CSE 190 Quadcopter.
Lab 1
Team # 6
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Requirement:

1. Measuring bandwidth:
   a. Methodology:

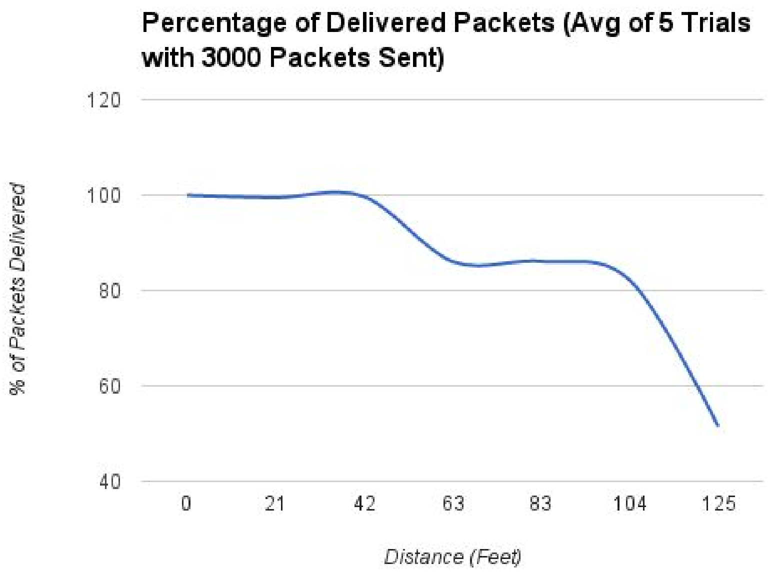
      To measure the maximum number of bits the board can send per seconds, we used rfPrint to send a string which was the largest packet we could send. We did this so we could fill the 128 byte frame buffer (http://www.atmel.com/Images/Atmel-8266-MCU_Wireless-ATmega128RFA1_Datasheet.pdf). and looped through to send 1000 packets. In our program, we put a timer for the time it took for this process to complete. We calculated the bits per second from the known amount of data transmitted and the known time to complete that action.

   b. Results:
      i. Find the maximum bytes we can send through rfPrint without losing information. We found that rfPrint can store 127 bytes given that the first byte of the buffer frame is used to store the length of the string, so we started with 127, and reduced the number of bytes per string(or per packet or per rfPrint call) from there, and found that the maximum number of bytes rfPrint can send without losing information is 125.
      ii. Use rfPrint to send 1000 packets and calculate the bps.
          125 byte/packet $\times 1000$ packet $\times$ 8bit/byte $\div$ (timeInMicros $\div 1000000$ ms/s)
          $= 125 \times 1000 \times 8 \div (4354176 \div 1000000)$
          ≈ 230 kbps
   c. Difficulties:
      i. At first, we mixed up the baud setting for Serial with rf channels.
      ii. At the beginning, we also did not realize that we do not need the other board to test the maximum bits we can send per second.
      iii. It also took us a while to figure out the difference between rfWrite and rfPrint. Using rfWrite, we are restricting ourselves with sending 1 byte per packet which had a lower throughput, but it increased the accuracy. Using rfPrint, we could send more data per “transaction”.
2. Measuring lost packet rate.
   a. Methodology:

      To measure packet drop, we transmitted 3000 packets of 1 byte with the content of characters of ‘5’ from one board to another, and the other board will count the number of ‘5’s it received. The difference will tell us the number of dropped packets. Therefore, we can calculate the lost packet rate from there. We sent 3000 individual packets so we can get a more accurate average packet loss rate.

      To measure how the packet drop vary when boards are further apart, we conducted an experiment and measured how many packets we lost out of the 3000, or the lost packet rate. Using this method, we started from 0 paces to about 60 paces (each pace was 25 inches), at intervals of 10 paces we did 5 trials. We took the average of the packet success rate from the 5 trials to conclude our results. The data is shown on the next page.

b. Results:



Every step is approximately 25 inches.

Paces	0	10	20	30	40	50	60
Timeout*	0	0	0	1	2	1	0
Average lost packet rate over 5 runs	0	0.005	0.003	0.139	0.138	0.178	0.485

*When our ending byte is lost in one session, we note it as a timeout, and invalidate that data.

c. Discussion:

We were testing this in an open area on campus, and we noticed significant packets drop when there are pedestrians or bikers passing by the line of sight for the two boards. The lost packet rate seems to be decreasing overtime, and we notice a significant drop when one board is 60 steps away from the other board. This gives us an estimate of the functional range of our boards, which is approximately 125 feet (38.1 m).

d. Difficulty:

Anything around us seem to influence the lost packet rate. We had several timeout due to loss of termination byte, which rendered the data invalid. We did not go through all 75 meters to test out when the lost packet rate drops under 50% due to time/space constraints.

3. Questions to consider:

a. How will you measure bandwidth with reasonable accuracy? [see part 1]

b. How will you determine whether a packet has been dropped? [See part 2]

To add to this question, we also calculated the lost packet rate using maximum speed. We found that if we use rfPrint to send 125 bytes for only one time, we can receive 100% of the bytes on another board, but if we use rfPrint 2-3 times in a row, we get 77% of the sent data, and if we send 125 bytes using rfPrint for1000 times in a row, we can only receive 65% of the data on the other board. If we reduce the speed by sending only 1 byte per packet, and call rfPrint for 125000 times, the speed is about 10 times slower, but we can receive 99.8% of the data sent.

c. Do you think you can send data in both directions as quickly?

We don't think we can send data in both directions at maximum kbps, because we noticed that we have more packet losses as we increase the kbps by increasing the number of bytes per packet. Because we can only read one byte at a time, sending too many bytes at the same time using rfPrint too often may cause the receiving end miss out on some random bytes.

On another hand, if we send one byte per packet, we have a lower lost packet rate, but to send the same amount of bits will cost more time. We noticed this trade-off between bytes per packet and speed.

d. How do these measurement vary as the boards move farther apart?

Based on b, we decided to send 1 byte per packet to minimize the lost packet rate. The details can be found in part 2.