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# Lab 1 Writeup

1. How will you measure bandwidth with reasonable accuracy?

We can measure the upper limit of the bandwidth to be the average time it takes for one of the red boards to transmit a packet of the largest possible size (in our case a data size of 125 bytes is the largest that will send successfully). Assuming packet acknowledgements are important, we could also try to measure the bandwidth in the way suggested on piazza. That is, we would transmit a packet on one red board, read it on the second red board, send an acknowledgement back to the first red board and measure how long that process takes, then divide by 2 to get the sending time.

In our tests, we sent 1000 packets each with 125 bytes of data for a total of 1,000,000 bits. The transmission time stayed consistent regardless of the distance between the boards, suggesting that sender does not wait for any acknowledgement from the receiver and does not attempt to resend any missed packets. The average time in our tests was 4354 ms, giving us a max bandwidth of 230 Kb/s assuming no packets are dropped.

2. How will you determine whether a packet has been dropped?

The red boards have a built in CRC part of a packet that helps in detecting packets that had invalid bits in them. The provided code has an interrupt routine that is called when a packet is finished receiving, so we can check the CRC there. We also can keep track of how many packets we are sending and keep a count of how many packets are received to see how many packets were invalid vs the ones that the receiver did not pick up at all.

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

No, because the wireless device can only either be in a sending state or a receiving state, not both simultaneously (half-duplex), and any packets that are sent while a device is not in the receiving state will be lost. So, in order to send data back and forth, the boards would have to stay synchronized with each other, possibly by waiting for an acknowledge packet every time data is sent.

4. How do these measurements vary as the boards get farther apart?

As the boards get farther apart, the number of dropped packets and thus the error rate increases. We could definitely think of this as the bandwidth decreasing especially if we are considering sending data with which all the packets need to get to their destination. This would mean we would need to retransmit some packets resulting in a smaller overall

throughput. For real-time applications retransmitting would often be undesired though because any significant delay could make the data previously sent invalid or unwanted at the current time.

P.S.
We should not use the 2.4 GHz channel 14 in the CSE building (at least in the 2nd floor lobby). There was a lot of interference on that channel. We received about 100 valid packets and about 2 packets that failed the CRC every 5 seconds. Channels 13 and 15 had no interference on them which leads us to believe someone in the area is using channel 14 on their own microcontroller.