

Farhad Ahmed  
Computer Networking  
10/16/18

### Lab – TCP Wireshark

*Running ifconfig:*

```
Last login: Tue Oct 16 09:54:04 on console
[10-18-221-197:~ Farhad_Ahmed$ ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
    options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
    inet 127.0.0.1 netmask 0xff000000
        inet6 ::1 prefixlen 128
        inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
            nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
XHC20: flags=0<> mtu 0
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    ether ac:bc:32:91:a2:af
    inet6 fe80::1882:fc8b:5798:ead%en0 prefixlen 64 secured scopeid 0x5
        inet 10.18.221.197 netmask 0xfffff0000 broadcast 10.18.255.255
            nd6 options=201<PERFORMNUD,DAD>
            media: autoselect
            status: active
p2p0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 2304
    ether 0e:bc:32:91:a2:af
    media: autoselect
    status: inactive
awdl0: flags=8943<UP,BROADCAST,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1484
    ether b2:8b:59:9e:bd:88
    inet6 fe80::b08b:59ff:fe9e:bd88%awdl0 prefixlen 64 scopeid 0x7
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=60<TS04,TS06>
    ether 4a:00:02:92:f1:80
    media: autoselect <full-duplex>
    status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=60<TS04,TS06>
    ether 4a:00:02:92:f1:81
    media: autoselect <full-duplex>
    status: inactive
```

```

status: inactive
bridge0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=63<RXCSUM,TXCSUM,TSO4,TSO6>
    ether 4a:00:02:92:f1:80
    Configuration:
        id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
        maxage 0 holdcnt 0 proto stp maxaddr 100 timeout 1200
        root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
        ipfilter disabled flags 0x2
    member: en1 flags=3<LEARNING,DISCOVER>
        ifmaxaddr 0 port 8 priority 0 path cost 0
    member: en2 flags=3<LEARNING,DISCOVER>
        ifmaxaddr 0 port 9 priority 0 path cost 0
    nd6 options=201<PERFORMNUD,DAD>
[media: <unknown type>
Introducing status: inactive
utun0: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 2000
    inet6 fe80::15c4:d2ae:ac4a:2df%utun0 prefixlen 64 scopeid 0xb
        nd6 options=201<PERFORMNUD,DAD>
utun1: flags=8051<UP,POINTOPOINT,RUNNING,MULTICAST> mtu 1380
    inet6 fe80::8523:684:c356:ad09%utun1 prefixlen 64 scopeid 0xc
        nd6 options=201<PERFORMNUD,DAD>

```

1. The IP address of the client computer is 10.18.221.197 and the TCP port number is 52508.

183 3.884027	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
184 3.884028	10.18.221.197	128.119.245.12	HTTP	570	POST /wireshark-labs/lab3-1-reply.htm HTTP/1.1 (text/plain)
185 3.906490	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=128256 Win=174592 Len=0 TSval=3076587430 TSecr=89045679
186 3.906498	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=129544 Win=173696 Len=0 TSval=3076587430 TSecr=89045679
187 3.906499	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=131377 Win=171904 Len=0 TSval=3076587430 TSecr=89045679
188 3.906500	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=131816 Win=171520 Len=0 TSval=3076587430 TSecr=89045679
189 3.906501	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=145984 Win=173696 Len=0 TSval=3076587430 TSecr=89045679
190 3.906506	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=152928 Win=167680 Len=0 TSval=3076587430 TSecr=89045679
191 3.907289	128.119.245.12	10.18.221.197	HTTP	843	HTTP/1.1 200 OK (text/html)
192 3.907366	10.18.221.197	128.119.245.12	TCP	66	52508 → 80 [ACK] Seq=152928 Ack=778 Win=130592 Len=0 TSval=890456820 TSecr=3076587
193 4.022477	10.18.221.197	172.29.246.177	TCP	78	[TCP Retransmission] 52505 → 8080 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=32 TSval=890456820 TSecr=3076587
194 4.486723	10.18.221.197	172.29.243.87	TCP	78	[TCP Retransmission] 52506 → 8080 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=32 TSval=890456820 TSecr=3076587

Frame 184: 570 bytes on wire (4560 bits), 570 bytes captured (4560 bits) on interface 0  
 ▶ Ethernet II, Src: Apple\_91:a2:af (ac:b3:91:a2:af), Dst: IETF-VRRP-VRID\_32 (00:00:5e:00:01:32)  
 ▶ Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12  
 ▶ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 152424, Ack: 1, Len: 504  
 Source Port: 52508  
 Destination Port: 80  
 [Stream index: 4]  
 [TCP Segment Len: 504]  
 Sequence number: 152424 (relative sequence number)  
 [Next sequence number: 152928 (relative sequence number)]  
 Acknowledgment number: 1 (relative ack number)  
 Header Length: 32 bytes  
 Flags: 0x018 (PSH, ACK)  
 Window size value: 4105  
 [Calculated window size: 131360]

2. The IP address of gaia.cs.umass.edu is 128.119.245.12 and the TCP Port Number is 80.
3. The client's IP is IP address is 10.18.221.197 and the TCP Port is 52508.
4. The Sequence number of the TCP SYN segment is 0 and the SYN Flag is set to 1 within the flags section which means that the segment is a SYN segment.

40	3.752242	10.18.221.197	128.119.245.12	TCP	78	52508 → 80 [SYN]	Seq=0 Win=65535 MSS=1460 WS=32 TSval=890456674 TSecr=0 SACK_
41	3.763806	128.119.245.12	10.18.221.197	TCP	74	80 → 52508 [SYN, ACK]	Seq=0 Ack=1 Win=28960 Len=0 MSS=1300 SACK_PERM=1 TSval=30765...
42	3.763874	10.18.221.197	128.119.245.12	TCP	66	52508 → 80 [ACK]	Seq=1 Ack=1 Win=131360 Len=0 TSval=890456685 TSecr=3076587797
► Frame 40: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface 0							
► Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRPP-VRID_32 (00:00:5e:00:01:32)							
► Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12							
▼ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 0, Len: 0							
Source Port: 52508							
Destination Port: 80							
[Stream index: 4]							
[TCP Segment Len: 0]							
Sequence number: 0 (relative sequence number)							
Acknowledgment number: 0							
Header Length: 44 bytes							
▼ Flags: 0x002 (SYN)							
000. .... .... = Reserved: Not set							
...0 .... .... = Nonce: Not set							
.... 0.... .... = Congestion Window Reduced (CWR): Not set							
.... .0.... .... = ECN-Echo: Not set							
.... ..0.... .... = Urgent: Not set							
.... ...0.... .... = Acknowledgment: Not set							
.... .... 0.... .... = Push: Not set							
.... .... .0.... .... = Reset: Not set							
► .... .... .1.... .... = Syn: Set							
.... .... ....0.... .... = Fin: Not set							
[TCP Flags: *****S*]							

5. The sequence number of the SYNACK segment is 0. The acknowledgement field has a value of 1 within the flags section. It is determined by the server which adds 1 to the initial sequence of number of the the SYN segment. The initial sequence number was from the SYN segment was 0 so adding 1 to 0 yields a value of 1 in the Acknowledgment field. The segment is identified as a SYNACK segment if the SYN flag and the Acknowledgement flag both have a value of 1.

41	3.763806	128.119.245.12	10.18.221.197	TCP	74	80 → 52508 [SYN, ACK]	Seq=0 Ack=1 Win=28960 Len=0 MSS=1300 SACK_PERM=1 TSval=30765...
42	3.763874	10.18.221.197	128.119.245.12	TCP	66	52508 → 80 [ACK]	Seq=1 Ack=1 Win=131360 Len=0 TSval=890456685 TSecr=3076587797
► Frame 41: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0							
► Ethernet II, Src: CiscoInc_25:4f:40 (24:01:c7:25:4f:40), Dst: Apple_91:a2:af (ac:bc:32:91:a2:af)							
► Internet Protocol Version 4, Src: 128.119.245.12, Dst: 10.18.221.197							
▼ Transmission Control Protocol, Src Port: 80 (80), Dst Port: 52508 (52508), Seq: 0, Ack: 1, Len: 0							
Source Port: 80							
Destination Port: 52508							
[Stream index: 4]							
[TCP Segment Len: 0]							
Sequence number: 0 (relative sequence number)							
Acknowledgment number: 1 (relative ack number)							
Header Length: 40 bytes							
▼ 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							

6. Segment number 43 contains the HTTP POST command and it has a sequence number of 1.

43	3.764303	10.18.221.197	128.119.245.12	TCP	672	[TCP segment of a reassembled PDU]
44	3.764580	10.18.221.197	128.119.245.12	TCP	203	[TCP segment of a reassembled PDU]
Destination Port: 80 [Stream index: 4] [TCP Segment Len: 606] Sequence number: 1 (relative sequence number) Next sequence number: 607 (relative sequence number) Acknowledgment number: 1 (relative ack number) Header Length: 32 bytes ▼ Flags: 0x018 (PSH, 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 .... .1... = Push: Set .... .... 0.. = Reset: Not set .... .... ..0. = Sync: Not set .... .... ..00 = Fin: Not set [TCP Flags: *****AP***]						
0000 00 00 5e 00 01 32 ac bc 32 91 a2 af 08 00 45 00 ...^.2.. 2.....E. 0010 02 92 00 00 40 00 40 06 db 08 08 12 dd c5 80 77 ....@. ....w 0020 f5 0c cd 1c 00 50 80 b2 f7 b9 e0 0c 58 ad 80 18 ....P. ....X.. 0030 10 09 ae 25 00 00 01 01 08 08 35 13 4a 6d b7 60 ...%.... .5.Jm. 0040 ff 17 50 4f 53 54 20 2f 77 69 72 65 73 68 61 72 ..POST / wireshar 0050 6b 2d 6c 61 62 73 2f 6c 61 62 33 2d 31 2d 72 65 k-labs/l ab3-1-re 0060 70 6c 79 2e 68 74 6d 20 48 54 54 50 2f 31 2e 31 ply.htm HTTP/1.1 0070 0d 0a 48 6f 73 74 3a 20 67 61 69 61 2e 63 73 2e ..Host: galia.cs.						

## 7. Segments 1 - 6 are Numbers 43, 44,46, 54, 62, 72

43	3.764303	10.18.221.197	128.119.245.12	TCP	672	[TCP segment of a reassembled PDU]
44	3.764580	10.18.221.197	128.119.245.12	TCP	203	[TCP segment of a reassembled PDU]
45	3.764857	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
46	3.764858	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
47	3.777357	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=607 Win=30208 Len=0 TStamp=3076587301 TSecr=890456685
48	3.777366	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=744 Win=31488 Len=0 TStamp=3076587301 TSecr=890456685
49	3.777367	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=3320 Win=36608 Len=0 TStamp=3076587301 TSecr=890456685
Frame 43: 672 bytes on wire (5376 bits), 672 bytes captured (5376 bits) on interface 0 ► Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRRP-VRID_32 (00:00:5e:00:01:32) ► Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12 ▼ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 1, Ack: 1, Len: 606						
Source Port: 52508 Destination Port: 80 [Stream index: 4] [TCP Segment Len: 606] Sequence number: 1 (relative sequence number) Next sequence number: 607 (relative sequence number) Acknowledgment number: 1 (relative ack number) Header Length: 32 bytes ▼ Flags: 0x018 (PSH, 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 .... .1... = Push: Set .... .... 0.. = Reset: Not set .... .... ..0. = Sync: Not set .... .... ..00 = Fin: Not set [TCP Flags: *****AP***]						
0000 00 00 5e 00 01 32 ac bc 32 91 a2 af 08 00 45 00 ...^.2.. 2.....E. 0010 02 92 00 00 40 00 40 06 db 08 08 12 dd c5 80 77 ....@. ....w 0020 f5 0c cd 1c 00 50 80 b2 f7 b9 e0 0c 58 ad 80 18 ....P. ....X.. 0030 10 09 ae 25 00 00 01 01 08 08 35 13 4a 6d b7 60 ...%.... .5.Jm. 0040 ff 17 50 4f 53 54 20 2f 77 69 72 65 73 68 61 72 ..POST / wireshar 0050 6b 2d 6c 61 62 73 2f 6c 61 62 33 2d 31 2d 72 65 k-labs/l ab3-1-re 0060 70 6c 79 2e 68 74 6d 20 48 54 54 50 2f 31 2e 31 ply.htm HTTP/1.1 0070 0d 0a 48 6f 73 74 3a 20 67 61 69 61 2e 63 73 2e ..Host: galia.cs.						

Segment 1 has a sequence number of 1 and ACK of 607.

43	3.764303	10.18.221.197	128.119.245.12	TCP	672	[TCP segment of a reassembled PDU]
44	3.764580	10.18.221.197	128.119.245.12	TCP	203	[TCP segment of a reassembled PDU]
45	3.764857	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
46	3.764858	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
47	3.777357	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=607 Win=30208 Len=0 TStamp=3076587301 TSect=890456685
▶	Frame 43:	672 bytes on wire (5376 bits), 672 bytes captured (5376 bits) on interface 0				
▶	Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRP-VRID_32 (00:00:5e:00:01:32)					
▶	Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12					
▼	Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 1, Ack: 1, Len: 606					
	Source Port: 52508					
	Destination Port: 80					
	[Stream index: 4]					
	[TCP Segment Len: 606]					
	Sequence number: 1 (relative sequence number)					
	[Next sequence number: 607 (relative sequence number)]					
	Acknowledgment number: 1 (relative ack number)					
	Header Length: 32 bytes					
▼	Flags: 0x018 (PSH, 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					
	.... .... 1.... .... = Push: Set					

Segment 2 has a sequence number of 607 and ACK of 744.

44	3.764580	10.18.221.197	128.119.245.12	TCP	203	[TCP segment of a reassembled PDU]
45	3.764857	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
46	3.764858	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
47	3.777357	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=607 Win=30208 Len=0 TStamp=3076587301 TSect=890456685
▶	Frame 44:	203 bytes on wire (1624 bits), 203 bytes captured (1624 bits) on interface 0				
▶	Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRP-VRID_32 (00:00:5e:00:01:32)					
▶	Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12					
▼	Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 607, Ack: 1, Len: 137					
	Source Port: 52508					
	Destination Port: 80					
	[Stream index: 4]					
	[TCP Segment Len: 137]					
	Sequence number: 607 (relative sequence number)					
	[Next sequence number: 744 (relative sequence number)]					
	Acknowledgment number: 1 (relative ack number)					
	Header Length: 32 bytes					
▼	Flags: 0x018 (PSH, 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					
	.... .... 1.... .... = Push: Set					

Segment 3 has a sequence number of 2032 and ACK of 18766.

46	3.764858	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
47	3.777357	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=607 Win=30208 Len=0 TSval=3076587301 TSecr=890456685
▶ Frame 46: 1354 bytes on wire (10832 bits), 1354 bytes captured (10832 bits) on interface 0						
▶ Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRP-VRID_32 (00:00:5e:00:01:32)						
▶ Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12						
▼ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 2032, Ack: 1, Len: 1288						
Source Port: 52508						
Destination Port: 80						
[Stream index: 4]						
[TCP Segment Len: 1288]						
Sequence number: 2032 (relative sequence number)						
[Next sequence number: 3320 (relative sequence number)]						
Acknowledgment number: 1 (relative ack number)						
Header Length: 32 bytes						
▼ Flags: 0x10 (ACK)						
000. .... .... = Reserved: Not set						
...0 .... .... = Nonce: Not set						
.... 0... .... = Congestion Window Reduced (CWR): Not set						
.... .0. .... = ECN-Echo: Not set						
.... ..0. .... = Urgent: Not set						
.... ...1 .... = Acknowledgment: Set						
.... .... 0... = Push: Not set						
.... .... ..0.. = Reset: Not set						
.... .... ...0.. = Syn: Not set						
.... .... ....0 = Fin: Not set						

Segment 4 has a sequence number of 8472 and ACK number of 9760.

54	3.777483	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
55	3.789212	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=9760 Win=49536 Len=0 TSval=3076587313 TSecr=890456697
56	3.789309	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
57	3.789310	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
58	3.789311	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
59	3.789311	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
▶ Frame 54: 1354 bytes on wire (10832 bits), 1354 bytes captured (10832 bits) on interface 0						
▶ Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRP-VRID_32 (00:00:5e:00:01:32)						
▶ Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12						
▼ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 8472, Ack: 1, Len: 1288						
Source Port: 52508						
Destination Port: 80						
[Stream index: 4]						
[TCP Segment Len: 1288]						
Sequence number: 8472 (relative sequence number)						
[Next sequence number: 9760 (relative sequence number)]						
Acknowledgment number: 1 (relative ack number)						
Header Length: 32 bytes						
▼ Flags: 0x10 (ACK)						
000. .... .... = Reserved: Not set						
...0 .... .... = Nonce: Not set						
.... 0... .... = Congestion Window Reduced (CWR): Not set						
.... .0. .... = ECN-Echo: Not set						
.... ..0. .... = Urgent: Not set						
.... ...1 .... = Acknowledgment: Set						
.... .... 0... = Push: Not set						
.... .... ..0.. = Reset: Not set						
.... .... ...0.. = Syn: Not set						
.... .... ....0 = Fin: Not set						

Segment 5 has a sequence number of 4608 and ACK of 18776.

62	3.789313	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
63	3.801670	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=18776 Win=67456 Len=0 TSval=3076587326 TSecr=890456708
▶ Frame 62: 1354 bytes on wire (10832 bits), 1354 bytes captured (10832 bits) on interface 0						
▶ Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRP-VRID_32 (00:00:5e:00:01:32)						
▶ Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12						
▼ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 17488, Ack: 1, Len: 1288						
Source Port: 52508						
Destination Port: 80						
[Stream index: 4]						
[TCP Segment Len: 1288]						
Sequence number: 17488 (relative sequence number)						
[Next sequence number: 18776 (relative sequence number)]						
Acknowledgment number: 1 (relative ack number)						
Header Length: 32 bytes						
▼ Flags: 0x10 (ACK)						
000. .... .... = Reserved: Not set						
...0 .... .... = Nonce: Not set						
.... 0... .... = Congestion Window Reduced (CWR): Not set						
.... .0. .... = ECN-Echo: Not set						
.... ..0. .... = Urgent: Not set						
.... ...1 .... = Acknowledgment: Set						
.... .... 0... = Push: Not set						
.... .... ..0.. = Reset: Not set						
.... .... ...0.. = Syn: Not set						
.... .... ....0 = Fin: Not set						

Segment 6 has a sequence number of 2908 and ACK of 30368.

72	3.801753	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
73	3.814933	128.119.245.12	10.18.221.197	TCP	66	80 → 52508 [ACK] Seq=1 Ack=30368 Win=90752 Len=0 TSval=3076587339 TSecr=890456720
74	3.815009	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
75	3.815010	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
76	3.815010	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
▶ Frame 72: 1354 bytes on wire (10832 bits), 1354 bytes captured (10832 bits) on interface 0						
▶ Ethernet II, Src: Apple_91:a2:af (ac:bc:32:91:a2:af), Dst: IETF-VRRP-VRID_32 (00:00:5e:00:01:32)						
▶ Internet Protocol Version 4, Src: 10.18.221.197, Dst: 128.119.245.12						
▼ Transmission Control Protocol, Src Port: 52508 (52508), Dst Port: 80 (80), Seq: 29080, Ack: 1, Len: 1288						
Source Port: 52508						
Destination Port: 80						
[Stream index: 4]						
[TCP Segment Len: 1288]						
Sequence number: 29080 (relative sequence number)						
[Next sequence number: 30368 (relative sequence number)]						
Acknowledgment number: 1 (relative ack number)						
Header Length: 32 bytes						
▼ Flags: 0x010 (ACK)						
000. .... .... = Reserved: Not set						
...0 .... .... = Nonce: Not set						
.... 0.... .... = Congestion Window Reduced (CWR): Not set						
.... .0.... .... = ECN-Echo: Not set						
.... ..0.... .... = Urgent: Not set						
.... ...1.... .... = Acknowledgment: Set						
.... .... 0.... = Push: Not set						
.... .... .0... = Reset: Not set						
.... .... ..0.. = Syn: Not set						
.... .... ....0 = Fin: Not set						

Segment Number	Time Sent	ACK received time	RTT
1	3.764303	3.777357	0.013054
2	3.764580	3.777366	0.012786
3	3.764858	3.777367	0.012509
4	3.777483	3.789212	0.011729
5	3.789313	3.801670	0.012357
6	3.801753	3.814933	0.01318

$$\text{Estimated RTT} = 0.875 * \text{Estimated RTT} + 0.125 * \text{SampleRTT}$$

Segment 1 Estimated RTT = 0.013054

Segment 2 Estimate RTT =  $0.01142225 + 0.00159825 = 0.0130205$

Segment 3 Estimate RTT =  $0.01139294 + 0.00156362 = 0.01295656$

Segment 4 Estimate RTT =  $0.01133699 + 0.00146612 = 0.01280312$

Segment 5 Estimate RTT =  $0.01120273 + 0.00154462 = 0.01274736$

Segment 6 Estimate RTT =  $0.01280144 + 0.0016475 = 0.01444894$

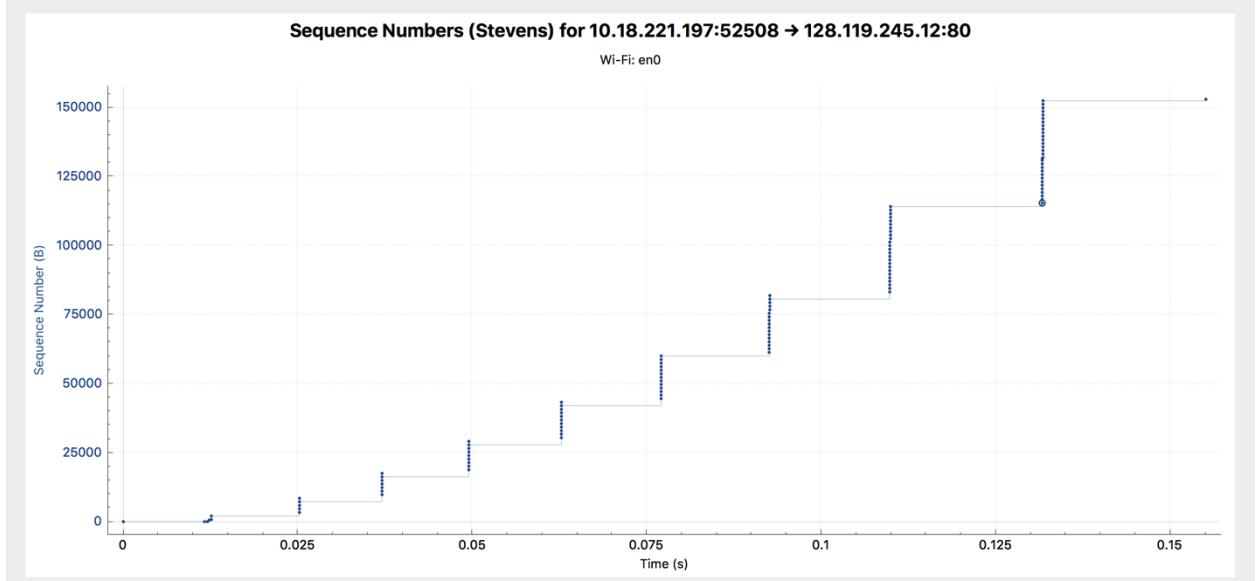
8.

Segment	Length
1	606
2	137
3	1288
4	1288
5	1288
6	1288

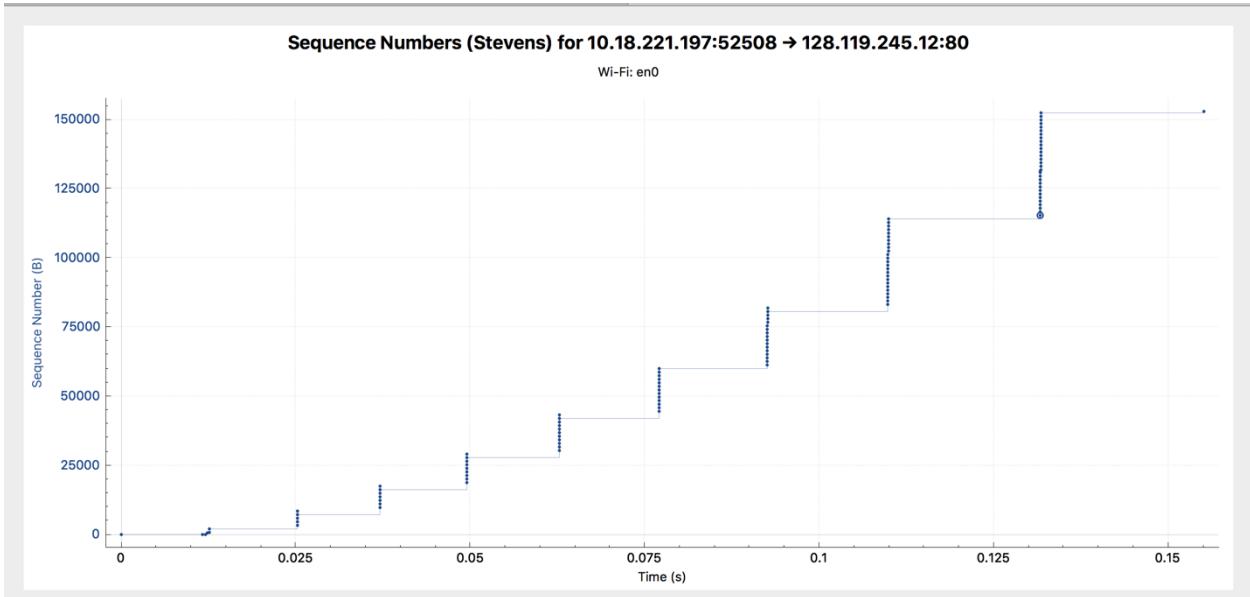
9. The minimum amount of available buffer space can be found in the first ACK from the server which has a value of 4105. The maximum receiver buffer size is 131360.

43	3.764303	10.18.221.197	128.119.245.12	TCP	672	[TCP segment of a reassembled PDU]
44	3.764580	10.18.221.197	128.119.245.12	TCP	203	[TCP segment of a reassembled PDU]
45	3.764857	10.18.221.197	128.119.245.12	TCP	1354	[TCP segment of a reassembled PDU]
Header Length: 32 bytes						
▼ Flags: 0x018 (PSH, 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						
.... .... 1... = Push: Set						
.... .... 0... = Reset: Not set						
.... .... ..0. = Syn: Not set						
.... .... ....0 = Fin: Not set						
[TCP Flags: *****AP***]						
Window size value: 4105						
[Calculated window size: 131360]						
[Window size scaling factor: 32]						
► Checksum: 0xae25 [validation disabled]						
Urgent pointer: 0						
► Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps						
▼ [SEQ/ACK analysis]						
[RTT: 0.011632000 seconds]						
[Bytes in flight: 606]						
TCP segment data (606 bytes)						

10. There are no retransmitted segments in the trace file as seen in the time sequence graph.



11. The receiver is ACKing every other segment. The data acknowledged was of size 10832.  
 12. The txt file is of size 152,138 bytes and the download time for the first TCP segment – last ACK is  $1.678736 - 0.371257 = 1.307479$ . The throughput is thus calculated as  $152,138 / 1.307479 = 116359.804$  bytes per second.  
 13.



The TCP's slowstart phase begins around 0.00125 and ends around 0.025. Congestion avoidance takes over at around .093 seconds.

14. The traces used above are the ones for transferring a file to the umass site.