TCP 实验报告

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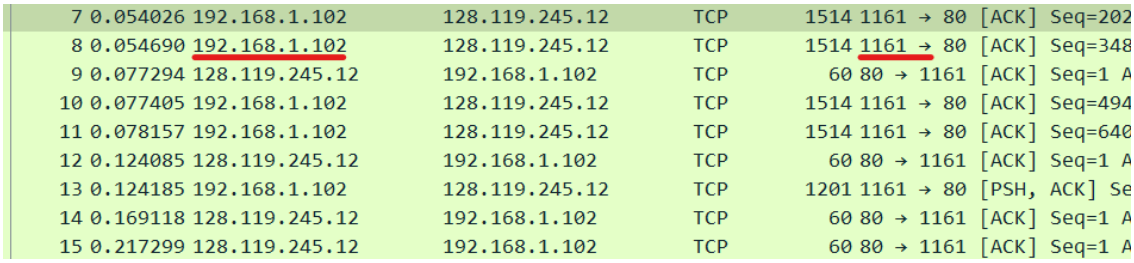
3 - 6 题分析的均为自己抓的包，其余为实验提供的包

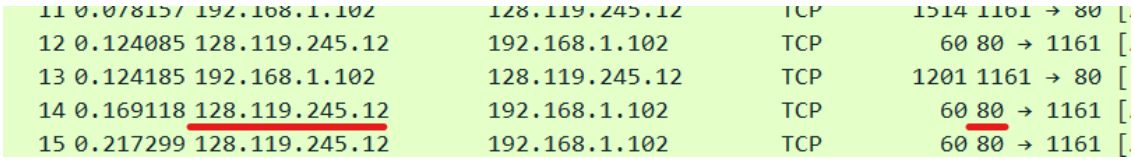
A first look at the captured trace

1. IP 地址是 **192.168.1.102**，端口是 **1161**



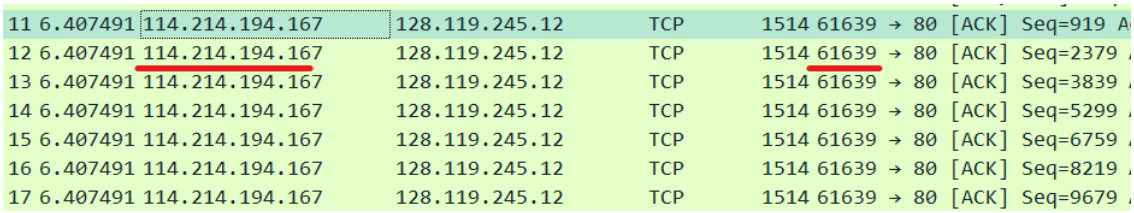
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=202
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=348
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 A
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=494
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=640
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 A
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [PSH, ACK] Se
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 A
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 A

2. gaia.cs.umass.edu 的 IP 地址是 **128.119.245.12**，使用的端口号是 **80**



11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [
13	0.124185	192.168.1.102	128.119.245.12	TCP	1201	1161 → 80 [
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [

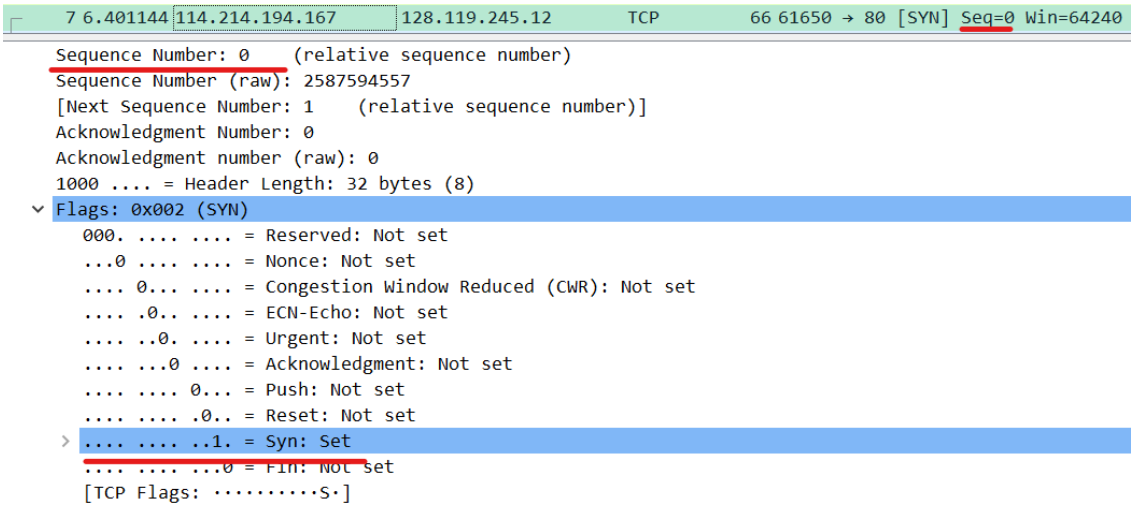
3. 我的 IP 地址是 **114.214.194.167**，我电脑端口用的端口是 **61639**



11	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=919 A
12	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=2379
13	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=3839
14	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=5299
15	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=6759
16	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=8219
17	6.407491	114.214.194.167	128.119.245.12	TCP	1514	61639 → 80 [ACK] Seq=9679

TCP Basics

4. 初始的序列号是 **0**，在报文段中用 **Syn: set** 表示该报文段是 SYN 报文段



```
    7 6.401144 114.214.194.167  128.119.245.12  TCP  66 61650 → 80 [SYN] Seq=0 Win=64240
Sequence Number: 0    (relative sequence number)
Sequence Number (raw): 2587594557
[Next Sequence Number: 1    (relative sequence number)]
Acknowledgment Number: 0
Acknowledgment number (raw): 0
1000 .... = Header Length: 32 bytes (8)
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·]
```

5. 序列号是 **0**，Acknowledgement 字段的值为 **set(1)**，它是通过标志位 Flags 来确认这些值的，报文段中有 Syn 和 Ack 来确认其是 SYNACK 报文段的

```
4 2.639296 128.119.245.12      114.214.194.167     TCP        66 80 → 61639 [SYN, ACK] Seq=0 Ack=1

Sequence Number: 0    (relative sequence number)
Sequence Number (raw): 854502980
[Next Sequence Number: 1    (relative sequence number)]
Acknowledgment Number: 1    (relative ack number)
Acknowledgment number (raw): 675454174
1000 .... = Header Length: 32 bytes (8)
Flags: 0x012 (SYN, ACK)
  000. .... .... = Reserved: Not set
  ...0 .... .... = Nonce: Not set
  .... 0... .... = Congestion Window Reduced (CWR): Not set
  .... .0.. .... = ECN-Echo: Not set
  .... ..0. .... = Urgent: Not set
  .... ...1 .... = Acknowledgment: Set
  .... .... 0... = Push: Not set
  .... .... .0.. = Reset: Not set
  .... .... ..1. = Syn: Set
    [Expert Info (Chat/Sequence): Connection establish acknowledge (SYN+ACK): server port 80]
      [Connection establish acknowledge (SYN+ACK): server port 80]
      [Severity level: Chat]
      [Group: Sequence]
  .... .... ...0 = Fin: Not set
  [TCP Flags: ·····A··S·]
```

6. 包含 POST 命令的 TCP 报文段序号是 **1**

```
10 6.407100 114.214.194.167    128.119.245.12      TCP        972 61639 → 80 [PSH, ACK] Seq=1 Ack=1
11 6.407491 114.214.194.167    128.119.245.12      TCP       1514 61639 → 80 [ACK] Seq=919 Ack=1 Wi
12 6.407491 114.214.194.167    128.119.245.12      TCP       1514 61639 → 80 [ACK] Seq=2379 Ack=1 W
13 6.407491 114.214.194.167    128.119.245.12      TCP       1514 61639 → 80 [ACK] Seq=3839 Ack=1 W
14 6.407491 114.214.194.167    128.119.245.12      TCP       1514 61639 → 80 [ACK] Seq=5299 Ack=1 W
15 6.407491 114.214.194.167    128.119.245.12      TCP       1514 61639 → 80 [ACK] Seq=6759 Ack=1 W

Transmission Control Protocol, Src Port: 61639, Dst Port: 80, Seq: 1, Ack: 1, Len: 918
  Source Port: 61639
  Destination Port: 80
  [Stream index: 0]
  [Conversation completeness: Incomplete (30)]
  [TCP Segment Len: 918]
  Sequence Number: 1    (relative sequence number)
  Sequence Number (raw): 675454174
  [Next Sequence Number: 919    (relative sequence number)]
  Acknowledgment Number: 1    (relative ack number)
  Acknowledgment number (raw): 854502981
  0101 .... = Header Length: 20 bytes (5)

0000  5c dd 70 91 72 e2 80 30  49 17 ac d8 08 00 45 00   \·p·r··0 I·····E·
0010  03 be 8e 39 40 00 80 06  bd fe 72 d6 c2 a7 80 77   ···9@··· ··r····w
0020  f5 0c f0 c7 00 50 28 42  9c de 32 ee ae 45 50 18   ·····P(B ··2··EP·
0030  02 01 51 63 00 00 50 4f  53 54 20 2f 77 69 72 65   ··Qc··PO ST /wire
0040  73 68 61 72 6b 2d 6c 61  62 73 2f 6c 61 62 33 2d   shark-la bs/lab3-
0050  31 2d 72 65 70 6c 79 2e  68 74 6d 20 48 54 54 50   1-reply. htm HTTP
0060  2f 31 2e 31 0d 0a 48 6f  73 74 3a 20 67 61 69 61   /1.1··Ho st: gaia
0070  2e 63 73 2e 75 6d 61 73  73 2e 65 64 75 0d 0a 43   .cs.umas s.edu··C
0080  6f 6e 6e 65 63 74 69 6f  6e 3a 20 6b 65 65 70 2d   onnectio n: keep-
```

7. 前 6 个 TCP 报文段的序号分别为：**1，566，2026，3486，4946，6406**

```
 4 0.026477 192.168.1.102    128.119.245.12      TCP        619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [T
 5 0.041737 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
 6 0.053937 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
 7 0.054026 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TC
 8 0.054690 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TC
 9 0.077294 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10 0.077405 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TC
11 0.078157 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TC
```

发送的时间分别为 **0.026477，0.041737，0.054026，0.054690，0.077405，0.078157**

接受每个 ACK 的时间为 **0.053937，0.077294，0.124085，0.169118，0.217299，0.267802**

```
 4 0.026477 192.168.1.102    128.119.245.12      TCP        619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP
 5 0.041737 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [
 6 0.053937 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
 7 0.054026 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP
 8 0.054690 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP
 9 0.077294 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10 0.077405 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP
11 0.078157 192.168.1.102    128.119.245.12      TCP       1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP
12 0.124085 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
13 0.124185 192.168.1.102    128.119.245.12      TCP       1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147
14 0.169118 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15 0.217299 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16 0.267802 128.119.245.12   192.168.1.102       TCP         60 80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
```

每个 RTT 分别为 **0.02746，0.035557，0.070059，0.114428，0.139894，0.189645**

EstimatedRTT = 0.02746，0.028472，0.033670，0.043765，0.055781，0.072514

8. 前 6 个 TCP 报文段的长度分别为：**619，1514，1514，1514，1514，1514**

4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [T
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
7	0.054026	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TC
8	0.054690	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TC
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10	0.077405	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TC
11	0.078157	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TC
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0

9. 接收方最小的缓冲区大小是 **5840**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.102	128.119.245.12	TCP	62	1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=
3	0.023265	192.168.1.102	128.119.245.12	TCP	54	1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
4	0.026477	192.168.1.102	128.119.245.12	TCP	619	1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of
5	0.041737	192.168.1.102	128.119.245.12	TCP	1514	1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment

不会限制发送方。因为这个接收区窗口在不断增加，直到 62780，所以可以说明发送方发送的数据也在相应的不断增加，同时发送发也不会因为接收方缓存空间不足而受到限制。因此不会限制发送方。

10. **没有**重新传送的包。如果有重传的包，会显示出这样的信息（下图是我随便抓的包得到的结果）

62	8.545101	114.214.194.167	128.119.245.12	TCP	1514 [TCP Retransmission]
63	8.728623	114.214.194.167	40.90.184.73	TCP	54 59678 → 443 [RST, ACK
64	8.815181	40.90.184.73	114.214.194.167	TCP	66 443 → 59678 [ACK] Seq
65	9.163250	114.214.194.167	40.90.184.73	TCP	66 [TCP Retransmission]

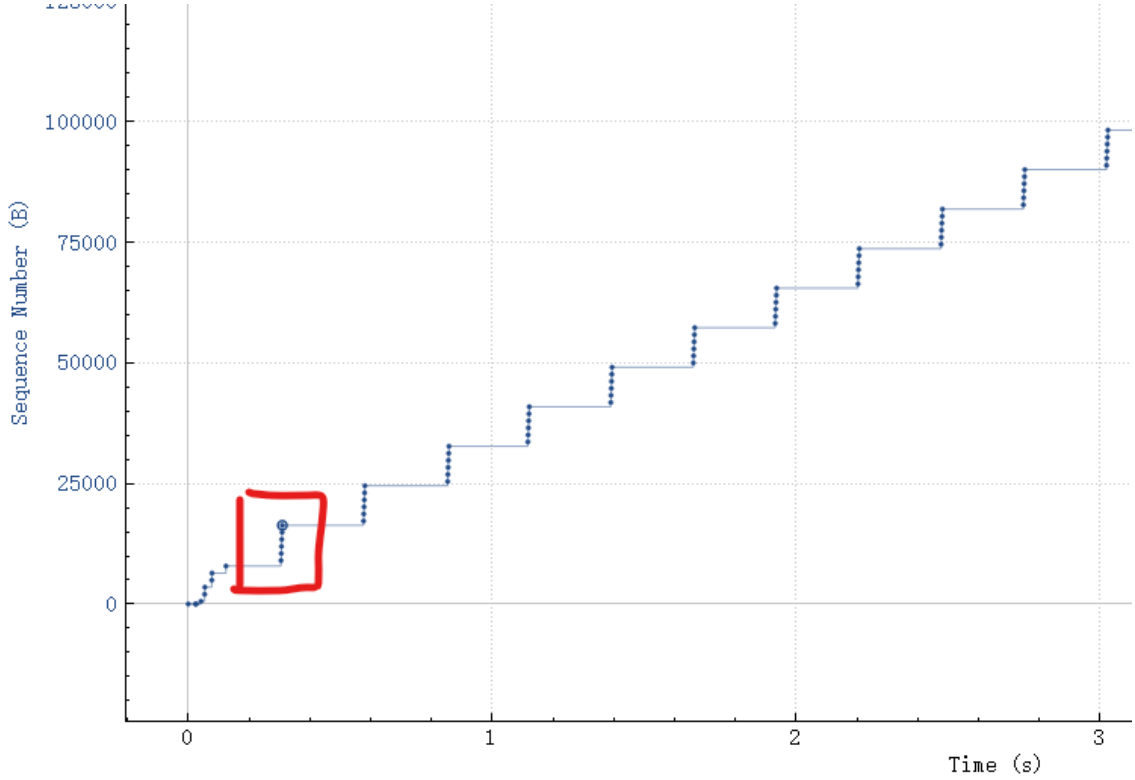
11. 接收方一般在一次 ACK 中 确认的数据量为 **1460**，这个从两次接收方的 ACK 数据差值可以看出。同时接收方也会确认数据量不为 1460 的报文段，例如 17 号的确认数据量为 1147

2	0.023172	128.119.245.12	192.168.1.102	TCP	62	80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=14
6	0.053937	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
9	0.077294	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
12	0.124085	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
14	0.169118	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
15	0.217299	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
16	0.267802	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
17	0.304807	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
24	0.356437	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=10473 Win=26280 Len=0
25	0.400164	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=11933 Win=29200 Len=0
26	0.448613	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=13393 Win=32120 Len=0
27	0.500029	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=14853 Win=35040 Len=0
28	0.545052	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=16313 Win=37960 Len=0
29	0.576417	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=17205 Win=37960 Len=0
36	0.626496	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=18665 Win=40880 Len=0
37	0.672796	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=20125 Win=43800 Len=0
38	0.730684	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=21585 Win=46720 Len=0
39	0.772990	128.119.245.12	192.168.1.102	TCP	60	80 → 1161 [ACK] Seq=1 Ack=23045 Win=49640 Len=0

12. 第一次发送 TCP 报文段的时间为 0.026477，最后一次确认时间为 5.461175 秒，总共发送的数据量为 164090 字节，所以吞吐量为 $\frac{164090\ bytes}{5.461175\ s - 0.026477\ s} = 30193.03\ bytes/s$

TCP congestion control in action

13. 从 0 时刻开始，到 0.124185 慢启动结束，然后开始拥塞避免。序列号从指数式增长变化成为线性增长。但是线性增长的速率和书上描述的不太一样，这里变化的更快，是以一种接近垂直的方式增长。



14. 对于自己抓的包，我无法辨别慢启动何时开始，而拥塞控制貌似是一开始就进行的。在我抓包的过程中，和实验中提供的 trace.zip 中的数据差距有点大，也出现了很多次重传，失序，超时以及冗余数据的情况。所以对 13 题两问无法给出准确的解答。