**Exercise #3: Raw Data Sheet**

**(Data Transmission over Bluetooth)**

**Part A Table 1. Data Throughput vs. Distance**

|  |  |  |  |
| --- | --- | --- | --- |
| Distance (m or ft) | Packet Type | Data Rate (kB/s) | Observations |
| 10 ft | DH1 | 62 | Mostly in 60s, some drops to 38-45 kB/s |
| DH3 | 198 | Some drops to 155-158 kB/s |
| DH5 | 260 | Some drops to 70-90, 120, and 170 kB/s |
| 15 ft | DH1 | 60 | More drops with lows of 42 or 43 kB/s |
| DH3 | 180 | Few drops to 52 or 78 kB/s |
| DH5 | 265 | Some drops to 90 and 150-160 kB/s |
| 30 ft | DH1 | 40.22 | Varies between 22-54 kB/s, with delay between packets |
| DH3 | 99.3 | Varies between 24-195 kB/s |
| DH5 | 118.74 | Varies between 56-177 kB/s |

Part A Graph 1. Data Throughput vs. Distance

|  |  |
| --- | --- |
| Key | |
| Symbol | Packet Type |
| ▲ | DH1 |
| ■ | DH3 |
| ● | DH5 |

**Part B Table 2. Data Throughput vs. # of Slaves**

(Distance from master to slave nodes: 5 feet)

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Slaves | Packet  Type | Data Rate (kB/s) | Observations |
| 1 | DH1 | 62.63 | Data rate usually constant, occasionally falls |
| DH3 | 197.54 | Occasional large outliers |
| DH5 | 260.24 | Fluctuates between 170-260 kB/s |
| 2 | DH1 | 28.02 | More variation than previous DH1; roughly constant |
| DH3 | 86.94 | More variation than previous DH3; smaller outliers |
| DH5 | 131.17 | Fluctuates around 70, 100, and 170 kB/s |
| 3 | DH1 | 17.57 | Most fluctuation so far |
| DH3 | 60.47 | Greater variant but smaller outliers than DH3 with 3 slaves |
| DH5 | 87.17 | Occasional high outliers |

Part B Graph 2. Data Throughput vs. # of Slaves

|  |  |
| --- | --- |
| Key | |
| Symbol | Packet Type |
| ■ | DH1 |
| ▲ | DH3 |
| ● | DH5 |

**Part C Table 3. Fairness among Bluetooth transmissions**

(Distance from master to slave nodes: 5 feet)

|  |  |  |
| --- | --- | --- |
| Measurement  Case | Data Rate for each pair of connections (kB/s) | Other Observations |
| Before  interference | 262.41 | Fluctuation between 170-260 kB/s |
| 3 connections  crossing | 176.85 | Mostly around 170 kB/s but some fluctuating |
| 178.17 | 1 rare low spike at about 90 kB/s |
| 176.15 | Fluctuations around 70, 100, 200 and 260 kB/s |

**Part D Table 4. Fairness between Bluetooth transmission and 802.11b TCP transmission**

(Distance from master to slave nodes: 12 feet)

|  |  |  |
| --- | --- | --- |
|  | Data Rate (kB/s) | Other Observations |
| Bluetooth Throughput | 174.67 kB/s | Also fluctuates between 260-282 kB/s |
| 802.11b TCP Throughput | 931 kB/s | Single connection, so no fluctuations |

Data Transmission over Bluetooth

*CS M117 Laboratory Exercise 3*

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**Observation**

Experiment 3 is similar to the previous experiment we looked at, but focuses this time on the data throughput of Bluetooth when faced with different factors. This exercise determines the effect of distance, bit error rate (BER), and the one-to-many phenomenon (that is, one master node connected to multiple slave nodes) on the data transmission rate of Bluetooth and its various packet types (DH1, DH3, and DH5). We also explore interference between Bluetooth devices and between 802.11 devices as well. To run these tests, we’ll be using the l2test tool to start data transmissions.

As usual, our results aligned with our expectations. Overall, as expected, we see that DH5 is faster than DH3, which is faster than DH1 in turn. Even when throughput drops, DH5>DH3>DH1 is maintained in terms of transmission rate. Part A demonstrates an inverse relationship between distance and Bluetooth data rate. Similar to wireless data throughput, the data rate of Bluetooth drops at higher distances between nodes and fluctuates more and more. In Part B, adding more and more slaves to the pool decreases the data rate drastically as well. Part C shows us that throughput drops when Bluetooth connections between different nodes cross. The difference doesn’t seem as large as with distance or number of slaves, but data rate still takes a substantial hit. Finally, in Part D, we try crossing a Bluetooth connection with a wireless LAN connection. When both are transmitting, we see that WiFi is actually more “favored” with a slightly higher data rate.

All in all, we see that Bluetooth is affected by many factors that also affect wireless LAN. But when these different types of wireless connections are set to interfere with each other, the data throughput is not necessarily “fair” or equal.

**Goals and Results**

|  |  |  |
| --- | --- | --- |
| # | **Main Goals** | **Results with error** |
| 1  2  3  4 | Effect of distance and Bit Error Rate (BER) on data transmission  Effect of one-to-many connection on Bluetooth data transmission  Interference among Bluetooth devices  Interference and fairness between Bluetooth and IEEE 802.11 devices | Distance is inversely related to Bluetooth data rate. Data rates at 30 feet away are about only half of what they were at 10 feet away. While we didn’t seem to get any packet errors, larger distances seemed to produce more fluctuations in throughput, which may imply an increased BER at even farther distances.  Connecting more slaves to the same group of nodes also decreases the Bluetooth data rate. When a master communicates with 3 slaves, throughput is around 1/3 of what it was with only 1 slave. As before, we also observe the most fluctuations and some outliers.  Crossing devices that are communicating with each other by Bluetooth decreases the data rate by a respectable amount (although not as drastic of a change as the distance or number of slaves affects). Before interference, we have 262 kB/s, but after crossing 3 connections, each one is at about 177 kB/s.  There is not very much fairness between interference of Bluetooth and 802.11n wireless LAN connections. Crossing these produces a Bluetooth data rate of 175 kB/s, whereas wireless TCP gets a whopping 931 kB/s. |