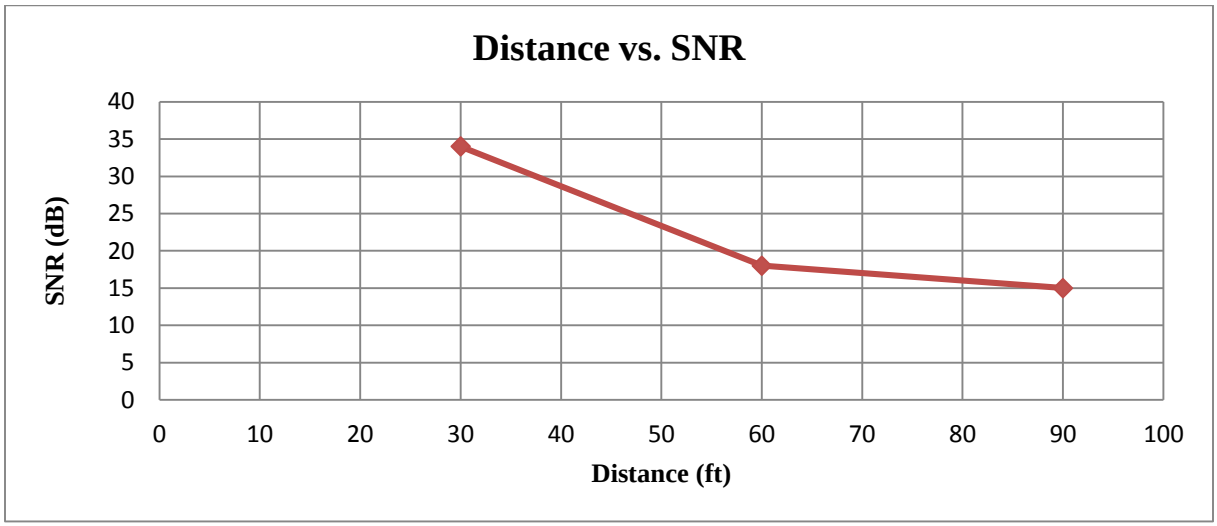
Exercise #2: Raw Data Sheet
(Data Transmission over 802.11b Wireless LAN)

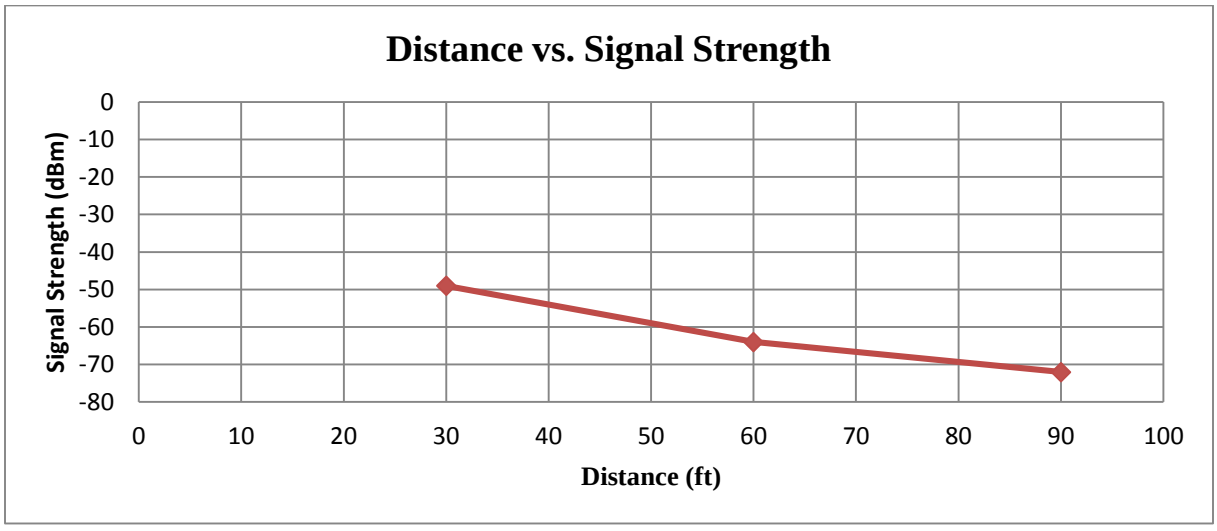
Part A Table 1. TCP and UDP Throughput vs. Signal Strength

Location	Approx. Distance from Access Point (feet)	Signal Strength (dBm)	Noise Power (dBm)	SNR (dB)	UDP Data Rate (Kbps)	TCP Data Rate (Kbps)	Observations
Wall across 3704 entry	30	-49	-83	34	22528	18636.8	1 packet out of order
Next to 3428 entry	60	-64	-82	18	5416.96	6973.44	1 packet out of order
Next to 3424 entry	90	-72	-87	15	1628.16	56	1 packet out of order

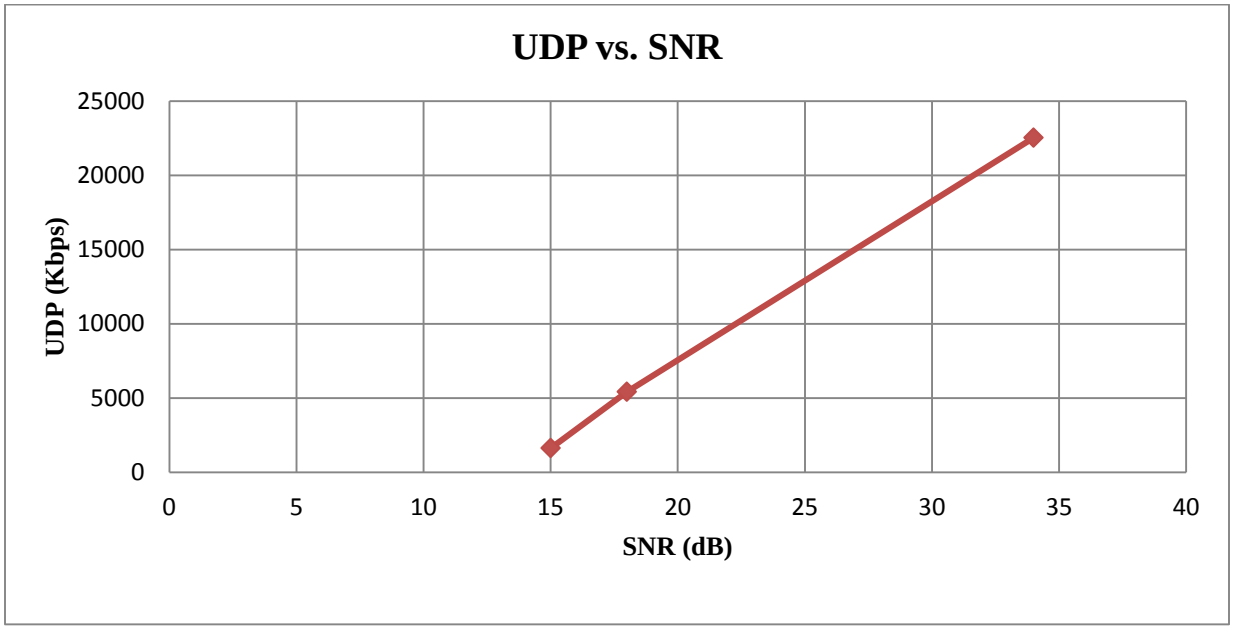
Graph from Table 1. Distance vs. Signal to Noise Ratio



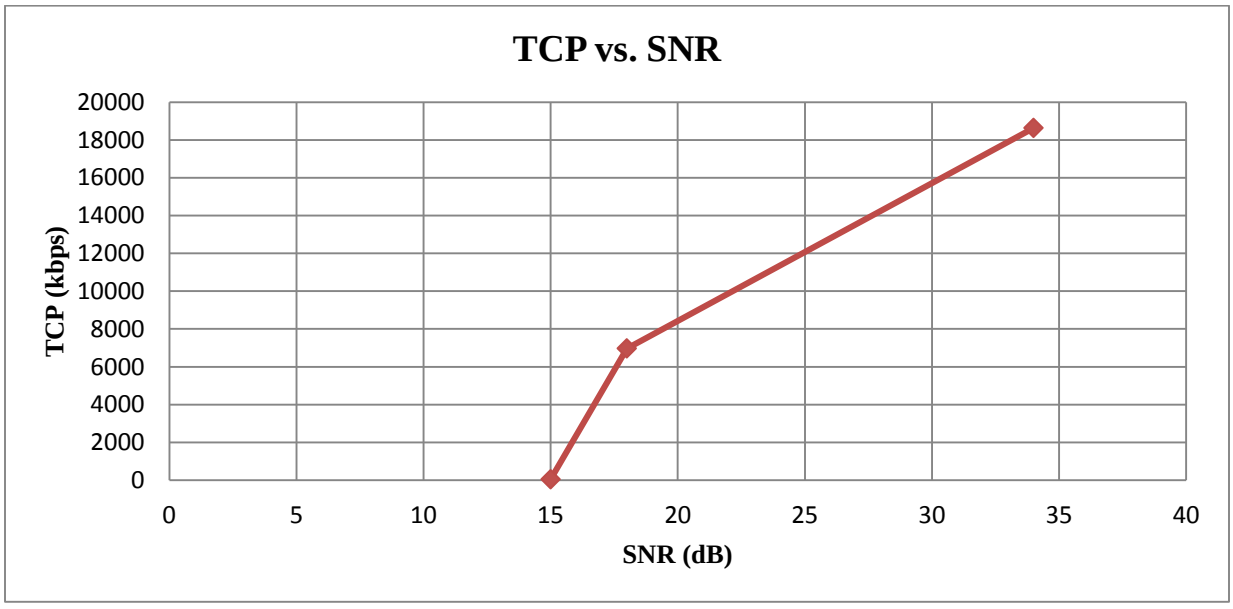
Graph from Table 1. Distance vs. Signal Strength



Graph from Table 1. UDP Throughput vs. Signal to Noise Ratio



Graph from RDS Table 1. TCP Throughput vs. Signal to Noise Ratio

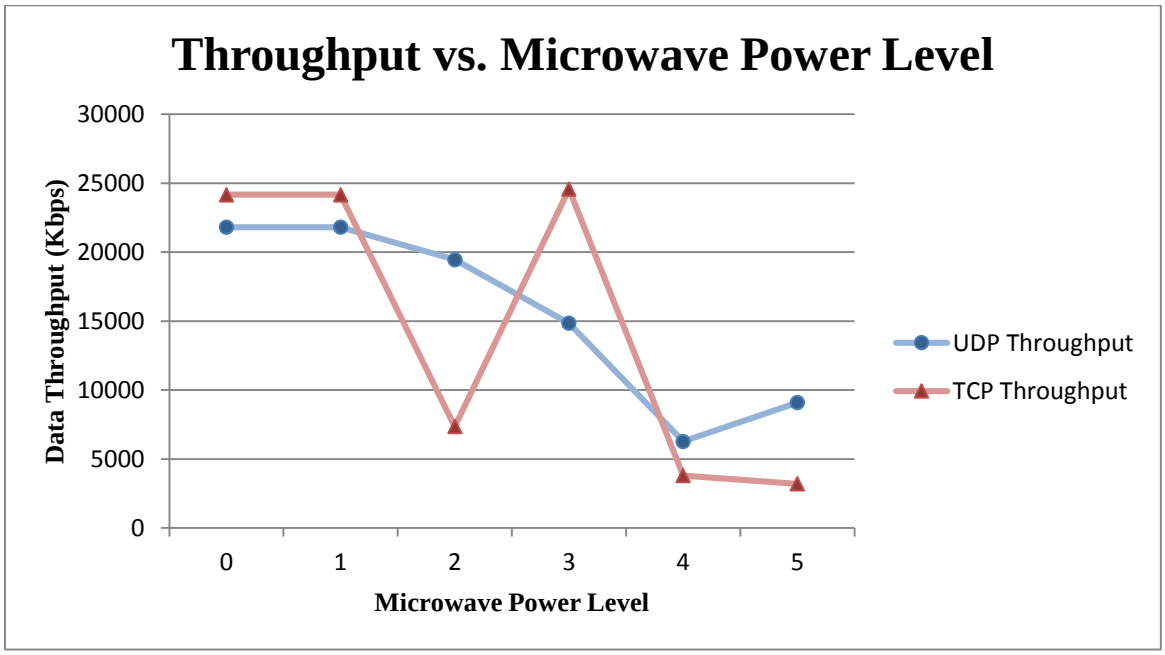


Part B Table 2. Noise and Throughput in presence of Microwave Oven

(Approximate distance from AP: 6 feet)

Microwave Oven Level	Signal Strength (dBm)	Noise Power (dBm)	UDP Data Rate (Kbps)	TCP Data Rate (Kbps)	Spectrum Analyzer Display Observation	Other Observation
Off	-29	-80	21811.2	24166.4	Noisy,1 occasional spike	No loss
High	-26	-83	9093.1	3194.9	2 frequent spikes	39% loss in UDP
Medium High	-27	-80	6277.1	3799	2 frequent spikes, smaller	No loss
Medium	-25	-80	14848	24576	1 frequent spike, 1 occasional spike, smaller	0.008% loss in UDP
Defrost	-25	-80	19456	7352.3	1 frequent spike, 1 occasional spike	No loss
Warm	-27	-81	20070	20480	1 occasional spike	No loss

Graph from RDS Table 2. Throughput vs. Microwave Power Level



Key	
Power Level	Microwave Level
0	Off
1	Warm
2	Defrost
3	Medium
4	Medium High
5	High

Data Transmission over 802.11b Wireless LAN

CS M117 Laboratory Exercise 2

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Observation

In Experiment 2, we explored data transmission over 802.11b Wireless LAN and how transmission rates are affected by distance between the nodes, different protocols such as UDP and TCP, and different environments of varying noise levels. In order to observe how these factors affect data throughput, we measured UDP and TCP rates in Boelter Hall at varying distances, using basic network measurement tools (Iperf) to act as UDP/TCP clients and servers. To test for noise, we utilized a microwave at different power levels to see if that interferes with data throughput as well.

All things considered, the resulting variance in data throughput was quite close to what was expected. In Part A, as the distance between the two nodes increased, signal strength and, correspondingly, Signal-Noise Ratio (SNR) decreased. We also see that there is a direct relationship between UDP/TCP data rates and SNR – the more signal we have relative to noise, the faster we can send and receive packets. When comparing UDP and TCP, we see that the UDP data rate is a bit faster than TCP in most scenarios, since the protocol allows a continuous stream of packets to be transmitted, without the reliability offered by TCP's acknowledgments and congestion control.

In Part B, the graph tells us that both UDP and TCP data rates suffer at high microwave power levels. This is just as expected, since having the microwave exert more power at a similar frequency of 2.4 GHz generates more noise. And as we saw in Part A, more noise means a lower SNR, thereby leading to lower data throughput. Of course, even when the microwave was off, the spectrum analyzer showed plenty of noise and occasional spikes. This can be attributed in part to our location (the third floor of Boelter), which can be expected to contain plenty of signal interference.

We had to rescale the graphs, since our throughput values were much higher than previous years. In fact, we are technically using 802.11n (not b), which is much faster than previous generations, such as a, b, or g. Overall, our results successfully demonstrate factors affecting wireless data throughput and taught us first-hand about the differences between wireless generations and protocols.

Goals and Results

#	Main Goals	Results with error
1	To give students the basic knowledge of various factors affecting data throughput in a wireless channel	We found that both UDP and TCP are inversely related with distance and microwave power, while directly related with signal and SNR. In other words, increasing the distance between two nodes or adding microwave interference makes their data transmission rates lower; but when signal strength relative to noise is high, data throughput improves.
2	To expose students to the effect of sporadic losses on TCP throughput	As our microwave oven test showed, TCP throughput experiences loss in rate when more noise exists in the environment. That is, we can expect TCP (and UDP as well) to perform less efficiently if there are many other sources of an approximate 2.4 GHz frequency. However, TCP, with its congestion control, prevents packet loss which is common in UDP.
3	To familiarize students with basic performance measurement tools in computer networks	Doing this experiment required us to use iperf to set up UDP and TCP servers and clients alike in order to test the throughput of different wireless protocols.