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CSC 257
Assignment 3 Report
10/31/2016

Running Instructions

1. Run the makefile with make
2. Start the server on one machine using
   java Server [client's machine name] [optionally include a port number]
3. Start the client on the specified machine using
   java Client [server's machine name] [optionally include a port number]

default port is 10000

Description:

In this project, I measured RTT from sending different amounts of packets between machines on the same network. To do this, I sent a byte array of the specified amount from the client to the server, and the server read this byte array and sent it back to the client. In measuring the RTT, I include the setup time of the sockets and all the sending and receiving. To get precise results, I used the System.nanoTime() function to get the elapsed time in nanoseconds. For each byte amount (1, 10, 100, 1000, 10000) I sent a byte array of the specified size to calculate RTT. I used a for loop to repeat this process 1000 times to get a stable average of the RTT for each byte amount. I did this process for both TCP and UDP. On the csug machines, I used cliff as my server and phelps as my client. Lastly, I sent a TCP packet to both an American and a Chinese server (http://www.dogpile.com and http://www.yangfenzi.com, respectively). My program sends 20 requests to each to calculate an average, and returns the average RTT in milliseconds (since this RTT is much larger than on the local machines).

Results:

Here are my results from 5 executions of my program (which each calculate an average over many trials)

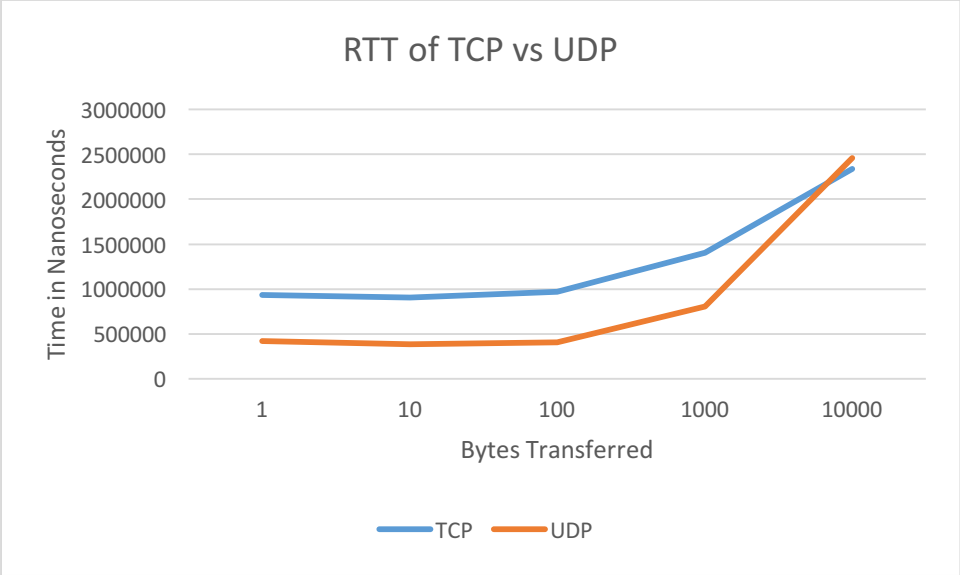

Chart of Trial 1

Trial 1:

Client

[jhrebena@phelps ~/TransmissionDelay]$ java Client cliff
Conducting 1000 trials sending bytes over TCP...
Average RTT for TCP 1 byte : 931456ns
Average RTT for TCP 10 bytes : 905282ns
Average RTT for TCP 100 bytes : 971234ns
Average RTT for TCP 1000 bytes : 1400872ns
Average RTT for TCP 10000 bytes : 2340266ns
Conducting 1000 trials sending bytes over UDP...
Average RTT for UDP 1 byte : 422068ns
Average RTT for UDP 10 bytes : 384668ns
Average RTT for UDP 100 bytes : 408248ns
Average RTT for UDP 1000 bytes : 807249ns
Average RTT for UDP 10000 bytes : 2460132ns
Conducting 20 trials sending bytes to American host over TCP
Average RTT for TCP to American (Oregon) host http://www.dogpile.com : 215ms
Conducting 20 trials sending bytes to Chinese host over TCP
Average RTT for TCP to Chinese host http://www.yangfenzi.com : 1461ms
[jhrebena@phelps ~/TransmissionDelay]$

Server

```
[jhrebena@cliff ~/TransmissionDelay]$ java Server phelps
[jhrebena@cliff ~/TransmissionDelay]$
```

Trial 2:

Client

```
[jhrebena@phelps ~/TransmissionDelay]$ java Client cliff
Conducting 1000 trials sending bytes over TCP...
Average RTT for TCP 1 byte : 934585ns
Average RTT for TCP 10 bytes : 902185ns
Average RTT for TCP 100 bytes : 970389ns
Average RTT for TCP 1000 bytes : 1401780ns
Average RTT for TCP 10000 bytes : 2342024ns
Conducting 1000 trials sending bytes over UDP...
Average RTT for UDP 1 byte : 422717ns
Average RTT for UDP 10 bytes : 396597ns
Average RTT for UDP 100 bytes : 418583ns
Average RTT for UDP 1000 bytes : 818647ns
Average RTT for UDP 10000 bytes : 2461403ns
Conducting 20 trials sending bytes to American host over TCP
Average RTT for TCP to American (Oregon) host http://www.dogpile.com : 215ms
Conducting 20 trials sending bytes to Chinese host over TCP
Average RTT for TCP to Chinese host http://www.yangfenzi.com : 564ms
[jhrebena@phelps ~/TransmissionDelay]$
```

Server

```
[jhrebena@cliff ~/TransmissionDelay]$ java Server phelps
[jhrebena@cliff ~/TransmissionDelay]$
```

Trial 3:

Client

```
[jhrebena@phelps ~/TransmissionDelay]$ java Client cliff
Conducting 1000 trials sending bytes over TCP...
Average RTT for TCP 1 byte : 945827ns
Average RTT for TCP 10 bytes : 917298ns
```

Average RTT for TCP 100 bytes : 975819ns
Average RTT for TCP 1000 bytes : 1409245ns
Average RTT for TCP 10000 bytes : 2349223ns
Conducting 1000 trials sending bytes over UDP...
Average RTT for UDP 1 byte : 432013ns
Average RTT for UDP 10 bytes : 387484ns
Average RTT for UDP 100 bytes : 407658ns
Average RTT for UDP 1000 bytes : 808625ns
Average RTT for UDP 10000 bytes : 2466059ns
Conducting 20 trials sending bytes to American host over TCP
Average RTT for TCP to American (Oregon) host http://www.dogpile.com : 212ms
Conducting 20 trials sending bytes to Chinese host over TCP
Average RTT for TCP to Chinese host http://www.yangfenzi.com : 972ms
[jhrebena@phelps ~/TransmissionDelay]$

Server

[jhrebena@cliff ~/TransmissionDelay]$ java Server phelps
[jhrebena@cliff ~/TransmissionDelay]$

Trial 4:

Client

[jhrebena@phelps ~/TransmissionDelay]$ java Client cliff
Conducting 1000 trials sending bytes over TCP...
Average RTT for TCP 1 byte : 1928648ns
Average RTT for TCP 10 bytes : 1857479ns
Average RTT for TCP 100 bytes : 1948385ns
Average RTT for TCP 1000 bytes : 2610190ns
Average RTT for TCP 10000 bytes : 3766255ns
Conducting 1000 trials sending bytes over UDP...
Average RTT for UDP 1 byte : 464496ns
Average RTT for UDP 10 bytes : 410540ns
Average RTT for UDP 100 bytes : 428060ns
Average RTT for UDP 1000 bytes : 829515ns
Average RTT for UDP 10000 bytes : 2489051ns
Conducting 20 trials sending bytes to American host over TCP
Average RTT for TCP to American (Oregon) host http://www.dogpile.com : 216ms
Conducting 20 trials sending bytes to Chinese host over TCP
Average RTT for TCP to Chinese host http://www.yangfenzi.com : 770ms
[jhrebena@phelps ~/TransmissionDelay]$

Server

```
[jhrebena@cliff ~/TransmissionDelay]$ java Server phelps
[jhrebena@cliff ~/TransmissionDelay]$
```

Trial 5:

Client

```
[jhrebena@phelps ~/TransmissionDelay]$ java Client cliff
Conducting 1000 trials sending bytes over TCP...
Average RTT for TCP 1 byte : 923023ns
Average RTT for TCP 10 bytes : 905170ns
Average RTT for TCP 100 bytes : 964117ns
Average RTT for TCP 1000 bytes : 1382624ns
Average RTT for TCP 10000 bytes : 2361468ns
Conducting 1000 trials sending bytes over UDP...
Average RTT for UDP 1 byte : 422929ns
Average RTT for UDP 10 bytes : 385823ns
Average RTT for UDP 100 bytes : 405005ns
Average RTT for UDP 1000 bytes : 806850ns
Average RTT for UDP 10000 bytes : 2463347ns
Conducting 20 trials sending bytes to American host over TCP
Average RTT for TCP to American (Oregon) host http://www.dogpile.com : 212ms
Conducting 20 trials sending bytes to Chinese host over TCP
Average RTT for TCP to Chinese host http://www.yangfenzi.com : 781ms
[jhrebena@phelps ~/TransmissionDelay]$
```

Server

```
[jhrebena@cliff ~/TransmissionDelay]$ java Server phelps
[jhrebena@cliff ~/TransmissionDelay]$
```

Interpretations:

Different Byte Amounts: Everything went as expected aside from one thing; for both TCP and UDP, there was a lower RTT for 10 bytes than there was for 1 byte. I assume that this is because special accommodations must be made to send just 1 byte due to the small size, making it slower than sending 10 bytes. I think what must have happened is there must have been byte stuffing to make the payload of the 1-byte packet long enough, which comes with overhead on both sides. This would explain the longer than expected RTT. Aside from that, the average RTT for each byte amount seems to scale appropriately.

TCP vs UDP: UDP was faster for sending 1 through 1000 bytes, but TCP performed better on average when sending 10000 bytes. I believe this is because although there is more initial overhead involved in TCP, once the connection was established TCP was more efficiently streaming packets. This is what allowed TCP to transmit a larger amount of bytes faster.

American vs Chinese Server: The results here were straightforward – since the American server is much closer, the RTT for our TCP bytes was much shorter than it was for the Chinese server. This is because the bytes travel less distance with likely less hops.