

## LAB-4

1. Pick a TCP request/response pair. Identify the IP address and port number used by the client and server. What are their sequence numbers? Observe the protocol number for TCP.

### Client:

11 0.194633	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
15 0.248708	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
18 0.266098	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=89 Win=69 Len=0
22 0.320992	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=177 Win=69 Len=0
40 0.668152	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
41 0.668249	192.168.0.9	216.58.197.68	TLSv1.2	93 Application Data
42 0.668539	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
44 0.685705	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
48 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=238 Win=520 Len=0
49 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=277 Win=520 Len=0
50 0.744209	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=514 Win=527 Len=0
51 0.747291	216.58.197.68	192.168.0.9	TLSv1.2	93 Application Data
52 0.756424	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=265 Win=69 Len=0
55 0.788685	192.168.0.9	216.58.197.68	TCP	54 1718 → 443 [ACK] Seq=514 Ack=40 Win=514 Len=0
57 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	284 Application Data
58 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	640 Application Data
59 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	412 Application Data
60 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	86 [TCP Previous segment not captured] , Application Data
61 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	124 Application Data. Application Data

Protocol: TCP (6)  
Header checksum: 0x0000 [validation disabled]  
[Header checksum status: Unverified]  
Source: 192.168.0.9 → IP Address  
Destination: 216.58.197.68  
Transmission Control Protocol, Src Port: 1718, Dst Port: 443, Seq: 1, Ack: 1, Len: 237  
Source Port: 1718 → Port Number  
Destination Port: 443  
[Stream index: 1]  
[TCP Segment Len: 237]  
Sequence number: 1 (relative sequence number)

### Server:

40 0.668152	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
41 0.668249	192.168.0.9	216.58.197.68	TLSv1.2	93 Application Data
42 0.668539	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
44 0.685705	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
48 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=238 Win=520 Len=0
49 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=277 Win=520 Len=0
50 0.744209	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=514 Win=527 Len=0
51 0.747291	216.58.197.68	192.168.0.9	TLSv1.2	93 Application Data
52 0.756424	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=265 Win=69 Len=0
55 0.788685	192.168.0.9	216.58.197.68	TCP	54 1718 → 443 [ACK] Seq=514 Ack=40 Win=514 Len=0
57 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	284 Application Data
58 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	640 Application Data
59 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	412 Application Data
60 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	86 [TCP Previous segment not captured] , Application Data
61 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	124 Application Data. Application Data

Protocol: TCP (6)  
Header checksum: 0x374f [validation disabled]  
[Header checksum status: Unverified]  
Source: 216.58.197.68 → IP Address  
Destination: 192.168.0.9  
Transmission Control Protocol, Src Port: 443, Dst Port: 1718, Seq: 1, Ack: 238, Len: 0  
Source Port: 443 → Port Number  
Destination Port: 1718  
[Stream index: 1]  
[TCP Segment Len: 0]  
Sequence number: 1 (relative sequence number)  
Sequence number (raw): 2172909561  
[Next sequence number: 1 (relative sequence number)]

Sequence Number: 1,238,277,514.....

42 0.668539	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
44 0.685705	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
48 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=238 Win=520 Len=0
49 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=277 Win=520 Len=0
50 0.744209	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=514 Win=527 Len=0
51 0.747291	216.58.197.68	192.168.0.9	TLSv1.2	93 Application Data
52 0.756424	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=265 Win=69 Len=0
55 0.788685	192.168.0.9	216.58.197.68	TCP	54 1718 → 443 [ACK] Seq=514 Ack=40 Win=514 Len=0
57 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	284 Application Data
58 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	640 Application Data
59 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	412 Application Data
60 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	86 [TCP Previous segment not captured] , Application Data
61 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	124 Application Data, Application Data
62 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	86 Application Data
63 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	85 Application Data
64 0.817012	192.168.0.9	216.58.197.68	TCP	66 1718 → 443 [ACK] Seq=514 Ack=1214 Win=510 Len=0 SLE=1800 SRE=1832
65 0.817074	192.168.0.9	216.58.197.68	TCP	66 [TCP Dup ACK 64#1] 1718 → 443 [ACK] Seq=514 Ack=1214 Win=510 Len=0 SLE=1800 SRE=1832

> Differentiated Services Field: 0x20 (DSCP: CS1, ECN: Not-ECT)  
Total Length: 79  
Identification: 0xaf33 (44851)  
> Flags: 0x0000  
Fragment offset: 0  
Time to live: 118  
Protocol: TCP (6)  
Header checksum: 0x3725 [validation disabled]  
[Header checksum status: Unverified]  
Source: 216.58.197.68  
Destination: 192.168.0.9  
> Transmission Control Protocol, Src Port: 443, Dst Port: 1718, Seq: 1, Ack: 514, Len: 39  
> Transport Layer Security

0000	5c 87 9c 8a c8 39 f4 8c	eb a7 c6 ab 08 00 45 20	\....9... ..E
0010	00 4f af 33 00 00 76 06	37 25 d8 3a c5 44 c0 a8	..0.3...v. 7%...D..
0020	00 09 01 bb 06 b6 81 83	f7 f9 d9 c9 b3 d1 50 18	.....P.....
0030	02 0f cf 97 00 00 17 03	03 00 22 60 72 ee 54 fd	....."r-T.....
0040	6b 75 c1 06 a0 56 ad a9	ab a1 d2 47 fc 8e b0 c8	ku...V... ..G....
0050	ed df 1d de 6d 18 f3 ee	hh q2 f1 6e bf	...Md... ..n....

Protocol number: 6

11 0.194633	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
15 0.248708	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
18 0.266098	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=89 Win=69 Len=0
22 0.320992	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=177 Win=69 Len=0
40 0.668152	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
41 0.668249	192.168.0.9	216.58.197.68	TLSv1.2	93 Application Data
42 0.668539	192.168.0.9	216.58.197.68	TLSv1.2	291 Application Data
44 0.685705	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
48 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=238 Win=520 Len=0
49 0.743280	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=277 Win=520 Len=0
50 0.744209	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1 Ack=514 Win=527 Len=0
51 0.747291	216.58.197.68	192.168.0.9	TLSv1.2	93 Application Data
52 0.756424	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=265 Win=69 Len=0
55 0.788685	192.168.0.9	216.58.197.68	TCP	54 1718 → 443 [ACK] Seq=514 Ack=40 Win=514 Len=0
57 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	284 Application Data
58 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	640 Application Data
59 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	412 Application Data
60 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	86 [TCP Previous segment not captured] , Application Data
61 0.816894	216.58.197.68	192.168.0.9	TLSv1.2	124 Application Data, Application Data

Protocol: TCP (6)  
Header checksum: 0x374f [validation disabled]  
[Header checksum status: Unverified]  
Source: 216.58.197.68  
Destination: 192.168.0.9  
Transmission Control Protocol, Src Port: 443, Dst Port: 1718, Seq: 1, Ack: 238, Len: 0  
Source Port: 443  
Destination Port: 1718  
[Stream index: 1]  
[TCP Segment Len: 0]  
Sequence number: 1 (relative sequence number)  
Sequence number (raw): 2172909561  
[Next sequence number: 1 (relative sequence number)]  
Relative sequence number: 238 (relative sequence number)

1. Observe the value of SYN flag in SYN and SYNACK messages from the client and server

#### Client:

139	2.211960	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=617 Win=69 Len=0
140	2.215644	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
144	2.287636	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=705 Win=69 Len=0
158	2.498009	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
162	2.569014	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=793 Win=69 Len=0
168	2.654705	192.168.0.9	142.250.71.3	TCP	66 1968 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
170	2.658886	192.168.0.9	216.58.197.68	TLSv1.2	814 Application Data
174	2.734029	142.250.71.3	192.168.0.9	TCP	66 443 → 1968 [SYN, ACK] Seq=0 Ack=1 Win=60720 Len=0 MSS=1360 SACK_PERM=1 WS=256
175	2.734222	192.168.0.9	142.250.71.3	TCP	54 1968 → 443 [ACK] Seq=1 Ack=1 Win=131840 Len=0
176	2.734612	192.168.0.9	142.250.71.3	TLSv1.3	637 Client Hello
177	2.734808	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1965 Ack=1313 Win=533 Len=0
178	2.808902	142.250.71.3	192.168.0.9	TCP	54 443 → 1968 [ACK] Seq=1 Ack=584 Win=61952 Len=0
179	2.834797	216.58.197.68	192.168.0.9	TLSv1.2	492 Application Data
180	2.834797	216.58.197.68	192.168.0.9	TLSv1.2	1414 Application Data

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
[TCP Flags: .....S.]		
Window size value: 64240		
[Calculated window size: 64240]		

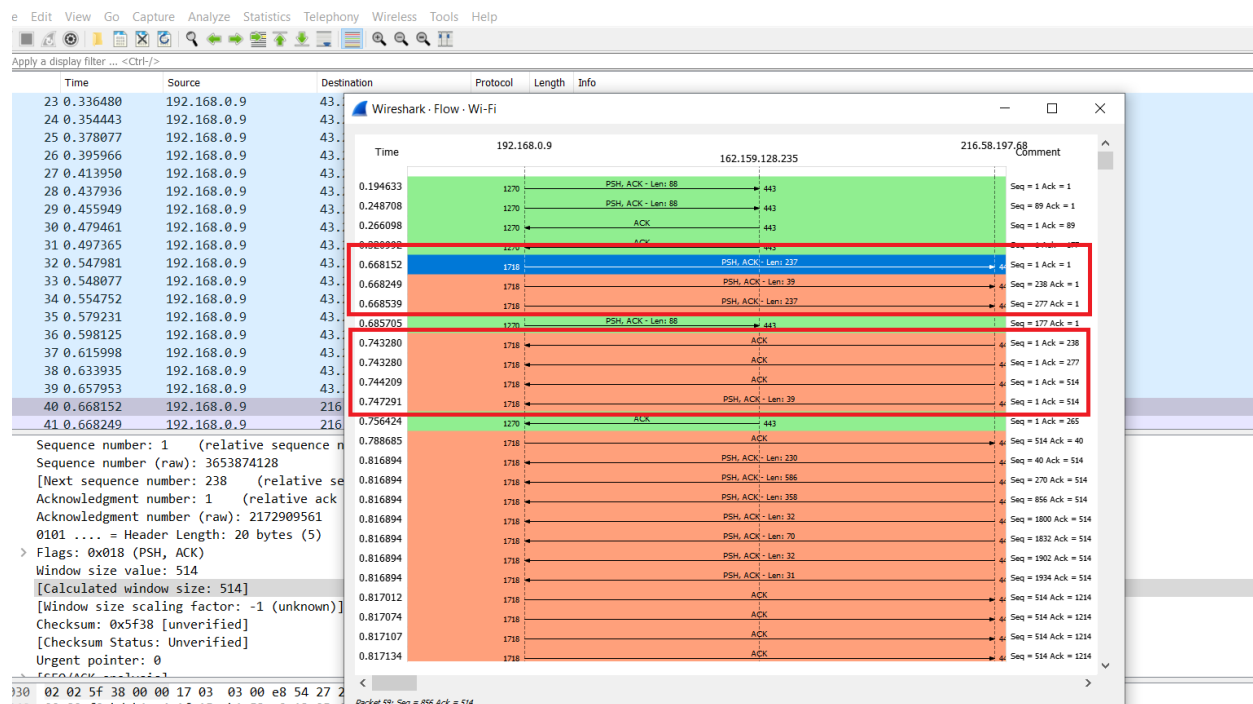
#### Server:

139	2.211960	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=617 Win=69 Len=0
140	2.215644	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
144	2.287636	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=705 Win=69 Len=0
158	2.498009	192.168.0.9	162.159.128.235	TLSv1.2	142 Application Data
162	2.569014	162.159.128.235	192.168.0.9	TCP	60 443 → 1270 [ACK] Seq=1 Ack=793 Win=69 Len=0
168	2.654705	192.168.0.9	142.250.71.3	TCP	66 1968 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
170	2.658886	192.168.0.9	216.58.197.68	TLSv1.2	814 Application Data
174	2.734029	142.250.71.3	192.168.0.9	TCP	66 443 → 1968 [SYN, ACK] Seq=0 Ack=1 Win=60720 Len=0 MSS=1360 SACK_PERM=1 WS=256
175	2.734222	192.168.0.9	142.250.71.3	TCP	54 1968 → 443 [ACK] Seq=1 Ack=1 Win=131840 Len=0
176	2.734612	192.168.0.9	142.250.71.3	TLSv1.3	637 Client Hello
177	2.734808	216.58.197.68	192.168.0.9	TCP	60 443 → 1718 [ACK] Seq=1965 Ack=1313 Win=533 Len=0
178	2.808902	142.250.71.3	192.168.0.9	TCP	54 443 → 1968 [ACK] Seq=1 Ack=584 Win=61952 Len=0
179	2.834797	216.58.197.68	192.168.0.9	TLSv1.2	492 Application Data
180	2.834797	216.58.197.68	192.168.0.9	TLSv1.2	1414 Application Data

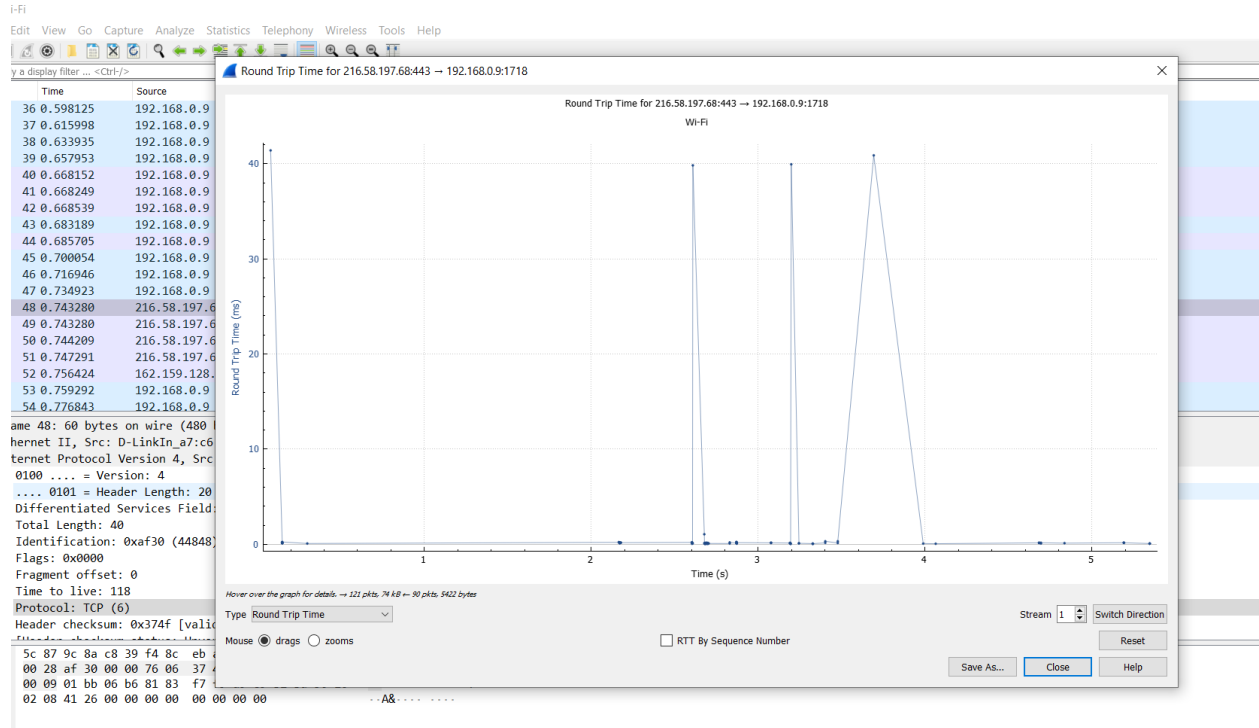
  

000.	.....	= Reserved: Not set
...0	.....	= Nonce: Not set
....0...	.....	= Congestion Window Reduced (CWR): Not set
....0...	.....	= ECN-Echo: Not set
....0...	.....	= Urgent: Not set
....0...	.....	= Acknowledgment: Not set
....0...	.....	= Push: Not set
....0...	.....	= Reset: Not set
> ....	...1.	= Syn: Set
....	.....0	= Fin: Not set
[TCP Flags: .....S.]		
Window size value: 64240		
[Calculated window size: 64240]		

Seq = 1 sent at 0.668152; ACK received at 0.743280, its RTT = 0.075128  
Seq = 238 sent at 0.668249; ACK received at 0.744209, its RTT = 0.07596  
Seq = 277 sent at 0.668539; ACK received at 0.747291, its RTT = 0.078752  
Seq = 514 sent at 0.788685; ACK received at 0.816894, its RTT = 0.078209

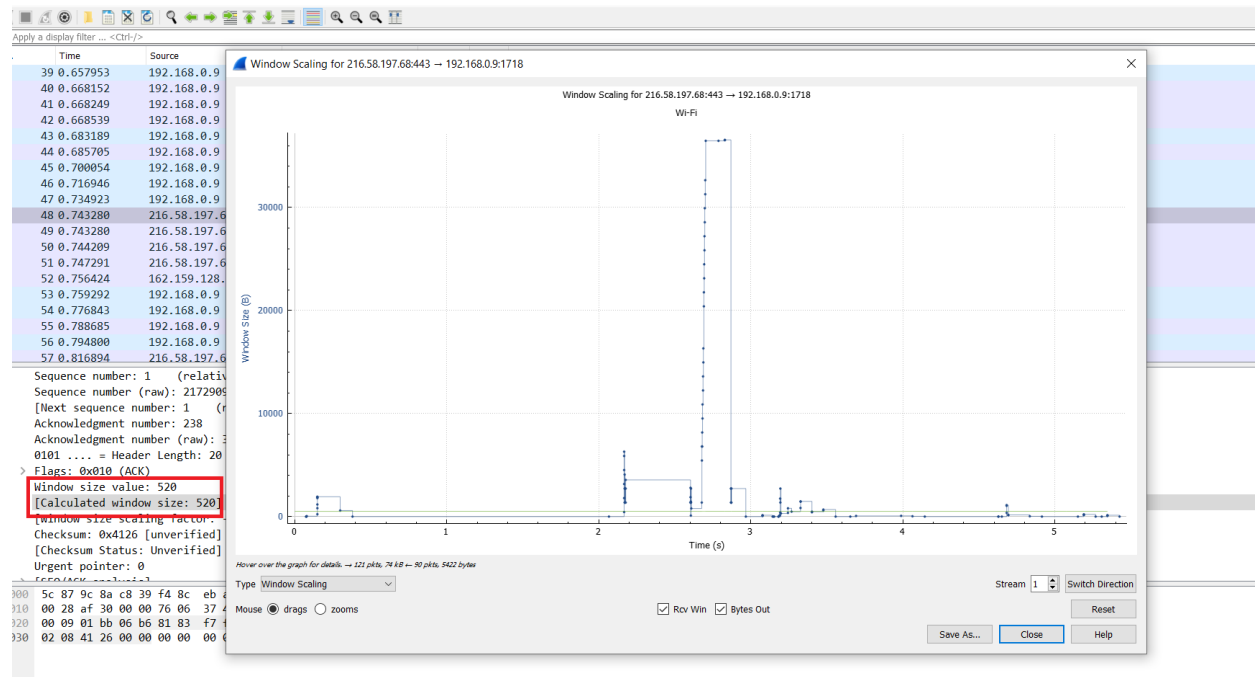


RTT graph:



4. Observe the growth of receive buffer in question 4. What is the size of send buffer?

The size of the receive buffer is 520



The size of send buffer is 514

