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**
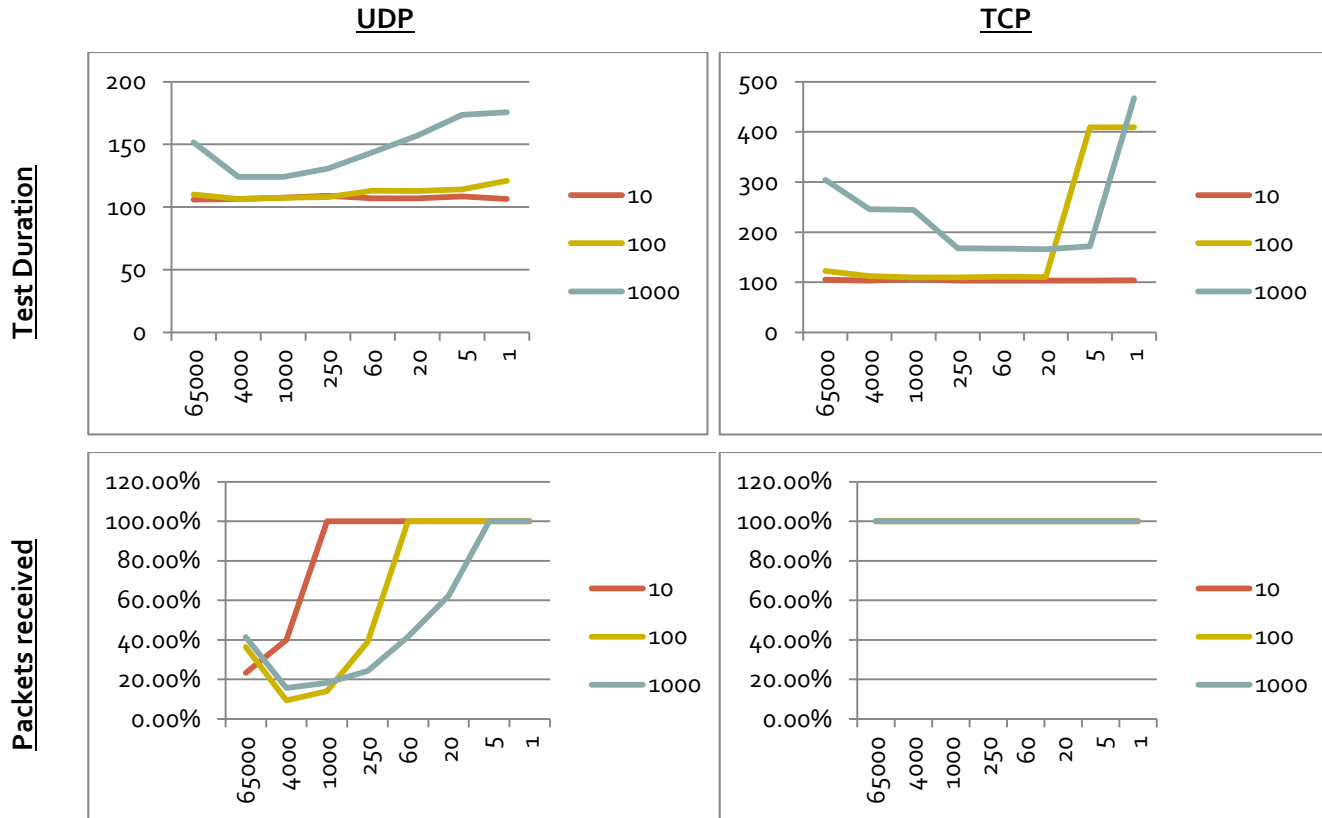
Some observations about the UDP tests:

- 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**
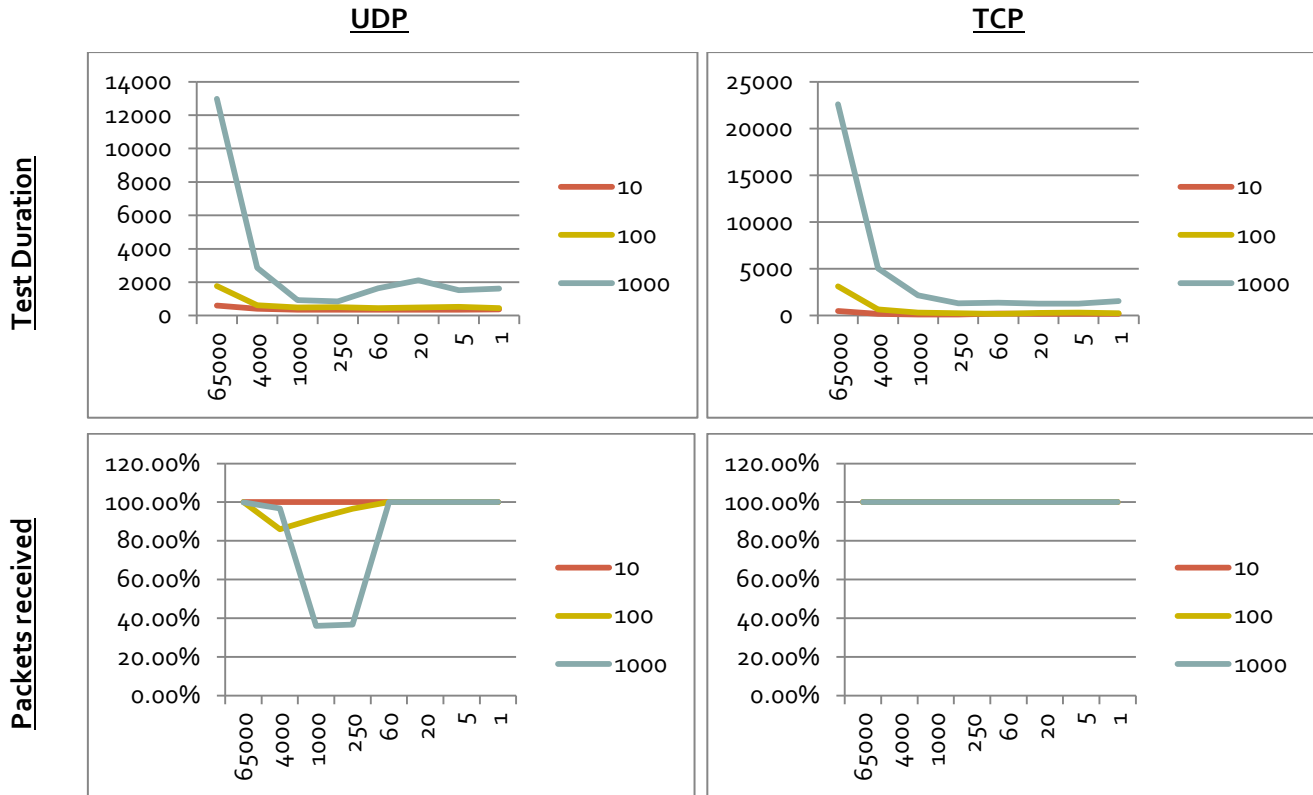
Some observations about the UDP tests:

- 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
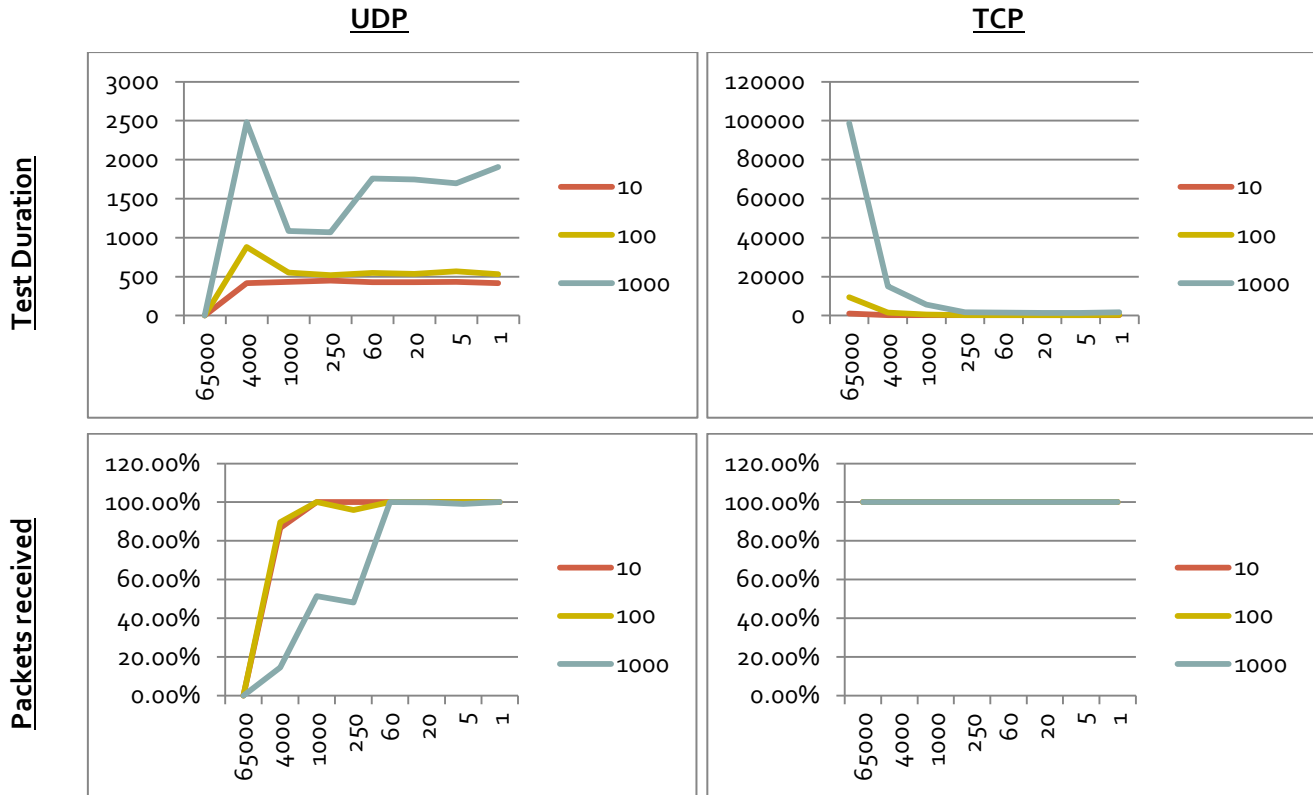
Some observations about the UDP tests:

- 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	• Has trouble sending larger packets
• Transmission time is much faster (excluding receiving)	• 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	• Takes significantly longer to transmit compared to UDP for large packets
• TCP orders the received packets	
• For small packets, TCP's test duration is overall shorter compared to UDP	

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.