

## Exercise1

### Question1

The IP address of **gaia.cs.umass.edu** is **128.119.245.12**, also the **port number** is **80**.  
The IP address of the **client computer** is **192.168.1.102**, also the **port number** is **1161**.  
We can also find the result from two pictures given below.

Source: 192.168.1.102 (192.168.1.102)

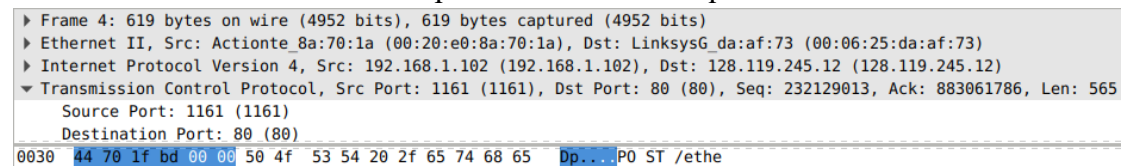
Destination: 128.119.245.12 (128.119.245.12)

Source Port: 1161 (1161)

Destination Port: 80 (80)

### Question2

We can find the keyword POST in frame 4. Therefore, we can get the **sequence number**, which is **232129013**. Here is the picture result of this question.



### Question3

Based on the formula, we can get the following table.

$$\text{EstimatedRTT} = (1-a) * \text{EstimatedRTT} + a * \text{SampleRTT}$$

Index	Sequence Number	Time sent	Time ACK received	RTT	EstimatedRTT
1	232129013	0.026477	0.053937	0.027460	0.027460
2	232129578	0.041737	0.077294	0.035557	0.028472
3	232131038	0.054026	0.124085	0.070059	0.033670
4	232132498	0.054690	0.169118	0.114428	0.043765
5	232133958	0.077405	0.217299	0.139894	0.055781
6	232135418	0.078157	0.267802	0.189645	0.072514

### Question4

The length of the first **TCP segment** is **565**. From the **second segment** to the **sixth segment**, the length of these **5 segments** are the same which is **1460**.

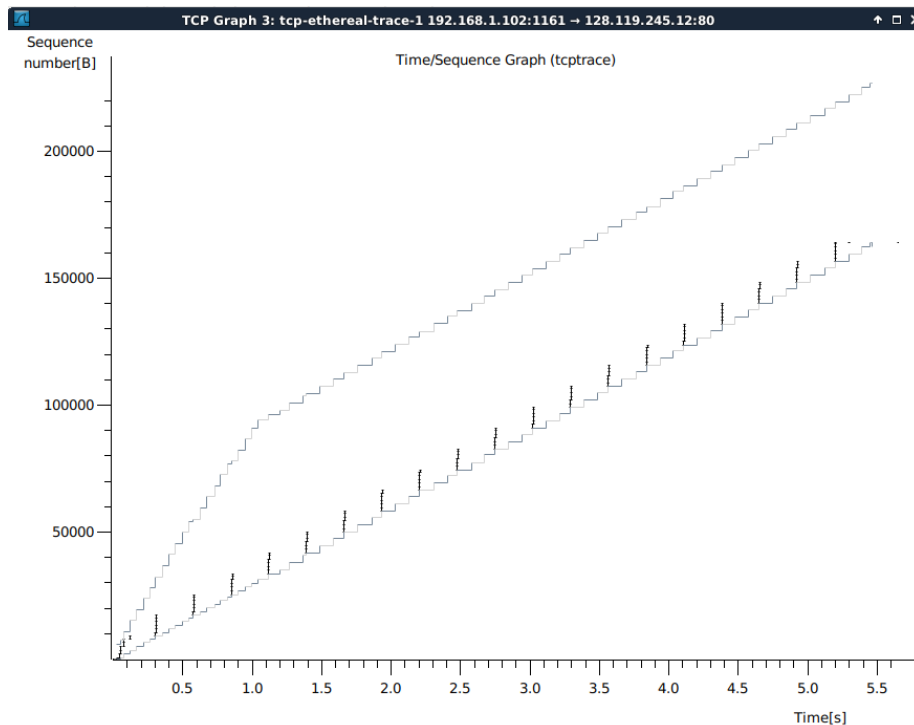
### Question5

The **minimum amount of buffer space** is **5840**. No, it doesn't. This is because the window size is **increasing** (never decreased). Here is the picture result of question 5.

2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80-1161	[SYN, ACK]	Seq=883061785	Ack=232129013	Win=0	Len=0
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161-80	[ACK]	Seq=232129013	Ack=883061785	Win=0	Len=0
Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0											
Ethernet II, Src: LinksysG_da:af:73 (00:06:25:da:af:73), Dst: Actionte_8a:70:1a (00:20:e0:8a:70:1a)											
Internet Protocol Version 4, Src: 128.119.245.12 (128.119.245.12), Dst: 192.168.1.102 (192.168.1.102)											
Transmission Control Protocol, Src Port: 80 (80), Dst Port: 1161 (1161), Seq: 883061785, Ack: 232129013, Len: 0											
Source Port: 80 (80)											
Destination Port: 1161 (1161)											
[Stream index: 0]											
[TCP Segment Len: 0]											
Sequence number: 883061785											
Acknowledgment number: 232129013											
Header Length: 28 bytes											
... 0000 0001 0010 = Flags: 0x012 (SYN, ACK)											
Window size value: 5840											

## Question6

No, there aren't. This is because the **sequence numbers are incremental**. We can also find this result in the Time/Sequence Graph printed by Wireshark. From the graph given below, the **sequence numbers are increasing** over time. Here is the picture result of this question.



## Question7

The receiver typically **acknowledges 1460 bytes**.

**Number 46**, which sequence number is **232160249**, **didn't receive** an ACK with number **232161709**. We can also find this result in the first picture, which means the receiver didn't get the ACK. Furthermore, **number 46 and number 47 share one single ACK** which number is **232162601**. Here are the pictures of the question7.

48	0.899423	128.119.245.12	192.168.1.102	TCP	60	80-1161	[ACK]	Seq=883061786	Ack=232155869	Win=55480	Len=0
49	0.949545	128.119.245.12	192.168.1.102	TCP	60	80-1161	[ACK]	Seq=883061786	Ack=232157329	Win=58400	Len=0
50	0.994715	128.119.245.12	192.168.1.102	TCP	60	80-1161	[ACK]	Seq=883061786	Ack=232158789	Win=61320	Len=0
51	1.039820	128.119.245.12	192.168.1.102	TCP	60	80-1161	[ACK]	Seq=883061786	Ack=232160249	Win=62780	Len=0
52	1.117097	128.119.245.12	192.168.1.102	TCP	60	80-1161	[ACK]	Seq=883061786	Ack=232162601	Win=62780	Len=0
53	1.117223	192.168.1.102	128.119.245.12	TCP	1514	1161-80	[ACK]	Seq=232162601	Ack=883061786	Win=0	Len=0

```

▶ Frame 46: 1514 bytes on wire (12112 bits), 1514 bytes captured (12112 bits)
▶ Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
▶ Internet Protocol Version 4, Src: 192.168.1.102 (192.168.1.102), Dst: 128.119.245.12 (128.119.245.12)
▼ Transmission Control Protocol, Src Port: 1161 (1161), Dst Port: 80 (80), Seq: 232160249, Ack: 883061786, Len: 1460
    Source Port: 1161 (1161)
    Destination Port: 80 (80)
    [Stream index: 0]
    [TCP Segment Len: 1460]
    Sequence number: 232160249
    [Next sequence number: 232161709]
    Acknowledgment number: 883061786
    Header Length: 20 bytes
    ▶ .... 0000 0001 0000 = Flags: 0x010 (ACK)

▶ Frame 47: 946 bytes on wire (7568 bits), 946 bytes captured (7568 bits)
▶ Ethernet II, Src: Actionte_8a:70:1a (00:20:e0:8a:70:1a), Dst: LinksysG_da:af:73 (00:06:25:da:af:73)
▶ Internet Protocol Version 4, Src: 192.168.1.102 (192.168.1.102), Dst: 128.119.245.12 (128.119.245.12)
▼ Transmission Control Protocol, Src Port: 1161 (1161), Dst Port: 80 (80), Seq: 232161709, Ack: 883061786, Len: 892
    Source Port: 1161 (1161)
    Destination Port: 80 (80)
    [Stream index: 0]
    [TCP Segment Len: 892]
    Sequence number: 232161709
    [Next sequence number: 232162601]
    Acknowledgment number: 883061786
    Header Length: 20 bytes
    ▶ .... 0000 0001 1000 = Flags: 0x018 (PSH, ACK)

```

## Question8

The last sequence number is 232293103. The first sequence number is 232129013. By using these 2 sequence numbers, we can get the transferred bytes are  $232293103 - 232129013 = 164090$  bytes. We can also find the last ACK time is 5.455830s. Also, the first-time sending message which is 0.026477s. We can get the time which is  $5.455830 - 0.026477 = 5.429353$ s. Therefore, we can calculate the **throughput** which is  $164090 / 5.429353 = 30222.754$  Bytes/s.

## Exercise2

### Question1

We can get the result from the SYN data packet. Therefore, the **sequence number** is **2818463618**.

295	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [SYN] Seq=2818463618 win=8192 MSS=1460
-----	-------------	-------------	-----	---

### Question2

The **sequence number** is **1247095790**. The value of the **Acknowledgement field** is **1**. When the server receives an SYN, then it returns an SYNACK to confirm the connection. To show this in the flags, it sets the Acknowledgement and SYN field as value 1. This is due to the Three-way Handshake.

296	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [SYN, ACK] Seq=1247095790 Ack=2818463619 win=262144 MSS=1460
-----	-------------	-------------	-----	---

### Question3

The **sequence number** is **2818463619**. The value of the **Acknowledgement field** is **1**. **Yes, it contains data**. By checking the value of ACK and Sequence number, we can

find the data is  $ACK_{301} - Seq_{297} = 2818463652 - 2818463619 = 33bytes$  .  
Therefore, it contains data, which amount is 33 bytes.

297	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [ACK] Seq=2818463619 Ack=1247095791 win=65535
301	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [ACK] Seq=1247095791 Ack=2818463652 win=262096

#### Question4

**Both server and client did the active close.** This is because after the client sent the FIN message, the server also sent the FIN message. The FIN segment is the last-sending on both the server-side and the client-side. This means both the server and the client want to close the connection. Therefore, this is a **simultaneous close**.

304	10.9.16.201	10.99.6.175	TCP	50045 > 5000 [FIN, ACK] Seq=2818463652 Ack=1247095831 win=65535
305	10.99.6.175	10.9.16.201	TCP	5000 > 50045 [FIN, ACK] Seq=1247095831 Ack=2818463652 win=262144

#### Question5

**Client ----sending to ----> Server:**  $2818463652 - 2818463619 = 33 \text{ Bytes}$

**Server ----sending to ----> Client:**  $1247095831 - 1247095791 = 40 \text{ Bytes}$

By doing the subtraction, we can find the relationship that if we minus the initial sequence number from the final ACK, the value of the subtraction would equal the number of bytes which have been transferred in this process plus one SYN and one FIN.

**Final ACK = initial Sequence number + Transferred bytes + one SYN + one FIN**