COMP 556: Project 1

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Part 3: Measurements

Definitions

$T_{\text{total}} = T_{\text{independent}} + T_{\text{bandwidth}}$ such that

T_{total} is the total round trip latency. $T_{\text{independent}}$ is the time overhead associated with physical propagation delay, software overhead, function calls, and other system delays, independent of the size of the data packet.

$T_{\text{bandwidth}}$ is the time taken to transfer the data between the client and server, which is proportional to $\frac{\text{Data size}}{\text{Network Bandwidth}}$.

Algorithm Design

1. Let us assume 2 data packets of size s_1 and s_2 respectively, where $s_2 > s_1$. We will choose s_1 and s_2 such that the difference between them is as high as possible. In our case, s_1 is 18 and $s_2 = 65535 - s_1$.

2. Let t_1 and t_2 be the average round-trip time after *count* number of exchanges for data packets of size s_1 and s_2 in the ping-pong server-client.

3. As shown below, the round-trip time is the sum of independent latency (t_{ind}) and dependent latency (t_{dep}). The dependent latency varies with the size of data packets, whereas the independent latency remains constant for all cases.
$$t_1 = t_{ind} + t_{dep1}$$
$$t_2 = t_{ind} + t_{dep2}$$

4. We know that bandwidth is the amount of data transmitted per time period. To remove the independent factors, calculate the increase in data transmitted per increase in latency. By using $(t_2 - t_1) = (t_{dep2} - tdep1)$ for latency, we remove the independent factor t_{ind}.

   The round-trip time involves 2 data packet exchanges (from client to server and vice-versa), hence the data transmitted is twice the data packet size. This explains the the difference in data size being doubled in the below equation.
$$BW_{dep} = \frac{(s_2 - s_1) * 2}{t_2 - t_1}$$

5. The equation for t_1 in step 3 can be re-written as -

$$t_1 = t_{ind} + \frac{s_1 * 2}{BW_{dep}}$$
$$t_{ind} = t_1 - \frac{s_1 * 2}{BW_{dep}}$$

   Hence, we can find the independent latency (t_{ind}).

6. Repeat step 1 to 5 with random data packet sizes s_1 and s_2 for 200 test iterations. Calculate the average independent delay and dependent bandwidth across 200 iterations and print them.

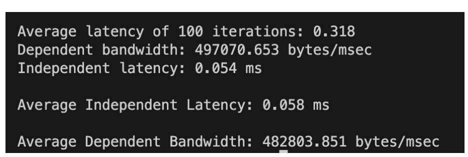
7. Note: In the above calculations, latency are measured in milliseconds and data size is measured in bytes, so the bandwidth is expressed in bytes per milliseconds. The above dependent bandwidth can be multiplied by $8 * 10^3$ to express it in bits/sec format.

Code

We made a copy of the client code and added the necessary code to perform the above calculations. The code is slightly modified to ensure that the send/receive buffers are allocated and freed correctly.

The executable runs in a manner similar to that of the client executable. However, the above code does not use the size command parameter. We did not change the command format to run the executable to maintain uniformity. So, any dummy value can be provided in its place.

Results



```
Average latency of 100 iterations: 0.318
Dependent bandwidth: 497070.653 bytes/msec
Independent latency: 0.054 ms

Average Independent Latency: 0.058 ms

Average Dependent Bandwidth: 482803.851 bytes/msec
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Figure 1: Latency Measurement Terminal Results

We found that $T_{\text{independent}} = 0.005ms$ and the dependent bandwidth is around 4.8 gb/s.