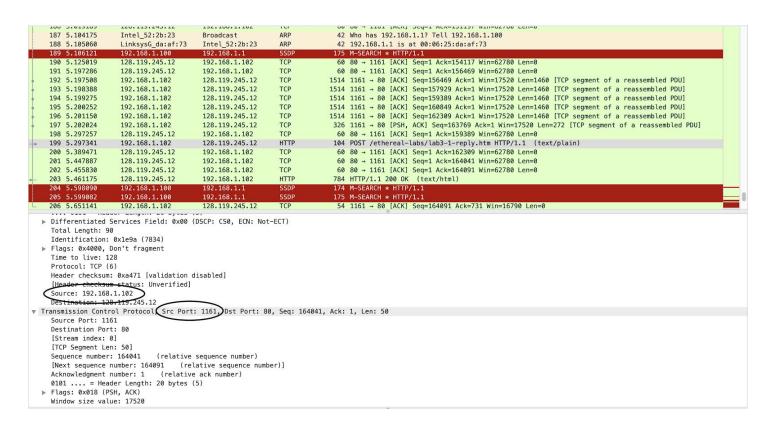
1.

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.



#### Printed Packet:

No. Time Source Destination Protocol Length Info 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)

Frame 199: 104 bytes on wire (832 bits), 104 bytes captured (832 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: 164041, Ack: 1, Len: 50

[122 Reassembled TCP Segments (164090 bytes): #4(565), #5(1460), #7(1460), #8(1460), #10(1460),

#11(1460), #13(1147), #18(1460), #19(1460), #20(1460), #21(1460), #22(1460), #23(892), #30(1460), #31(1460), #32(1460), #32(1460), #34(1460), #31(1460), #32(1460), #

Hypertext Transfer Protocol

MIME Multipart Media Encapsulation, Type: multipart/form-data, Boundary:

"-----265001916915724"

## 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?

|                                       |   | Time  | Source   | Destination  | Protocol              |                   | Info   |
|---------------------------------------|---|---|--|--|-----------------------|-------------------|--|
|                                       |   | 5.104175  | Intel 52:2b:23   | Broadcast  | ARP                   |                   | Who has 192.168.1.1? Tell 192.168.1.100  |
|                                       |   | 5.105060  | LinksysG_da:af:73  | Intel 52:2b:23   | ARP                   |                   | 192.168.1.1 is at 00:06:25:da:af:73  |
|                                       |   | 5.106121  | 192.168.1.100  | 192.168.1.1  | SSDP                  |                   | M-SEARCH * HTTP/1.1  |
|                                       |   | 5.125019  | 128,119,245,12   | 192,168,1,102  | TCP                   |                   | 80 → 1161 [ACK] Seq=1 Ack=154117 Win=62780 Len=0   |
|                                       |   | 5.197286  | 128.119.245.12   | 192.168.1.102  | TCP                   |                   | 80 → 1161 [ACK] Seq=1 Ack=154117 Will=02780 Len=0  |
|                                       |   | 5.197508  | 192.168.1.102  | 128.119.245.12   | TCP                   |                   | 1161 → 80 [ACK] Seq=156469 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]     |
|                                       |   | 5.198388  | 192.168.1.102  | 128.119.245.12   | TCP                   |                   | 1161 → 80 [ACK] Seq=157929 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]     |
|                                       |   | 5.199275  | 192.168.1.102  | 128,119,245,12   | TCP                   |                   | 1161 → 80 [ACK] Seq=159389 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]     |
|                                       |   | 5.200252  | 192.168.1.102  | 128,119,245,12   | TCP                   |                   | 1161 → 80 [ACK] Seq=160849 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]     |
|                                       |   | 5.201150  | 192.168.1.102  | 128,119,245,12   | TCP                   |                   | 1161 → 80 [ACK] Seq=162309 Ack=1 Win=17520 Len=1460 [TCP segment of a reassembled PDU]     |
|                                       |   | 5.202024  | 192.168.1.102  | 128,119,245,12   | TCP                   |                   | 1161 → 80 [PSH, ACK] Seq=163769 Ack=1 Win=17520 Len=272 [TCP segment of a reassembled PDU] |
|                                       |   | 5.297257  | 128,119,245,12   | 192.168.1.102  | TCP                   |                   | 80 → 1161 [ACK] Seq=1 Ack=159389 Win=62780 Len=0   |
|                                       |   | 5.297341  | 192.168.1.102  | 128,119,245,12   | HTTP                  |                   | POST /ethereal-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)                                 |
|                                       |   | 5.389471  | 128,119,245,12   | 192.168.1.102  | TCP                   |                   | 80 → 1161 [ACK] Seq=1 Ack=162309 Win=62780 Len=0   |
|                                       |   | 5.447887  | 128, 119, 245, 12  | 192.168.1.102  | TCP                   |                   | 80 → 1161 [ACK] Seq=1 Ack=164041 Win=62780 Len=0   |
|                                       |   | 5.455830  | 128.119.245.12   | 192.168.1.102  | TCP                   |                   | 80 → 1161 [ACK] Seq=1 Ack=164091 Win=62780 Len=0   |
|                                       |   | 5.461175  | (128,119,245,12)   | 192.168.1.102  | HTTP                  |                   | HTTP/1.1 200 OK (text/html)  |
|                                       |   | 5.598090  | 192.168.1.100  | 192.168.1.1  | SSDP                  |                   |  |
|                                       |   |   |  |  |                       |                   |  |
|                                       |   |   |  |  |                       |                   | M-SEARCH * HTTP/1.1  |
| • • • • • • • • • • • • • • • • • • • | 205<br>206<br><br>Dif   | 5.599082<br>5.651141<br>ferentiated   | 192.168.1.100<br>192.168.1.102<br>Services Field: 0x00 (   | 192.168.1.1<br>128.119.245.12  | SSDP<br>TCP           | 175               | M-SEARCH * HTTP/1.1  1161 - 80 (ACK) Seq=164091 Ack=731 Win=16790 Len=0                    |
| <b>&gt;</b>                           | 205<br>206<br>Tota<br>Iden<br>Flag<br>Time<br>Pro-<br>Head<br>[Head<br>Sour                 | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 tocol: TCP ( der checksum ader necksu rce: [128.119 tinatia:: 19   | 192.168.1.100 192.168.1.102 Services Field: 0x00 (70.58bc (22716) Don't fragment 55 (6) 1. 0xb0a7 [validation of matter of the control of the | 192.168.1.1<br>128.119.245.12<br>DSCP: CSØ, ECN: No  | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
|                                       | 205 206 Tota Iden Flag Time Pro Head [Head Sour   | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 tocool: TCP (der checksum ader necksum ree: [128.11] e tination: 19 nission Cont   | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 10x058bc (22716) Don't fragment 155 16) 10x080a7 [validation of the control of the cont | 192.168.1.1<br>128.119.245.12<br>DSCP: CSØ, ECN: No  | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| b<br>b                                | 205 206 Diff Tota Iden Flag Time Pro Head [Head Soun Des                                    | 5.599082 5.651141 ferentiated al Length: 7 milification: gs: 0x4000, e to live: 5 tocol: TCP (der checksum der checksum ce: [128.119 tination: 19 tinssion Control Research Prof. 80  | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 0x58bc (22716) Don't fragment (55 66) 0xb0a7 [validation of the control of the control ox (750 o | 192.168.1.1<br>128.119.245.12<br>DSCP: CSØ, ECN: No  | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| b b                                   | 205 206 Diff Tota Iden Flag Time Pro Heac [Heac Soun Des: Soun Des:                         | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 der checksum ader checksum tree: [128.11 triation: 19 tination: 19 tination: 19 tination: 19 tination: 19 tination: 19 tination: 19 tination                           | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 : 0x58bc (22716) Don't fragment 55 160 1 0x5007 [validation of matter than 10 (10 (10 (10 (10 (10 (10 (10 (10 (10  | 192.168.1.1<br>128.119.245.12<br>DSCP: CSØ, ECN: No  | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| ►<br>►                                | 205 206 Diff Tota Iden Flag Time Pro Heaa (Hea Soun Des ansm Des [St                        | 5.59982 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, c to live: 5 tocol: TCP ( der checksum der fnecksurce: [128.119 tination: 128 tinission Cont rce Port: 88 tination Por ream index:   | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 10x58bc (22716) Don't fragment (55 16) 10x5007 [validation of mystatos: Unverified] 1,245.12 12.168.1.102 1701 Protocol Src Port (16) 1111 Protocol Src Port (16) 1111 Protocol Src Port (16)  | 192.168.1.1<br>128.119.245.12<br>DSCP: CSØ, ECN: No  | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| ►<br>►                                | 205 206 Diff Tota Iden Flag Timm Prof Head (Hea Soun Des Soun Est (ITCI                     | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 tocol: TCP ( der checksum adder necksu rce: [128.119 tination: 19 nission Cont rce Port: 80 tination Por ream index: P Segment Le                                      | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 0x58bc (22716) Don't fragment (55 16) 0x58bc (22716) 0x5bc (22716) 0x | 192.168.1.1<br>128.119.245.12<br>DSCP: CS0, ECN: Nor   | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| b<br>Tra                              | 205 206 Diff Tota Iden Flag Time Pro Head Soun Des Soun Est [TCI Sequ                       | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 der checksum ader checksum rece: [128.1] tination: 19 tination: 19 tination Por ream index: P Segment Le uence number  | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 : 0x58bc (22716) Don't fragment 55 16) 10 0x5007 [validation of the content of the cont | 192.168.1.1<br>128.119.245.12<br>DSCP: CSØ, ECN: No:   | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| b<br>b                                | 205 206 Diff Tota Idea Flag Timm Pro Head [Head Soun Des ansm Soun [Sti [TCI Sequ [Ne:      | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, c to live: 5 tocol: TCP ( der checksum ader fnecksurce: [128.119 tination: 128 tinission Cont rce Port: 88 tination Por ream index: P Segment Le uence number xt sequence           | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 10x58bc (22716) Don't fragment (55 16) 10x5007 [validation of the content of the conten | 192.168.1.1 128.119.245.12 DSCP: CS0, ECN: North Stabled] Establed Stabled Sta | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| b<br>b                                | 205 206 Diff Tota Iden Flag From Head [Head Soun Des Soun Est [TCI Sequ [Nex                | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 tocol: TCP ( der checksum adder necksu rce: [128.119 tination: 19 nission Cont rce Port: 80 tination Por ream index: P Segment Le uence number xt sequence nowledgment | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 700 0x58bc (22716) Don't fragment 55 66) 10x00a7 [validation of the control of the cont | 192.168.1.1 128.119.245.12 DSCP: CS0, ECN: Nor disabled] : 80, Dst Port: 116   | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |
| b<br>b                                | 205 206 Diff Tota Iden Flag Time Prod Head Soun Des ansm Soun [Str [TCI Sequ [Nex Ackn 010: | 5.599082 5.651141 ferentiated al Length: 7 ntification: gs: 0x4000, e to live: 5 tocol: TCP ( der checksum adder necksu rce: [128.119 tination: 19 nission Cont rce Port: 80 tination Por ream index: P Segment Le uence number xt sequence nowledgment | 192.168.1.100 192.168.1.102 Services Field: 0x00 (770 : 0x58bc (22716) Don't fragment 55.66) 1. 0x5007 [validation of mastate: Unverified] 0.245.12 0.245.12 0.245.12 0.2168.1.102 rol Protocol Src Port 1: 1161 0] en: 730] : 1 (relative sequenumber: 731 (relatinumber: 731 (relatinumber: 164091 (relatinumber Length: 20 bytes (1400)   | 192.168.1.1 128.119.245.12 DSCP: CS0, ECN: Nor disabled] : 80, Dst Port: 116   | SSDP<br>TCP<br>t-ECT) | 1 <b>75</b><br>54 | M-SEARCH * HTTP/1.1  1161 - 80 [ACK] Seq=164091 Ack=731 Win=16790 Len=0                    |

#### **Packet Print**

No. Time Source Destination Protocol Length Info 203 5.461175 128.119.245.12 192.168.1.102 HTTP 784 HTTP/1.1 200

OK (text/html)

Frame 203: 784 bytes on wire (6272 bits), 784 bytes captured (6272 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)

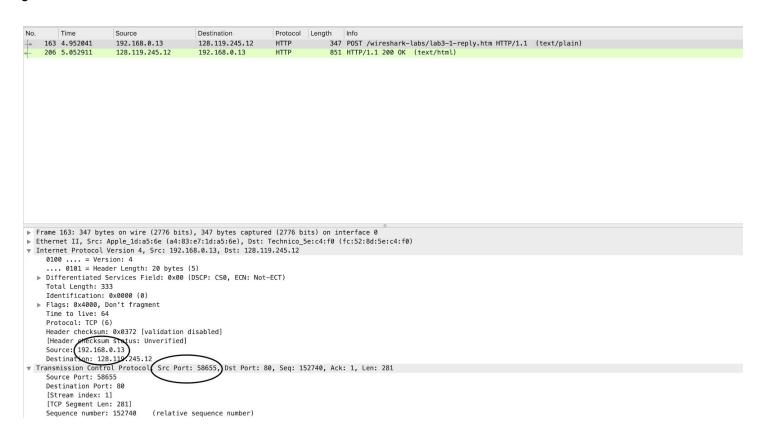
Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.1.102

Transmission Control Protocol, Src Port: 80, Dst Port: 1161, Seq: 1, Ack: 164091, Len: 730

Hypertext Transfer Protocol

Line-based text data: text/html (11 lines)

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



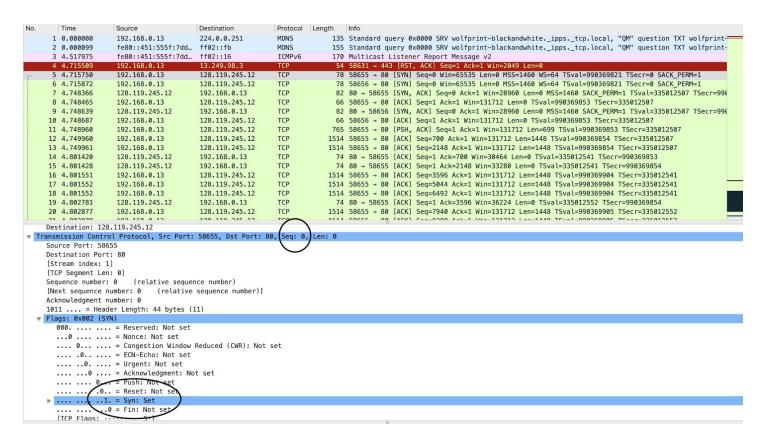
The source IP address is 192.168.0.13 The source port is 58655

#### **Print Packet**

No. Time Source Destination Protocol Length Info 163 4.952041 192.168.0.13 128.119.245.12 HTTP 347 POST /

```
wireshark-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
Frame 163: 347 bytes on wire (2776 bits), 347 bytes captured (2776 bits) on interface 0
Ethernet II, Src: Apple_1d:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0 (fc:52:8d:5e:c4:f0)
Internet Protocol Version 4, Src: 192.168.0.13 Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 152740, Ack: 1, Len: 281
[107 Reassembled TCP Segments (153020 bytes): #11(699), #12(1448), #13(1448), #16(1448), #17(1448), #20(1448), #21(1448), #23(1448), #24(1448), #27(1448), #28(1448), #29(1448), #30(1448), #31(1448), #32(1448), #34(1448), #35(1448]
Hypertext Transfer Protocol
MIME Multipart Media Encapsulation, Type: multipart/form-data, Boundary: "----
WebKitFormBoundarykFfvTdSCjsoHX2Ub"
```

# 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?



The sequence number of the TCP SYN segment is 0 as it is used to initiate the TCP connection between the client computer and server. In the Flags section, the Syn flag is set to 1 that indicates, this segment is a SYN segment.

What is the sequence number of the SYN ACK 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?

| Time  | Source   | Destination   | Protocol | Length | Info  |
|---|--|---|----------|--------|---|
| 1 0.000000  | 192.168.0.13   | 224.0.0.251   | MDNS     | 135    | Standard query 0x0000 SRV wolfprint—blackandwhiteippstcp.local, "QM" question TXT wolfprint=          |
| 2 0.000099  | fe80::451:555f:7dd   | ff02::fb  | MDNS     | 155    | Standard query 0x0000 SRV wolfprint-blackandwhiteippstcp.local, "QM" question TXT wolfprint-          |
| 3 4.517975  | fe80::451:555f:7dd   | ff02::16  | ICMPv6   | 170    | Multicast Listener Report Message v2  |
| 4 4.715509  | 192.168.0.13   | 13.249.98.3   | TCP      | 54     | 58631 → 443 [RST, ACK] Seq=1 Ack=1 Win=2049 Len=0   |
| 5 4.715750  | 192.168.0.13   | 128.119.245.12  | TCP      | 78     | 58655 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=64 TSval=990369821 TSecr=0 SACK_PERM=1             |
| 6 4.715872  | 192.168.0.13   | 128.119.245.12  | TCP      | 78     | <del>58656 - 80 [SYN] Seq=0 Win=</del> 65535 Len=0 MSS=1460 WS=64 TSval=990369821 TSecr=0 SACK_PERM=1 |
| 7 4.748366  | 128.119.245.12   | 192.168.0.13  | TCP      | 82     | 80 → 58655 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=335012507 TSecr=990      |
| 8 4.748465  | 192.168.0.13   | 128.119.245.12  | TCP      | 66     | <del>58655 - 00 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=990369853 TSecr=335012507</del>              |
| 9 4.748639  | 128.119.245.12   | 192.168.0.13  | TCP      | 82     | 80 → 58656 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=335012507 TSecr=99€      |
| 10 4.748687   | 192.168.0.13   | 128.119.245.12  | TCP      | 66     | 58656 → 80 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=990369853 TSecr=335012507                         |
| 11 4.748960   | 192.168.0.13   | 128.119.245.12  | TCP      | 765    | 58655 → 80 [PSH, ACK] Seq=1 Ack=1 Win=131712 Len=699 TSval=990369853 TSecr=335012507                  |
| 12 4.749960   | 192.168.0.13   | 128.119.245.12  | TCP      | 1514   | 58655 → 80 [ACK] Seq=700 Ack=1 Win=131712 Len=1448 TSval=990369854 TSecr=335012507                    |
| 13 4.749961   | 192.168.0.13   | 128.119.245.12  | TCP      | 1514   | 58655 → 80 [ACK] Seq=2148 Ack=1 Win=131712 Len=1448 TSval=990369854 TSecr=335012507                   |
| 14 4.801420   | 128.119.245.12   | 192.168.0.13  | TCP      | 74     | 80 → 58655 [ACK] Seq=1 Ack=700 Win=30464 Len=0 TSval=335012541 TSecr=990369853                        |
| 15 4.801428   | 128.119.245.12   | 192.168.0.13  | TCP      | 74     | 80 → 58655 [ACK] Seq=1 Ack=2148 Win=33280 Len=0 TSval=335012541 TSecr=990369854                       |
| 16 4.801551   | 192.168.0.13   | 128.119.245.12  | TCP      | 1514   | 58655 → 80 [ACK] Seq=3596 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541                   |
| 17 4.801552   | 192.168.0.13   | 128.119.245.12  | TCP      | 1514   | 58655 → 80 [ACK] Seq=5044 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541                   |
| 18 4.801552   | 192.168.0.13   | 128.119.245.12  | TCP      | 1514   | 58655 → 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541                   |
| 19 4.802781   | 128.119.245.12   | 192.168.0.13  | TCP      | 74     | 80 → 58655 [ACK] Seq=1 Ack=3596 Win=36224 Len=0 TSval=335012552 TSecr=990369854                       |
| 20 4.802877   | 192.168.0.13   | 128.119.245.12  | TCP      | 1514   | 58655 → 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552                   |
| 21 4 002070   | 100 100 0 10   | 100 110 045 10  | TCD      | 1514   | EDCEE On FACEL C 0300 A-1-1 MG131713 L1440 TC1-000300000E TC320013000                                 |
| [TCP Segment  | Len: 0]  |   |          |        |   |
| Sequence number [Next sequence Acknowledgmen 1010 = He  | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (  | <pre>sequence number)] ack number)</pre>              |          |        |   |
| Sequence numb<br>[Next sequence<br>Acknowledgmen<br>1010 = Ho<br>Flags: 0x012   | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (  | <pre>sequence number)] ack number)</pre>              |          |        |   |
| Sequence numb<br>[Next sequence<br>Acknowledgmen<br>1010 = H<br>Flags: 0x012<br>000   | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set   | <pre>sequence number)] ack number)</pre>              |          |        |   |
| Sequence numb [Next sequence Acknowledgmen 1010 = H Flags: 0x012 000  | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Nonce: Not set   | sequence number)]<br>ack number)<br>10)               | set      |        |   |
| Sequence numb<br>[Next sequence<br>Acknowledgmen:<br>1010 = H:<br>Flags: 0x012<br>000<br>0 0  | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set   | sequence number)]<br>ack number)<br>10)               | set      |        |   |
| Sequence numb. [Next sequence Acknowledgmen 1010 = H Flags: 0x012 000   | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Nonce: Not set<br>= Congestion Window<br>= ECN-Echo: Not set   | sequence number)]<br>ack number)<br>10)               | set      |        |   |
| Sequence numb [Next sequenc. Acknowledgmen 1010 = H Flags: 0x012 000 0 0 0 0  | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Konce: Not set<br>= Congestion Window<br>= ECN-Echo: Not set<br>= Urgent: Not set  | sequence number)] ack number) 10)  Reduced (CWR): Not | set      |        |   |
| Sequence numb [Next sequence Acknowledgmen 1010 = H Flags: 0x012 000 0 0 1  | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Nonce: Not set<br>= Congestion Window<br>= ECN-Echo: Not set<br>= Urgent: Not set<br>= Acknowledgment: Se  | sequence number)] ack number) 10)  Reduced (CWR): Not | set      |        |   |
| Sequence numb [Next sequenc Acknowledgmen 1010 = H Flags: 0x012 000 0 0 0 0 0 0 1 0 1 0   | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Konce: Not set<br>= Congestion Window<br>= ECN-Echo: Not set<br>= Urgent: Not set  | sequence number)] ack number) 10)  Reduced (CWR): Not | set      |        |   |
| Sequence numb   | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Nonce: Not set<br>= Congestion Window<br>= ECN-Echo: Not set<br>= Acknowledgment: Sc<br>= Push: Not set  | sequence number)] ack number) 10)  Reduced (CWR): Not | set      |        |   |
| Sequence numb   [Next sequence   Acknowledgmen   1010 = H   Flags: 0x012   0000   0     0 | er: 0 (relative seque<br>e number: 0 (relative<br>t number: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Congestion Window<br>= ECN-Echo: Not set<br>= Vergent: Not set<br>= Acknowledgment: So<br>= Push: Not set<br>0. = Reset: Not set   | sequence number)] ack number) 10)  Reduced (CWR): Not | set      |        |   |
| Sequence numb   [Next sequence   Acknowledgmen   1010 = H   Flags: 0x012   000 0   .  | er: 0 (relative seque<br>e number: 0 (relative<br>toumber: 1 (relative<br>eader Length: 40 bytes (<br>(SYN, ACK)<br>= Reserved: Not set<br>= Congestion Window<br>= ECN-Echo: Not set<br>= Urgent: Not set<br>= Acknowledgment: Se<br>= Push: Not set<br>= Push: Not set<br>= Reset: Not set<br>= Reset: Not set<br>= Reset: Not set<br>= Reset: Not set | sequence number)] ack number) 10)  Reduced (CWR): Not | set      |        |   |

#### **Printed Packet**

/var/folders/gz/wqm9l2y918g3kj8tl3zd0cf80000gn/T//wireshark\_Wi-Fi\_20191002235443\_g9rBzs.pcapng 211 total packets, 211 shown

No. Time Source Destination Protocol Length Info 7.4.748366 128.119.245.12 192.168.0.13 TCP 82  $80 \rightarrow 58655$ 

[SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK\_PERM=1 TSval=335012507 TSecr=990369821

WS=128

Frame 7: 82 bytes on wire (656 bits), 82 bytes captured (656 bits) on interface 0 Ethernet II, Src: Technico\_5e:c4:f0 (fc:52:8d:5e:c4:f0), Dst: Apple\_1d:a5:6e (a4:83:e7:1d:a5:6e) Internet Protocol Version 4, Src: 128.119.245.12, Dst: 192.168.0.13

```
0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
  Total Length: 60
  Identification: 0x0000 (0)
  Flags: 0x4000, Don't fragment
  Time to live: 50
  Protocol: TCP (6)
  Header checksum: 0x1283 [validation disabled]
  [Header checksum status: Unverified]
  Source: 128.119.245.12
  Destination: 192.168.0.13
Transmission Control Protocol, Src Port: 80, Dst Port: 58655, Seq: 0, Ack: 1, Len: 0
  Source Port: 80
 Destination Port: 58655
  [Stream index: 1]
  [TCP Segment Len: 0]
  Sequence number: 0 (relative sequence number)
  [Next sequence number: 0 (relative sequence number)]
  Acknowledgment number: 1 (relative ack number)
 1010 .... = Header Length: 40 bytes (10)
  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 size value: 28960

[Calculated window size: 28960] Checksum: 0x834d [unverified] [Checksum Status: Unverified]

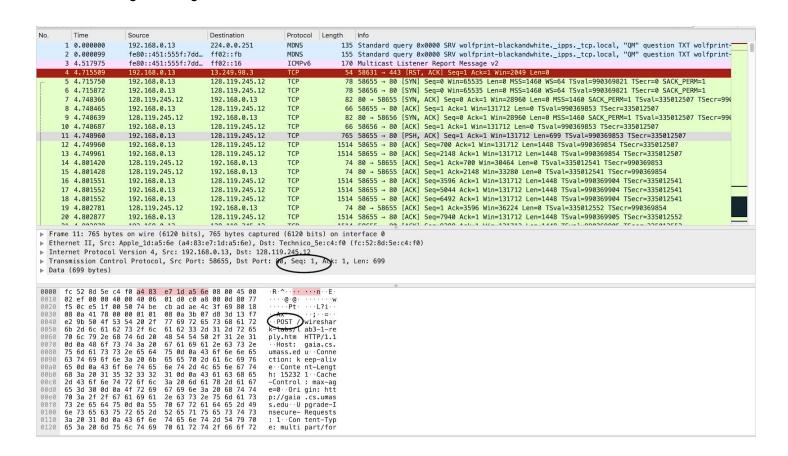
Urgent pointer: 0

Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP),

Window scale
[SEQ/ACK analysis]
[Timestamps]

- > the sequence number of the SYNACK segment sent by server to the client in reply to the SYN is 0.
- >The value of the acknowledgment field in the SYNACK segment is 1
- >The server adds 1 to the sequence number of SYN segment form the client as this will be the next sequence number that it is expecting.
- >A segment will be identified as a SYNACK segment if both SYN flag and Acknowledgement in the segment are set to 1.

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.



The sequence number in the Post command will is 1.

#### **Printed Packet:**

```
No.
        Time
                       Source
                                              Destination
                                                                    Protocol Length Info
     11 4.748960
                                                                    TCP
                       192.168.0.13
                                              128.119.245.12
                                                                              765
                                                                                     58655 → 80
[PSH, ACK] Seq=1 Ack=1 Win=131712 Len=699 TSval=990369853 TSecr=335012507
Frame 11: 765 bytes on wire (6120 bits), 765 bytes captured (6120 bits) on interface 0
Ethernet II, Src: Apple_1d:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0 (fc:52:8d:5e:c4:f0)
Internet Protocol Version 4, Src: 192.168.0.13, Dst: 128.119.245.12
Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 1, Ack: 1, Len: 699
Data (699 bytes)
     50 4f 53 54 20 2f 77 69 72 65 73 68 61 72 6b 2d
0000
                                                         POST /wireshark-
0010
      6c 61 62 73 2f 6c 61 62 33 2d 31 2d 72 65 70 6c
                                                         labs/lab3-1-repl
0020
      79 2e
            68
               74 6d 20 48 54 54 50 2f 31 2e 31
                                                 0d 0a
                                                         y.htm HTTP/1.1..
0030
      48 6f 73
               74 3a
                     20 67 61 69 61 2e 63 73 2e
                                                 75
                                                    6d
                                                         Host: gaia.cs.um
0040
      61 73
            73
               2e
                  65
                     64 75
                           0d
                              0a 43 6f 6e 6e 65
                                                 63
                                                         ass.edu..Connect
0050
      69 6f
               3a
                  20
                     6b
                        65
                           65
                              70
                                 2d
                                                 65
            6e
                                    61
                                       6c 69
                                              76
                                                         ion: keep-alive.
0060
      0a 43 6f
               6e
                  74
                     65 6e 74
                              2d 4c 65 6e 67
                                                 68
                                                    3a
                                                         .Content-Length:
      20 31 35
0070
               32
                  33 32
                        31 0d
                              0a 43 61 63 68 65
                                                 2d
                                                    43
                                                          152321..Cache-C
                                                    3d
0080
      6f 6e 74 72
                  6f 6c 3a 20 6d 61 78
                                       2d 61 67
                                                         ontrol: max-age=
0090
     30 0d 0a 4f 72 69 67 69 6e 3a 20 68 74 74 70 3a
                                                         0..Origin: http:
00a0
      2f 2f 67 61 69 61 2e 63 73 2e 75 6d 61 73
                                                         //gaia.cs.umass.
      65 64 75 0d 0a 55 70 67 72 61 64 65 2d 49
                                                         edu..Upgrade-Ins
00c0 65 63 75 72 65 2d 52 65 71 75 65 73 74 73
                                                         ecure-Requests:
00d0
     31 0d 0a 43 6f 6e 74 65 6e 74 2d 54 79 70
                                                         1..Content-Type:
00e0
     20 6d 75 6c 74 69 70 61 72 74 2f 66 6f 72
                                                          multipart/form-
00f0
      64 61 74 61 3b 20 62 6f 75 6e 64 61 72 79
                                                 3d 2d
                                                         data; boundary=-
0100
      2d 2d 2d 57
                  65 62 4b 69 74 46 6f 72 6d 42
                                                         ---WebKitFormBou
0110
      6e 64
            61
               72
                  79
                     6b 46 66
                              76 54 64 53 43 6a
                                                 73
                                                         ndarykFfvTdSCjso
0120
      48 58 32
               55
                     0d
                        0a 55
                              73 65 72 2d 41 67
                  62
                                                         HX2Ub..User-Agen
0130
      74 3a 20
               4d
                  6f
                     7a 69
                           6c 6c 61 2f
                                                         t: Mozilla/5.0 (
                                       35 2e
0140
      4d 61 63 69
                  6e
                     74 6f
                           73 68 3b 20 49 6e
                                             74
                                                         Macintosh; Intel
      20 4d 61 63
                                                          Mac 0S X 10_14_
0150
                  20
                     4f 53 20 58 20 31 30 5f 31 34 5f
0160
                  70
                     70 6c 65 57 65 62 4b 69
                                                         AppleWebKit/5
      33 29 20 41
0170
     33 37 2e 33
                        28 4b 48 54 4d 4c 2c 20
                                                         37.36 (KHTML, li
                  36
                     20
0180
      6b 65 20 47
                  65
                     63 6b 6f 29 20 43 68 72 6f
                                                         ke Gecko) Chrome
0190
      2f 37 37 2e
                  30
                     2e
                        33 38 36 35 2e 39 30 20
                                                         /77.0.3865.90 Sa
01a0
      66 61 72
               69
                  2f
                     35
                        33 37 2e 33 36 0d 0a 41
                                                         fari/537.36..Acc
01b0
      65 70 74 3a 20 74 65 78 74 2f 68 74 6d 6c
                                                 2c 61
                                                         ept: text/html,a
01c0
     70 70 6c 69 63 61 74 69 6f 6e 2f 78 68 74
                                                         pplication/xhtml
                        70
01d0
                     61
      2b 78 6d
               6c 2c
                           70 6c 69 63 61 74 69
                                                 6f
                                                         +xml,application
01e0
                     71
                        3d 30 2e 39 2c 69 6d 61
      2f
        78 6d 6c
                  3b
                                                 67
                                                         /xml; q=0.9, image
01f0
      2f
        77
            65
               62
                  70
                     2c
                        69
                           6d
                              61 67
                                    65 2f
                                           61
                                             70
                                                 6e
                                                         /webp,image/apng
                                                         ,*/*;q=0.8,appli
0200
      2c
        2a
            2f
               2a
                  3b
                     71
                        3d
                           30
                              2e
                                 38
                                    2c 61
                                           70
                                              70
                                                 6c
0210
      63 61 74
               69
                  6f
                        2f
                           73
                              69
                                 67
                                                    78
                     6e
                                    6e 65
                                           64
                                                         cation/signed-ex
0220
      63 68
            61
               6e
                  67
                     65
                        3b
                           76
                              3d
                                 62
                                    33 0d
                                           0a 52
                                                 65
                                                         change; v=b3..Ref
                              74
0230
      65 72 65
               72
                  3a
                     20
                        68
                           74
                                 70
                                    3a 2f
                                           2f
                                              67
                                                 61
                                                    69
                                                         erer: http://gai
0240
      61 2e 63
               73
                  2e
                     75
                        6d 61 73
                                 73 2e 65 64 75
                                                    77
                                                         a.cs.umass.edu/w
0250
      69 72 65 73 68 61 72 6b 2d 6c 61 62 73 2f
                                                         ireshark-labs/TC
0260
      50 2d 77 69 72 65 73 68 61 72 6b 2d 66 69 6c 65
                                                         P-wireshark-file
     31 2e 68 74 6d 6c 0d 0a 41 63 63 65 70 74 2d 45
0270
                                                         1.html..Accept-E
0280
      6e 63 6f 64 69 6e 67 3a 20 67 7a 69 70 2c 20 64
                                                         ncoding: gzip, d
0290
    65 66 6c 61 74 65 0d 0a 41 63 63 65 70 74 2d 4c
                                                         eflate..Accept-L
02a0 61 6e 67 75 61 67 65 3a 20 65 6e 2d 55 53 2c 65
                                                         anguage: en-US,e
02b0 6e 3b 71 3d 30 2e 39 0d 0a 0d 0a
                                                         n;q=0.9....
```

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 Section 3.5.3, page 239 in text) after the receipt of each ACK? Assume that the value of the EstimatedRTT is equal to the

7.

measured RTT for the first segment, and then is computed using the EstimatedRTT equation on page 239 for all subsequent segments.

Note: Wireshark has a nice feature that allows you to plot the RTT for each of the TCP segments sent. Select a TCP segment in the "listing of captured packets" window that is being sent from the client to the gaia.cs.umass.edu server. Then select: Statistics->TCP Stream Graph->Round Trip Time Graph.

The segments that are sending the data are : 11,12,13,16,17,18

The acknowledgments to these segments are:

14, 15, 19, 22, 25, 26

The acknowledgment on line 25 acts as a cumulative ack for 17 and 18

The sequence number of the segment:

11 - 1

12 - 700

13 - 2184

16 - 3596

17 - 5044

18 - 6492

Recording the sending time for the segment and the receiving time for the acknowledgment:

|      | Sent Time | Ack receive time | RTT      |
|------|-----------|------------------|----------|
|      |           |                  |          |
| Seg1 | 4.748960  | 4.801420         | 0.05246  |
| Seg2 | 4.749960  | 4.801428         | 0.051468 |
| Seg3 | 4.749961  | 4.801551         | 0.05159  |
| Seg4 | 4.801551  | 4.834084         | 0.032533 |
| Seg5 | 4.801552  | 4.834511         | 0.032959 |

| Seg6 | 4.801552 | 4.834511 | 0.032959 |
|------|----------|----------|----------|
|      |          |          |          |

EstimatedRTT = (1 – alpha) • EstimatedRTT + alpha • SampleRTT

Alpha = 0.125

EstimatedRTT = 0.875 \* EstimatedRTT + 0.125 \* SampleRTT

Estimated RTT after receipt of ACK1 that is for seg 1

Estimated RTT = RTT after segment 1 = 0.05246 seconds

Estimated RTT after receipt of ACK 2 that is for seg 2

Estimated RTT=0.875 \* 0.05246 + 0.125 \*0.051468 = 0.052336 seconds

Estimated RTT after receipt of ACK 3 that is for seg 3

Estimated RTT=0.875 \* 0.052336 + 0.125 \*0.05159= 0.05224275 seconds

Estimated RTT after receipt of ACK 4 that is for seg 4

Estimated RTT=0.875 \*0.05224275 + 0.125 \* 0.032533 = 0.04977903125 seconds

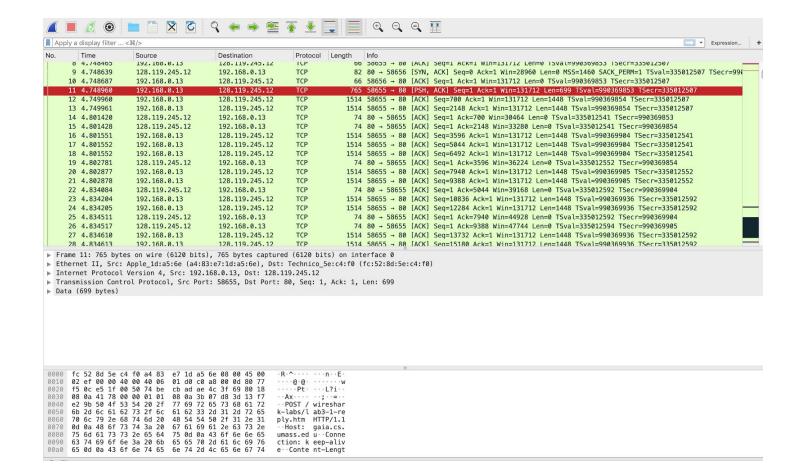
Estimated RTT after receipt of ACK 5 that is for seg 5

Estimated RTT=0.875 \* 0.04977903125 + 0.125 \* 0.032959 = 0.04767652734 seconds

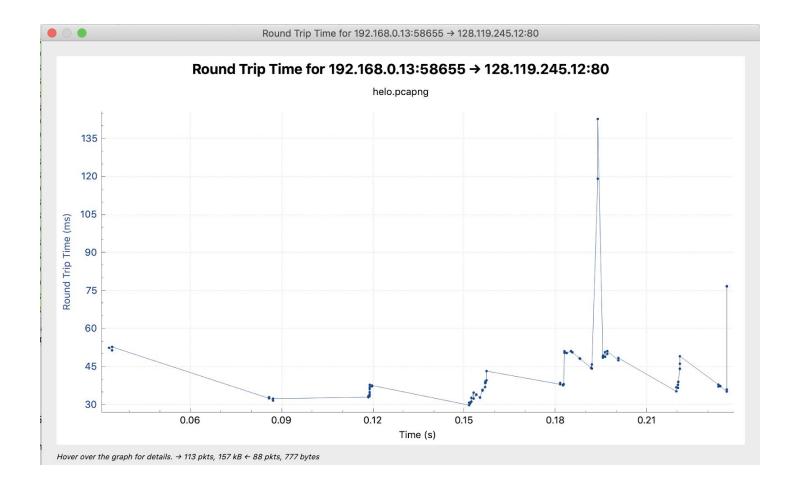
Estimated RTT after receipt of ACK 6 that is for seg 6

Estimated RTT=0.875 \* 0.04767652734 + 0.125 \* 0.032959 = 0.04583683642 seconds

You can see all these packets in the below packet capture :



#### Graph for RTT



8.

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

- 1-The length of the first TCP segment is 699 Bytes
- 2-1448 Bytes
- 3-1448 Bytes
- 4-1448 Bytes
- 5-1448 Bytes
- 6-1448 Bytes

Packet 1

| 8 4.784669 192.168.0.13 128.119.245.12 TCP 66 58655 =8 [ACK] Sept Ackel Min=313712 Lene1 TSval=998369853 TSecr=335812597 Tecr=996 19.4.748687 192.168.0.13 128.119.245.12 TCP 82 86 - 58655 E8 [ACK] Sept Ackel Min=313712 Lene1 TSval=99836953 TSecr=335812597 TSecr=996 19.2.168.0.13 128.119.245.12 TCP 65 58656 - 80 [ACK] Sept Ackel Min=313712 Lene1 TSval=99836953 TSecr=335812597 TSecr=996 19.2.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836985 TSecr=335812597 12.4.749960 19.2.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836985 TSecr=335812597 14.4.881428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836985 TSecr=335812597 14.8.81428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836985 TSecr=335812597 14.8.81428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836985 TSecr=335812597 14.8.81552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836985 TSecr=335812597 14.8.81552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=335812541 18.4.881552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=335812551 192.468.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=33581259 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=33581259 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=33581259 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=33581259 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99836998 TSecr=33581259 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Sept Ackel Min=313712 Lene148 TSval=99 | No.        | Time   | Source   | Destination                                    | Protocol               | Length   | Info          |       |   |  |  |  |
|--|------------|--|--|--|------------------------|----------|---------------|-------|---|--|--|--|
| 10 4.748687 192.168.0.13 128.119.245.12 TCP 66 58665 - 80 [ACK] Seq=1 Ack=1 Min=13/172 Len=0 TSval=990859953 TSccr=335012597  12 4.749960 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=2 Ack=1 Min=13/172 Len=1448 TSval=990859953 TSccr=335012597  13 4.749961 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=2 Ack=1 Min=13/172 Len=1448 TSval=990859954 TSccr=335012597  14 4.801420 128.119.245.12 192.168.0.13 TCP 74 80 - 58655  15 4.801428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655  16 4.801428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655  16 4.801551 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=3 Ack=2 Min=33501254 TSecr=990369854  16 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=3 Ack=2 Min=3 Ack=2 Min=3 Ack=3 Min=3 Min=  |            | 8 4.748465   | 192.168.0.13   | 128.119.245.12                                 | TCP                    | 66       | 5 58655 → 80  | [ACK] | Seq=1 Ack=1 Win=131712 Len=0 TSval=990369853 TSecr=335012507                    |  |  |  |
| 11 4.749968 192.168.0.13 128.119.245.12 TCP 765 \$8655 + 80 [PSH, ACK] Seq=1 Ack=1 Wine=131712 Len=1484 TSVal=990369953 TSGcr=335012567 124.749969 192.168.0.13 128.119.245.12 TCP 1514 \$8655 - 80 [ACK] Seq=2708 Ack=1 Win=131712 Len=1448 TSVal=990369953 TSGcr=335012567 14 4.801420 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=700 Win=30464 Lene TSVal=335012541 TSGcr=990369853 154.801428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=700 Win=30464 Lene TSVal=335012541 TSGcr=990369854 16 4.801551 192.168.0.13 128.119.245.12 TCP 1514 \$8655 - 80 [ACK] Seq=5046 Ack=1 Win=131712 Len=1448 TSVal=990369945 TSGcr=335012541 TSGCr=99036985 [ACK] Seq=1 Ack=7148 Win=3200 Ack=1 Win=33712 Lene1448 TSVal=99036994 TSGcr=335012541 TSGCr=990369954 TSGCr=335012541 TSGCr=9036994 TSGCr=335012541 TSGCr=9036994 TSGCr=335012541 TSGCr=9036994 TSGCr=335012541 TSGCCr=9036994 TSGCr=335012541 TSGCCr=9036994 TSGCr=335012541 TSGCCr=9036994 TSGCr=335012541 TSGCCr=9036994 TSGCr=335012541 TSGCCr=9036994 TSGCCr=335012541 TSGCCr=9036994 TSGCCr=335012541 TSGCCr=9036994 TSGCCr=335012541 TSGCCr=9036994 TSGCCr=335012541 TSGCCr=9036994 TSGCCr=335012552 TSGCCCP990369954 TSGCCCr=335012552 TSGCCCP990369954 TSGCCCR=903699595 TSGCCCCR=903699595 TSGCCCCR=903699595 TSGCCCCCR=903699595 TSGCCCCCR=903699595 TSGCCCCCCR=903699595 TSGCCCCCCR=903699595 TSGCCCCCCCCR=903699596 TSGCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC  |            | 9 4.748639   | 128.119.245.12   | 192.168.0.13                                   | TCP                    | 82       | 80 → 58656    | [SYN, | ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=335012507 TSecr=990 |  |  |  |
| 12 4.749960 192.168.0.13 128.119.245.12 TCP 1514 \$8655 - 80 [ACK) Seq=2168 Ack=1 Win=131712 Len=1448 TSval=99836984 TSccr=335012507 14 4.801420 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=21.448 Win=33280 Len=0 TSval=335012541 TSccr=99836985   |            | 10 4.748687  | 192.168.0.13   | 128.119.245.12                                 | TCP                    | 66       | 58656 → 80    | [ACK] | Seq=1 Ack=1 Win=131712 Len=0 TSval=990369853 TSecr=335012507                    |  |  |  |
| 13 4.749961 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=2148 Ack=1 Win=131712 Len=1448 TSval=998369854 TSecr=335012507 14 4.801428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=700 Win=30464 Len=0 TSval=335012541 TSecr=990369854 16 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=3596 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=359012541 17 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=355012541 19 4.802781 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=355012541 19 4.802781 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=355012541 19 4.802781 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=355012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.803404 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=590 4 Win=3913712 Len=1448 TSval=990369905 TSecr=335012552 12 4.803404 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.803405 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369906 TSecr=335012592 12 4.803405 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369906 TSecr=335012592 12 4.803405 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369906 TSecr=335012592 12 4.803405 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369906 TSecr=335012592 12 4.803405 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 |            | 11 4.748960  |  | 128.119.245.12                                 | TCP                    | 765      | 58655 → 80    | [PSH, | ACK] Seq=1 Ack=1 Win=131712 Len=699 TSval=990369853 TSecr=335012507             |  |  |  |
| 14 4.801428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=700 Win=30464 Lene0 TSval=335012541 TSecr=990369985 15 4.801428 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=2148 Win=33280 Lene0 TSval=335012541 TSecr=990369985 16 4.801551 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=3996 Ack=1 Win=131712 Len=1448 TSval=990369994 TSecr=335012541 18 4.801552 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=5904 Ack=1 Win=131712 Len=1448 TSval=990369994 TSecr=335012541 19 4.801552 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=69492 Ack=1 Win=131712 Len=1448 TSval=990369994 TSecr=335012541 19 4.802787 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=9903699965 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369996 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369996 TSecr=335012552 12 4.832404 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Lene0 TSval=335012592 TSecr=990369904 12 4.834204 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Lene0 TSval=335012592 TSecr=990369904 12 4.834204 192.168.0.13 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=1 Ack=7940 Win=40428 Lene0 TSval=335012592 TSecr=990369904 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=7940 Win=40428 Lene0 TSval=335012592 TSecr=990369904 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=7940 Win=31712 Len=1448 TSval=990369936 TSecr=335012592 TSecr=990369904 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=7948 Win=31712 Lene1 T448 TSval=990369936 TSecr=335012592 TSecr=990369904 12 4.834511 128.119.245.12 TCP 1514 S8655 - 80 [ACK] Seq=1 Ack=7948 Win=31712 Lene1 T448 TSval=990369936 TSecr=335012592 TSecr=990369904 12 4.834511 12 4.834511 12 4.834511 12 4.834511  |            | 12 4.749960  | 192.168.0.13   | 128.119.245.12                                 | TCP                    | 1514     | 58655 → 80    | [ACK] | Seq=700 Ack=1 Win=131712 Len=1448 TSval=990369854 TSecr=335012507               |  |  |  |
| 15 4.801428 128.119.245.12 192.168.0.13 TCP 74 80 − 58655 [ACK] Seq=1 Ack=2148 Win=33280 Lene TSval=398012541 TSecr=990369854 16 4.801551 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=5944 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541 17 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=6944 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541 18 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=6924 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541 19 4.802781 128.119.245.12 192.168.0.13 TCP 74 80 − 58655 [ACK] Seq=7 Ack=3596 Min=32024 Lene TSval=338012552 TSecr=99086854 20 4.802877 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=740 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 19 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=7380 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 19 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=5044 Win=39168 Lene TSval=335012592 TSecr=990369904 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=5044 Win=39168 Lene TSval=335012592 TSecr=990369904 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=5044 Win=39168 Lene TSval=3936995 TSecr=335012592 124 4.834205 192.168.0.13 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 124 4.834517 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 125 4.834517 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 125 4.834517 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 125 4.834517 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 125 4.834517 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 125 4.834517 128.119.245.12 TCP 1514 58655 − 80 [ACK] Seq=1  |            |  | 192.168.0.13   | 128.119.245.12                                 |                        | 1514     | 1 58655 → 80  | [ACK] | Seq=2148 Ack=1 Win=131712 Len=1448 TSval=990369854 TSecr=335012507              |  |  |  |
| 16 4.801551 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=3596 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541 17 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=5044 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541 18 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=604 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541 19 4.802781 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=740 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=740 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=9388 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.834204 129.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=18ck=5044 Win=3168 Lene TSval=335012592 TSecr=990369904 12 4.834204 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834204 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 Ack [ACK] Seq=1286 Ack=1 Win=131712 Len=1448 TSval=990369936 TSec  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 17 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=5044 Ack=1 Win=131712 Len=1448 TSval=990369994 TSecr=335012541 18 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369994 TSecr=335012541 19 4.802781 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369995 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369996 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=388 Ack=1 Win=131712 Len=1448 TSval=990369996 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369944 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369944 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369944 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369944 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369944 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 TSecr=990369944 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=7940 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 TSecr=990369945 TSecr=990369945 TSecr=990369945 TSecr=990369945 TSecr=990369946 TSecr=990  |            |  | 128.119.245.12   | 192.168.0.13                                   | TCP                    | 74       | 80 → 58655    | [ACK] | Seq=1 Ack=2148 Win=33280 Len=0 TSval=335012541 TSecr=990369854                  |  |  |  |
| 18 4.801552 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=6492 Ack=1 Win=131712 Len=1448 TSval=99036994 TSecr=35012551 19 4.802781 120.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=7940 Ack=1 Win=31712 Len=1448 TSval=99036995 TSecr=39036984 120.119.245.12 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=99036995 TSecr=39036984 120.119.245.12 192.168.0.13 120.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.834694 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834510 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834510 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4.834510 12 4 |            |  |  |  |                        |          |               |       |   |  |  |  |
| 19 4.802781 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=74ck=3596 Win=36224 Len=0 TSval=335012552 TSecr=990369854 20 4.802877 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.802878 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=9388 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 12 4.802878 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369904 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10.836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834205 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 12 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369904 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 TSecr=335012592 TSecr=900369905 TSecr=335  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 20 4.802877 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 21 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=9388 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 22 4.834804 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=5044 Win=391712 Len=1448 TSval=990369904 23 4.834204 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 24 4.834205 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 25 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9494 Win=44928 Len=0 TSval=335012592 TSecr=990369904 26 4.834517 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9494 Win=44928 Len=0 TSval=335012594 TSecr=990369905 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 3732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Se  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 21 4.802878 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=9388 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552 22 4.834084 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369904 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=18036 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 24 4.834205 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 25 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369904 126.4834517 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834517 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834510 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834510 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834510 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834510 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834510 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812594 TSecr=990369905 126.4834510 126.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812592 TSecr=990369905 126.4834510 126.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812592 TSecr=990369905 126.4834510 126.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=3350812592 TSecr=335012592 TSecr=335  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 22 4.834084 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369904 23 4.834204 192.168.0.13 128.119.245.12 TCP 1514 58655 → 80 [ACK] Seq=12836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 24 4.834205 192.168.0.13 128.119.245.12 TCP 1514 58655 → 80 [ACK] Seq=12848 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 25 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=335012592 TSecr=990369904 26 4.834517 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 4.834610 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 124 58655 → 80 [ACK] Se  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 23 4.834204 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 24 4.834205 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 25 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=9498 Win=44928 Len=0 TSval=335012594 TSecr=990369904 26 4.834517 128.119.245.12 192.168.0.13 TCP 74 80 - 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 ■ Frame 11: 765 bytes on wire (6120 bits), 765 bytes captured (6120 bits) on interface 0 Ethernet II, Src: Apple_1d:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0 (fc:52:8d:5e:c4:f0) ■ Internet Protocol Version 4, Src: 192.168.0.13, Dst: 128.119.245.12 ▼ Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 1, Ack: 1, Len: 699 Source Port: 58655 Destination Port: 80 [Stream index: 1] [TCP Segment Len: 699] Sequence number: 1 (relative sequence number) [Next sequence number: 700 (relative sequence number)] Acknowledgment number: 1 (relative ack number) 1 (relative ack number) 1 (relative ack number) 1000 = Header Length: 32 bytes (8)   |            |  |  |  |                        |          |               |       |   |  |  |  |
| 24 4,834205 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 25 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=335012592 TSecr=990369904 126.4.834517 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 127 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 127 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=19388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=19388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=19388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 128.119.129.129.129.129.129.129.129.129.129  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 25 4.834511 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=7940 Win=44928 Len=0 TSval=335012592 TSecr=990369904 26 4.834517 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 126 4.834517 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 127 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012592 TSecr=990369905 TSecr=335012592 TSecr=990369905 TSecr=335012592 TSecr=90369905 TSecr=90369905 TSecr=335012592 TSecr=90369905 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=90369905 TSecr=90369905 TSecr=90369905 TSecr=935012592 TSecr=90369905 TSecr=90369905 TSecr=935012592 TSecr=930269905 TSecr=9305012592 TSecr=930269905 TSecr=930269906 TSecr=930269906 TSecr=930269906 TSecr=9302  |            |  |  |  | 0.00                   |          |               |       |   |  |  |  |
| 26 4.834517 128.119.245.12 192.168.0.13 TCP 74 80 → 58655 [ACK] Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592 ■  Frame 11: 765 bytes on wire (6120 bits), 765 bytes captured (6120 bits) on interface 0  Ethernet II, Src: Apple_1d:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0 (fc:52:8d:5e:c4:f0)  Internet Protocol Version 4, Src: 192.168.0.13, Dst: 128.119.245.12  ▼ Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 1, Ack: 1, Len: 699  Source Port: 58655  Destination Port: 80  [Stream index: 1]  ITCP Segment Len: 699]  Sequence number: 1 (relative sequence number)  [Next sequence number: 700 (relative sequence number)]  Acknowledgment number: 1 (relative ack number)  1000 = Header Length: 32 bytes (8)  |            |  |  |  |                        |          |               |       |   |  |  |  |
| 27 4.834610 192.168.0.13 128.119.245.12 TCP 1514 58655 - 80 [ACK] Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592  ▶ Frame 11: 765 bytes on wire (6120 bits), 765 bytes captured (6120 bits) on interface 0  ▶ Ethernet II, Src: Apple_Id:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_Sec:c4:f0 (fc:52:8d:5e:c4:f0)  ■ Internet Protocol Version 4, Src: 192.168.0.13, Dst: 128.119.245.12  ▼ Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 1, Ack: 1, Len: 699  Source Port: 58655  Destination Port: 80  [Stream index: 1]  ITCP Segment Len: 699]  Sequence number: 1 (relative sequence number)  [Next sequence number: 700 (relative sequence number)]  Acknowledgment number: 1 (relative ack number)  1000 = Header Length: 32 bytes (8)  |            |  |  |  |                        |          |               |       |   |  |  |  |
| Frame 11: 765 bytes on wire (6120 bits), 765 bytes captured (6120 bits) on interface 0  Ethernet II, Src: Apple_id:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0 (fc:52:8d:5e:c4:f0)  Internet Protocol Version 4, Src: 192.168.0.13, Dst: 128.119.245.12  Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 1, Ack: 1, Len: 699  Source Port: 58655  Destination Port: 80  [Stream index: 1]  [ITCP Segment Len: 699]  Sequence number: 1 (relative sequence number)  [Next sequence number: 700 (relative sequence number)]  Acknowledgment number: 1 (relative ack number)  1000 = Header Length: 32 bytes (8)   |            |  |  |  |                        |          |               |       |   |  |  |  |
| <pre> Ethernet II, Src: Apple_1d:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0 (fc:52:8d:5e:c4:f0)  Internet Protocol Version 4, Src: 192.168.0.13, Dst: 128.119.245.12  Transmission Control Protocol, Src Port: 58655, Dst Port: 80, Seq: 1, Ack: 1, Len: 699  Source Port: 58655  Destination Port: 80 [Stream index: 1]  [TCP Segment Len: 699]  Sequence number: 1 (relative sequence number)  [Next sequence number: 700 (relative sequence number)]  Acknowledgment number: 1 (relative ack number)  1000 = Header Length: 32 bytes (8)  Ethernet II, Src: Apple_1d:a5:6e (a4:83:e7:1d:a5:6e), Dst: Technico_5e:c4:f0)  ### Transmission Control Protocol   Version   Ver</pre> |            | 27 4.834610  | 192.168.0.13   | 128.119.245.12                                 | TCP                    | 1514     | 1 58655 → 80  | [ACK] | Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592             |  |  |  |
| Destination Port: 80 [Stream index: 1] [TCP Segment Len: 699] Sequence number: 1 (relative sequence number) [Next sequence number: 700 (relative sequence number)] Acknowledgment number: 1 (relative ack number) 1000 = Header Length: 32 bytes (8)   | ⊳ E<br>⊳ I | thernet II, Src:<br>nternet Protocol<br>ransmission Cont | Apple_1d:a5:6e (a4:<br>Version 4, Src: 192<br>rol Protocol, Src Po | 83:e7:1d:a5:6e), Dst:<br>.168.0.13, Dst: 128.1 | Technico_<br>19.245.12 | 5e:c4:f0 | (fc:52:8d:5e: | c4:f0 |   |  |  |  |
| [Stream index: 1] [TCP Segment Len: 699] Sequence number: 1 (relative sequence number) [Next sequence number: 700 (relative sequence number)] Acknowledgment number: 1 (relative ack number) 1000 = Header Length: 32 bytes (8)  |            |  |  |  |                        |          |               |       |   |  |  |  |
| [TCP Segment Len: 699]  Sequence number: 1 (relative sequence number) [Next sequence number: 700 (relative sequence number)] Acknowledgment number: 1 (relative ack number) 1000 = Header Length: 32 bytes (8)   |            |  | 0.00 0.0   |  |                        |          |               |       |   |  |  |  |
| Sequence number: 1 (relative sequence number) [Next sequence number: 700 (relative sequence number)] Acknowledgment number: 1 (relative ack number) 1000 = Header Length: 32 bytes (8)   |            |  |  |  |                        |          |               |       |   |  |  |  |
| <pre>[Next sequence number: 700</pre>  |            |  |  | uence number)                                  |                        |          |               |       |   |  |  |  |
| Acknowledgment number: 1 (relative ack number) 1000 = Header Length: 32 bytes (8)  |            |  |  |  | )]                     |          |               |       |   |  |  |  |
| 1000 = Header Length: 32 bytes (8)   |            |  |  |  | · ·                    |          |               |       |   |  |  |  |
|  |            |  |  |  |                        |          |               |       |   |  |  |  |
|  | w          |  |  | N 1545   |                        |          |               |       |   |  |  |  |

#### Packet 2 You can see TCP segment length as 1448 Bytes

|  | Time                           | Source            | Destination                                  | Protocol                | Length     | Info         |       |   |
|--|--------------------------------|-------------------|--|-------------------------|------------|--------------|-------|---|
|  | 8 4.748465                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 66         | 58655 → 80   | [ACK] | Seq=1 Ack=1 Win=131712 Len=0 TSval=990369853 TSecr=335012507                    |
|  | 9 4.748639                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     | 82         | 80 → 58656   | [SYN, | ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK_PERM=1 TSval=335012507 TSecr=990 |
| 1  | 0 4.748687                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 66         | 58656 → 80   | [ACK] | Seq=1 Ack=1 Win=131712 Len=0 TSval=990369853 TSecr=335012507                    |
| 1  | 1 4.748960                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 765        | 58655 → 80   | [PSH, | ACK] Seq=1 Ack=1 Win=131712 Len=699 TSval=990369853 TSecr=335012507             |
|  | 2 4.749960                     | 192.168.0.13      | 128.119.245.12                               | TCP                     |            |              |       | Seq=700 Ack=1 Win=131712 Len=1448 TSval=990369854 TSecr=335012507               |
|  | 3 4.749961                     | 192.168.0.13      | 128.119.245.12                               | TCP                     |            |              |       | Seq=2148 Ack=1 Win=131712 Len=1448 TSval=990369854 TSecr=335012507              |
|  | 4 4.801420                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     |            |              |       | Seq=1 Ack=700 Win=30464 Len=0 TSval=335012541 TSecr=990369853                   |
|  | 5 4.801428                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     |            |              |       | Seq=1 Ack=2148 Win=33280 Len=0 TSval=335012541 TSecr=990369854                  |
| 1  | 6 4.801551                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=3596 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541              |
| 1  | 7 4.801552                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=5044 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541              |
| 1  | 8 4.801552                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=6492 Ack=1 Win=131712 Len=1448 TSval=990369904 TSecr=335012541              |
| 1  | 9 4.802781                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     | 74         | 80 → 58655   | [ACK] | Seq=1 Ack=3596 Win=36224 Len=0 TSval=335012552 TSecr=990369854                  |
| 2  | 0 4.802877                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=7940 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552              |
| 2  | 1 4.802878                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=9388 Ack=1 Win=131712 Len=1448 TSval=990369905 TSecr=335012552              |
| 2  | 2 4.834084                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     | 74         | 80 → 58655   | [ACK] | Seq=1 Ack=5044 Win=39168 Len=0 TSval=335012592 TSecr=990369904                  |
| 2  | 3 4.834204                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=10836 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592             |
| 2  | 4 4.834205                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=12284 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592             |
| 2  | 5 4.834511                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     | 74         | 80 → 58655   | [ACK] | Seq=1 Ack=7940 Win=44928 Len=0 TSval=335012592 TSecr=990369904                  |
| 2  | 6 4.834517                     | 128.119.245.12    | 192.168.0.13                                 | TCP                     | 74         | 80 → 58655   | [ACK] | Seq=1 Ack=9388 Win=47744 Len=0 TSval=335012594 TSecr=990369905                  |
| 2  | 7 4.834610                     | 192.168.0.13      | 128.119.245.12                               | TCP                     | 1514       | 58655 → 80   | [ACK] | Seq=13732 Ack=1 Win=131712 Len=1448 TSval=990369936 TSecr=335012592             |
| Ethe<br>Inte<br>Tran   | rnet II, Src:<br>rnet Protocol | 505               | 3:e7:1d:a5:6e), Dst:<br>168.0.13, Dst: 128.1 | Technico_!<br>19.245.12 | 5e:c4:f0 ( | fc:52:8d:5e: |       |   |
| (5)  | Stream index: 1                |                   |  |                         |            |              |       |   |
|  | TCP Seament Lei                |                   |  |                         |            |              |       |   |
|  |                                | : 700 (relative s | equence number)                              |                         |            |              |       |   |
|  |                                | number: 2148 (rel |  | r)]                     |            |              |       |   |
|  |                                |                   |  | . 73                    |            |              |       |   |
| Acknowledgment number: 1 (relative ack number)  1000 = Header Length: 32 bytes (8) |                                |                   |  |                         |            |              |       |   |
| 11   | 100 - Hear                     |                   | (8)  |                         |            |              |       |   |

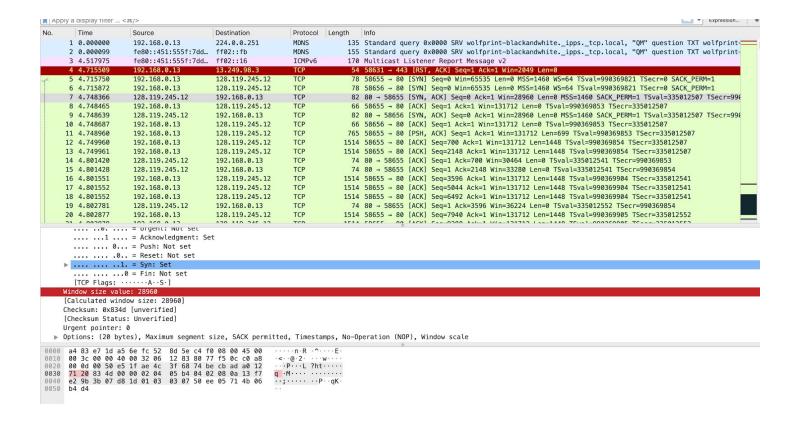
Similarly, it is for all the other 4 packets also.

#### 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?

The minimum amount of available buffer space advertised at the received for the entire trace is indicated the first ACK from the server, its value is 28960 bytes

We can see from the trace that the sender is never throttled due to lack of receiver buffer space.r

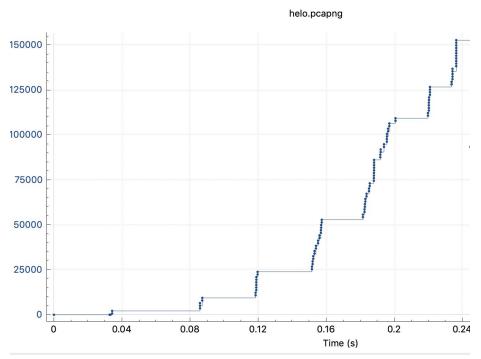


The value of the receiver window increases to a value of 226688.

10.

There are no retransmitted segments in the trace file and the same can be seen in the time sequence graph (stevens), as the sequence numbers are increasing monotonically

#### Sequence Numbers (Stevens) for 192.168.0.13:58655 → 128.



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11.

The difference between the acknowledged sequence numbers of two consecutive ACKs indicates the data received by the server between these two ACKs.

We can see that

Packet on line 11 is acknowledged by a packet on line 14

12 by 15

13 by 19

16 by 22

But 17 and 18 both by 25

12.

The throughput of the network:

152,138 bytes = File size

Total time = last ack - first tcp = 5.052911 - 4.748960 = 0.303951

500,534.6 bytes/ sec

13.

In the Stevens graphs that was given to us ( tcp-etherealtrace-1)

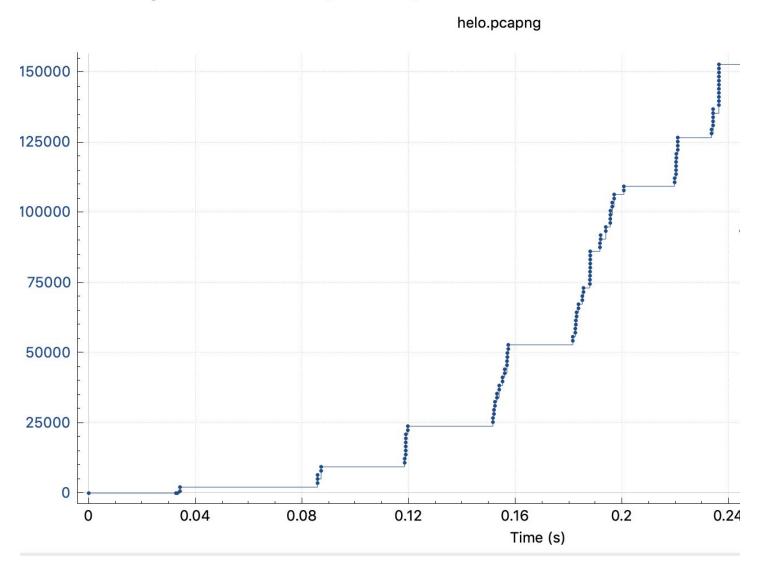
I could observe that:

Here also I could not observe the linear increase behavior as there is in case of congestion avoidance. There is a possibility that flow control is not being practised as the receiver window is more than the number of packets being sent in a batch.

The slow start phase is there only for a few seconds that is 1 to 1.5 second. After that it is always in the congestion avoidance state.

Stevens Graph for my wireshark capture:

### Sequence Numbers (Stevens) for 192.168.0.13:58655 → 128.



Similar observation for my graph plot as well.

#### Answers to the Research Papers

#### Paper 1

1

What are the two main approaches for improving TCP performance over networks with lossy links (i.e., wireless networks with significant losses due to bit errors and handoffs)? Are hybrid schemes possible?

Ans.

The first approach hides any non-congestion-related losses from the TCP sender and therefore it does not require to change the existing implementations in the server. The idea behind solving this problem is that since the problem is local, it should be solved locally and that the transport layer need not be aware of the characteristics of the individual links.

Some protocols that adopt this approach attempt to make the lossy links appear a better quality link with reduced effective bandwidth. As a result, most of the losses seen by the TCP sender are caused by congestion.

Examples of this approach include wireless links with reliable link layer protocols such as AIRMAIL, split connection approaches such as IndirectTCP, and TCP-aware link-layer schemes such as the snoop protocol.

The second technique attempted is to make the sender aware of the existence of wireless hops and realize that some packet losses are not due to congestion.

Yes, a hybrid approach is possible as the sender can then avoid invoking congestion control algorithms when non-congestion-related losses occur Hence, it is possible for a wireless-aware transport protocol to coexist with link-layer schemes to achieve good performance.

A few important protocols that have been proposed to improve the performance of TCP over wireless links are as follows:

Link-layer protocols- The 2 main techniques involved are error correction (using techniques such as forward error correction (FEC)), and retransmission of lost packets in response to automatic repeat request (ARQ) messages

- -Indirect-TCP (I-TCP) protocol
- -The Snoop Protocol
- -Selective Acknowledgments

#### 2.

The paper classifies the main schemes into three groups. Explain the underlying philosophy of each group. Ans.

The main schemes have been classified into 3 groups in the paper. Below is the philosophy underlying each group:

#### - End-To-End Schemes

The E2E protocol improves the performance of TCP-Reno after multiple packet losses in a window by remaining in a fast recovery mode if the first new acknowledgment received after fast retransmission is "partial", i.e, is less than the value of the last byte transmitted when the fast retransmission was done.

This method enables the connection to make progress at the rate of one segment per round trip time, rather than stall until a coarse timeout.

#### - Link-Layer Schemes

Existing link-layer protocols choose from techniques such as Stop-and-Wait, Go-Back-N, Selective Repeat, and Forward Error Correction to provide reliability.

The base link-layer algorithm, called LL, uses cumulative acknowledgments to discover the lost packets that are retransmitted locally from the base station to the host.

In order to minimize the overhead, the implementation of LL uses TCP acknowledgments instead of generating its own acknowledgments.

Further, the timeout based retransmissions are managed by a smoothed round-trip time estimate.

#### - Split-Connection Schemes

Uses an intermediate host to divide a TCP connection into two separate TCP connections.

The implementation avoids the copying of data copying in the intermediate hosts by passing the pointers to the same buffer between the two TCP connections

3.

Discuss the main conclusions that the authors draw from the experiments.

Several experiments were performed to determine the performance and efficiency of each of the protocols

The protocols were implemented as a set of modifications to the BSD/OS TCP/IP (Reno) network stack

#### Link-Layer Protocols

Traditional link-layer protocols operate independently of the higher-layer protocol, and consequently, do not necessarily shield the sender from the lossy link.

Hence the performance is impacted due to 2 reasons:

- (i) competing retransmissions caused by an incompatible setting of timers at the two layers, and
- (ii) the effect of the link-layer protocol on the TCP fast retransmission mechanism

The effects of the first situation were simulated and analyzed for a TCP-like transport protocol and a reliable link layer protocol.

It was concluded that unless the packet loss rate is high, competing retransmissions by the link and transport layers often lead to significant performance degradation.

However, this is not the dominating effect when link-layer schemes, such as LL, are used with TCP Reno and its variants.

The real problem is that when packets are lost, link-layer protocols that do not attempt in-order delivery across the link (e.g., LL) cause packets to reach the TCP receiver out-of-order. This leads to the generation of duplicate acknowledgments by the TCP receiver, which causes the sender to invoke fast retransmission and recovery, and can potentially cause degraded throughput and goodput, especially when the delay-bandwidth product is large.

A simple link-layer retransmission scheme could adversely impact TCP performance. An enhanced link-layer scheme, that uses knowledge of TCP semantics to prevent duplicate acknowledgments caused by wireless losses from reaching the sender, achieves significantly better performance.

#### End-To-End Protocols

>E2E-NEWRENO is better than E2E, especially for large socket buffer sizes.

- >Adding ELN to TCP improves throughput significantly by successfully preventing unnecessary fluctuations in the transmission window.
- >SACKs provide a significant improvement over TCP Reno but perform about 10-15% worse than the best local schemes in the LAN tests

#### Split-Connection Protocols

- >The split-connection approach results in a better throughput if the wireless connection uses some special mechanisms, the performance does not exceed that of a well-tuned, TCP-aware link-layer protocol (LL-OPT). >Moreover, the link-layer protocol maintains the end-to-end semantics of TCP acknowledgments, unlike the split-connection approach.
- >This demonstrates that the end-to-end connection need not be split at the base station in order to achieve good performance.

#### Paper 2

1.

Describe the TCP ECN protocol and what actions various devices may take to subvert congestion control.

- >Explicit Congestion Notification (ECN) [21], with active queue management in the form of RED gateways, has been proposed as a standard mechanism to improve congestion control in the Internet. With ECN, routers are able to mark packets to signal incipient congestion, as well as simply drop them during congestion. This avoids loss and improves performance
- >The design of ECN is on TCP, because it is the only mainstream transport protocol for which ECN is currently defined.
- >Explicit Congestion Notification (ECN) changes the character of congestion signaling to improve performance.
- > It allows routers to signal congestion to end hosts explicitly, rather than implicitly via packet drops.
- > Routers mark packets along congested links, and the receiver returns these congestion marks to the sender in a transport-specific manner.

Actions various devices may take to subvert congestion control:

- >A receiver may receive marked packets but neglect to inform the sender
- >A router on the reverse path may clear the congestion echo signals being returned to the sender.
- > To signal congestion, routers set the Congestion Experienced (CE) state in the IP header of ECN-capable packets.
- >The receiver returns this signal to the sender by setting the ECN-Echo (ECE) flag in the TCP header of subsequent acknowledgements. To ensure reliable delivery of this signal, the receiver continues to set the ECE flag in acknowledgements until a Congestion Window Reduced (CWR) flag is received, implying the sender has reacted to the congestion

>the design of ECN requires routers and receivers to explicitly and correctly participate in the congestion control loop, but has no means to check or enforce this cooperation.

2. Explain why receiver misbehavior is worse than sender misbehavior, and describe the effects of the former.

Ans.

The receiver misbehavior is more dangerous than the sender's misbehavior because by hiding congestion signals, a misbehaving TCP receiver can persuade the sender into increasing the congestion window. Because the data packets are ECN-capable, they will not be dropped by the router until the link becomes congested. This behavior is dangerous because

- >they subvert congestion control
- >A receiver may receive marked packets but neglect to inform the sender
- >A router may clear congestion signals received from upstream
- >A router on the reverse path may clear the congestion echo signals being returned to the sender.

The effects of the receivers misbehavior are as follows:

- >Less Bandwidth obtained-We show the bandwidth obtained by all flows relative to their "fair share" of the bottleneck as the number of competing flows varies. The "fair share" is easy to interpret, but underestimates the impact of misbehavior because not only does the misbehavior receive up to six times its fair share, the behavers receive as little as one tenth their fair share.
- >Misbehavior gains a significant performance advantage over compliant flows, does not harm its own performance in the absence of contention, and greatly reduces the bandwidth available to compliant flows.
- >When the misbehavior competes with ECN-enabled TCP connections, it forces the sender's congestion window to increase until the router drops packets. When the number of flows is sufficient to saturate the router, it no longer marks packets to alleviate congestion and instead drops packets from all flows in proportion to their queue consumption, decreasing the misbehaver's effectiveness
- 3. Describe the main elements of the proposed robust ECN protocol.

When a router drops a packet to signal congestion, this signal is permanent: a downstream router cannot "undrop" a packet. If we enable the ECN sender to detect when marked packets are unmarked, we make ECN as robust a congestion signal as packet drops.

#### One-bit Nonces:

- >Large nonces of 16 or 32 bits would be effective at identifying concealed ECN congestion signals.
- > An insight enabling a less expensive implementation is that congestion control applies to a sequence of packets.
- >Even a one-bit random nonce per packet is enough to detect misbehavior in the congestion control loop since each mark of congestion is a separate trial.

#### **Cumulative Nonce Protocol**

- >Cumulative nonces allow the receiver to prove receipt of unmarked packets without returning every original nonce.
- >The sender places a random nonce in each packet, which is cleared by a router to signal congestion.
- >The receiver maintains a cumulative nonce, which is the sum of the nonces received for all in-order packets and includes it in every acknowledgment to be verified by the sender.
- >Because every nonce is needed to calculate the correct cumulative nonce, it depends on the receipt of only unmarked packets
- >In the case of TCP, we suspend the checking of the cumulative nonce while the Congestion Window Reduced (CWR) signal is delivered to the receiver.
- >We reset the sender's cumulative nonce to the receiver's when the packet containing CWR is acknowledged.

#### **Detected Misbehaviors**

- >ECN with nonces protects ECN from various abuses and incompatibilities. ECN-nonce senders are able to detect the dangerous misbehaviors and the potential misbehavior of network devices removing ECN capability from packets
- > The ECN-nonce can also be used to protect other congestion-related protocols from misbehavior.
- >The ECN-nonce also prevents the optimistic acknowledgment vulnerability
- >The ECN-nonce provides a mechanism to detect misbehavior but leaves unspecified the sender-specific policy to address it.

#### **Extensions for Other Transports**

- >The Stream Control Transmission Protocol is a new, reliable transport protocol being developed by the IETF that includes modern features such as multi-homing, framing, and multiple concurrent streams per connection.
- >SCTP uses selective acknowledgments and supports ECN.
- > The cumulative nonce can be used in SCTP because like TCP, it uses cumulative acknowledgments. The cumulative nonce can be carried in a new SCTP option, known as a chunk

- >The ECN-nonce can also be applied to unreliable transports by taking advantage of the transport-specific acknowledgment mechanism.
- >TCP-Friendly Rate Control (TFRC) is an unreliable transport protocol that uses a model of TCP performance to calculate a smooth sending rate based on the loss event rate and round trip time.
- >TFRC receivers calculate the loss event rate from a weighted average of the length of recent loss intervals.