

Lab 3

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).

Answer

| 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/pla |
| 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
 Flags: 0x018 (PSH, ACK)

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

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?

Answer

| 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/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

According to above figure, the IP address of `gaia.cs.umass.edu` is 128.119.245.12 and the TCP 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`?

Answer

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| 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/plai |
| 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-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: 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 | | | | | | |

According to above figure, my client computer's IP address is 192.168.1.8 and the TCP port is 60706.

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?

Answer

| 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 |

| | | | | | | |
|---|--|--|--|--|--|--|
| 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-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: 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] | | | | | | |

The sequence number of the TCP SYN segment is 0 since it is used to imitate the TCP connection between the client computer and gaia.cs.umass.edu.

According to above figure, in the Flags section, the Syn flag is set to 1 which indicates that this segment 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?

Answer

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| 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=1 |

Frame 4: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
 Ethernet II, Src: Tp-Link_Tf8:6d:f9 (a0:f3:c1:f8:6d:f9), Dst: Apple_1f:d4:56 (b8:e8:56:1f:d4:56)
 Internet Protocol Version 4, Src: 128.119.245.12 (128.119.245.12), Dst: 192.168.1.8 (192.168.1.8)
 Transmission Control Protocol, Src Port: http (80), Dst Port: 60706 (60706), Seq: 0, Ack: 1, Len: 0

Source port: http (80)
 Destination port: 60706 (60706)
 [Stream index: 0]
 Sequence number: 0 (relative sequence number)
 Acknowledgment number: 1 (relative ack number)
 Header length: 40 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

window size value: 5792
 [calculated window size: 5792]

According to the above figure, 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. The value of the ACKnowledgement field in the SYNACK segment is determined by the server gaia.cs.umass.edu. The server adds 1 to the 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 the segment are set to 1.

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.

Answer

| 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=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 |

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
 1... = 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.Z@.@. ....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.edu 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
  
```

According to above figure, the segment No.6 contains the HTTP POST command, the sequence number of this segment is 1.

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 239 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 Estimated RTT equation on page 239 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.

Answer

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|------------|----------------|----------------|----------|--------|---|
| 4 | 0.26949200 | 192.168.1.8 | 128.119.245.12 | TCP | 74 | HTTP > 60706 [ACK] Seq=0 Ack=1 win=932 Len=0 MSS=1460 |
| 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 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 |

Frame 6: 644 bytes on wire (5152 bits), 644 bytes captured (5152 bits) on interface 0
 Ethernet II, Src: Apple1f:d4:56 (b8:e8:56:1f:d4:56), Dst: Tp-LinkTf8:6d: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

```

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 .w.Z@. ....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-labs/ 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
  
```

Segments 1-6

| 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 | 0.36708100 | 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 |
| 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=5060 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 T |
| 21 | 0.48010600 | 192.168.1.8 | 128.119.245.12 | TCP | 1514 | 60706 > http [ACK] Seq=12300 Ack=1 win=131760 Len=1448 T |
| 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
 Ethernet II, Src: Tp-LinkTf8:6d:f9 (a0:f3:c1:f8:6d:f9), Dst: Apple1f:d4:56 (b8:e8:56:1f:d4:56)
 Internet Protocol Version 4, Src: 128.119.245.12 (128.119.245.12), Dst: 192.168.1.8 (192.168.1.8)
 Transmission Control Protocol, Src Port: http (80), Dst Port: http (80), Seq: 1, Ack: 579, Len: 0
 Source port: http (80)
 Destination port: 60706 (60706)
 [Stream index: 0]
 Sequence number: 1 (relative sequence number)
 Acknowledgment number: 579 (relative ack number)
 Header length: 32 bytes
 Flags: 0x010 (ACK)
 000. = Reserved: Not set
 ...0 = Nonce: Not set
 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 .4o-@.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 01 01 08 0a 86 ca ef 27 05 16 .7.....
0040 f8 ee
  
```

ACK of segments 1-6

According to above figures, the segments 1-6 are No. 6, 7, 8, 9, 11 and 14. The ACK of segments 1-6 are No. 10, 12, 13, 16, 19 and 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

Recording the sending time and received time of ACKs:

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

According to the formula: $\text{EstimatedRTT} = 0.875 * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$

EstimatedRTT after the receipt of the ACK of segment 1:

EstimatedRTT = RTT for Segment 1 = 0.095674 s

EstimatedRTT after the receipt of the ACK of segment 2:

EstimatedRTT = $0.875 * 0.095674 + 0.125 * 0.095864 = 0.09569775$ s

EstimatedRTT after the receipt of the ACK of segment 3:

EstimatedRTT = $0.875 * 0.09569775 + 0.125 * 0.09682 = 0.09583803125$ s

EstimatedRTT after the receipt of the ACK of segment 4:

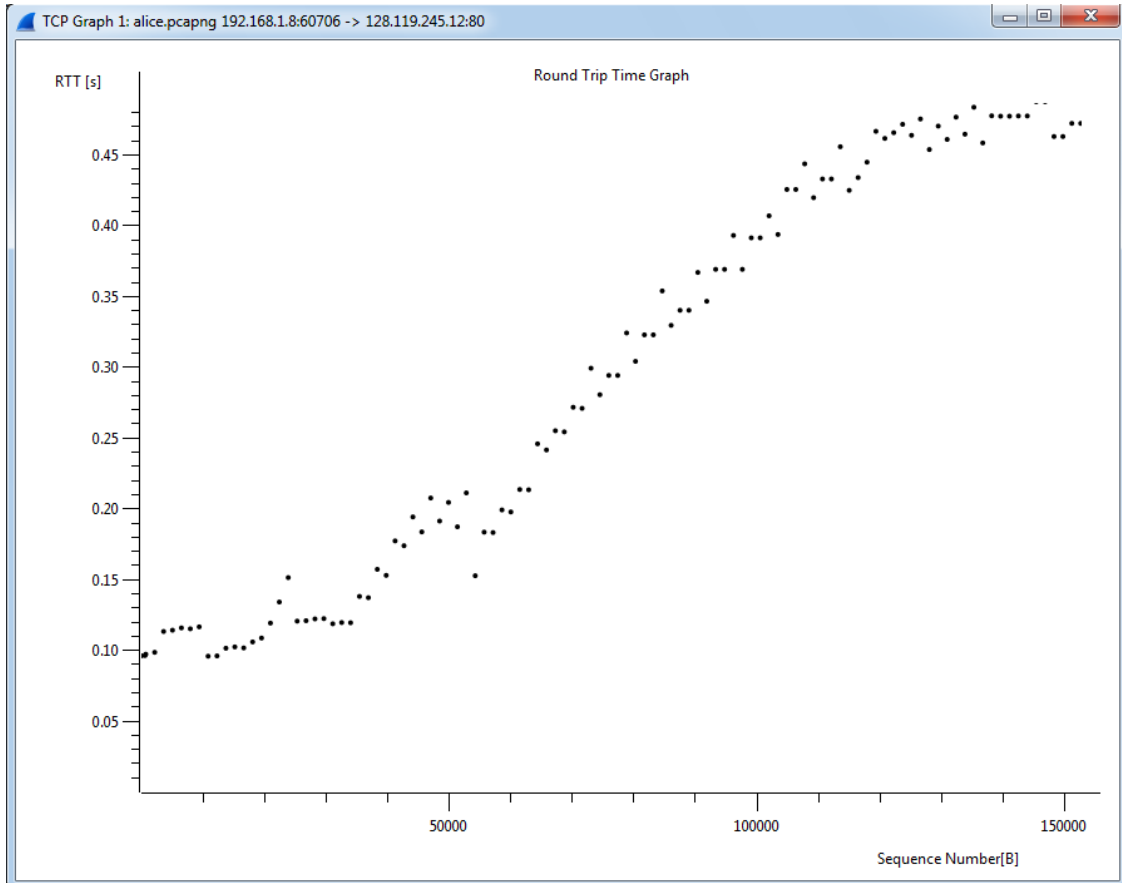
EstimatedRTT = $0.875 * 0.09583803125 + 0.125 * 0.098154 = 0.09612752734$ s

EstimatedRTT after the receipt of the ACK of segment 5:

EstimatedRTT = $0.875 * 0.09612752734 + 0.125 * 0.112884 = 0.09822208642$ s

EstimatedRTT after the receipt of the ACK of segment 6:

$$\text{EstimatedRTT} = 0.875 * 0.09822208642 + 0.125 * 0.113781 = 0.10016695061 \text{ s}$$



Round Trip Time Graph

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

Answer

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| 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=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 |
| 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 |

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...
 [Length: 578]

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.

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?

Answer

| 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=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 |
| 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 |

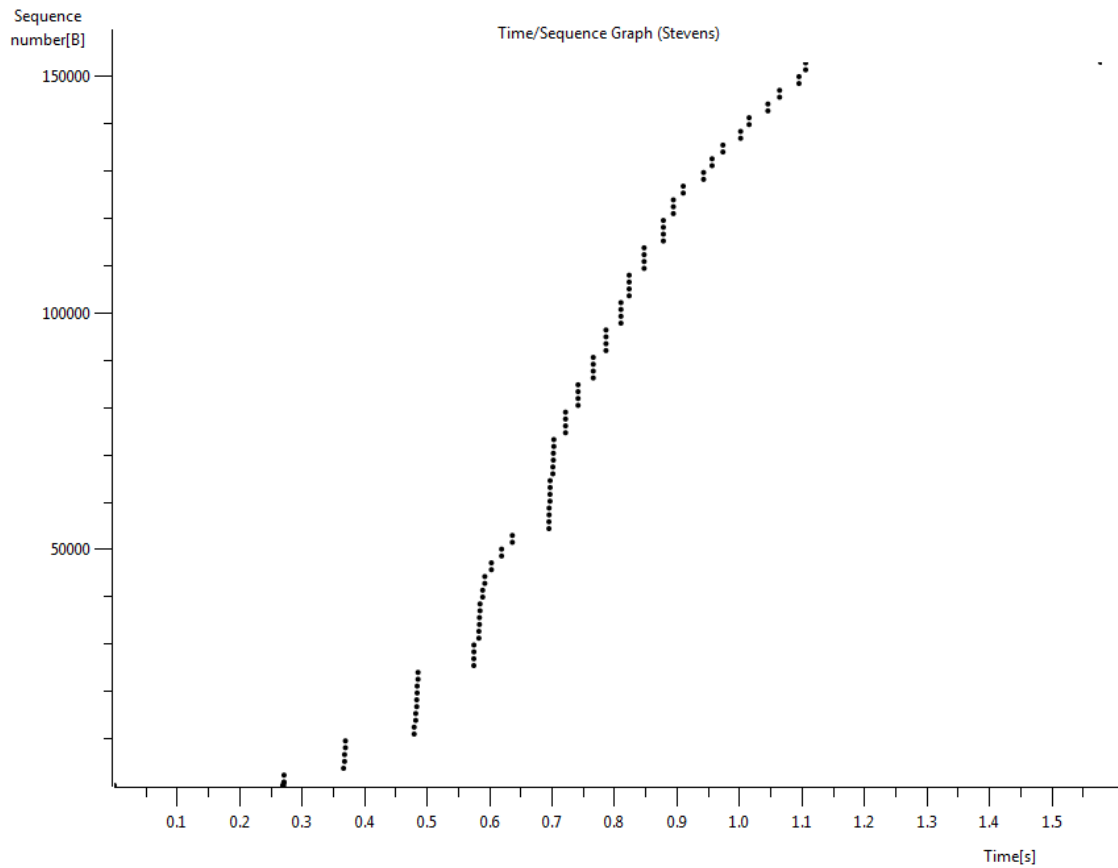
.... ..0. = Urgent: Not set
1. = Acknowledgment: Set
 0... = Push: Not set
0.. = Reset: Not set
1. = Syn: Set
0 = Fin: Not set
 window size value: 5792
 [calculated window size: 5792]

The 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 (shown in above figure).

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.

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

Answer



There is no retransmitted segments in the trace file since in the time sequence graph (stevens), all sequence numbers are monotonically increasing.

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 247 in the text).

Answer

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.

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| | | | | | | | | | | |
|----|------------|----------------|----------------|-----|------|-------|---|-------|------------|---------------------------------------|
| 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 |

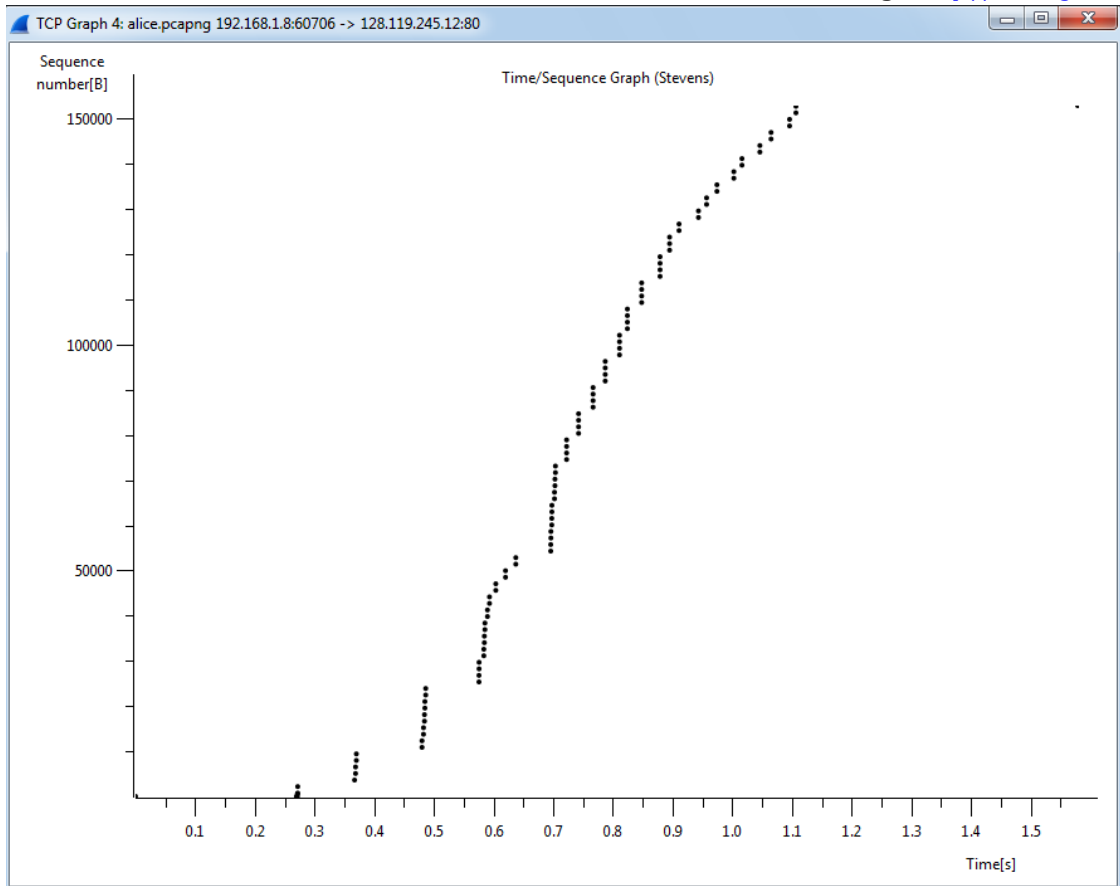
12. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

Answer

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.

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 slowstart 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.

Answer



The slow start of the TCP seems to begin at about 0.27 seconds and then ends at about 0.35 seconds. Congestion avoidance takes over at about 0.7 seconds because it cut down the amount being sent.

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

Answer

The questions had been answered .