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? To answer this question, it's probably easiest to select an HTTP message and explore the details of the TCP packet used to carry this HTTP message, using the "details of the selected packet header window" (refer to Figure 2 in the "Getting Started with Wireshark" Lab if you're uncertain about the Wireshark windows).

Ans: IP address:192.168.1.102 TCP port:1161

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 0.026477	192.168.1.102	128.119.245.12	TCP	619 [TCP segment of a reassembled PDU]
5 0.041737	192.168.1.102	128.119.245.12	TCP	1514 [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 [TCP segment of a reassembled PDU]
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]

▷ 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
▷ Transmission Control Protocol, Src Port: 1161 (1161), Dst Port: 80 (80), Seq: 0, Len: 0

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?

Ans: IP address:128.119.245.12 TCP port:80

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 0.026477	192.168.1.102	128.119.245.12	TCP	619 [TCP segment of a reassembled PDU]
5 0.041737	192.168.1.102	128.119.245.12	TCP	1514 [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 [TCP segment of a reassembled PDU]
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]

▷ Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 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 (80), Dst Port: 1161 (1161), Seq: 0, Ack: 1, Len: 0

If you have been able to create your own trace, answer the following question:

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?

ANS: IP address :10.211.55.7 TCP port:49265

13 0.999025	10.211.55.7	128.119.245.12	TCP	66 49265 → 80 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
15 1.274570	128.119.245.12	10.211.55.7	TCP	62 80 → 49265 [SYN, ACK] Seq=0 Ack=1 Win=32768 Len=0 MSS=1460 WS=2
16 1.274632	10.211.55.7	128.119.245.12	TCP	54 49265 → 80 [ACK] Seq=1 Ack=1 Win=65536 Len=0
18 1.276919	128.119.245.12	10.211.55.7	TCP	60 80 → 49265 [ACK] Seq=1 Ack=637 Win=32768 Len=0
19 1.277081	10.211.55.7	128.119.245.12	TCP	2974 49265 → 80 [ACK] Seq=637 Ack=1 Win=65536 Len=2920
20 1.277337	128.119.245.12	10.211.55.7	TCP	60 80 → 49265 [ACK] Seq=1 Ack=2097 Win=32768 Len=0
21 1.277338	128.119.245.12	10.211.55.7	TCP	60 80 → 49265 [ACK] Seq=1 Ack=3557 Win=32768 Len=0
22 1.277354	10.211.55.7	128.119.245.12	TCP	5894 49265 → 80 [ACK] Seq=3557 Ack=1 Win=65536 Len=5840

▷ Frame 13: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0
▷ Ethernet II, Src: Parallel_6f:2a:4c (00:1c:42:6f:2a:4c), Dst: Parallel_00:00:18 (00:1c:42:00:00:18)
▷ Internet Protocol Version 4, Src: 10.211.55.7, Dst: 128.119.245.12
◢ Transmission Control Protocol, Src Port: 49265 (49265), Dst Port: 80 (80), Seq: 0, Len: 0

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?
ANS: sequence number: 0   Syn Set = 1 identifies the segment as a SYN segment

```
    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 0.026477      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=1460
    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
    8 0.054690      192.168.1.102      128.119.245.12     TCP    1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
    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
   11 0.078157      192.168.1.102      128.119.245.12     TCP    1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460
```

```
  Sequence number: 0    (relative sequence number)
  Acknowledgment number: 0
  Header Length: 28 bytes
⊿ Flags: 0x002 (SYN)
     000. .... .... = Reserved: Not set
     ...0 .... .... = Nonce: Not set
     .... 0... .... = Congestion Window Reduced (CWR): Not set
     .... .0.. .... = ECN-Echo: Not set
     .... ..0. .... = Urgent: Not set
     .... ...0 .... = Acknowledgment: Not set
     .... .... 0... = Push: Not set
     .... .... .0.. = Reset: Not set
   ▷ .... .... ..1. = Syn: Set
     .... .... ...0 = Fin: Not set
     [TCP Flags: **********S*]
```

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?

ANS: The sequence number: 0

        ACKnowledgement number : 1 which is sequence number plus 1

        Both the sequence flag and the ACKnowledgement flag been set as 1, identifies
the segment as SYNACK segment.

```
    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 0.026477      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=1460
    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
    8 0.054690      192.168.1.102      128.119.245.12     TCP    1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
    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
   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 Len: 0]
  Sequence number: 0    (relative sequence number)
  Acknowledgment number: 1    (relative ack number)
  Header Length: 28 bytes
⊿ Flags: 0x012 (SYN, ACK)
     000. .... .... = Reserved: Not set
     ...0 .... .... = Nonce: Not set
     .... 0... .... = Congestion Window Reduced (CWR): Not set
     .... .0.. .... = ECN-Echo: Not set
     .... ..0. .... = Urgent: Not set
     .... ...1 .... = Acknowledgment: Set
     .... .... 0... = Push: Not set
     .... .... .0.. = Reset: Not set
   ▷ .... .... ..1. = Syn: Set
     .... .... ...0 = Fin: Not set
```

6. 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 Wireshark window, looking for a segment with a "POST" within its
DATA field.

Ans: The sequence number : 1

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=1460
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
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460
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
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460

```
▷ 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
▲ Transmission Control Protocol, Src Port: 1161 (1161), Dst Port: 80 (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)
    [Next sequence number: 566    (relative sequence number)]
    Acknowledgment number: 1    (relative ack number)
    Header Length: 20 bytes
  ▷ Flags: 0x018 (PSH, ACK)
```

```
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
```

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 EstimatedRTT value (see page 249 in text) after the receipt of each ACK? Assume that the value of the EstimatedRTT is equal to the measured RTT for the first segment, and then is computed using the EstimatedRTT equation on page 249 for all subsequent segments.
Note: Wireshark has a nice feature that allows you to plot the RTT for each of the TCP segments sent. Select a TCP segment in the "listing of captured packets" window that is being sent from the client to the gaia.cs.umass.edu server. Then select: Statistics->TCP Stream Graph- >Round Trip Time Graph.

199 5.297341	192.168.1.102	128.119.245.12	HTTP	104 POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
200 5.389471	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
201 5.447887	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
202 5.455830	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=164091 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
205 5.599082	192.168.1.100	192.168.1.1	SSDP	175 M-SEARCH * HTTP/1.1
206 5.651141	192.168.1.102	128.119.245.12	TCP	54 1161 → 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0

```
▷ 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 (1161), Dst Port: 80 (80), Seq: 164041, Ack: 1, Len: 50
▲ [122 Reassembled TCP Segments (164090 bytes): #4(565), #5(1460), #7(1460), #8(1460), #10(1460), #11(1460), #13(1147), #18(1460), #19(1460), #20(1460), #21(
    [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)]
```

4 0.026477	192.168.1.102	128.119.245.12	TCP	619 [TCP segment of a reassembled PDU]
5 0.041737	192.168.1.102	128.119.245.12	TCP	1514 [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 [TCP segment of a reassembled PDU]
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]

▷ 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
▲ Transmission Control Protocol, Src Port: 1161 (1161), Dst Port: 80 (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)
    [Next sequence number: 566   (relative sequence number)]
    Acknowledgment number: 1   (relative ack number)
    Header Length: 20 bytes
▷ Flags: 0x018 (PSH, ACK)

Segment 1

5 0.041737	192.168.1.102	128.119.245.12	TCP	1514 [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 [TCP segment of a reassembled PDU]
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]

▷ 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 (1161), Dst Port: 80 (80), Seq: 566, Ack: 1, Len: 1460
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 1460]
    Sequence number: 566   (relative sequence number)
    [Next sequence number: 2026   (relative sequence number)]
    Acknowledgment number: 1   (relative ack number)
    Header Length: 20 bytes

Segment 2

7 0.054026	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]

▷ Frame 7: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 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 (1161), Dst Port: 80 (80), Seq: 2026, Ack: 1, Len: 1460
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 1460]
    Sequence number: 2026   (relative sequence number)
    [Next sequence number: 3486   (relative sequence number)]
    Acknowledgment number: 1   (relative ack number)
    Header Length: 20 bytes

Segment 3

8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]

▷ Frame 8: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 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 (1161), Dst Port: 80 (80), Seq: 3486, Ack: 1, Len: 1460
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 1460]
    Sequence number: 3486   (relative sequence number)
    [Next sequence number: 4946   (relative sequence number)]
    Acknowledgment number: 1   (relative ack number)

Segment 4

10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	
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 [TCP segment of a reassembled PDU]	

▷ Frame 10: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 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 (1161), Dst Port: 80 (80), Seq: 4946, Ack: 1, Len: 1460
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 1460]
    Sequence number: 4946   (relative sequence number)
    [Next sequence number: 6406   (relative sequence number)]

Segment 5

11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	
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 [TCP segment of a reassembled PDU]	

▷ Frame 11: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 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 (1161), Dst Port: 80 (80), Seq: 6406, Ack: 1, Len: 1460
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 1460]
    Sequence number: 6406   (relative sequence number)
    [Next sequence number: 7866   (relative sequence number)]

Segment 6

4 0.026477	192.168.1.102	128.119.245.12	TCP	619 [TCP segment of a reassembled PDU]	
5 0.041737	192.168.1.102	128.119.245.12	TCP	1514 [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 [TCP segment of a reassembled PDU]	
8 0.054690	192.168.1.102	128.119.245.12	TCP	1514 [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=8760 Len=0	
10 0.077405	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	
11 0.078157	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	
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 [TCP segment of a reassembled PDU]	
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	
16 0.267802	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0	
17 0.304807	128.119.245.12	192.168.1.102	TCP	60 80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0	
18 0.305040	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	
19 0.305813	192.168.1.102	128.119.245.12	TCP	1514 [TCP segment of a reassembled PDU]	

ANS:

	Sequence number	Sent time	ACK received time	RTT	EstimatedRTT value	Length /bytes
Segment 1	1	0.026477	0.053937	0.02746	0.02746	565
Segment 2	566	0.041737	0.077294	0.035557	0.028472	1460
Segment 3	2026	0.054026	0.124085	0.070059	0.033670	1460
Segment 4	3486	0.054690	0.169118	0.11443	0.043765	1460
Segment 5	4946	0.077405	0.217299	0.13989	0.055781	1460
Segment 6	6406	0.078157	0.267802	0.18964	0.072513	1460

EstimatedRTT = 0.875 * Last EstimatedRTT + 0.125 * sample RTT
After Segment 1 : EstimatedRTT = 0.02746
After Segment 2 : EstimatedRTT = 0.875 * 0.02746 + 0.125*0.035557 = 0.028472
After Segment 3 : EstimatedRTT = 0.875 * 0.028472 + 0.125*0.070059 = 0.033670
After Segment 4 : EstimatedRTT = 0.875 * 0.033670 + 0.125*0.11443 = 0.043765
After Segment 5 : EstimatedRTT = 0.875 * 0.043765 + 0.125*0.13989 = 0.055781
After Segment 6 : EstimatedRTT = 0.875 * 0.055781 + 0.125*0.18964 = 0.072513

8. What is the length of each of the first six TCP segments?(see Q7)

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 thesender?
ANS:The minimum amount of buffer space (receiver window) advertised at gaia.cs.umass.edu for the entire trace is 5840 bytes;
This receiver window grows steadily until a maximum receiver buffer size of 62780 bytes.
The sender is never throttled due to lacking of receiver buffer space by inspecting this trace.

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 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	0.026477	192.168.1.102	128.119.245.12	TCP	619	[TCP segment of a reassembled PDU]
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	[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	[TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	[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=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	[TCP segment of a reassembled PDU]
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0

10. Are there any retransmitted segments in the trace file? What did you check for (in the trace) in order to answer this question?
ANS: There are no retransmitted segments in the trace file. We can verify this by checking the sequence numbers of the TCP segments in the trace file. All sequence numbers are increasing.so there is no retramstmitted segment.

Sequence Numbers (Stevens) for 192.168.1.102:1161 → 128.119.245.12:80
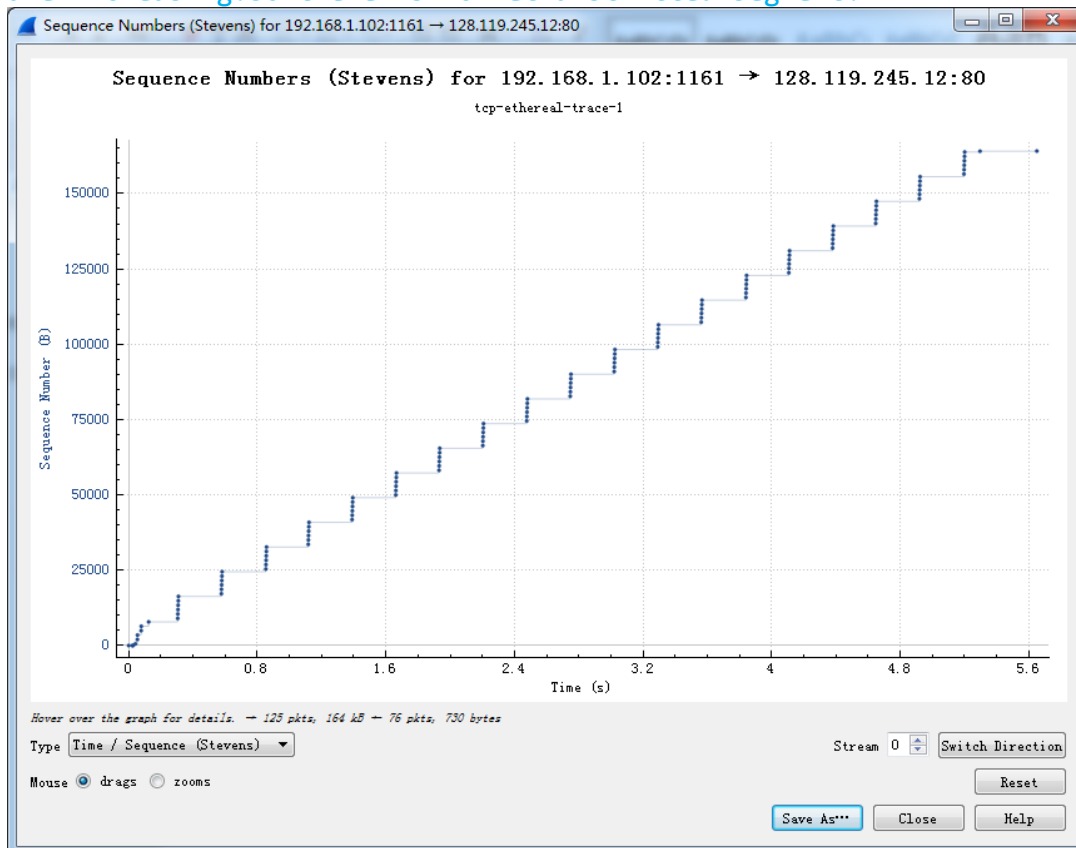
11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 257 in the text).

▲ [122 Reassembled TCP Segments (164090 bytes): #4(56
   [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)]
   [Frame: 13, payload: 7865-9011 (1147 bytes)]
   [Frame: 18, payload: 9012-10471 (1460 bytes)]
   [Frame: 19, payload: 10472-11931 (1460 bytes)]
   [Frame: 20, payload: 11932-13391 (1460 bytes)]
   [Frame: 21, payload: 13392-14851 (1460 bytes)]
   [Frame: 22, payload: 14852-16311 (1460 bytes)]
   [Frame: 23, payload: 16312-17203 (892 bytes)]
   [Frame: 30, payload: 17204-18663 (1460 bytes)]
   [Frame: 31, payload: 18664-20123 (1460 bytes)]
   [Frame: 32, payload: 20124-21583 (1460 bytes)]
   [Frame: 33, payload: 21584-23043 (1460 bytes)]
   [Frame: 34, payload: 23044-24503 (1460 bytes)]
   [Frame: 35, payload: 24504-25395 (892 bytes)]

ANS: According to this screenshot, the data received by the server between these two ACKs is 1460bytes. there are cases where the receiver is ACKing every other segment 2920 bytes = 1460*2 bytes. For 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. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

ANS: total amount data = 164091 - 1 = 164090 bytes

      #164091 bytes for NO.202 segment and 1 bytes for NO.4 segment

      Total transmission time = 5.455830 – 0.026477 = 5.4294

So the throughput for the TCP connection is computed as 164090/5.4294 = 30.222 KByte/sec.

| 4 0.026477 | 192.168.1.102 | 128.119.245.12 | TCP | 619 [TCP segment of a reassembled PDU] |
| 202 5.455830 | 128.119.245.12 | 192.168.1.102 | TCP | 60 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0 |

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.
ANS: Slow start begins when HTTP POST segment begins. But we can't identify where TCP's slow start phase ends, and where congestion avoidance takes over.
14. Answer each of two questions above for the trace that you have gathered when you transferred a file from your computer to gaia.cs.umass.edu
ANS: Slow start begins when HTTP POST segment begins. But we can't identify where TCP's slow start phase ends, and where congestion avoidance takes over.