

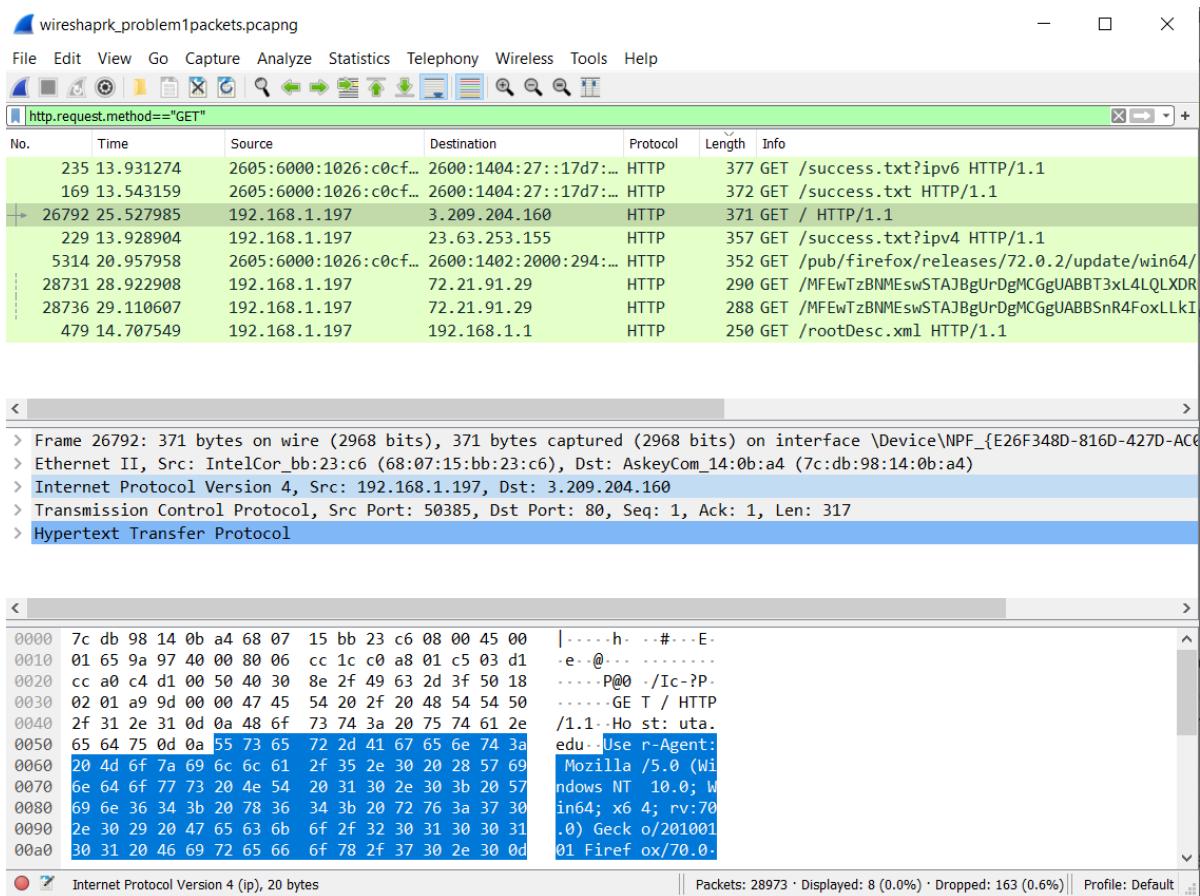
**Computer Networks Project 2**  
**Name : Vaishnavi Chitloor Venkatesh**  
**Student ID : 1001724384**

Problem Set 1:

- What is the IP address and TCP port number used by your client computer (source) to browse the page [uta.edu](http://uta.edu).  
 (Use the 'GET' message to answer the following questions )

Ans : Source IP : 192.168.1.197

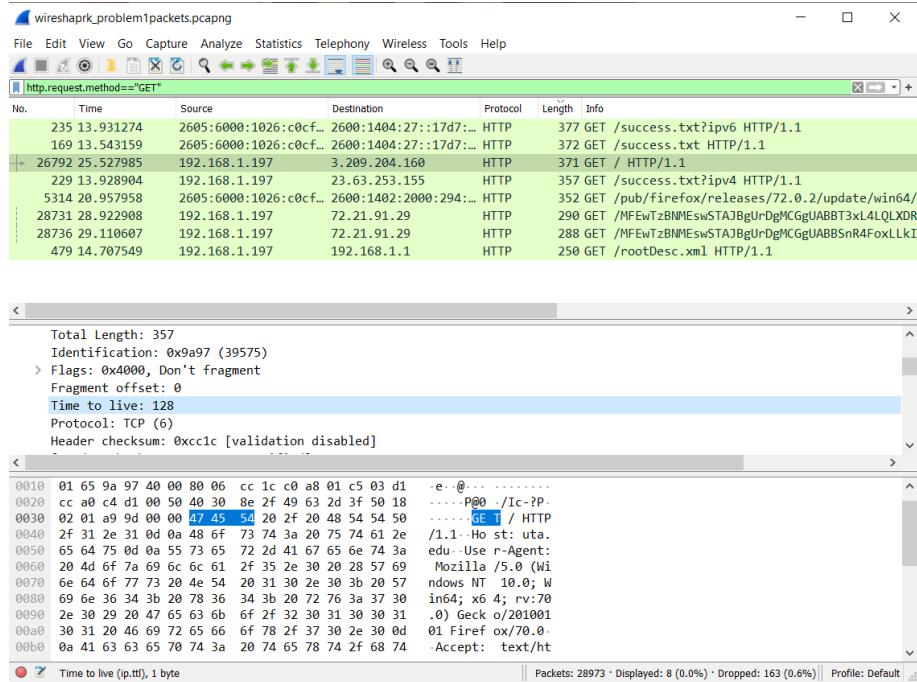
Source Port: 50385



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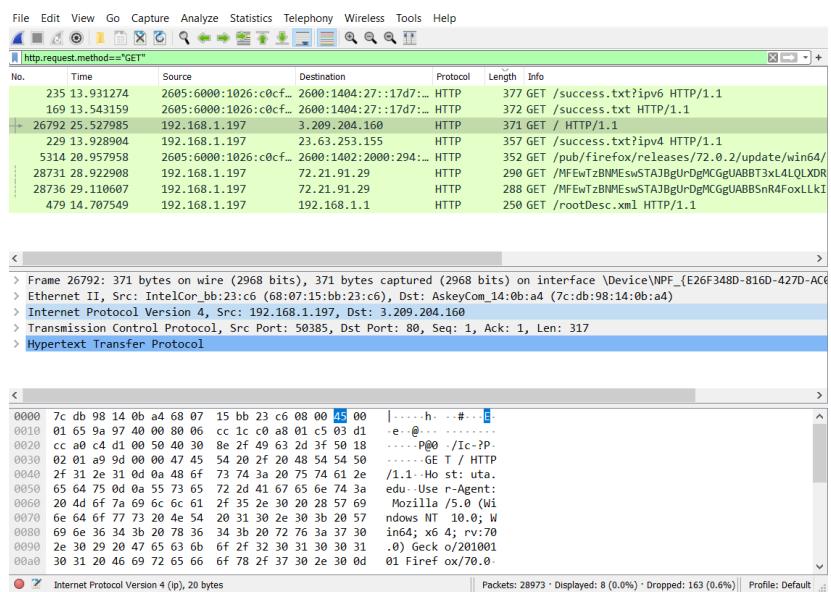
2. What is the TTL value that is used in this communication ?

TTL Value is 128



3. Did you Use IPV4 or IPV6 for communication ?

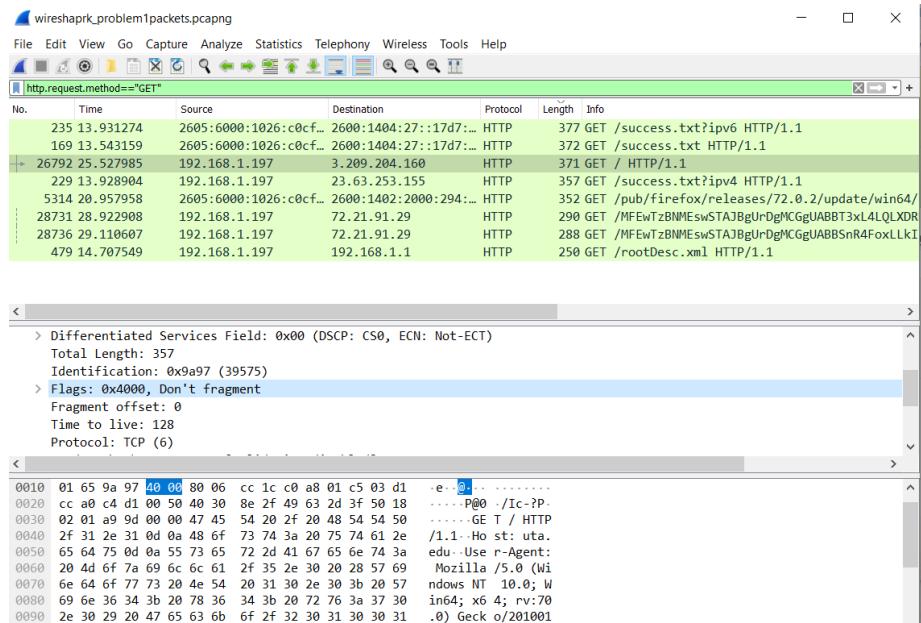
IPV4 is used during communication



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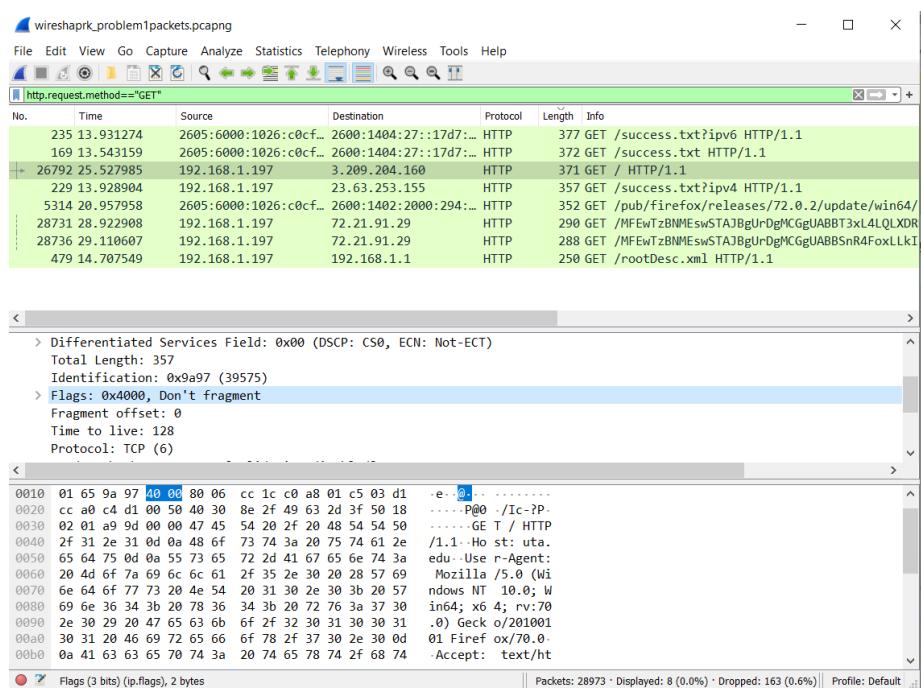
4. Does your optional field has some particular information or not.

No, it does not contain any particular information in the optional field.



5. Is the Packet Fragmented ?

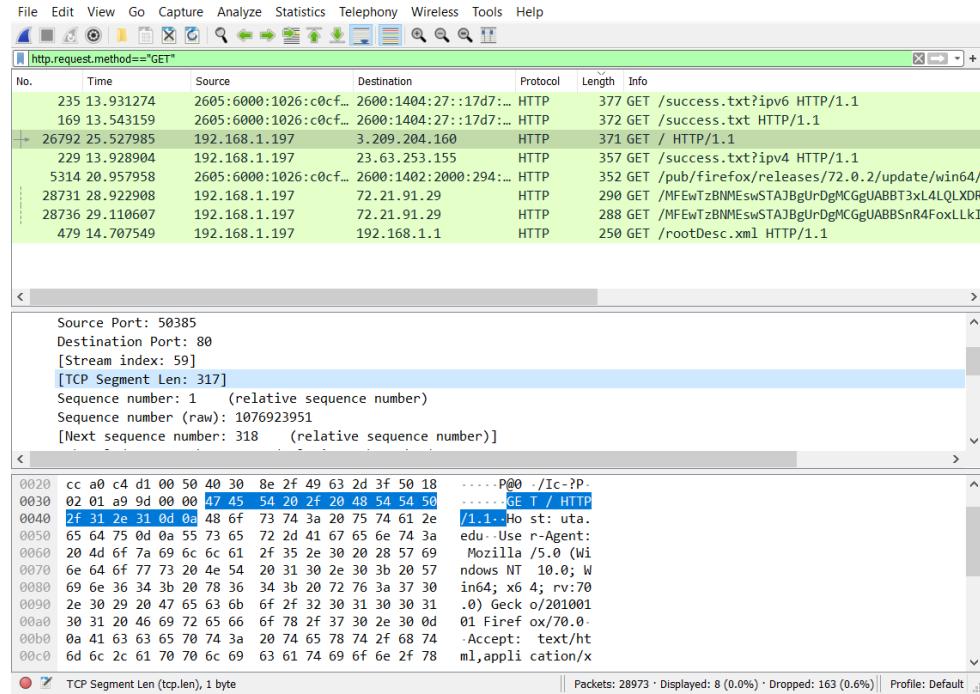
Packet Fragmented ( Don't Fragment)



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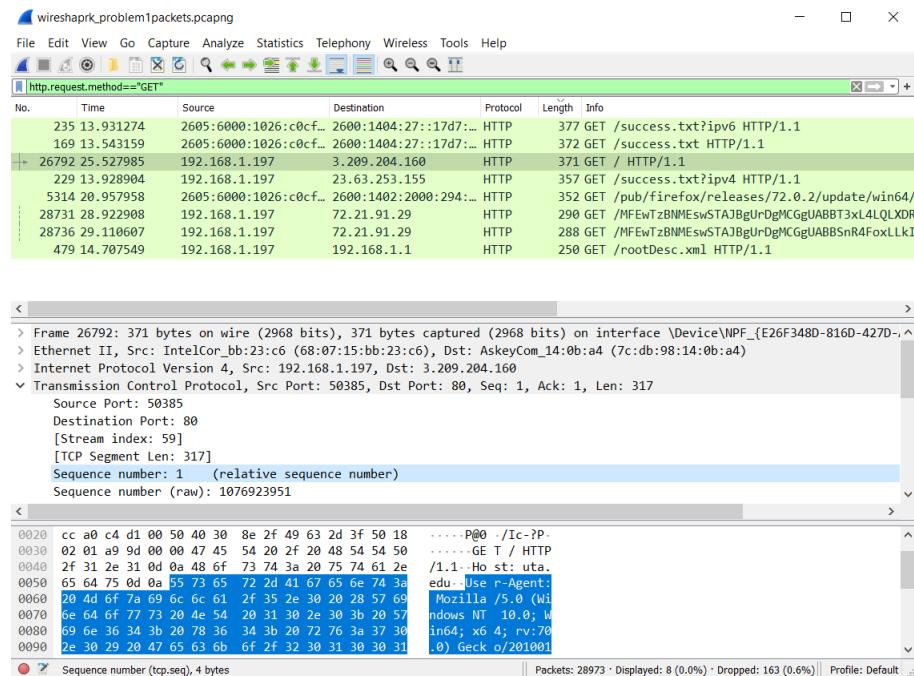
## 6. What is the TCP segment length ?

TCP Segment Length: 317



## 7. What is the Sequence Number of TCP segment (you can use the relative sequence number).

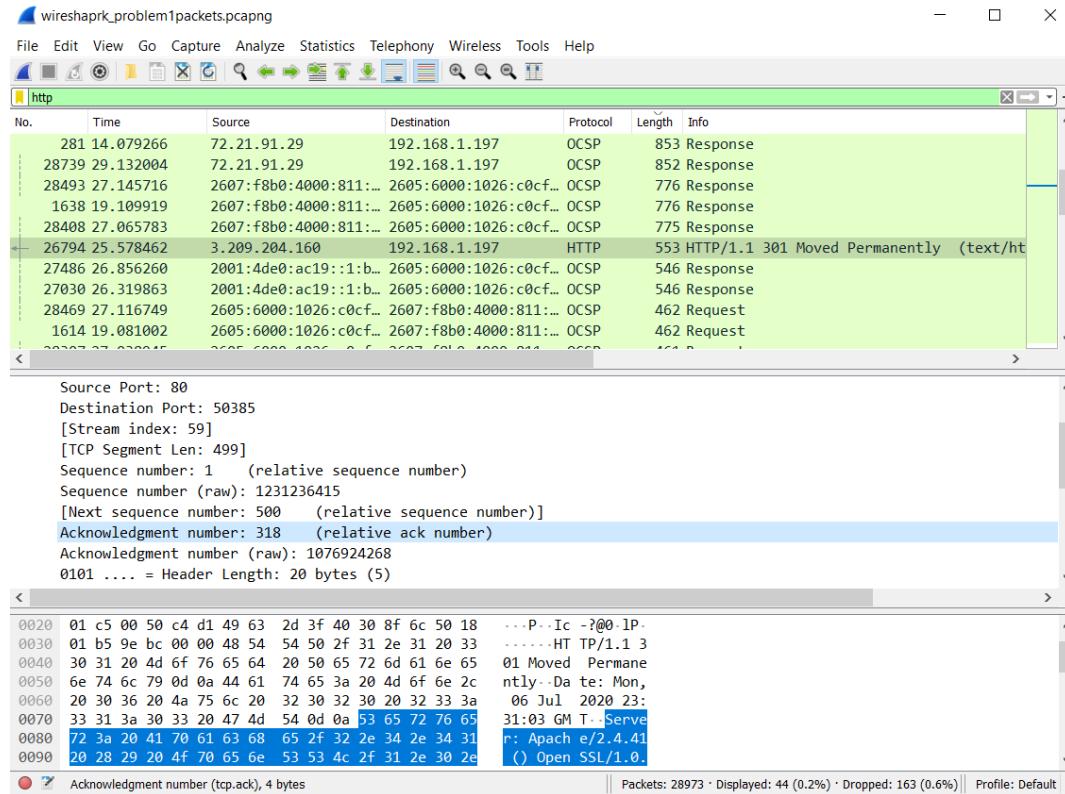
Sequence number is 1



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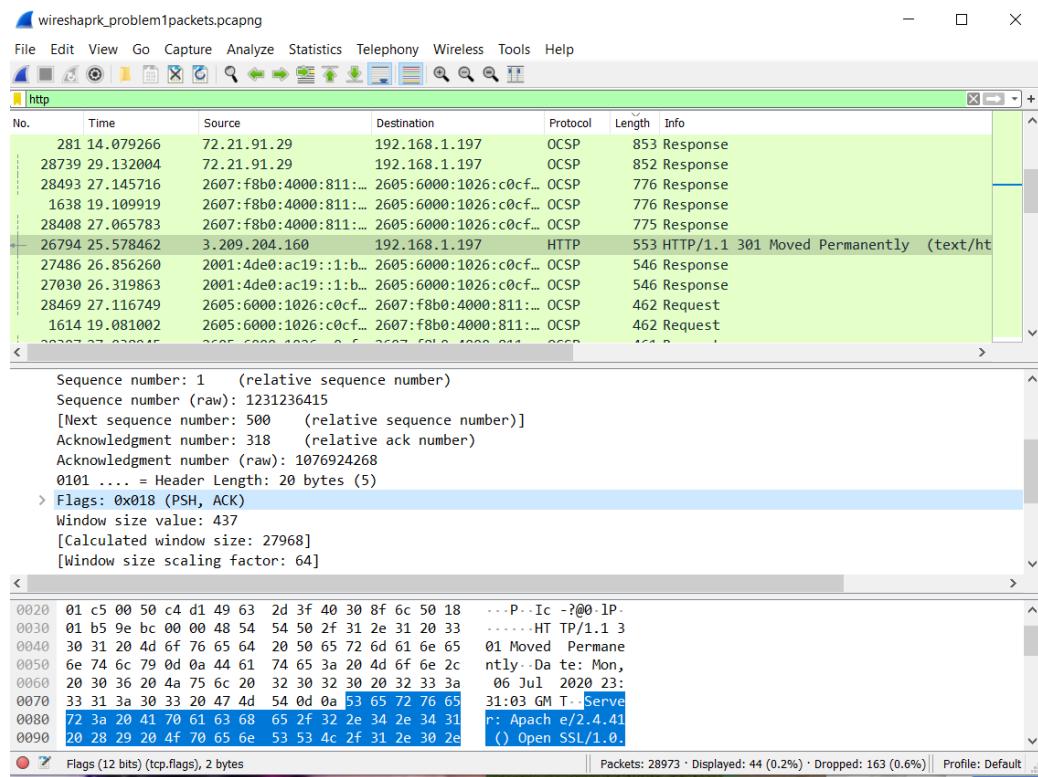
8. Calculate the acknowledgement number based on the two questions above. Verify your solution with the Wireshark values.

Ack Number = TCP Segment Length + Sequence number = 318



9. What are the fields in the TCP Flags. No need to give any values but give the field names given in Wireshark

Ans: PSH Flag is used in the Packet capture

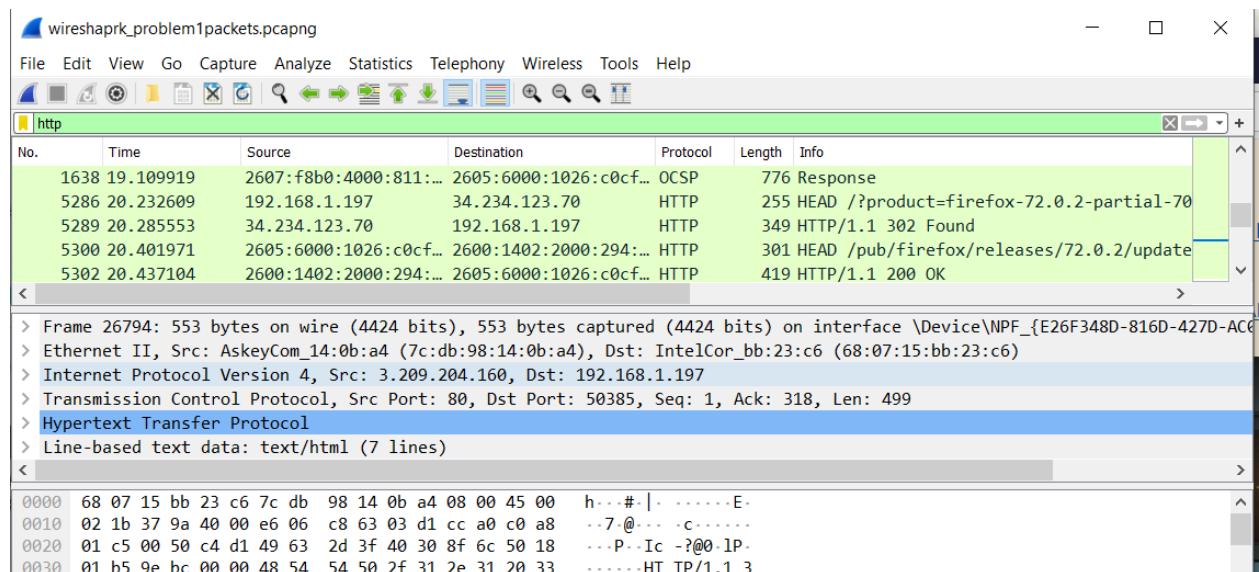


10. What is the IP address of [uta.edu](http://uta.edu)? On what port number is it sending and receiving TCP segments for this connection?

IP address of [uta.edu](http://uta.edu) : 3.209.204.160

Sending Port No. : 80

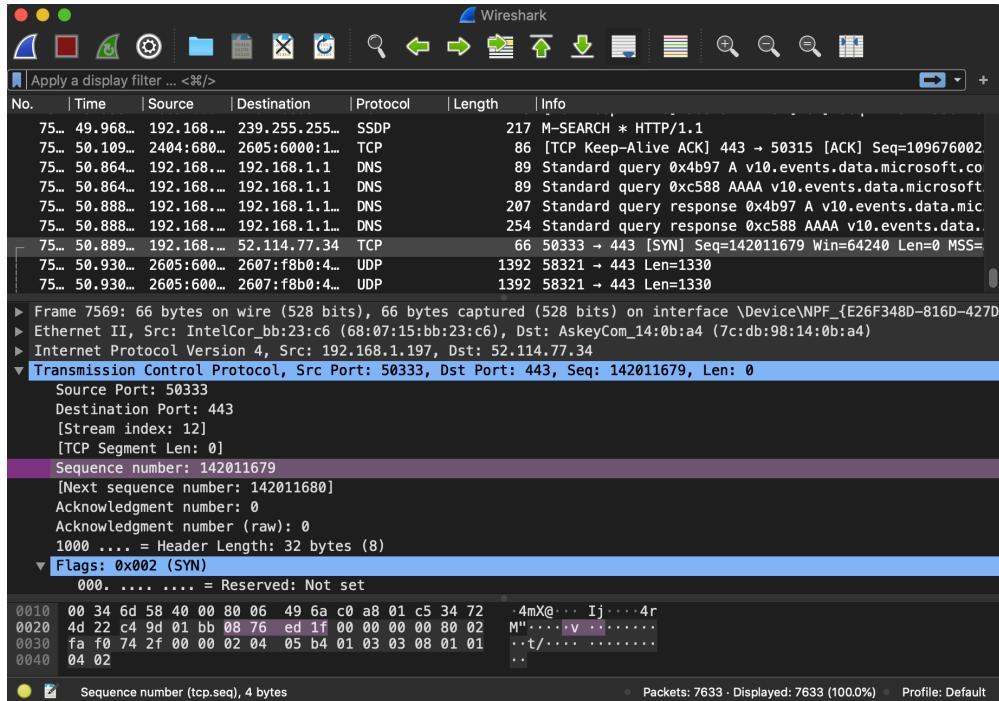
Receiving Port No. : 50385



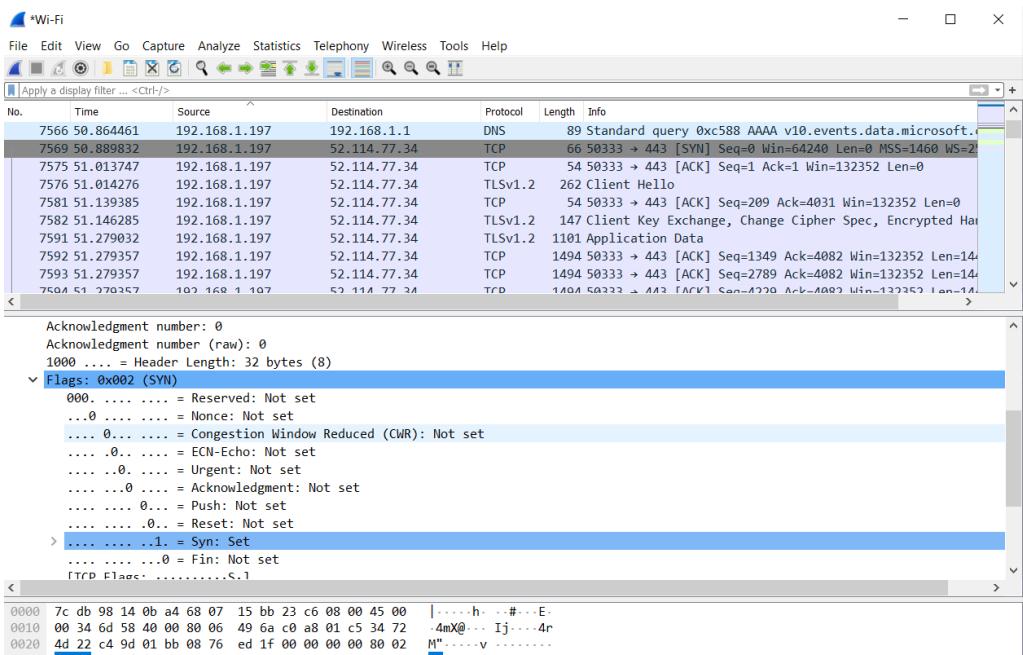
### Problem Set 2:

- What is the sequence number ( absolute ) of the TCP SYN segment that is used to initiate the TCP connection between the client computer and youtube.com?

Absolute Sequence number : 142011679



- What is it in the segment that identifies the segment as a SYN segment?

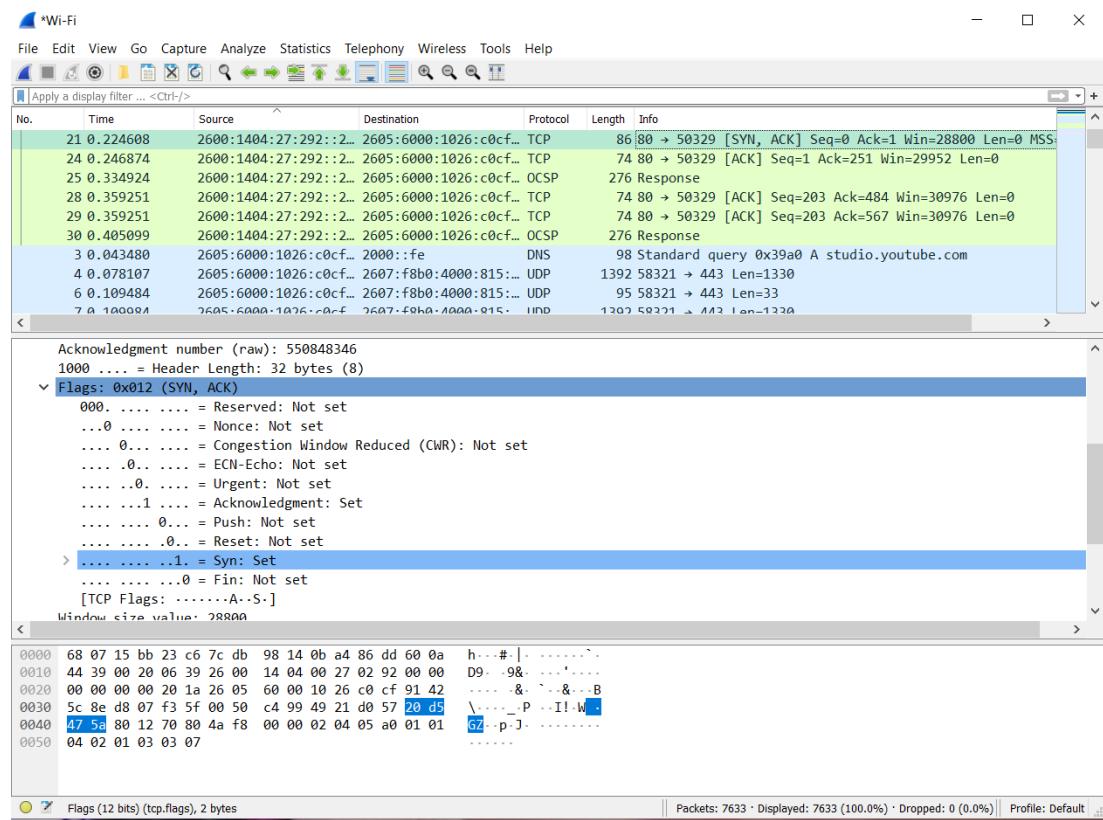


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The SYN bit is set to 1 which indicates that this segment is SYN segment.

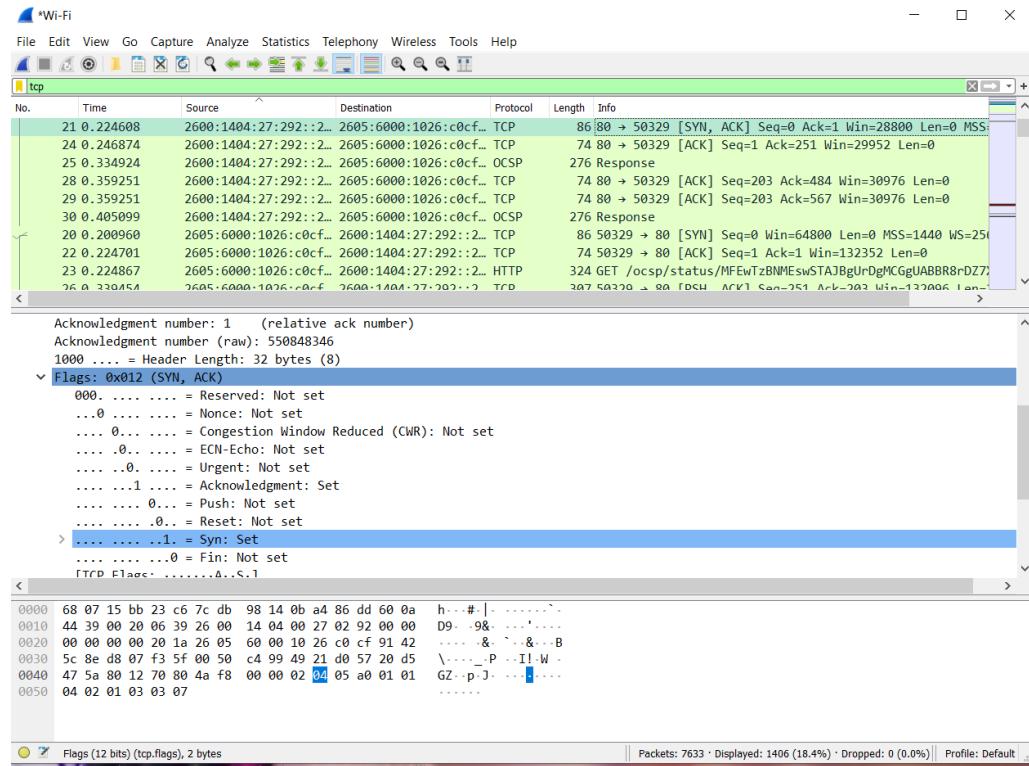
3. What is the sequence number of the SYNACK segment sent by youtube.com to the client computer in reply to the SYN? What is the value of the Acknowledgement field in the SYNACK segment?

Seq No. Of the SYNACK segment from youtube.com to the client computer in reply to the SYN has value 0 in this trace. The value of the acknowledgment field in the SYNACK segment is 1.



4. How did youtube.com determine that value? What is it in the segment that identifies the segment as a SYNACK segment?

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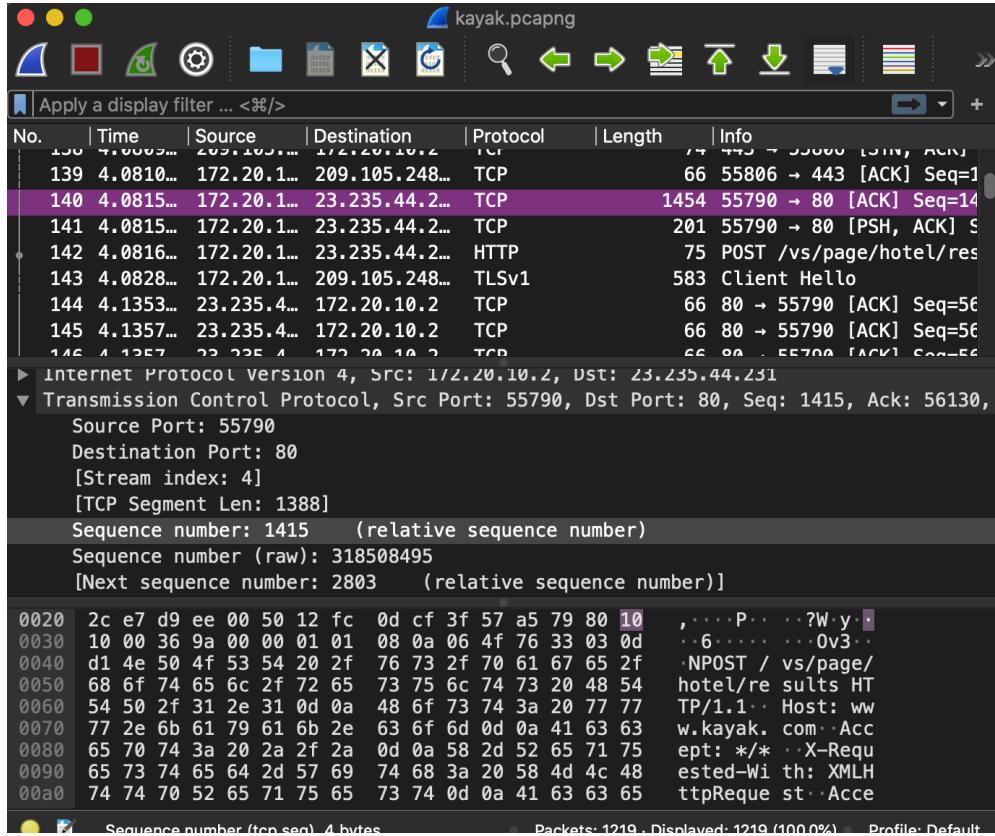
The value of the Acknowledgement field i.e when ACK is set to 1 in the SYNACK

Segment is determined by [youtube.com](https://youtube.com) by adding 1 to the initial sequence number of SYN segment i.e Sequence number = 0 from the client computer. The SYN flag and Acknowledgement flag in the segment are set to 1 and they indicate that this segment is A SYNACK segment.

### Problem Set 3

- What is the sequence number of the TCP segment containing the first HTTP POST command?

Sequence Number is 1415

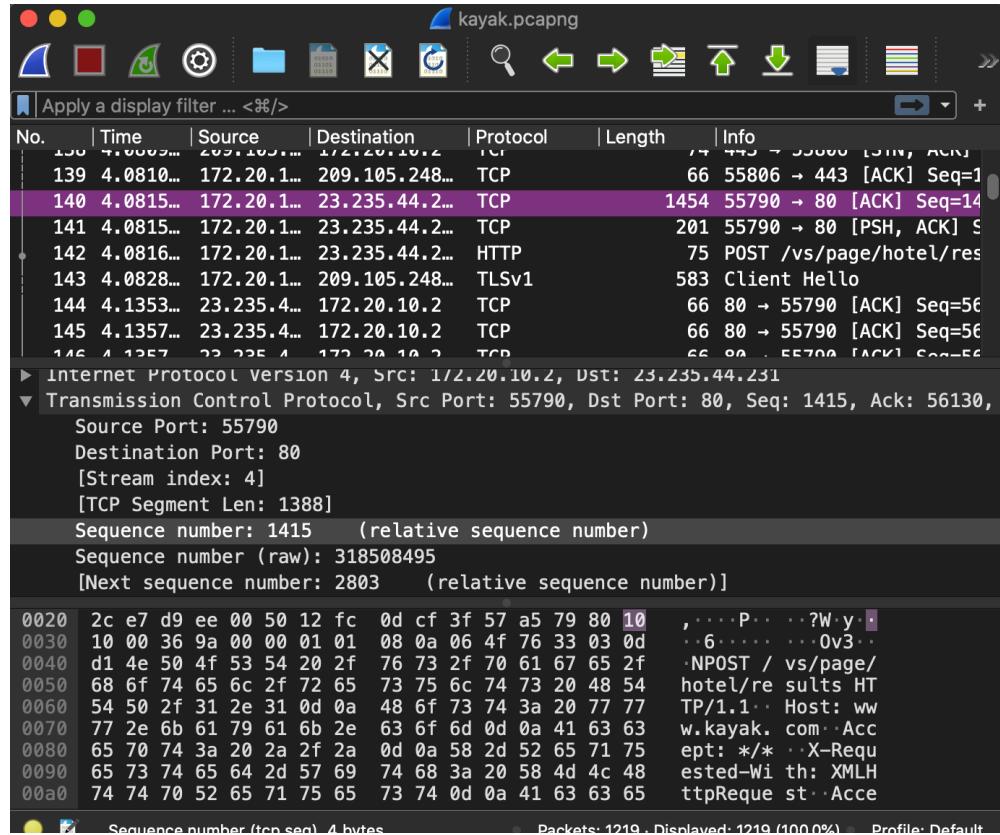


- Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection.

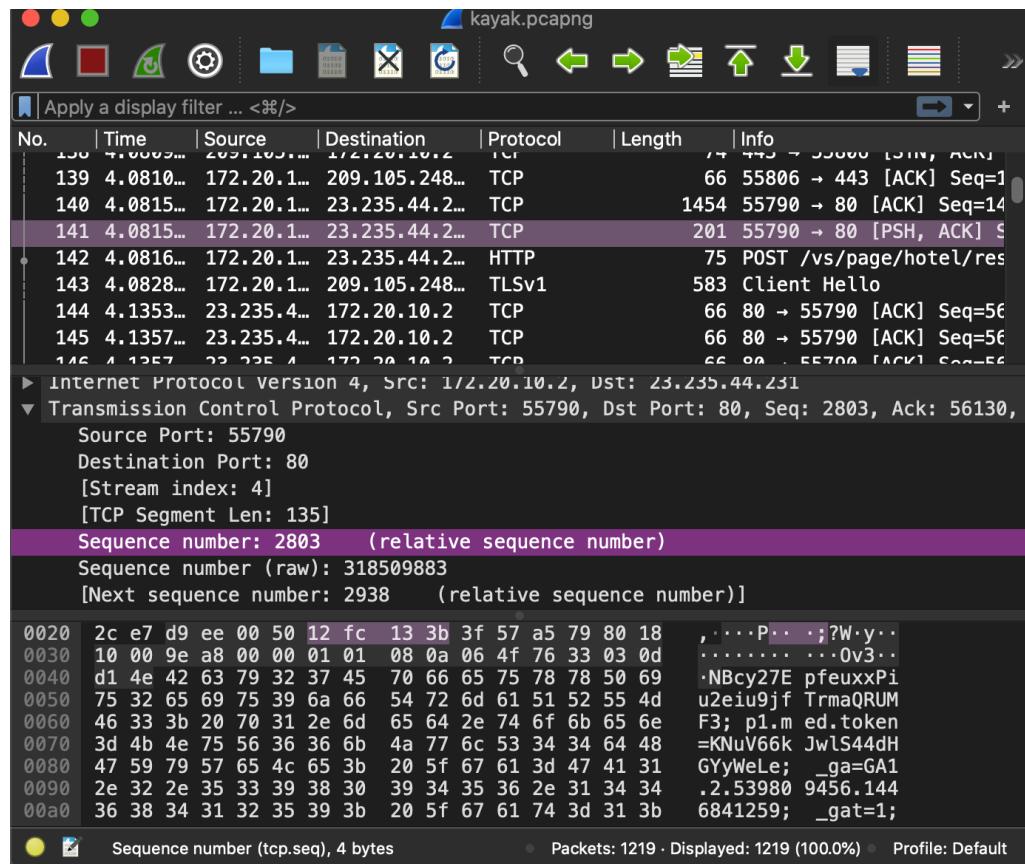
- What are the sequence numbers of the first four segments in the TCP connection (including the segment containing the HTTP POST)?

Segment 1: 1415

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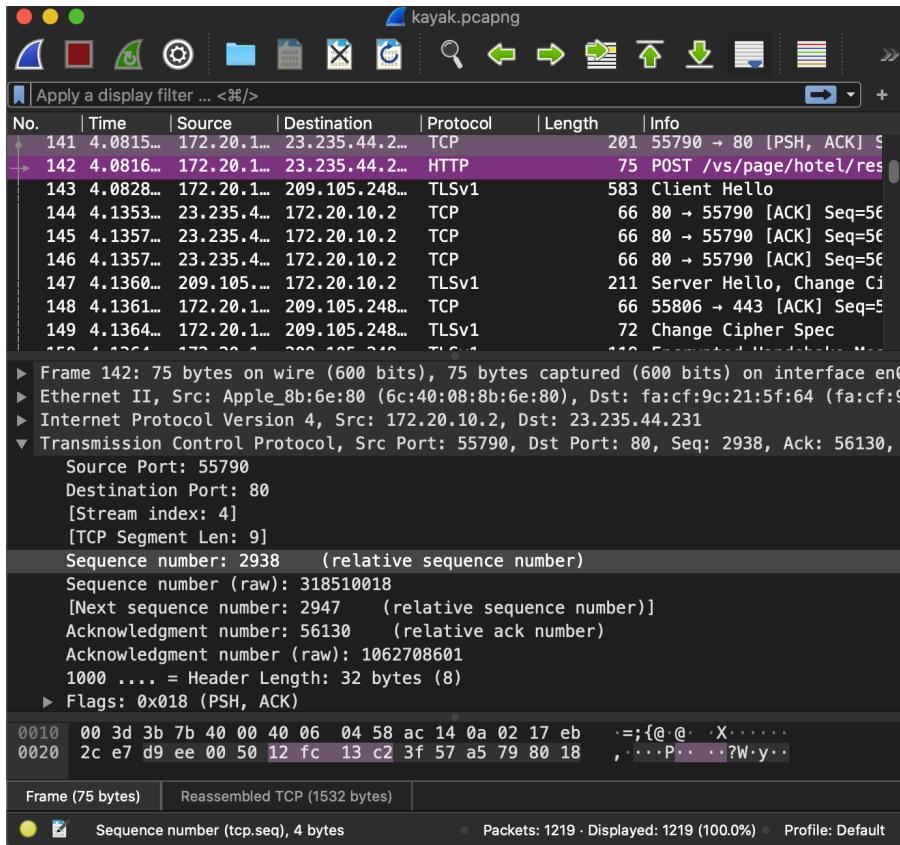


Segment 2: 2803

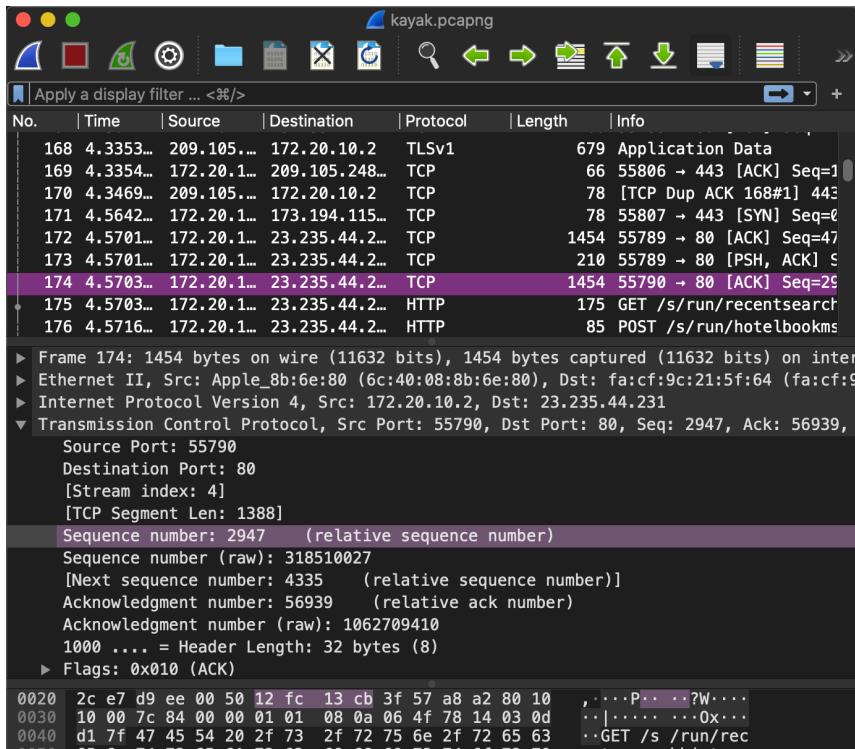


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## Segment 3: 2938

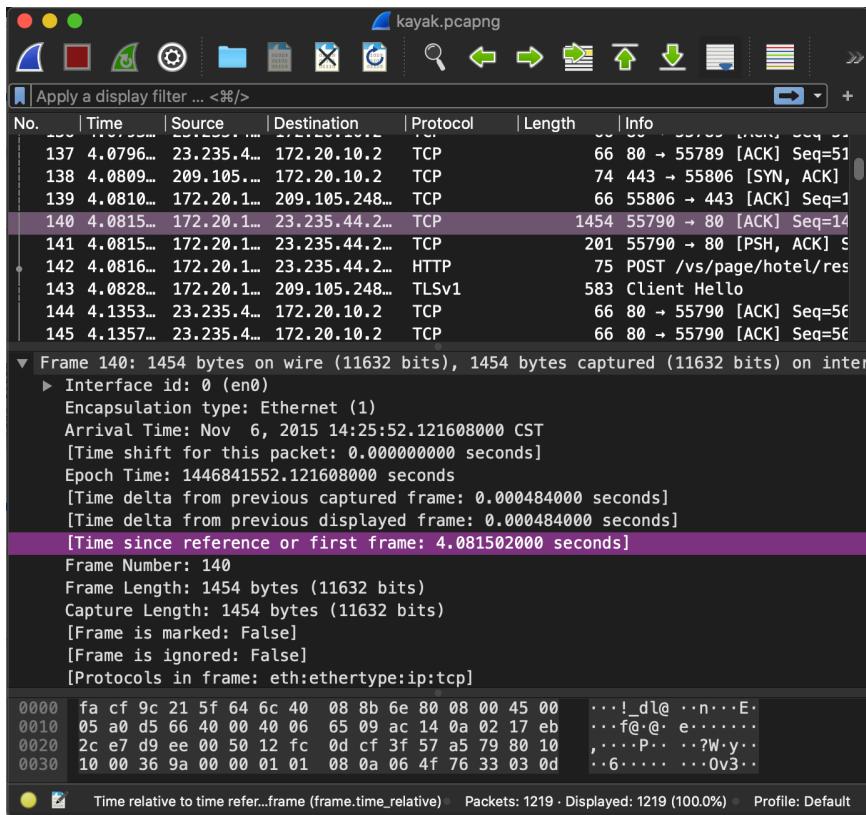


## Segment 4: 2947



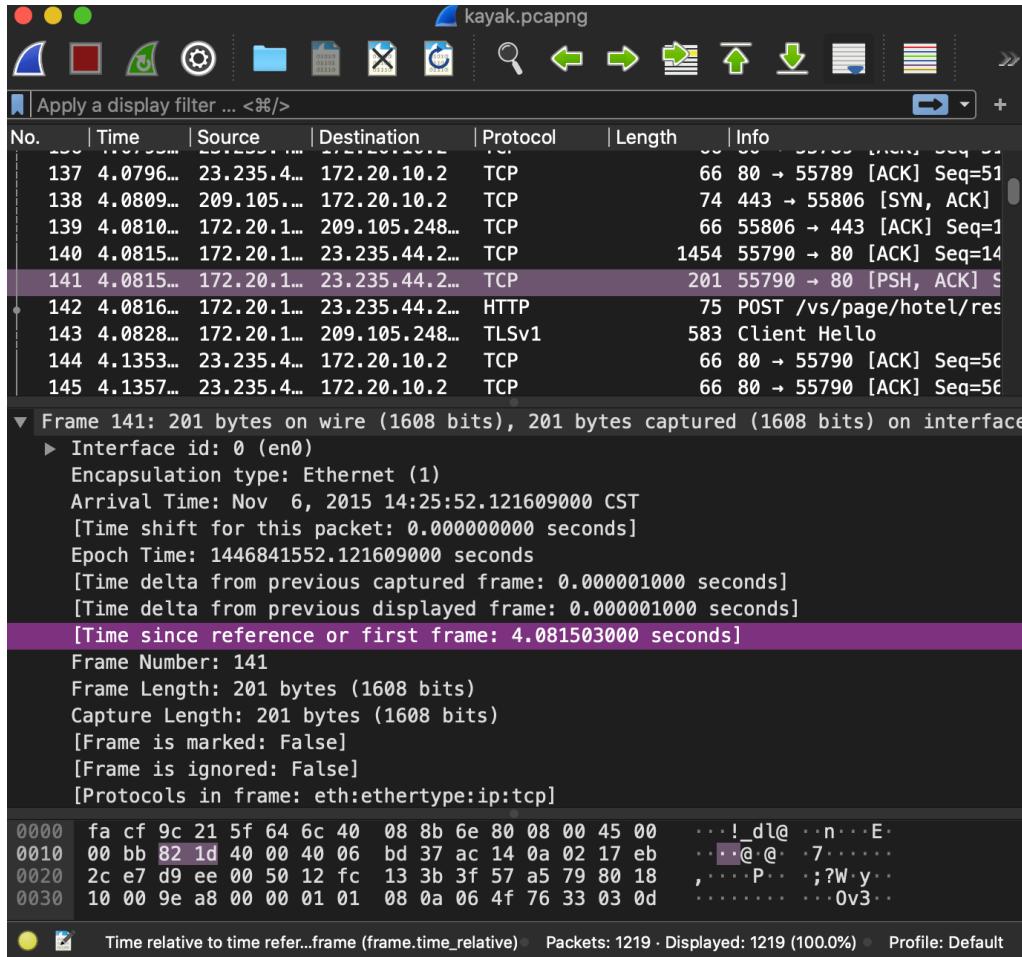
ii) At what time was each segment sent?

Segment 1: 4.081502000 sec

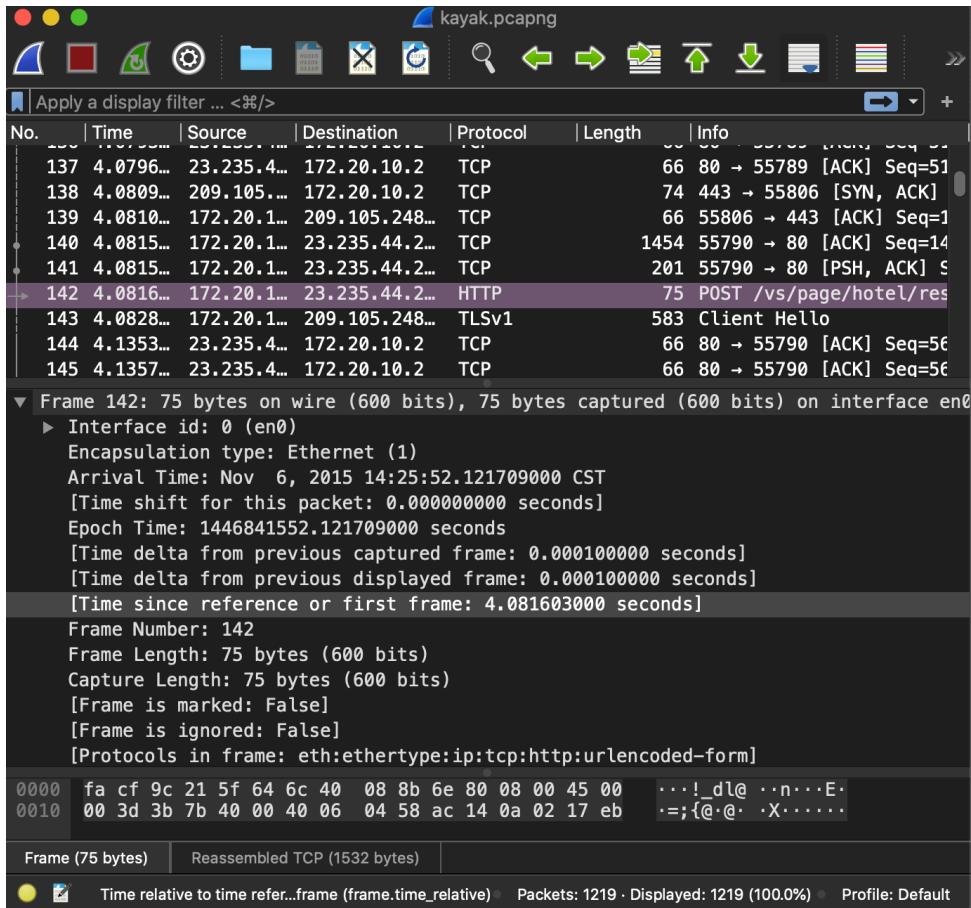


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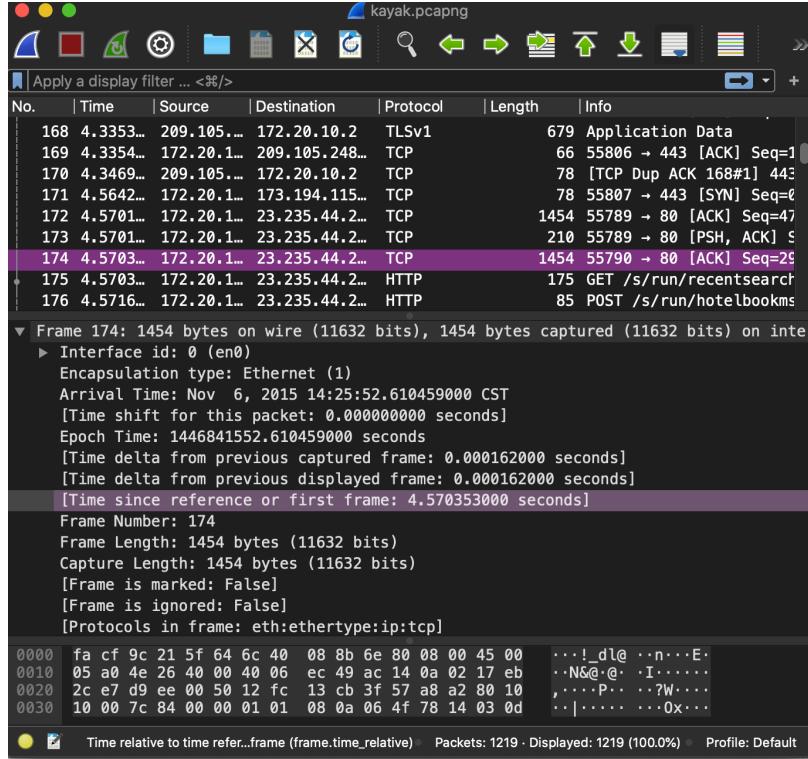
Segment 2: 4.081503000 sec



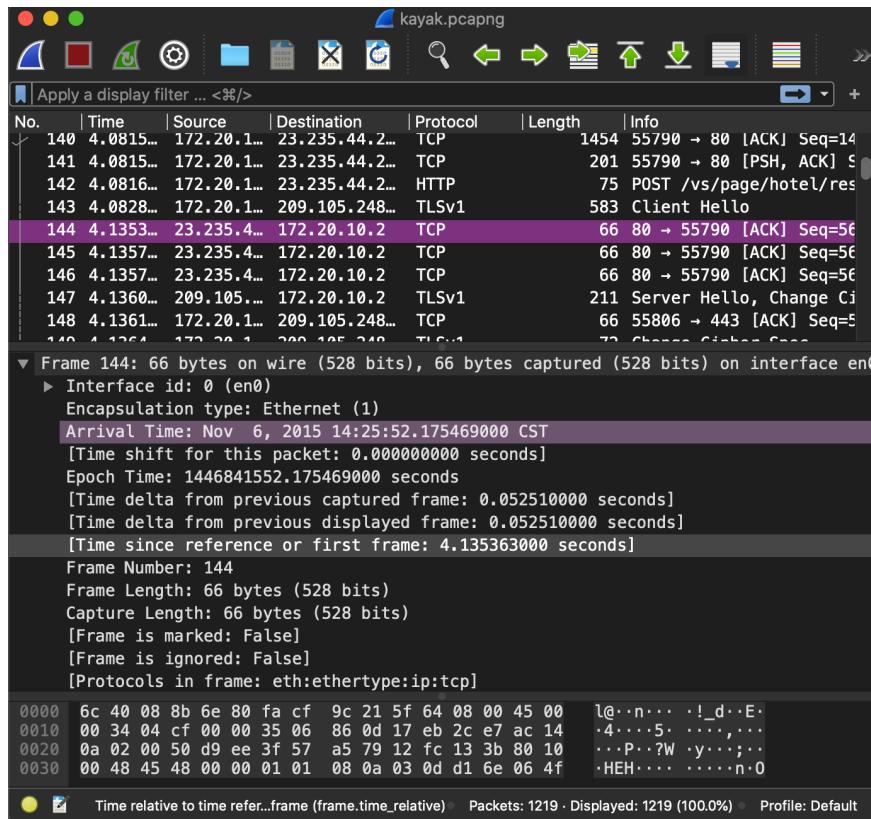
Segment 3: 4.081603000 sec



Segment 4: 4.570353000 sec



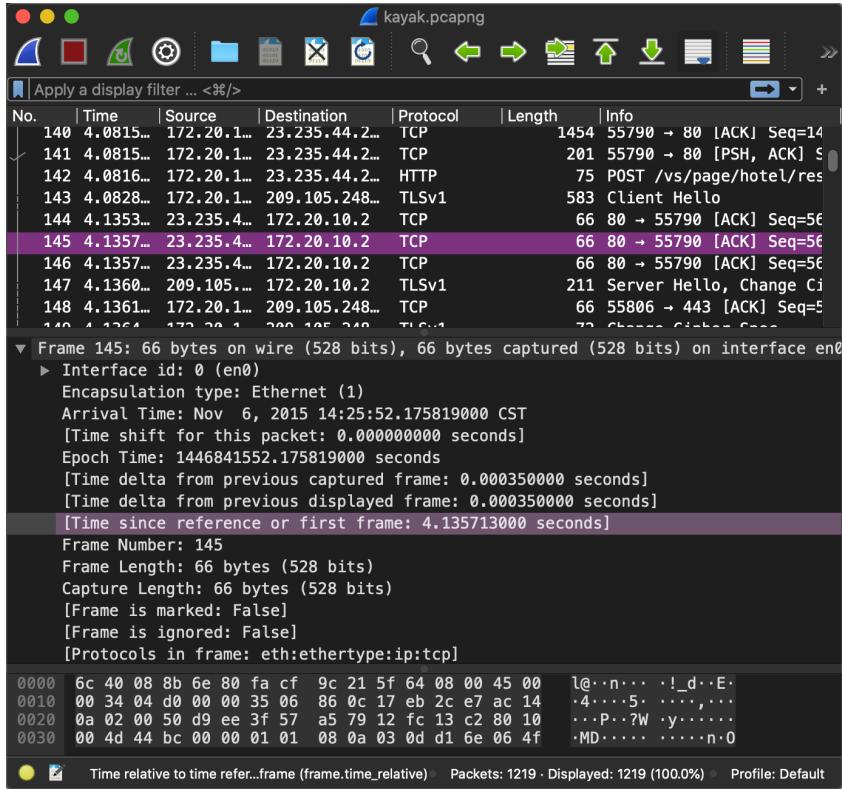
iii) When was the ACK for each segment received?



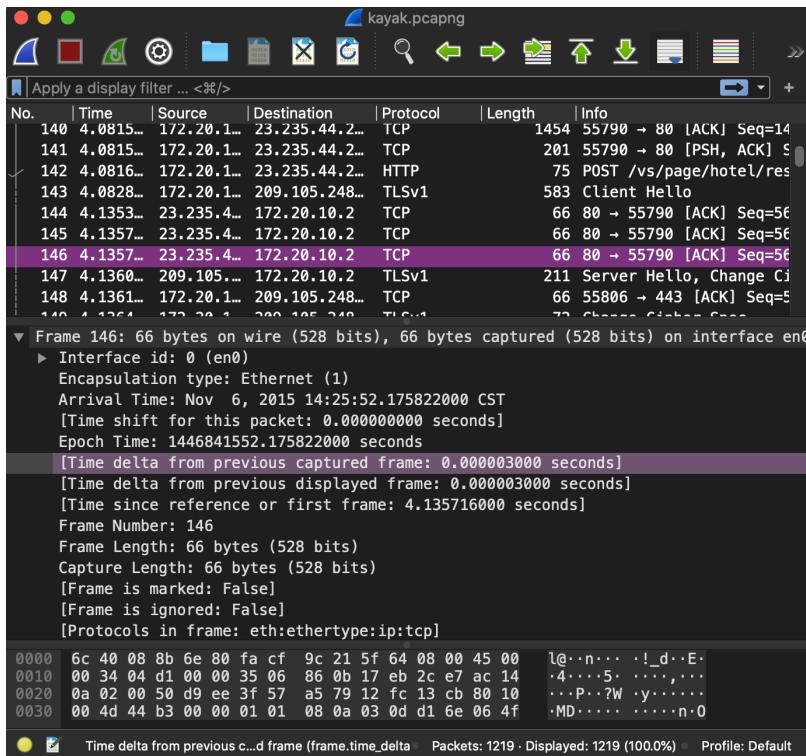
Segment 1:  
 4.135363000

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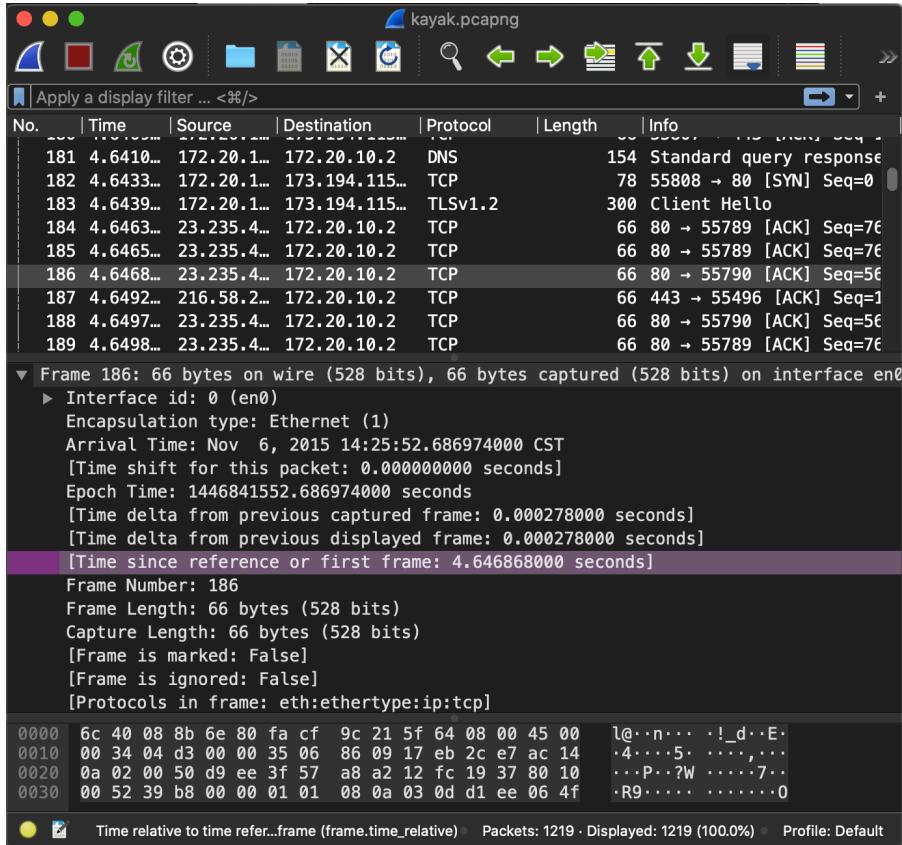
## Segment 2: 4.135713000



## Segment 3: 4.135716000



Segment 4: 4.646868000



- iv) Given the difference between when each TCP segment was sent, and when its acknowledgement was received,
- v) what is the RTT value for each of the four segments?

RTT value of each segment is mentioned below:

Segment	RTT
Segment 1	0.053861 sec
Segment 2	0.05421 sec
Segment 3	0.054113 sec
Segment 4	0.076515 sec

Estimated RTT = 0.875 \* Estimated RTT + 0.125 \* Sample RTT

Segment 1:

Estimated RTT = RTT for the First segment = 0.053861 sec (This will be used in Segment 2)

Segment 2:

Estimated RTT = 0.875 \* 0.053861 + 0.125 \* 0.05421 = 0.05390 sec (This will be used in segment 3)

Segment 3 :

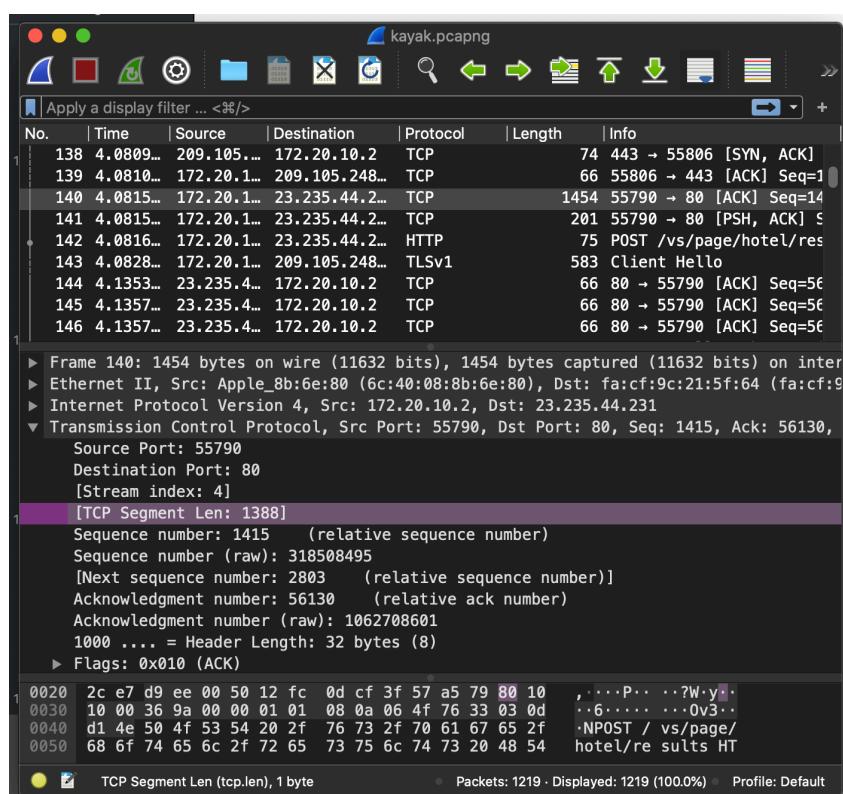
Estimated RTT = 0.875 \* 0.05390 + 0.125 \* 0.054113 = 0.05393 sec ( This will be used in Segment 4)

Segment 4:

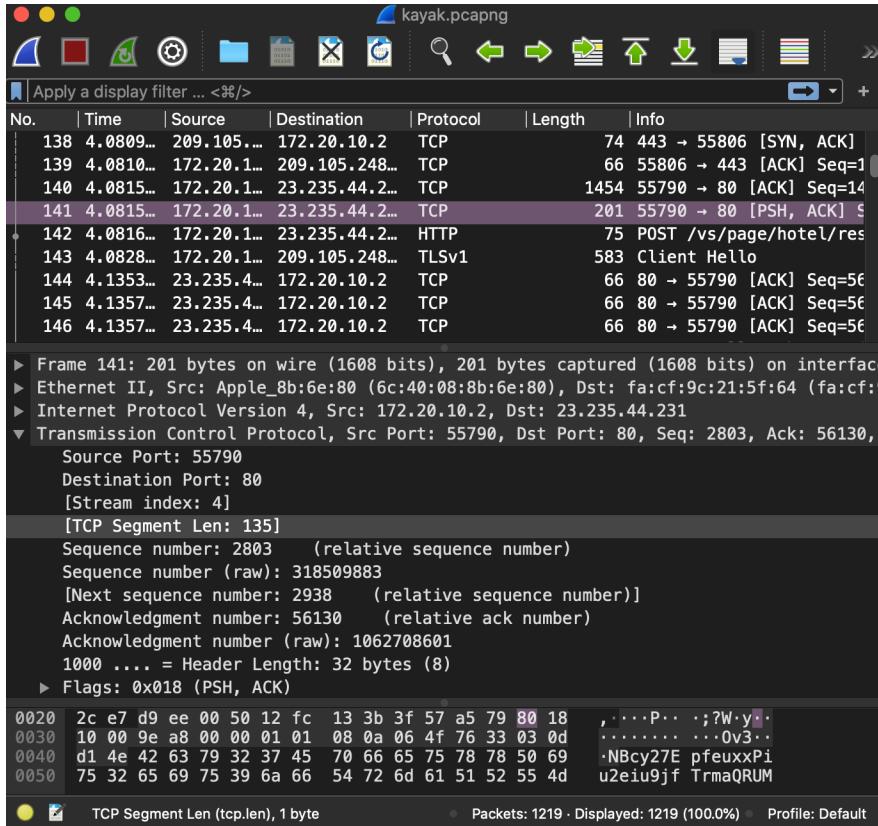
Estimated RTT = 0.875 \* 0.05390 + 0.125 \* 0.076515 = 0.05672658 sec (This will be used in the next segment)

3. What is the length of each of the first four TCP segments?

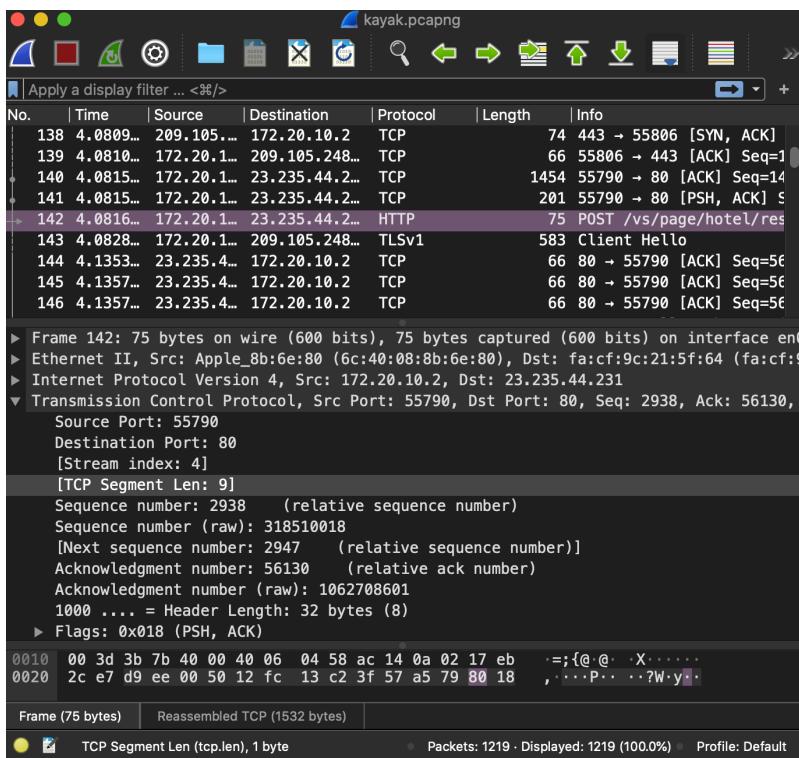
Segment 1: 1388



## Segment 2: Length - 135

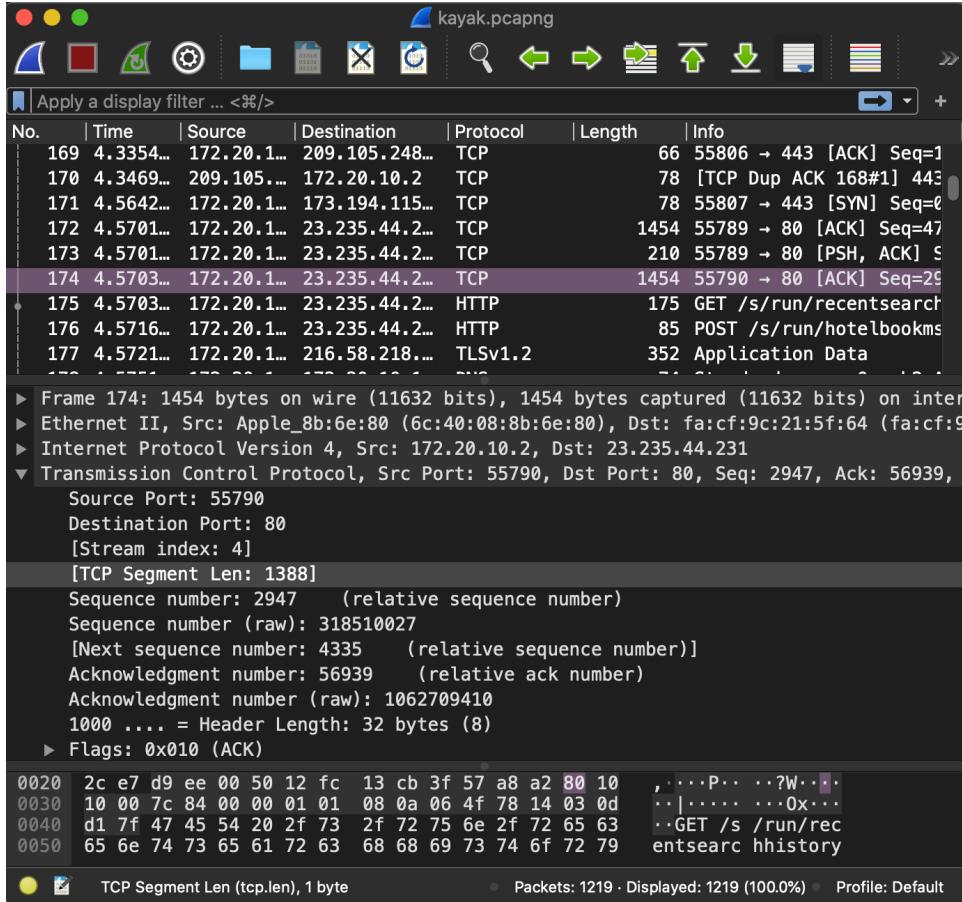


## Segment 3: Length - 9



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### Segment 4: Length -1388



Length Of Segment 1: 1388

Length Of Segment 2: 135

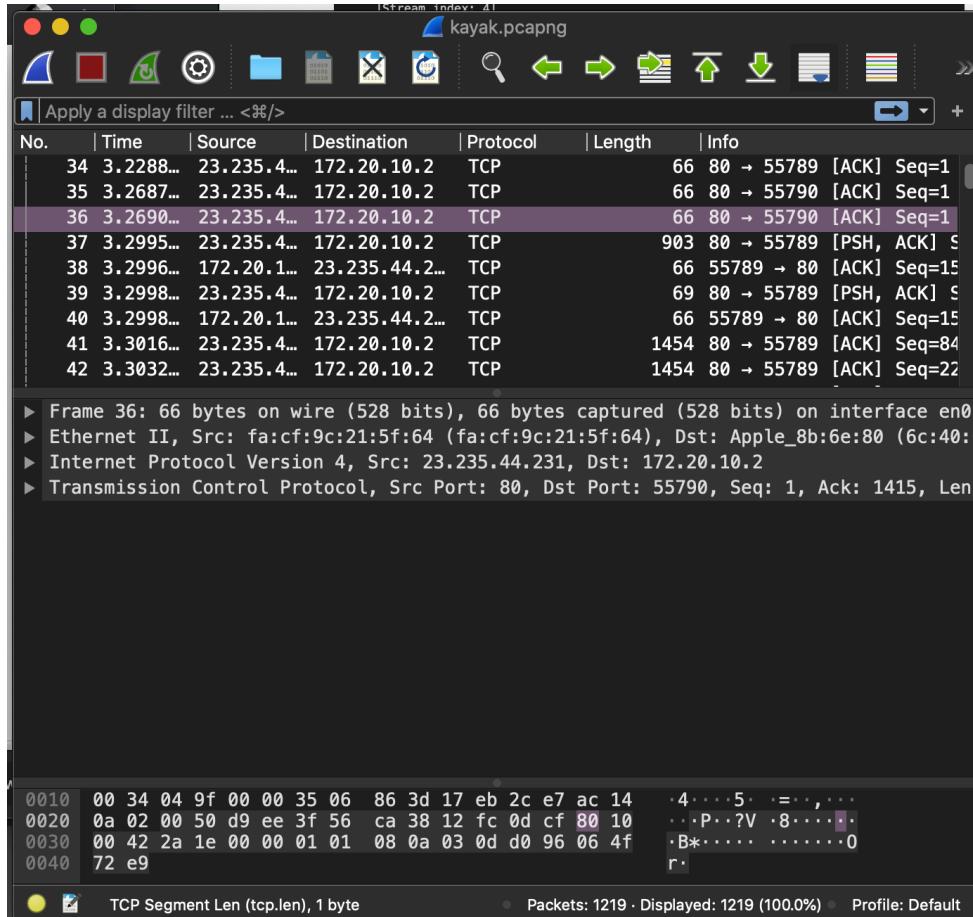
Length Of Segment 3 : 9

Length Of Segment 4: 1388

4. What is the minimum amount of available buffer space advertised at the receiver for the entire trace?

Minimum amount of available buffer space advertised at the receiver : 66

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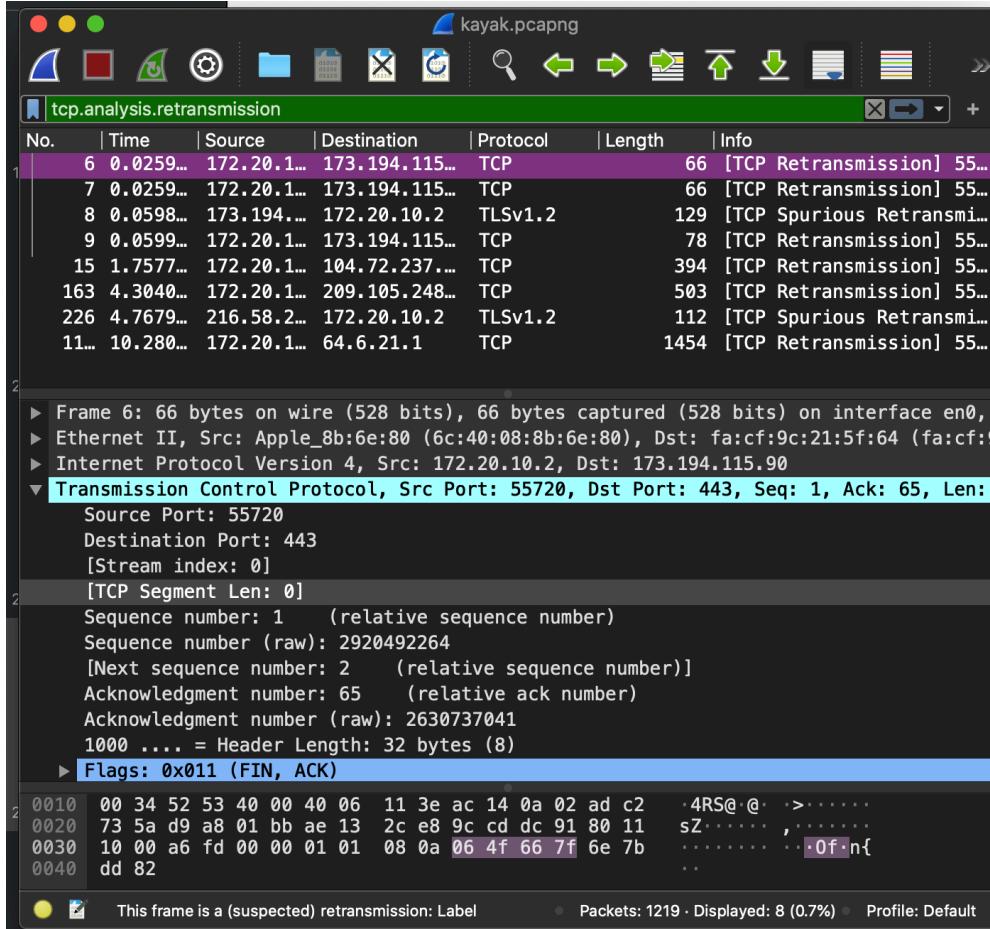


5. Does the lack of receiver buffer space ever throttle the sender?

No, Lack of the receiver buffer space does not throttle the sender.

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

Yes, There are 8 retransmitted segments in the trace file. For checking the same, we can apply "tcp.analysis.retransmission" as shown below in the screenshot.

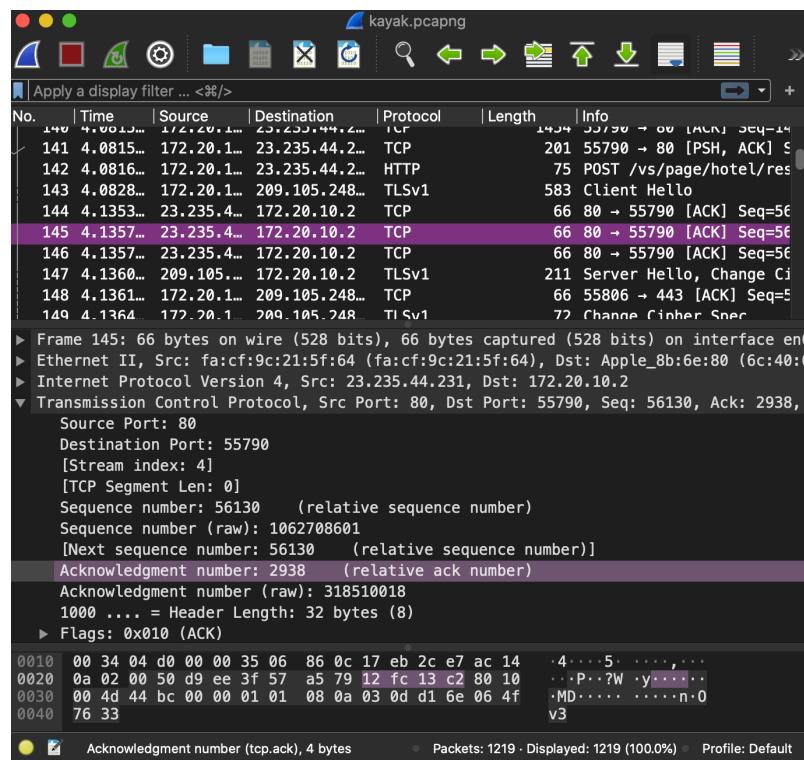
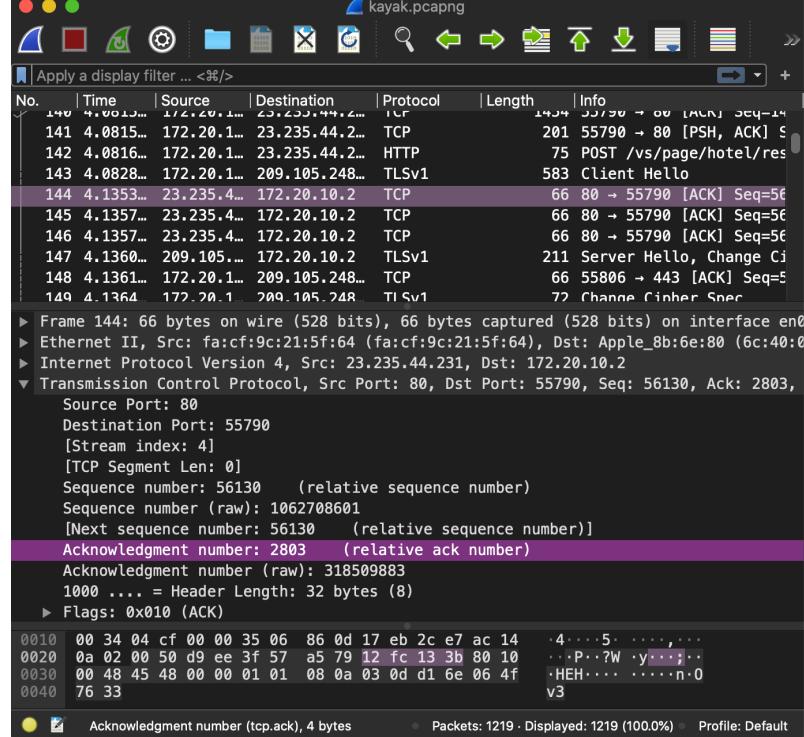


7. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACK-ing every other received segment (see Table 3.2 on page 247 in the text).

For each of the 4 packets, in order , the data that is acknowledged is: 0, 135, 9 and 1388.

This is done by subtracting ACK field of 2nd packet from the ACK field of first packet

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File Edit View Insert Tools Options Help kayak.pcapng

Apply a display filter ... <%/>

No.	Time	Source	Destination	Protocol	Length	Info
140	4.0813...	172.20.1...	23.235.44.2...	TCP	201	55790 → 80 [PSH, ACK] Seq=140
141	4.0815...	172.20.1...	23.235.44.2...	TCP	201	55790 → 80 [PSH, ACK] Seq=141
142	4.0816...	172.20.1...	23.235.44.2...	HTTP	75	POST /vs/page/hotel/res
143	4.0828...	172.20.1...	209.105.248...	TLSv1	583	Client Hello
144	4.1353...	23.235.4...	172.20.10.2	TCP	66	80 → 55790 [ACK] Seq=56
145	4.1357...	23.235.4...	172.20.10.2	TCP	66	80 → 55790 [ACK] Seq=56
146	4.1357...	23.235.4...	172.20.10.2	TCP	66	80 → 55790 [ACK] Seq=56
147	4.1360...	209.105...	172.20.10.2	TLSv1	211	Server Hello, Change Ci
148	4.1361...	172.20.1...	209.105.248...	TCP	66	55806 → 443 [ACK] Seq=5
149	4.1364...	172.20.1...	209.105.248...	TLSv1	72	Change Cipher Spec

▶ Frame 146: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface en0  
 ▶ Ethernet II, Src: fa:cf:9c:21:f6:64 (fa:cf:9c:21:f6:64), Dst: Apple\_8b:6e:80 (6c:40:0)  
 ▶ Internet Protocol Version 4, Src: 23.235.44.231, Dst: 172.20.10.2  
 ▶ Transmission Control Protocol, Src Port: 80, Dst Port: 55790, Seq: 56130, Ack: 2947,  
 Source Port: 80  
 Destination Port: 55790  
 [Stream index: 4]  
 [TCP Segment Len: 0]  
 Sequence number: 56130 (relative sequence number)  
 Sequence number (raw): 1062708601  
 [Next sequence number: 56130 (relative sequence number)]  
 Acknowledgment number: 2947 (relative ack number)  
 Acknowledgment number (raw): 318510027  
 1000 .... = Header Length: 32 bytes (8)  
 ► Flags: 0x010 (ACK)

```
0010  00 34 04 d1 00 00 35 06  86 0b 17 eb 2c e7 ac 14  ·4···5· ···,···
0020  0a 02 00 50 d9 ee 3f 57  a5 79 12 fc 13 cb 80 10  ···P?W ·y····
0030  00 4d 44 b3 00 00 01 01  08 0a 03 0d d1 6e 06 4f  ·MD···· ···n·0
0040  76 33                                     v3
```

Acknowledgment number (tcp.ack), 4 bytes    Packets: 1219 · Displayed: 1219 (100.0%)    Profile: Default

File Edit View Insert Tools Options Help kayak.pcapng

Apply a display filter ... <%/>

No.	Time	Source	Destination	Protocol	Length	Info
180	4.6409...	172.20.1...	173.194.115...	TCP	66	55807 → 443 [ACK] Seq=1
181	4.6410...	172.20.1...	173.194.115...	DNS	154	Standard query response
182	4.6433...	172.20.1...	173.194.115...	TCP	78	55808 → 80 [SYN] Seq=0
183	4.6439...	172.20.1...	173.194.115...	TLSv1.2	300	Client Hello
184	4.6463...	23.235.4...	172.20.10.2	TCP	66	80 → 55789 [ACK] Seq=76
185	4.6465...	23.235.4...	172.20.10.2	TCP	66	80 → 55789 [ACK] Seq=76
186	4.6468...	23.235.4...	172.20.10.2	TCP	66	80 → 55790 [ACK] Seq=56
187	4.6492...	216.58.2...	172.20.10.2	TCP	66	443 → 55496 [ACK] Seq=1
188	4.6497...	23.235.4...	172.20.10.2	TCP	66	80 → 55790 [ACK] Seq=56

▶ Frame 186: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface en0  
 ▶ Ethernet II, Src: fa:cf:9c:21:f6:64 (fa:cf:9c:21:f6:64), Dst: Apple\_8b:6e:80 (6c:40:0)  
 ▶ Internet Protocol Version 4, Src: 23.235.44.231, Dst: 172.20.10.2  
 ▶ Transmission Control Protocol, Src Port: 80, Dst Port: 55790, Seq: 56939, Ack: 4335,  
 Source Port: 80  
 Destination Port: 55790  
 [Stream index: 4]  
 [TCP Segment Len: 0]  
 Sequence number: 56939 (relative sequence number)  
 Sequence number (raw): 1062709410  
 [Next sequence number: 56939 (relative sequence number)]  
 Acknowledgment number: 4335 (relative ack number)  
 Acknowledgment number (raw): 318511415  
 1000 .... = Header Length: 32 bytes (8)  
 ► Flags: 0x010 (ACK)

```
0010  00 34 04 d3 00 00 35 06  86 09 17 eb 2c e7 ac 14  ·4···5· ···,···
0020  0a 02 00 50 d9 ee 3f 57  a8 a2 12 fc 19 37 80 10  ···P?W ·7···
0030  00 52 39 b8 00 00 01 01  08 0a 03 0d d1 ee 06 4f  ·R9···· ···n·0
0040  78 14                                     x
```

Acknowledgment number (tcp.ack), 4 bytes    Packets: 1219 · Displayed: 1219 (100.0%)    Profile: Default

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8. What is the throughput (bytes transferred per unit time) for the TCP connection (Just consider a single connection )? Think on how to calculate the throughput!

Throughput = ( Amount of Data Transmitted)/ (Time Incurred)

=>  $2920/0.565366$

=> $5,164.795 \text{ Kb/sec}$

9. Explain how you calculated this value.

Amount of Data Transmitted can be calculated by subtracting sequence number of the first byte being sent (That is Packet 140) from the ACK of the last packet (Packet 186)

I.e  $4335 - 1415 = 2920$

Time Incurred can be calculated by subtracting the time of the first byte that was sent from the time of the last ack

I.e  $4.646868 - 4.081502 = 0.565366$

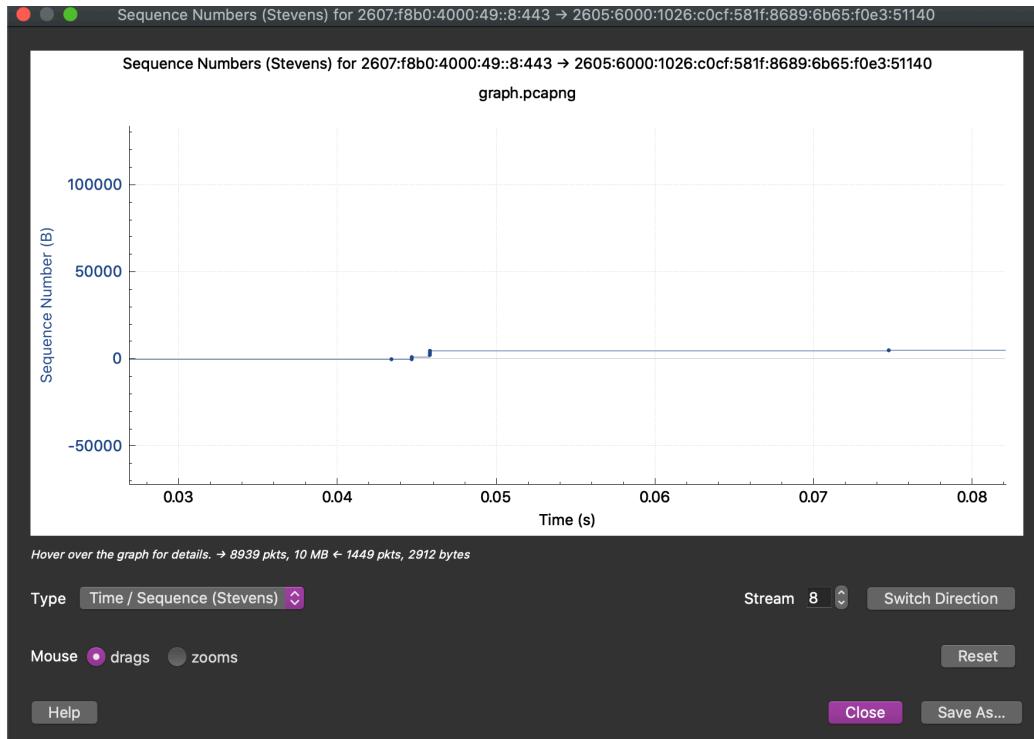
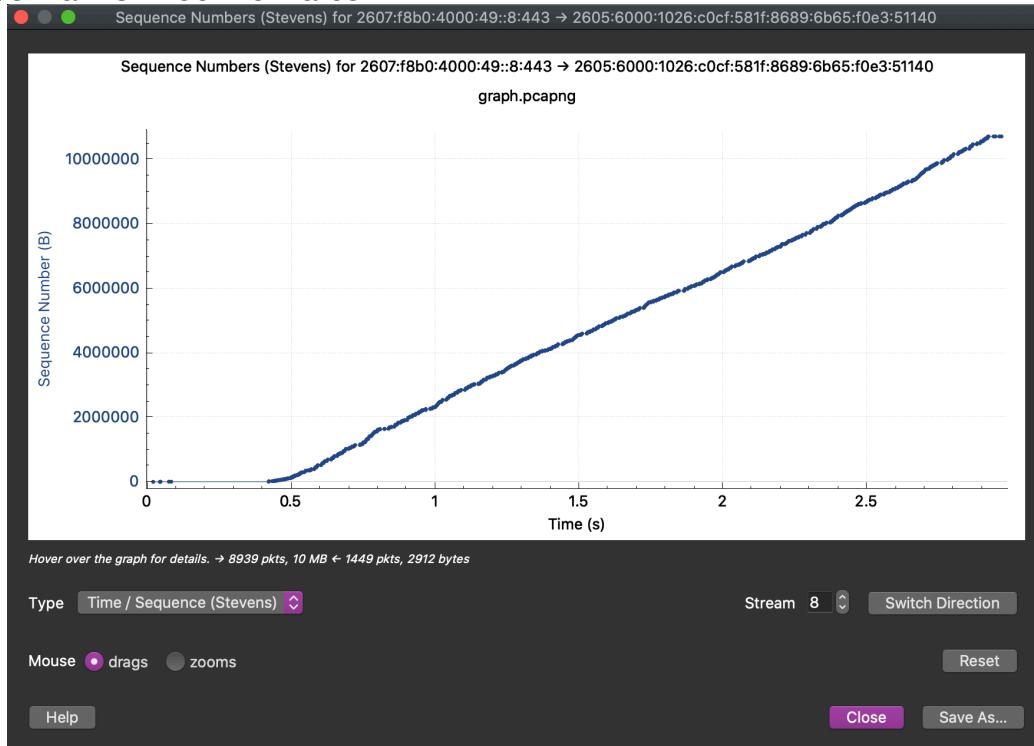
## Problem Set 4:

1. Can you identify where TCP's slow-start phase begins and ends.

Slow starts Begins at : 0.043

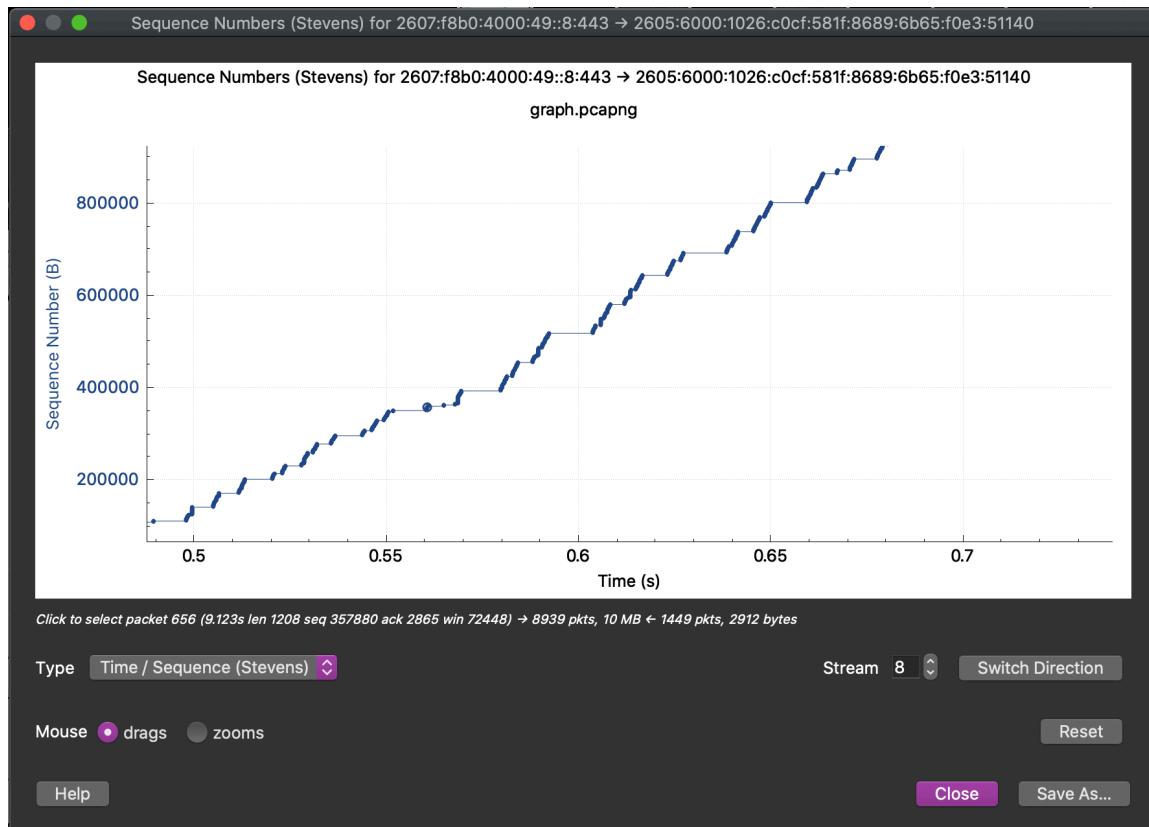
Slow starts ends at : 0.074

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2. Where congestion avoidance takes over? Highlight these areas .

TCP congestion avoidance phase starts at 0.49



3.Comment on ways in which the measured data differs from the idealized behavior of TCP that we've studied in the text.

By Observing the above graph we see that it is in the Slow Start phase upto 0.074 Seconds, after this Congestion Avoidance takes over. The expected behavior during this phase is For the TCP transmit window to grow linearly but, it does not happen as expected. According to The idealized behavior that we studied in textbook TCP senders are aggressive in sending the Data. AIMD algorithm should be followed by TCP when there is any network congestion

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Detected in the network drop their sending window size.