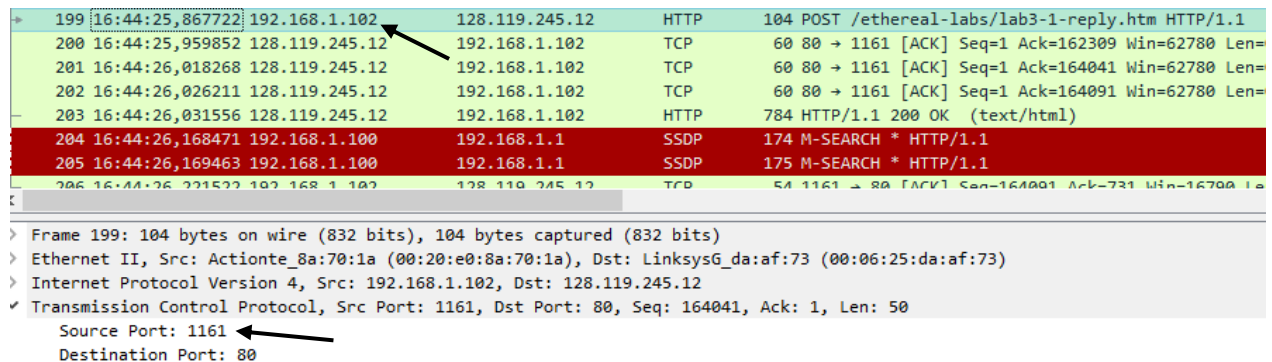**MARMARA UNIVERSITY**

**FACULTY OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING
DEPARTMENT**

**CSE4074
COMPUTER NETWORKS
Homework #3**

A. Tunahan Cinsoy
150117062

2. A first look at the captured trace

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?
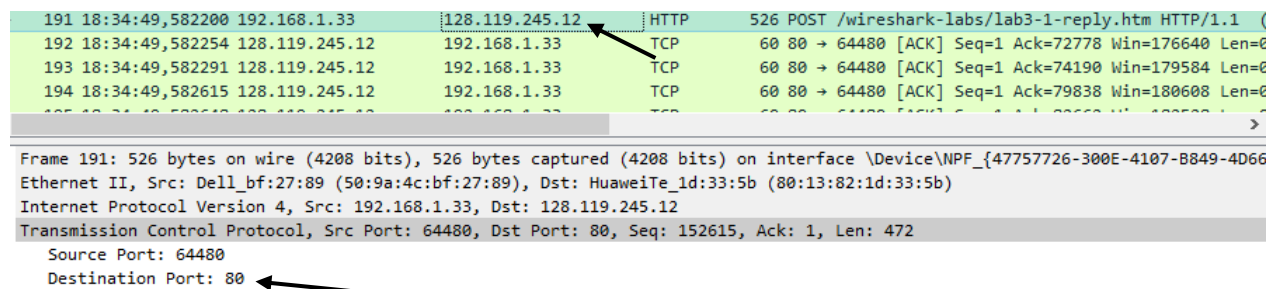
```
  199 16:44:25,867722 192.168.1.102      128.119.245.12     HTTP     104 POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1
  200 16:44:25,959852 128.119.245.12     192.168.1.102      TCP       60 80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=
  201 16:44:26,018268 128.119.245.12     192.168.1.102      TCP       60 80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=
  202 16:44:26,026211 128.119.245.12     192.168.1.102      TCP       60 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=
  203 16:44:26,031556 128.119.245.12     192.168.1.102      HTTP     784 HTTP/1.1 200 OK  (text/html)
  204 16:44:26,168471 192.168.1.100      192.168.1.1        SSDP     174 M-SEARCH * HTTP/1.1
  205 16:44:26,169463 192.168.1.100      192.168.1.1        SSDP     175 M-SEARCH * HTTP/1.1
  206 16:44:26 221522 192 168 1 102      128 119 245 12     TCP       54 1161 → 80 [ACK] Seq=164091 Ack=731 Win=16790 Le
```

> Frame 199: 104 bytes on wire (832 bits), 104 bytes captured (832 bits)
> 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: 164041, Ack: 1, Len: 50
    Source Port: 1161
    Destination Port: 80

Source IP address is 192.168.102, and it uses 1161 as source port.

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?
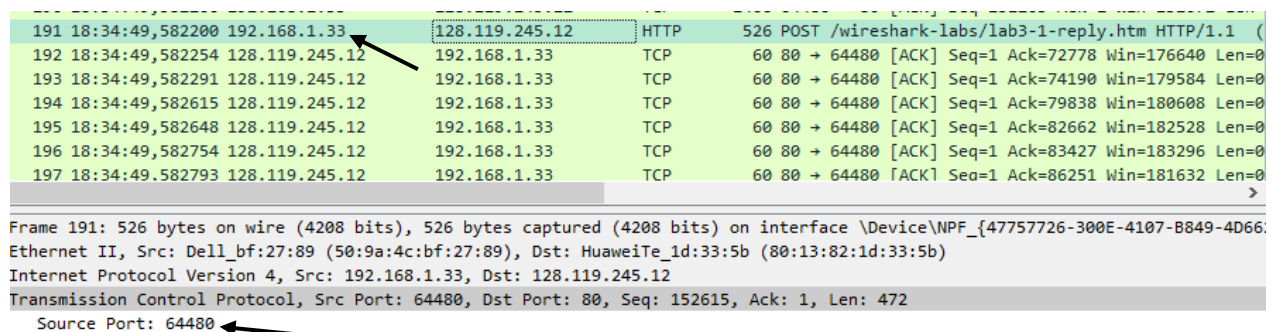
```
  191 18:34:49,582200 192.168.1.33       128.119.245.12     HTTP     526 POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1  (
  192 18:34:49,582254 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=72778 Win=176640 Len=0
  193 18:34:49,582291 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=74190 Win=179584 Len=0
  194 18:34:49,582615 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=79838 Win=180608 Len=0
```

Frame 191: 526 bytes on wire (4208 bits), 526 bytes captured (4208 bits) on interface \Device\NPF_{47757726-300E-4107-B849-4D66
Ethernet II, Src: Dell_bf:27:89 (50:9a:4c:bf:27:89), Dst: HuaweiTe_1d:33:5b (80:13:82:1d:33:5b)
Internet Protocol Version 4, Src: 192.168.1.33, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 64480, Dst Port: 80, Seq: 152615, Ack: 1, Len: 472
    Source Port: 64480
    Destination Port: 80

IP address of gaia.cs.umass.edu is 128.119.245.12, port number is 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?

```
  191 18:34:49,582200 192.168.1.33       128.119.245.12     HTTP     526 POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1  (
  192 18:34:49,582254 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=72778 Win=176640 Len=0
  193 18:34:49,582291 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=74190 Win=179584 Len=0
  194 18:34:49,582615 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=79838 Win=180608 Len=0
  195 18:34:49,582648 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=82662 Win=182528 Len=0
  196 18:34:49,582754 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=83427 Win=183296 Len=0
  197 18:34:49,582793 128.119.245.12     192.168.1.33       TCP       60 80 → 64480 [ACK] Seq=1 Ack=86251 Win=181632 Len=0
```

Frame 191: 526 bytes on wire (4208 bits), 526 bytes captured (4208 bits) on interface \Device\NPF_{47757726-300E-4107-B849-4D66
Ethernet II, Src: Dell_bf:27:89 (50:9a:4c:bf:27:89), Dst: HuaweiTe_1d:33:5b (80:13:82:1d:33:5b)
Internet Protocol Version 4, Src: 192.168.1.33, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 64480, Dst Port: 80, Seq: 152615, Ack: 1, Len: 472
    Source Port: 64480

Source IP address is 192.168.1.33, and it uses 64480 as source port.

3. TCP Basics

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?

```
20 18:34:49,067628 192.168.1.33      128.119.245.12    TCP      66 64479 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
21 18:34:49,067800 192.168.1.33      128.119.245.12    TCP      66 64480 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
22 18:34:49,072180 192.168.1.33      172.217.169.110   QUIC   1392 Initial, DCID=5783f2e7b5b646ec, PKN: 1, CRYPTO, PADDING
23 18:34:49,084356 172.217.17.163    192.168.1.33      TCP      60 443 → 64454 [FIN, ACK] Seq=1 Ack=2 Win=261 Len=0
24 18:34:49,084428 192.168.1.33      172.217.17.163    TCP      54 64454 → 443 [ACK] Seq=2 Ack=2 Win=509 Len=0
```

```
> Frame 20: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface \Device\NPF_{47757726-300E-4107-B849-4D6627335A75}, id 0
> Ethernet II, Src: Dell_bf:27:89 (50:9a:4c:bf:27:89), Dst: HuaweiTe_1d:33:5b (80:13:82:1d:33:5b)
> Internet Protocol Version 4, Src: 192.168.1.33, Dst: 128.119.245.12
∨ Transmission Control Protocol, Src Port: 64479, Dst Port: 80, Seq: 0, Len: 0
    Source Port: 64479
    Destination Port: 80
    [Stream index: 4]
    [TCP Segment Len: 0]
    Sequence Number: 0    (relative sequence number)
    Sequence Number (raw): 3234297140
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 0
    Acknowledgment number (raw): 0
    1000 .... = Header Length: 32 bytes (8)
  > Flags: 0x002 (SYN)
```

The sequence number of the TCP SYN segment that is used to initiate the TCP connection is 0. "SYN" flag segment identifies that it is a 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?

```
41 18:34:49,196305 128.119.245.12    192.168.1.33      TCP      66 80 → 64480 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1412 SACK_PERM=1 WS=128
42 18:34:49,196395 192.168.1.33      128.119.245.12    TCP      54 64480 → 80 [ACK] Seq=1 Ack=1 Win=131072 Len=0
43 18:34:49,196833 192.168.1.33      128.119.245.12    TCP     819 64480 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131072 Len=765 [TCP segment of a reassembled
44 18:34:49,197001 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=766 Ack=1 Win=131072 Len=1412 [TCP segment of a reassembled P
45 18:34:49,197001 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=2178 Ack=1 Win=131072 Len=1412 [TCP segment of a reassembled
46 18:34:49,197001 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=3590 Ack=1 Win=131072 Len=1412 [TCP segment of a reassembled
47 18:34:49,197001 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=5002 Ack=1 Win=131072 Len=1412 [TCP segment of a reassembled
```

```
Frame 41: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface \Device\NPF_{47757726-300E-4107-B849-4D6627335A75}, id 0
Ethernet II, Src: HuaweiTe_1d:33:5b (80:13:82:1d:33:5b), Dst: Dell_bf:27:89 (50:9a:4c:bf:27:89)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.33
Transmission Control Protocol, Src Port: 80, Dst Port: 64480, Seq: 0, Ack: 1, Len: 0
    Source Port: 80
    Destination Port: 64480
    [Stream index: 5]
    [TCP Segment Len: 0]
    Sequence Number: 0    (relative sequence number)
    Sequence Number (raw): 2952558133
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 1    (relative ack number)
    Acknowledgment number (raw): 16159494
    1000 .... = Header Length: 32 bytes (8)
  > Flags: 0x012 (SYN, ACK)
```

The sequence number of the SYNACK segment is 0. The value of Acknowledgement field in SYNACK segment is 1. It is determined by the initial sequence number plus 1. The message carries SYN ACK flag as identification.

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

```
191 18:34:49,582200 192.168.1.33       128.119.245.12      HTTP     526 POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1  (text/plain)
192 18:34:49,582254 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=72778 Win=176640 Len=0
193 18:34:49,582291 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=74190 Win=179584 Len=0
```

```
Frame 191: 526 bytes on wire (4208 bits), 526 bytes captured (4208 bits) on interface \Device\NPF_{47757726-300E-4107-B849-4D6627335A75}, id 0
Ethernet II, Src: Dell_bf:27:89 (50:9a:4c:bf:27:89), Dst: HuaweiTe_1d:33:5b (80:13:82:1d:33:5b)
Internet Protocol Version 4, Src: 192.168.1.33, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 64480, Dst Port: 80, Seq: 152615, Ack: 1, Len: 472
    Source Port: 64480
    Destination Port: 80
    [Stream index: 5]
    [TCP Segment Len: 472]
    Sequence Number: 152615     (relative sequence number)
    Sequence Number (raw): 16312108
    [Next Sequence Number: 153087     (relative sequence number)]
```

The sequence number of the TCP segment that contains HTTP POST command is 152615.

7. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection. 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 Estimated RTT value (see Section 3.5.3, page 242 in text) after the receipt of each ACK?

```
191 18:34:49,582200 192.168.1.33       128.119.245.12      HTTP     526 POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1  (text/plain)
192 18:34:49,582254 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=72778 Win=176640 Len=0
193 18:34:49,582291 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=74190 Win=179584 Len=0
194 18:34:49,582615 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=79838 Win=180608 Len=0
195 18:34:49,582648 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=82662 Win=182528 Len=0
196 18:34:49,582754 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=83427 Win=183296 Len=0
197 18:34:49,582793 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=86251 Win=181632 Len=0
198 18:34:49,583641 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=89075 Win=182528 Len=0
```

```
    Sequence Number: 152615     (relative sequence number)
    Sequence Number (raw): 16312108
```

```
192 18:34:49,582254 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=72778 Win=176640 Len=0
193 18:34:49,582291 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=74190 Win=179584 Len=0
194 18:34:49,582615 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=79838 Win=180608 Len=0
195 18:34:49,582648 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=82662 Win=182528 Len=0
196 18:34:49,582754 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=83427 Win=183296 Len=0
197 18:34:49,582793 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=86251 Win=181632 Len=0
198 18:34:49,583641 128.119.245.12     192.168.1.33        TCP       60 80 → 64480 [ACK] Seq=1 Ack=89075 Win=182528 Len=0
```

```
Frame 192: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface \Device\NPF_{47757726-300E-4107-B849-4D6627335A75}, id 0
Ethernet II, Src: HuaweiTe_1d:33:5b (80:13:82:1d:33:5b), Dst: Dell_bf:27:89 (50:9a:4c:bf:27:89)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.33
Transmission Control Protocol, Src Port: 80, Dst Port: 64480, Seq: 1, Ack: 72778, Len: 0
    Source Port: 80
    Destination Port: 64480
    [Stream index: 5]
    [TCP Segment Len: 0]
    Sequence Number: 1     (relative sequence number)
    Sequence Number (raw): 2952558134
```

Round Trip Time for 128.119.245.12:80 → 192.168.1.33:64480
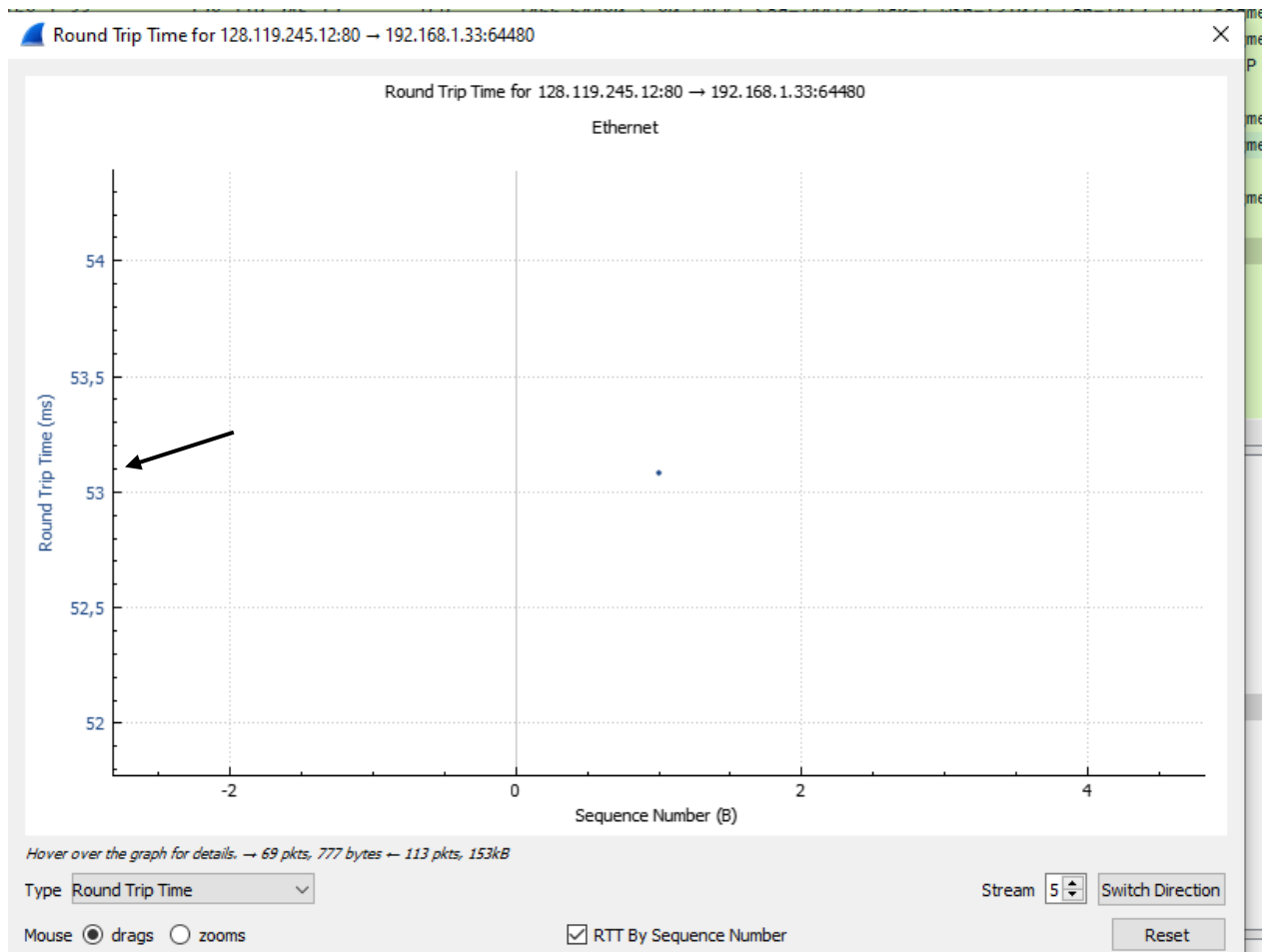
Sequence number of HTTP POST segment is 152615. Segment numbers of the first 6 TCP segments are all 1. Sent time and ACK segment receive time can be seen above. The RTT value of these 6 segments is approximately 53.1 milliseconds. Estimated RTT values for the subsequent segments are 0.9 * (53.1) + 0.1(53.1) = 53.1 milliseconds.

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


```
43 18:34:49,196833 192.168.1.33      128.119.245.12     TCP     819 64480 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131072 Len=765 [TCP segment of a reassembl
44 18:34:49,197001 192.168.1.33      128.119.245.12     TCP    1466 64480 → 80 [ACK] Seq=766 Ack=1 Win=131072 Len=1412 [TCP segment of a reassembled
45 18:34:49,197001 192.168.1.33      128.119.245.12     TCP    1466 64480 → 80 [ACK] Seq=2178 Ack=1 Win=131072 Len=1412 [TCP segment of a reassemble
46 18:34:49,197001 192.168.1.33      128.119.245.12     TCP    1466 64480 → 80 [ACK] Seq=3590 Ack=1 Win=131072 Len=1412 [TCP segment of a reassemble
47 18:34:49,197001 192.168.1.33      128.119.245.12     TCP    1466 64480 → 80 [ACK] Seq=5002 Ack=1 Win=131072 Len=1412 [TCP segment of a reassemble
48 18:34:49,197001 192.168.1.33      128.119.245.12     TCP    1466 64480 → 80 [ACK] Seq=6414 Ack=1 Win=131072 Len=1412 [TCP segment of a reassemble
```

Lengths of the first six TCP segments are 765,1412,1412,1412,1412,1412.

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?

```
 99 18:34:49,453159 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=58658 Ack=1 Win=131072 Len=1412 [TCP segment of a rea
100 18:34:49,453159 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=60070 Ack=1 Win=131072 Len=1412 [TCP segment of a rea
101 18:34:49,453159 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=61482 Ack=1 Win=131072 Len=1412 [TCP segment of a rea
102 18:34:49,453617 128.119.245.12    192.168.1.33      TCP      60 80 → 64480 [ACK] Seq=1 Ack=27594 Win=84608 Len=0
103 18:34:49,453630 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=62894 Ack=1 Win=131072 Len=1412 [TCP segment of a rea
104 18:34:49,453630 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=64306 Ack=1 Win=131072 Len=1412 [TCP segment of a rea
105 18:34:49,453630 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [PSH, ACK] Seq=65718 Ack=1 Win=131072 Len=1412 [TCP segment of
106 18:34:49,453630 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=67130 Ack=1 Win=131072 Len=1412 [TCP segment of a rea
107 18:34:49,453745 128.119.245.12    192.168.1.33      TCP      60 80 → 64480 [ACK] Seq=1 Ack=29006 Win=87552 Len=0

Window: 512
[Calculated window size: 131072]
```

Calculated window size is 131072 bytes. Throttle has never occurred.

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

There are not segments that retransmitted. We can check it by looking at ack number occurrence.

11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment?

```
172 18:34:49,580885 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [PSH, ACK] Seq=131435 Ack=1 Win=131072 Len=1412 [TCP segment of a r
173 18:34:49,580885 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=132847 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
174 18:34:49,580885 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=134259 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
175 18:34:49,580885 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=135671 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
176 18:34:49,581113 128.119.245.12    192.168.1.33      TCP      60 80 → 64480 [ACK] Seq=1 Ack=64306 Win=159488 Len=0
177 18:34:49,581137 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=137083 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
178 18:34:49,581137 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=138495 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
179 18:34:49,581137 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=139907 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
180 18:34:49,581137 192.168.1.33      128.119.245.12    TCP    1466 64480 → 80 [ACK] Seq=141319 Ack=1 Win=131072 Len=1412 [TCP segment of a reasse
```

Receiver typically acknowledges 1412 bytes in an ack. If the data is doubled, then acking other segment occurs.

12. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

Total byte transferred is approximately 153138 bytes, and the time is approximately 1.1 seconds so it makes 139216 bps.

4. TCP congestion control in action

13. Use the Time-Sequence-Graph (Stevens) plotting tool to view the sequence number versus time plot of segments being sent from the client to the gaia.cs.umass.edu server. Can you identify where TCP's slow start phase begins and ends, and where congestion avoidance takes over? Comment on ways in which the measured data differs from the idealized behavior of TCP that we've studied in the text.
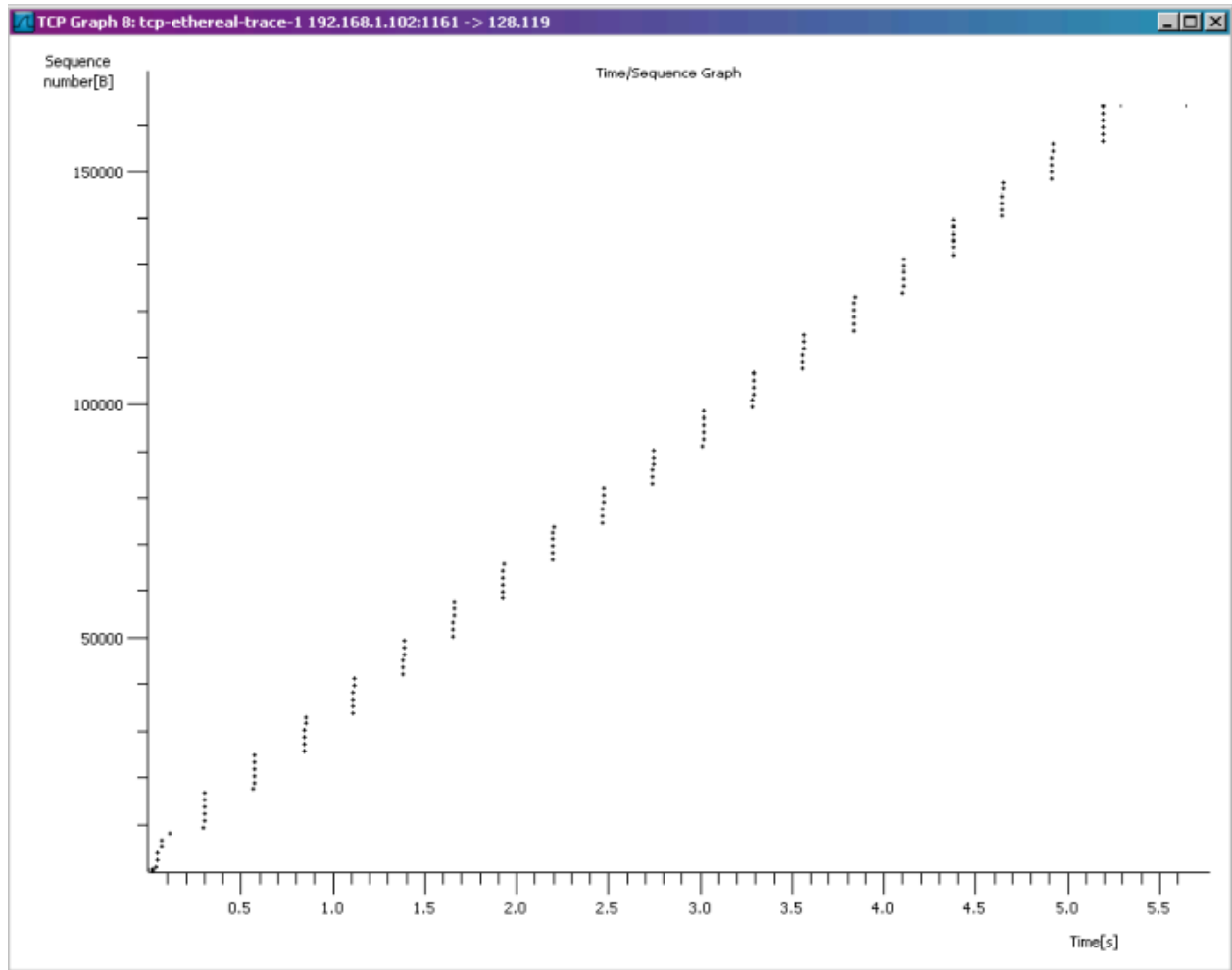
Slow start phase begins at time 0 and ends at 0.15 sec.

Sequence Numbers (Stevens) for 192.168.1.33:64480 → 128.119.245.12:80
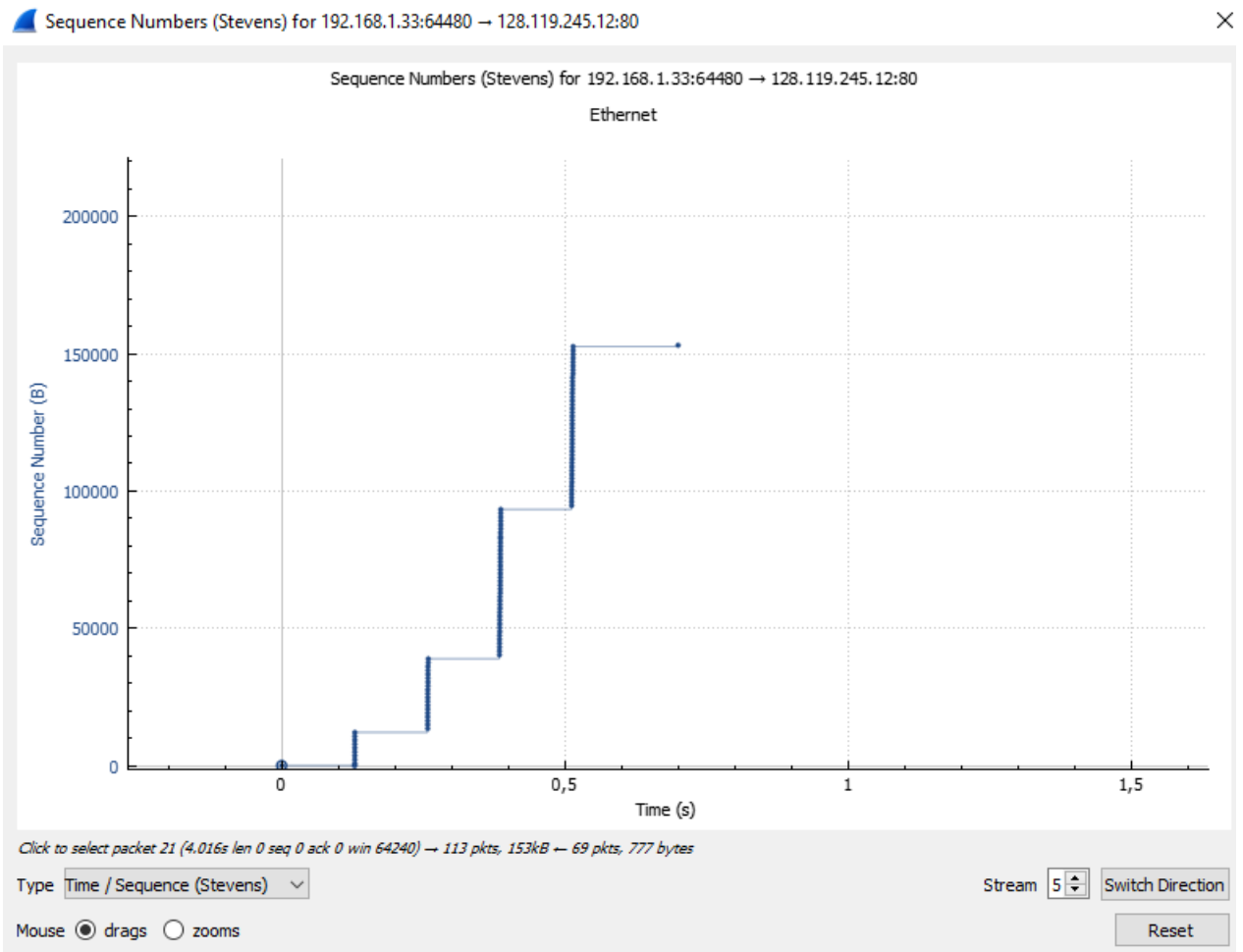
Slow start phase begins at 0 and ends at 0.125.