

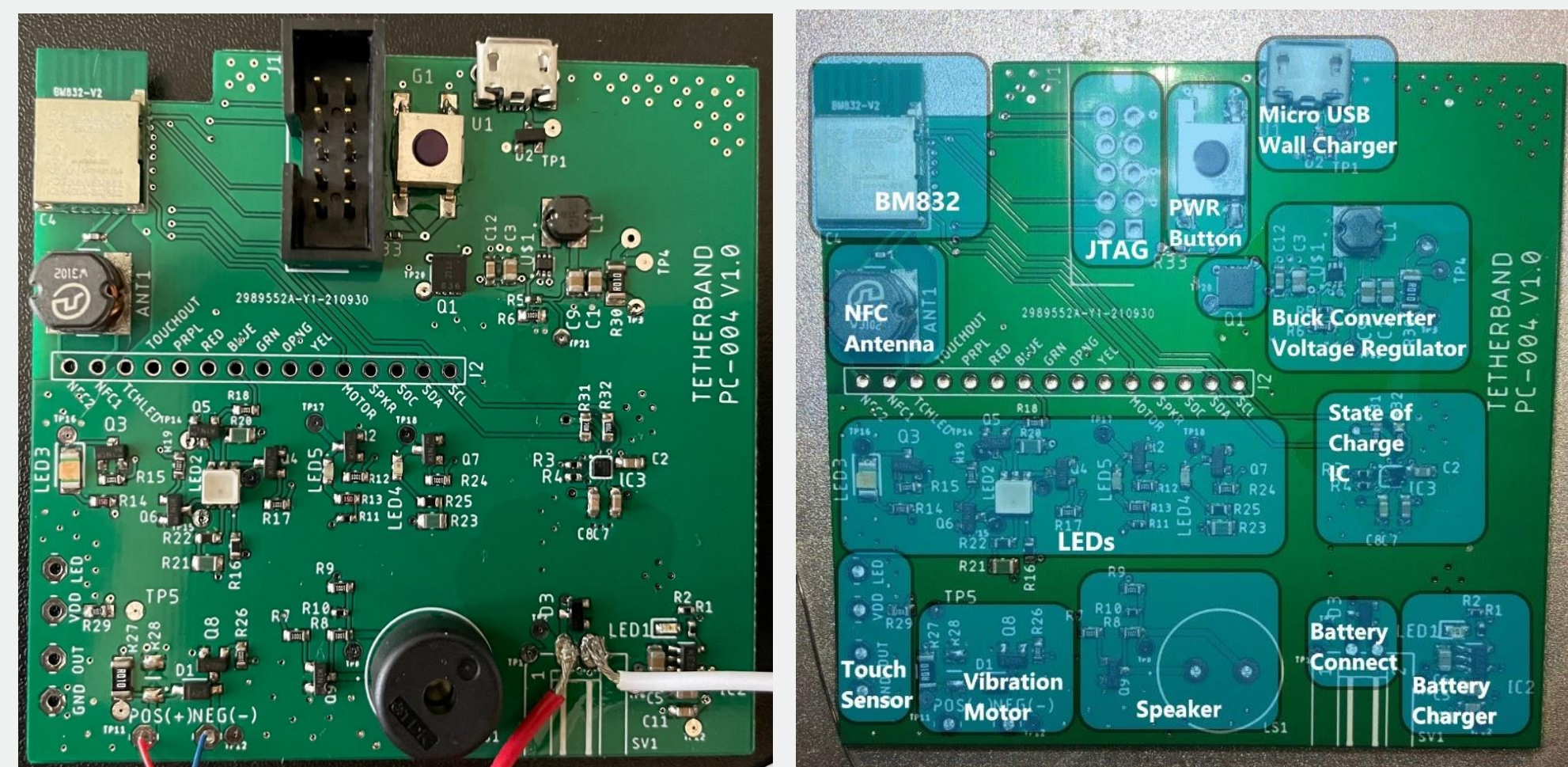
Key Design Decisions

- Nordic nRF52832 MCU chosen to run our design due to low BLE power consumption and package size.
- NFC chosen to wake bracelet from power off and to pair Bluetooth so no power or pairing buttons would need to be accessible from outside of housing.
- LiPo rechargeable battery, fuel gauge, and voltage regulator used to safely power the device and monitor battery level.
- 6 different colored LEDs, speaker, and vibrating motor chosen to generate local alert; capacitive touch sensor used to ensure child wears bracelet during operation.
- iPhone and iOS chosen due to wealth of Bluetooth development documentation and all team members own iPhones.

PCB Design

- Design Steps:
- Subsystems were designed with careful consideration for interactions between components. Schematics were created.
 - Individual footprints were created and are contained within our team library, 'Tesseract'
 - The full schematics and board were designed in Eagle CAD
 - The boards were ordered from JLC PCB and inspected for shorts
 - The boards were then populated by hand and soldered using the reflow oven in the Advance Prototyping Lab.
 - The electrical connections were tested, and it was then passed off to be tested with software.

The first print did not include the MCU and had a pin header for compatibility with the SDK (software dev kit). This is the fourth print and a fifth is near completion to miniaturize it but could not be completed due to a shortage of components.



Project Inspiration

According to Safe Havens International, improvements in student supervision are a highly effective measure in reducing risks to students and personnel. Additional security provided by Tetherband will enhance the learning and social experiences gained from group outings while providing a cost-effective harm reduction solution.

Acknowledgments

Mr. Hinkle, Mr. Welker, Dr. Larson – Course Instructors
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 Dr. Goss – Liaison for TXST Advanced Prototyping Lab
 Family & Friends – Moral support
 Spring '21 SD Team E2.11 – Mentorship

E2.09 - Tetherband

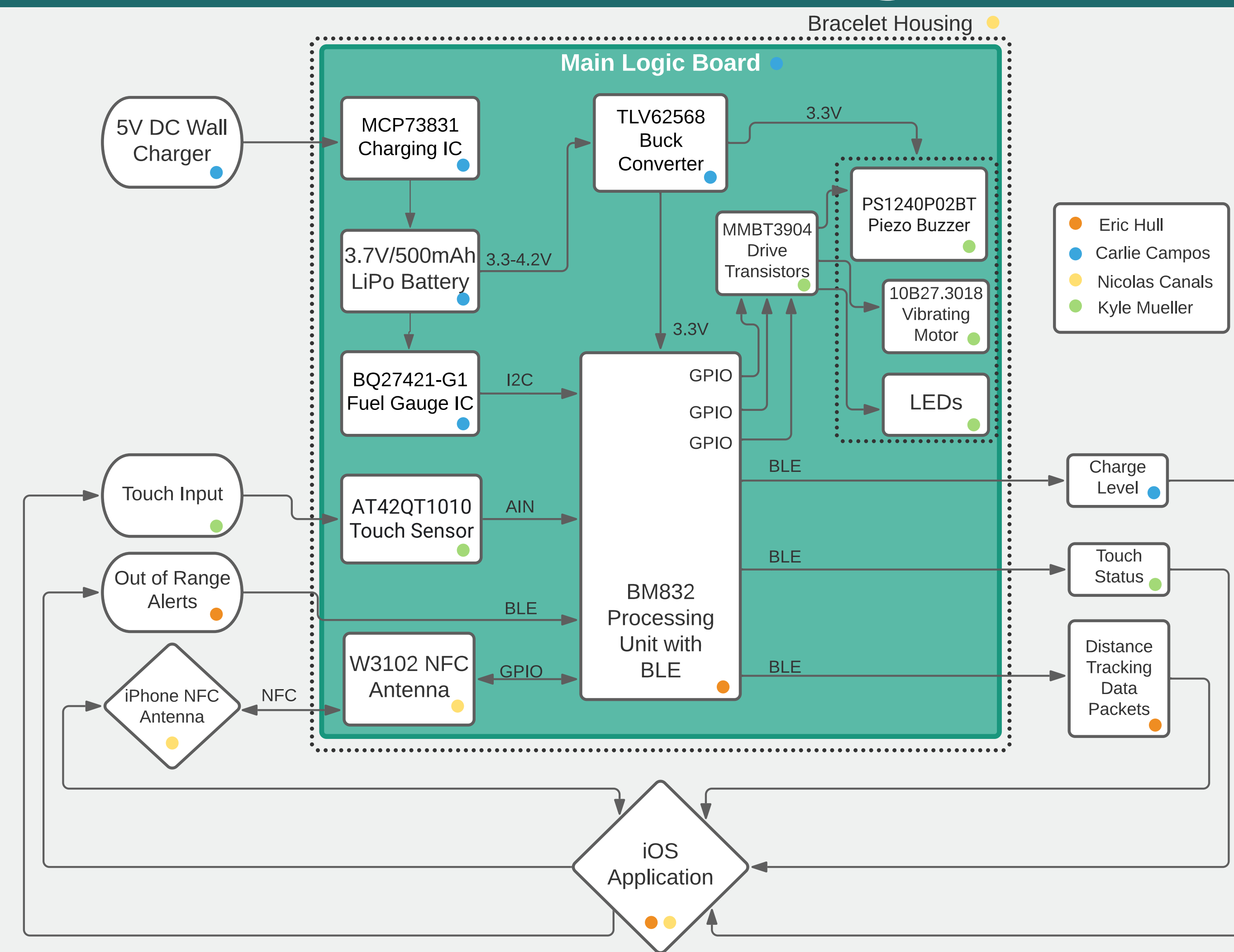
Eric Hull, Carlie Campos, Kyle Mueller, Nicolas Canals
 Sponsor: Texas State University



Project Description

- A unique, low-cost system for monitoring groups of children efficiently and proactively that includes individual bracelets for children and a custom-built iOS application.
- When a child exceeds a 15m proximity of the chaperone or removes their bracelet, visual, auditory, and haptic alerts go off to let the child know they should go back in range or put the bracelet back on. Notifications for the event are also shown on the chaperones iPhone.
- Utilizes NFC for easy pairing and team color configuration to the bracelets with the chaperones iPhone.

Overall Block Diagram



Distance Tracking

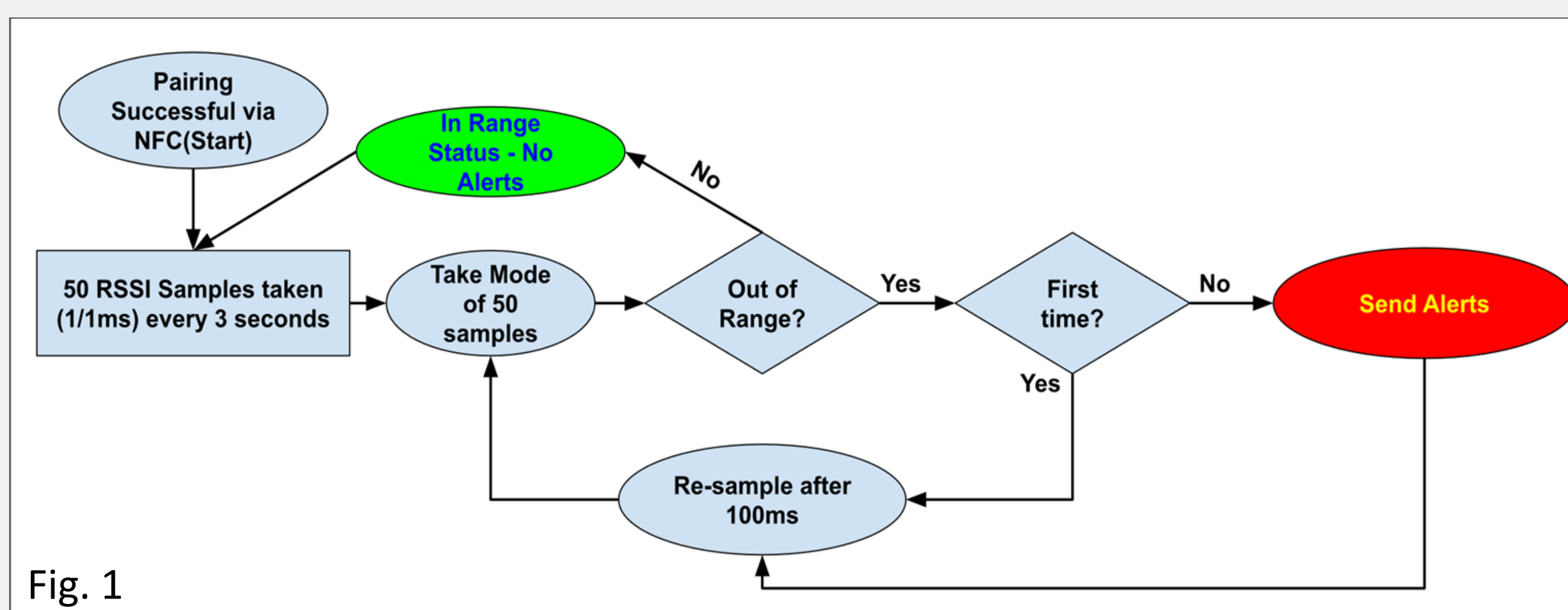


Fig. 1

- Figure 1: State Diagram for distance tracking algorithm, which is run on the iPhone app.
- Figure 2: Count of different RSSI values read at varying distances. At distances greater than 15m, the RSSI values overlap, making distinguishing different distance values hard. This shows that RSSI is not a good tool for trying to track proximity greater than 15m.
- Figure 3: Range Status determination using varied values for N in the Distance equation below the chart. N is the Radio Interference Environmental Factor, which usually ranges from 2-3.4 depending on obstacles in the environment.

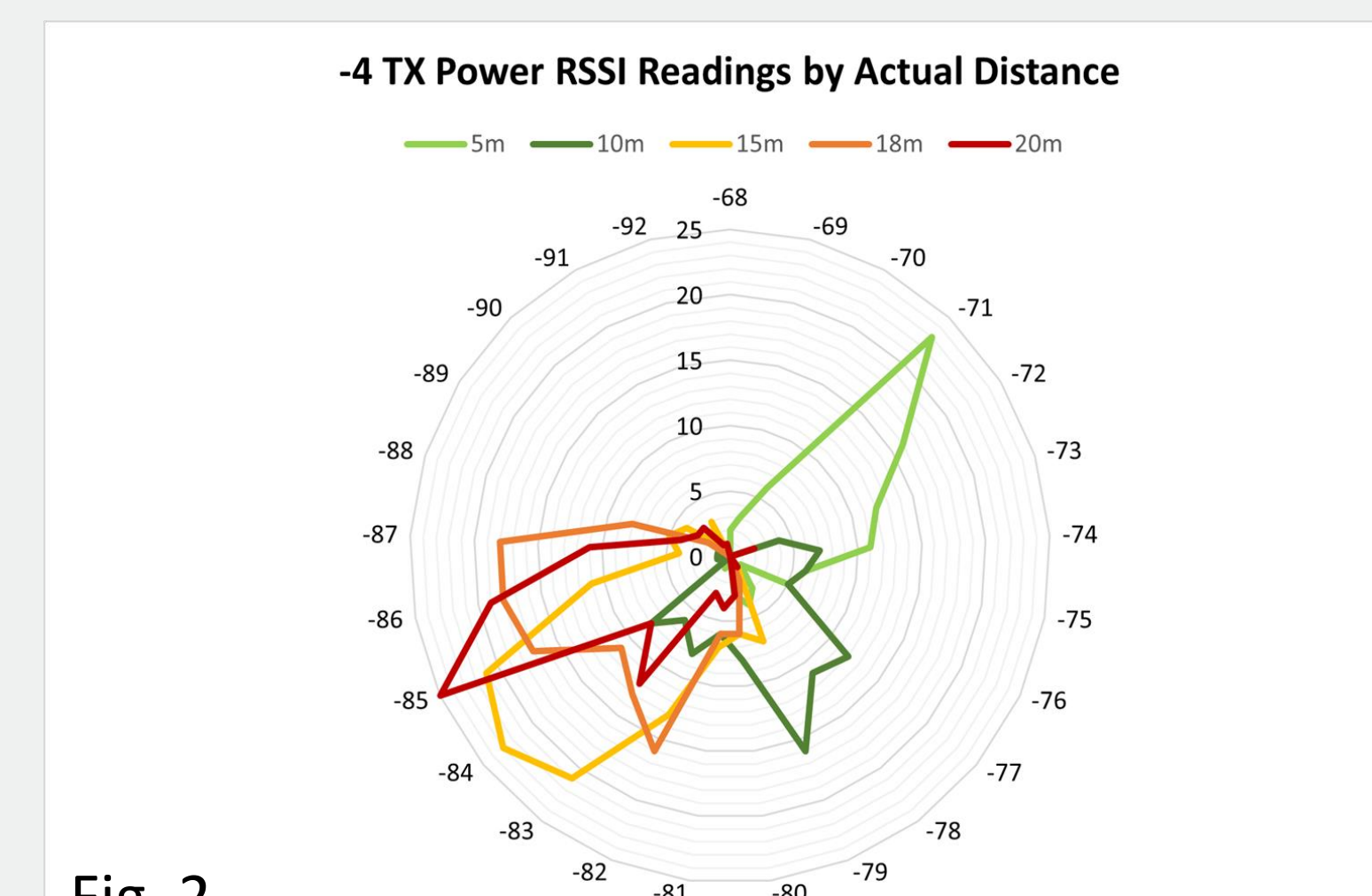


Fig. 2

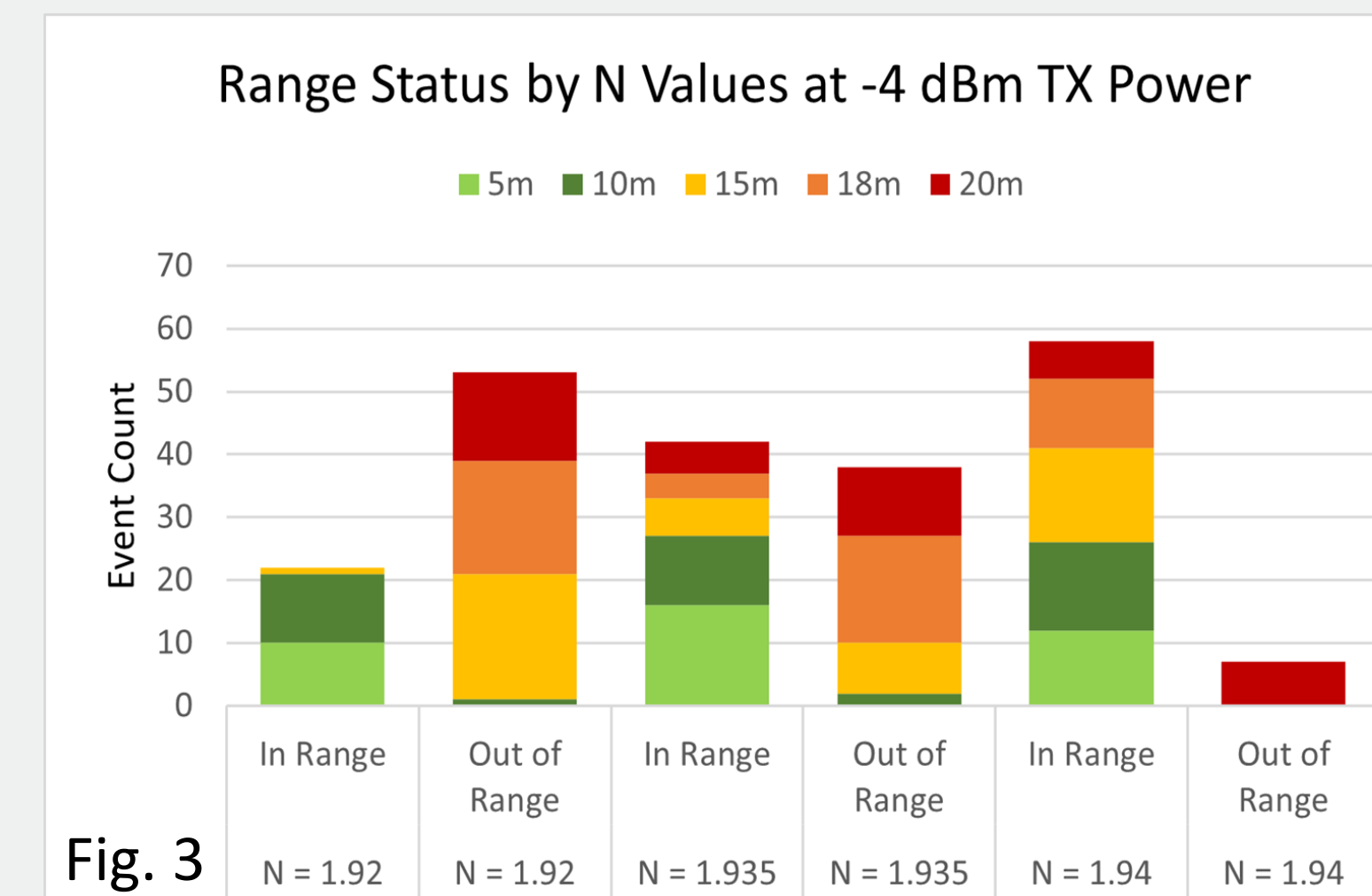
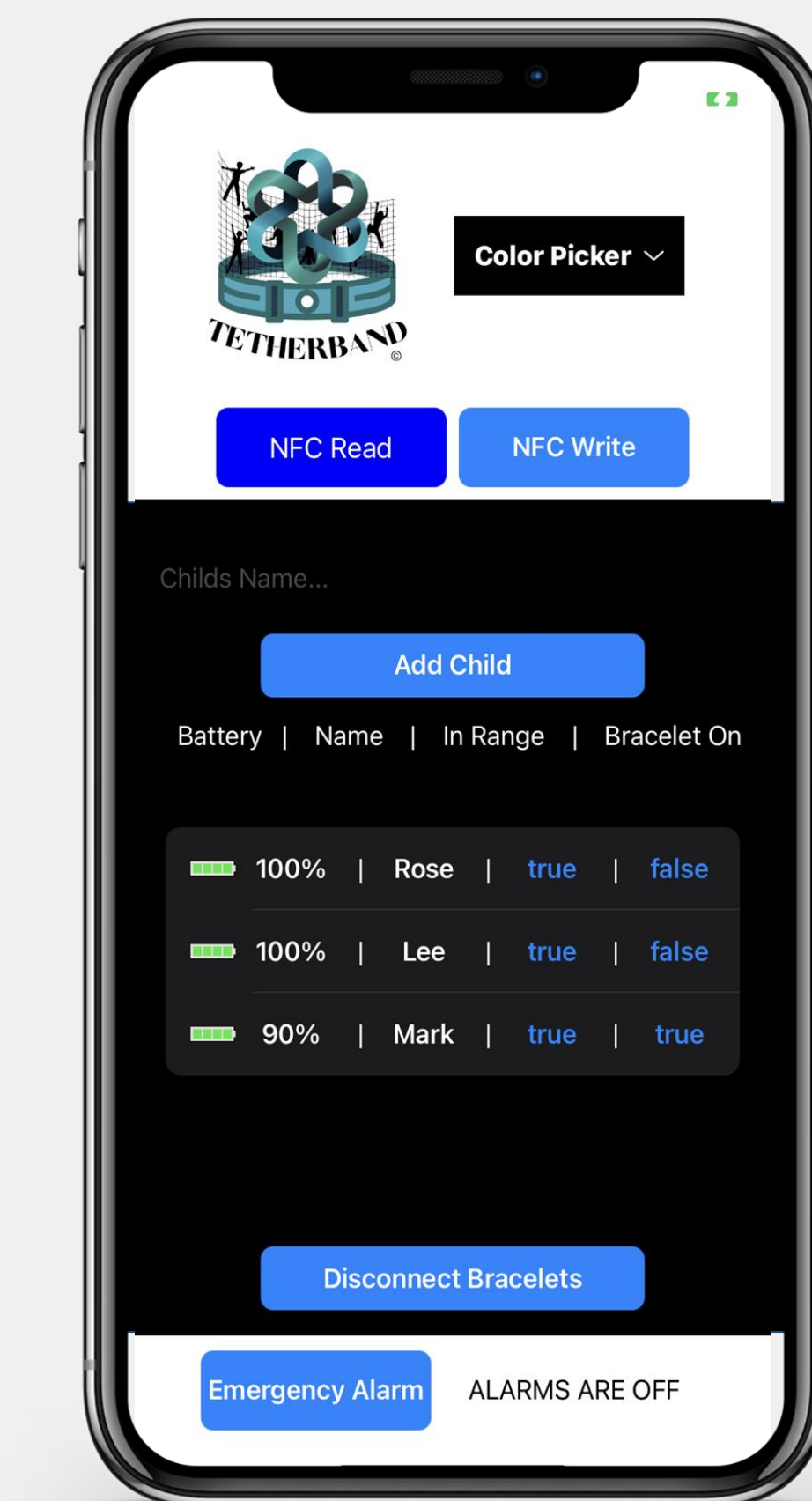


Fig. 3

$$Distance(mm) = 10^{\left(\frac{TX Power - Read RSSI}{10 * N}\right)}$$

Tetherband Application



Responsibilities:

- Handles team color choice
- Displays list of paired bracelets
- Notifications to base station when bracelets break range barrier or are taken off.
- Button to activate emergency alert function.

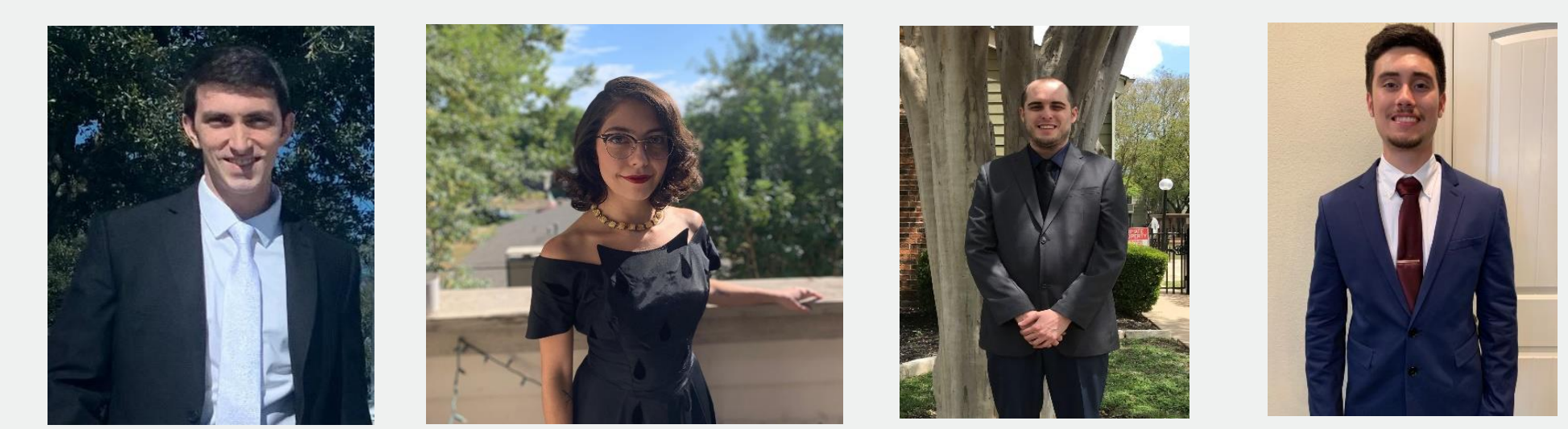
Steps To Pair Bracelet:

- Use NFC Read Button to pair bracelet
- Choose Color Using Color Dropdown Button
- Use NFC Write button to configure team color to bracelet
- Type in Childs name into empty box
- Click Add Child

Requirements Testing

Requirement	Measured Data	Result
Min 3hr Battery Life	Measured time from fully charged (4.2V) to fully depleted (3.3V) 5 times.	Pass – Average of 3.4hrs over 5 trials
Battery recharges < 6hrs	Measured time from fully depleted (3.3V) to fully charged (4.2V) 5 times.	Pass – 43.75 mins average to full charge
Detect Out of Range at 15m (+/- 3m) and Activate Alerts	Measured Out of Range status at 15m, 18m, 20m over 10 trials totaling ~100 data points.	Pass – 97.3% measurements in correct range
6 Distinguishable Colors	Illuminate 1 of the 6 colors in random order, 10 times each, and record if user was able to identify the colors.	Pass – All colors distinct in random surveys with 3 people
Touch Sensor Reliability	Perform 10 trials in cases of "touch on/off" and record if notification displays and LEDs/Speaker enable.	Pass – 10/10 trials, alerts properly set off
Emergency Alert Function	Triggered all alerts on every bracelet paired to application.	Pass – 10 trials on 3 different iPhone models
NFC Configures Color	NFC Write functionality used to set team color to bracelet.	Pass – 10 trials on 3 different iPhone models
Weighs less than 110g	Weigh the bracelet and all components.	Fail – Bracelet weighed 155g
Handle 1 min from watering can	Poured water from watering can for 1 minute with tissue paper inside housing.	Pass – tissue paper was not wet

Team Members



Eric Hull Carlie Campos Kyle Mueller Nicolas Canals