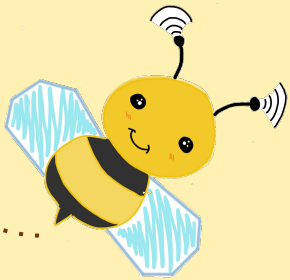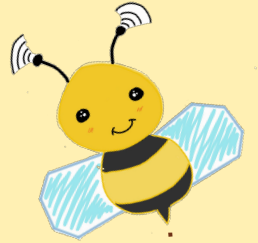# Final Presentation

Team Bumblebee
Spring 2021

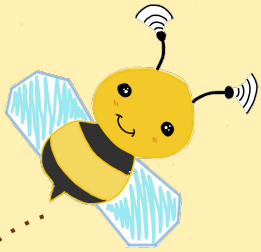# Members

**Brian Griswold**
EE396, EE- EP

**Francis Sonoda**
EE496, EE- EP

**Thant Thiri**
EE396, EE- EP

**Lauryn Corpuz**
EE496, EE-EP

**Yin Aye**
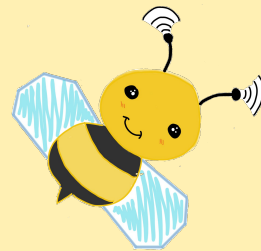EE396, EE-EP

# Presentation Overview

- Block Diagrams
  - Power
  - Signal/Communication
- Team Progress
- Problems
- Gantt Chart
- Future Work
- Questions

# Power Block Diagram



**POWER SYSTEM**

Solar Panel → Charing Circuit → 5V Voltage Regulator → 3.3V Voltage Regulator → Wireless Transceiver XBee S2C Pro

Battery

ATMEGA 328

ISP Programming Pins
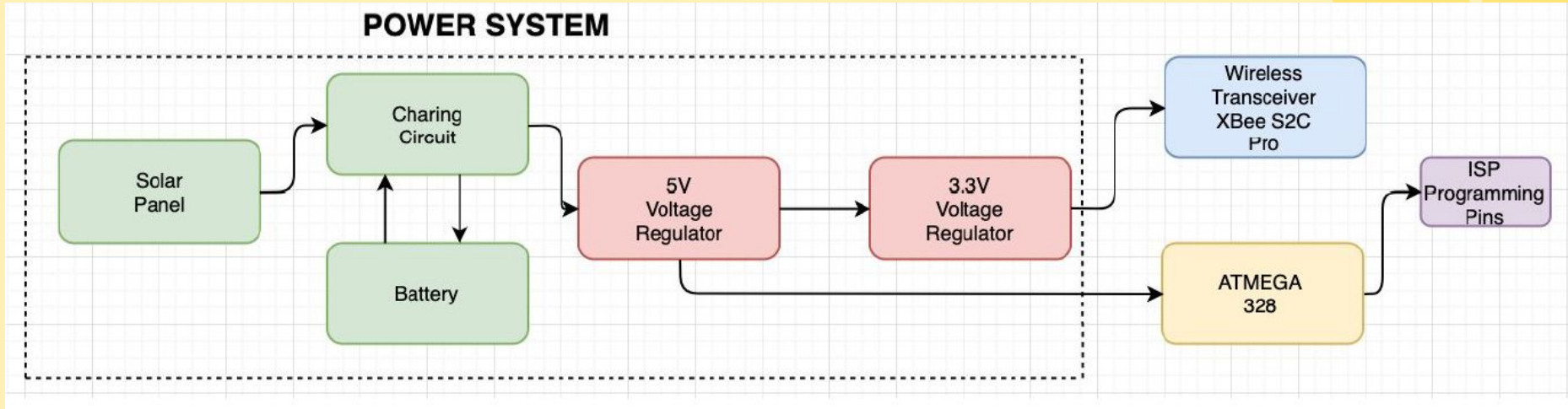
# Signal/ Communication Block Diagram
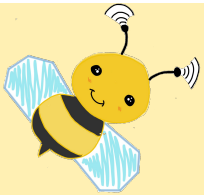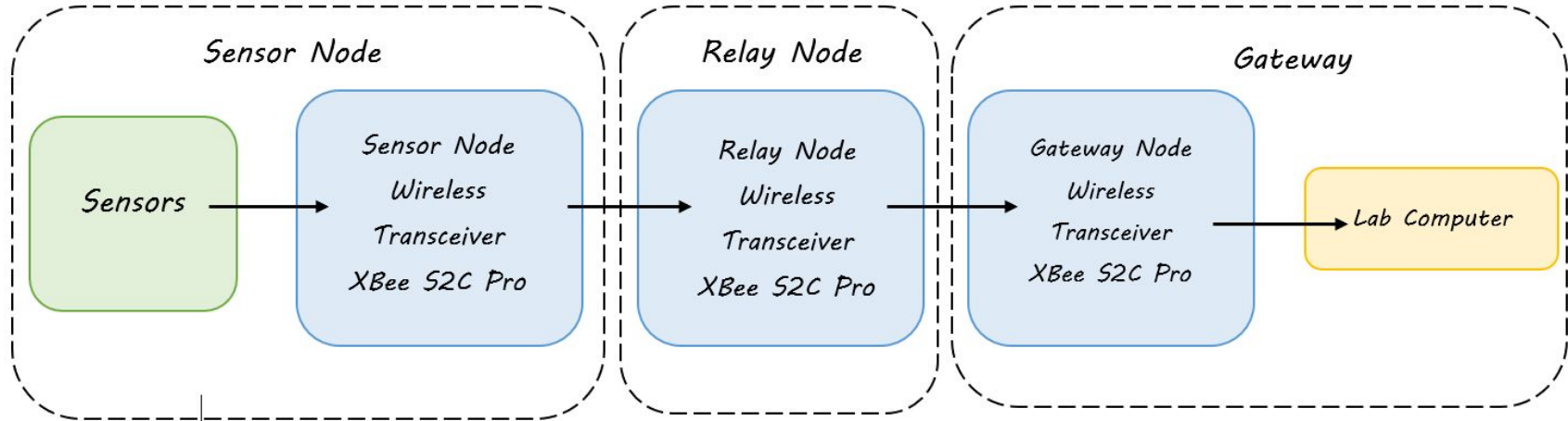
# Team Progress

- Verified that with or without voltage regulator, still works thorough range testing
    - Decided to keep Volt. Reg as part of our design. Range Testing
- Range testing
    - Conducted another range test: line of sight
        - Did it along Dole street
        - Used up to 4 XBees

## Multiple XBee Line of Sight

Decibals (dBm)

legend: local, remote

Distance (ft.): 250, 500, 750, 1000

## Single XBee Line of Sight

Decibals (dBm)

legend: local, remote

Distance (ft.): 250, 500, 750, 1000
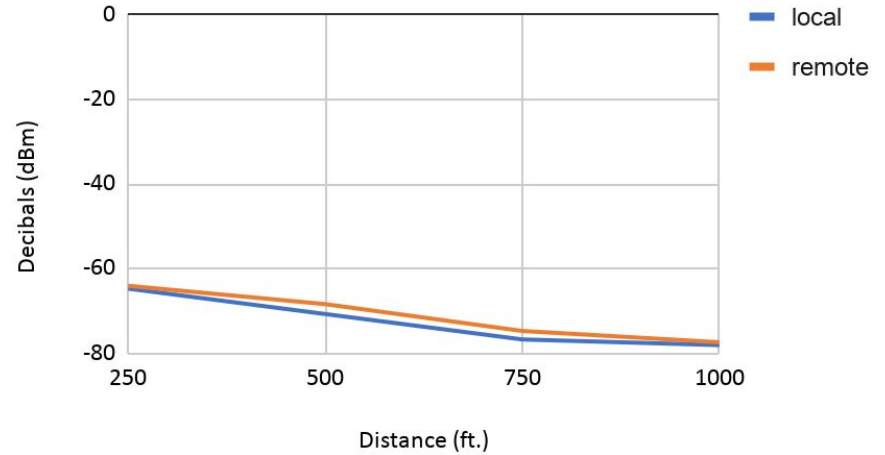
**Average Line of Sight w/o Volt. Reg**

Signal Strength (dBm)

local
remote

Distance (ft)

**Average Line of Sight**

Signal Strength (dBm)

local
remote
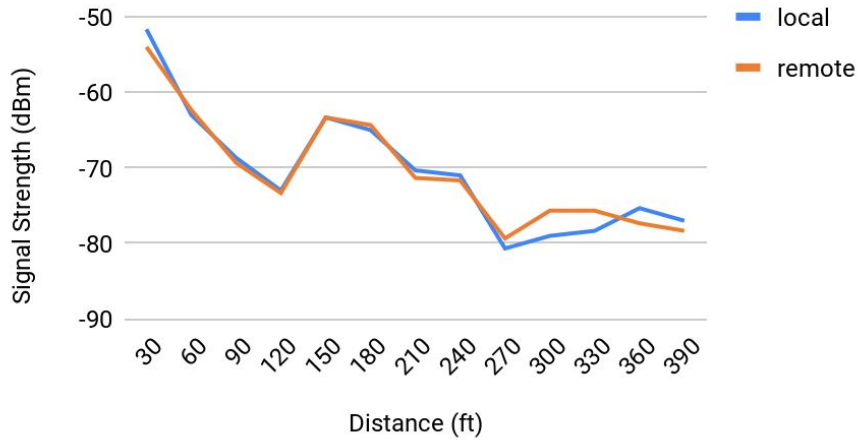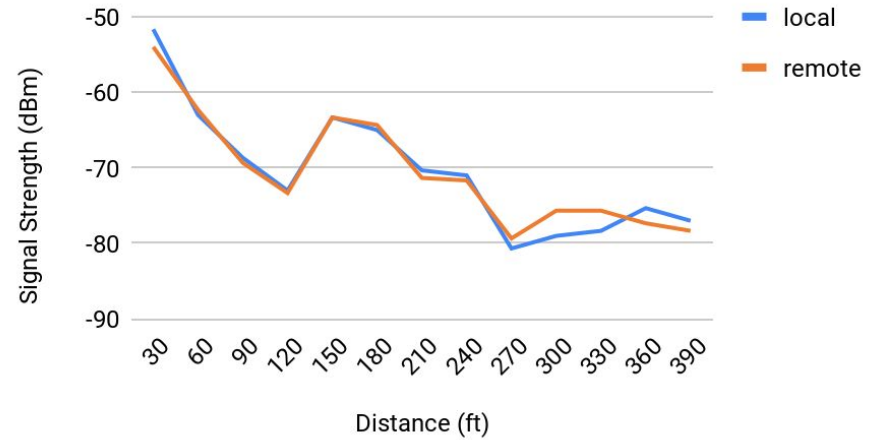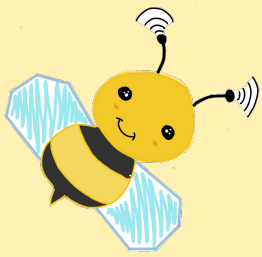
Distance (ft)

# Problems

- When range testing greater distances, harder to keep track of distances

  - Used telephone poles to find distances "125ft between"

- V4.0 intermittent connection on one PCB during range tests

  - Battery power supply from loose regulator

# TEAM BUMBLEBEE

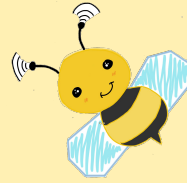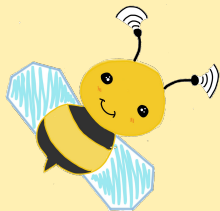| Spring 2021 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1/18/21 | 1/25/21 | 2/1/21 | 2/8/21 | 2/15/21 | 2/22/21 | 3/1/21 | 3/8/21 | 3/22/21 | 3/29 | 4/5/21 | 4/12/21 | 4/19/21 | 4/26/21 | 5/3/21 |
| **Presentations** | | | | | | | | | | | | | | | |
| Proposal | | ██ | | | | | | | | | | | | | |
| PDR | | | | | ██ | | | | | | | | | | |
| CDR | | | | | | | | | | ██ | | | | | |
| Final | | | | | | | | | | | | | | ██ | |
| **Bare Bumblebee** | | | | | | | | | | | | | | | |
| Build Bare Board | | | | | | | | | | | | | | | |
| Test Board | | | | | | | | | | | | | | | |
| Relay Testing | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ |
| **PCB Bumblebee** | | | | | | | | | | | | | | | |
| Fabricate New Board | | | | | | | | | | | | | | | |
| Order New Parts | | | | | | | | | | | | | | | |
| Populate | | | | | ██ | | | | | | | | | | |
| Test Board | | | | | ██ | ██ | ██ | ██ | | | | | | | |
| Relay Testing | | | | | | | | | ██ | ██ | ██ | ██ | ██ | ██ | |
| **Research** | | | | | | | | | | | | | | | |
| Raspberry Pi | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | | |
| WiFi Method | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | | |
| **Reports** | | | | | | | | | | | | | | | |
| Final Report | | | | | | | | | | | | | ██ | ██ | |
| **New Plan** | | | | | | | | | | | | | | | |
| Range Testing | | | | | | | | | | ██ | ██ | ██ | ██ | ██ | ██ |
| Documentation | | | | | | | | | | ██ | ██ | ██ | ██ | | |
| Research | | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ | ██ |

# Future Work

- Create a new design called version 4.2

- Range testing using version 4.2 PCB

- Range testing with other hardware team's board since v4.0 works properly

# Upcoming Tasks on version 4.2 design

- V4.2

  - Implement decoupling capacitors in Xbee voltage supply per manufacturer recommendations.

**Power supply design**

A poor power supply can lead to poor device performance, especially if you do not keep the supply voltage within tolerance or if it is excessively noisy. To help reduce noise, place a 1.0 μF and 8.2 pF capacitor as near as possible to the VCC connection on the XBee 3 (pad 2 for micro and surfacemount, and pin 1 for through-hole). Adding a 10 μF decoupling capacitor is also recommended. If you are using a switching regulator for the power supply, switch the frequencies above 500 kHz. Limit the power supply ripple to a maximum 50 mV peak to peak. For best results, place the lower capacitance capacitors closest to the XBee 3 device.

**Note** XBee 3 parts with an early revision of the microcontroller unit (MCU) may experience an issue recovering from brownouts under rare conditions. See Brownout issue for details on how to avoid this issue.

**Board layout**

We design XBee 3 modules to be self-sufficient and have minimal sensitivity to nearby processors, crystals or other printed circuit board (PCB) components. Keep power and ground traces thicker than signal traces and make sure that they are able to comfortably support the maximum current specifications. There are no other special PCB design considerations to integrate XBee 3 modules, with the exception of antennas.

**Antenna performance**

Antenna location is important for optimal performance. The following suggestions help you achieve optimal antenna performance. Point the antenna up vertically (upright). Antennas radiate and receive the best signal perpendicular to the direction they point, so a vertical antenna's omnidirectional radiation pattern is strongest across the horizon.

Position the antennas away from metal objects whenever possible. Metal objects between the transmitter and receiver can block the radiation path or reduce the transmission distance. Objects that are often overlooked include:
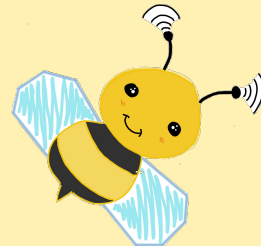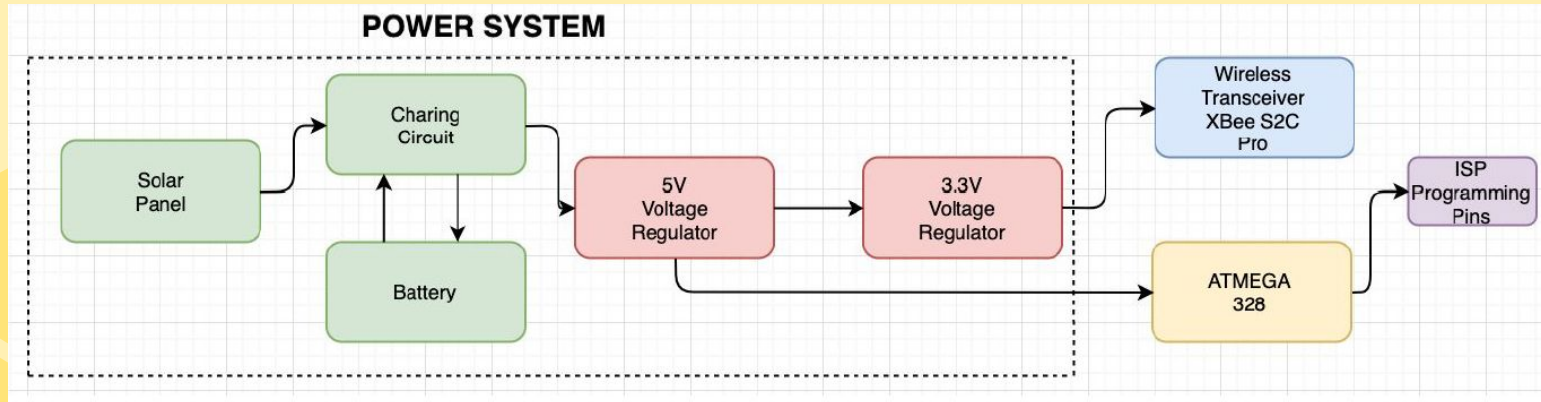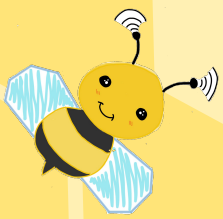
# Upcoming Tasks on version 4.2 design

■ Change voltage regulator.

TBD new design.

Operating voltage:

- 2.7V to 5.5V for ATmega328P ● Temperature range:
- Automotive temperature range: –40°C to +125°C ● Speed grade:
- 0 to 8MHz at 2.7 to 5.5V (automotive temperature range: –40°C to +125°C)
- 0 to 16MHz at 4.5 to 5.5V (automotive temperature range: –40°C to +125°C) ● Low power consumption
- Active mode: 1.5mA at 3V - 4MHz
- Power-down mode: 1μA at 3V

**POWER SYSTEM**

Solar Panel → Charing Circuit → 5V Voltage Regulator → 3.3V Voltage Regulator → Wireless Transceiver XBee S2C Pro / ATMEGA 328 → ISP Programming Pins
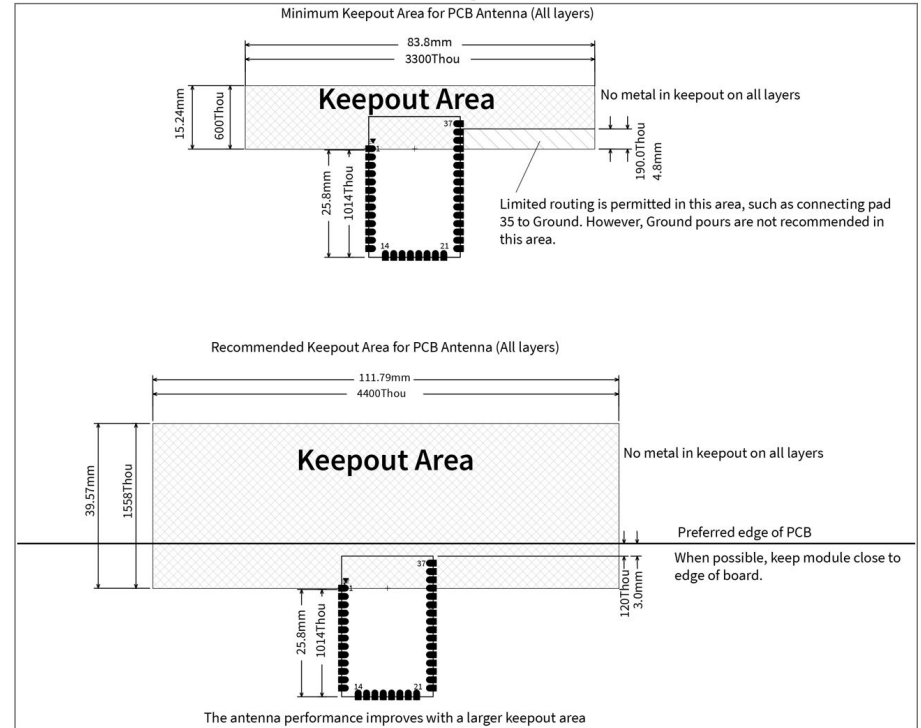
Battery

# Upcoming Tasks on version 4.2 design

- ● V4.2

  - ○ Enlarge PCB in order to increase separation of XBee antenna.

  - ○ Reduces interference by keeping PCB traces out of EM wave while antenna is transmitting.



**Surface-mount embedded antenna keepout area**

Minimum Keepout Area for PCB Antenna (All layers)

83.8mm
3300Thou

15.24mm 600Thou

**Keepout Area**

No metal in keepout on all layers

25.8mm 1014Thou

190.0Thou 4.8mm

Limited routing is permitted in this area, such as connecting pad 35 to Ground. However, Ground pours are not recommended in this area.

Recommended Keepout Area for PCB Antenna (All layers)

111.79mm
4400Thou

39.57mm 1558Thou

**Keepout Area**

No metal in keepout on all layers

Preferred edge of PCB

When possible, keep module close to edge of board.

25.8mm 1014Thou

120Thou 3.0mm

The antenna performance improves with a larger keepout area

Questions?