Capturing a Bulk TCP Transfer from your Computer to a Remote Server

A First Look at the Captured Trace

1. Did not use the downloadable trace packet listing.

2. IP Address of gaia.cs.umass.edu: 128.119.245.12 ✓

   Port Number: 80 ✓

```
    4 14:41:58.512394   128.119.245.12       192.168.0.104      TCP     68    80 → 54368 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1440
SACK_PERM=1 WS=128
Frame 4: 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface 0
Ethernet II, Src: Tp-LinkT_93:d0:8c (14:cc:20:93:d0:8c), Dst: IntelCor_1c:96:a2 (5c:51:4f:1c:96:a2)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.0.104
Transmission Control Protocol, Src Port: 80 (80), Dst Port: 54368 (54368), Seq: 0, Ack: 1, Len: 0
    Source Port: 80
    Destination Port: 54368
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 0     (relative sequence number)
    Acknowledgment number: 1    (relative ack number)
    Header Length: 32 bytes
    Flags: 0x012 (SYN, ACK)
    Window size value: 29200
    [Calculated window size: 29200]
    Checksum: 0x4fe8 [validation disabled]
    Urgent pointer: 0
    Options: (12 bytes), Maximum segment size, No-Operation (NOP), No-Operation (NOP), SACK permitted, No-Operation (NOP), Window scale
    [SEQ/ACK analysis]
VSS-Monitoring ethernet trailer, Source Port: 28165
```

3. IP Address of Client Computer: 192.168.0.104

   TCP Port Number: 54368 ✓

```
    4 14:41:58.512394   128.119.245.12       192.168.0.104      TCP     68    80 → 54368 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1440
SACK_PERM=1 WS=128
Frame 4: 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface 0
Ethernet II, Src: Tp-LinkT_93:d0:8c (14:cc:20:93:d0:8c), Dst: IntelCor_1c:96:a2 (5c:51:4f:1c:96:a2)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.0.104
Transmission Control Protocol, Src Port: 80 (80), Dst Port: 54368 (54368), Seq: 0, Ack: 1, Len: 0
    Source Port: 80
    Destination Port: 54368
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 0     (relative sequence number)
    Acknowledgment number: 1    (relative ack number)
    Header Length: 32 bytes
    Flags: 0x012 (SYN, ACK)
    Window size value: 29200
    [Calculated window size: 29200]
    Checksum: 0x4fe8 [validation disabled]
    Urgent pointer: 0
    Options: (12 bytes), Maximum segment size, No-Operation (NOP), No-Operation (NOP), SACK permitted, No-Operation (NOP), Window scale
    [SEQ/ACK analysis]
VSS-Monitoring ethernet trailer, Source Port: 28165
```

TCP Basics

4. Sequence Number of the TCP SYN Segment: 0

   Being the first TCP command identifies this segment being a SYN segment valued at 0.

```
    3 14:41:58.407600   192.168.0.104       128.119.245.12      TCP     66    54368 → 80 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256
SACK_PERM=1
Frame 3: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0
Ethernet II, Src: IntelCor_1c:96:a2 (5c:51:4f:1c:96:a2), Dst: Tp-LinkT_93:d0:8c (14:cc:20:93:d0:8c)
Internet Protocol Version 4, Src: 192.168.0.104, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 54368 (54368), Dst Port: 80 (80), Seq: 0, Len: 0
    Source Port: 54368
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 0     (relative sequence number)
    Acknowledgment number: 0
    Header Length: 32 bytes
    Flags: 0x002 (SYN) ✓
    Window size value: 8192
    [Calculated window size: 8192]
    Checksum: 0xeb2c [validation disabled]
    Urgent pointer: 0
    Options: (12 bytes), Maximum segment size, No-Operation (NOP), Window scale, No-Operation (NOP), No-Operation (NOP), SACK permitted
```

5. Sequence Number of the SYNACK Segment: <u>0</u>

Value of the ACKnowledgement Field in the SYNACK Segment: <u>1</u> ✓

<u>gaia.cs.umass.edu determined that value by adding 1 to the previous value of 0 of the sequence number.</u>

<u>The ACKnowledgement value being set to 1 after being the previous sequence number valued at 0, identifies the segment as a SYNACK segment.</u>

```
     4 14:41:58.512394    128.119.245.12      192.168.0.104     TCP    68    80 → 54368 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1440
SACK_PERM=1 WS=128
Frame 4: 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface 0
Ethernet II, Src: Tp-LinkT_93:d0:8c (14:cc:20:93:d0:8c), Dst: IntelCor_1c:96:a2 (5c:51:4f:1c:96:a2)
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.0.104
Transmission Control Protocol, Src Port: 80 (80), Dst Port: 54368 (54368), Seq: 0, Ack: 1, Len: 0
    Source Port: 80
    Destination Port: 54368
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 0    (relative sequence number)
    Acknowledgment number: 1    (relative ack number)  ✓
    Header Length: 32 bytes
    Flags: 0x012 (SYN, ACK)
    Window size value: 29200
    [Calculated window size: 29200]
    Checksum: 0x4fe8 [validation disabled]
    Urgent pointer: 0
    Options: (12 bytes), Maximum segment size, No-Operation (NOP), No-Operation (NOP), SACK permitted, No-Operation (NOP), Window scale
    [SEQ/ACK analysis]
VSS-Monitoring ethernet trailer, Source Port: 28165
```

6. Sequence Number of TCP Segment Containing the HTTP POST Command: <u>1</u> ✓

```
     6 14:41:58.513827    192.168.0.104      128.119.245.12     TCP    699    54368 → 80 [PSH, ACK] Seq=1 Ack=1 Win=66048 Len=645
Frame 6: 699 bytes on wire (5592 bits), 699 bytes captured (5592 bits) on interface 0
Ethernet II, Src: IntelCor_1c:96:a2 (5c:51:4f:1c:96:a2), Dst: Tp-LinkT_93:d0:8c (14:cc:20:93:d0:8c)
Internet Protocol Version 4, Src: 192.168.0.104, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 54368 (54368), Dst Port: 80 (80), Seq: 1, Ack: 1, Len: 645
    Source Port: 54368
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 645]
    Sequence number: 1    (relative sequence number)
    [Next sequence number: 646    (relative sequence number)]
    Acknowledgment number: 1    (relative ack number)
    Header Length: 20 bytes
    Flags: 0x018 (PSH, ACK)
    Window size value: 258
    [Calculated window size: 66048]
    [Window size scaling factor: 256]
    Checksum: 0x254f [validation disabled]
    Urgent pointer: 0
    [SEQ/ACK analysis]
Data (645 bytes)
0000   50 4f 53 54 20 2f 77 69 72 65 73 68 61 72 6b 2d   POST /wireshark-
0010   6c 61 62 73 2f 6c 61 62 33 2d 31 2d 72 65 70 6c   labs/lab3-1-repl
0020   79 2e 68 74 6d 20 48 54 54 50 2f 31 2e 31 0d 0a   y.htm HTTP/1.1..
0030   48 6f 73 74 3a 20 67 61 69 61 2e 63 73 2e 75 6d   Host: gaia.cs.um
0040   61 73 73 2e 65 64 75 0d 0a 43 6f 6e 6e 65 63 74   ass.edu..Connect
0050   69 6f 6e 3a 20 6b 65 65 70 2d 61 6c 69 76 65 0d   ion: keep-alive.
```

7.

Segments 6 and 12, 7 and 13, 8 and 14, 9 and 15, 16 and 25, 17 and 27

Sequence Numbers of First Six Segments:	Time Each Segment was Sent:
· <u>1</u>	· <u>14:41:58.513827</u>
· <u>646</u>	· <u>14:41:58.514253</u>
· <u>2086</u>	· <u>14:41:58.514284</u>
· <u>3526</u> ✓	· <u>14:41:58.514307</u>
· <u>4966</u>	· <u>14:41:58.901032</u>
· <u>6406</u>	· <u>14:41:58.901071</u>

Time ACK Each Segment Received:
- 14:41:58.900887
- 14:41:58.900888
- 14:41:58.900889
- 14:41:58.900889
- 14:42:00.981250
- 14:42:00.981251

RTT Value Each of Six Segments:
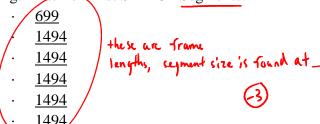- 00.387060
- 00.386635
- 00.386605
- 00.386582
- 02.080218
- 02.080180

EstimatedRTT Value after the Receipt Each ACK:

*EstimatedRTT = 0.875 * EstimatedRTT + 0.125 * SampleRTT*

- 00.387060
- 00.387007
- 00.386957 ✓
- 00.386910
- 00.598573
- 00.783774

No.	Time	Source	Destination	Protocol	Length	Info
6	14:41:58.513827	192.168.0.104	128.119.245.12	TCP	699	54368 → 80 [PSH, ACK] Seq=1 Ack=1 Win=66048 Len=645
7	14:41:58.514253	192.168.0.104	128.119.245.12	TCP	1494	54368 → 80 [ACK] Seq=646 Ack=1 Win=66048 Len=1440
8	14:41:58.514284	192.168.0.104	128.119.245.12	TCP	1494	54368 → 80 [ACK] Seq=2086 Ack=1 Win=66048 Len=1440
9	14:41:58.514307	192.168.0.104	128.119.245.12	TCP	1494	54368 → 80 [ACK] Seq=3526 Ack=1 Win=66048 Len=1440
10	14:41:58.875578	192.168.0.104	128.119.245.12	TCP	1494	[TCP Retransmission] 54368 → 80 [PSH, ACK] Seq=1 Ack=1 Win=66048 Len=1440
12	14:41:58.900887	128.119.245.12	192.168.0.104	TCP	56	80 → 54368 [ACK] Seq=1 Ack=646 Win=30592 Len=0
13	14:41:58.900888	128.119.245.12	192.168.0.104	TCP	56	80 → 54368 [ACK] Seq=1 Ack=2086 Win=32536 Len=0
14	14:41:58.900889	128.119.245.12	192.168.0.104	TCP	56	80 → 54368 [ACK] Seq=1 Ack=3526 Win=36352 Len=0
15	14:41:58.900889	128.119.245.12	192.168.0.104	TCP	56	80 → 54368 [ACK] Seq=1 Ack=4966 Win=39296 Len=0
16	14:41:58.901032	192.168.0.104	128.119.245.12	TCP	1494	54368 → 80 [ACK] Seq=4966 Ack=1 Win=66048 Len=1440
17	14:41:58.901071	192.168.0.104	128.119.245.12	TCP	1494	54368 → 80 [ACK] Seq=6406 Ack=1 Win=66048 Len=1440
22	14:41:58.977539	128.119.245.12	192.168.0.104	TCP	68	[TCP Dup ACK 15#1] 80 → 54368 [ACK] Seq=1 Ack=4966 Win=39296 Len=0 SLE=1 SRE=1441
23	14:41:59.875826	192.168.0.104	128.119.245.12	TCP	1494	[TCP Retransmission] 54368 → 80 [ACK] Seq=4966 Ack=1 Win=66048 Len=1440
25	14:42:00.981250	128.119.245.12	192.168.0.104	TCP	56	80 → 54368 [ACK] Seq=1 Ack=6406 Win=42240 Len=0
26	14:42:00.981251	128.119.245.12	192.168.0.104	TCP	68	[TCP Dup ACK 25#1] 80 → 54368 [ACK] Seq=1 Ack=6406 Win=42240 Len=0 SLE=4966 SRE=6406
27	14:42:00.981251	128.119.245.12	192.168.0.104	TCP	56	80 → 54368 [ACK] Seq=1 Ack=7286 Win=48000 Len=0

8. Length Each of First Six TCP Segments:
- 699
- 1494
- 1494
- 1494
- 1494
- 1494

[handwritten: these are frame lengths, segment size is found at ___ (-3)]

9. The minimum amount of available buffer space advertised at the received for the entire trace represented within the acknowledgement message is 30592 bytes. And no, the lack of receiver buffer space never throttles the sender. ✓

10. Yes, there are retransmitted segments in the trace file. I checked for the segments that contained the "TCP Retransmission" statement within the Info column of the trace in order to answer this question. ✓

11. Identifiable Cases (Figure 3.2)

Event	TCP Receiver Action
Arrival of in-order segment with expected sequence number. All data up to expected sequence number already acknowledged.	Delayed ACK. Wait up to 500 msec for arrival of another in-order segment. If next in-order segment does not arrive in this interval, send an ACK.
Arrival of in-order segment with expected sequence number. One other in-order segment waiting for ACK transmission.	Immediately send single cumulative ACK, ACKing both in-order segments.
Arrival of out-of-order segment with higher-than-expected sequence number. Gap detected.	Immediately send duplicate ACK, indicating sequence number of next expected byte (which is the lower end of the gap).
Arrival of segment that partially or completely fills in gap in received data.	Immediately send ACK, provided that segment starts at the lower end of gap.

12. (Total Amount of Data Transferred)/(Overall Time of the Trace) = Throughput for the TCP Connection
(152967 - 1)/5.394636 = 152966/5.394636 = 28355
28355 Bytes/seconds is how much data the receiver typically acknowledges in an ACK. ✓

TCP Congestion Control in Action

13.

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

tcp-ethereal-trace-1