

实验二 TCP 协议分析

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一. 实验内容

观察 TCP 三次握手与四次挥手报文，注意报文收发过程中，双方 TCP 状态的变化。以本次捕获的报文为依据，分别画出本次 TCP 连接三次握手与四次挥手的时序图，结合 TCP 状态机，在双方各阶段标出对应的 TCP 状态。选择其中一个 TCP 报文，配合 Wireshark 截图，分析该报文 TCP 首部各字段的定义、值及其含义。

二. 实验步骤与分析

1. 分析 TCP 三次握手与四次挥手报文

(1) 选择一个 TCP 会话

打开 Wireshark 选用 WLAN 进行捕获，此时打开浏览器访问一个网站，在捕获的流量数据里，鼠标点击任何一个 TCP 数据包，右键菜单中“追踪流”功能，再选择 TCP，Wireshark 就会显示这个 TCP 会话所有的数据包，并且列表在一个新的窗口中显示。

No.	Time	Source	Destination	Protocol	Length	Info
845	47.683612	10.208.98.218	175.6.193.181	TCP	66	60677 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
846	47.744764	175.6.193.181	10.208.98.218	TCP	66	80 → 60677 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 SACK_PERM=1 WS=64
847	47.744911	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0
848	47.745062	10.208.98.218	175.6.193.181	HTTP	336	GET /msdownload/update/v3/static/trustedr/en/pinrulesstl.cab?30789ac7170e873c HTTP/1.1
849	47.771044	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=1 Ack=283 Win=117888 Len=0
850	47.771044	175.6.193.181	10.208.98.218	HTTP	373	HTTP/1.1 304 Not Modified
853	47.777145	10.208.98.218	175.6.193.181	HTTP	341	GET /msdownload/update/v3/static/trustedr/en/disallowedcertstl.cab?23a71f9de8bd3fee HTTP/1.1
859	47.817207	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=320 Ack=570 Win=118976 Len=0
860	47.818786	175.6.193.181	10.208.98.218	HTTP	373	HTTP/1.1 304 Not Modified
867	47.868087	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=570 Ack=639 Win=130560 Len=0
868	47.878301	175.6.193.181	10.208.98.218	TCP	60	[TCP Spurious Retransmission] 80 → 60677 [PSH, ACK] Seq=637 Ack=570 Win=118976 Len=1
869	47.878357	10.208.98.218	175.6.193.181	TCP	66	[TCP Dup ACK 867#1] 60677 → 80 [ACK] Seq=570 Ack=639 Win=130560 Len=0 SLE=637 SRE=638
879	48.050488	10.208.98.218	175.6.193.181	HTTP	335	GET /msdownload/update/v3/static/trustedr/en/authrootstl.cab?4289cc697752e82 HTTP/1.1
880	48.074262	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=639 Ack=851 Win=120064 Len=0
881	48.074262	175.6.193.181	10.208.98.218	HTTP	333	HTTP/1.1 304 Not Modified
883	48.119420	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=851 Ack=918 Win=130304 Len=0
886	48.138296	175.6.193.181	10.208.98.218	TCP	60	[TCP Spurious Retransmission] 80 → 60677 [PSH, ACK] Seq=914 Ack=851 Win=120064 Len=1
887	48.138336	10.208.98.218	175.6.193.181	TCP	66	[TCP Dup ACK 883#1] 60677 → 80 [ACK] Seq=851 Ack=918 Win=130304 Len=0 SLE=914 SRE=915
3177	108.076276	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [FIN, ACK] Seq=918 Ack=851 Win=120064 Len=0
3178	108.076382	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=851 Ack=919 Win=130304 Len=0
3179	108.076418	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [FIN, ACK] Seq=851 Ack=919 Win=130304 Len=0
3182	108.118319	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=919 Ack=852 Win=120064 Len=0

Transmission Control Protocol, Src Port: 60677, Dst Port: 80, Seq: 0, Len: 0
Source Port: 60677
Destination Port: 80
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 1541758181

(2) 分析 TCP 三次握手

① 首先找到 TCP 连接建立过程的三次握手

通过追踪任何一个 TCP 数据流，这个数据流开始的三个数据包都是其连接建立过程的三次握手。或者，也可以使用 Flags 标志位进行检索，例如三次握手的第二个数据包非常特殊，`tcp.flags.syn == 1 && tcp.flags.ack == 1`，可以利用这个特点发现一个三次握手过程。

因此找到 TCP 连接建立过程的三次握手如下：

No.	Time	Source	Destination	Protocol	Length	Info
845	47.683612	10.208.98.218	175.6.193.181	TCP	66	60677 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
846	47.744764	175.6.193.181	10.208.98.218	TCP	66	80 → 60677 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 SACK_PERM=1 WS=64
847	47.744911	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0

② 第一次握手

客户端向服务器发送连接请求报文，标志位 SYN 置 1，随机选择的初始序号为

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1541758181, 相对序号为 0, 为方便后续分析, 这里序号选取相对序号 seq=client_isn=0。

```
No.      Time      Source      Destination  Protocol Length  Info
-----
845 47.683612  10.208.98.218 175.6.193.181 TCP          66 60677 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
Transmission Control Protocol, Src Port: 60677, Dst Port: 80, Seq: 0, Len: 0
Source Port: 60677
Destination Port: 80
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 1541758181
[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.]
Window: 64240
[Calculated window size: 64240]
Checksum: 0xde8c [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
```

③ 第二次握手

服务器收到客户端 TCP SYN 报文段, 为该 TCP 连接分配 TCP 缓存和变量并向该客户 TCP 发送允许连接的报文段, 该报文 SYN 被置为 1, ACK (相对) 被置为客户序列号+1=client_isn+1=1 (看原始 ACK 也是客户原始序列号+1=1541758182), 自己初始序号选择为 861161616, 相对序号为 0, 同样为方便后续分析, 选取 seq=server_isn=0;

```
No.      Time      Source      Destination  Protocol Length  Info
-----
845 47.683612  10.208.98.218 175.6.193.181 TCP          66 60677 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
846 47.744764  175.6.193.181 10.208.98.218 TCP          66 80 → 60677 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 SACK_PERM=1 WS=64
Transmission Control Protocol, Src Port: 80, Dst Port: 60677, Seq: 0, Ack: 1, Len: 0
Source Port: 80
Destination Port: 60677
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 861161616
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 1541758182
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
.... ....0 = Fin: Not set
[TCP Flags: .....A..S.]
Window: 65535
[Calculated window size: 65535]
Checksum: 0x6e96 [unverified]
[Checksum Status: Unverified]
```

④ 第三次握手

客户端收到服务器发来的 SYNACK 报文段后检查 ACK 是否正确, 即第一次握手发送的序号加 1 (client_isn+1=1), 以及标志位 ACK 是否为 1。若正确, 客户端则向服务器发送另一个报文段, 这最后一个报文段对服务器的允许连接的报文段进行确认, 通过 ACK 置 server_isn+1=1, SYN 置 0 来完成。第三次握手发送的报文段可在负载中接待客户到服务器的数据。一旦完成上述三个步骤, 客户和服务器就可以传送数据了, 在以后每一个报文段中 SYN 标志位均置 0。

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No.	Time	Source	Destination	Protocol	Length	Info
845	47.683612	10.208.98.218	175.6.193.181	TCP	66	60677 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
846	47.744764	175.6.193.181	10.208.98.218	TCP	66	80 → 60677 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 SACK_PERM=1 WS=64
847	47.744911	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=1 Ack=1 Win=131328 Len=0

Transmission Control Protocol, Src Port: 60677, Dst Port: 80, Seq: 1, Ack: 1, Len: 0

Source Port: 60677
Destination Port: 80
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 1 (relative sequence number)
Sequence Number (raw): 1541758182
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 1 (relative ack number)
Acknowledgment number (raw): 861161617
0101 = Header Length: 20 bytes (5)

Flags: 0x010 (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
..... ..0. = Syn: Not set
..... ...0 = Fin: Not set
[TCP Flags:A....]
Window: 513
[Calculated window size: 131328]
[Window size scaling factor: 256]

(3) 分析 TCP 四次挥手

① 首先找到 TCP 断开连接的四次挥手

在上述追踪的 TCP 数据流最后的四个数据包恰是 TCP 连接的正常关闭过程的四次挥手。或者，也可以使用 Flags 标志位进行检索，例如发起 TCP 连接终止的数据包非常特殊，`tcp.flags.fin == 1`，可以利用这个特点发现一次终止过程。

因此找到 TCP 断开连接的四次挥手如下：

No.	Time	Source	Destination	Protocol	Length	Info
3177	108.076276	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [FIN, ACK] Seq=918 Ack=851 Win=120064 Len=0
3178	108.076382	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=851 Ack=919 Win=130304 Len=0
3179	108.076418	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [FIN, ACK] Seq=851 Ack=919 Win=130304 Len=0
3182	108.118319	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=919 Ack=852 Win=120064 Len=0

Transmission Control Protocol, Src Port: 80, Dst Port: 60677, Seq: 918, Ack: 851, Len: 0

Source Port: 80
Destination Port: 60677
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 918 (relative sequence number)
Sequence Number (raw): 861162534
[Next Sequence Number: 919 (relative sequence number)]
Acknowledgment Number: 851 (relative ack number)
Acknowledgment number (raw): 1541759032
0101 = Header Length: 20 bytes (5)

Flags: 0x011 (FIN, 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
..... ..0. = Syn: Not set
..... ...1 = Fin: Set
[TCP Flags:A...F]
Window: 1876
[Calculated window size: 120064]

② 第一次挥手

当客户打算关闭连接时，向服务器发送一个用于关闭连接的 TCP 报文段，将标志位 FIN 和 ACK 置 1，序号为 1541758181，相对序号为 918，确认序号（相对）为 851。

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```

Time        Source                Destination                Protocol Length Info
3177 108.076276 175.6.193.181          10.208.98.218    TCP        60 80 → 60677 [FIN, ACK] Seq=918 Ack=851 Win=120064 Len=0
▼ Transmission Control Protocol, Src Port: 80, Dst Port: 60677, Seq: 918, Ack: 851, Len: 0
    Source Port: 80
    Destination Port: 60677
    [Stream index: 22]
    [Conversation completeness: Complete, WITH_DATA (31)]
    [TCP Segment Len: 0]
    Sequence Number: 918      (relative sequence number)
    Sequence Number (raw): 861162534
    [Next Sequence Number: 919      (relative sequence number)]
    Acknowledgment Number: 851      (relative ack number)
    Acknowledgment number (raw): 1541759032
    0101 .... = Header Length: 20 bytes (5)
▼ Flags: 0x011 (FIN, 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
    .... .... ..0. = Syn: Not set
    .... .... ...1 = Fin: Set
    [TCP Flags: .....A...F]
Window: 1876
[Calculated window size: 120064]
[Window size scaling factor: 64]
Checksum: 0xa12b [unverified]
[Checksum Status: Unverified]

```

③ 第二次挥手

当服务器收到该报文段后，就向发送方回送一个确认报文段，标志位 ACK=1，序号（相对）为收到的确认序号=851，确认序号（相对）为收到的序号+1=918+1=919。

```

Time           Source           Destination       Protocol Length Info
3177 108.076276 175.6.193.181  10.208.98.218   TCP        60 80 → 60677 [FIN, ACK] Seq=918 Ack=951 Win=120064 Len=0
3178 108.076382 10.208.98.218  175.6.193.181  TCP        54 60677 → 80 [ACK] Seq=851 Ack=919 Win=130304 Len=0

▼ Transmission Control Protocol, Src Port: 60677, Dst Port: 80, Seq: 851, Ack: 919, Len: 0
  Source Port: 60677
  Destination Port: 80
  [Stream index: 22]
  [Conversation completeness: Complete, WITH_DATA (31)]
  [TCP Segment Len: 0]
  Sequence Number: 851 (relative sequence number)
  Sequence Number (raw): 1541759032
  [Next Sequence Number: 851 (relative sequence number)]
  Acknowledgment Number: 919 (relative ack number)
  Acknowledgment number (raw): 861162535
  0101 .... = Header Length: 20 bytes (5)
  Flags: 0x010 (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
    .......0. = Syn: Not set
    .......0 = Fin: Not set
  [TCP Flags: .....A....]
  Window: 509
  [Calculated window size: 130304]
  [Window size scaling factor: 256]
  Checksum: 0xde80 [unverified]

```

④ 第三次挥手

服务器关闭与客户端的连接，发送它自己的终止报文段，其标志位 FIN 和 ACK 置 1，序号（相对）为 851，确认序号（相对）为 919。

```

  Time         Source                Destination              Protocol Length  Info
  3177 108.076276 175.6.193.181  10.208.98.218  TCP        60 80 → 60677 [FIN, ACK] Seq=918 Ack=951 Win=120064 Len=0
  3178 108.076382 10.208.98.218  175.6.193.181  TCP        54 60677 → 80 [ACK] Seq=851 Ack=919 Win=130304 Len=0
  3179 108.076418 10.208.98.218  175.6.193.181  TCP        54 60677 → 80 [FIN, ACK] Seq=851 Ack=919 Win=130304 Len=0
  ✓ Transmission Control Protocol, Src Port: 60677, Dst Port: 80, Seq: 851, Ack: 919, Len: 0
    Source Port: 60677
    Destination Port: 80
    [Stream index: 22]
    [Conversation completeness: Complete, WITH_DATA (31)]
    [TCP Segment Len: 0]
    Sequence Number: 851 (relative sequence number)
    Sequence Number (raw): 1541759032
    [Next Sequence Number: 852 (relative sequence number)]
    Acknowledgment Number: 919 (relative ack number)
    Acknowledgment number (raw): 861162535
    001 ..... = Header Length: 20 bytes (5)
  ✓ Flags: 0x011 (FIN, ACK)
    000. .... = Reserved: Not set
    ...0 .... = Nonce: Not set
    ... 0... = Congestion Window Reduced (CWR): Not set
    ... .. = ECN-Echo: Not set
    ....0. .... = Urgent: Not set
    .... ..1 .... = Acknowledgment: Set
    .... ..0.. = Push: Not set
    .... ..0.. = Reset: Not set
    .... ..0. = Syn: Not set
    ... ..1 = Fin: Set
    [TCP Flags: .....A...F]
  Window: 509
  [Calculated window size: 130304]
  [Window size scaling factor: 256]

```


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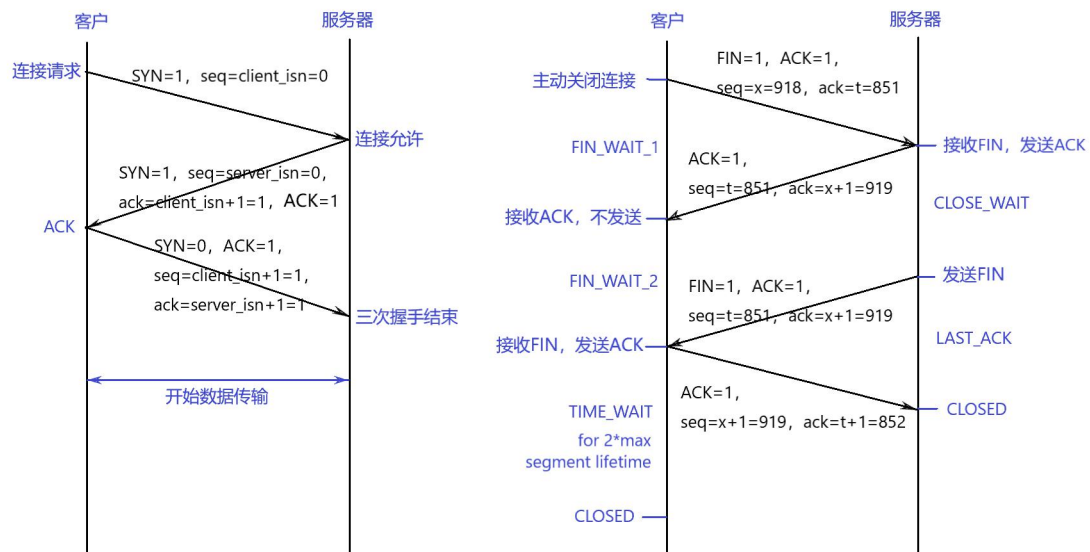
⑤ 第四次挥手

客户端收到服务器发送的终止报文段之后，进行确认，发回一个标志位 ACK 置 1 的报文段，序号（相对）为收到的确认序号=919，确认序号（相对）为收到的序号+1=851+1=852。

No.	Time	Source	Destination	Protocol	Length	Info
3177	108.076276	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [FIN, ACK] Seq=918 Ack=851 Win=120064 Len=0
3178	108.076382	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [ACK] Seq=851 Ack=919 Win=130304 Len=0
3179	108.076418	10.208.98.218	175.6.193.181	TCP	54	60677 → 80 [FIN, ACK] Seq=851 Ack=919 Win=130304 Len=0
3182	108.118319	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=919 Ack=852 Win=120064 Len=0

Transmission Control Protocol, Src Port: 80, Dst Port: 60677, Seq: 919, Ack: 852, Len: 0
Source Port: 80
Destination Port: 60677
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 919 (relative sequence number)
Sequence Number (raw): 861162535
[Next Sequence Number: 919 (relative sequence number)]
Acknowledgment Number: 852 (relative ack number)
Acknowledgment number (raw): 1541759033
0101 = Header Length: 20 bytes (5)
Flags: 0x010 (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
....0 = Syn: Not set
....0 = Fin: Not set
[TCP Flags:A....]
Window: 1876
[Calculated window size: 120064]

(4) 本次 TCP 连接三次握手与四次挥手的时序图



(5) 分析一个 TCP 报文

选择追踪的该 TCP 数据流中任意一个 TCP 报文如下，分析该报文 TCP 首部各字段的定义、值及其含义。

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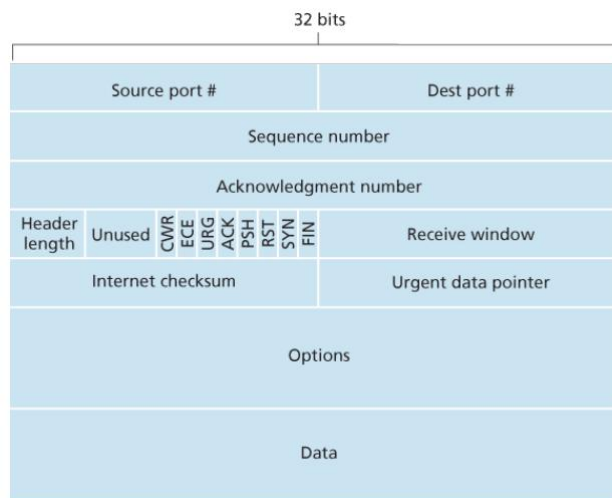
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No.	Time	Source	Destination	Protocol	Length	Info
	849.47.771044	175.6.193.181	10.208.98.218	TCP	60	80 → 60677 [ACK] Seq=1 Ack=283 Win=117888 Len=0

```

Source Port: 80
Destination Port: 60677
[Stream index: 22]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 1      (relative sequence number)
Sequence Number (raw): 861161617
[Next Sequence Number: 1      (relative sequence number)]
Acknowledgment Number: 283      (relative ack number)
Acknowledgment number (raw): 1541758464
0101 .... = Header Length: 20 bytes (5)
▼ Flags: 0x010 (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
  .... .... ..0. = Syn: Not set
  .... .... ...0 = Fin: Not set
  [TCP Flags: .....A.....]
Window: 1842
[Calculated window size: 117888]
[Window size scaling factor: 64]
Checksum: 0xa71b [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
  
```

对照 TCP 报文的格式，逐句分析：



Source Port: 80 16 位源端口号

Destination Port: 60677 16 位目的端口号

[Stream index: 22]

[Conversation completeness: Complete, WITH_DATA (31)]

[TCP Segment Len: 0]

Sequence Number: 1 (relative sequence number) 32 位序列号

Sequence Number (raw): 861161617

[Next Sequence Number: 1 (relative sequence number)]

Acknowledgment Number: 283 (relative ack number) 32 位确认序列号

Acknowledgment number (raw): 1541758464

0101 = Header Length: 20 bytes (5) 4 位头部长度 (0101) + Unused

实验二 TCP 协议分析
09019204 曹邹颖

Flags: 0x010 (ACK) **Flags 字段**

000. = Reserved: Not set 保留

...0 = Nonce: Not set

.... 0... = Congestion Window Reduced (CWR): Not set

.... .0.. = ECN-Echo: Not set

.... ..0. = Urgent: Not set 当 URG=1 时，表示报文段中有紧急数据，应尽快传送

.... ...1 = Acknowledgment: Set ACK=1 代表一个确认的 TCP 包，否则不是确认包

.... 0... = Push: Not set PSH=1 代表接收端尽快的交付给应用进程

....0.. = Reset: Not set RST=1 代表 TCP 连接中出现严重差错，必须释放连接，
再重新建立连接

....0. = Syn: Not set 在建立连接是用来同步序号。SYN=1，ACK=0 表示连接请
求报文段；SYN=1，ACK=1 表示同意建立连接。

....0 = Fin: Not set FIN=1 表示此报文段的发送端的数据已经发送完毕，并要求
释放传输连接。

[TCP Flags:A.....]

Window: 1842 用来控制对方发送的数据量，通知发放已确定的发送窗口上限。

[Calculated window size: 117888]

[Window size scaling factor: 64]

Checksum: 0xa71b [unverified] 校验和，检验的范围包括首部和数据这两部分

[Checksum Status: Unverified]

Urgent Pointer: 0 紧急指针在 URG=1 时有效，它指出本报文段中的紧急数据的字节数。

[Timestamps]

[SEQ/ACK analysis]

三. 实验体会

本次实验通过使用 Wireshark 观察 TCP 协议报文，分析通信时序，理解了 TCP 连接管理的过程，掌握了 TCP 工作原理与实现，明确了 TCP 报文首部各字段的定义、值及其含义。

在观察 TCP 三次握手与四次挥手报文的过程中，我观察到在 TCP 四次挥手中第二、三两次挥手的 seq 序号是等于第一次挥手的 ACK 序号，原因是第二、三次挥手是服务器发送的报文，其 seq 序号应为服务器接收 FIN，发送 ACK 前的上一条报文段序号+其 segment len=客户端对其确认的 ACK 序号即客户端期待从服务器收到的下一个报文的序号，通过此对 TCP 报文段序号和确认号的特征加深了认识。