~~~~~~~~~~~~~~~~~~~~Lab04~~~~~~~~~~~~~~~~~~~

Exercise 1: Understanding TCP using Wireshark

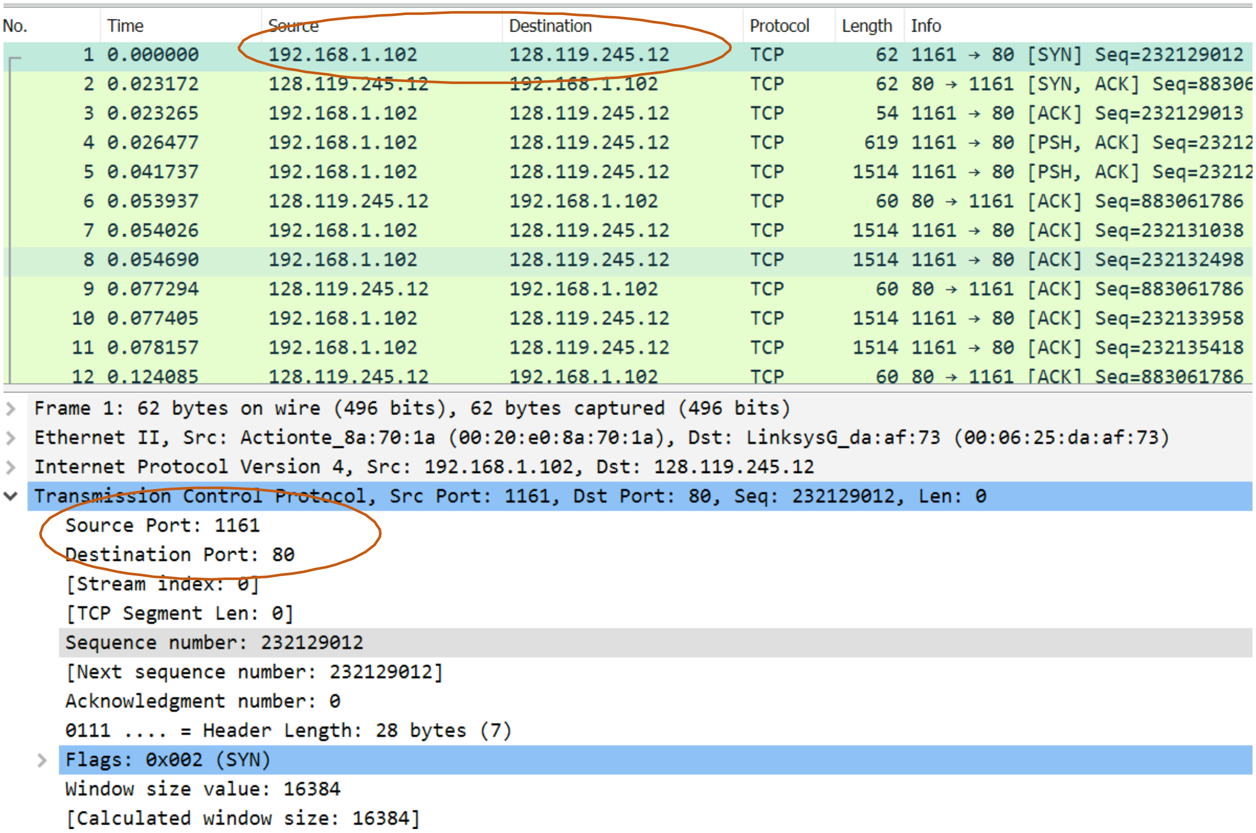
Question 1 . What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection? What is the IP address and TCP port number used by the client computer (source) that is transferring the file to gaia.cs.umass.edu?

The IP address: 128.119.245.12

Port number: 80

Client IP address: 192.168.1.102

Client port number: 1161

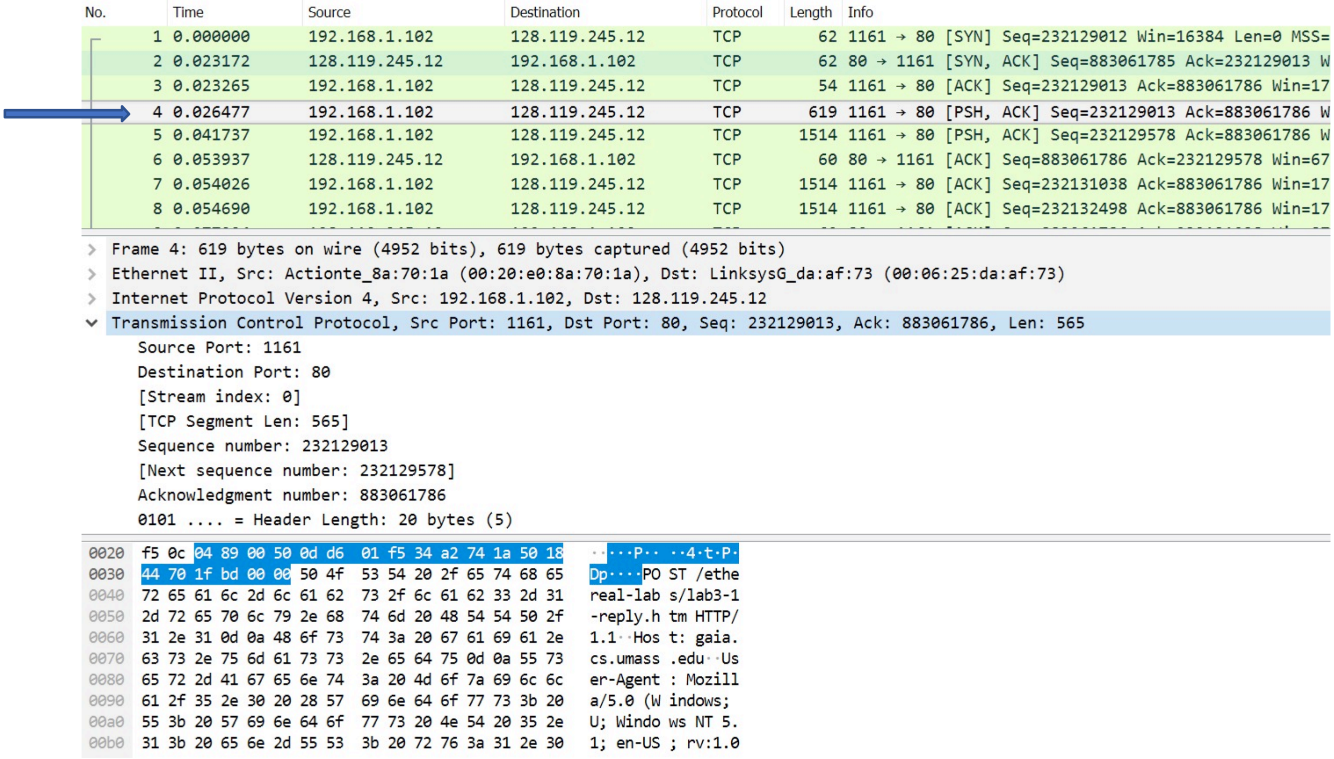


```
No.   Time      Source          Destination     Protocol Length Info
    1 0.000000  192.168.1.102   128.119.245.12  TCP        62 1161 → 80 [SYN] Seq=232129012
    2 0.023172  128.119.245.12  192.168.1.102   TCP        62 80 → 1161 [SYN, ACK] Seq=88306
    3 0.023265  192.168.1.102   128.119.245.12  TCP        54 1161 → 80 [ACK] Seq=232129013
    4 0.026477  192.168.1.102   128.119.245.12  TCP       619 1161 → 80 [PSH, ACK] Seq=23212
    5 0.041737  192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=23212
    6 0.053937  128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786
    7 0.054026  192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232131038
    8 0.054690  192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232132498
    9 0.077294  128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786
   10 0.077405  192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232133958
   11 0.078157  192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232135418
   12 0.124085  128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786

> Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 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
v Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129012, Len: 0
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 232129012
    [Next sequence number: 232129012]
    Acknowledgment number: 0
    0111 .... = Header Length: 28 bytes (7)
  > Flags: 0x002 (SYN)
    Window size value: 16384
    [Calculated window size: 16384]
```

Question 2. What is the sequence number of the TCP segment containing the HTTP POST command? Note that in order to find the POST command, you'll need to dig into the packet content field at the bottom of the Ethereal window, looking for a segment with a "POST" within its DATA field.

No. 4 segment is the TCP segment containing the HTTP POST command. The sequence number: 232129013.



```
No.     Time       Source           Destination      Protocol  Length  Info
  1 0.000000   192.168.1.102    128.119.245.12   TCP         62 1161 → 80 [SYN] Seq=232129012 Win=16384 Len=0 MSS=
  2 0.023172   128.119.245.12   192.168.1.102    TCP         62 80 → 1161 [SYN, ACK] Seq=883061785 Ack=232129013 W
  3 0.023265   192.168.1.102    128.119.245.12   TCP         54 1161 → 80 [ACK] Seq=232129013 Ack=883061786 Win=17
  4 0.026477   192.168.1.102    128.119.245.12   TCP        619 1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 W
  5 0.041737   192.168.1.102    128.119.245.12   TCP       1514 1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 W
  6 0.053937   128.119.245.12   192.168.1.102    TCP         60 80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=67
  7 0.054026   192.168.1.102    128.119.245.12   TCP       1514 1161 → 80 [ACK] Seq=232131038 Ack=883061786 Win=17
  8 0.054690   192.168.1.102    128.119.245.12   TCP       1514 1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17

> Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 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
v Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129013, Ack: 883061786, Len: 565
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 565]
    Sequence number: 232129013
    [Next sequence number: 232129578]
    Acknowledgment number: 883061786
    0101 .... = Header Length: 20 bytes (5)

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.h tm HTTP/
0060  31 2e 31 0d 0a 48 6f 73  74 3a 20 67 61 69 61 2e   1.1··Hos t: gaia.
0070  63 73 2e 75 6d 61 73 73  2e 65 64 75 0d 0a 55 73   cs.umass .edu··Us
0080  65 72 2d 41 67 65 6e 74  3a 20 4d 6f 7a 69 6c 6c   er-Agent : Mozill
0090  61 2f 35 2e 30 20 28 57  69 6e 64 6f 77 73 3b 20   a/5.0 (W indows; 
00a0  55 3b 20 57 69 6e 64 6f  77 73 20 4e 54 20 35 2e   U; Windo ws NT 5.
00b0  31 3b 20 65 6e 2d 55 53  3b 20 72 76 3a 31 2e 30   1; en-US ; rv:1.0
```

Question 3. 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) sent from the client to the web server (Do not consider the ACKs received from the server as part of these six segments)? 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 *EstimatedRTT*value (see relevant parts of Section 3.5 or lecture slides) after the receipt of each ACK? Assume that the initial value of *EstimatedRTT* is equal to the measured RTT (*SampleRTT*) for the first segment, and then is computed using the *EstimatedRTT* equation for all subsequent segments. Set alpha to 0.125.

	Sequence Num	Segment Sent (sec)	ACK Receive (sec)	RTT (sec)
Segment 1(No.4)	232129013	0.026477	0.053937	0.027460
Segment 2(No.5)	232129578	0.041737	0.077294	0.035557
Segment 3(No.7)	232131038	0.054026	0.124085	0.070059
Segment 4(No.8)	232132498	0.054690	0.169118	0.114428
Segment 5(No.10)	232133958	0.077405	0.217299	0.139894
Segment 6(No.11)	232135418	0.078157	0.267802	0.189645

EstimatedRTT = EstimatedRTT * (1-0.125) + 0.125 * SampleRTT

Segment 1: EstimatedRTT = 0.02746 second

Segment 2: EstimatedRTT = 0.02746 * 0.875 + 0.125 * 0.035557 = 0.02847 second

Segment 3: EstimatedRTT = 0.02847 * 0.875 + 0.125 * 0.070059 = 0.03367 second

Segment 4: EstimatedRTT = 0.03367 * 0.875 + 0.125 * 0.114428 = 0.04376 second

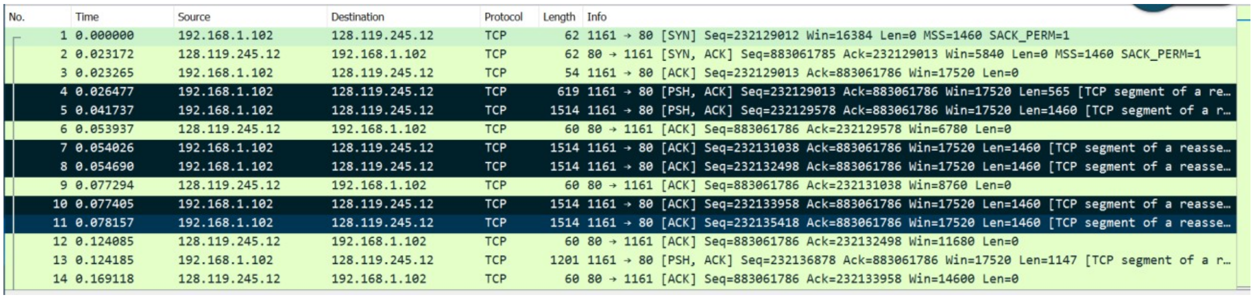
Segment 5: EstimatedRTT = 0.04376 * 0.875 + 0.125 * 0.139894 = 0.05578 second

Segment 6: EstimatedRTT = 0.05578 * 0.875 + 0.125 * 0.189645 = 0.07251 second

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

Segment 1: 565 bytes

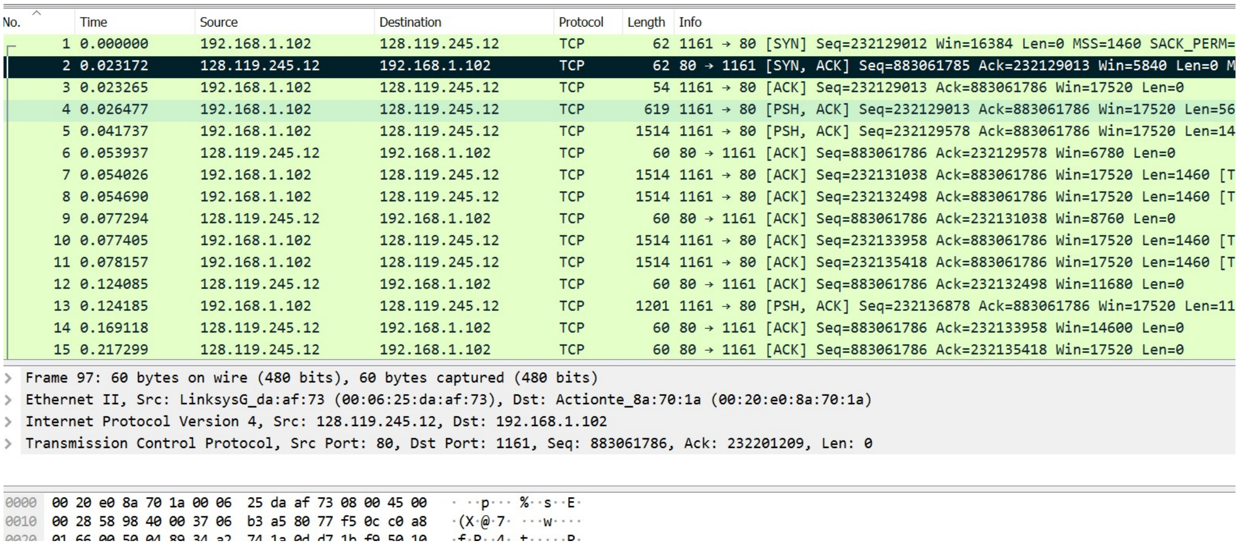
Segment 2~6: 1460 bytes



```
No.   Time       Source          Destination     Protocol Length Info
   1 0.000000   192.168.1.102   128.119.245.12  TCP        62 1161 → 80 [SYN] Seq=232129012 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=883061785 Ack=232129013 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=232129013 Ack=883061786 Win=17520 Len=0
   4 0.026477   192.168.1.102   128.119.245.12  TCP       619 1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 Win=17520 Len=565 [TCP segment of a re…
   5 0.041737   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=17520 Len=1460 [TCP segment of a r…
   6 0.053937   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0
   7 0.054026   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232131038 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reasse…
   8 0.054690   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reasse…
   9 0.077294   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=8760 Len=0
  10 0.077405   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232133958 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reasse…
  11 0.078157   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232135418 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reasse…
  12 0.124085   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0
  13 0.124185   192.168.1.102   128.119.245.12  TCP      1201 1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 Win=17520 Len=1147 [TCP segment of a r…
  14 0.169118   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232133958 Win=14600 Len=0
```

Question 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?

The minimum amount of available buffer space at the receiver for the entire trace is 5840 bytes. The buffer space grows steadily and the maximum receiver buffer size is 62780 bytes. Thus, the sender never throttle.



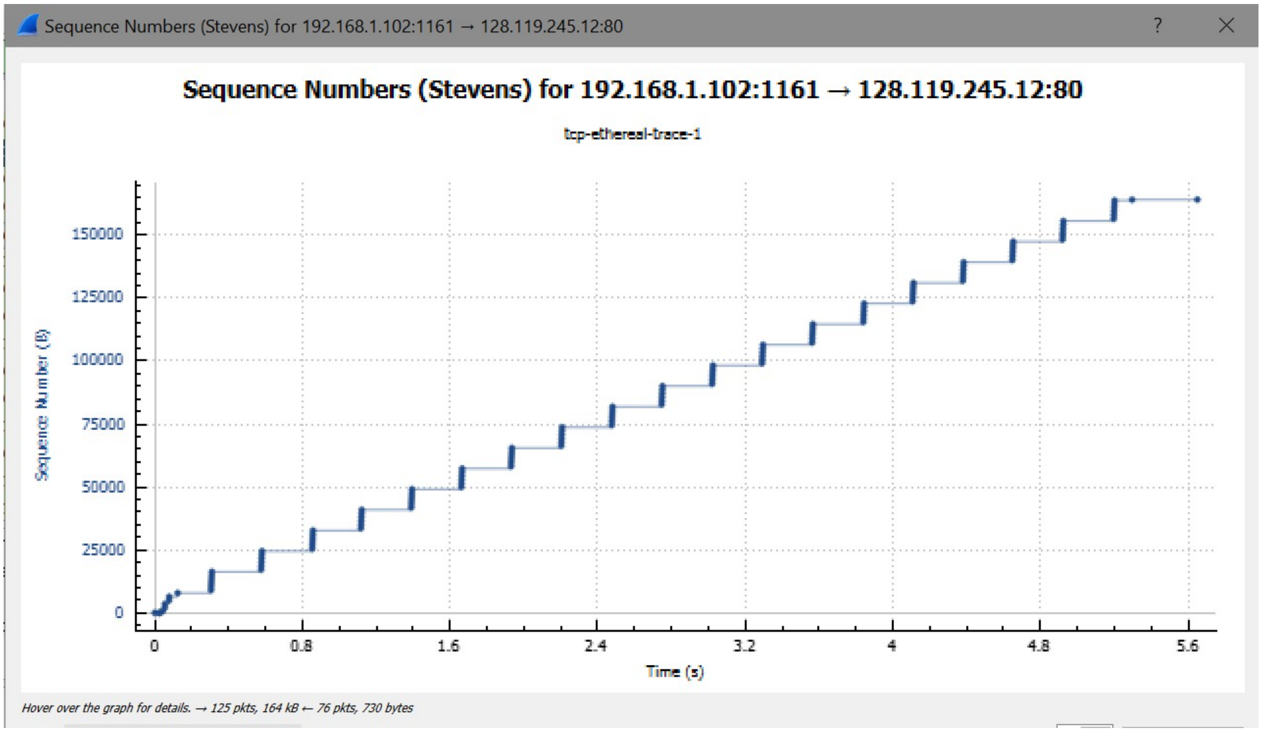
```
No.   Time       Source          Destination     Protocol Length Info
   1 0.000000   192.168.1.102   128.119.245.12  TCP        62 1161 → 80 [SYN] Seq=232129012 Win=16384 Len=0 MSS=1460 SACK_PERM=
   2 0.023172   128.119.245.12  192.168.1.102   TCP        62 80 → 1161 [SYN, ACK] Seq=883061785 Ack=232129013 Win=5840 Len=0 M
   3 0.023265   192.168.1.102   128.119.245.12  TCP        54 1161 → 80 [ACK] Seq=232129013 Ack=883061786 Win=17520 Len=0
   4 0.026477   192.168.1.102   128.119.245.12  TCP       619 1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 Win=17520 Len=56
   5 0.041737   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=17520 Len=14
   6 0.053937   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0
   7 0.054026   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232131038 Ack=883061786 Win=17520 Len=1460 [T
   8 0.054690   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17520 Len=1460 [T
   9 0.077294   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=8760 Len=0
  10 0.077405   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232133958 Ack=883061786 Win=17520 Len=1460 [T
  11 0.078157   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=232135418 Ack=883061786 Win=17520 Len=1460 [T
  12 0.124085   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=11680 Len=0
  13 0.124185   192.168.1.102   128.119.245.12  TCP      1201 1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 Win=17520 Len=11
  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 0.217299   128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0

> Frame 97: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
> Ethernet II, Src: LinksysG_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: 883061786, Ack: 232201209, Len: 0

0000  00 20 e0 8a 70 1a 00 06  25 da af 73 08 00 45 00   · ··p··· %··s··E·
0010  00 28 58 98 40 00 37 06  b3 a5 80 77 f5 0c c0 a8   ·(X·@·7· ···w····
0020  01 66 00 50 04 89 34 a2  74 1a 0d d7 1b f9 50 10   ·f·P··4· t·····P·
```

Question 6. 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 no retransmitted segments in the trace file. I was checking the segment sequence number by using Sequence Numbers (Stevens) graphics. The sequence number form the client to the server is increasing. If any segments retransmitted, the sequence number should be smaller than its neighboring segments.


Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80

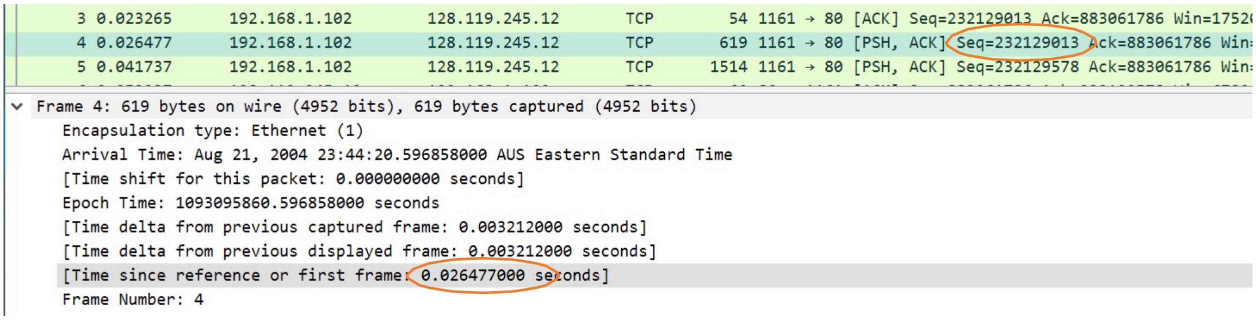
Hover over the graph for details. → 125 pkts, 164 kB ← 76 pkts, 730 bytes

Question 7. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (recall the discussion about delayed acks from the lecture notes or Section 3.5 of the text).

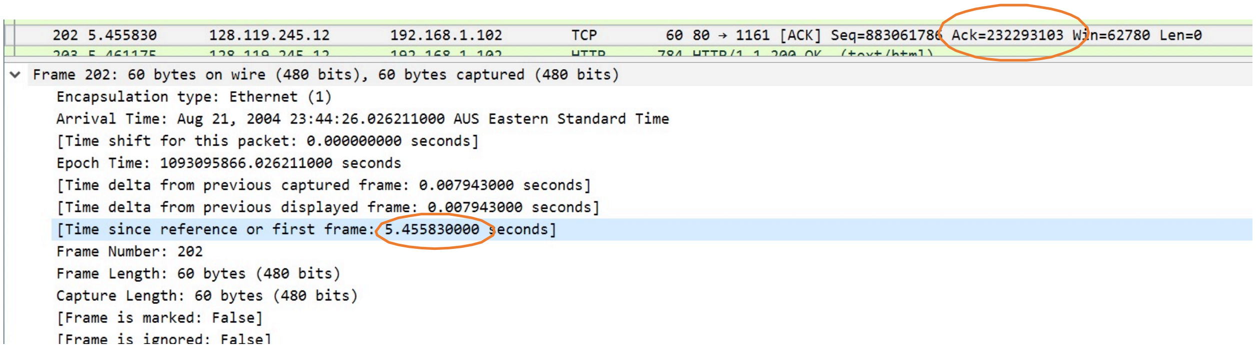
The typically acknowledge is 1460 bytes. In the early part of the trace file, we noticed that the receiver individually confirmed each packet. Observe the behavior of the sender sending a packet burst, and then the receiver sends back an ACK for each packet. However, later in the trace, especially at segment number 70, we will notice that the ACK with the acknowledgment field of 232176633 actually acknowledges the two segments with sequences 232173713 and 232175173. From this point on, the receiver sends an acknowledgment packet received by each. other. The receiver typically sends a cumulative ACK of the two TCP segments it receives. This is because TCP uses a delayed ACK where the receiver waits up to 500 milliseconds, the other arrives at the order segment, and then sends the accumulated ACK for the two segments received.

Question 8. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

The total bytes transferred is the last ACK number – the first sequence number, which is 232293103 – 232129013 = 164090 bytes. Therefore, the throughput is total data/total time = 164090 / (5.455830-0.026477) = 30.222 Kbyte/sec.



```
  3 0.023265      192.168.1.102        128.119.245.12       TCP        54 1161 → 80 [ACK] Seq=232129013 Ack=883061786 Win=1752
  4 0.026477      192.168.1.102        128.119.245.12       TCP       619 1161 → 80 [PSH, ACK] Seq=232129013 Ack=883061786 Win=
  5 0.041737      192.168.1.102        128.119.245.12       TCP      1514 1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=
Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 bits)
    Encapsulation type: Ethernet (1)
    Arrival Time: Aug 21, 2004 23:44:20.596858000 AUS Eastern Standard Time
    [Time shift for this packet: 0.000000000 seconds]
    Epoch Time: 1093095860.596858000 seconds
    [Time delta from previous captured frame: 0.003212000 seconds]
    [Time delta from previous displayed frame: 0.003212000 seconds]
    [Time since reference or first frame: 0.026477000 seconds]
    Frame Number: 4
```



```
 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)
Frame 202: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
    Encapsulation type: Ethernet (1)
    Arrival Time: Aug 21, 2004 23:44:26.026211000 AUS Eastern Standard Time
    [Time shift for this packet: 0.000000000 seconds]
    Epoch Time: 1093095866.026211000 seconds
    [Time delta from previous captured frame: 0.007943000 seconds]
    [Time delta from previous displayed frame: 0.007943000 seconds]
    [Time since reference or first frame: 5.455830000 seconds]
    Frame Number: 202
    Frame Length: 60 bytes (480 bits)
    Capture Length: 60 bytes (480 bits)
    [Frame is marked: False]
    [Frame is ignored: False]
```

Exercise 2: TCP Connection Management

Question 1 . What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and server?

Sequence number: 2818463618

Question 2. What is the sequence number of the SYNACK segment sent by the server to the client computer in reply to the SYN? What is the value of the Acknowledgement field in the SYNACK segment? How did the server determine that value?

Sequence number: 1247095790

ACK: 2818463619

TCP is using 3-way handshake to set up a connection. SYNACK means initiating a connection. The client maintains a 32-bit sequence number to keep track of how much data it has sent. When a host initials a TCP session, its initial sequence number is effectively random. It may be any value between 0 and 4,294,967,295, inclusive. In the initial connection, the client would try to send one byte data to check the connection is done or not. Thus, the ACK is the current sequence number in client plus one.

Question 3 . What is the sequence number of the ACK segment sent by the client computer in response to the SYNACK? What is the value of the Acknowledgment field in this ACK segment? Does this segment contain any data?

Sequence number: 2818463619

The ACK: 1247095791

The segment does not contain any data because the line 301, the sequence number is 1247095791.

Question 4 . Who has done the active close? client or the server? how you have determined this? What type of closure has been performed? 3 Segment (FIN/FINACK/ACK), 4 Segment (FIN/ACK/FIN/ACK) or Simultaneous close?

Client and server has done the active close. In line 304 and line 305, they both sent FIN ACK before they receive FIN from the other side. Thus, this is Simultaneous close.

Question 5 . How many data bytes have been transferred from the client to the server and from the server to the client during the whole duration of the connection? What relationship does this have with the Initial Sequence Number and the final ACK received from the other side?

The data form the client to the server is 33 bytes and the data from server to client is 40 bytes.

The different of Initial Sequence Number and the final ACK received form the other side is the same as the data transfer though the connection.