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Lab4

Exercise1:

1、

The IP address of gaia.cs.umass.edu(destination) is 128.119.245.12, and the port is 80;

The IP address of client computer (source) is 192.168.1.102 and the port is 1161.

Time	Source	Destination	Protocol
0.000000	192.168.1.102	128.119.245.12	TCP

2、

```
Source Port: 1161
Destination Port: 80
[Stream index: 0]
[TCP Segment Len: 565]
Sequence number: 232129013
[Next sequence number: 232129578]
Acknowledgment number: 883061786
0101 .... = Header Length: 20 bytes (5)
```

The sequence number which contains the HTTP command is 232129013.

This value is the same as the ACK segment that was sent prior to this segment, because this segments didn't contain any data, therefore the server keep the sequence unchanged.

3、

If we consider HTTP post as the first segment.

The segments 1-6 are No.4,5,7,8,10,11 in this trace; and the ACKs of each segments is No.6,9,12,14,15,16 in this trace.

No.4 , segment 1, sequence number: 232129013;

No.5 , segment 2, sequence number: 232129578;

No.7 , segment 3, sequence number: 232131038;

No.8 , segment 4, sequence number: 232132498;

No.10 ,segment 5, sequence number: 232133958;

No.11, segment 6, sequence number: 232135418;

The sending time and the received time of ACKs are shown below:

	Sent time	ACK received time	RTT(s)
Segement1	0.026477	0.053937	0.02746
Segement2	0.041737	0.077294	0.035557
Segement3	0.054026	0.124085	0.070059
Segement4	0.054690	0.169118	0.11443
Segement5	0.077405	0.217299	0.13989
Segement6	0.078157	0.267802	0.18964

2	0.023172	128.119.245.12	19
3	0.023265	192.168.1.102	12
4	0.026477	192.168.1.102	12
5	0.041737	192.168.1.102	12
6	0.053937	128.119.245.12	19
7	0.054026	192.168.1.102	12
8	0.054690	192.168.1.102	12
9	0.077294	128.119.245.12	19
10	0.077405	192.168.1.102	12
11	0.078157	192.168.1.102	12
12	0.124085	128.119.245.12	19
13	0.124185	192.168.1.102	12

the sent time show above

No.	Time	Source	Destination
4	0.026477	192.168.1.102	128.119.245.12
5	0.041737	192.168.1.102	128.119.245.12
6	0.053937	128.119.245.12	192.168.1.102
7	0.054026	192.168.1.102	128.119.245.12
8	0.054690	192.168.1.102	128.119.245.12
9	0.077294	128.119.245.12	192.168.1.102
10	0.077405	192.168.1.102	128.119.245.12
11	0.078157	192.168.1.102	128.119.245.12
12	0.124085	128.119.245.12	192.168.1.102
13	0.124185	192.168.1.102	128.119.245.12
14	0.169118	128.119.245.12	192.168.1.102
15	0.217299	128.119.245.12	192.168.1.102
16	0.267802	128.119.245.12	192.168.1.102
17	0.304807	128.119.245.12	192.168.1.102

the ACK received time show above.

$$\text{EstimatedRTT} = 0.875 * \text{EstimatedRTT} + 0.125 * \text{SampleRTT}$$

after the receipt of the ACK of segment 1:

$$\text{EstimatedRTT} = \text{RTT for Segment 1} = 0.02746 \text{ s}$$

EstimatedRTT after the receipt of the ACK of segment 2:

$$\text{EstimatedRTT} = 0.875 * 0.02746 + 0.125 * 0.035557 = 0.0285 \text{ s}$$

EstimatedRTT after the receipt of the ACK of segment 3:

$$\text{EstimatedRTT} = 0.875 * 0.0285 + 0.125 * 0.070059 = 0.0337 \text{ s}$$

EstimatedRTT after the receipt of the ACK of segment 4:

$$\text{EstimatedRTT} = 0.875 * 0.0337 + 0.125 * 0.11443 = 0.0438 \text{ s}$$

EstimatedRTT after the receipt of the ACK of segment 5:

$$\text{EstimatedRTT} = 0.875 * 0.0438 + 0.125 * 0.13989 = 0.0558 \text{ s}$$

EstimatedRTT after the receipt of the ACK of segment 6:

$$\text{EstimatedRTT} = 0.875 * 0.0558 + 0.125 * 0.18964 = 0.0725 \text{ s}$$

4、

No.4 , segment 1, segment length: 565 ;

```
▼ Transmission Control Protocol, Src Port: 1161
  Source Port: 1161
  Destination Port: 80
  [Stream index: 0]
  [TCP Segment Len: 565]
  Sequence number: 232129013
```

No.5 , segment 2, segment length: 1460;

```
▼ Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129578
  Source Port: 1161
  Destination Port: 80
  [Stream index: 0]
  [TCP Segment Len: 1460]
  Sequence number: 232129578
  [Next sequence number: 232131038]
```

No.7 , segment 3, segment length: 1460

No.8 , segment 4, segment length: 1460

No.10 ,segment 5, segment length: 1460

No.11, segment 6, segment length: 1460

5、

The minimum amount of available buffer space is 5840.

```
Destination Port: 1161
[Stream index: 0]
[TCP Segment Len: 0]
Sequence number: 883061785
[Next sequence number: 883061786]
Acknowledgment number: 232129013
0111 .... = Header Length: 28 bytes (7)
► Flags: 0x012 (SYN, ACK)
Window size value: 5840
[Calculated window size: 5840]
Checksum: 0x774d [unverified]
[Checksum Status: Unverified]
Urgent pointer: 0
► Options: (8 bytes), Maximum segment size, No-Operation
► [SEQ/ACK analysis]
▼ [Timestamps]
```

The lack of receiver buffer space didn't throttle the sender, the buffer space go up to 62780, until the connection stopped.

191	5.197286	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232285481 Win=62780 Len=0
192	5.197508	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232285481 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
193	5.198388	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232286941 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
194	5.199275	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232288481 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
195	5.200252	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232289861 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
196	5.201158	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232291321 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
197	5.202024	192.168.1.102	128.119.245.12	TCP	326	1161 → 80 [PSH, ACK] Seq=232292781 Ack=883061786 Win=17520 Len=272 [TCP segment of a reassembled PDU]
198	5.297257	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232288481 Win=62780 Len=0
199	5.297341	192.168.1.102	128.119.245.12	HTTP	104	POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
200	5.389471	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232291321 Win=62780 Len=0
201	5.447887	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232293053 Win=62780 Len=0
232	5.455330	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232293113 Win=62780 Len=0
283	5.461175	128.119.245.12	192.168.1.102	HTTP	784	HTTP/1.1 200 OK (text/html)

6、

In this trace file, there are no retransmitted segments, all the segments received successfully to the client in one transmitted. By checking the sequence number from the source to the destination, the segments number grows larger than the last one, if there something wrong, we will find a smaller segment number compare to the last one.

7、

In this continuous ACK, the sequence number of each one is 232129578, 232131038, 232132498, 232133958, 232135418, 232136878 respectively, we can find that the acknowledged data of ACK are all 1460

5	0.054131	192.168.1.102	192.168.1.102	TCP	60	1161 → 80 [PSH, ACK] Seq=232129578 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129578 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232131038 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232132498 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
9	0.072294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232131038 Win=6780 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232133958 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232135418 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
12	0.124885	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232132498 Win=1680 Len=0
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Seq=232136878 Ack=883061786 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232133958 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232135418 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232136878 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232138025 Win=23360 Len=0
18	0.305440	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232136878 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

And there are cases where the receiver is ACKing every other segments, from checking the acknowledged data by each ACK. In the segment of No.80, the acknowledged data is 2920bytes.

78	1.758227	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232181905 Win=62780 Len=0
79	1.860063	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232184825 Win=62780 Len=0
80	1.930880	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232187177 Win=62780 Len=0
81	1.931099	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232187177 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
82	1.931870	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232188637 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

8、

The throughput for the TCP connection = the total amount data transmitted/ the total data transmission time

The total amount data transmitted can be calculated by the difference between the first segment(No.4) and the acknowledged sequence of the last ACK (No.202), which is 232293103 - 232129013 = 164090bytes

Destination: 128.119.245.12	
Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 232129013	
Source Port: 1161	
Destination Port: 80	
[Stream index: 0]	
[TCP Segment Len: 565]	
Sequence number: 232129013	
[Next sequence number: 232129578]	
Acknowledgment number: 883061786	
Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 883061786	
Source Port: 80	
Destination Port: 1161	
[Stream index: 0]	
[TCP Segment Len: 0]	
Sequence number: 883061786	
[Next sequence number: 883061786]	
Acknowledgment number: 232293103	
0101 = Header Length: 20 bytes (5)	
Flags: 0x010 (ACK)	
Window size value: 62780	

The total data transmission time are similar as the data transmission, which can be calculated by the difference between the First TCP segments time and the last ACK time, which is 5.455830 - 0.26477 = 5.4294s.

2	0.023172	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
3	0.023265	192.168.1.102	128.119.245.12	TCP	60	1161 → 80 [ACK] Seq=232129013 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
4	0.026477	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
5	0.041737	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
200	5.389471	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
201	5.447887	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
202	5.455830	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
203	5.461175	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=883061786 Ack=232129013 Win=62780 Len=0
206	5.651141	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=232188637 Ack=883061786 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

In conclusion, the throughput of the TCP connection is $164090 / 5.4294 = 30.222$ kbyte/s

Exercise2

1、

The sequence number of the TCP SYN segment initiate the TCP connection is 2818463618.

2、

The sequence number of SYNACK is 1247095790, the value of the acknowledgement field is 28218463619, the server determine this number by increasing 1 from the sequence number receive from the client.(which is 50045 in this question)

3、

The sequence number is 2818463619, which sent by the client computer in response to the SYNACK, the acknowledgement field in this ACK segment is 1247095791. This segment didn't contain any data.

4、

The type of closure is simultaneous close. Both client and server didn't sent FIN to the other one, we can know that by checking the ACK numbers of these FIN segments.

5、

Client:

The data transferred is : $2818463653 - 2818463618 - 2 = 35 - 1 - 1 = 33$ bytes
In this equation the "1" are SYN and "FIN" respectively

Server:

The data transferred is : $1247095832 - 1247095790 - 2 = 42 - 1 - 1 = 40$ bytes
In this equation the "1" are SYN and "FIN" respectively

The data is equal to the difference between first TCP initial sequence number and the final ACK, and minus the SYK and FIN.