Technical Report

Data Communications - Assignment 2

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# Introduction

I have conducted 216 tests UDP tests, as well as 216 TCP tests with varying parameters, in varying settings:

* **Localhost**; Transmitting from my desktop, to itself using the loopback address.
* **Local Area Network**; From my desktop computer, being the client, to my laptop, the server within my home.
* **Wide Area Network**; My sister's laptop in San Francisco, the client, to my laptop in Richmond, the server.

This document presents my test results, and observations. I will briefly compare and contrast the two protocols, identifying their strengths, weaknesses, and identify what each protocol is best suited for.

# UDP & TCP Tests

The test parameters used are varying packet sizes, and packet counts. The used packet sizes are:

|  |  |  |  |
| --- | --- | --- | --- |
| * 65000 * 4000 | * 1000 * 250 | * 60 * 20 | * 5 * 1 |

Each of these packet sizes were used in test by sending 10, 100, and 1000 of them to the server at a time. every one of these tests were run 3 times, and the average of the result was finally recorded, and plotted on graphs.

## UDP & TCP Localhost Tests

The following is a table that displays the results for all the tests done on localhost; my desktop sending packets to itself through the loop back port.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Localhost | | | Protocol & Number of Packets | | | | | |
| UDP | | | TCP | | |
| 10 | 100 | 1000 | 10 | 100 | 1000 |
| Payload Size | 65000 | Test Duration | **106** | **110** | **151.6667** | **105.3333** | **122.6667** | **304.6667** |
| Packets Received | **23.33%** | **36.33%** | **41.43%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **151666.7** | **2361667** | **26931667** | **650000** | **6500000** | **65000000** |
| 4000 | Test Duration | **106.3333** | **106.3333** | **124** | **103.3333** | **112** | **245.6667** |
| Packets Received | **40.00%** | **9.33%** | **15.63%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **16000** | **37333.33** | **625333.3** | **40000** | **400000** | **4000000** |
| 1000 | Test Duration | **107.3333** | **107.3333** | **124** | **107** | **109.6667** | **244.6667** |
| Packets Received | **100.00%** | **14.00%** | **18.27%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **10000** | **14000** | **182666.7** | **10000** | **100000** | **1000000** |
| 250 | Test Duration | **109** | **108** | **130.6667** | **103.3333** | **110** | **168** |
| Packets Received | **100.00%** | **39.00%** | **24.33%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **2500** | **9750** | **60833.33** | **2500** | **25000** | **250000** |
| 60 | Test Duration | **107** | **113** | **143.6667** | **103.3333** | **110.6667** | **167** |
| Packets Received | **100.00%** | **100.00%** | **41.57%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **600** | **6000** | **24940** | **600** | **6000** | **60000** |
| 20 | Test Duration | **107** | **112.6667** | **157** | **103.3333** | **110.3333** | **166** |
| Packets Received | **100.00%** | **100.00%** | **62.33%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **200** | **2000** | **12466.67** | **200** | **2000** | **20000** |
| 5 | Test Duration | **108.3333** | **114** | **173.6667** | **103.3333** | **409.3333** | **171.6667** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **50** | **500** | **5000** | **50** | **500** | **5000** |
| 1 | Test Duration | **106.3333** | **121** | **175.6667** | **103.6667** | **409.3333** | **467** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **10** | **100** | **1000** | **10** | **100** | **1000** |

Here is the data from the chart above put into some graphs:

* Packet size is on the x axis
* All tests done with some number of packets is represented by a single line
* Test duration is measured in milliseconds
* Packets received is in a percentage

|  |  |  |
| --- | --- | --- |
|  | **UDP** | **TCP** |
| **Test Duration** |  |  |
| **Packets received** |  |  |

Some observations about the UDP tests:

* There is a minor correlation between test duration, and packets received; as test duration increases, so does the packets received.
* There is a correlation between packet size and packets received; the smaller the packet, the more reliable it is.
* Oddly, there is an increase in performance for the 65000 byte packets in the 1000 and 100 packet tests.

Some observations about the TCP tests:

* As expected, 100% of the packets always go through in the TCP tests.
* There is a correlation between packet size, and test duration; the larger the packet, the longer the test duration. This is caused by longer transmission times due to larger packets.
* When the packets get small, the test duration also increases. Small packets are easy to transmit at a high rate, but on the receiving side, it fails to receive them all at such a high rate; packets are dropped, and must be retransmitted, causing the delay.

## UDP & TCP Local Area Network Tests

Below is a table of the results from testing on my local area network in my home. My laptop is the server, and my desktop is the client.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Local Area Network | | | Protocol & Number of Packets | | | | | |
| UDP | | | TCP | | |
| 10 | 100 | 1000 | 10 | 100 | 1000 |
| Payload Size | 65000 | Test Duration | **593.3333** | **1776.333** | **12976.33** | **479.3333** | **3115.667** | **22579.33** |
| Packets Received | **100.00%** | **100.00%** | **99.87%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **650000** | **6500000** | **64913333** | **650000** | **6500000** | **65000000** |
| 4000 | Test Duration | **417** | **615** | **2865.333** | **182.3333** | **651.3333** | **5055.667** |
| Packets Received | **100.00%** | **86.00%** | **96.83%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **40000** | **344000** | **3873333** | **40000** | **400000** | **4000000** |
| 1000 | Test Duration | **359.3333** | **495.3333** | **932.6667** | **135.6667** | **328** | **2187.667** |
| Packets Received | **100.00%** | **91.67%** | **36.10%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **10000** | **91666.67** | **361000** | **10000** | **100000** | **1000000** |
| 250 | Test Duration | **359.3333** | **516.3333** | **843.6667** | **130.3333** | **250** | **1317.667** |
| Packets Received | **100.00%** | **96.67%** | **36.73%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **2500** | **24166.67** | **91833.33** | **2500** | **25000** | **250000** |
| 60 | Test Duration | **359** | **453** | **1635.333** | **229** | **203** | **1375.333** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **600** | **6000** | **60000** | **600** | **6000** | **60000** |
| 20 | Test Duration | **359** | **479** | **2115** | **182.3333** | **281** | **1288.667** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **200** | **2000** | **20000** | **200** | **2000** | **20000** |
| 5 | Test Duration | **359.3333** | **521** | **1521** | **187.6667** | **317.3333** | **1271** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **50** | **500** | **5000** | **50** | **500** | **5000** |
| 1 | Test Duration | **369.3333** | **458.3333** | **1625.333** | **182.6667** | **266** | **1542** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **10** | **100** | **1000** | **10** | **100** | **1000** |

Here is the data from the chart above put into some graphs:

* Packet size is on the x axis
* All tests done with some number of packets is represented by a single line
* Test duration is measured in milliseconds
* Packets received is in a percentage

|  |  |  |
| --- | --- | --- |
|  | **UDP** | **TCP** |
| **Test Duration** |  |  |
| **Packets received** |  |  |

Some observations about the UDP tests:

* There is a minor correlation between test duration, and packets received; as test duration increases, so does the packets received.
* There is a correlation between packet size and packets received; the smaller the packet, the more reliable it is.
* Oddly, there is an increase in performance for the larger packets.

Some observations about the TCP tests:

* As expected, 100% of the packets always go through in the TCP tests.
* There is a correlation between packet size, and test duration; the larger the packet, the longer the test duration. This is caused by longer transmission times due to larger packets.
* When the packets get small, the test duration also increases slightly. Small packets are easy to transmit at a high rate, but on the receiving side, it fails to receive them all at such a high rate; packets are dropped, and must be retransmitted, causing the delay.

## UDP & TCP Wide Area Network Tests

Next are the results from all the tests gathered for the wide area network test; my sister's laptop in San Francisco, CA, is the client, and my laptop in Richmond, BC, is the server.

I had a few issues here trying to set up my router correctly. When using port forwarding, my program fails to make any sort of connections, but when using "virtual servers" it works fine. Research on the internet suggests that "port forwarding" and "virtual servers" do the same thing, so I don't know what my problem is.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Canda to USA | | | Protocol & Number of Packets | | | | | |
| UDP | | | TCP | | |
| 10 | 100 | 1000 | 10 | 100 | 1000 |
| Payload Size | 65000 | Test Duration | **0** | **0** | **0** | **1047** | **9366.667** | **98748.33** |
| Packets Received | **0.00%** | **0.00%** | **0.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **0** | **0** | **0** | **650000** | **6500000** | **65000000** |
| 4000 | Test Duration | **416.6667** | **880.6667** | **2480** | **307** | **1510.667** | **14967** |
| Packets Received | **86.67%** | **89.67%** | **14.57%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **34666.67** | **358666.7** | **582666.7** | **40000** | **400000** | **4000000** |
| 1000 | Test Duration | **432.3333** | **552.3333** | **1083.667** | **213** | **646.3333** | **5579.333** |
| Packets Received | **100.00%** | **100.00%** | **51.43%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **10000** | **100000** | **514333.3** | **10000** | **100000** | **1000000** |
| 250 | Test Duration | **448** | **521** | **1068** | **189.3333** | **297** | **1719.333** |
| Packets Received | **100.00%** | **96.00%** | **48.17%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **2500** | **24000** | **120416.7** | **2500** | **25000** | **250000** |
| 60 | Test Duration | **427.3333** | **547** | **1760.333** | **224** | **271** | **1495** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **600** | **6000** | **60000** | **600** | **6000** | **60000** |
| 20 | Test Duration | **427.3333** | **536.3333** | **1744.667** | **187.6667** | **265.6667** | **1406.333** |
| Packets Received | **100.00%** | **100.00%** | **99.93%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **200** | **2000** | **19986.67** | **200** | **2000** | **20000** |
| 5 | Test Duration | **432.6667** | **568** | **1698.333** | **218.6667** | **297** | **1401.333** |
| Packets Received | **100.00%** | **100.00%** | **99.17%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **50** | **500** | **4958.333** | **50** | **500** | **5000** |
| 1 | Test Duration | **417** | **531.3333** | **1906.667** | **198.3333** | **328** | **1651** |
| Packets Received | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| Bytes Received | **10** | **100** | **1000** | **10** | **100** | **1000** |

Here is the data from the chart above put into some graphs:

* Packet size is on the x axis
* All tests done with some number of packets is represented by a single line
* Test duration is measured in milliseconds
* Packets received is in a percentage

|  |  |  |
| --- | --- | --- |
|  | **UDP** | **TCP** |
| **Test Duration** |  |  |
| **Packets received** |  |  |

Some observations about the UDP tests:

* Unlike the other tests where larger packets means increased reliability, this is not true for the WAN test. Here, the largest packets fail all the time. since none of the packets received, the "test duration" is zero milliseconds.
* There is a correlation between packet size and packets received; the smaller the packet, the more reliable it is.

Some observations about the TCP tests:

* It looks the same as the LAN tests, but overall, it takes more time.

# Conclusion

The most useful results are from the LAN and WAN tests, because those situations are more useful, so I will ignore the results gathered from the localhost tests.

## UDP

UDP's strengths and weaknesses:

|  |  |
| --- | --- |
| **Strengths** | **Weaknesses** |
| * Overall, much quicker transmission times * Transmission time is much faster (excluding receiving) | * Has trouble sending larger packets * Packets usually don't arrive in order |

From looking at the graphs, it seems that the best packet size for UDP is 60 bytes. With 60 bytes, the packets seem to have the most reliability regardless of the number of packets being sent.

## TCP

TCP's strengths and weaknesses:

|  |  |
| --- | --- |
| **Strengths** | **Weaknesses** |
| * 100% of the packets are transmitted * TCP orders the received packets * For small packets, TCP's test duration is overall shorter compared to UDP | * Takes significantly longer to transmit compared to UDP for large packets |

From looking at the graphs, and from the testing experience, it seems that TCP is good for transmitting large packets. The best packet size for TCP is around 1000 bytes. With 1000 bytes, the packets are transmitted reasonably quickly, and are usually received without any need for a retransmission.