

**Lu Lu**

## **Program 3 Report**

### **Build Script**

Build Server file:

```
[lulu1031@csslalab2 HW3]$ tcpdump -vtt host csslab3.uwb.edu and port 8080 and tcp >& tcpdump.rtf  
g++ hw3_demo.cpp Socket.cpp Timer.cpp -o server
```

Build Client file:

```
[lulu1031@csslalab3 HW3]$ g++ hw3_demo.cpp Socket.cpp Timer.cpp -o client
```

(Make sure to run server first)

Run Server: `./server 8080`

Run Client: `[lulu1031@csslalab3 HW3]$ ./client 8080 csslab2.uwb.edu`

Port Used: 8080

### **Test1:**

Tcpdump result

```

tcpdump: listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
1589812141.621007 IP (tos 0x0, ttl 64, id 62884, offset 0, flags [DF], proto TCP (6),
length 60)
  csslab3.uwb.edu.45102 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x15fa
(correct), seq 3001277493, win 26880, options [mss 8960, sackOK, TS val 2917542289 ecr
0, nop, wscale 7], length 0
1589812141.621127 IP (tos 0x0, ttl 64, id 58751, offset 0, flags [DF], proto TCP (6),
length 40)
  csslab2.uwb.edu.webcache > csslab3.uwb.edu.45102: Flags [R.], cksum 0xdb8d
(correct), seq 0, ack 3001277494, win 0, length 0
1589812142.623626 IP (tos 0x0, ttl 64, id 62885, offset 0, flags [DF], proto TCP (6),
length 60)
  csslab3.uwb.edu.45102 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x120f
(correct), seq 3001277493, win 26880, options [mss 8960, sackOK, TS val 2917543292 ecr
0, nop, wscale 7], length 0
1589812142.623669 IP (tos 0x0, ttl 64, id 58915, offset 0, flags [DF], proto TCP (6),
length 40)
  csslab2.uwb.edu.webcache > csslab3.uwb.edu.45102: Flags [R.], cksum 0xdb8d
(correct), seq 0, ack 1, win 0, length 0
1589812142.624160 IP (tos 0x0, ttl 64, id 61764, offset 0, flags [DF], proto TCP (6),
length 60)
  csslab3.uwb.edu.45104 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x120a
(correct), seq 3001277496, win 26880, options [mss 8960, sackOK, TS val 2917543292 ecr
0, nop, wscale 7], length 0
1589812142.624180 IP (tos 0x0, ttl 64, id 58916, offset 0, flags [DF], proto TCP (6),
length 40)
  csslab2.uwb.edu.webcache > csslab3.uwb.edu.45104: Flags [R.], cksum 0xdb88
(correct), seq 0, ack 3001277497, win 0, length 0
1589812142.624335 IP (tos 0x0, ttl 64, id 61767, offset 0, flags [DF], proto TCP (6),
length 60)
  csslab3.uwb.edu.45106 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x1205
(correct), seq 3001277499, win 26880, options [mss 8960, sackOK, TS val 2917543292 ecr
0, nop, wscale 7], length 0
1589812142.624346 IP (tos 0x0, ttl 64, id 58917, offset 0, flags [DF], proto TCP (6),
length 40)
  csslab2.uwb.edu.webcache > csslab3.uwb.edu.45106: Flags [R.], cksum 0xdb83
(correct), seq 0, ack 3001277500, win 0, length 0
1589812142.624480 IP (tos 0x0, ttl 64, id 61763, offset 0, flags [DF], proto TCP (6),
length 60)
  csslab3.uwb.edu.45108 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x11ff

```

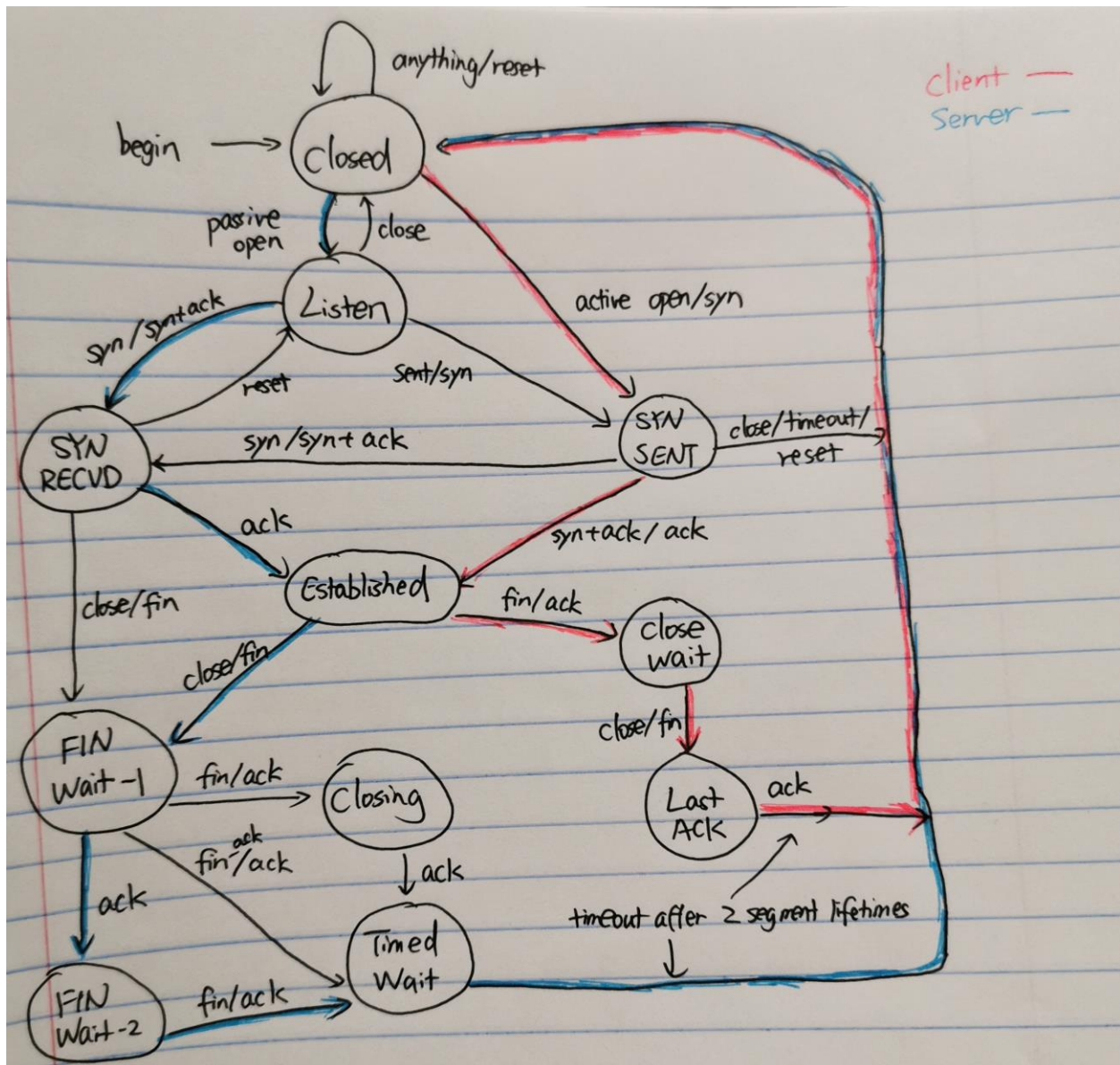
**End:**

```

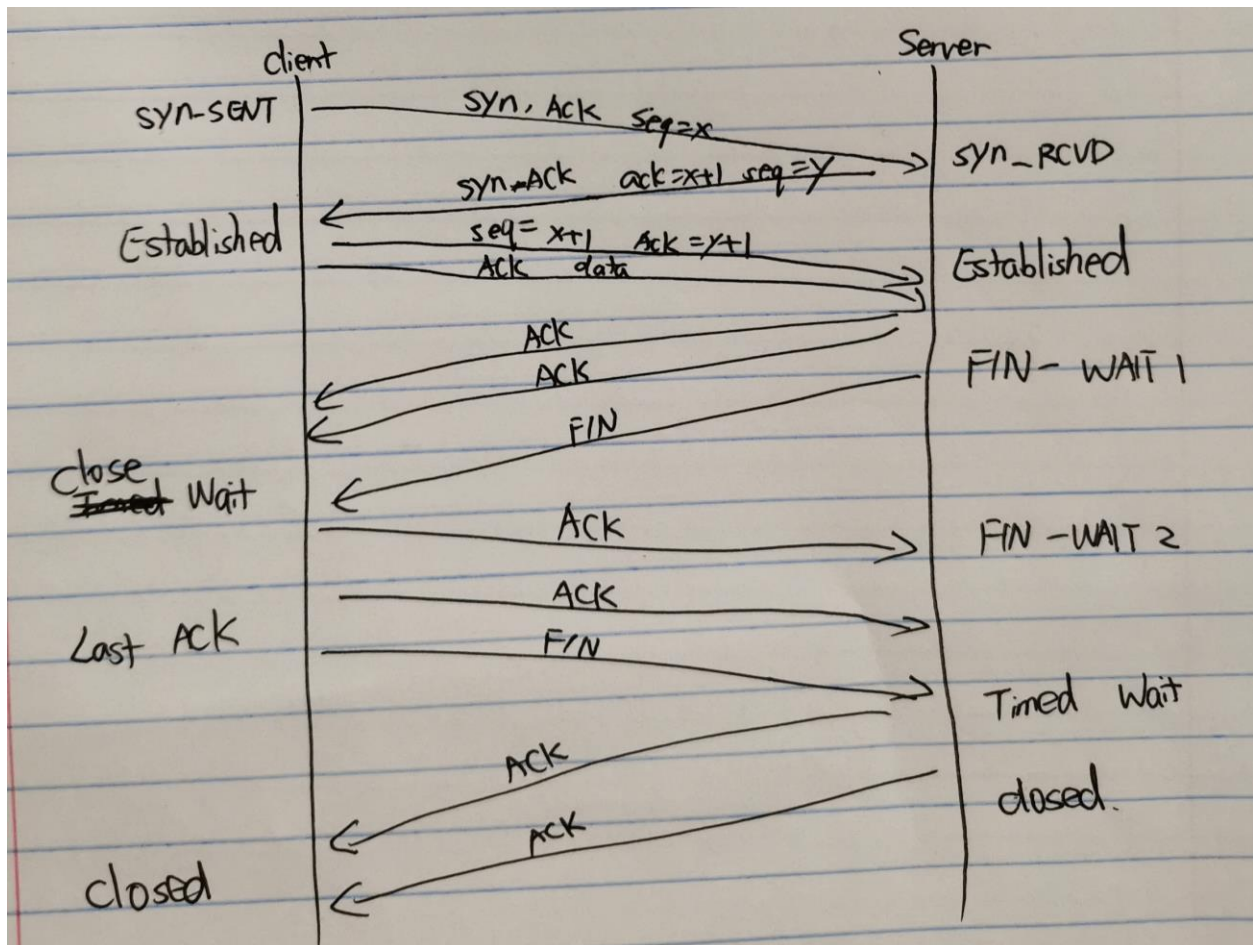
-----
  csslab3.uwb.edu.60690 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x6b87
(correct), seq 3001427919, win 26880, options [mss 8960, sackOK, TS val 2917550979 ecr
0, nop, wscale 7], length 0
1589812150.311309 IP (tos 0x0, ttl 64, id 44552, offset 0, flags [DF], proto TCP (6),
length 40)
  csslab2.uwb.edu.webcache > csslab3.uwb.edu.60690: Flags [R.], cksum 0x530d
(correct), seq 0, ack 127045, win 0, length 0
1589812150.311417 IP (tos 0x0, ttl 64, id 27729, offs

```

## Analysis Flow Diagram for client and server



## State Diagram Analysis



```

length 60)
csslab3.uwb.edu.45102 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x15fa
(correct), seq 3001277493, win 26880, options [mss 8960, sackOK, TS val 2917542289 ecr
0,nop,wscale 7], length 0
1589812141.621127 IP (tos 0x0, ttl 64, id 58751, offset 0, flags [DF], proto TCP (6),
length 40)
csslab2.uwb.edu.webcache > csslab3.uwb.edu.45102: Flags [R.], cksum 0xdb8d
(correct), seq 0, ack 3001277494, win 0, length 0
1589812142.623626 IP (tos 0x0, ttl 64, id 62885, offset 0, flags [DF], proto TCP (6),
length 60)
csslab3.uwb.edu.45102 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x120f
(correct), seq 3001277493, win 26880, options [mss 8960, sackOK, TS val 2917543292 ecr
0,nop,wscale 7], length 0
1589812142.623669 IP (tos 0x0, ttl 64, id 58915, offset 0, flags [DF], proto TCP (6),
length 40)
csslab2.uwb.edu.webcache > csslab3.uwb.edu.45102: Flags [R.], cksum 0xdb8d
(correct), seq 0, ack 1, win 0, length 0
1589812142.624160 IP (tos 0x0, ttl 64, id 61764, offset 0, flags [DF], proto TCP (6),
length 60)
csslab3.uwb.edu.45104 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x120a
(correct), seq 3001277496, win 26880, options [mss 8960, sackOK, TS val 2917543292 ecr
0,nop,wscale 7], length 0
1589812142.624180 IP (tos 0x0, ttl 64, id 58916, offset 0, flags [DF], proto TCP (6),
length 40)
csslab2.uwb.edu.webcache > csslab3.uwb.edu.45104: Flags [R.], cksum 0xdb88
(correct), seq 0, ack 3001277497, win 0, length 0
1589812142.624335 IP (tos 0x0, ttl 64, id 61767, offset 0, flags [DF], proto TCP (6),
length 60)
csslab3.uwb.edu.45106 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x1205
(correct), seq 3001277499, win 26880, options [mss 8960, sackOK, TS val 2917543292 ecr
0,nop,wscale 7], length 0
1589812142.624346 IP (tos 0x0, ttl 64, id 58917, offset 0, flags [DF], proto TCP (6),
length 40)
csslab2.uwb.edu.webcache > csslab3.uwb.edu.45106: Flags [R.], cksum 0xdb83
(correct), seq 0, ack 3001277500, win 0, length 0
1589812142.624480 IP (tos 0x0, ttl 64, id 61763, offset 0, flags [DF], proto TCP (6),
length 60)
csslab3.uwb.edu.45108 > csslab2.uwb.edu.webcache: Flags [S], cksum 0x11ff
(correct), seq 3001277502, win 26880, options [mss 8960, sackOK, TS val 2917543293 ecr
0,nop,wscale 7], length 0
1589812142.624486 IP (tos 0x0, ttl 64, id 58918, offset 0, flags [DF], proto TCP (6),
length 40)
csslab2.uwb.edu.webcache > csslab3.uwb.edu.45108: Flags [R.], cksum 0xdb7e
(correct), seq 0, ack 3001277503, win 0, length 0

```

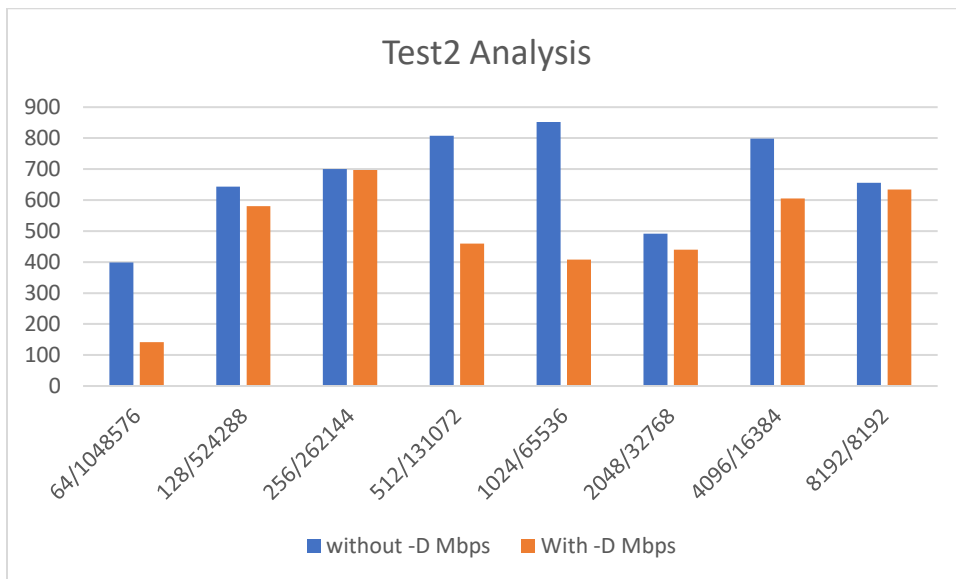
From the transmitting activity, we can see the pattern between client and server. Client sent the request and Server reply to establish connection, then transmitting data with seq and ack updating. After last packet, close the connection.



Test 2:

Test2

-l(message length)	without -D Mbps	With -D Mbps
64/1048576	399.1	141.9
128/524288	643.4	580.9
256/262144	700.1	697.7
512/131072	808.1	459.4
1024/65536	852.2	407.9
2048/32768	491.3	439.8
4096/16384	798.6	605.8
8192/8192	656.1	633.9



Without using -D flag, the Mbps is generally slightly faster than with -D flag. Analyzing the graph, given additional message length requires longer time.

In 256 message length, with -D Mbps reaches the highest speed, while without -D flag has the highest speed at 1024 message length.

Without -D

server:

```
./ttcp -r -l64 -n1048576
```

```
[lulu1031@csslab2 HW3]$ ./ttcp -r -l64 -n1048576  
^C
```

```
./ttcp -r -l128 -n524288
```

```
./ttcp -r -l256 -n262144
```

```
./ttcp -r -l512 -n131072
```

./ttcp -r -l1024 -n65536

./ttcp -r -l2048 -n32768

./ttcp -r -l4096 -n16384

./ttcp -r -l8192 -n8192

```
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l128 -n524288
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l256 -n262144
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l512 -n131072
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l1024 -n65536
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l2048 -n32768
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l4096 -n16384
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l8192 -n8192
^C
[lulu1031@csslalab2 HW3]$ ./ttcp -r -l16384 -n16384
```

client:

./ttcp -t -l64 -n1048576 csslab2.uwb.edu

```
[lulu1031@csslalab3 HW3]$ ./ttcp -t -l64 -n1048576 csslab2.uwb.edu
ttcp-t: buflen=64, nbuf=1048576, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=1345140 Mbps=399.119 I/Ocalls=1048576
ttcp-rbytes=67108864 time=1345377 Mbps=399.049 I/Ocalls=1051821
```

./ttcp -t -l128 -n524288 csslab2.uwb.edu

```
[lulu1031@csslalab3 HW3]$ ./ttcp -t -l128 -n524288 csslab2.uwb.edu
ttcp-t: buflen=128, nbuf=524288, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=834377 Mbps=643.439 I/Ocalls=524288
ttcp-rbytes=67108864 time=834104 Mbps=643.65 I/Ocalls=533270
```

./ttcp -t -l256 -n262144 csslab2.uwb.edu

```
[lulu1031@csslalab3 HW3]$ ./ttcp -t -l256 -n262144 csslab2.uwb.edu
ttcp-t: buflen=256, nbuf=262144, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=766879 Mbps=700.073 I/Ocalls=262144
ttcp-rbytes=67108864 time=766936 Mbps=700.021 I/Ocalls=270544
```

./ttcp -t -l512 -n131072 csslab2.uwb.edu

```
[lulu1031@csslab3 HW3]$ ./ttcp -t -l512 -n131072 csslab2.uwb.edu
ttcp-t: buflen=512, nbuf=131072, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=664403 Mbps=808.05 I/Ocalls=131072
ttcp-rbytes=67108864 time=664290 Mbps=808.188 I/Ocalls=140743
```

./ttcp -t -l1024 -n65536 csslab2.uwb.edu

```
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1024 -n65536 csslab2.uwb.edu
ttcp-t: buflen=1024, nbuf=65536, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=629951 Mbps=852.242 I/Ocalls=65536
ttcp-rbytes=67108864 time=629988 Mbps=852.192 I/Ocalls=75460
```

./ttcp -t -l2048 -n32768 csslab2.uwb.edu

```
[lulu1031@csslab3 HW3]$ ./ttcp -t -l2048 -n32768 csslab2.uwb.edu
ttcp-t: buflen=2048, nbuf=32768, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=1092958 Mbps=491.209 I/Ocalls=32768
ttcp-rbytes=67108864 time=1092668 Mbps=491.339 I/Ocalls=41321
```

./ttcp -t -l4096 -n16384 csslab2.uwb.edu

```
[lulu1031@csslab3 HW3]$ ./ttcp -t -l4096 -n16384 csslab2.uwb.edu
ttcp-t: buflen=4096, nbuf=16384, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=672298 Mbps=798.561 I/Ocalls=16384
ttcp-rbytes=67108864 time=672160 Mbps=798.725 I/Ocalls=24895
```

./ttcp -t -l8192 -n8192 csslab2.uwb.edu

```
[lulu1031@csslab3 HW3]$ ./ttcp -t -l8192 -n8192 csslab2.uwb.edu
ttcp-t: buflen=8192, nbuf=8192, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=818295 Mbps=656.085 I/Ocalls=8192
ttcp-rbytes=67108864 time=818327 Mbps=656.059 I/Ocalls=17267
```

With -D

server:

./ttcp -r -l64 -n1048576 -D

./ttcp -r -l128 -n524288 -D

./ttcp -r -l256 -n262144 -D

./ttcp -r -l512 -n131072 -D

./ttcp -r -l1024 -n65536 -D

./ttcp -r -l2048 -n32768 -D

./ttcp -r -l4096 -n16384 -D



`./ttcp -r -l8192 -n8192 -D`

```
[lulu1031@csslab2 HW3]$ ./ttcp -r -l64 -n1048576 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l128 -n524288 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l256 -n262144 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l512 -n131072 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1024 -n65536 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l2048 -n32768 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l4096 -n16384 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l8192 -n8192 -D
```

client:

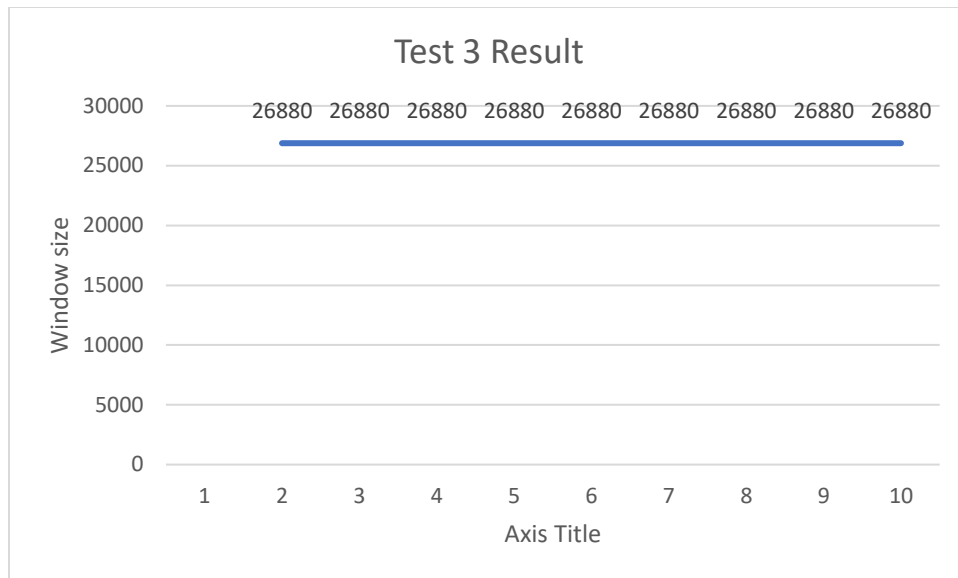
```
./ttcp -t -l64 -n1048576 -D csslab2.uwb.edu
./ttcp -t -l128 -n524288 -D csslab2.uwb.edu
./ttcp -t -l256 -n262144 -D csslab2.uwb.edu
./ttcp -t -l512 -n131072 -D csslab2.uwb.edu
./ttcp -t -l1024 -n65536 -D csslab2.uwb.edu
./ttcp -t -l2048 -n32768 -D csslab2.uwb.edu
./ttcp -t -l4096 -n16384 -D csslab2.uwb.edu
./ttcp -t -l8192 -n8192 -D csslab2.uwb.edu
```

```

[lulul031@csslab3 HW3]$ ./ttcp -t -l64 -n1048576 -D csslab2.uwb.edu
ttcp-t: buflen=64, nbuf=1048576, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=3782004 Mbps=141.954 I/Ocalls=1048576
ttcp-rbytes=67108864 time=3782277 Mbps=141.944 I/Ocalls=1051390
[lulul031@csslab3 HW3]$ ./ttcp -t -l128 -n524288 -D csslab2.uwb.edu
ttcp-t: buflen=128, nbuf=524288, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=924267 Mbps=580.861 I/Ocalls=524288
ttcp-rbytes=67108864 time=924123 Mbps=580.952 I/Ocalls=531605
[lulul031@csslab3 HW3]$ ./ttcp -t -l256 -n262144 -D csslab2.uwb.edu
ttcp-t: buflen=256, nbuf=262144, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=769481 Mbps=697.705 I/Ocalls=262144
ttcp-rbytes=67108864 time=769543 Mbps=697.649 I/Ocalls=266054
[lulul031@csslab3 HW3]$ ./ttcp -t -l512 -n131072 -D csslab2.uwb.edu
ttcp-t: buflen=512, nbuf=131072, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=1168685 Mbps=459.38 I/Ocalls=131072
ttcp-rbytes=67108864 time=1168665 Mbps=459.388 I/Ocalls=139289
[lulul031@csslab3 HW3]$ ./ttcp -t -l1024 -n65536 -D csslab2.uwb.edu
ttcp-t: buflen=1024, nbuf=65536, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=1316050 Mbps=407.941 I/Ocalls=65536
ttcp-rbytes=67108864 time=1316204 Mbps=407.893 I/Ocalls=75524
[lulul031@csslab3 HW3]$ ./ttcp -t -l2048 -n32768 -D csslab2.uwb.edu
ttcp-t: buflen=2048, nbuf=32768, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=1220475 Mbps=439.887 I/Ocalls=32768
ttcp-rbytes=67108864 time=1220739 Mbps=439.792 I/Ocalls=43690
[lulul031@csslab3 HW3]$ ./ttcp -t -l4096 -n16384 -D csslab2.uwb.edu
ttcp-t: buflen=4096, nbuf=16384, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=886246 Mbps=605.781 I/Ocalls=16384
ttcp-rbytes=67108864 time=886191 Mbps=605.818 I/Ocalls=18945
[lulul031@csslab3 HW3]$ ./ttcp -t -l8192 -n8192 -D csslab2.uwb.edu
ttcp-t: buflen=8192, nbuf=8192, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108864 time=846999 Mbps=633.851 I/Ocalls=8192
ttcp-rbytes=67108864 time=846882 Mbps=633.938 I/Ocalls=15680
[lulul031@csslab3 HW3]$

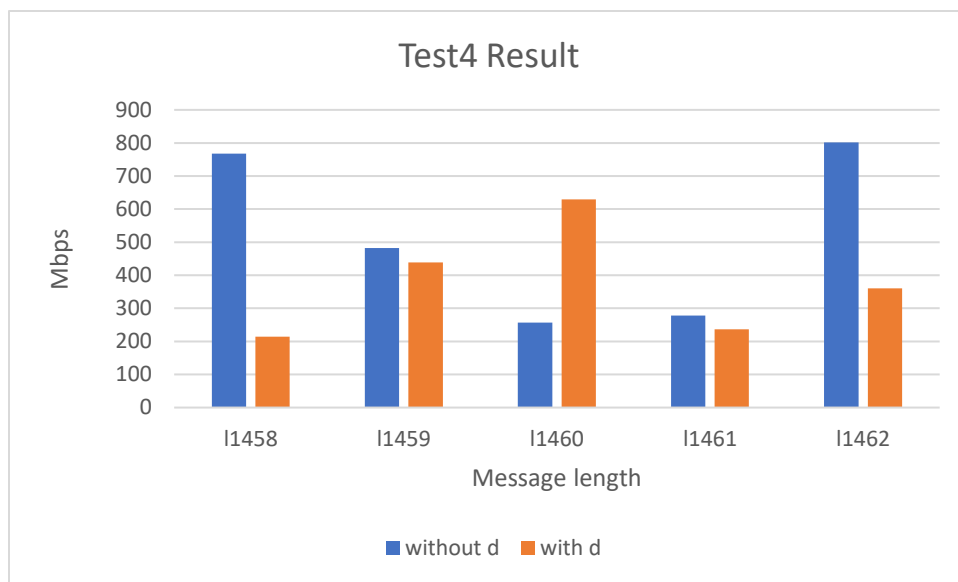
```

Test3:



For the first 10 window size from server Ack, they all have the same window size, the window size doesn't change while transferring message.

Test4:



There is a dramatic difference between with D and without D from the graph. Without D tend to have higher speed at lower and higher length while with D tend to have higher Mbps in 1460 length.

Server: Without D

```

^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1458 -n46028
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1459 -n45996
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1460 -n45965
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1461 -n45934
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1462 -n45902
^C

```

With D

```

[lulu1031@csslab2 HW3]$ ./ttcp -r -l1458 -n46028 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1459 -n45996 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1460 -n45965 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1461 -n45934 -D
^C
[lulu1031@csslab2 HW3]$ ./ttcp -r -l1462 -n45902 -D
^C

```

Client: Without D

```

[lulu1031@csslab3 HW3]$ ./ttcp -t -l1458 -n46028 csslab2.uwb.edu
ttcp-t: buflen=1458, nbuf=46028, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108824 time=699322 Mbps=767.702 I/Ocalls=46028
ttcp-rbytes=67108824 time=699351 Mbps=767.67 I/Ocalls=54188
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1459 -n45996 csslab2.uwb.edu
ttcp-t: buflen=1459, nbuf=45996, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108164 time=1113064 Mbps=482.331 I/Ocalls=45996
ttcp-rbytes=67108164 time=1112894 Mbps=482.405 I/Ocalls=53370
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1460 -n45965 csslab2.uwb.edu
ttcp-t: buflen=1460, nbuf=45965, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108900 time=2093739 Mbps=256.417 I/Ocalls=45965
ttcp-rbytes=67108900 time=2093826 Mbps=256.407 I/Ocalls=54483
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1461 -n45934 csslab2.uwb.edu
ttcp-t: buflen=1461, nbuf=45934, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67109574 time=1930548 Mbps=278.095 I/Ocalls=45934
ttcp-rbytes=67109574 time=1930562 Mbps=278.093 I/Ocalls=54845
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1462 -n45902 csslab2.uwb.edu
ttcp-t: buflen=1462, nbuf=45902, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108724 time=669584 Mbps=801.796 I/Ocalls=45902
ttcp-rbytes=67108724 time=669494 Mbps=801.904 I/Ocalls=54212

```

With D

```

[lulu1031@csslab3 HW3]$ ./ttcp -t -l1458 -n46028 -D csslab2.uwb.edu
ttcp-t: buflen=1458, nbuf=46028, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108824 time=2503174 Mbps=214.476 I/Ocalls=46028
ttcp-rbytes=67108824 time=2503550 Mbps=214.444 I/Ocalls=53089
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1459 -n45996 -D csslab2.uwb.edu
ttcp-t: buflen=1459, nbuf=45996, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108164 time=1222968 Mbps=438.986 I/Ocalls=45996
ttcp-rbytes=67108164 time=1222988 Mbps=438.978 I/Ocalls=56512
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1460 -n45965 -D csslab2.uwb.edu
ttcp-t: buflen=1460, nbuf=45965, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108900 time=853386 Mbps=629.107 I/Ocalls=45965
ttcp-rbytes=67108900 time=853661 Mbps=628.904 I/Ocalls=53551
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1461 -n45934 -D csslab2.uwb.edu
ttcp-t: buflen=1461, nbuf=45934, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67109574 time=2272080 Mbps=236.293 I/Ocalls=45934
ttcp-rbytes=67109574 time=2272142 Mbps=236.287 I/Ocalls=57415
[lulu1031@csslab3 HW3]$ ./ttcp -t -l1462 -n45902 -D csslab2.uwb.edu
ttcp-t: buflen=1462, nbuf=45902, port=5001, sockbufsize=16384, tcp -> csslab2.uwb.edu
16384
ttcp-tbytes=67108724 time=1491284 Mbps=360.005 I/Ocalls=45902
ttcp-rbytes=67108724 time=1491351 Mbps=359.989 I/Ocalls=57376

```

	4 without d	with d	
31			
32	1458	767.7	214.5
33	1459	482.4	438.9
34	1460	256.4	629
35	1461	278.1	236.3
36	1462	801.9	360
37			

Test5:

Without -D

server:

netstat

./ttcp -r -l64 -n1048576

netstat

client:

netstat -s

./ttcp -t -l64 -n1048576 csslab2.uwb.edu

netstat -s

With -D

server:

netstat -s

./ttcp -r -l64 -n1048576 -D

netstat -s

client:

netstat -s

./ttcp -t -l64 -n1048576 -D csslab2.uwb.edu

netstat -s

It does not have much differences in results for server and client if it with D or without D.

But there some errors happening in Client side for unknown and invalid cookie received. There might be differences between D flags, but not showing in the results here due to some runtime errors.



```

[lulu1031@csslab2 HW3]$ netstat
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp      0      0 csslab2.uwb.edu:33782  ldi1.s.uw.edu:ldap     ESTABLISHED
tcp      0      48 csslab2.uwb.edu:ssh    10.102.83.107:53392    ESTABLISHED
tcp      0      0 csslab2.uwb.edu:33780  ldi1.s.uw.edu:ldap     ESTABLISHED
tcp      0      0 csslab2.uwb.edu:33774  ldi1.s.uw.edu:ldap     ESTABLISHED
tcp      0      0 csslab2.uwb.edu:33776  ldi1.s.uw.edu:ldap     ESTABLISHED
tcp      0      0 csslab2.uwb.edu:ssh    10.102.83.107:53395    ESTABLISHED
tcp      0      0 csslab2.uwb.edu:38828  ldi2.s.uw.edu:ldap     ESTABLISHED
tcp      0      0 csslab2.uwb.edu:919    cssnfs3.uwb.edu:nfs     ESTABLISHED
tcp      0      0 csslab2.uwb.edu:ssh    d-10-155-176-27.a:57888 ESTABLISHED

Active UNIX domain sockets (w/o servers)
Proto RefCnt Flags       Type       State         I-Node  Path
unix   3      [ ]          DGRAM                    291      /run/systemd/notify
unix   2      [ ]          DGRAM                    293      /run/systemd/cgroups-agent
unix   5      [ ]          DGRAM                    307      /run/systemd/journal/socket
unix  19      [ ]          DGRAM                    309      /dev/log
unix   2      [ ]          DGRAM                    16493     /var/run/chrony/chronyd.sock
unix   2      [ ]          DGRAM                    13945     /run/systemd/shutdown
unix   3      [ ]          STREAM      CONNECTED      2514461
unix   2      [ ]          DGRAM                    16095
unix   3      [ ]          STREAM      CONNECTED      20493
unix   3      [ ]          STREAM      CONNECTED      19612
unix   3      [ ]          STREAM      CONNECTED      17036
unix   3      [ ]          STREAM      CONNECTED      16005      /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      2514455    @/tmp/dbus-7NisD9MDVd
unix   3      [ ]          STREAM      CONNECTED      2543823
unix   3      [ ]          STREAM      CONNECTED      20494      /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      2513368    /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      19613      /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      2514454
unix   2      [ ]          DGRAM                    16084
unix   3      [ ]          STREAM      CONNECTED      2537051    /run/dbus/system_bus_socket
unix   3      [ ]          STREAM      CONNECTED      2514460
unix   3      [ ]          STREAM      CONNECTED      2513367    /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      2543709
unix   3      [ ]          STREAM      CONNECTED      15360
unix   3      [ ]          STREAM      CONNECTED      2543708
unix   2      [ ]          DGRAM                    20516
unix   3      [ ]          STREAM      CONNECTED      2543822
unix   3      [ ]          STREAM      CONNECTED      2537582
unix   2      [ ]          DGRAM                    17153
unix   3      [ ]          STREAM      CONNECTED      18933
unix   2      [ ]          DGRAM                    21712
unix   2      [ ]          DGRAM                    18908
unix   3      [ ]          DGRAM                    14649
unix   2      [ ]          DGRAM                    2542948
unix   3      [ ]          STREAM      CONNECTED      15988      /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      18934
unix   2      [ ]          DGRAM                    2543106
unix   3      [ ]          STREAM      CONNECTED      16120
unix   3      [ ]          STREAM      CONNECTED      19549      /run/systemd/journal/stdout
unix   3      [ ]          STREAM      CONNECTED      15987
unix   3      [ ]          STREAM      CONNECTED      2514463    @/tmp/dbus-7NisD9MDVd
unix   2      [ ]          DGRAM                    18547

```

```

[lulul031@csslab2 HW3]$ ./ttcp -r -164 -n1048576
Usage: ttcp -t [options] remotehost
      ttcp -r [local options]
where:
      -t      transmit data
      -r      receive data
common options:
      -l#     length of bufs read from or written to network (default 8192)
      -b#     set the socket buffer size if supported (default is 16384)
      -p#     specify another service port (default is 5001)
      -?      print this help
options specific to -t:
      -n#     number of source bufs written to network (default 2048)
      -D      don't buffer TCP writes (sets TCP_NODELAY socket option)
[lulul031@csslab2 HW3]$ netstat
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 csslab2.uwb.edu:33782   ldil.s.uwb.edu:ldap    ESTABLISHED
tcp        0      48 csslab2.uwb.edu:ssh     10.102.83.107:53392     ESTABLISHED
tcp        0      0 csslab2.uwb.edu:33780   ldil.s.uwb.edu:ldap    ESTABLISHED
tcp        0      0 csslab2.uwb.edu:33774   ldil.s.uwb.edu:ldap    ESTABLISHED
tcp        0      0 csslab2.uwb.edu:33776   ldil.s.uwb.edu:ldap    ESTABLISHED
tcp        0      0 csslab2.uwb.edu:ssh     10.102.83.107:53395     ESTABLISHED
tcp        0      0 csslab2.uwb.edu:38828   ldi2.s.uwb.edu:ldap    ESTABLISHED
tcp        0      0 csslab2.uwb.edu:919     cssnfs3.uwb.edu:nfs     ESTABLISHED
tcp        0      0 csslab2.uwb.edu:ssh     d-10-155-176-27.a:57888 ESTABLISHED
Active UNIX domain sockets (w/o servers)
Proto RefCnt Flags       Type       State         I-Node      Path
unix   3        [ ]         DGRAM                    291         /run/systemd/notify
unix   2        [ ]         DGRAM                    293         /run/systemd/cgroups-agent
unix   5        [ ]         DGRAM                    307         /run/systemd/journal/socket
unix  19        [ ]         DGRAM                    309         /dev/log
unix   2        [ ]         DGRAM                   16493       /var/run/chrony/chronyd.sock
unix   2        [ ]         DGRAM                   13945       /run/systemd/shutdown
unix   3        [ ]         STREAM      CONNECTED      2514461
unix   2        [ ]         DGRAM                   16095
unix   3        [ ]         STREAM      CONNECTED      20493
unix   3        [ ]         STREAM      CONNECTED      19612
unix   3        [ ]         STREAM      CONNECTED      17036
unix   3        [ ]         STREAM      CONNECTED      16005       /run/systemd/journal/stdout
unix   3        [ ]         STREAM      CONNECTED      2514455     @/tmp/dbus-7NisD9MDVd
unix   3        [ ]         STREAM      CONNECTED      2543823
unix   3        [ ]         STREAM      CONNECTED      20494       /run/systemd/journal/stdout
unix   3        [ ]         STREAM      CONNECTED      2513368     /run/systemd/journal/stdout
unix   3        [ ]         STREAM      CONNECTED      19613       /run/systemd/journal/stdout
unix   3        [ ]         STREAM      CONNECTED      2514454
unix   2        [ ]         DGRAM                   16084
unix   3        [ ]         STREAM      CONNECTED      2537051     /run/dbus/system_bus_socket
unix   3        [ ]         STREAM      CONNECTED      2514460
unix   3        [ ]         STREAM      CONNECTED      2513367     /run/systemd/journal/stdout
unix   3        [ ]         STREAM      CONNECTED      2543709
unix   3        [ ]         STREAM      CONNECTED      15360
unix   3        [ ]         STREAM      CONNECTED      2543708
unix   2        [ ]         DGRAM                   20516

```

Client:

```
[lulu1031@csslab3 HW3]$ netstat -s
Ip:
  698456022 total packets received
  0 forwarded
  0 incoming packets discarded
  698456019 incoming packets delivered
  673343054 requests sent out
  73 outgoing packets dropped
  32 dropped because of missing route
Icmp:
  3398115 ICMP messages received
  115 input ICMP message failed.
  ICMP input histogram:
    destination unreachable: 3397972
    echo requests: 40
    echo replies: 103
  3400230 ICMP messages sent
  0 ICMP messages failed
  ICMP output histogram:
    destination unreachable: 3400058
    echo request: 132
    echo replies: 40
IcmpMsg:
  InType0: 103
  InType3: 3397972
  InType8: 40
  OutType0: 40
  OutType3: 3400058
  OutType8: 132
Tcp:
  120769449 active connections openings
  2918 passive connection openings
  120763304 failed connection attempts
  775 connection resets received
  9 connections established
  239512914 segments received
  249577415 segments send out
  37039 segments retransmited
  3 bad segments received.
  58509013 resets sent
Udp:
  174625268 packets received
  200418641 packets to unknown port received.
  80483873 packet receive errors
  427598692 packets sent
  80483871 receive buffer errors
  73 send buffer errors
UdpLite:
TcpExt:
  35 invalid SYN cookies received
  87196 packets pruned from receive queue because of socket buffer overrun
```

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2 packets dropped from out-of-order queue because of socket buffer overrun  
2444 TCP sockets finished time wait in fast timer  
3 time wait sockets recycled by time stamp  
7816 packets rejects in established connections because of timestamp  
98027 delayed acks sent  
70 delayed acks further delayed because of locked socket  
Quick ack mode was activated 4708 times  
14679141 packets directly queued to recvmsg prequeue.  
7047819 bytes directly in process context from backlog  
5741252795 bytes directly received in process context from prequeue  
640446 packets dropped from prequeue  
23192889 packet headers predicted  
1946762 packets header predicted and directly queued to user  
6557850 acknowledgments not containing data payload received  
32092144 predicted acknowledgments  
5552 times recovered from packet loss by selective acknowledgements  
8 bad SACK blocks received  
Detected reordering 1 times using FACK  
Detected reordering 164 times using SACK  
Detected reordering 55 times using time stamp  
11 congestion windows fully recovered without slow start  
58 congestion windows partially recovered using Hoe heuristic  
211 congestion windows recovered without slow start by DSACK  
397 congestion windows recovered without slow start after partial ack  
TCPLostRetransmit: 408  
709 timeouts after SACK recovery  
5 timeouts in loss state  
25723 fast retransmits  
1346 forward retransmits  
2020 retransmits in slow start  
2905 other TCP timeouts  
TCPLOSSProbes: 5336  
TCPLOSSProbeRecovery: 2765  
173 SACK retransmits failed  
61656 packets collapsed in receive queue due to low socket buffer  
4748 DSACKs sent for old packets  
2 DSACKs sent for out of order packets  
3534 DSACKs received  
7 DSACKs for out of order packets received  
58 connections reset due to unexpected data  
558 connections reset due to early user close  
2 connections aborted due to timeout  
TCPDSACKIgnoredOld: 21  
TCPDSACKIgnoredNoUndo: 1464  
TCPSPuriousRTOs: 131  
TCPSackShifted: 45147  
TCPSackMerged: 40152  
TCPSackShiftFallback: 26504  
TCPRcvCoalesce: 3651910  
TCPFOQueue: 11507  
TCPFOMerge: 2  
TCPChallengeACK: 14  
TCPSYNChallenge: 13  
TCPSPuriousRtxHostQueues: 1

```

TCPAutoCorking: 40090
TCPFromZeroWindowAdv: 304281
TCPToZeroWindowAdv: 304282
TCPWantZeroWindowAdv: 67118
TCPSynRetrans: 1161
TCPOrigDataSent: 52062490
TCPHystartTrainDetect: 740
TCPHystartTrainCwnd: 18742
TCPHystartDelayDetect: 95
TCPHystartDelayCwnd: 4372
TCPACKSkippedPAWS: 7350
TCPACKSkippedSeq: 399
IpExt:
  InNoRoutes: 3
  InOctets: 615666360990
  OutOctets: 791907132995
  InNoECTPkts: 698809464
  InECT0Pkts: 223493
[lulul031@csslab3 HW3]$ ./ttcp -t -l64 -n1048576 csslab2.uwb.edu
Usage: ttcp -t [options] remotehost
      ttcp -r [local options]
      where:
      -t      transmit data
      -r      receive data
      common options:
      -l#     length of bufs read from or written to network (default 8192)
      -b#     set the socket buffer size if supported (default is 16384)
      -p#     specify another service port (default is 5001)
      -?      print this help
      options specific to -t:
      -n#     number of source bufs written to network (default 2048)
      -D      don't buffer TCP writes (sets TCP_NODELAY socket option)
[lulul031@csslab3 HW3]$ netstat -s
Ip:
  698456251 total packets received
  0 forwarded
  0 incoming packets discarded
  698456248 incoming packets delivered
  673343345 requests sent out
  73 outgoing packets dropped
  32 dropped because of missing route
Icmp:
  3398115 ICMP messages received
  115 input ICMP message failed.
  ICMP input histogram:
    destination unreachable: 3397972
    echo requests: 40
    echo replies: 103
  3400230 ICMP messages sent
  0 ICMP messages failed
  ICMP output histogram:
    destination unreachable: 3400058
    echo request: 132
    echo replies: 40

```

IcmpMsg:

InType0: 103  
InType3: 3397972  
InType8: 40  
OutType0: 40  
OutType3: 3400058  
OutType8: 132

Tcp:

120769449 active connections openings  
2918 passive connection openings  
120763304 failed connection attempts  
775 connection resets received  
9 connections established  
239513143 segments received  
249577707 segments send out  
37039 segments retransmitted  
3 bad segments received.  
58509013 resets sent

Udp:

174625268 packets received  
200418641 packets to unknown port received.  
80483873 packet receive errors  
427598692 packets sent  
80483871 receive buffer errors  
73 send buffer errors

UdpLite:

TcpExt:

35 invalid SYN cookies received  
87196 packets pruned from receive queue because of socket buffer overrun  
2 packets dropped from out-of-order queue because of socket buffer overrun  
2445 TCP sockets finished time wait in fast timer  
3 time wait sockets recycled by time stamp  
7816 packets rejects in established connections because of timestamp  
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Quick ack mode was activated 4708 times  
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640446 packets dropped from prequeue  
23192920 packet headers predicted  
1946762 packets header predicted and directly queued to user  
6557864 acknowledgments not containing data payload received  
32092302 predicted acknowledgments  
5552 times recovered from packet loss by selective acknowledgements  
8 bad SACK blocks received  
Detected reordering 1 times using FACK  
Detected reordering 164 times using SACK  
Detected reordering 55 times using time stamp  
11 congestion windows fully recovered without slow start  
58 congestion windows partially recovered using Hoe heuristic  
211 congestion windows recovered without slow start by DSACK  
397 congestion windows recovered without slow start after partial ack  
TCPLostRetransmit: 408  
709 timeouts after SACK recovery  
5 timeouts in loss state  
25723 fast retransmits



```
1346 forward retransmits
2020 retransmits in slow start
2905 other TCP timeouts
TCPLOSSProbes: 5336
TCPLOSSProbeRecovery: 2765
173 SACK retransmits failed
61656 packets collapsed in receive queue due to low socket buffer
4748 DSACKs sent for old packets
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3534 DSACKs received
7 DSACKs for out of order packets received
58 connections reset due to unexpected data
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TCPDSACKIgnoredNoUndo: 1464
TCPSPuriousRTOs: 131
TCPSackShifted: 45147
TCPSackMerged: 40152
TCPSackShiftFallback: 26504
TCPRcvCoalesce: 3651910
TCP0F0Queue: 11507
TCP0F0Merge: 2
TCPChallengeACK: 14
TCPSYNChallenge: 13
TCPSPuriousRtxHostQueues: 1
TCPAutoCorking: 40090
TCPFromZeroWindowAdv: 304281
TCPToZeroWindowAdv: 304282
TCPWantZeroWindowAdv: 67118
TCPSynRetrans: 1161
TCPOrigDataSent: 52062779
TCPHystartTrainDetect: 740
TCPHystartTrainCwnd: 18742
TCPHystartDelayDetect: 95
TCPHystartDelayCwnd: 4372
TCPACKSkippedPAWS: 7350
TCPACKSkippedSeq: 399
```

#### IpExt:

```
InNoRoutes: 3
InOctets: 615666375366
OutOctets: 791907170931
InNoECTPkts: 698809693
InECT0Pkts: 223493
```