



# COMPUTER NETWORKS ASSIGNMENT 1

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1) What is the IP address and TCP port number used by the client computer (source) that is transferring the alice.txt 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"(refertoFigure 2 in the "Getting Started with Wireshark" Lab if you're uncertain about the Wireshark windows).

| No. | Time     | Source         | Destination    | Protocol | Length | Info   |
|-----|----------|----------------|----------------|----------|--------|--|
| 189 | 5.106121 | 192.168.1.100  | 192.168.1.1    | SSDP     | 175    | M-SEARCH * HTTP/1.1                                    |
| 199 | 5.297341 | 192.168.1.102  | 128.119.245.12 | HTTP     | 104    | POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/pl |
| 203 | 5.461175 | 128.119.245.12 | 192.168.1.102  | HTTP     | 784    | HTTP/1.1 200 OK (text/html)                            |

|   |
|---|
| 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 (192.168.1.102), Dst: 128.119.245.12 (128.119.245.12)             |
| Transmission Control Protocol, Src Port: health-polling (1161), Dst Port: http (80), Seq: 164041, Ack: 1, Len: 50 |
| Source port: health-polling (1161)  |
| Destination port: http (80)   |
| [Stream index: 0]   |
| Sequence number: 164041 (relative sequence number)  |
| [Next sequence number: 164091 (relative sequence number)]   |
| Acknowledgment number: 1 (relative ack number)  |
| Header length: 20 bytes   |

According to above figure, the client computer (source)'s IP address is 192.168.1.102 and the TPC port number is 1161.

What is the IP address of gaia.cs.umass.edu? On what port number is it sending andreceiving TCP segments for this connection?

|     |          |                |                |      |     |   |
|-----|----------|----------------|----------------|------|-----|---|
| 189 | 5.106121 | 192.168.1.100  | 192.168.1.1    | SSDP | 175 | M-SEARCH * HTTP/1.1                                     |
| 199 | 5.297341 | 192.168.1.102  | 128.119.245.12 | HTTP | 104 | POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/pla |
| 203 | 5.461175 | 128.119.245.12 | 192.168.1.102  | HTTP | 784 | HTTP/1.1 200 OK (text/html)                             |

|  |
|--|
| Frame 203: 784 bytes on wire (6272 bits), 784 bytes captured (6272 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 (128.119.245.12), Dst: 192.168.1.102 (192.168.1.102)              |
| Transmission Control Protocol, Src Port: http (80), Dst Port: health-polling (1161), Seq: 1, Ack: 164091, Len: 730 |
| Source port: http (80)   |
| Destination port: health-polling (1161)  |
| [Stream index: 0]  |
| Sequence number: 1 (relative sequence number)  |
| [Next sequence number: 731 (relative sequence number)]   |
| Acknowledgment number: 164091 (relative ack number)  |
| Header length: 20 bytes  |

the IP address of gaia.cs.umass.edu is 128.119.245.12 and the TCP port number is 80

What is the IP address and TCP port number used by your client computer (source) to transfer the file to gaia.cs.umass.edu

| No. | Time       | Source         | Destination    | Protocol | Length | Info   |
|-----|------------|----------------|----------------|----------|--------|--|
| 158 | 1.10679300 | 192.168.1.8    | 128.119.245.12 | HTTP     | 210    | POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1 (text/html) |
| 189 | 1.57893400 | 128.119.245.12 | 192.168.1.8    | HTTP     | 785    | HTTP/1.1 200 OK (text/html)                                |

|  |
|--|
| Frame 158: 210 bytes on wire (1680 bits), 210 bytes captured (1680 bits) on interface 0                    |
| Ethernet II, Src: Apple_1f:d4:56 (b8:e8:56:1f:d4:56), Dst: Tp-Link_f8:6d:f9 (a0:f3:c1:f8:6d:f9)            |
| Internet Protocol Version 4, Src: 192.168.1.8 (192.168.1.8), Dst: 128.119.245.12 (128.119.245.12)          |
| Transmission Control Protocol, Src Port: 60706 (60706), Dst Port: http (80), Seq: 152756, Ack: 1, Len: 144 |
| Source port: 60706 (60706)   |
| Destination port: http (80)  |
| [Stream index: 0]  |
| Sequence number: 152756 (relative sequence number)   |
| [Next sequence number: 152900 (relative sequence number)]  |
| Acknowledgment number: 1 (relative ack number)   |
| Header length: 32 bytes  |

client computer's IP address is 192.168.1.8 and the TCP port is 60706

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?

|   |
|---|
| Frame 1: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface 0                 |
| Ethernet II, Src: Apple_1f:d4:56 (b8:e8:56:1f:d4:56), Dst: Tp-Link_f8:6d:f9 (a0:f3:c1:f8:6d:f9)   |
| Internet Protocol Version 4, Src: 192.168.1.8 (192.168.1.8), Dst: 128.119.245.12 (128.119.245.12) |
| Transmission Control Protocol, Src Port: 60706 (60706), Dst Port: http (80), Seq: 0, Len: 0       |
| Source port: 60706 (60706)  |
| Destination port: http (80)   |
| [Stream index: 0]   |
| Sequence number: 0 (relative sequence number)   |
| Header length: 44 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  |
| Window size value: 65535  |
| [calculated window size: 65535]   |

sequence number of the TCP SYN segment is 0

in the Flags section, the Syn flag is set to 1 which indicates that this segment is a SYN segment

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

| No. | Time       | Source         | Destination    | Protocol | Length | Info  |
|-----|------------|----------------|----------------|----------|--------|---|
| 1   | 0.00000000 | 192.168.1.8    | 128.119.245.12 | TCP      | 78     | 60706 > http [SYN] Seq=0 Win=65535 Len=0 MSS=1460 W5=16 |
| 4   | 0.26949200 | 128.119.245.12 | 192.168.1.8    | TCP      | 74     | http > 60706 [SYN, ACK] Seq=0 Ack=1 win=5792 Len=0 MSS= |

|  |
|--|
| <div> <div>Frame 4: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0</div> <div>Ethernet II, Src: Tp-LinkT_f8:6d:f9 (a0:f3:c1:f8:6d:f9), Dst: Apple_1f:d4:56 (b8:e8:56:1f:d4:56)</div> <div>Internet Protocol Version 4, Src: 128.119.245.12 (128.119.245.12), Dst: 192.168.1.8 (192.168.1.8)</div> <div> <div>Transmission Control Protocol, Src Port: http (80), Dst Port: 60706 (60706), Seq: 0, Ack: 1, Len: 0</div> <div>Source port: http (80)</div> <div>Destination port: 60706 (60706)</div> <div>[Stream index: 0]</div> <div>Sequence number: 0 (relative sequence number)</div> <div>Acknowledgment number: 1 (relative ack number)</div> <div>Header length: 40 bytes</div> <div> <div>Flags: 0x012 (SYN, ACK)</div> <div> <div>000. .... = Reserved: Not set</div> <div>...0 .... = Nonce: Not set</div> <div>... 0... = Congestion window Reduced (CWR): Not set</div> <div>... .0.. = ECN-Echo: Not set</div> <div>... ..0. = Urgent: Not set</div> <div>... ...1... = Acknowledgment: Set</div> <div>... .... 0... = Push: Not set</div> <div>... .... .0.. = Reset: Not set</div> <div>... .... ..1. = Syn: Set</div> <div>... .... ...0 = Fin: Not set</div> </div> <div>Window size value: 5792</div> <div>[calculated window size: 5792]</div> </div> </div> </div> |
|--|

the sequence number of the SYNACK segment sent by gaia.cs.umass.edu to the client computer in reply to the SYN is 0

The value of the acknowledgement field in the SYNACK segment is 1.

value of the Acknowledgement field in the SYNACK segment = 1 + initial sequence number of SYN segment from the client computer.

For this case, the initial sequence number of SYN segment from the client computer is 0, thus the value of the Acknowledgement field in the SYNACK segment is 1.

A segment will be identified as a SYNACK segment if both SYN flag and Acknowledgement in this segment are set to 1

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

| Filter: tcp   |                         | Expression... Clear Apply Save |                |          |            |   |
|---|-------------------------|--------------------------------|----------------|----------|------------|---|
| No.   | Time                    | Source                         | Destination    | Protocol | Length     | Info  |
| 1   | 0.00000000              | 192.168.1.8                    | 128.119.245.12 | TCP      | 78         | 60706 > http [SYN] Seq=0 win=65535 Len=0 MSS=1460 WS=16 |
| 4   | 0.26949200              | 128.119.245.12                 | 192.168.1.8    | TCP      | 74         | http > 60706 [SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS= |
| 5   | 0.26960900              | 192.168.1.8                    | 128.119.245.12 | TCP      | 66         | 60706 > http [ACK] Seq=1 Ack=1 win=131760 Len=0 TSval=8 |
| 6   | 0.27125700              | 192.168.1.8                    | 128.119.245.12 | TCP      | 644        | 60706 > http [PSH, ACK] Seq=1 Ack=1 Win=131760 Len=578  |
| 7   | 0.27142500              | 192.168.1.8                    | 128.119.245.12 | TCP      | 203        | 60706 > http [PSH, ACK] Seq=579 Ack=1 win=131760 Len=13 |
| 8   | 0.27179700              | 192.168.1.8                    | 128.119.245.12 | TCP      | 1514       | 60706 > http [ACK] Seq=716 Ack=1 Win=131760 Len=1448 TS |
| Frame 6: 644 bytes on wire (5152 bits), 644 bytes captured (5152 bits) on interface 0                 |                         |                                |                |          |            |   |
| Ethernet II, Src: Apple_1f:d4:56 (b8:e8:56:1f:d4:56), Dst: Tp-LinkT_f8:6d:f9 (a0:f3:c1:f8:6d:f9)      |                         |                                |                |          |            |   |
| Internet Protocol version 4, Src: 192.168.1.8 (192.168.1.8), Dst: 128.119.245.12 (128.119.245.12)     |                         |                                |                |          |            |   |
| Transmission Control Protocol, Src Port: 60706 (60706), Dst Port: http (80), Seq: 1, Ack: 1, Len: 578 |                         |                                |                |          |            |   |
| Source port: 60706 (60706)  |                         |                                |                |          |            |   |
| Destination port: http (80)   |                         |                                |                |          |            |   |
| [Stream index: 0]   |                         |                                |                |          |            |   |
| Sequence number: 1 (relative sequence number)   |                         |                                |                |          |            |   |
| [Next sequence number: 579 (relative sequence number)]  |                         |                                |                |          |            |   |
| Acknowledgment number: 1 (relative ack number)  |                         |                                |                |          |            |   |
| Header length: 32 bytes   |                         |                                |                |          |            |   |
| Flags: 0x018 (PSH, 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   |                         |                                |                |          |            |   |
| .... .... = Push: Set   |                         |                                |                |          |            |   |
| .... ...0. = Reset: NOT SET   |                         |                                |                |          |            |   |
| 0000  | a0 f3 c1 f8 6d f9 b8 e8 | 56 1f d4 56 08 00 45 00        | ...            | m...     | V..V..E.   |   |
| 0010  | 02 76 f6 5a 40 00 40 06 | 0a f3 c0 a8 01 08 80 77        | ...            | V.20.0.  | .....W     |   |
| 0020  | f5 0c ed 22 00 50 1f e9 | a7 e8 79 47 80 0a 80 18        | ...            | .P..     | ..yG....   |   |
| 0030  | 20 2b bf 08 00 00 01 01 | 08 0a 05 16 f8 ee 86 ca        | +              | .....    | .....      |   |
| 0040  | ee 56 50 4f 53 54 20 2f | 77 69 72 65 73 68 61 72        | .              | VPOST    | / wireshar |   |
| 0050  | 6b 2d 6c 61 62 73 2f 6c | 61 62 33 2d 31 2d 72 65        | k-Tabs/1       | ab3-1-re |            |   |
| 0060  | 70 6c 79 2e 68 74 6d 20 | 48 54 54 50 2f 31 2e 31        | ply.htm        | HTTP/1.1 |            |   |
| 0070  | 0d 0a 48 6f 73 74 3a 20 | 67 61 69 61 2e 63 73 2e        | ..Host:        | gaia.cs. |            |   |
| 0080  | 75 6d 61 73 73 2e 65 64 | 75 0d 0a 43 6f 6e 74 65        | umass.ed       | u..Conte |            |   |
| 0090  | 6e 74 2d 54 79 70 65 3a | 20 6d 75 6c 74 69 70 61        | nt-Type:       | multipa  |            |   |
| 00a0  | 72 74 2f 66 6f 72 6d 2d | 64 61 74 61 3b 20 62 6f        | rt/Form-       | data; bo |            |   |

Segment 6 has http post, its sequence number is 1

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 Section 3.5.3, page 242 in text) after the receipt of each ACK? Assume that the value of the Estimated RTT is equal to the measured RTT for the first segment, and then is computed using the EstimatedRTT equation on page 242 for all subsequent segments.



| No.   | Time                    | Source                     | Destination    | Protocol | Length   | Info  |
|---|-------------------------|----------------------------|----------------|----------|----------|---|
| 5   | 0.26960900              | 192.168.1.8                | 128.119.245.12 | TCP      | 66       | 60706 > http [ACK] Seq=1 Ack=1 win=131760 Len=0 TSval=85  |
| 6   | 0.27125700              | 192.168.1.8                | 128.119.245.12 | TCP      | 644      | 60706 > http [PSH, ACK] Seq=1 Ack=1 win=131760 Len=578 TS |
| 7   | 0.27142500              | 192.168.1.8                | 128.119.245.12 | TCP      | 203      | 60706 > http [PSH, ACK] Seq=579 Ack=1 win=131760 Len=137  |
| 8   | 0.27179700              | 192.168.1.8                | 128.119.245.12 | TCP      | 1514     | 60706 > http [ACK] Seq=716 Ack=1 win=131760 Len=1448 TS   |
| 9   | 0.27179800              | 192.168.1.8                | 128.119.245.12 | TCP      | 1514     | 60706 > http [ACK] Seq=2164 Ack=1 win=131760 Len=1448 TS  |
| 10  | 0.36693100              | 128.119.245.12             | 192.168.1.8    | TCP      | 66       | http > 60706 [ACK] Seq=1 Ack=579 win=7040 Len=0 TSval=22  |
| 11  | 0.36706100              | 192.168.1.8                | 128.119.245.12 | TCP      | 1514     | 60706 > http [ACK] Seq=3612 Ack=1 win=131760 Len=1448 TS  |
| 12  | 0.36728900              | 128.119.245.12             | 192.168.1.8    | TCP      | 66       | http > 60706 [ACK] Seq=1 Ack=716 win=8192 Len=0 TSval=22  |
| 13  | 0.36861700              | 128.119.245.12             | 192.168.1.8    | TCP      | 66       | http > 60706 [ACK] Seq=1 Ack=2164 win=11008 Len=0 TSval=  |
| 14  | 0.36871100              | 192.168.1.8                | 128.119.245.12 | TCP      | 1514     | 60706 > http [ACK] Seq=5060 Ack=1 win=131760 Len=1448 TS  |
| Frame 6: 644 bytes on wire (5152 bits), 644 bytes captured (5152 bits) on interface 0<br>Ethernet II, Src: Apple_1f:d4:56 (b8:e8:56:1f:d4:56), Dst: Tp-Link_f8:6d:f9 (a0:f3:c1:f8:6d:f9)<br>Internet Protocol Version 4, Src: 192.168.1.8 (192.168.1.8), Dst: 128.119.245.12 (128.119.245.12)<br>Transmission Control Protocol, Src Port: 60706 (60706), Dst Port: http (80), Seq: 1, Ack: 1, Len: 578<br>source port: 60706 (60706)<br>Destination port: http (80)<br>[Stream index: 0]<br>Sequence number: 1 (relative sequence number)<br>[Next sequence number: 579 (relative sequence number)]<br>Acknowledgment number: 1 (relative ack number)<br>Header length: 32 bytes<br>Flags: 0x018 (PSH, ACK)<br>000. .... = Reserved: Not set<br>...0 .... = Nonce: Not set<br>.... 0... = Congestion Window Reduced (CWR): Not set<br>.... 0... = ECN-Echo: Not set |                         |                            |                |          |          |   |
| 0000  | a0 f3 c1 f8 6d f9 b8 e8 | 56 1f d4 56 08 00 45 00    | ...            | m...     | V..V..E. |   |
| 0010  | 02 76 f6 5a 40 00 04 06 | 0a f3 c0 a8 01 08 80 77    | ...            | V.Z0.0.  | .....W   |   |
| 0020  | f5 0c ed 22 00 50 1f e9 | a7 e8 79 47 80 0a 80 18    | ...            | ..P..    | ..YG.... |   |
| 0030  | 20 2b bf 08 00 01 01 01 | 08 0a 05 16 f8 ee 86 ca    | +              | .....    | .....    |   |
| 0040  | ee 56 50 4f 53 54 20 2f | 77 69 72 65 73 68 61 72    | ..             | vpost /  | wiresnar |   |
| 0050  | 6b 2d 6c 61 62 73 2f 6c | 61 62 33 2d 31 2d 72 65    | k-             | tabs/1   | ab3-1-re |   |
| 0060  | 70 6c 79 2e 68 74 6d 20 | 48 54 54 50 2f 31 2e 31    | ply.htm        | HTTP/1.1 |          |   |
| 0070  | 0d 0a 48 6f 73 74 3a 20 | 67 61 69 61 2e 63 73 2e    | ..Host:        | gaia.cs. |          |   |
| 0080  | 75 6d 61 73 73 2e 65 64 | 75 0d 0a 43 6f 6e 74 65    | umass.ed       | u..Conte |          |   |
| 0090  | 6e 74 2d 54 79 70 65 3a | 20 6d 75 6c 74 69 70 61    | nt-Type:       | multipa  |          |   |
| 00a0  | 72 74 2f 66 6f 72 6d 2d | 64 61 74 61 61 3b 20 62 6f | rt/form-       | data: bo |          |   |

## Segment 1 to 6

| No.  | Time                    | Source                  | Destination    | Protocol  | Length | Info  |
|--|-------------------------|-------------------------|----------------|-----------|--------|---|
| 10   | 0.36693100              | 128.119.245.12          | 192.168.1.8    | TCP       | 66     | http > 60706 [ACK] Seq=1 Ack=579 win=7040 Len=0 TSval=22  |
| 11   | 0.36706100              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=3612 Ack=1 win=131760 Len=1448 TS  |
| 12   | 0.36728900              | 128.119.245.12          | 192.168.1.8    | TCP       | 66     | http > 60706 [ACK] Seq=1 Ack=716 win=8192 Len=0 TSval=22  |
| 13   | 0.36861700              | 128.119.245.12          | 192.168.1.8    | TCP       | 66     | http > 60706 [ACK] Seq=1 Ack=2164 win=11008 Len=0 TSval=  |
| 14   | 0.36871100              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=5060 Ack=1 win=131760 Len=1448 TS  |
| 15   | 0.36871200              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=6508 Ack=1 win=131760 Len=1448 TS  |
| 16   | 0.36995200              | 128.119.245.12          | 192.168.1.8    | TCP       | 66     | http > 60706 [ACK] Seq=1 Ack=3612 win=13952 Len=0 TSval=  |
| 17   | 0.37006300              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=7956 Ack=1 win=131760 Len=1448 TS  |
| 18   | 0.37006400              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=9404 Ack=1 win=131760 Len=1448 TS  |
| 19   | 0.47996500              | 128.119.245.12          | 192.168.1.8    | TCP       | 66     | http > 60706 [ACK] Seq=1 Ack=3060 win=16896 Len=0 TSval=  |
| 20   | 0.48010500              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=10852 Ack=1 win=131760 Len=1448 TS |
| 21   | 0.48010600              | 192.168.1.8             | 128.119.245.12 | TCP       | 1514   | 60706 > http [ACK] Seq=12300 Ack=1 win=131760 Len=1448 TS |
| 22   | 0.48249200              | 128.119.245.12          | 192.168.1.8    | TCP       | 66     | http > 60706 [ACK] Seq=1 Ack=6508 win=19712 Len=0 TSval=  |
| Frame 10: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0<br>Ethernet II, Src: Tp-Link_f8:6d:f9 (a0:f3:c1:f8:6d:f9), Dst: Apple_1f:d4:56 (b8:e8:56:1f:d4:56)<br>Internet Protocol Version 4, Src: 128.119.245.12 (128.119.245.12), Dst: 192.168.1.8 (192.168.1.8)<br>Transmission Control Protocol, Src Port: http (80), Dst Port: 60706 (60706), Seq: 1, Ack: 579, Len: 0<br>source port: http (80)<br>destination port: 60706 (60706)<br>[Stream index: 0]<br>Sequence number: 1 (relative sequence number)<br>Acknowledgment number: 579 (relative ack number)<br>Header length: 32 bytes<br>Flags: 0x010 (ACK)<br>000. .... = Reserved: Not set<br>...0 .... = Nonce: Not set<br>.... 0... = Congestion Window Reduced (CWR): Not set |                         |                         |                |           |        |   |
| 0000   | b8 e8 56 1f d4 56 a0 f3 | c1 f8 6d f9 08 00 45 00 | ..V..V..       | m...E.    |        |   |
| 0010   | 00 34 6f 2d 40 00 31 06 | a3 62 80 77 f5 0c c0 a8 | ..40-0.1.      | ..b.w...  |        |   |
| 0020   | 01 08 00 50 ed 22 79 47 | 80 0a 1f e9 aa 2a 80 10 | ..P..          | "YG ..... |        |   |
| 0030   | 00 37 1a 82 00 00 01 01 | 08 0a 86 ca ef 27 05 16 | ..f.....       | .....     |        |   |
| 0040   | f8 ee                   |                         | ..             |           |        |   |

## Ack of segments 1 to 6

Segments 1-6 : 6, 7, 8, 9, 11, 14

Ack of segments 1-6 : 10, 12, 13, 16, 19, 22

Segment 1 sequence number is 1

Segment 2 sequence number is 579

Segment 3 sequence number is 716  
 Segment 4 sequence number is 2164  
 Segment 5 sequence number is 3612  
 Segment 6 sequence number is 5060

|                  | Sent time   | ACK received time | RTT      |
|------------------|-------------|-------------------|----------|
| <b>Segment 1</b> | 0.271257000 | 0.366931000       | 0.095674 |
| <b>Segment 2</b> | 0.271425000 | 0.367289000       | 0.095864 |
| <b>Segment 3</b> | 0.271797000 | 0.368617000       | 0.09682  |
| <b>Segment 4</b> | 0.271798000 | 0.369952000       | 0.098154 |
| <b>Segment 5</b> | 0.367081000 | 0.479965000       | 0.112884 |
| <b>Segment 6</b> | 0.368711000 | 0.482492000       | 0.113781 |

According to the formula:

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

EstimatedRTT after the receipt of the ACK of segment 1:

EstimatedRTT = RTT for Segment 1 = 0.095 s

EstimatedRTT after the receipt of the ACK of segment 2:

Estimated RTT =  $0.875 * 0.095 + 0.125 * 0.095 = 0.095\text{s}$

Estimated RTT after the receipt of the ACK of segment 3:

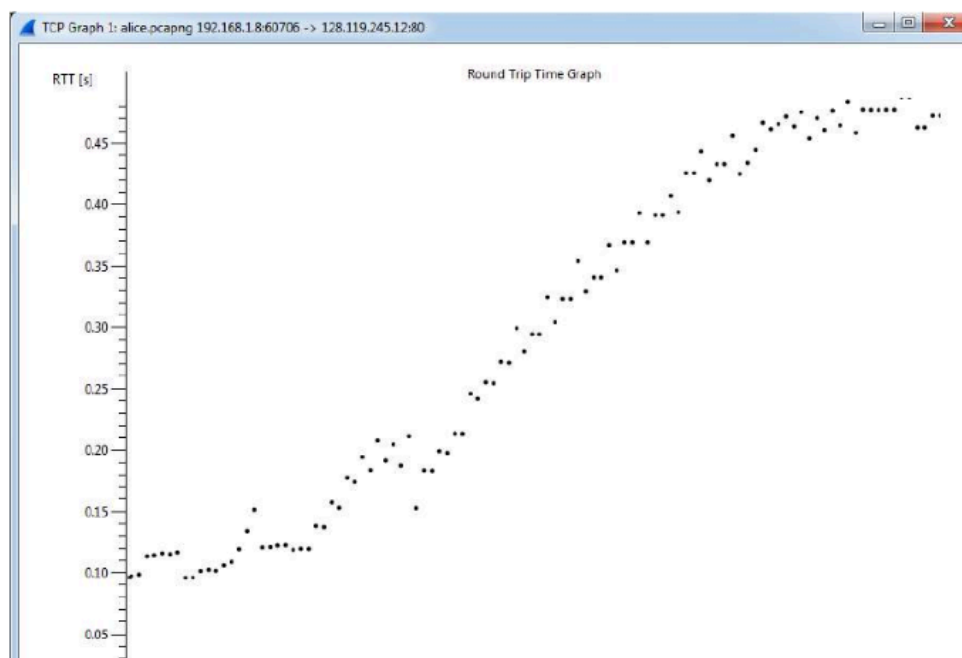
Estimated RTT =  $0.875 * 0.095 + 0.125 * 0.096 = 0.095\text{s}$

Estimated RTT after the receipt of the ACK of segment 4:

Estimated RTT =  $0.875 * 0.095 + 0.125 * 0.098 = 0.09612752734 \text{ s}$

Estimated RTT after the receipt of the ACK of segment 5:

Estimated RTT =  $0.875 * 0.096 + 0.125 * 0.11 = 0.09822208642 \text{ s}$



EstimatedRTT after the receipt of the ACK of segment 6:EstimatedRTT =  
 $0.875 * 0.09822208642 + 0.125 * 0.113781 = 0.10016695061$  sRound Trip Time

Graph7. What is the length of each of the first six TCP segments?

| No. | Time       | Source         | Destination    | Protocol | Length | Info   |
|-----|------------|----------------|----------------|----------|--------|--|
| 1   | 0.00000000 | 192.168.1.8    | 128.119.245.12 | TCP      | 78     | 60706 > http [SYN] Seq=0 win=65535 Len=0 MSS=1460 WS=16  |
| 4   | 0.26949200 | 128.119.245.12 | 192.168.1.8    | TCP      | 74     | http > 60706 [SYN, ACK] Seq=0 Ack=1 win=5792 Len=0 MSS=  |
| 5   | 0.26960900 | 192.168.1.8    | 128.119.245.12 | TCP      | 66     | 60706 > http [ACK] Seq=1 Ack=1 win=131760 Len=0 TSval=8: |
| 6   | 0.27125700 | 192.168.1.8    | 128.119.245.12 | TCP      | 644    | 60706 > http [PSH, ACK] Seq=1 Ack=1 win=131760 Len=578:  |
| 7   | 0.27142500 | 192.168.1.8    | 128.119.245.12 | TCP      | 203    | 60706 > http [PSH, ACK] Seq=579 Ack=1 win=131760 Len=13: |
| 8   | 0.27179700 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=716 Ack=1 win=131760 Len=1448 TS  |
| 9   | 0.27179800 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=2164 Ack=1 win=131760 Len=1448 TS |
| 10  | 0.36693100 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=579 win=7040 Len=0 TSval=2: |
| 11  | 0.36708100 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=3612 Ack=1 win=131760 Len=1448 TS |
| 12  | 0.36728900 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=716 win=8192 Len=0 TSval=2: |
| 13  | 0.36861700 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=2164 win=11008 Len=0 TSval: |
| 14  | 0.36871100 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=5060 Ack=1 win=131760 Len=1448 TS |
| 15  | 0.36871200 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=6508 Ack=1 win=131760 Len=1448 TS |

Options: (12 bytes), No-operation (NOP), No-operation (NOP), Timestamps

- No-operation (NOP)
- No-operation (NOP)
- Timestamps: TSval 85391598, TSecr 2261446230
  - Kind: Timestamp (8)
  - Length: 10
  - Timestamp value: 85391598
  - Timestamp echo reply: 2261446230

[SEQ/ACK analysis]

Data (578 bytes)

Data: 504f5354202f77697265736861726b2d6c6162732f6c6162...

The length of the first TCP segment is 578 bytes, the length of the second TCP segment is 137 bytes. The length of each of the following five TCP segments is 1448 bytes.

$0.875 * 0.09822208642 + 0.125 * 0.113781 = 0.10016695061$  sRound Trip Time

Graph7. What is the length of each of the first six TCP segments?

| No. | Time       | Source         | Destination    | Protocol | Length | Info   |
|-----|------------|----------------|----------------|----------|--------|--|
| 1   | 0.00000000 | 192.168.1.8    | 128.119.245.12 | TCP      | 78     | 60706 > http [SYN] Seq=0 win=65535 Len=0 MSS=1460 WS=16  |
| 4   | 0.26949200 | 128.119.245.12 | 192.168.1.8    | TCP      | 74     | http > 60706 [SYN, ACK] Seq=0 Ack=1 win=5792 Len=0 MSS=  |
| 5   | 0.26960900 | 192.168.1.8    | 128.119.245.12 | TCP      | 66     | 60706 > http [ACK] Seq=1 Ack=1 win=131760 Len=0 TSval=8: |
| 6   | 0.27125700 | 192.168.1.8    | 128.119.245.12 | TCP      | 644    | 60706 > http [PSH, ACK] Seq=1 Ack=1 win=131760 Len=578:  |
| 7   | 0.27142500 | 192.168.1.8    | 128.119.245.12 | TCP      | 203    | 60706 > http [PSH, ACK] Seq=579 Ack=1 win=131760 Len=13: |
| 8   | 0.27179700 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=716 Ack=1 win=131760 Len=1448 TS  |
| 9   | 0.27179800 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=2164 Ack=1 win=131760 Len=1448 TS |
| 10  | 0.36693100 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=579 win=7040 Len=0 TSval=2: |
| 11  | 0.36708100 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=3612 Ack=1 win=131760 Len=1448 TS |
| 12  | 0.36728900 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=716 win=8192 Len=0 TSval=2: |
| 13  | 0.36861700 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=2164 win=11008 Len=0 TSval: |
| 14  | 0.36871100 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=5060 Ack=1 win=131760 Len=1448 TS |
| 15  | 0.36871200 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=6508 Ack=1 win=131760 Len=1448 TS |

Options: (12 bytes), No-operation (NOP), No-operation (NOP), Timestamps

- No-operation (NOP)
- No-operation (NOP)
- Timestamps: TSval 85391598, TSecr 2261446230
  - Kind: Timestamp (8)
  - Length: 10
  - Timestamp value: 85391598
  - Timestamp echo reply: 2261446230

[SEQ/ACK analysis]

Data (578 bytes)

Data: 504f5354202f77697265736861726b2d6c6162732f6c6162...

The length of the first TCP segment is 578 bytes, the length of the second TCP segment is 137 bytes. The length of each of the following five TCP segments is 1448 bytes.



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?

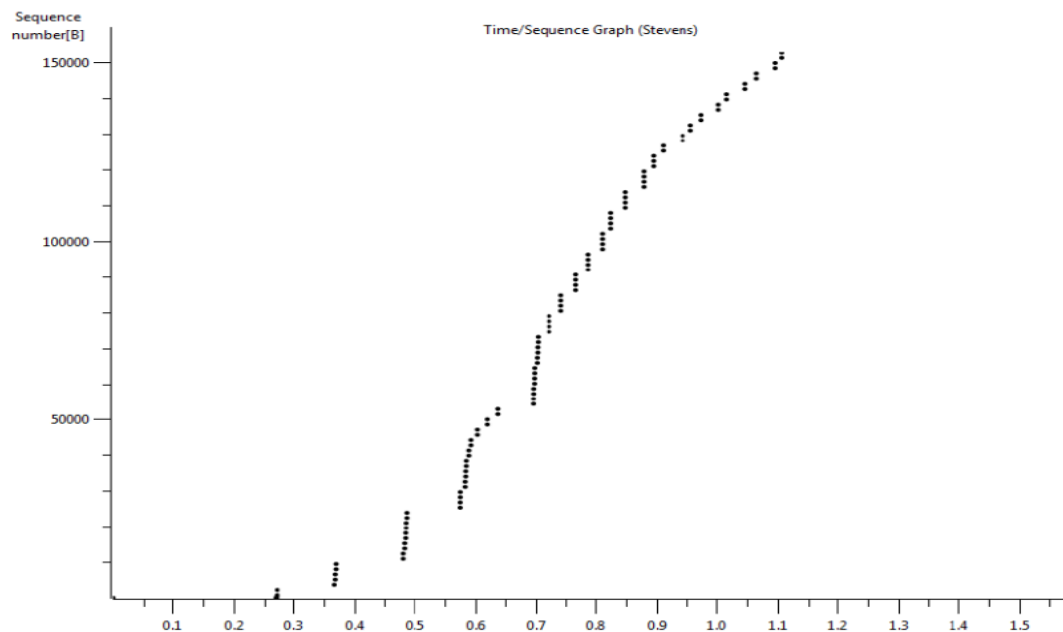
| No. | Time       | Source         | Destination    | Protocol | Length | Info   |
|-----|------------|----------------|----------------|----------|--------|--|
| 1   | 0.00000000 | 192.168.1.8    | 128.119.245.12 | TCP      | 78     | 60706 > http [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16  |
| 4   | 0.26949200 | 128.119.245.12 | 192.168.1.8    | TCP      | 74     | http > 60706 [SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS=  |
| 5   | 0.26960900 | 192.168.1.8    | 128.119.245.12 | TCP      | 66     | 60706 > http [ACK] Seq=1 Ack=1 Win=131760 Len=0 TSval=8  |
| 6   | 0.27125700 | 192.168.1.8    | 128.119.245.12 | TCP      | 644    | 60706 > http [PSH, ACK] Seq=1 Ack=1 Win=131760 Len=578   |
| 7   | 0.27142500 | 192.168.1.8    | 128.119.245.12 | TCP      | 203    | 60706 > http [PSH, ACK] Seq=579 Ack=1 Win=131760 Len=13  |
| 8   | 0.27179700 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=716 Ack=1 Win=131760 Len=1448 TS  |
| 9   | 0.27179800 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=2164 Ack=1 Win=131760 Len=1448 TS |
| 10  | 0.36693100 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=579 Win=7040 Len=0 TSval=2  |
| 11  | 0.36708100 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=3612 Ack=1 Win=131760 Len=1448 TS |
| 12  | 0.36728900 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=716 Win=8192 Len=0 TSval=2  |
| 13  | 0.36861700 | 128.119.245.12 | 192.168.1.8    | TCP      | 66     | http > 60706 [ACK] Seq=1 Ack=2164 Win=11008 Len=0 TSval= |
| 14  | 0.36871100 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=5060 Ack=1 Win=131760 Len=1448 TS |
| 15  | 0.36871200 | 192.168.1.8    | 128.119.245.12 | TCP      | 1514   | 60706 > http [ACK] Seq=6508 Ack=1 Win=131760 Len=1448 TS |

|                               |                     |
|-------------------------------|---------------------|
| .... ..0.                     | Urgent: Not set     |
| .... ..1                      | Acknowledgment: Set |
| .... ..0                      | Push: Not set       |
| .... ..0                      | Reset: Not set      |
| .... ..1                      | Syn: Set            |
| .... ..0                      | Fin: Not set        |
| window size value: 5792       |                     |
| calculated window size: 57921 |                     |

minimum amount of available buffer space advertised at the received for the entire trace is indicated first ACK from the server, its value is 5792 bytes  
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 lacking of receiver buffer space

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



**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 247 in the text).**

|    |            |                |                |     |      |              |   |
|----|------------|----------------|----------------|-----|------|--------------|---|
| 1  | 0.00000000 | 192.168.1.8    | 128.119.245.12 | TCP | 78   | 60706 > http | [SYN] Seq=0 win=65535 Len=0 MSS=1460 WS=16  |
| 4  | 0.26949200 | 128.119.245.12 | 192.168.1.8    | TCP | 74   | http > 60706 | [SYN, ACK] Seq=0 Ack=1 win=5792 Len=0 MSS=1 |
| 5  | 0.26960900 | 192.168.1.8    | 128.119.245.12 | TCP | 66   | 60706 > http | [ACK] Seq=1 Ack=1 win=131760 Len=0 TSval=85 |
| 6  | 0.27125700 | 192.168.1.8    | 128.119.245.12 | TCP | 644  | 60706 > http | [PSH, ACK] Seq=1 Ack=1 win=131760 Len=578 T |
| 7  | 0.27142500 | 192.168.1.8    | 128.119.245.12 | TCP | 203  | 60706 > http | [PSH, ACK] Seq=579 Ack=1 win=131760 Len=137 |
| 8  | 0.27179700 | 192.168.1.8    | 128.119.245.12 | TCP | 1514 | 60706 > http | [ACK] Seq=716 Ack=1 win=131760 Len=1448 TSv |
| 9  | 0.27179800 | 192.168.1.8    | 128.119.245.12 | TCP | 1514 | 60706 > http | [ACK] Seq=2164 Ack=1 win=131760 Len=1448 TS |
| 10 | 0.36693100 | 128.119.245.12 | 192.168.1.8    | TCP | 66   | http > 60706 | [ACK] Seq=1 Ack=579 win=7040 Len=0 TSval=22 |
| 11 | 0.36708100 | 192.168.1.8    | 128.119.245.12 | TCP | 1514 | 60706 > http | [ACK] Seq=3612 Ack=1 win=131760 Len=1448 TS |
| 12 | 0.36728900 | 128.119.245.12 | 192.168.1.8    | TCP | 66   | http > 60706 | [ACK] Seq=1 Ack=716 win=8192 Len=0 TSval=22 |
| 13 | 0.36861700 | 128.119.245.12 | 192.168.1.8    | TCP | 66   | http > 60706 | [ACK] Seq=1 Ack=2164 win=11008 Len=0 TSval= |
| 14 | 0.36871100 | 192.168.1.8    | 128.119.245.12 | TCP | 1514 | 60706 > http | [ACK] Seq=5060 Ack=1 win=131760 Len=1448 TS |
| 15 | 0.36871200 | 192.168.1.8    | 128.119.245.12 | TCP | 1514 | 60706 > http | [ACK] Seq=6508 Ack=1 win=131760 Len=1448 TS |

The difference between the acknowledged sequence numbers of two consecutive ACKs indicates the data received by the server between these two ACKs. The receiver is ACKing every other segment. For example, segment of No. 13 acknowledged data with 1430 bytes

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

The alice.txt on the hard drive is 152,138 bytes, and the download time is 1.578736000 (First TCP segment) - 0.271257000 (last ACK) = 1.307479 second. Therefore, the throughput for the TCP connection is computed as  $152,138 / 1.307479 = 116359.803867$  bytes/second