WIRELESS DATA TRANSMISSION

Lab 1 & 2

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CS M117 – Discussion 1B – Summer 2017

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Abstract (Goals)

- Lab 1
  - *Develop a basic understanding of wireless throughput by analyzing UDP and TCP connections under multiple scenarios*
  - *Experience potential instability of TCP under certain circumstances*
  - *Become familiar with network performance measurement tools*
  - *Measure the relationship between communication distance and data transmission rates/signal strength*
- Lab 2
  - *Measure the relationship between communication distance and Bit Error Rate (BER)*
  - *Measure the effects of one-to-many Bluetooth connections on multiple devices*
  - *Measure the interference of Bluetooth devices*
  - *Measure the interference and fairness between Bluetooth and IEEE 802.11 devices*

Theory

- Lab 1A
  - *UDP* `iperf` *client sends constant bit rate stream to server*
  - *UDP* `iperf` *server reports datagram losses and throughput*
  - *TCP* `iperf` *client sends as much data as possible for a fixed time period*
  - *TCP* `iperf` *server reports throughput*
  - *Expect UDP (No ACK) to be faster than TCP (ACK)*
- Lab 1B
  - *Expect microwave interference to reduce WiFi throughput due to shared frequency*

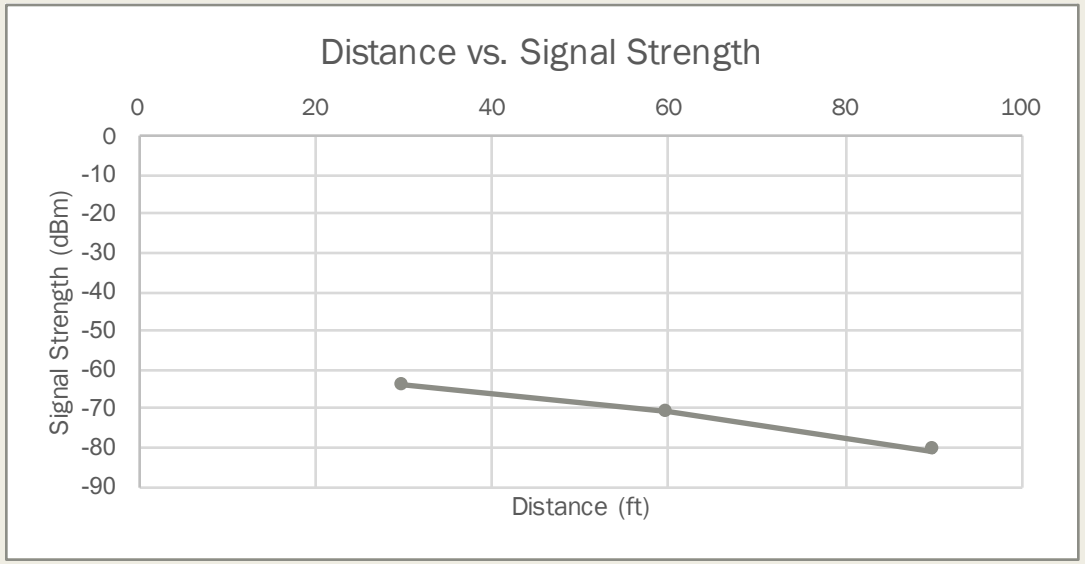
Theory

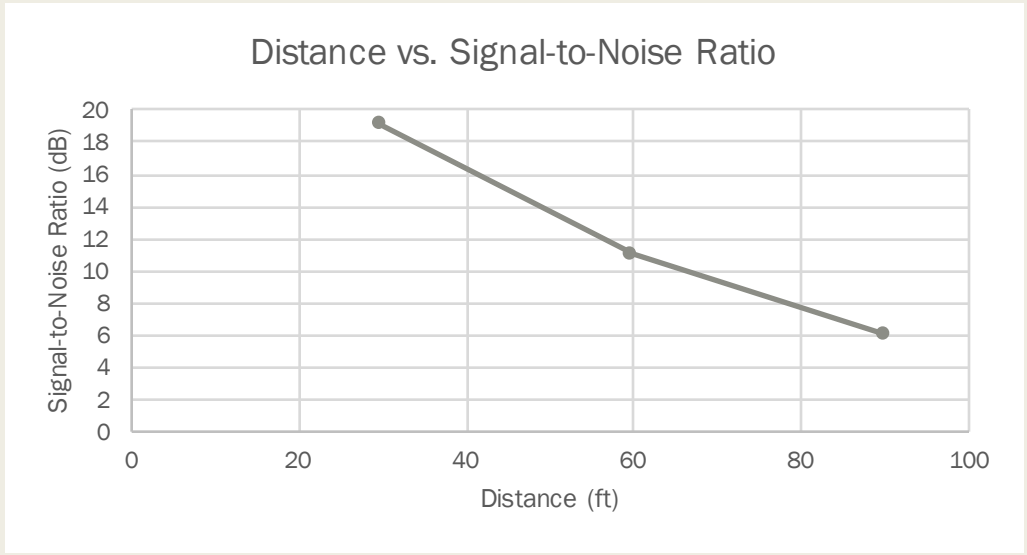
- Lab 2A
  - *Expected data rates: DH1 < DH3 < DH5*
  - *Expect data rate to decrease as distance increases*
- Lab 2B
  - *Expect data rate to decrease as number of slaves increases*
- Lab 2C
  - *Expect data rate to decrease with crossing connections due to interference*
- Lab 2D
  - *Expect Bluetooth throughput to be less than WiFi throughput*

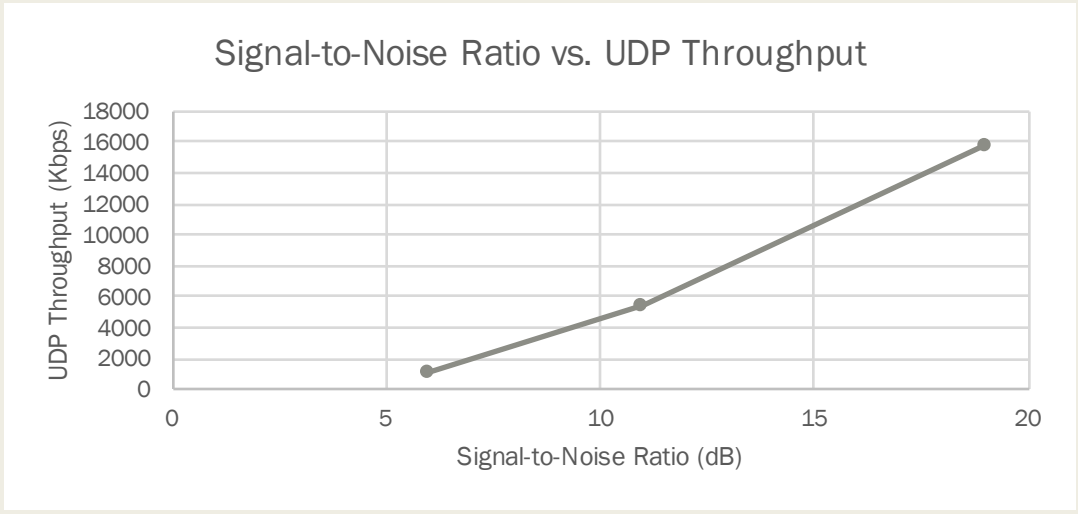
Lab 1A Results – TCP and UDP Throughput vs. Signal Strength

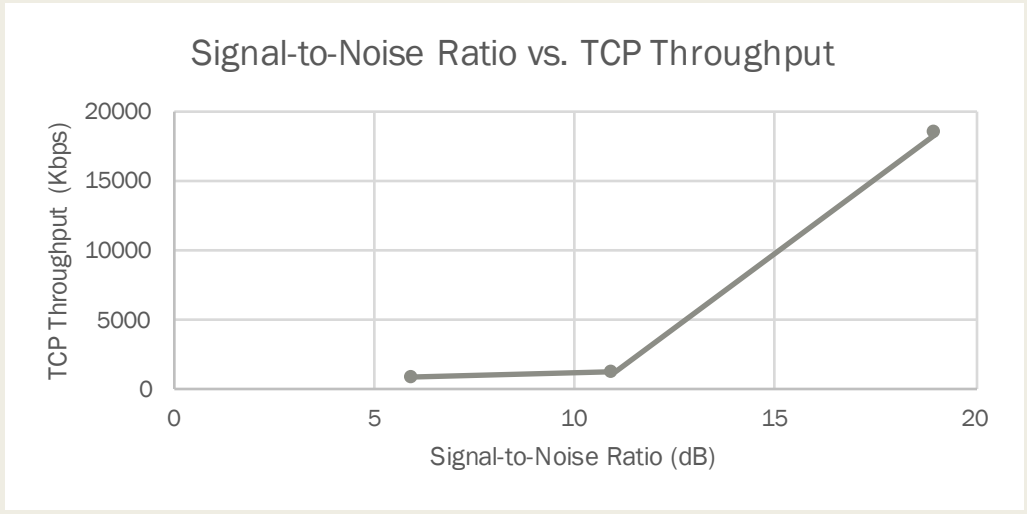
Location	Approx. Distance from Access Point (feet)	Signal Strength (dBm)	Noise Power (dBm)	SNR (dB)	UDP Data Rate (Kbps)	TCP Data Rate (Kbps)	Observations
Wall Across 3704 Entry	30 ft	-64	-83	19	15,800	18,400	
Next to 3428 Suite Main Entry	60 ft	-71	-82	11	5,470	1,240	Did not receive ACK of last datagram after 10 tries
Next to 3424 Entry	90	-81	-87	6	1,100	892	1 datagram received out of order

Lab 1A Results – Diagrams





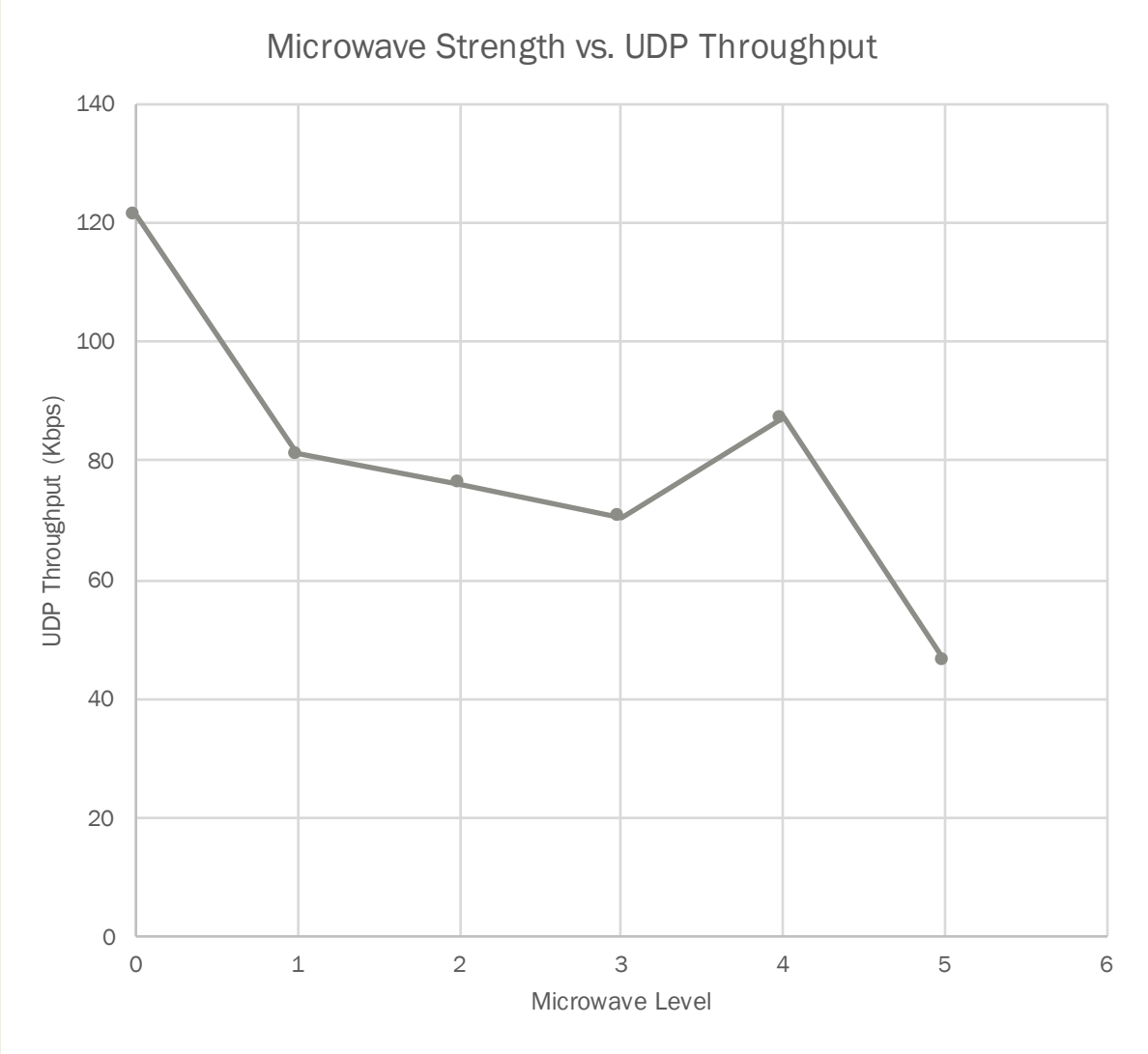


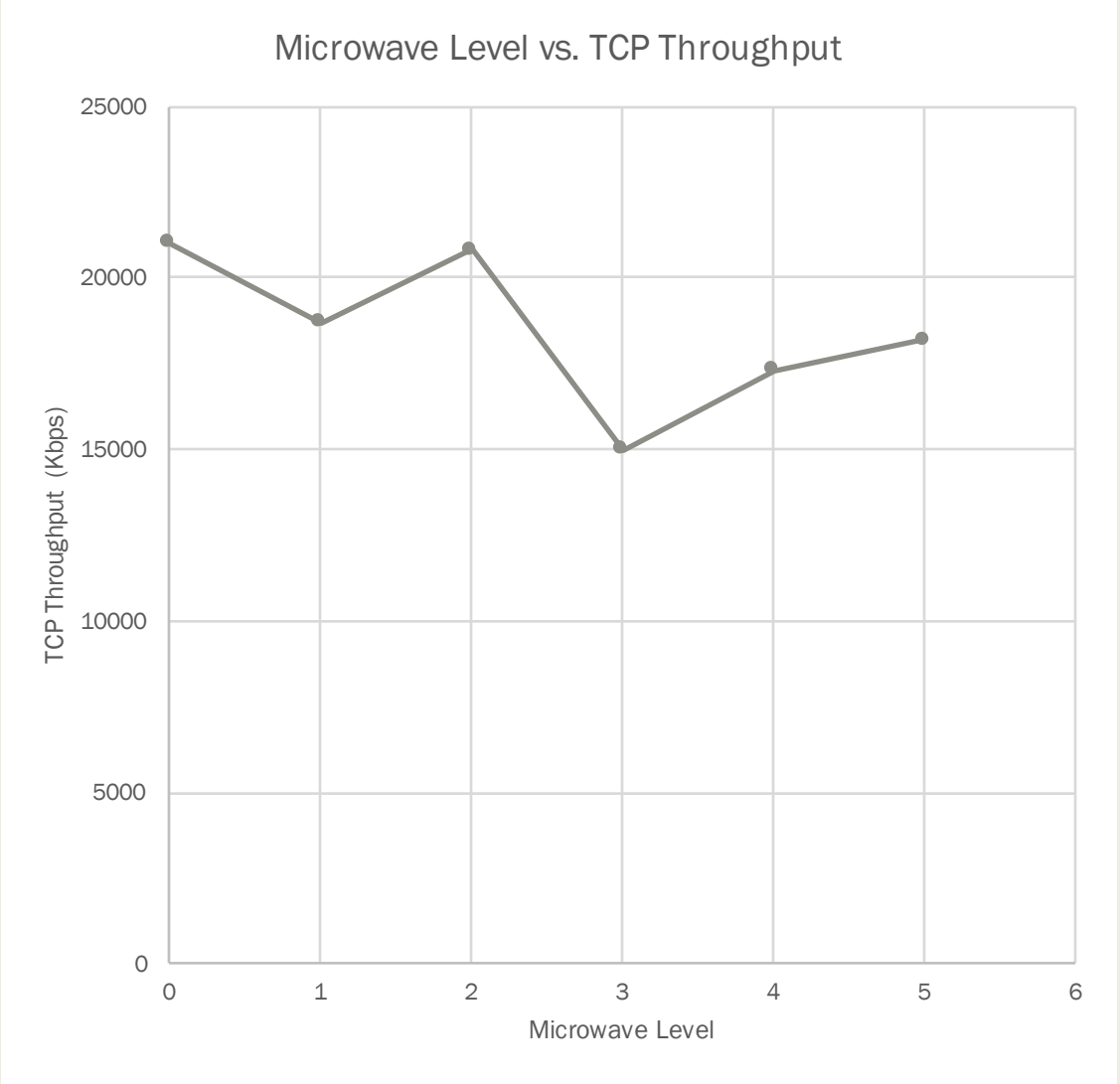


Lab 1B Results – Noise & Throughput with Microwave Oven

Microwave Oven Level	Signal Strength (dBm)	Noise Power (dBm)	UDP Data Rate (Kbps)	TCP Data Rate (Kbps)	Spectrum Analyzer Display Observation (GHz)	Observations
Off	-27	-80	121	21,000	0	None
High	-30	-83	46.6	18,200	30	1 datagram received out of order
Medium High	-27	-80	87.1	17,300	25	1 datagram received out of order
Medium	-29	-80	70.6	15,000	25	1 datagram received out of order
Defrost	-31	-80	76.2	20,800	25	None
Warm	-27	-81	81.1	18,700	20	1 datagram received out of order

Lab 1B Results -- Diagrams





Lab 2A & 2B Results – Data Throughput vs. Distance & Data Throughput vs. # of Slaves

Distance (ft)	Packet Type	Data Rate (Kbps)	Observations
10	DH1	55	Consistent
	DH3	180	“
	DH5	240	Inconsistent
15	DH1	45	Consistent
	DH3	120	“
	DH5	210	Inconsistent
30	DH1	16	Consistent
	DH3	70	“
	DH5	80	Inconsistent

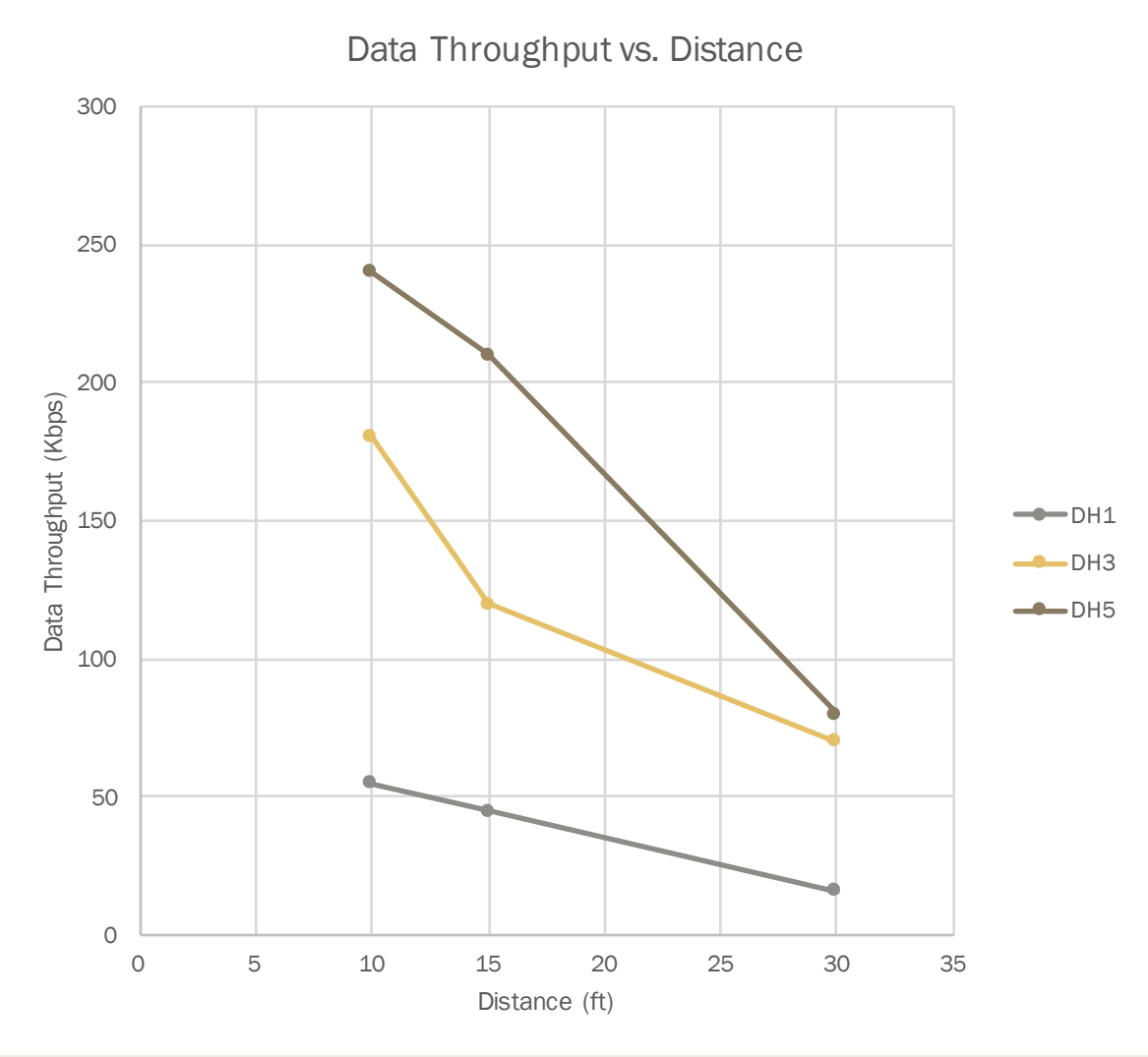
Number of Slaves	Packet Type	Data Rate (Kbps)	Observations
1	DH1	60	Base
	DH3	195	“
	DH5	260	“
2	DH1	15	4x smaller
	DH3	50	“
	DH5	65	“
3	DH1	8	8x smaller
	DH3	25	“
	DH5	40	“

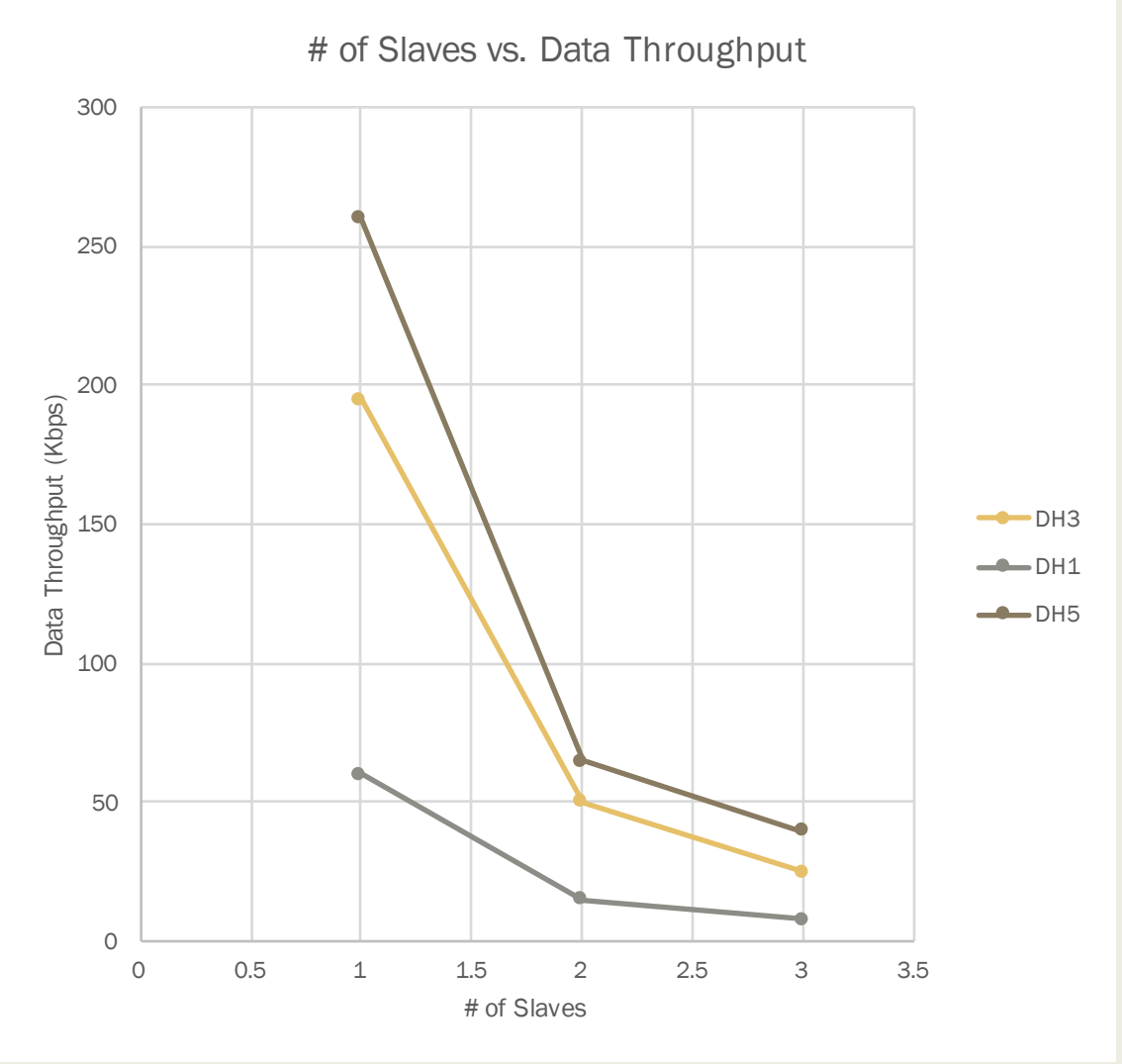
Lab 2C & 2D Results – Fairness of Bluetooth & Fairness between Bluetooth and 802.11b TCP

Case	Pair Data Rate (Kbps)	Observations
Before Interference	266.56	None
3 connections crossing	175	Many tries to establish connection
	260	“
	100	“

	Data Rate (Kbps)	Observations
Bluetooth Throughput	266.56	None
802.11b TCP Throughput	20,000	None

Lab 2A & 2B – Diagrams





Discussion

- Lab 1A
  - *The decrease in UDP throughput is fairly linear with decrease in SNR*
  - *The decrease in TCP is not very linear with decrease in SNR*
  - *TCP throughput decreased faster than that UDP throughput*
- Lab 1B
  - *UDP throughput is significantly lower than TCP throughput with Microwave Off*
  - *UDP throughput is significantly lower than TCP throughput with Microwave On*
  - *UDP throughput decreases more than TCP throughput with Microwave On*
- Lab 2A
  - *Data rate relationship: DH1 < DH3 < DH5*
  - *Data rate decreases almost linearly as distance increases*
- Lab 2B
  - *Data rate relationship: DH1 < DH3 < DH5*
  - *Data rate decreases almost exponentially as number of slaves increases*
- Lab 2C
  - *Data rates for 3 connections crossing is inconsistent*
  - *Data rates for 3 connections crossing is expected to decrease (maybe error was made)*
- Lab 2D
  - *Bluetooth and WiFi fairness accurate: WiFi throughput is significantly higher than Bluetooth*

Conclusion

- For both TCP, UDP, and Bluetooth, throughput will decrease as distance, number of nodes, and interference increases
- Bluetooth transmission speeds are always much lower than WiFi
- `iperf` is a tool for performing measurements on network parameters
- Results were fairly consistent with expectations