

UDP:

1. Select the first UDP segment in your trace. What is the packet number of this segment in the trace file? What type of application-layer payload or protocol message is being carried in this UDP segment? Look at the details of this packet in Wireshark. How many fields there are in the UDP header? (You shouldn't look in the textbook! Answer these questions directly from what you observe in the packet trace.) What are the names of these fields?

Ans:

Packet number : 5

Application-layer protocol: Simple Service Discovery Protocol (SSDP)

Fields: 4

1. Source Port
2. Destination Port
3. Length
4. Checksum

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> Frame 5: 317 bytes on wire (2536 bits), 317 bytes captured (2536 bits) on interface en0, id 0
> Ethernet II, Src: NarayInf_03:02:01 (00:05:04:03:02:01), Dst: IPv4mcast_7f:ff:fa (01:00:5e:7f:ff:fa)
> Internet Protocol Version 4, Src: 10.0.0.254, Dst: 239.255.255.250
> User Datagram Protocol, Src Port: 47931, Dst Port: 1900
    Source Port: 47931
    Destination Port: 1900
    Length: 283
    Checksum: 0xf7a8 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
    > [Timestamps]
    UDP payload (275 bytes)
> Simple Service Discovery Protocol
```

2. By consulting the displayed information in Wireshark's packet content field for this packet (or by consulting the textbook), what is the length (in bytes) of each of the UDP header fields?

Ans: Source Port : 2 byte (bb 3b)

Destination Port : 2 byte (07 6c)

Length : 2 byte (01 1b)

Checksum : 2 byte (f7 a8)

```

Frame 5: 317 bytes on wire (2536 bits), 317 bytes captured (2536 bits) on interface en0, id 0
Ethernet II, Src: NarayInf_03:02:01 (00:05:04:03:02:01), Dst: IPv4mcast_7f:ff:fa (01:00:5e:7f:ff:fa)
Internet Protocol Version 4, Src: 10.0.0.254, Dst: 239.255.255.250
User Datagram Protocol, Src Port: 47931, Dst Port: 1900
  Source Port: 47931
  Destination Port: 1900
  Length: 283
  Checksum: 0xf7a8 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
  > [Timestamps]
    UDP payload (275 bytes)
Simple Service Discovery Protocol

0020 ff fa bb 3b 07 6c 01 1b f7 a8 4e 4f 54 49 46 59 . . ; l . . NOTIFY
0030 20 2a 20 48 54 54 50 2f 31 2e 31 0d 0a 48 4f 53 * HTTP/ 1.1 . HOS
0040 54 3a 20 32 33 39 2e 32 35 35 2e 32 35 35 2e 32 T: 239.2 55.255.2
0050 35 30 3a 31 39 30 0d 0a 43 41 43 48 45 2d 43 50:1900 . CACHE-C
0060 4f 4e 54 52 4f 4c 3a 20 6d 61 78 2d 61 67 65 3d ONTROL: max-age=
0070 31 38 30 31 0d 0a 4e 54 53 3a 20 73 73 64 70 3a 1801 . NT S: ssdp:
0080 61 6c 69 76 65 0d 0a 4c 4f 43 41 54 49 4f 4e 3a alive . L OCATION:
0090 20 68 74 74 70 3a 2f 2f 31 30 2e 30 2e 30 2e 32 http:// 10.0.0.2
00a0 35 34 3a 34 39 31 35 32 2f 77 70 73 5f 64 65 76 54:49152 /wps_dev
00b0 69 63 65 2a 78 6d 6c 0d 03 52 15 52 56 15 52 2a ice vml . . CFDVFD.


```

3. The value in the Length field is the length of what? (You can consult the text for this answer). Verify your claim with your captured UDP packet.

Ans: UDP Length field is the total length in bytes of the UDP headed (8 bytes) + UDP Payload (275 bytes) = total 283 bytes

```

User Datagram Protocol, Src Port: 47931, Dst Port: 1900
  Source Port: 47931
  Destination Port: 1900
  Length: 283
  Checksum: 0xf7a8 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 0]
  > [Timestamps]
    UDP payload (275 bytes)
Simple Service Discovery Protocol

```

4. What is the maximum number of bytes that can be included in a UDP payload? (Hint: the answer to this question can be determined by your answer to 2. above)

Ans: Maximum number of bytes = $65536 (2^{16}) - 1 - 8$ (header bytes) = 65527

5. What is the largest possible source port number? (Hint: see the hint in 4.)

Ans: Ports are 16-bit unsigned values, so their numeric range is 0–65,535 (0 is reserved / uncommon). The maximum numeric value is therefore 65535.

6. What is the protocol number for UDP? Give your answer in decimal notation. To answer this question, you'll need to look into the Protocol field of the IP datagram containing this UDP segment (see Figure 4.13 in the text, and the discussion of IP header fields).

Ans: Protocol number : UDP (17) - 11

```
Internet Protocol Version 4, Src: 10.0.0.254, Dst: 239.255.255.250
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  ▶ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 303
    Identification: 0xa1c3 (41411)
  ▶ Flags: 0x40, Don't fragment
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 4
  Protocol: UDP (17)
  Header Checksum: 0xd902 [validation disabled]
0010 01 2f a1 c3 40 00 04 11 d9 02 0a 00 00 fe ef ff ./.@... . . .
```

7. Examine the pair of UDP packets in which your host sends the first UDP packet and the second UDP packet is a reply to this first UDP packet. (Hint: for a second packet to be sent in response to a first packet, the sender of the first packet should be the destination of the second packet). What is the packet number of the first of these two UDP segments in the trace file? What is the value in the source port field in this UDP segment? What is the value in the destination port field in this UDP segment? What is the packet number of the second of these two UDP segments in the trace file? What is the value in the source port field in this second UDP segment? What is the value in the destination port field in this

second UDP segment? Describe the relationship between the port numbers in the two packets.

Ans: Packet number of the first UDP segment : 15

Source port field : 58350 (SP1)

Destination port field : 53 (DP1)

Packet number of the second UDP segment : 17

Source port field : 53 (SP2)

Destination port field : 58350 (DP2)

Relationship : SP1 = DP2 , SP2 = DP1

15	3.325064	10.0.0.44	75.75.75.75	DNS
17	3.348972	75.75.75.75	10.0.0.44	DNS
30	3.427392	10.0.0.44	75.75.75.75	DNS
▶ Frame 15: 77 bytes on wire (616 bits), 77 bytes captured (616 bits) on interface eth0 ▶ Ethernet II, Src: Apple_98:d9:27 (78:4f:43:98:d9:27), Dst: Maxlinea_80:00:00 (00:50:f1:80:00:00) ▶ Internet Protocol Version 4, Src: 10.0.0.44, Dst: 75.75.75.75 ▶ User Datagram Protocol, Src Port: 58350, Dst Port: 53				
Source Port: 58350 Destination Port: 53 Length: 43 Checksum: 0xc31d [unverified] [Checksum Status: Unverified] [Stream index: 1] ▶ [Timestamps] UDP payload (35 bytes) ▶ Domain Name System (query)				

15	3.325064	10.0.0.44	75.75.75.75	DNS
17	3.348972	75.75.75.75	10.0.0.44	DNS
30	3.427392	10.0.0.44	75.75.75.75	DNS
▶ Frame 17: 93 bytes on wire (744 bits), 93 bytes captured (744 bits) on interface eth0 ▶ Ethernet II, Src: Maxlinea_80:00:00 (00:50:f1:80:00:00), Dst: Apple_98:d9:27 (78:4f:43:98:d9:27) ▶ Internet Protocol Version 4, Src: 75.75.75.75, Dst: 10.0.0.44 ▶ User Datagram Protocol, Src Port: 53, Dst Port: 58350				
Source Port: 53 Destination Port: 58350 Length: 59 Checksum: 0x4af2 [unverified] [Checksum Status: Unverified] [Stream index: 1] ▶ [Timestamps] UDP payload (51 bytes) ▶ Domain Name System (response)				

TCP :

1. What is the IP address and TCP port number used by the client computer (source) that is transferring the alice.txt file to gaia.cs.umass.edu? To answer this question, it's probably easiest to select an HTTP message and explore the details of the TCP packet used to carry this HTTP message, using the "details of the selected packet header window" (refer to Figure 2 in the "Getting Started with Wireshark" Lab if you're uncertain about the Wireshark windows).

Ans: IP Address : 192.168.86.68

Port : 55639

http						
No.	Time	Source	Destination	Protocol	Length	Info
→	153 0.147682	192.168.86.68	128.119.245.12	HTTP	1451	POST
←	179 0.192625	128.119.245.12	192.168.86.68	HTTP	843	HTTP
<pre>▶ Frame 153: 1451 bytes on wire (11608 bits), 1451 bytes captured (11608 bits) on interface en0, id 0 ▶ Ethernet II, Src: Apple_98:d9:27 (78:4f:43:98:d9:27), Dst: Google_89:0e:c8 (3c:28:6d:89:0e:c8) ▶ Internet Protocol Version 4, Src: 192.168.86.68, Dst: 128.119.245.12 ▼ Transmission Control Protocol, Src Port: 55639, Dst Port: 80, Seq: 152041, Ack: 1, Len: 1385 Source Port: 55639 Destination Port: 80 [Stream index: 0] [Conversation completeness: Incomplete, DATA (15)] TCP Segment Len: 1385</pre>						

2. What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection?

Ans: IP Address : 128.119.245.12

Port : 80

http						
No.	Time	Source	Destination	Protocol	Length	Info
153	0.147682	192.168.86.68	128.119.245.12	HTTP	1451	POST /wireshark-1
179	0.192625	128.119.245.12	192.168.86.68	HTTP	843	HTTP/1.1 200 OK
Internet Protocol Version 4, Src: 192.168.86.68, Dst: 128.119.245.12						
0100 = Version: 4						
.... 0101 = Header Length: 20 bytes (5)						
> Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)						
Total Length: 1437						
Identification: 0x0000 (0)						
> Flags: 0x40, Don't fragment						
...0 0000 0000 0000 = Fragment Offset: 0						
Time to Live: 64						
Protocol: TCP (6)						
Header Checksum: 0xa8ea [validation disabled]						
[Header checksum status: Unverified]						
Source Address: 192.168.86.68						
Destination Address: 128.119.245.12						
Transmission Control Protocol, Src Port: 55639, Dst Port: 80, Seq: 152041, Ack: 1, Len: 1385						
Source Port: 55639						
Destination Port: 80						
[Stream index: 0]						

3. What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu? (Note: this is the “raw” sequence number carried in the TCP segment itself; it is NOT the packet # in the “No.” column in the Wireshark window. Remember there is no such thing as a “packet number” in TCP or UDP; as you know, there are sequence numbers in TCP and that’s what we’re after here. Also note that this is not the relative sequence number with respect to the starting sequence number of this TCP session.). What is it in this TCP segment that identifies the segment as a SYN segment? Will the TCP receiver in this session be able to use Selective Acknowledgments (allowing TCP to function a bit more like a “selective repeat” receiver, see section 3.4.5 in the text)?

Ans: Sequence number (raw) : 4236649187

tcp.flags.syn == 1						
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.86.68	128.119.245.12	TCP	78	55639 .. 80
2	0.022414	128.119.245.12	192.168.86.68	TCP	74	80 → 55639


```
Frame 1: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface en0, id 0x0000000000000000
Ethernet II, Src: Apple_98:d9:27 (78:4f:43:98:d9:27), Dst: Google_89:0e:c8 (3c:28:6d:89:0e:c8)
Internet Protocol Version 4, Src: 192.168.86.68, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 55639, Dst Port: 80, Seq: 0, Len: 0
    Source Port: 55639
    Destination Port: 80
    [Stream index: 0]
    [Conversation completeness: Incomplete, DATA (15)]
    [TCP Segment Len: 0]
    Sequence Number: 0      (relative sequence number)
    Sequence Number (raw): 4236649187
    [Next Sequence Number: 1      (relative sequence number)]
    Acknowledgment Number: 0
    Acknowledgment number (raw): 0
    1011 .... = Header Length: 44 bytes (11)
```

SYN flag : Set to 1 → This is a SYN segment

ACK flag : Set to 0 → Not SYNACK segment

Flags: 0x002 (SYN)
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.]

TCP Option - SACK Permitted

Options: (24 bytes), Maximum segment size, No-Operation (NOP), Window scale, No-Operation (NOP)
▶ TCP Option - Maximum segment size: 1460 bytes
▶ TCP Option - No-Operation (NOP)
▶ TCP Option - Window scale: 6 (multiply by 64)
▶ TCP Option - No-Operation (NOP)
▶ TCP Option - No-Operation (NOP)
▶ TCP Option - Timestamps: TSval 725607509, TSecr 0
▶ TCP Option - SACK permitted
Kind: SACK Permitted (4)
Length: 2
▶ TCP Option - End of Option List (EOL)
▶ [Timestamps]

4. What is the sequence number of the SYNACK segment sent by [gaia.cs.umass.edu](#) to the client computer in reply to the SYN? What is it in the segment that identifies the segment as a SYNACK segment? What is the value of the Acknowledgement field in the SYNACK segment? How did [gaia.cs.umass.edu](#) determine that value?

Ans: Sequence number (relative) : 0

Sequence number (raw) : 1068969752

SYN flag = Set to 1 → This is a SYN segment

ACK flag = Set to 1 → This is a SYNACK segment

ACK field : 4236649188

How it is determined :

TCP rule:

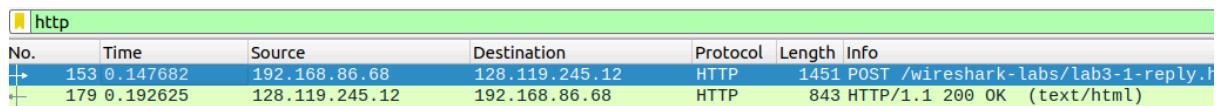
To acknowledge a segment, set Ack = (received Seq) + 1

Received sequence : 4236649187

ACK Sequence : $4236649187 + 1 = 4236649188$

5. What is the sequence number of the TCP segment containing the header of the HTTP POST command? Note that in order to find the POST message header, you'll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with the ASCII text "POST" within its DATA field^{4,5}. How many bytes of data are contained in the payload (data) field of this TCP segment? Did all of the data in the transferred file alice.txt fit into this single segment?

Ans: Sequence number (relative) : 152041
Sequence number (raw) : 4236801228



```
Frame 153: 1451 bytes on wire (11608 bits), 1451 bytes captured (11608 bits) on interface en0, id 0
Ethernet II, Src: Apple_98:d9:27 (78:4f:43:98:d9:27), Dst: Google_89:0e:c8 (3c:28:6d:89:0e:c8)
Internet Protocol Version 4, Src: 192.168.86.68, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 55639, Dst Port: 80, Seq: 152041, Ack: 1, Len: 1385
Source Port: 55639
Destination Port: 80
[Stream index: 0]
[Conversation completeness: Incomplete, DATA (15)]
[TCP Segment Len: 1385]
Sequence Number: 152041      (relative sequence number)
Sequence Number (raw): 4236801228
[Next Sequence Number: 153426      (relative sequence number)]
Acknowledgment Number: 1      (relative ack number)
Acknowledgment number (raw): 1068969753
1000 .... = Header Length: 32 bytes (8)
Flags: 0x018 (PSH, ACK)
Window: 2058
[Calculated window size: 131712]
[Window size scaling factor: 64]
Checksum: 0xbd46 [unverified]
[Checksum Status: Unverified]
Irrgent Pointer: 0
```

Payload field : 1385

http								
No.	Time	Source	Destination	Protocol	Length	Info		
→	153 0.147682	192.168.86.68	128.119.245.12	HTTP	1451	POST /wireshark		
←	179 0.192625	128.119.245.12	192.168.86.68	HTTP	843	HTTP/1.1 200 OK		
Sequence Number: 152041 (relative sequence number) Sequence Number (raw): 4236801228 [Next Sequence Number: 153426 (relative sequence number)] Acknowledgment Number: 1 (relative ack number) Acknowledgment number (raw): 1068969753 1000 = Header Length: 32 bytes (8) Flags: 0x018 (PSH, ACK) Window: 2058 [Calculated window size: 131712] [Window size scaling factor: 64] Checksum: 0xbd46 [unverified] [Checksum Status: Unverified] Urgent Pointer: 0 Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps [Timestamps] [SEQ/ACK analysis] TCP payload (1385 bytes) TCP segment data (1385 bytes)								
[106 Reassembled TCP Segments (153425 bytes): #4(1448), #5(1448), #6(1448), #9(1448), #10(1448), #11(1448), #12(1448)] [Hypertext Transfer Protocol] [MIME Multipart Media Encapsulation, Type: multipart/form-data, Boundary: -----19395076943]								
0040	a2 69 20 75 70 20 77 69 74 68 20 74 68 65 20 64 0050 69 73 74 61 6e 74 20 73 6f 62 73 20 6f 66 20 74 0060 68 65 20 6d 69 73 65 72 61 62 6c 65 0d 0a 4d 6f 0070 63 6b 20 54 75 72 74 6c 65 2e 0d 0a 0d 0a 20 20 0080 53 6f 20 73 68 65 20 73 61 74 20 6f 6e 2c 20 77 0090 69 74 68 20 63 6c 6f 73 65 64 20 65 79 65 73 2c 00a0 20 61 6e 64 20 68 61 6c 66 20 62 65 6c 69 65 76 00b0 65 64 20 68 65 72 73 65 6c 66 20 69 6e 0d 0a 57 00c0 6f 6e 64 65 72 6c 61 6e 64 2c 20 74 68 6f 75 67 00d0 68 20 73 68 65 20 6b 6e 65 77 20 73 68 65 20 68 00e0 61 64 20 62 75 74 20 74 6f 20 6f 70 65 6e 20 74 00f0 68 65 6d 20 61 67 61 69 6e 2c 20 61 6e 64 0d 0a 0100 61 6c 6c 20 77 6f 75 6c 64 20 63 68 61 6e 67 65 0110 20 74 6f 20 64 75 6c 6c 20 72 65 61 6c 69 74 79 0120 2d 2d 74 68 65 20 67 72 61 73 73 20 77 6f 75 6c	<i>i up wi th the d istant s obs of t he miser able..Mo ck Turtl e..... So she s at on, w ith clos ed eyes, and hal f believ ed herse lf in..W onderlan d, thoug h she kn ew she h ad but t o open t hem agai n, and.. all woul d change to dull reality --the gr ass woul</i>						

From pdf - size of alice.txt = 153425 bytes
The file was divided into 106 segments (each frame's limit is 1448 bytes)

TCP payload (1385 bytes) TCP segment data (1385 bytes)
[106 Reassembled TCP Segments (153425 bytes): #4(1448), #5(1448), #6(1448), #9(1448) [Frame: 4, payload: 0-1447 (1448 bytes)] [Frame: 5, payload: 1448-2895 (1448 bytes)] [Frame: 6, payload: 2896-4343 (1448 bytes)] [Frame: 9, payload: 4344-5791 (1448 bytes)] [Frame: 10, payload: 5792-7239 (1448 bytes)] [Frame: 11, payload: 7240-8687 (1448 bytes)] [Frame: 12, payload: 8688-10135 (1448 bytes)] [Frame: 14, payload: 10136-11583 (1448 bytes)] [Frame: 15, payload: 11584-13031 (1448 bytes)] [Frame: 20, payload: 13032-14479 (1448 bytes)] [Frame: 21, payload: 14480-15927 (1448 bytes)] [Frame: 22, payload: 15928-17375 (1448 bytes)] [Frame: 23, payload: 17376-18823 (1448 bytes)] [Frame: 24, payload: 18824-20271 (1448 bytes)]]

6. Consider the TCP segment containing the HTTP “POST” as the first segment in the data transfer part of the TCP connection.
- At what time was the first segment (the one containing the HTTP POST) in the data-transfer part of the TCP connection sent?
 - At what time was the ACK for this first data-containing segment received?
 - What is the RTT for this first data-containing segment?
 - What is the RTT value the second data-carrying TCP segment and its ACK?
 - What is the EstimatedRTT value (see Section 3.5.3, in the text) after the ACK for the second data-carrying segment is received? Assume that in making this calculation after the received of the ACK for the second segment, that the initial value of EstimatedRTT is equal to the measured RTT for the first segment, and then is computed using the EstimatedRTT equation on page 242, and a value of $\alpha = 0.125$.

Ans: First segment in the data-transfer part of the TCP connection is sent at 0.024647s. Its sequence number is 1 and length is 1448. That means the ACK for this segment is the one containing ACK number $(1+1448) = 1449$, as the next segment's sequence number is 1449. So the ACK for the first segment is sent at 0.052671s.

So, the RTT for this first data-containing segment is:

$$RTT_1 = 0.052671s - 0.024647s = 0.028624s = 28.624 \text{ ms}$$

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.86.68	128.119.245.12	TCP	78	55639 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=725607509 TSecr=0 SACK_PERM=1
2	0.022414	128.119.245.12	192.168.86.68	TCP	74	80 → 55639 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=3913851370 TSecr=3913851370
3	0.022505	192.168.86.68	128.119.245.12	TCP	66	55639 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=725607531 TSecr=3913851370
4	0.024047	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
5	0.024048	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=1449 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
6	0.024049	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=2897 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
7	0.052671	128.119.245.12	192.168.86.68	TCP	66	80 → 55639 [ACK] Seq=1 Ack=1449 Win=31872 Len=0 TSval=3913851399 TSecr=725607532
8	0.052676	128.119.245.12	192.168.86.68	TCP	66	80 → 55639 [ACK] Seq=1 Ack=2897 Win=34816 Len=0 TSval=3913851400 TSecr=725607532

Second segment in the data-transfer part of the TCP connection is sent at 0.024048s. Its sequence number is 1449 and length is 1448

That means the ACK for this segment is the one containing ACK number $(1449+1448) = 2897$, as the next segment's sequence number is 2897. So the ACK for the first segment is sent at 0.052676s.

So, the RTT for this first data-containing segment is:

$$RTT_2 = 0.052676s - 0.024048s = 0.028628s = 28.628 \text{ ms}$$

tcp						
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.86.68	128.119.245.12	TCP	78	55639 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=725607509 TSecr=0 SACK_PERM=0
2	0.022414	128.119.245.12	192.168.86.68	TCP	74	80 → 55639 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=3913851370 TSecr=0
3	0.022505	192.168.86.68	128.119.245.12	TCP	66	55639 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=725607531 TSecr=3913851370
4	0.024047	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
5	0.024048	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=1449 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
6	0.024049	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=2897 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
7	0.052671	128.119.245.12	192.168.86.68	TCP	66	80 → 55639 [ACK] Seq=1 Ack=1449 Win=31872 Len=0 TSval=3913851399 TSecr=725607532
8	0.052676	128.119.245.12	192.168.86.68	TCP	66	80 → 55639 [ACK] Seq=1 Ack=2897 Win=34816 Len=0 TSval=3913851400 TSecr=725607532
9	0.052774	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=4345 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851399 [TCP segment of a retransmission]

Estimated RTT value after the ACK received for the second data-carrying segment:

$$\begin{aligned} \text{EstimatedRTT}_2 &= (1 - \alpha) * \text{RTT}_1 + \alpha * \text{RTT}_2 \\ &= (1 - 0.125) * 28.624 + 0.125 * 28.628 \\ &= 28.6245 \text{ ms} \end{aligned}$$

7. What is the length (header plus payload) of each of the first four data-carrying TCP segments?

Ans: The length of each of the first four data-carrying TCP segments (at #4, #5, #6, #9) is 1514

tcp						
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.86.68	128.119.245.12	TCP	78	55639 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=725607509 TSecr=0 SACK_PERM=0
2	0.022414	128.119.245.12	192.168.86.68	TCP	74	80 → 55639 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=3913851370 TSecr=0
3	0.022505	192.168.86.68	128.119.245.12	TCP	66	55639 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=725607531 TSecr=3913851370
4	0.024047	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
5	0.024048	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=1449 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
6	0.024049	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=2897 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a retransmission]
7	0.052671	128.119.245.12	192.168.86.68	TCP	66	80 → 55639 [ACK] Seq=1 Ack=1449 Win=31872 Len=0 TSval=3913851399 TSecr=725607532
8	0.052676	128.119.245.12	192.168.86.68	TCP	66	80 → 55639 [ACK] Seq=1 Ack=2897 Win=34816 Len=0 TSval=3913851400 TSecr=725607532
9	0.052774	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=4345 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851399 [TCP segment of a retransmission]
10	0.052775	192.168.86.68	128.119.245.12	TCP	1514	55639 → 80 [ACK] Seq=5793 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851399 [TCP segment of a retransmission]

8. What is the minimum amount of available buffer space advertised to the client by gaia.cs.umass.edu among these first four data-carrying TCP segments? Does the lack of receiver buffer space ever throttle the sender for these first four data-carrying segments?

Ans: The minimum amount of available buffer space advertised among these first four data-carrying TCP segments (at #4, #5, #6, #9) is 131712 bytes, as that is the calculated window size for all of these first four segments.

The lack of receiver buffer space does not throttle the sender for the first four data-carrying TCP segments.

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

Ans: There is no retransmitted segments in the trace file.

How to check :

1. Use filter “tcp.analysis.retransmission” and see if there is any data segment that is retransmitted or not.
2. Manually check through every TCP data segment inspecting their sequence numbers and duplicate ACKs.

tcp.analysis.retransmission						
No.	Time	Source	Destination	Protocol	Length	Info

10. How much data does the receiver typically acknowledge in an ACK among the first ten data-carrying segments sent from the client to gaia.cs.umass.edu? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 in the text) among these first ten data-carrying segments?

Ans: The receiver typically acknowledges 1448 bytes of data in an ACK among the first ten data-carrying segments sent from the client. As the length of each segments is 1448 bytes.

tcp							
No.	Time	Source	Destination	Protocol	Length	Info	
3 0.022505	192.168.86.68	128.119.245.12	TCP	66 55639 → 80	[ACK]	Seq=1 Ack=1 Win=131712 Len=0 TSval=725607531 TSecr=3913851370	
4 0.024047	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=1 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment of a	
5 0.024648	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=1449 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment o	
6 0.024049	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=2897 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370 [TCP segment o	
7 0.052671	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=1449 Win=31872 Len=0 TSval=3913851399 TSecr=725607532	
8 0.052676	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=2897 Win=34816 Len=0 TSval=3913851400 TSecr=725607532	
9 0.052774	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=4345 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851399 [TCP segment o	
10 0.052775	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=5793 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851399 [TCP segment o	
11 0.052854	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=7241 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851400 [TCP segment o	
12 0.052855	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=8689 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851400 [TCP segment o	
13 0.053626	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=4345 Win=37760 Len=0 TSval=3913851400 TSecr=725607532	
14 0.053710	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=10137 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851400 [TCP segment	
15 0.053711	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=11585 Ack=1 Win=131712 Len=1448 TSval=725607560 TSecr=3913851400 [TCP segment	
16 0.080768	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=5793 Win=40576 Len=0 TSval=3913851421 TSecr=725607560	
17 0.080771	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=7241 Win=43520 Len=0 TSval=3913851422 TSecr=725607560	
18 0.080772	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=8689 Win=46336 Len=0 TSval=3913851422 TSecr=725607560	
19 0.080772	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=10137 Win=49280 Len=0 TSval=3913851422 TSecr=725607560	
20 0.080845	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=13833 Ack=1 Win=131712 Len=1448 TSval=725607588 TSecr=3913851421 [TCP segment	

We can identify cases where the receiver is ACKing every other received segment among these first ten data-carrying segments.

- The receiver does sends an ACK for every single segment.
- Because, it acknowledges every segments (after receiving 1448 bytes)

11. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

Ans: First data-carrying packet : pkt #4 (time = 0.024047s)
Last data segment (HTTP POST end) : pkt #153 (time = 0.147682s)

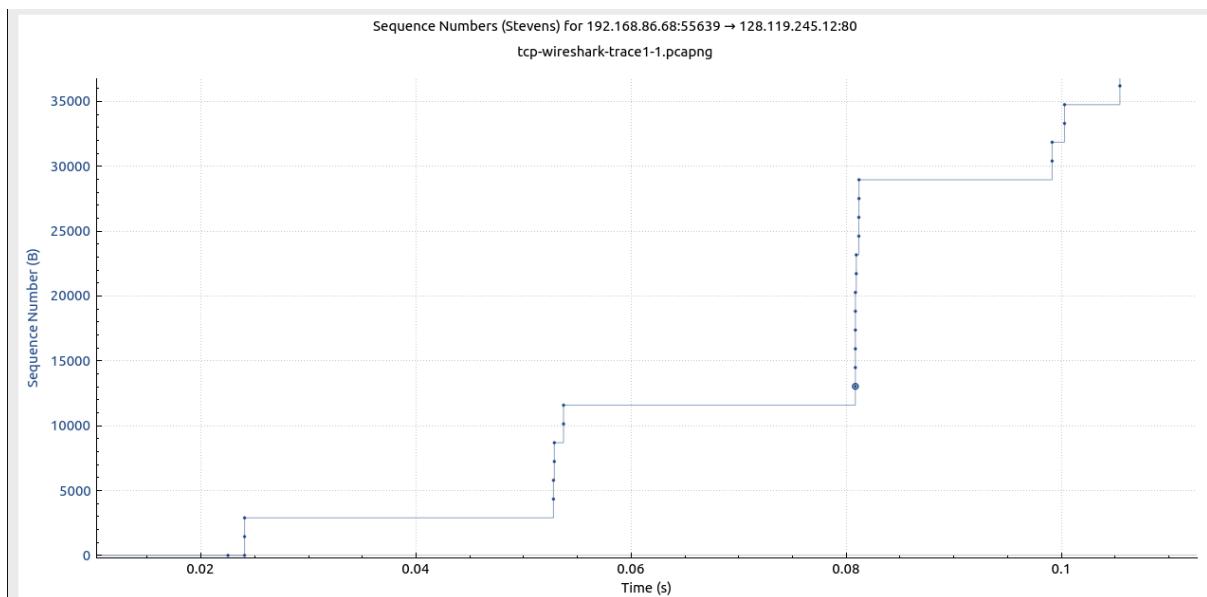
Total data transferred = 153425 bytes

$$\begin{aligned} \text{Throughput} &= \text{Total bytes} / \text{transfer duration} \\ &= 153425 / (0.147682 - 0.024047) \\ &= 1240951.187 \text{ bytes/s} \end{aligned}$$

tcp							
No.	Time	Source	Destination	Protocol	Length	Info	
1 0.000000	192.168.86.68	128.119.245.12	TCP	78 55639 → 80	[SYN]	Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=725607509 TSecr=3913851370	
2 0.022414	128.119.245.12	192.168.86.68	TCP	74 80 → 55639	[SYN, ACK]	Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TS	
3 0.022505	192.168.86.68	128.119.245.12	TCP	66 55639 → 80	[ACK]	Seq=1 Ack=1 Win=131712 Len=0 TSval=725607531 TSecr=3913851370	
4 0.024047	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=1 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370	
5 0.024048	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=1449 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370	
6 0.024049	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=2897 Ack=1 Win=131712 Len=1448 TSval=725607532 TSecr=3913851370	
148 0.147565	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=76745 Win=182528 Len=0 TSval=3913851498 TSecr=	
149 0.147566	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=78193 Win=182528 Len=0 TSval=3913851498 TSecr=	
150 0.147620	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=147697 Ack=1 Win=131712 Len=1448 TSval=725607650 TSe	
151 0.147621	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=149145 Ack=1 Win=131712 Len=1448 TSval=725607650 TSe	
152 0.147680	192.168.86.68	128.119.245.12	TCP	1514 55639 → 80	[ACK]	Seq=150593 Ack=1 Win=131712 Len=1448 TSval=725607650 TSe	
153 0.147682	192.168.86.68	128.119.245.12	HTTP	1451 POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)			
154 0.149626	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=81089 Win=182528 Len=0 TSval=3913851498 TSecr=	
155 0.149626	128.119.245.12	192.168.86.68	TCP	66 80 → 55639	[ACK]	Seq=1 Ack=81089 Win=182528 Len=0 TSval=3913851498 TSecr=	

12. Use the Time-Sequence-Graph(Stevens) plotting tool to view the sequence number versus time plot of segments being sent from the client to the gaia.cs.umass.edu server. Consider the “fleets” of packets sent around $t = 0.025$, $t = 0.053$, $t = 0.082$ and $t = 0.1$. Comment on whether this looks as if TCP is in its slow start phase, congestion avoidance phase or some other phase. Figure 6 shows a slightly different view of this data.

Ans:



Interpretation:

- The number of segments per fleet doubles early (slow start behavior).
- Then, fleets are spaced more evenly and of similar size - transition to congestion avoidance.

So the connection starts in Slow Start, then shifts toward Congestion Avoidance.

13. These “fleets” of segments appear to have some periodicity.
What can you say about the period?

Ans: Approximate fleet intervals:

$$0.053 - 0.025 = 0.028 \text{ s}$$

$$0.082 - 0.053 = 0.029 \text{ s}$$

$$0.100 - 0.082 = 0.018 \text{ s}$$

Average period ≈ 0.025 seconds (25 ms)

This matches the RTT from earlier (~ 28 ms), showing each fleet corresponds to one RTT’s worth of ACK-triggered transmissions — ACK-clocked behavior.