Spaceflight “Passive” Wireless Sensors

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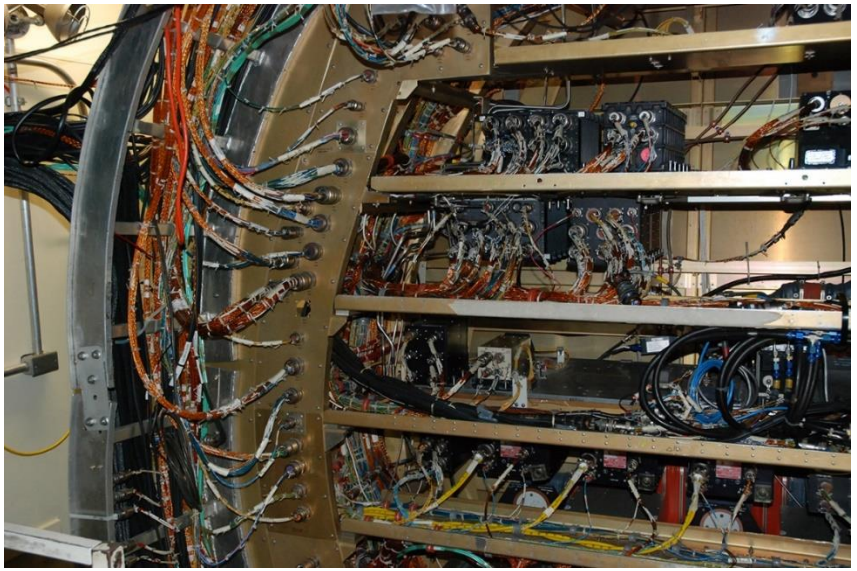
Introduction

Project Statement: Develop wireless sensors that can be used on instruments and spacecraft during flight and/or integration and test that can provide a significant increase in data acquisition capabilities.

Why Go Wireless?

- Eliminates mass and clutter associated with using wired connections
- Significantly reduces cost and time it takes to run tests
- Allows for spindle and deployment mechanisms to operate more efficiently
- Can more effectively collect data in hard-to-reach locations (vacuum chamber)
- Able to stay on flight as passive item unless queried



Source: http://www.collectspace.com/news/news-081512a.html

Background on ZigBee/XBee

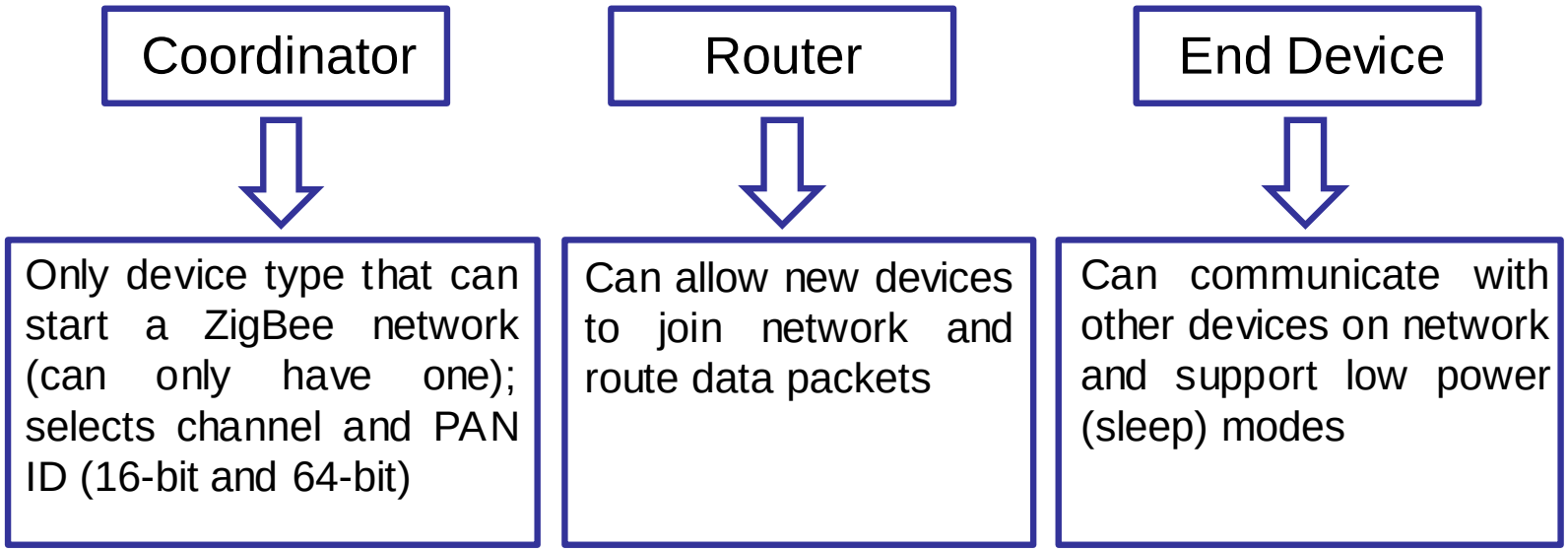
- ZigBee: a packet-based RF protocol that can be used to create low-rate wireless personal area networks
  - Low power, low duty cycle, low data rate requirement devices
- XBee: physical radio module whose name refers to form factor

XBee S2C image from Digi.com.

Frequency Band	Data Rate	Max. Indoor Range	Max. Outdoor Range	Supply Voltage	Operating Current
2.4 GHz	250 kb/s	133 ft (40 m)	400 ft (120 m)	2.1 – 3.6 V	~40 mA

Xbee Module Specifications from Digi ZigBee RF Modules Documentation.

ZigBee Network



ZigBee Network

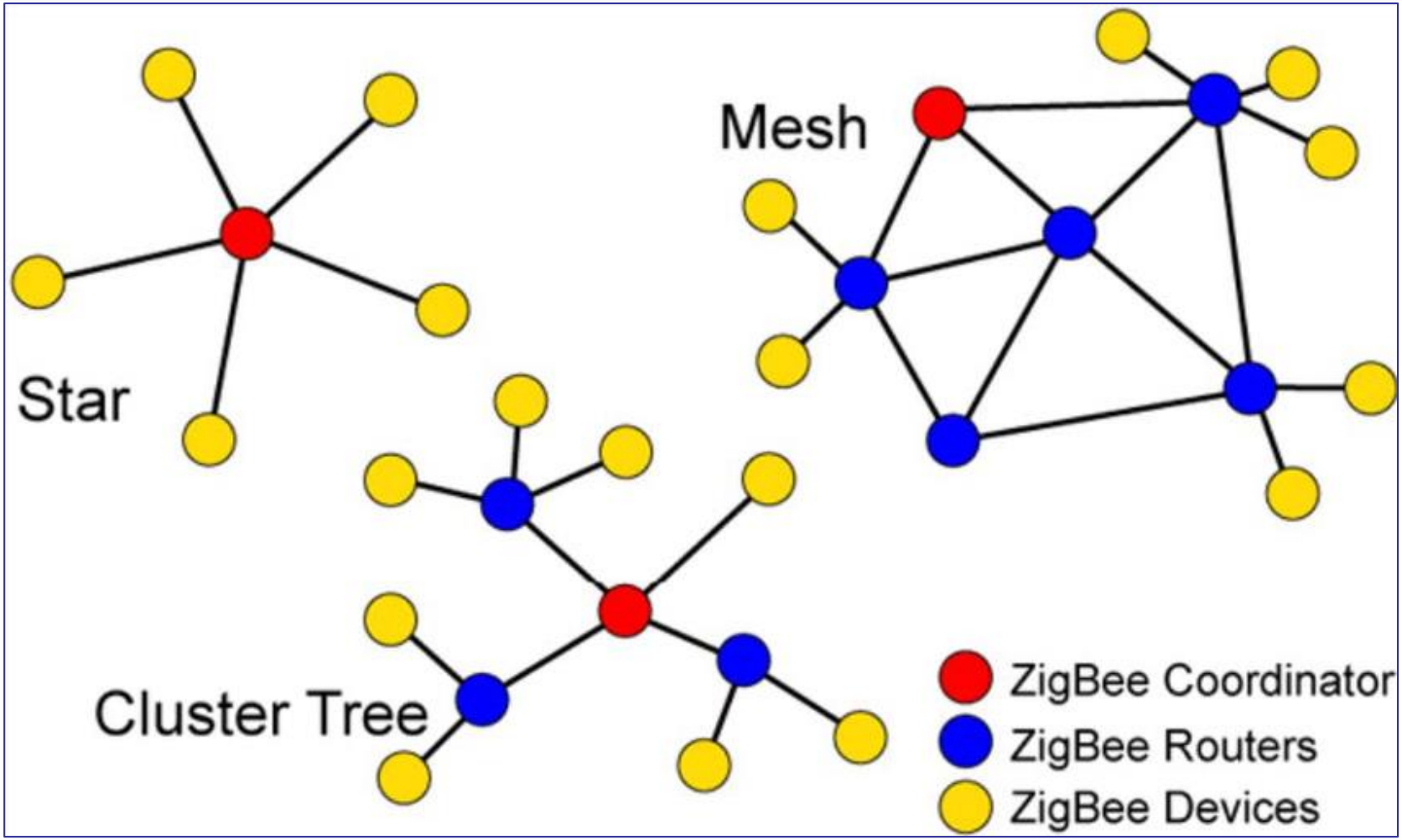


*Image from "*Wireless body sensor networks for health-monitoring applications."

XBee Operation

Transparent (AT) Mode	Application Programming Interface (API) Mode
• Simple interface that easily allows for data to transmit through XBees • What you send is exactly what you receive	• Can send RF data to multiple XBees • Can configure devices in network remotely • Can view source address of received RF data

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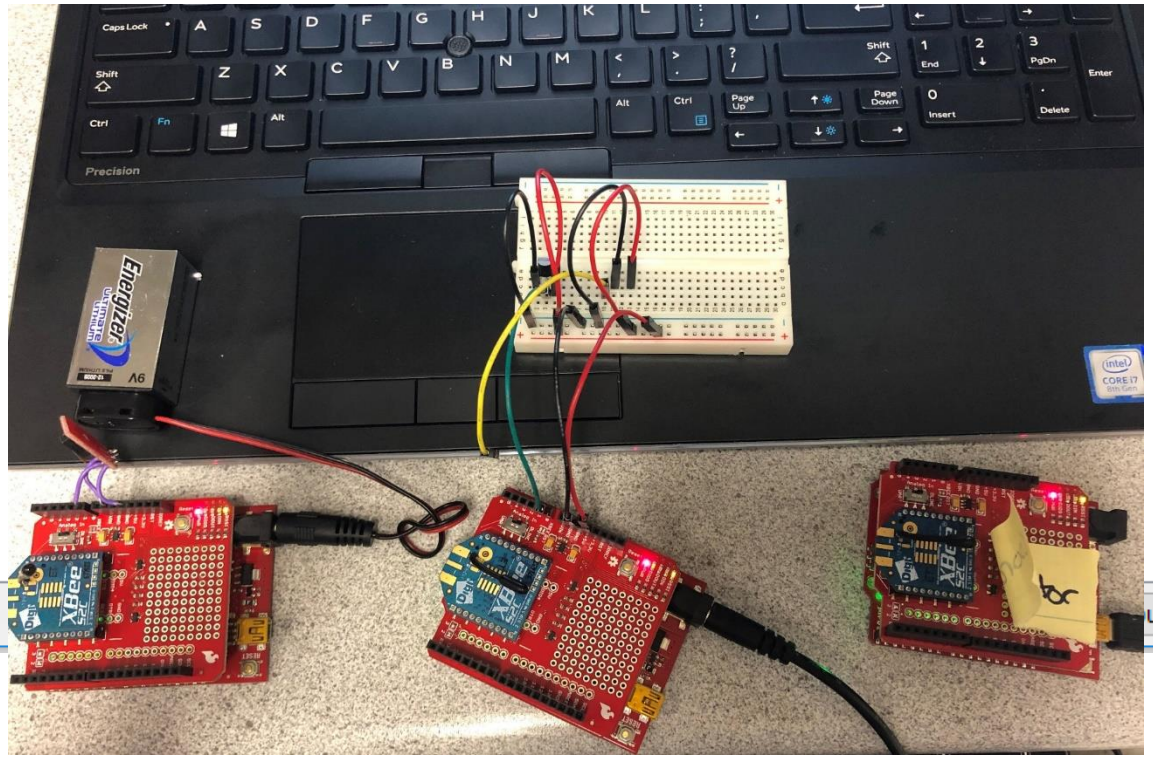
Programming Sensors

COM4

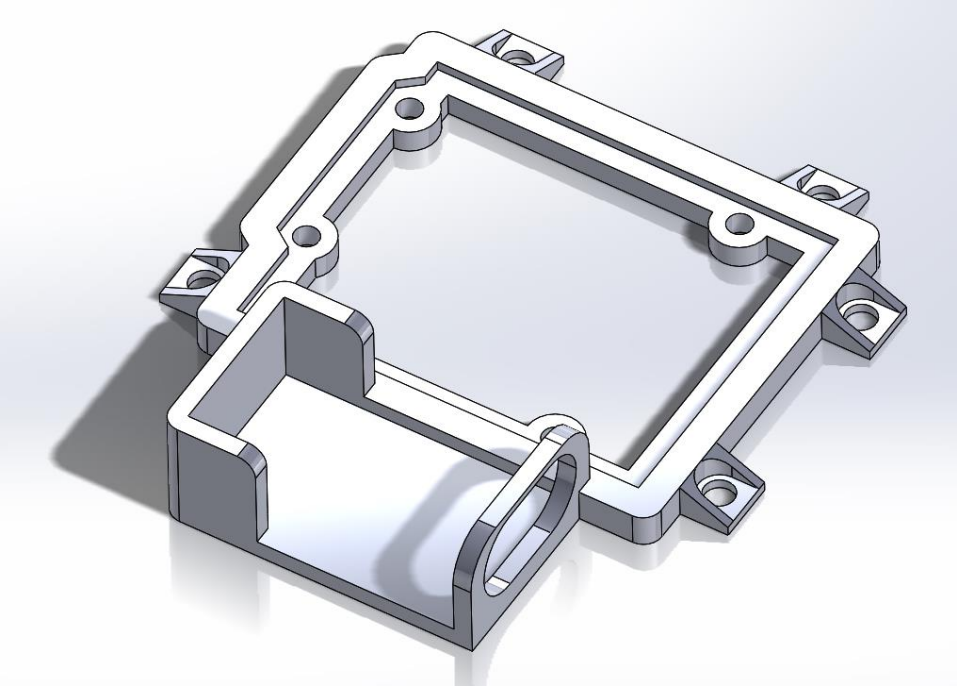
Send

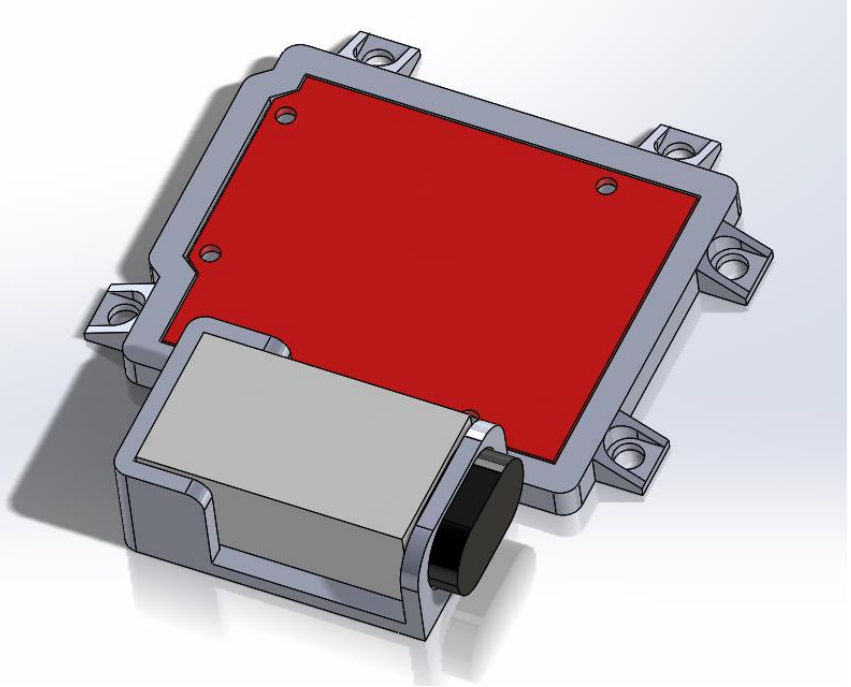
```
Attempting to retrieve data from XBee...

Data retrieval successful.

Address: 0013A20041768C2B (Router 2)
Temperature =  25.00 C ( 77.00 F)
Sensor Voltage =   2.53 V
Relative Humidity =  55.70 %
True Relative Humidity =  56.14 %

Address: 0013A2004151F069 (Router 1)
  0.73 volts
 22.75 degrees C
 72.96 degrees F

Address: 0013A20041768C2B (Router 2)
```

Autoscroll Show timestamp



Electronics Mount





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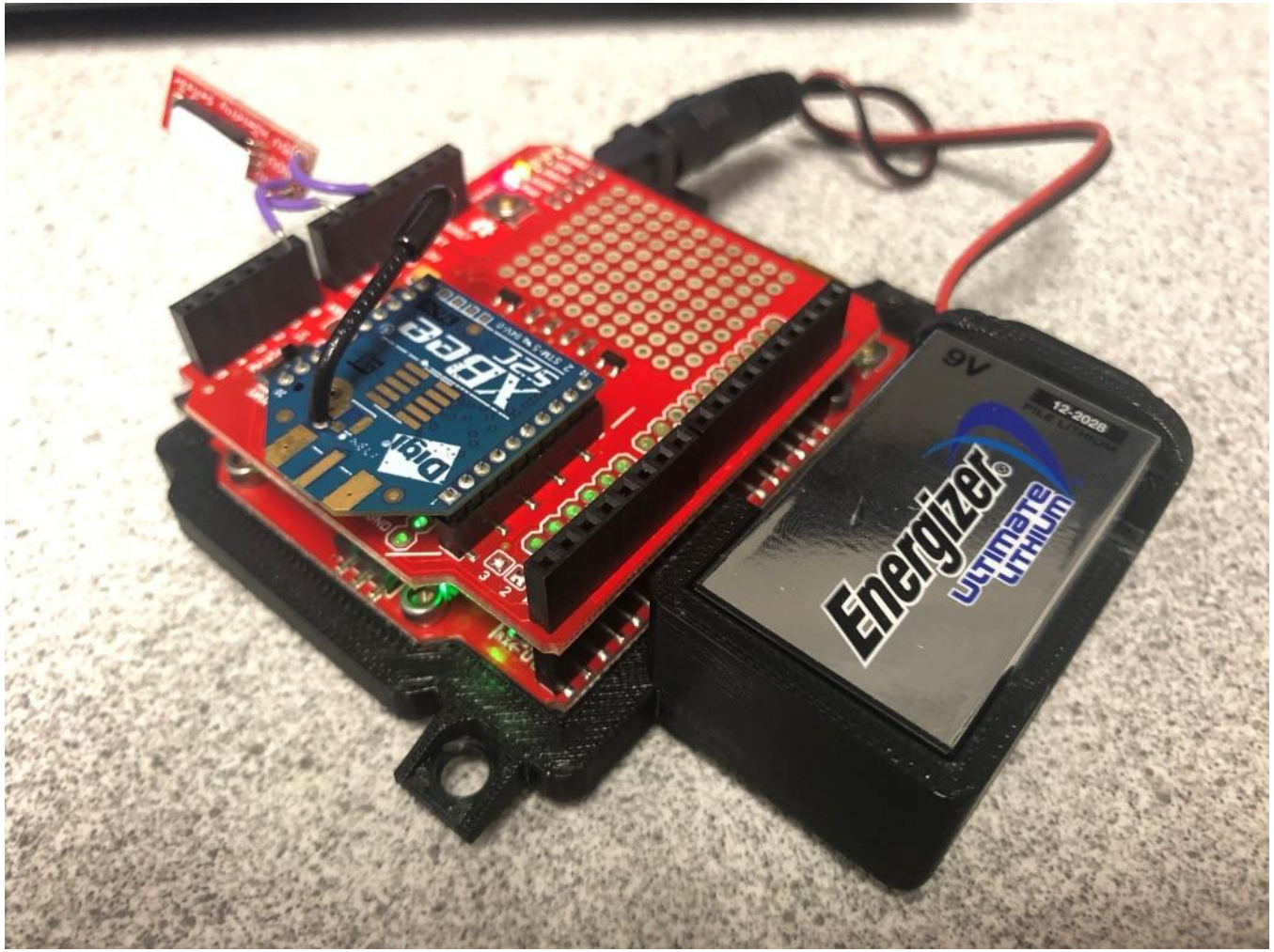
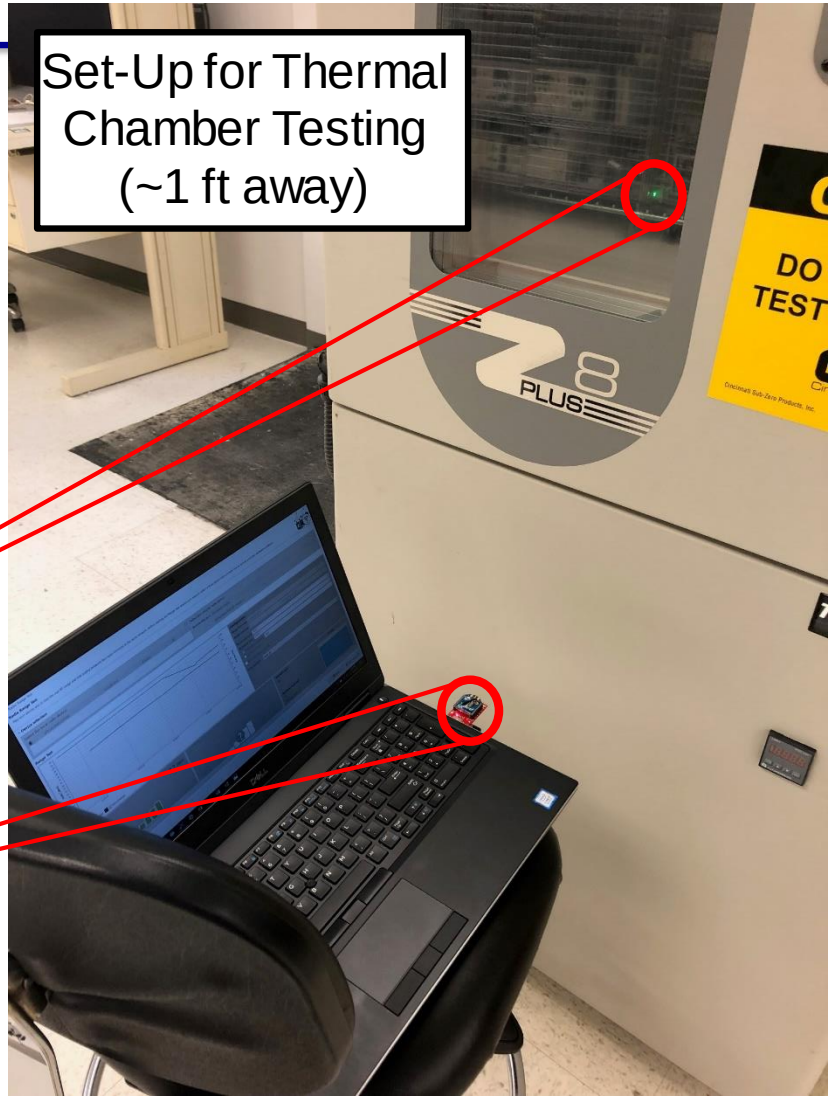


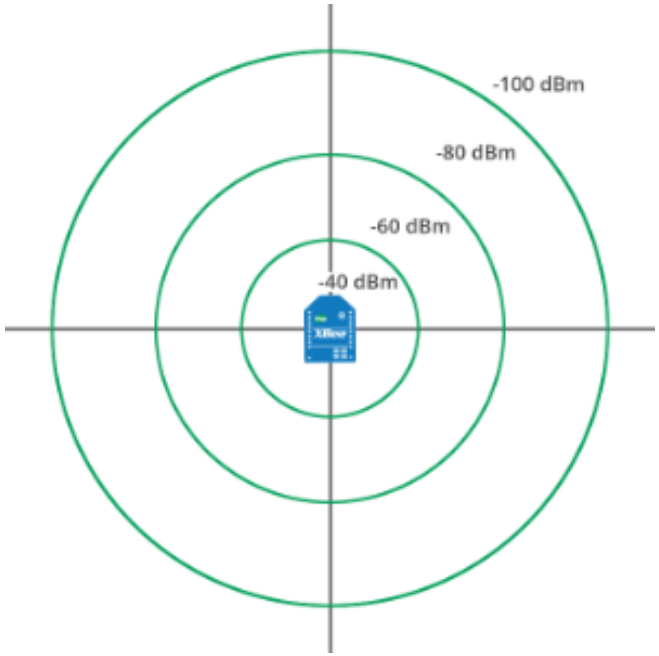
Range Testing

- Conducted XBee range test
  - Nominal and in Thermal Chamber
  - 1 ft and 10 ft distance for each
    - 4 total types of tests
  - 3 rounds of tests for each type
  - 100 packets per test



Range Testing (cont'd.)

	Nominal (1ft)	Nominal (10ft)	Chamber (1ft)	Chamber (10ft)
Avg. Success (%)	87.7	87.3	88	88
Avg. RSSI (dBm)	-27.3	-50	-31.7	-46.3



Source: https://www.digi.com/resources/documentation/Digidocs/90001456-13/concepts/c_rssi_pin_and_signal_strength.htm

- A greater negative RSSI value indicates a weaker signal
- 5 bars (full) for all 1ft testing
- 4 bars (sometimes 3) for all 10ft testing

Future Work

- Short-Term Goals:
  - Solder sensors onto perf board and verify sensor data
  - Spindle testing
  - Design other electronic mounts
  - Implement API mode
  - Develop XBee user guide document for future interns
- Long-Term Goals:
  - Finalizing XBee package for official spindle testing in a thermal/vacuum chamber
  - Data transmission between XBee and phone

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Questions?