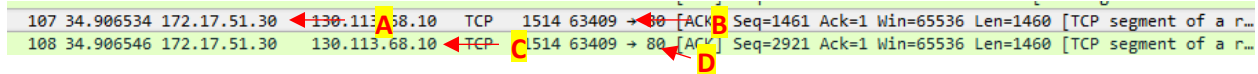


2. A first look at the captured trace

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



No.	Time	Source	Destination	Protocol	Length	Info
107	34.906534	172.17.51.30	130.113.68.10	TCP	1514	63409 → 80 [ACK] Seq=1461 Ack=1 Win=65536 Len=1460 [TCP segment of a r...]
108	34.906546	172.17.51.30	130.113.68.10	TCP	1514	63409 → 80 [ACK] Seq=2921 Ack=1 Win=65536 Len=1460 [TCP segment of a r...]

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)

Transmission Control Protocol, Src Port: 63409, Dst Port: 80, Seq: 0, Len: 0

Source Port: 63409

Destination Port: 80

[Stream index: 7]

[TCP Segment Len: 0]

Sequence number: 0 (relative sequence number) ← A

Acknowledgment number: 0

1000 = Header Length: 32 bytes (8)

Flags: 0x002 (SYN) ← B

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

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)

```

Transmission Control Protocol, Src Port: 80, Dst Port: 63409, Seq: 0, Ack: 1, Len: 0
Source Port: 80
Destination Port: 63409
[Stream index: 7]
[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number) ← A
Acknowledgment number: 1 (relative ack number) ← B
1000 .... = Header Length: 32 bytes (8)
✓ Flags: 0x012 (SYN, ACK) ← C
  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
[TCP Flags: .....A..S.]

```

Figure 3

5. Sequence number: 1 (relative sequence number) (Figure 4, 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
Frame 106: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits) on interface 0
Ethernet II, Src: IntelCor_6d:c3:65 (34:02:86:6d:c3:65), Dst: Cisco_ff:fd:9c (00:08:e3:ff:fd:9c)
Internet Protocol Version 4, Src: 172.17.51.30, Dst: 130.113.68.10
Transmission Control Protocol, Src Port: 63409, Dst Port: 80, Seq: 1, Ack: 1, Len: 1460
Source Port: 63409
Destination Port: 80
[Stream index: 7]
[TCP Segment Len: 1460]
Sequence number: 1 (relative sequence number) ← A
[Next sequence number: 1461 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
0101 .... = Header Length: 20 bytes (5)
Flags: 0x010 (ACK)
Window size value: 256
[Calculated window size: 65536]
[Window size scaling factor: 256]
Checksum: 0xf65d [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
[SEQ/ACK analysis]
  [iRTT: 0.006015000 seconds]
  [Bytes in flight: 1460]
  [Bytes sent since last PSH flag: 1460]
TCP payload (1460 bytes)
Data (1460 bytes)
0000 50 4f 53 54 20 2f 7e 72 7a 68 65 6e 67 2f 63 6f POST /~rzheng/co
0010 75 72 73 65 2f 43 41 53 34 43 30 33 57 31 37 2f urse/CAS4C03u17/

```

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)

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

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=25
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	

Sequence number: 1 (relative sequence number)
 [Next sequence number: 1461 (relative sequence number)]
 Acknowledgment number: 1 (relative ack number)
 0101 = Header Length: 20 bytes (5)
 > Flags: 0x010 (ACK)
 Window size value: 256
 [Calculated window size: 65536]
 [Window size scaling factor: 256]
 Checksum: 0xf65d [unverified]
 [Checksum Status: Unverified]
 Urgent pointer: 0
 ✓ [SEQ/ACK analysis]
 [iRTT: 0.006015000 seconds]
 [Bytes in flight: 1460]
 [Bytes sent since last PSH flag: 1460]
 TCP payload (1460 bytes)
 Data (1460 bytes)
 Data: 504f5354202f7e727a68656e672f636f757273652f434153...
 [Length: 1460]

0 01 00 f6 5d 00 00 50 4f 53 54 20 2f 7e 72 7a 68 ...].PO ST /~rzh

Figure 5

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4C03 – ASSIGNMENT 2

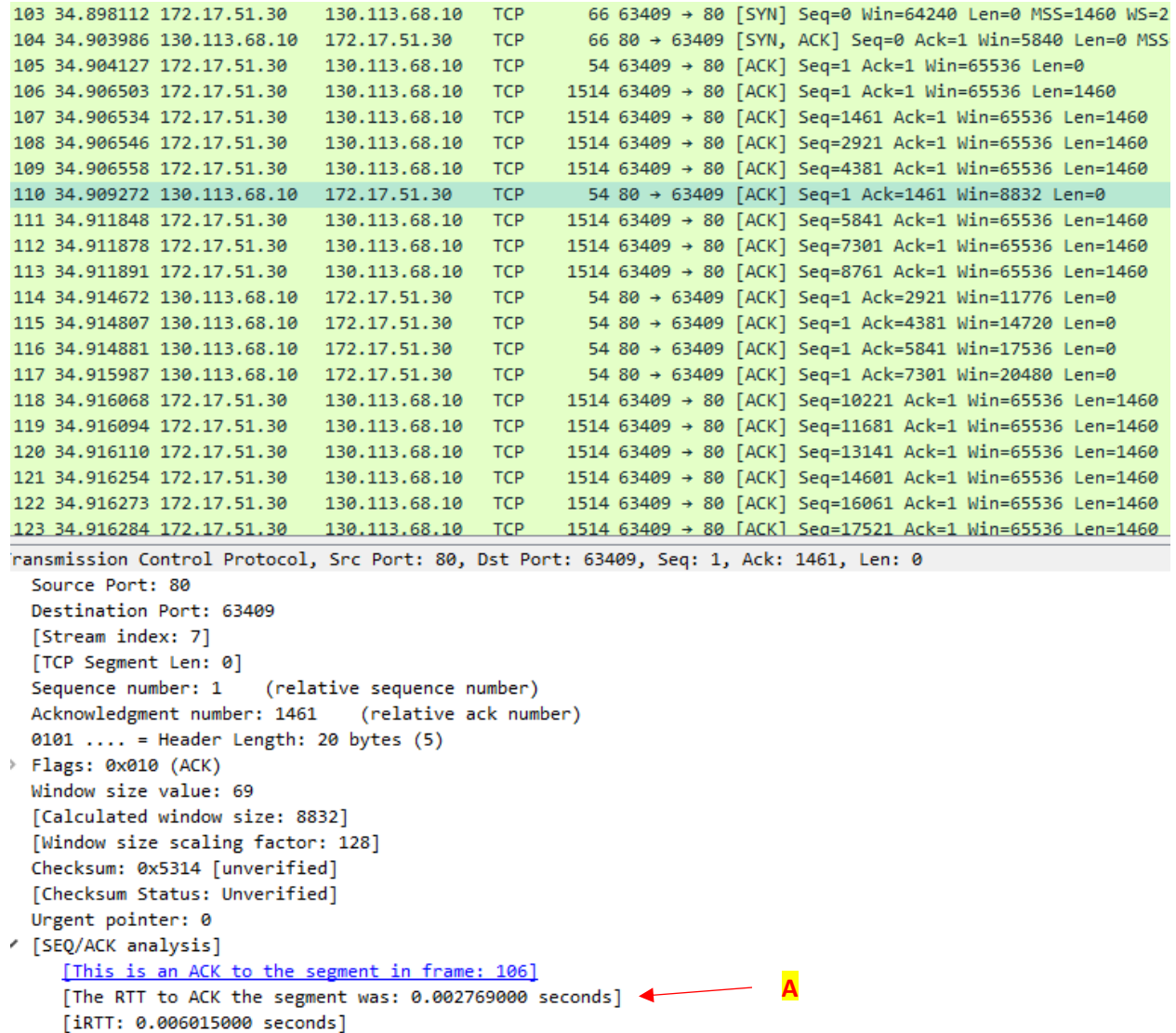


Figure 6

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)

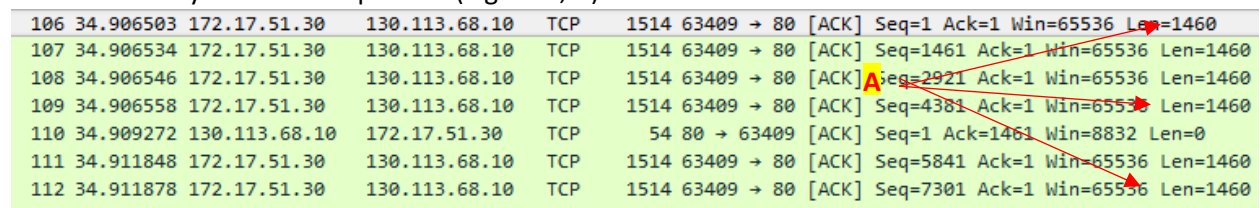


Figure 7

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

```
Transmission Control Protocol, Src Port: 80, Dst Port: 63409, Seq: 0, Ack: 1, Len: 0
  Source Port: 80
  Destination Port: 63409
  [Stream index: 7]
  [TCP Segment Len: 0]
  Sequence number: 0    (relative sequence number)
  Acknowledgment number: 1    (relative ack number)
  1000 .... = Header Length: 32 bytes (8)
> Flags: 0x012 (SYN, ACK)
  Window size value: 5840
  [Calculated window size: 5840]
```

Figure 8

9. ???

10. ???

11. ???

4. TCP congestion control in action

12. ???