中国科学技术大学计算机学院

计算机网络实验报告

实验三

利用 Wireshark 观察 TCP 报文

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2020 年 11 月 24 日

一、 实验目的

1、　通过捕获观察并分析 TCP 报文，理解 TCP 的细节，包括：为了 reliable 传输的 SEQ、ACK 序号使用；TCP 的拥塞控制算法-慢启动和拥塞避免；TCP 的流控制机制；TCP 连接的建立。

二、 实验原理

Wireshark 是一个 packet 分析工具，可以抓取 packet，并分析出详细信息。Wireshark 使用 wincap 作为接口，直接与网卡进行 packet 交换，监听共享网络上传送的 packet。

三、 实验条件

1、　硬件条件：　联想拯救者 Y7000：

i5-8300H 2.30GHz

16G 内存

Intel UHD Graphics 630

2、　软件条件：　Win10

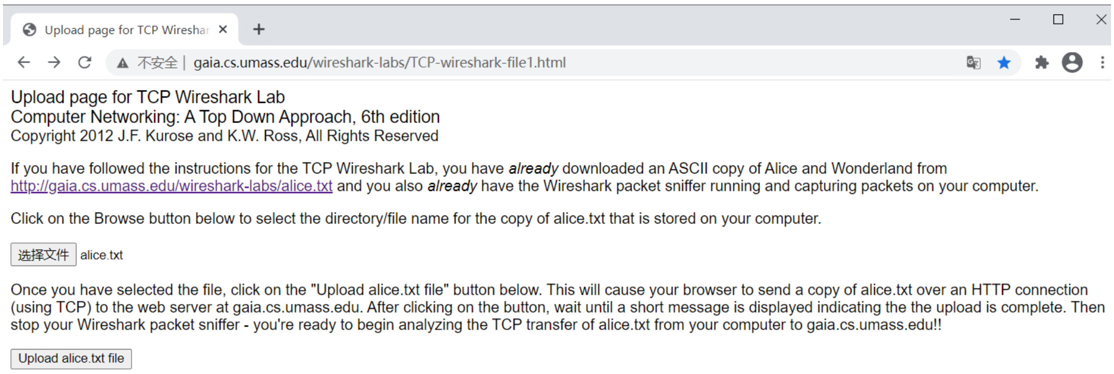
Wireshark3.4.0

四、 实验过程

1、 向远程服务器发送一个 txt 文件，并捕获 TCP 报文。

·首先下载 alice.txt

·到指定页面选中要上传的文件。


Upload page for TCP Wireshar ×
不安全 | gaia.cs.umass.edu/wireshark-labs/TCP-wireshark-file1.html

Upload page for TCP Wireshark Lab
Computer Networking: A Top Down Approach, 6th edition
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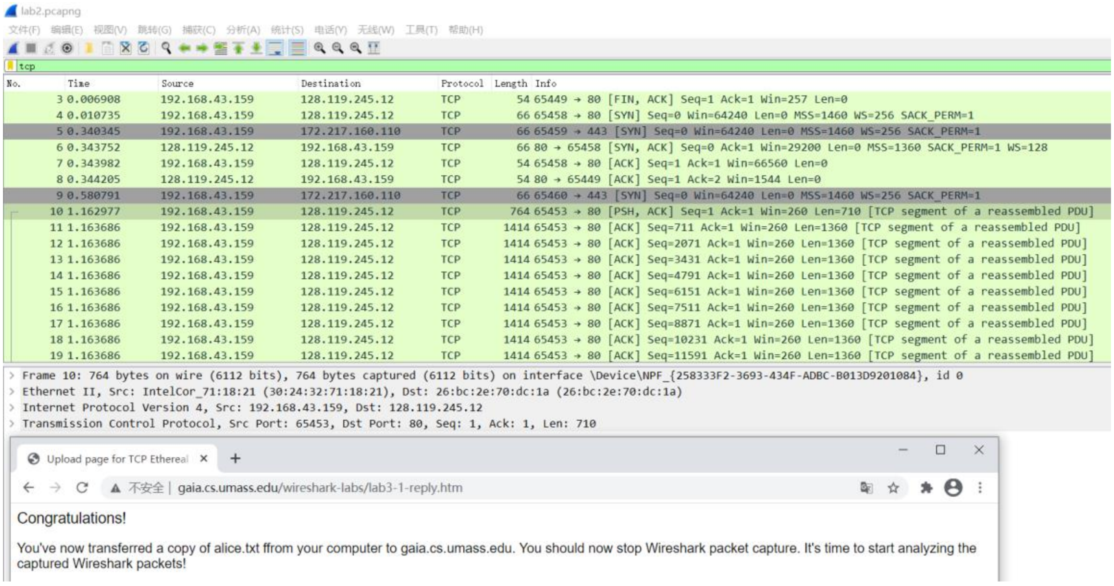
If you have followed the instructions for the TCP Wireshark Lab, you have *already* downloaded an ASCII copy of Alice and Wonderland from http://gaia.cs.umass.edu/wireshark-labs/alice.txt and you also *already* have the Wireshark packet sniffer running and capturing packets on your computer.

Click on the Browse button below to select the directory/file name for the copy of alice.txt that is stored on your computer.

Once you have selected the file, click on the "Upload alice.txt file" button below. This will cause your browser to send a copy of alice.txt over an HTTP connection (using TCP) to the web server at gaia.cs.umass.edu. After clicking on the button, wait until a short message is displayed indicating the the upload is complete. Then stop your Wireshark packet sniffer - you're ready to begin analyzing the TCP transfer of alice.txt from your computer to gaia.cs.umass.edu!!

- 打开 wireshark 开始捕获。
- 开始上传文件。
- 成功上传之后，终止捕获。


lab2.pcapng
文件(F) 编辑(E) 视图(V) 跳转(G) 捕获(C) 分析(A) 统计(S) 电话(Y) 无线(W) 工具(T) 帮助(H)
tcp

```
No.  Time      Source          Destination     Protocol Length Info
   3 0.006908  192.168.43.159  128.119.245.12  TCP        54 65449 → 80 [FIN, ACK] Seq=1 Ack=1 Win=257 Len=0
   4 0.010735  192.168.43.159  128.119.245.12  TCP        66 65458 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
   5 0.340345  192.168.43.159  172.217.160.110 TCP        66 65459 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
   6 0.343752  128.119.245.12  192.168.43.159  TCP        66 80 → 65458 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1360 SACK_PERM=1 WS=128
   7 0.343982  192.168.43.159  128.119.245.12  TCP        54 65458 → 80 [ACK] Seq=1 Ack=1 Win=66560 Len=0
   8 0.344205  128.119.245.12  192.168.43.159  TCP        54 80 → 65449 [ACK] Seq=1 Ack=2 Win=1544 Len=0
   9 0.580791  192.168.43.159  172.217.160.110 TCP        66 65460 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
  10 1.162977  192.168.43.159  128.119.245.12  TCP       764 65453 → 80 [PSH, ACK] Seq=1 Ack=1 Win=260 Len=710 [TCP segment of a reassembled PDU]
  11 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=711 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  12 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=2071 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  13 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=3431 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  14 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=4791 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  15 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=6151 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  16 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=7511 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  17 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=8871 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  18 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=10231 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
  19 1.163686  192.168.43.159  128.119.245.12  TCP      1414 65453 → 80 [ACK] Seq=11591 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
```

```
> Frame 10: 764 bytes on wire (6112 bits), 764 bytes captured (6112 bits) on interface \Device\NPF_{258333F2-3693-434F-ADBC-B013D9201084}, id 0
> Ethernet II, Src: IntelCor_71:18:21 (30:24:32:71:18:21), Dst: 26:bc:2e:70:dc:1a (26:bc:2e:70:dc:1a)
> Internet Protocol Version 4, Src: 192.168.43.159, Dst: 128.119.245.12
> Transmission Control Protocol, Src Port: 65453, Dst Port: 80, Seq: 1, Ack: 1, Len: 710
```

Upload page for TCP Ethereal ×
不安全 | gaia.cs.umass.edu/wireshark-labs/lab3-1-reply.htm

Congratulations!

You've now transferred a copy of alice.txt ffrom your computer to gaia.cs.umass.edu. You should now stop Wireshark packet capture. It's time to start analyzing the captured Wireshark packets!

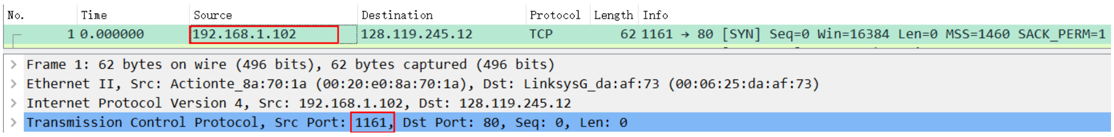
2、 开始回答问题。

五、 结果分析

以下是 pdf 中 14 个问题对应的回答（除 3、14 题，都是用的提供的 trace 文件。）

1. What is the IP address and TCP port number used by the client computer (source) that is transferring the 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).

答：客户端电脑的 ip 地址：192.168.1.102；TCP 端口：1161。如下图：

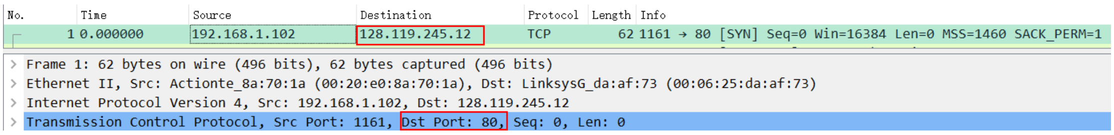


```
No.     Time        Source          Destination     Protocol  Length  Info
      1 0.000000    192.168.1.102   128.119.245.12  TCP           62  1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1

> Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 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, Dst: 128.119.245.12
> Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0
```

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?

答： IP地址为：128.119.245.12；端口号：80。

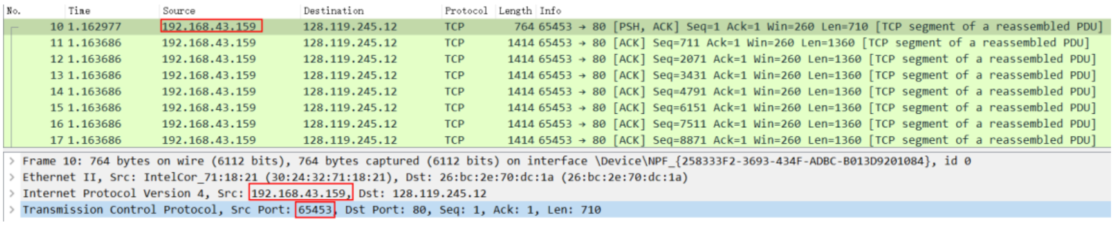
图：



```
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

> Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 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, Dst: 128.119.245.12
> Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0
```

3. What is the IP address and TCP port number used by your client computer (source) to transfer the file to gaia.cs.umass.edu?

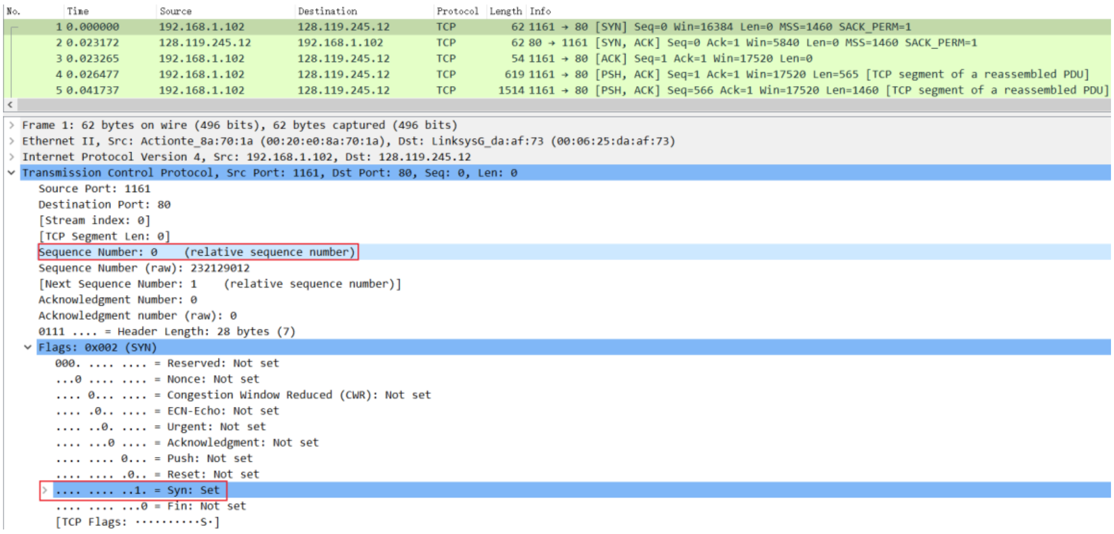
答：自己捕获一遍之后，得到下图。我自己电脑的 IP 地址为：192.168.43.159，端口号：65453



```
No.     Time        Source          Destination     Protocol  Length  Info
     10 1.162977    192.168.43.159  128.119.245.12  TCP          764  65453 → 80 [PSH, ACK] Seq=1 Ack=1 Win=260 Len=710 [TCP segment of a reassembled PDU]
     11 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=711 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
     12 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=2071 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
     13 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=3431 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
     14 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=4791 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
     15 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=6151 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
     16 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=7511 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]
     17 1.163686    192.168.43.159  128.119.245.12  TCP         1414  65453 → 80 [ACK] Seq=8871 Ack=1 Win=260 Len=1360 [TCP segment of a reassembled PDU]

> Frame 10: 764 bytes on wire (6112 bits), 764 bytes captured (6112 bits) on interface \Device\NPF_{258333F2-3693-434F-ADBC-B013D9201084}, id 0
> Ethernet II, Src: IntelCor_71:18:21 (30:24:32:71:18:21), Dst: 26:bc:2e:70:dc:1a (26:bc:2e:70:dc:1a)
> Internet Protocol Version 4, Src: 192.168.43.159, Dst: 128.119.245.12
> Transmission Control Protocol, Src Port: 65453, Dst Port: 80, Seq: 1, Ack: 1, Len: 710
```

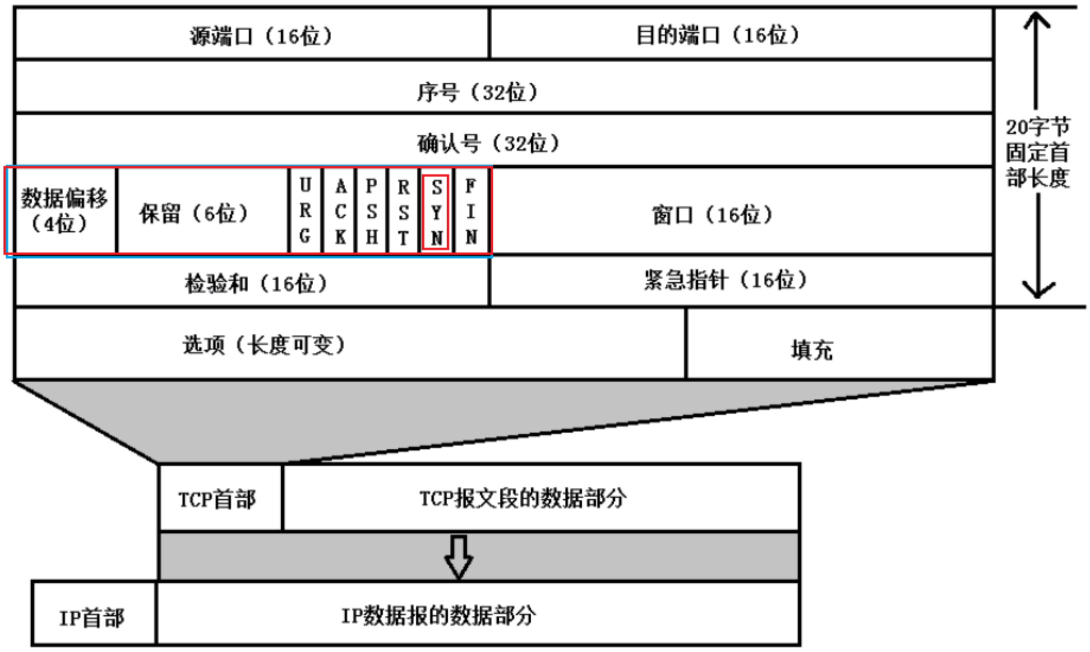
4. What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu? What is it in the segment that identifies the segment as a SYN segment?

答：如下图，SYN 的 Seq 序号为 0。



```
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=1
     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 a reassembled PDU]
     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 of a reassembled PDU]

> Frame 1: 62 bytes on wire (496 bits), 62 bytes captured (496 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, Dst: 128.119.245.12
v Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 0, Len: 0
    Source Port: 1161
    Destination Port: 80
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence Number: 0    (relative sequence number)
    Sequence Number (raw): 232129012
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 0
    Acknowledgment number (raw): 0
    0111 .... = Header Length: 28 bytes (7)
  v 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·]
```

确认报文为 SYN 报文的标志是报文的 TCP HEADER 中的 flag field 中被置为 1 的 SYN 标志。



5. What is the sequence number of the SYNACK segment sent by gaia.cs.umass.edu

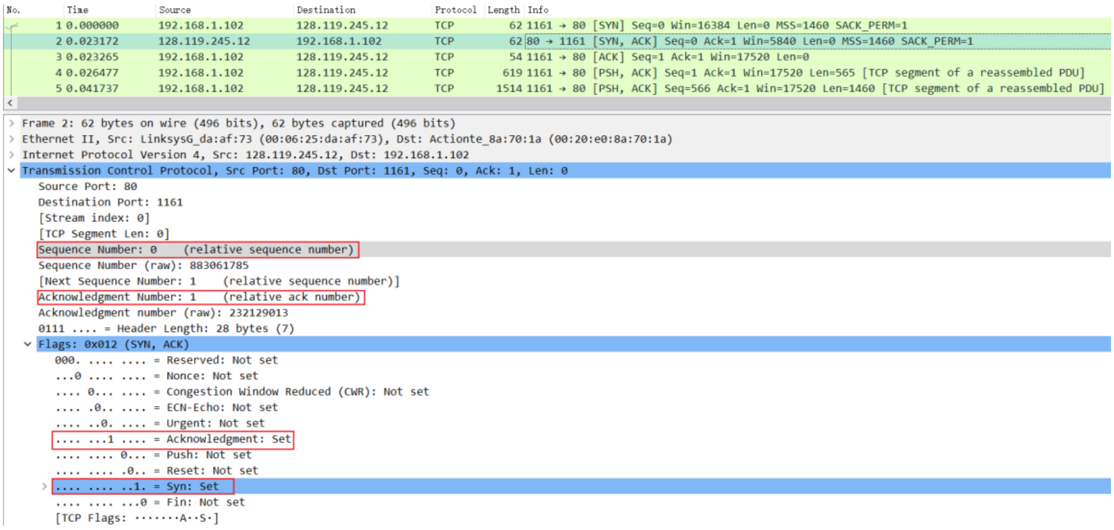
to the client computer in reply to the SYN? What is the value of the ACKnowledgement field in the SYNACK segment? How did gaia.cs.umass.edu determine that value? What is it in the segment that identifies the segment as a SYNACK segment?

答：如下图。

序号为 0。

Acknowledgement field 为 1。

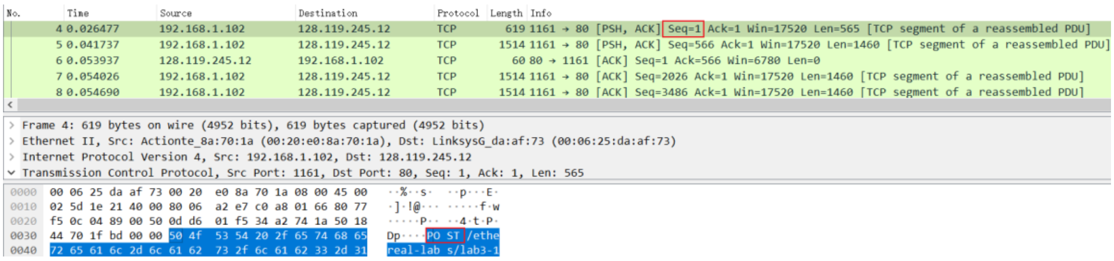
gaia.cs.umass.edu 将该值设置为所期望的下一个来自客户端的报文的 Sequence Number。
Flag field 中被置为 1 的 ACK 位和 SYN 位。



```
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=1
   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 a reassembled PDU]
   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 of a reassembled PDU]

> Frame 2: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
> 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, Dst: 192.168.1.102
v Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 0, Ack: 1, Len: 0
    Source Port: 80
    Destination Port: 1161
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence Number: 0    (relative sequence number)
    Sequence Number (raw): 883061785
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 1    (relative ack number)
    Acknowledgment number (raw): 232129013
    0111 .... = Header Length: 28 bytes (7)
  v 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
      .... .... ...0 = Fin: Not set
      [TCP Flags: ·······A··S·]
```

6. What is the sequence number of the TCP segment containing the HTTP POST command? Note that in order to find the POST command, you’ll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with a “POST” within its DATA field.

答：如下图，1。



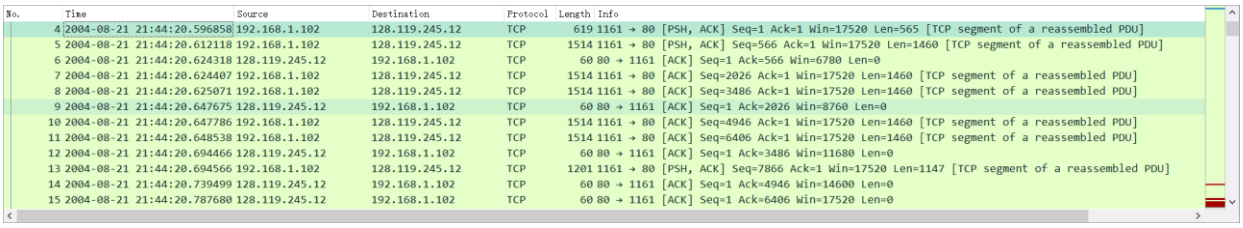
```
No.  Time       Source          Destination     Protocol Length Info
   4 0.026477   192.168.1.102   128.119.245.12  TCP       619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
   5 0.041737   192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   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 segment of a reassembled PDU]
   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 segment of a reassembled PDU]

> Frame 4: 619 bytes on wire (4952 bits), 619 bytes captured (4952 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, Dst: 128.119.245.12
v Transmission Control Protocol, Src Port: 1161, Dst Port: 80, Seq: 1, Ack: 1, Len: 565

0000  00 06 25 da af 73 00 20  e0 8a 70 1a 08 00 45 00   ··%··s·  ··p···E·
0010  02 5d 1e 21 40 00 80 06  a2 e7 c0 a8 01 66 80 77   ·]·!@···  ·····f·w
0020  f5 0c 04 89 00 50 0d d6  01 f5 34 a2 74 1a 50 18   ·····P··  ··4·t·P·
0030  44 70 1f bd 00 00 50 4f  53 54 20 2f 65 74 68 65   Dp····PO ST /ethe
0040  72 65 61 6c 2d 6c 61 62  73 2f 6c 61 62 33 2d 31   real-lab s/lab3-1
```

7. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection. What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST)? At what

time was each segment sent? When was the ACK for each segment received? Given the difference between when each TCP segment was sent, and when its acknowledgement was received, what is the RTT value for each of the six segments? What is the `EstimatedRTT` value (see page 249 in text) after the receipt of each ACK? Assume that the value of the `EstimatedRTT` is equal to the measured RTT for the first segment, and then is computed using the `EstimatedRTT` equation on page 249 for all subsequent segments.
（注：在第七题时，已经更改时间格式为日期和时间）

答：根据下图，再根据等式：

$$\text{EstimatedRTT} = (1 - \alpha) \cdot \text{EstimatedRTT} + \alpha \cdot \text{SampleRTT}$$



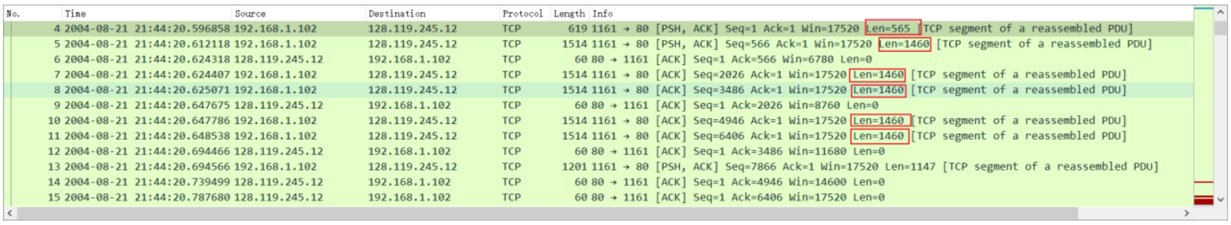
```
No.  Time                        Source          Destination     Protocol Length Info
   4 2004-08-21 21:44:20.596858 192.168.1.102   128.119.245.12  TCP       619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
   5 2004-08-21 21:44:20.612118 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   6 2004-08-21 21:44:20.624318 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
   7 2004-08-21 21:44:20.624407 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   8 2004-08-21 21:44:20.625071 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   9 2004-08-21 21:44:20.647675 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
  10 2004-08-21 21:44:20.647786 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  11 2004-08-21 21:44:20.648538 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  12 2004-08-21 21:44:20.694466 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
  13 2004-08-21 21:44:20.694566 192.168.1.102   128.119.245.12  TCP      1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
  14 2004-08-21 21:44:20.739499 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
  15 2004-08-21 21:44:20.787680 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
```

（令α为 0. 125, ）得到下表：

i	seq	发送时间	收到ACK时间	RTT(ms)	EstimatedRTT(ms)
1	1	21:44:20.596858	21:44:20.624318	27.5	27.5
2	566	21:44:20.612118	21:44:20.647675	35.6	28.5125
3	2026	21:44:20.624407	21:44:20.694466	70.1	33.7109375
4	3486	21:44:20.625071	21:44:20.737499	114.4	43.79707031
5	4946	21:44:20.647786	21:44:20.787680	139.9	55.80993652
6	6406	21:44:20.648538	21:44:20.838183	189.7	72.54619446

8. What is the length of each of the first six TCP segments?

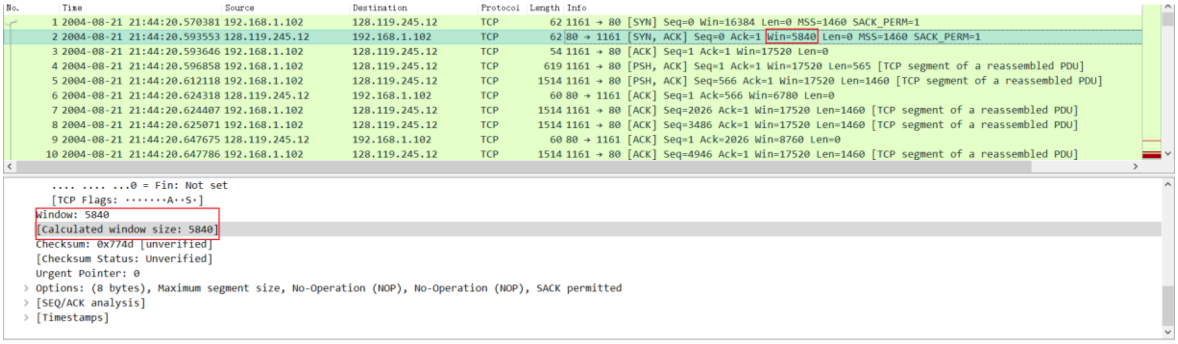
答：分别是565, 1460, 1460, 1460, 1460, 1460。如下图：



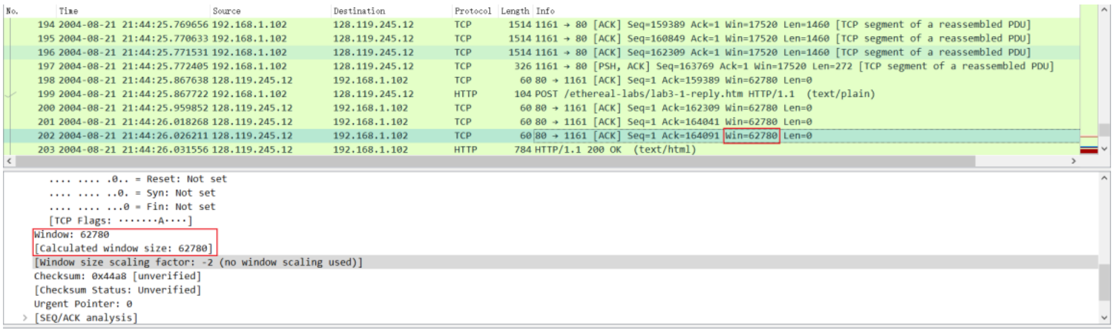
```
No.  Time                        Source          Destination     Protocol Length Info
   4 2004-08-21 21:44:20.596858 192.168.1.102   128.119.245.12  TCP       619 1161 → 80 [PSH, ACK] Seq=1 Ack=1 Win=17520 Len=565 [TCP segment of a reassembled PDU]
   5 2004-08-21 21:44:20.612118 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   6 2004-08-21 21:44:20.624318 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
   7 2004-08-21 21:44:20.624407 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   8 2004-08-21 21:44:20.625071 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   9 2004-08-21 21:44:20.647675 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
  10 2004-08-21 21:44:20.647786 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  11 2004-08-21 21:44:20.648538 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  12 2004-08-21 21:44:20.694466 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
  13 2004-08-21 21:44:20.694566 192.168.1.102   128.119.245.12  TCP      1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
  14 2004-08-21 21:44:20.739499 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
  15 2004-08-21 21:44:20.787680 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
```

9. What is the minimum amount of available buffer space advertised at the received for the entire trace? Does the lack of receiver buffer space ever throttle the sender?

答：服务器最小的缓冲空间（Win）为 5840 字节。全程服务器端的 Win 在慢慢变大，最后变到 62780 字节，没有 throttle 发送端。



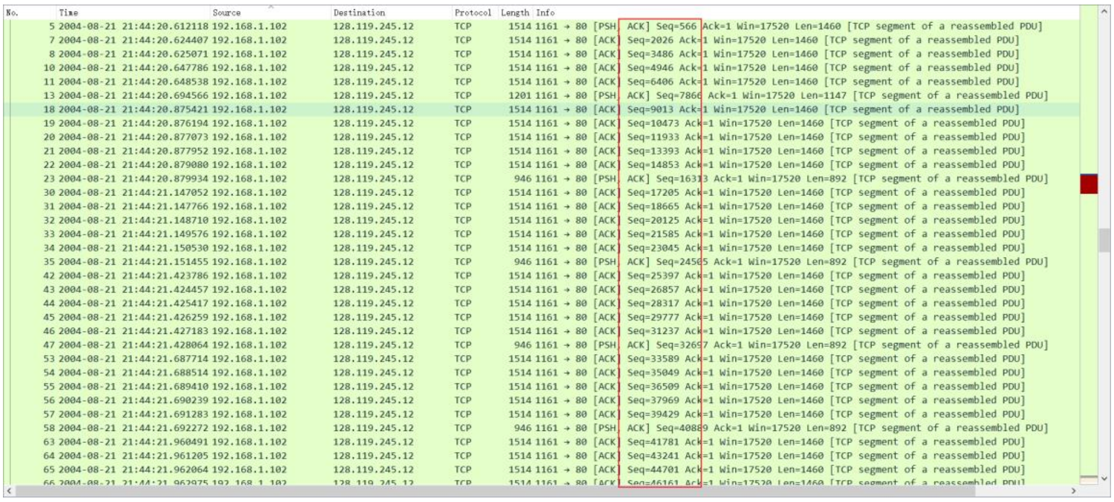
```
No.  Time                       Source          Destination     Protocol Length Info
   1 2004-08-21 21:44:20.570381 192.168.1.102   128.119.245.12  TCP        62 1161 → 80 [SYN] Seq=0 Win=16384 Len=0 MSS=1460 SACK_PERM=1
   2 2004-08-21 21:44:20.593553 128.119.245.12  192.168.1.102   TCP        62 80 → 1161 [SYN, ACK] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1
   3 2004-08-21 21:44:20.593646 192.168.1.102   128.119.245.12  TCP        54 1161 → 80 [ACK] Seq=1 Ack=1 Win=17520 Len=0
   4 2004-08-21 21:44:20.596858 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 a reassembled PDU]
   5 2004-08-21 21:44:20.612118 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   6 2004-08-21 21:44:20.624318 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
   7 2004-08-21 21:44:20.624407 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   8 2004-08-21 21:44:20.625071 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   9 2004-08-21 21:44:20.647675 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
  10 2004-08-21 21:44:20.647786 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]

      .... .... ...0 = Fin: Not set
      [TCP Flags: ·······A··S·]
    Window: 5840
    [Calculated window size: 5840]
    Checksum: 0x774d [unverified]
    [Checksum Status: Unverified]
    Urgent Pointer: 0
  > Options: (8 bytes), Maximum segment size, No-Operation (NOP), No-Operation (NOP), SACK permitted
  > [SEQ/ACK analysis]
  > [Timestamps]
```



```
No.  Time                       Source          Destination     Protocol Length Info
 194 2004-08-21 21:44:25.769656 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=159389 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
 195 2004-08-21 21:44:25.770633 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=160849 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
 196 2004-08-21 21:44:25.771531 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=162309 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
 197 2004-08-21 21:44:25.772405 192.168.1.102   128.119.245.12  TCP       326 1161 → 80 [PSH, ACK] Seq=163769 Ack=1 Win=17520 Len=272 [TCP segment of a reassembled PDU]
 198 2004-08-21 21:44:25.867638 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
 199 2004-08-21 21:44:25.867722 192.168.1.102   128.119.245.12  HTTP      104 POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1  (text/plain)
 200 2004-08-21 21:44:25.959852 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
 201 2004-08-21 21:44:26.018268 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
 202 2004-08-21 21:44:26.026211 128.119.245.12  192.168.1.102   TCP        60 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
 203 2004-08-21 21:44:26.031556 128.119.245.12  192.168.1.102   HTTP      784 HTTP/1.1 200 OK  (text/html)

      .... .... .0.. = Reset: Not set
      .... .... ..0. = Syn: Not set
      .... .... ...0 = Fin: Not set
      [TCP Flags: ·······A····]
    Window: 62780
    [Calculated window size: 62780]
    [Window size scaling factor: -2 (no window scaling used)]
    Checksum: 0x44a8 [unverified]
    [Checksum Status: Unverified]
    Urgent Pointer: 0
  > [SEQ/ACK analysis]
```

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

答：没有重传的报文。通过检查发送端是否发送过两个具有相同Seq序号的报文，Seq序号是否严格单调递增来回答此问题。例如：



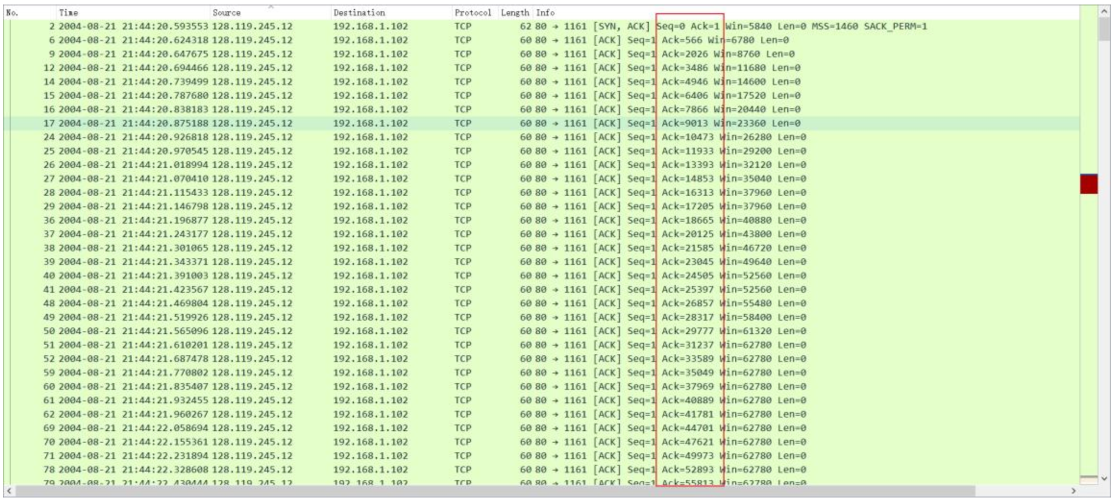
```
No.  Time                       Source          Destination     Protocol Length Info
   5 2004-08-21 21:44:20.612118 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   7 2004-08-21 21:44:20.624407 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
   8 2004-08-21 21:44:20.625071 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  10 2004-08-21 21:44:20.647786 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  11 2004-08-21 21:44:20.648538 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  13 2004-08-21 21:44:20.694566 192.168.1.102   128.119.245.12  TCP      1201 1161 → 80 [PSH, ACK] Seq=7866 Ack=1 Win=17520 Len=1147 [TCP segment of a reassembled PDU]
  18 2004-08-21 21:44:20.875421 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=9013 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  19 2004-08-21 21:44:20.876194 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=10473 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  20 2004-08-21 21:44:20.877073 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=11933 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  21 2004-08-21 21:44:20.877952 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=13393 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  22 2004-08-21 21:44:20.879080 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=14853 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  23 2004-08-21 21:44:20.879934 192.168.1.102   128.119.245.12  TCP       946 1161 → 80 [PSH, ACK] Seq=16313 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
  30 2004-08-21 21:44:21.147052 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=17205 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  31 2004-08-21 21:44:21.147766 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=18665 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  32 2004-08-21 21:44:21.148710 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=20125 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  33 2004-08-21 21:44:21.149576 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=21585 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  34 2004-08-21 21:44:21.150530 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=23045 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  35 2004-08-21 21:44:21.151455 192.168.1.102   128.119.245.12  TCP       946 1161 → 80 [PSH, ACK] Seq=24505 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
  42 2004-08-21 21:44:21.423786 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=25397 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  43 2004-08-21 21:44:21.424457 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=26857 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  44 2004-08-21 21:44:21.425417 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=28317 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  45 2004-08-21 21:44:21.426259 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=29777 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  46 2004-08-21 21:44:21.427183 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=31237 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  47 2004-08-21 21:44:21.428064 192.168.1.102   128.119.245.12  TCP       946 1161 → 80 [PSH, ACK] Seq=32697 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
  53 2004-08-21 21:44:21.687714 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=33589 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  54 2004-08-21 21:44:21.688514 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=35049 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  55 2004-08-21 21:44:21.689410 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=36509 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  56 2004-08-21 21:44:21.690239 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=37969 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  57 2004-08-21 21:44:21.691283 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=39429 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  58 2004-08-21 21:44:21.692272 192.168.1.102   128.119.245.12  TCP       946 1161 → 80 [PSH, ACK] Seq=40889 Ack=1 Win=17520 Len=892 [TCP segment of a reassembled PDU]
  63 2004-08-21 21:44:21.960491 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=41781 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  64 2004-08-21 21:44:21.961205 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=43241 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  65 2004-08-21 21:44:21.962064 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=44701 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
  66 2004-08-21 21:44:21.962975 192.168.1.102   128.119.245.12  TCP      1514 1161 → 80 [ACK] Seq=46161 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
```

当然只是截图了一部分，但方法这样的。

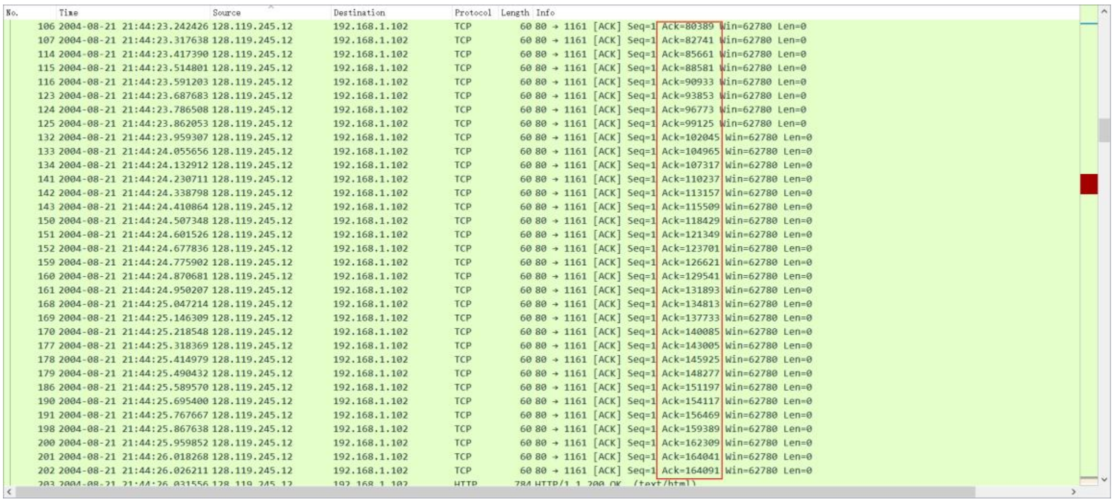
11. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment (see Table 3.2 on page 257 in the text).

答：典型的有1460（比如第24个报文和第26个报文以及第39个报文等等）和2920字节（比如第78个报文和第79个报文等等）。此外还

有50（比如第202个报文），566（比如第6个报文），1147（比如第17个报文），892（比如第41个报文），2352（892+1460）（比如第143个报文），2920（比如第60个报文）等等。一次ACK所acknowledge的字节数可以根据相邻Ack的差值算出。一次确认两个报文的有确认2920和2352字节的。比如trace文件中第52个报文，就是确认了2352字节；比如第60个报文，就是确认了2920字节。



```
No.    Time                       Source          Destination    Protocol Length Info
     2 2004-08-21 21:44:20.593553 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=1
     6 2004-08-21 21:44:20.624318 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
     9 2004-08-21 21:44:20.647675 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
    12 2004-08-21 21:44:20.694466 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0
    14 2004-08-21 21:44:20.739499 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=4946 Win=14600 Len=0
    15 2004-08-21 21:44:20.787680 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=6406 Win=17520 Len=0
    16 2004-08-21 21:44:20.838183 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=7866 Win=20440 Len=0
    17 2004-08-21 21:44:20.875188 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=9013 Win=23360 Len=0
    24 2004-08-21 21:44:20.926818 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=10473 Win=26280 Len=0
    25 2004-08-21 21:44:20.970545 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=11933 Win=29200 Len=0
    26 2004-08-21 21:44:21.018994 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=13393 Win=32120 Len=0
    27 2004-08-21 21:44:21.070410 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=14853 Win=35040 Len=0
    28 2004-08-21 21:44:21.115433 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=16313 Win=37960 Len=0
    29 2004-08-21 21:44:21.146798 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=17205 Win=37960 Len=0
    36 2004-08-21 21:44:21.196877 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=18665 Win=40880 Len=0
    37 2004-08-21 21:44:21.243177 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=20125 Win=43800 Len=0
    38 2004-08-21 21:44:21.301065 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=21585 Win=46720 Len=0
    39 2004-08-21 21:44:21.343371 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=23045 Win=49640 Len=0
    40 2004-08-21 21:44:21.391003 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=24505 Win=52560 Len=0
    41 2004-08-21 21:44:21.423567 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=25397 Win=52560 Len=0
    48 2004-08-21 21:44:21.469804 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=26857 Win=55480 Len=0
    49 2004-08-21 21:44:21.519926 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=28317 Win=58400 Len=0
    50 2004-08-21 21:44:21.565096 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=29777 Win=61320 Len=0
    51 2004-08-21 21:44:21.610201 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=31237 Win=62780 Len=0
    52 2004-08-21 21:44:21.687478 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=33589 Win=62780 Len=0
    59 2004-08-21 21:44:21.770802 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=35049 Win=62780 Len=0
    60 2004-08-21 21:44:21.835407 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=37969 Win=62780 Len=0
    61 2004-08-21 21:44:21.932455 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=40889 Win=62780 Len=0
    62 2004-08-21 21:44:21.960267 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=41781 Win=62780 Len=0
    69 2004-08-21 21:44:22.058694 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=44701 Win=62780 Len=0
    70 2004-08-21 21:44:22.155361 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=47621 Win=62780 Len=0
    71 2004-08-21 21:44:22.231894 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=49973 Win=62780 Len=0
    78 2004-08-21 21:44:22.328608 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=52893 Win=62780 Len=0
    79 2004-08-21 21:44:22.430444 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=55813 Win=62780 Len=0
```



```
No.    Time                       Source          Destination    Protocol Length Info
   106 2004-08-21 21:44:23.242426 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=80389 Win=62780 Len=0
   107 2004-08-21 21:44:23.317638 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=82741 Win=62780 Len=0
   114 2004-08-21 21:44:23.417390 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=85661 Win=62780 Len=0
   115 2004-08-21 21:44:23.514801 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=88581 Win=62780 Len=0
   116 2004-08-21 21:44:23.591203 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=90933 Win=62780 Len=0
   123 2004-08-21 21:44:23.687683 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=93853 Win=62780 Len=0
   124 2004-08-21 21:44:23.786508 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=96773 Win=62780 Len=0
   125 2004-08-21 21:44:23.862053 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=99125 Win=62780 Len=0
   132 2004-08-21 21:44:23.959307 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=102045 Win=62780 Len=0
   133 2004-08-21 21:44:24.055656 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=104965 Win=62780 Len=0
   134 2004-08-21 21:44:24.132912 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=107317 Win=62780 Len=0
   141 2004-08-21 21:44:24.230711 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=110237 Win=62780 Len=0
   142 2004-08-21 21:44:24.338798 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=113157 Win=62780 Len=0
   143 2004-08-21 21:44:24.410864 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=115509 Win=62780 Len=0
   150 2004-08-21 21:44:24.507348 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=118429 Win=62780 Len=0
   151 2004-08-21 21:44:24.601526 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=121349 Win=62780 Len=0
   152 2004-08-21 21:44:24.677836 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=123701 Win=62780 Len=0
   159 2004-08-21 21:44:24.775902 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=126621 Win=62780 Len=0
   160 2004-08-21 21:44:24.870681 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=129541 Win=62780 Len=0
   161 2004-08-21 21:44:24.950207 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=131893 Win=62780 Len=0
   168 2004-08-21 21:44:25.047214 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=134813 Win=62780 Len=0
   169 2004-08-21 21:44:25.146309 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=137733 Win=62780 Len=0
   170 2004-08-21 21:44:25.218548 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=140085 Win=62780 Len=0
   177 2004-08-21 21:44:25.318369 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=143005 Win=62780 Len=0
   178 2004-08-21 21:44:25.414979 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=145925 Win=62780 Len=0
   179 2004-08-21 21:44:25.490432 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=148277 Win=62780 Len=0
   186 2004-08-21 21:44:25.589570 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=151197 Win=62780 Len=0
   190 2004-08-21 21:44:25.695400 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=154117 Win=62780 Len=0
   191 2004-08-21 21:44:25.767667 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=156469 Win=62780 Len=0
   198 2004-08-21 21:44:25.867638 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0
   200 2004-08-21 21:44:25.959852 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0
   201 2004-08-21 21:44:26.018268 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0
   202 2004-08-21 21:44:26.026211 128.119.245.12  192.168.1.102  TCP      60 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
   203 2004-08-21 21:44:26.031556 128.119.245.12  192.168.1.102  HTTP     784 HTTP/1.1 200 OK  (text/html)
```

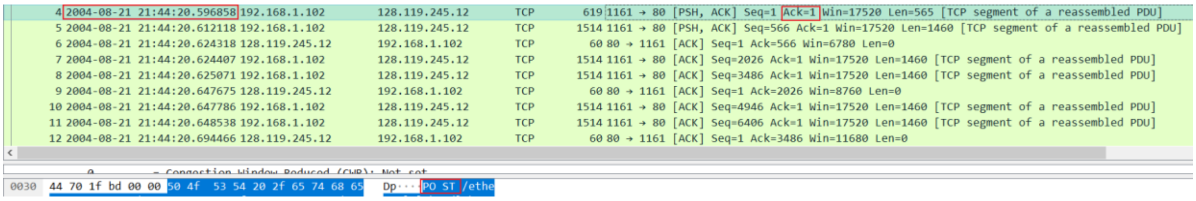
12. What is the throughput (bytes transferred per unit time) for the TCP connection? Explain how you calculated this value.

答：考虑第一次发送post到发送端收到最后一条Ack这一过程。

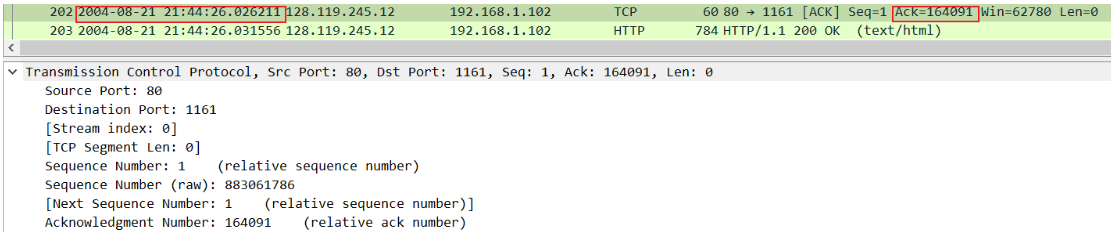
总的时长t = 21:44:26.026211-21:44:20.596858= 5.429353（s）。

所传递的字节数w = 164091-1=164090（Bytes）。

吞吐量为 w/t = 30222 Bps=30.222 KBps



```
 4 2004-08-21 21:44:20.596858 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 a reassembled PDU]
 5 2004-08-21 21:44:20.612118 192.168.1.102   128.119.245.12  TCP  1514 1161 → 80 [PSH, ACK] Seq=566 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
 6 2004-08-21 21:44:20.624318 128.119.245.12  192.168.1.102   TCP    60 80 → 1161 [ACK] Seq=1 Ack=566 Win=6780 Len=0
 7 2004-08-21 21:44:20.624407 192.168.1.102   128.119.245.12  TCP  1514 1161 → 80 [ACK] Seq=2026 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
 8 2004-08-21 21:44:20.625071 192.168.1.102   128.119.245.12  TCP  1514 1161 → 80 [ACK] Seq=3486 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
 9 2004-08-21 21:44:20.647675 128.119.245.12  192.168.1.102   TCP    60 80 → 1161 [ACK] Seq=1 Ack=2026 Win=8760 Len=0
10 2004-08-21 21:44:20.647786 192.168.1.102   128.119.245.12  TCP  1514 1161 → 80 [ACK] Seq=4946 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
11 2004-08-21 21:44:20.648538 192.168.1.102   128.119.245.12  TCP  1514 1161 → 80 [ACK] Seq=6406 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]
12 2004-08-21 21:44:20.694466 128.119.245.12  192.168.1.102   TCP    60 80 → 1161 [ACK] Seq=1 Ack=3486 Win=11680 Len=0

        0       = Congestion Window Reduced (CWR): Not set
0030  44 70 1f bd 00 00 50 4f  53 54 20 2f 65 74 68 65   Dp····PO ST /ethe
```



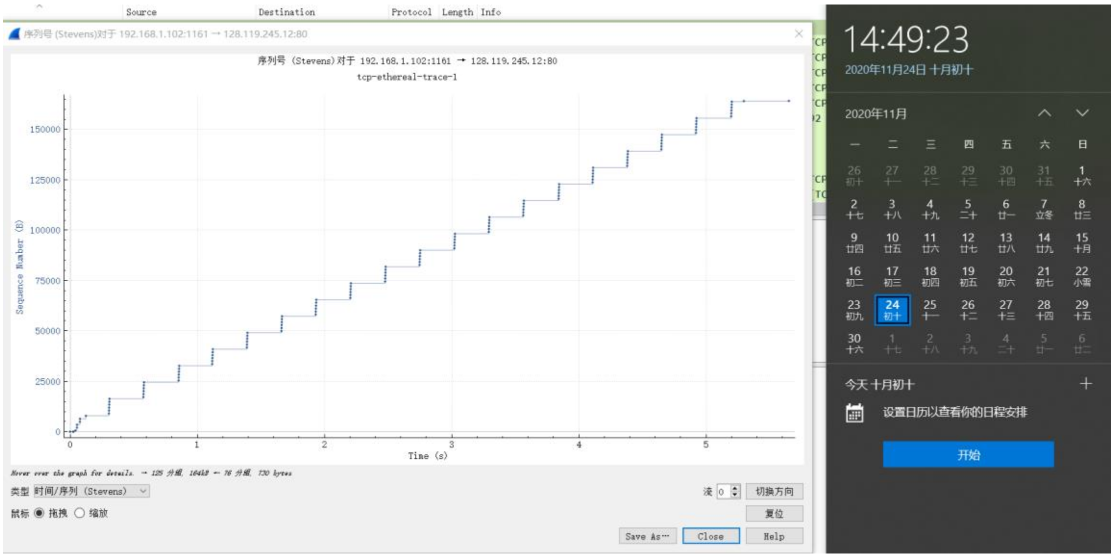
```
202 2004-08-21 21:44:26.026211 128.119.245.12   192.168.1.102   TCP     60 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0
203 2004-08-21 21:44:26.031556 128.119.245.12   192.168.1.102   HTTP   784 HTTP/1.1 200 OK  (text/html)

∨ Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 164091, Len: 0
     Source Port: 80
     Destination Port: 1161
     [Stream index: 0]
     [TCP Segment Len: 0]
     Sequence Number: 1    (relative sequence number)
     Sequence Number (raw): 883061786
     [Next Sequence Number: 1    (relative sequence number)]
     Acknowledgment Number: 164091    (relative ack number)
```

13. 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. Can you identify where TCP's slowstart phase begins and ends, and where congestion avoidance takes over? Comment on ways in which the measured data differs from the idealized behavior of TCP that we've studied in the text.

答： 慢启动在post发送开始时开始，但是看不出何时结束，也看不出拥塞避免何时开始。因为从这个trace可以看出没有出现3次冗余ACK或者超时，也就没有丢包，没有拥塞发生。

不同点：

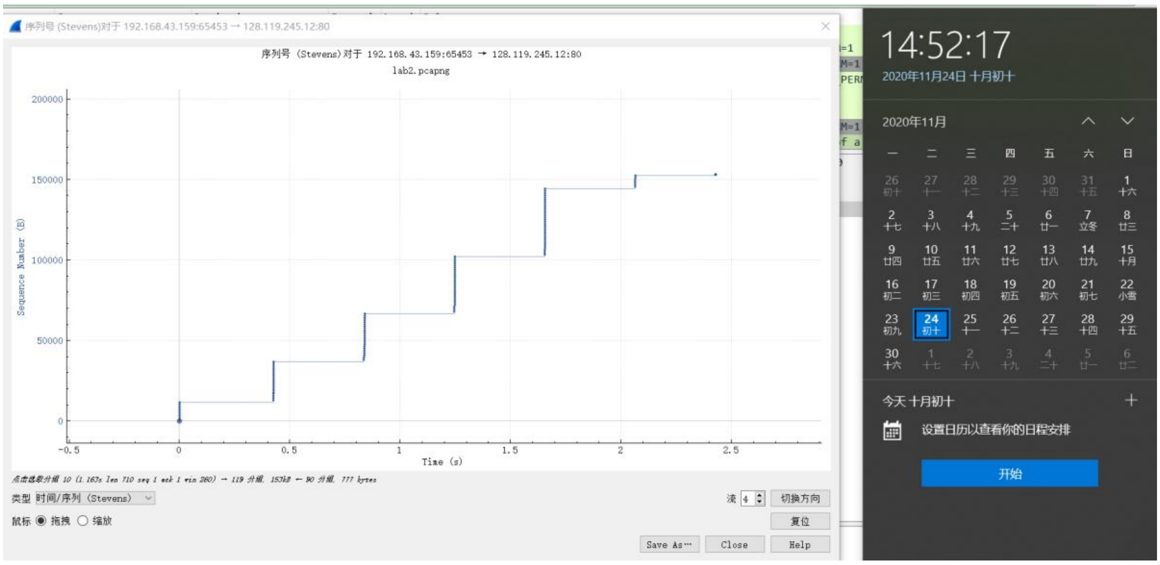
不同于课本上所说的先第一次慢启动，等到拥塞时再第二次进入慢启动同时调整ssthresh，cwnd值，等到cwnd大于等于ssthresh时进入拥塞避免这样的策略，我们的trace文件中没有冗余ACK，没有丢包，没有拥塞，没有以上的状态转换。而是：数据发送的速率被严格限制在了第一次慢启动结束前，并且到了后面一直重复这一过程：连续发送1460*5+892*1字节=8192字节的包就会暂停发送，直到这8192字节被全部ACK。这一数据传输过程，应该是被应用程序所严格的控制着，而不仅仅依赖于TCP自身的拥塞控制机制。



14. Answer each of two questions above for the trace that you have gathered when you transferred a file from your computer to gaia.cs.umass.edu

答：同样，慢启动在post发送开始时开始，在0.425s左右结束，因为从0s附近到0.425s附近cwnd值翻了一番；同时，0.839s左右出现了三个冗余ACK，即慢启动结束，拥塞避免开始。2.052s左右出现了超时情况。

不同点：我这里的实际情况是，在慢启动开始时，cwnd不是从1MSS开始，而是以大约9个MSS（MSS=1360Bytes）开始，之后再指数递增。慢启动遇到三个冗余ACK结束，并且进入拥塞避免状态，并不是像书上所说的每次只增加一个MSS，而是每次较上次的增加量增加一个MSS，比如19 22 26 31对应中间四段的MSS，后三次每次较上次的增加分别为3 4 5。遇到超时情况，也不是设置为1个MSS，而是从6个MSS开始。直到这里，便已发送完所有数据。这一数据传输过程，应该是应用程序和TCP自身的拥塞控制机制相互作用完成的。



序列号 (Stevens)对于 192.168.43.159:65453 → 128.119.245.12:80

序列号 (Stevens) 对于 192.168.43.159:65453 → 128.119.245.12:80
lab2.pcapng

点击选取分组 10 (1.163s len 710 seq 1 ack 1 win 260) → 119 分組, 153kB ← 90 分組, 777 bytes

类型 时间/序列 (Stevens)

鼠标 ● 拖拽 ○ 缩放

流 4

14:52:17
2020年11月24日 十月初十

2020年11月

一	二	三	四	五	六	日
26 初十	27 十一	28 十二	29 十三	30 十四	31 十五	1 十六
2 十七	3 十八	4 十九	5 二十	6 廿一	7 立冬	8 廿三
9 廿四	10 廿五	11 廿六	12 廿七	13 廿八	14 廿九	15 十月
16 初二	17 初三	18 初四	19 初五	20 初六	21 初七	22 小雪
23 初九	24 初十	25 十一	26 十二	27 十三	28 十四	29 十五
30 十六	1 十七	2 十八	3 十九	4 二十	5 廿一	6 廿二

今天 十月初十

设置日历以查看你的日程安排