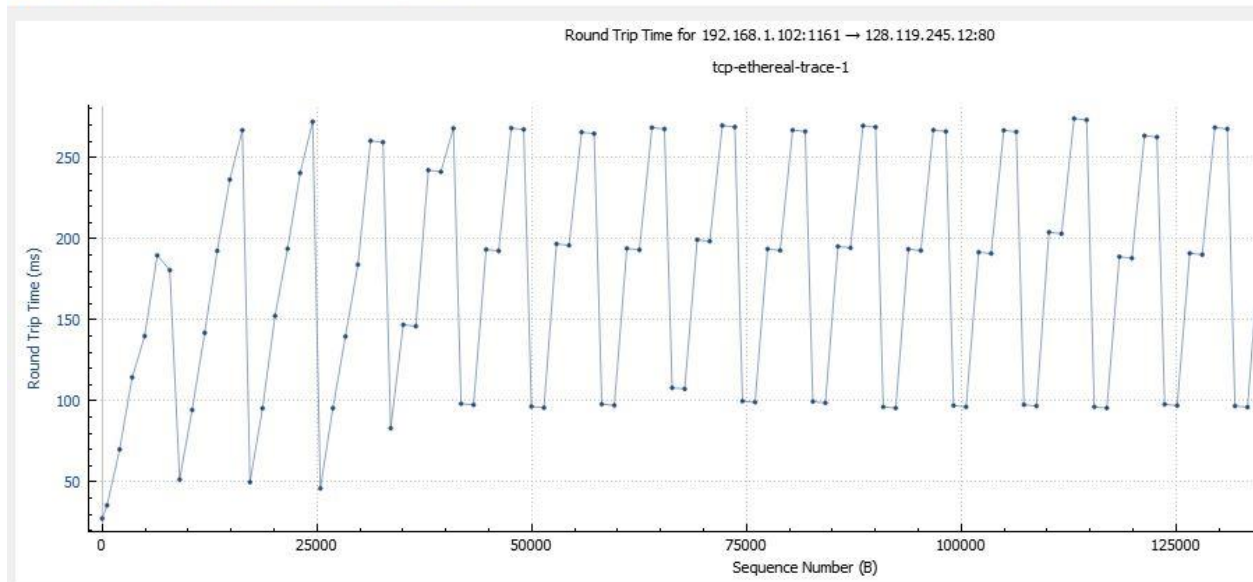
Estimated RTT

Formula:

$$\text{Estimated RTT} = 0.875 * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$$

ESTIMATED RTT AFTER ACK OF SEGMENT 1:
ESTIMATED RTT = RTT FOR SEGMENT 1 = 0.027460
ESTIMATED RTT AFTER ACK OF SEGMENT 2:
ESTIMATED RTT = $0.875 * 0.027460 + 0.125 * 0.035557 = 0.028472125$
ESTIMATED RTT AFTER ACK OF SEGMENT 3:
ESTIMATED RTT = $0.875 * 0.028472125 + 0.125 * 0.070059 = 0.03367048438$
ESTIMATED RTT AFTER ACK OF SEGMENT 4:
ESTIMATED RTT = $0.875 * 0.03367048438 + 0.125 * 0.114428 = 0.04376517383$
ESTIMATED RTT AFTER ACK OF SEGMENT 5:
ESTIMATED RTT = $0.875 * 0.04376517383 + 0.125 * 0.139894 = 0.0557812771$
ESTIMATED RTT AFTER ACK OF SEGMENT 6:
ESTIMATED RTT = $0.875 * 0.0557812771 + 0.125 * 0.189645 = 0.07251424246$

Round Trip Time for 192.168.1.102:1161 → 128.119.245.12:80



8.

Segment No.	Length
1	565
2	1460
3	1460
4	1460
5	1460
6	1460

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 a reassembled PDU]
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 of a reassembled PDU]
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 a reassembled PDU]
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 a reassembled PDU]
9 0.077294	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8768 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 a reassembled PDU]
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 a reassembled PDU]

9.

A. The minimum amount of available buffer space = 5840

This receiver window grows until it reaches the maximum receiver buffer size of 62780 bytes.

According to the trace, the sender is never throttled due to the lack of receiver buffer space.

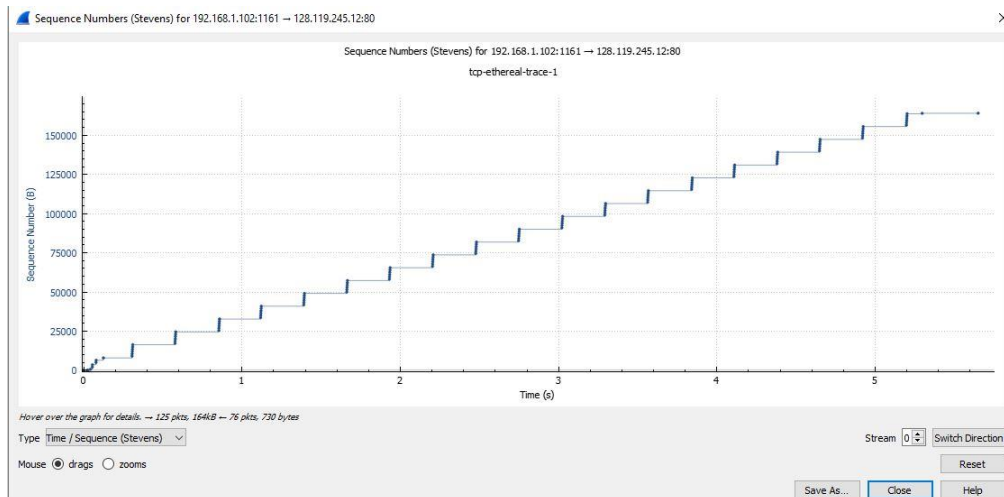
2 0.023172	128.119.245.12	192.168.1.102	TCP	62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460
<pre> >1. = Syn: Set0 = Fin: Not set [TCP Flags:A..S.] Window: 5840 [Calculated window size: 5840] Checksum: 0x774d [unverified] [Checksum Status: Unverified] </pre>				

10.

No retransmitted segments are observed. There are two ways to find retransmitted packets.

1. Packet tracer tells you if a packet is retransmitted.
2. By plotting a time-sequence graph.

If there is a point where the sequence number drops, then a packet has been retransmitted, but in the graph below, sequence numbers are continuously increasing.



11.

Subtracting the acknowledgment numbers between 2 messages, we can know how much data has been received between the two ACK segments.

Example

$$(64005-61085) = 2920$$

87	2.029069	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=61085 Win=62780 Len=0
88	2.126682	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=64005 Win=62780 Len=0

12.

The size of the alice.txt file is 152,138 bytes. The time taken to download the file is the time for the first TCP segment - time for the last ACK segment. So, download time = 5.455830 - 0.026477 = 5.429353. The throughput is total bytes/total time taken = 152,138/5.429353 = 28021.3867 bytes/second.

Size: 148 KB (152,138 bytes)

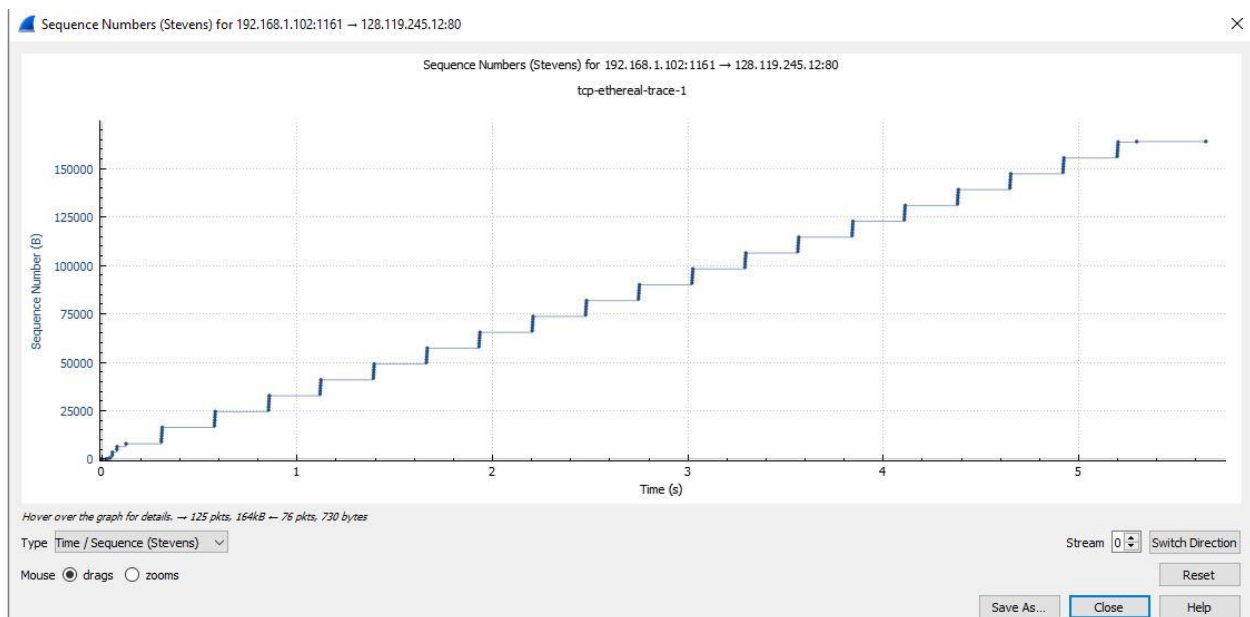
1st TCP Segment Time

4 0.826477	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 PDU]
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Last ACK Time

202 5.455830	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
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13.



we can see from this graph, the slow start phase starts from 0 seconds and lasts till about 0.17 seconds.

There is no congestion avoidance seen here since the size of the segments remains the same throughout.

14.

Total Size of File: 152,136 bytes

Time For first segment: 1.60109

1332	13.160109	192.168.100.34	128.119.245.12	TCP	776	57513 → 80 [PSH, ACK]
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Time for last ACK= 14.053659

1532	14.053659	128.119.245.12	192.168.100.34	TCP	60	80 → 57513 [ACK] Seq=1 Ack=153046 Win=186240 Len=0
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Time taken to upload= 14.053659-1.60109=12.452569

Throughput = 152,138/12.452569 = 12,217.39867492403 bytes/second.

Time Sequence Graph

