2. A first look at the captured trace

1. IP address: 172.17.51.30 (Figure 1, A)
   TCP port number: 63409 (Figure 1, B)

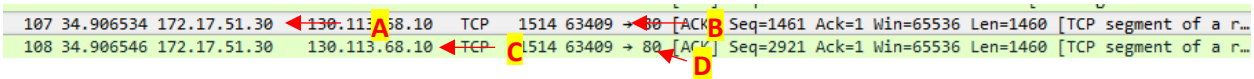

Figure 1

2. IP address: 130.113.68.10 (Figure 1, C)
   TCP port number: 80 (Figure 1, D)

3. TCP Basics

3. Sequence number: 0 (relative sequence number) (Figure 2, A)
   The 0x002 SYN flag identifies the segment by setting the Syn bit. (Figure 2, B)

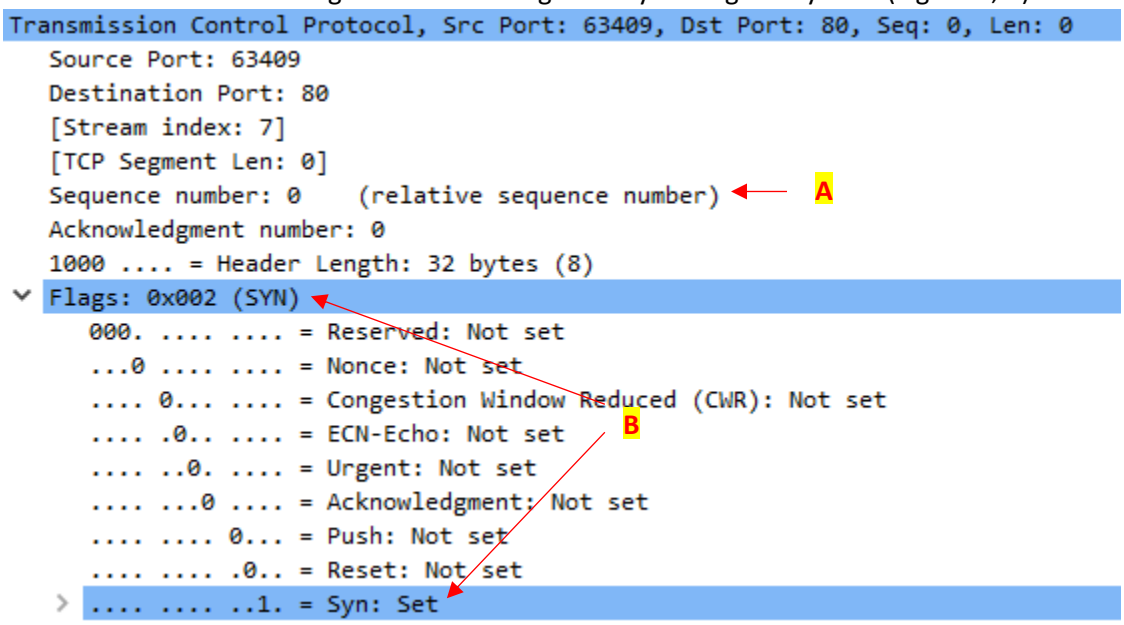

Figure 2

4. Sequence number: 0 (relative sequence number) (Figure 3, A)
   Acknowledge number: 1 (relative ack number) (Figure 3, B), determined by incrementing the SYN sequence number.
   The 0x012 SYN, ACK flag identifies the segment. (Figure 3, C)

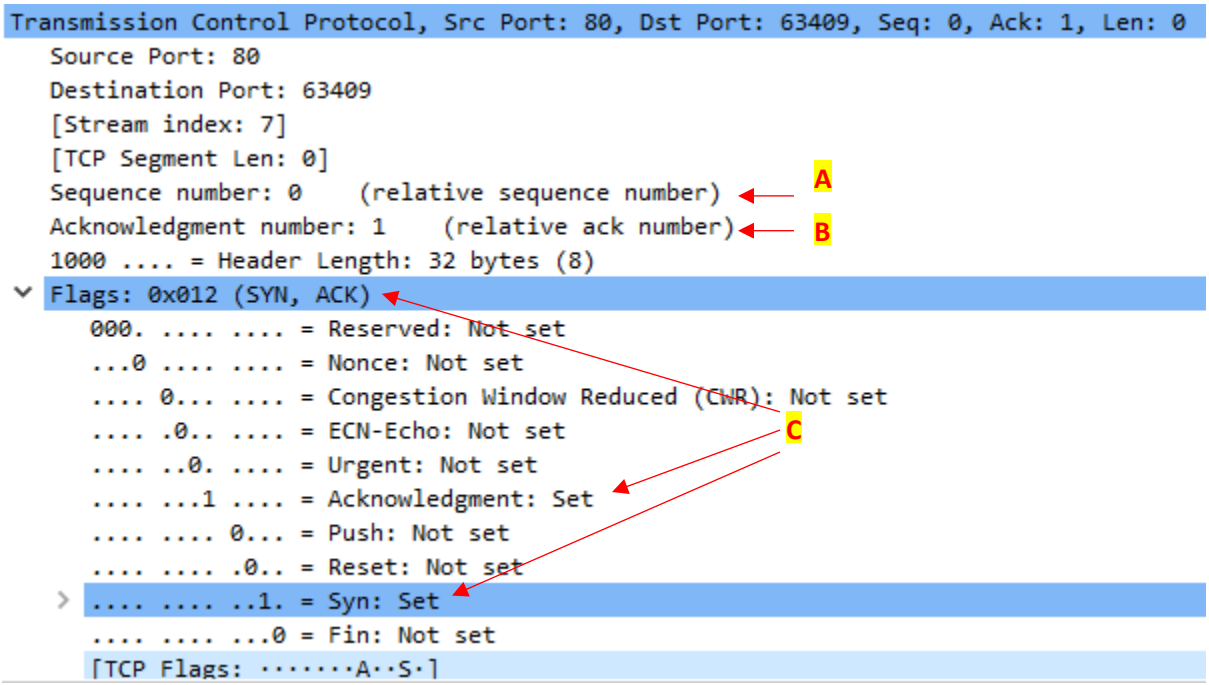

Figure 3

5. Sequence number: 1 (relative sequence number) (Figure 4, A)

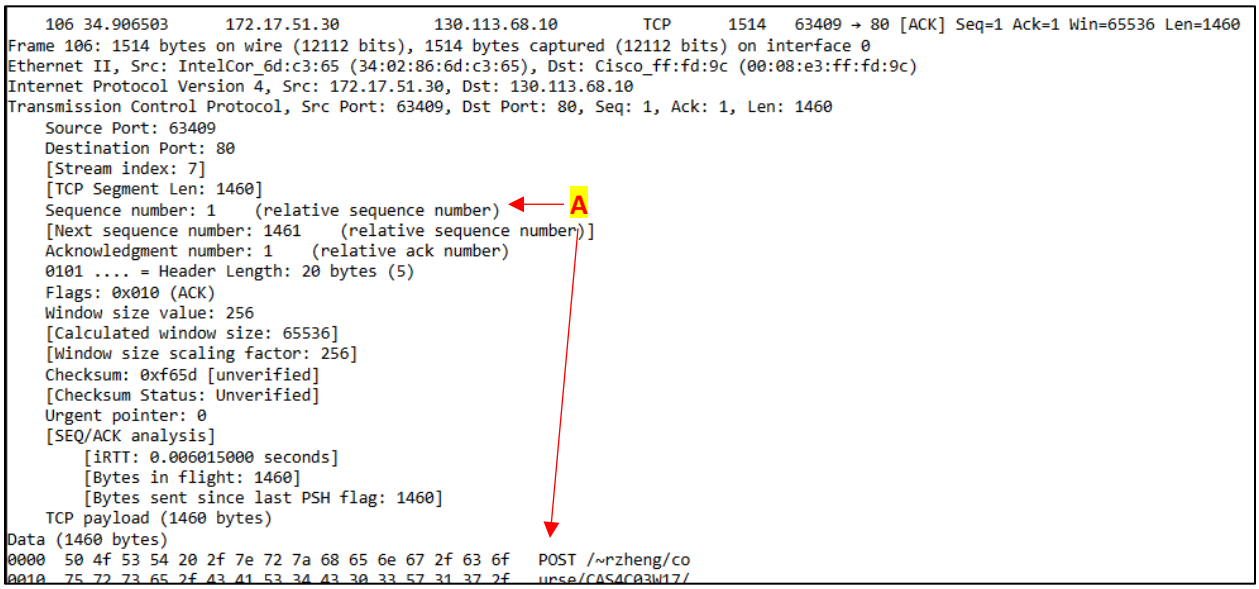

Figure 4

6.

Segment	Sequence Number	Time sent	ACK received	RTT	EstimatedRTT
1	1	34.906503	34.909272	0.002769	0.002769
2	1461	34.906534	34.914672	0.008138	(0.003439)
3	2921	34.906546	34.914807	0.008261	(0.004042)
4	4381	34.906558	34.914881	0.008323	(0.004577)

5	5841	34.911848	34.915987	0.004139	(0.004522)
6	7301	34.911878	34.918953	0.007075	(0.004841)

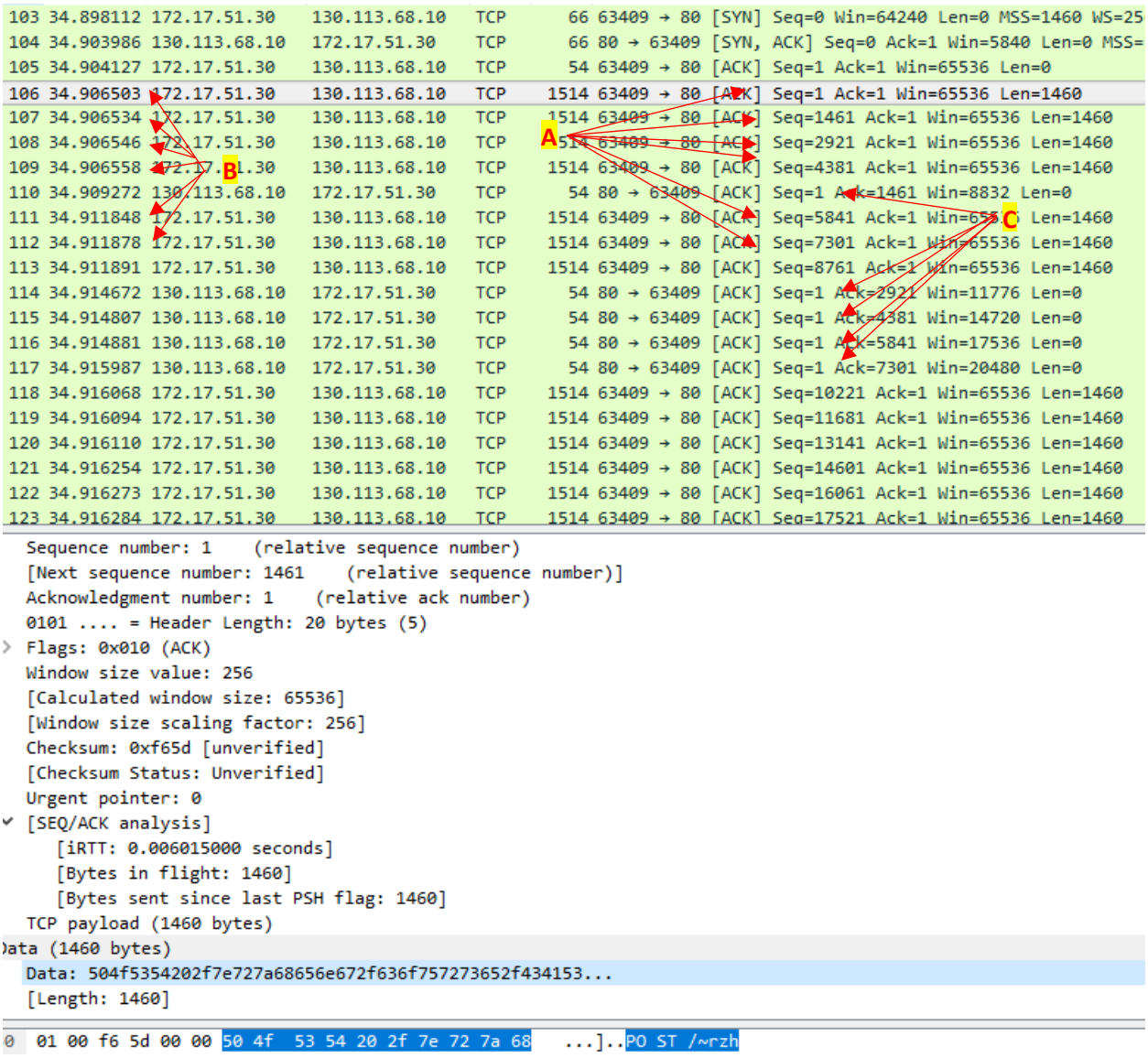

Figure 5

```
103 34.898112 172.17.51.30   130.113.68.10   TCP      66 63409 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=2
104 34.903986 130.113.68.10   172.17.51.30    TCP      66 80 → 63409 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS
105 34.904127 172.17.51.30    130.113.68.10   TCP      54 63409 → 80 [ACK] Seq=1 Ack=1 Win=65536 Len=0
106 34.906503 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=1 Ack=1 Win=65536 Len=1460
107 34.906534 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=1461 Ack=1 Win=65536 Len=1460
108 34.906546 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=2921 Ack=1 Win=65536 Len=1460
109 34.906558 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=4381 Ack=1 Win=65536 Len=1460
110 34.909272 130.113.68.10   172.17.51.30    TCP      54 80 → 63409 [ACK] Seq=1 Ack=1461 Win=8832 Len=0
111 34.911848 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=5841 Ack=1 Win=65536 Len=1460
112 34.911878 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=7301 Ack=1 Win=65536 Len=1460
113 34.911891 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=8761 Ack=1 Win=65536 Len=1460
114 34.914672 130.113.68.10   172.17.51.30    TCP      54 80 → 63409 [ACK] Seq=1 Ack=2921 Win=11776 Len=0
115 34.914807 130.113.68.10   172.17.51.30    TCP      54 80 → 63409 [ACK] Seq=1 Ack=4381 Win=14720 Len=0
116 34.914881 130.113.68.10   172.17.51.30    TCP      54 80 → 63409 [ACK] Seq=1 Ack=5841 Win=17536 Len=0
117 34.915987 130.113.68.10   172.17.51.30    TCP      54 80 → 63409 [ACK] Seq=1 Ack=7301 Win=20480 Len=0
118 34.916068 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=10221 Ack=1 Win=65536 Len=1460
119 34.916094 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=11681 Ack=1 Win=65536 Len=1460
120 34.916110 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=13141 Ack=1 Win=65536 Len=1460
121 34.916254 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=14601 Ack=1 Win=65536 Len=1460
122 34.916273 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=16061 Ack=1 Win=65536 Len=1460
123 34.916284 172.17.51.30    130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=17521 Ack=1 Win=65536 Len=1460
```

```
ransmission Control Protocol, Src Port: 80, Dst Port: 63409, Seq: 1, Ack: 1461, Len: 0
  Source Port: 80
  Destination Port: 63409
  [Stream index: 7]
  [TCP Segment Len: 0]
  Sequence number: 1    (relative sequence number)
  Acknowledgment number: 1461    (relative ack number)
  0101 .... = Header Length: 20 bytes (5)
  Flags: 0x010 (ACK)
  Window size value: 69
  [Calculated window size: 8832]
  [Window size scaling factor: 128]
  Checksum: 0x5314 [unverified]
  [Checksum Status: Unverified]
  Urgent pointer: 0
  [SEQ/ACK analysis]
    [This is an ACK to the segment in frame: 106]
    [The RTT to ACK the segment was: 0.002769000 seconds]
    [iRTT: 0.006015000 seconds]
```

A

Figure 6

Sequence Number (Figure 5, A)
Time sent (Figure 5, B)
ACK received (Figure 5, C)
RTT for each packet (Figure 6, A)
Estimated RTT = (1-0.125) * EstimatedRTT + 0.125 * RTT

7. 1460 bytes for all six packets (Figure 7, A)

```
106 34.906503 172.17.51.30   130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=1 Ack=1 Win=65536 Len=1460
107 34.906534 172.17.51.30   130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=1461 Ack=1 Win=65536 Len=1460
108 34.906546 172.17.51.30   130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=2921 Ack=1 Win=65536 Len=1460
109 34.906558 172.17.51.30   130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=4381 Ack=1 Win=65536 Len=1460
110 34.909272 130.113.68.10  172.17.51.30    TCP      54 80 → 63409 [ACK] Seq=1 Ack=1461 Win=8832 Len=0
111 34.911848 172.17.51.30   130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=5841 Ack=1 Win=65536 Len=1460
112 34.911878 172.17.51.30   130.113.68.10   TCP    1514 63409 → 80 [ACK] Seq=7301 Ack=1 Win=65536 Len=1460
```

A

Figure 7

8. Buffer space: 5840 (Figure 8, A) ???

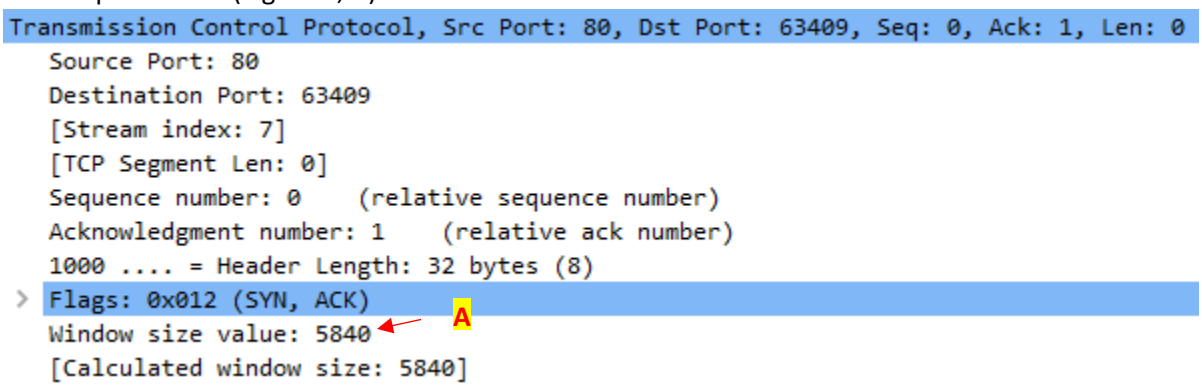

Figure 8

9. ???
10. ???
11. ???

4. TCP congestion control in action

12. ???