Knight Guard

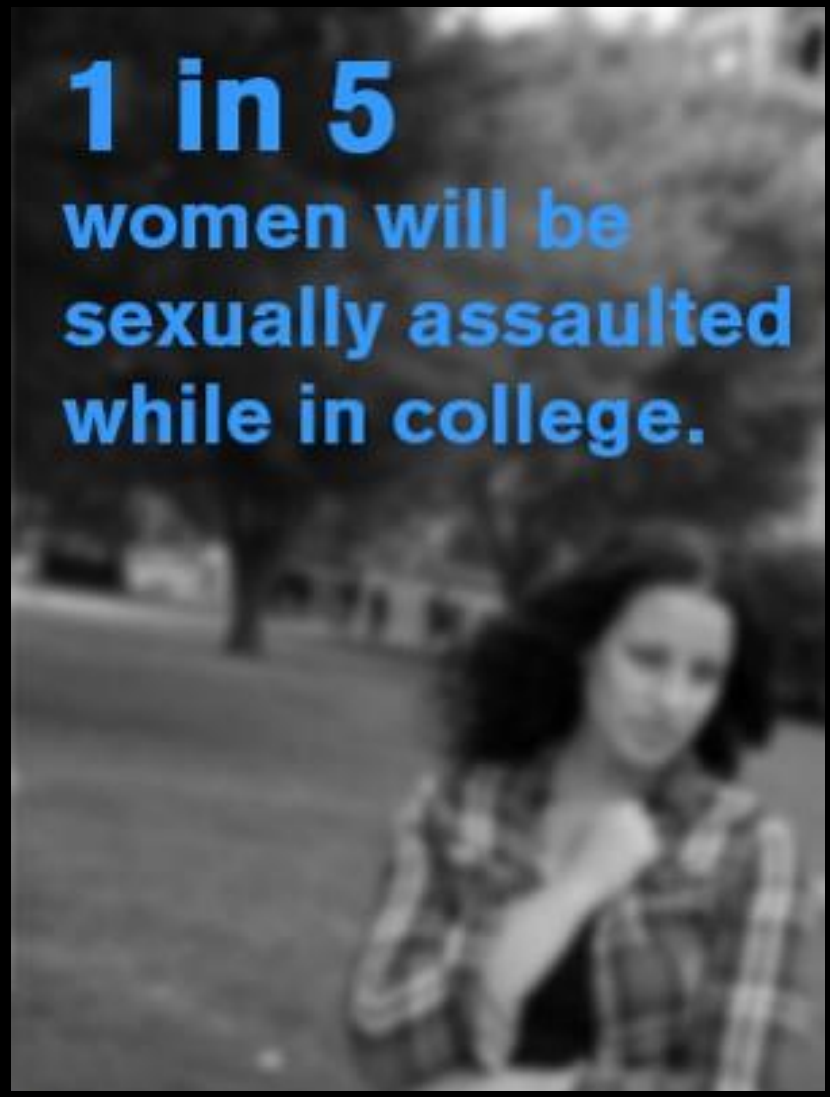
Group 16

Matthew Lucente – Electrical Engineering

Brandon Carruth – Computer Engineering

Dominic Brumfield - Electrical Engineering

Motivations



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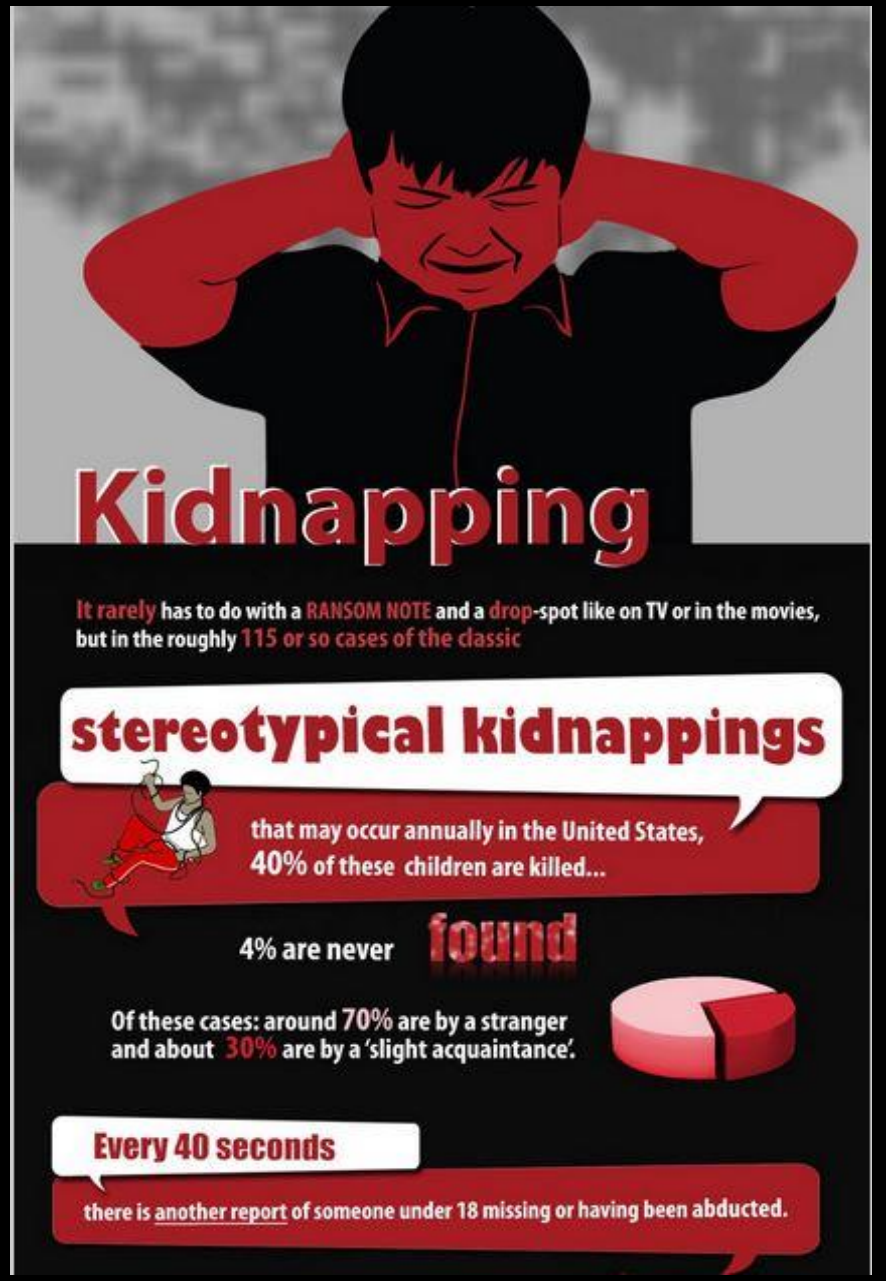


Objectives

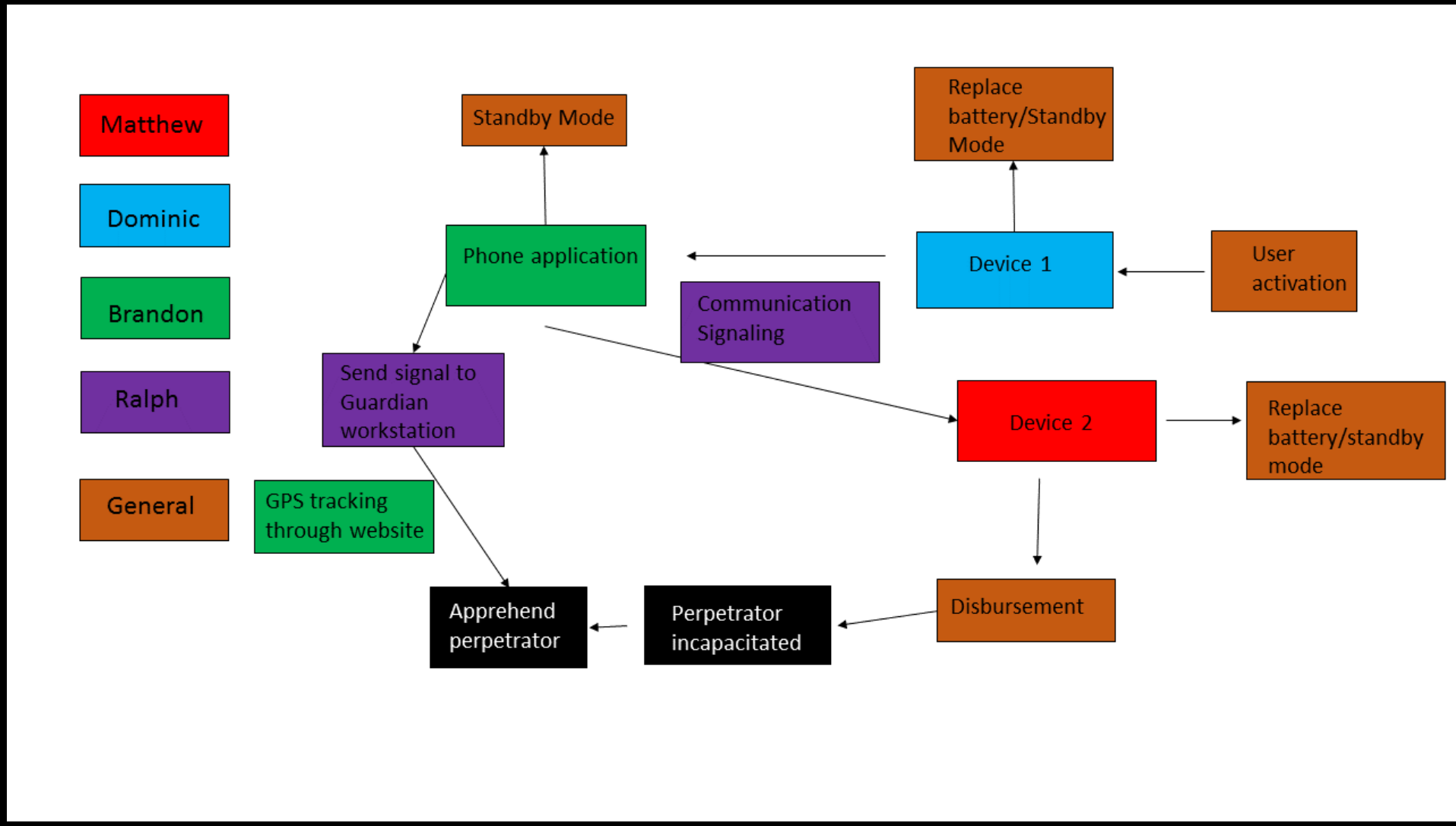
- Solve this using our discreet, self-defense system
- Bluetooth Communication between Devices and Phone
- Alert the local officers to take care of the situation

Constraints

- Largest constraint was size
  First Device has to be smaller than a quarter
  Second device has to be 50mm X 50mm X 8mm
  (1.97 in X 1.97 in X .315 in)
- Final Devices need to be consumer friendly in terms of price and usability
- Needs an activation response time of under 3 seconds
- Device 2 battery life of 12 hours

Project Roles

	Device 1	Device 2	Phone App	Communication/Signaling
Main	Dominic	Matt	Brandon	Ralph
Backup	Matt	Dominic	Ralph	Brandon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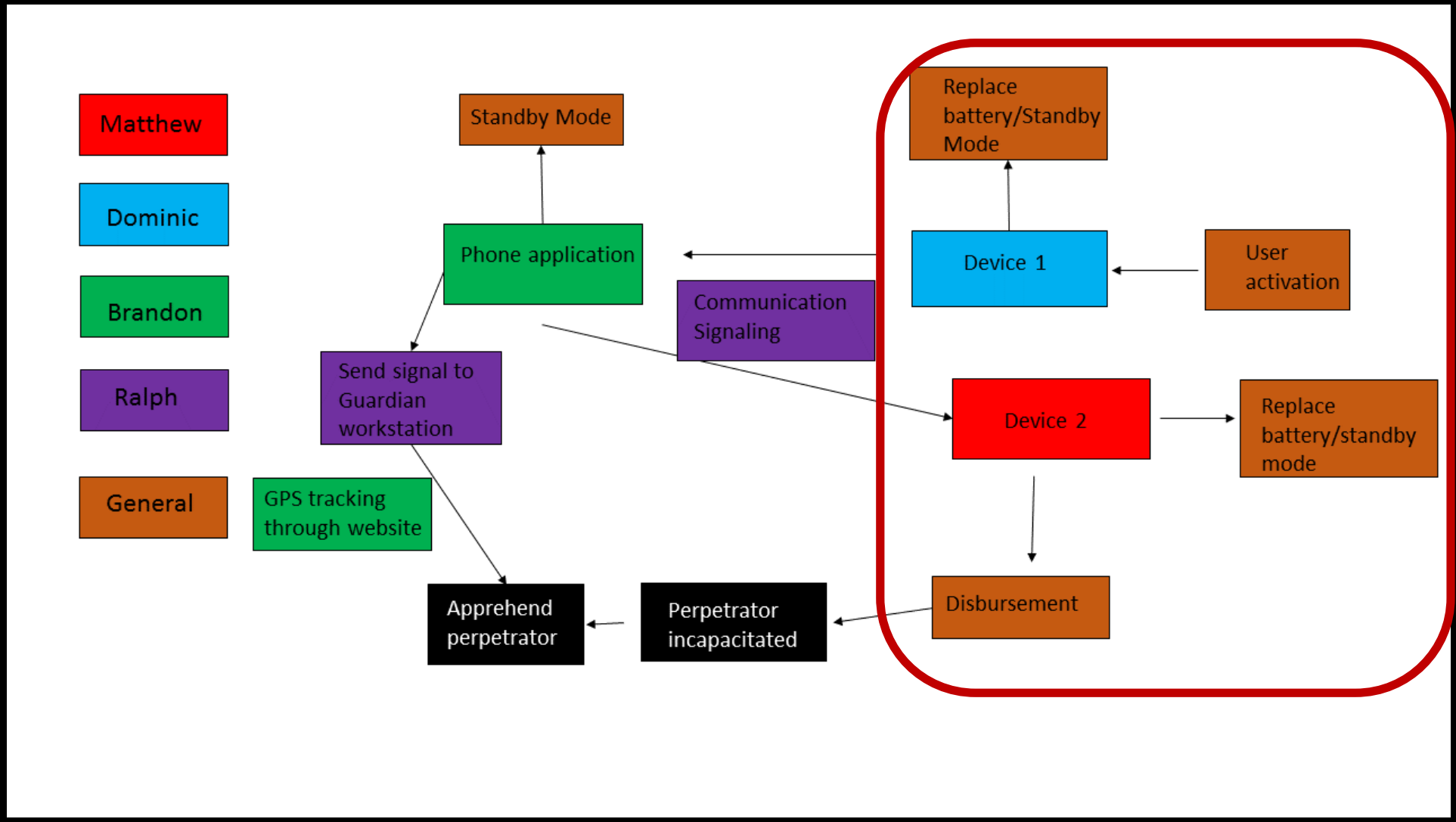
Standby Mode
Replace battery/Standby Mode
Phone application
Device 1
User activation
Communication Signaling
Send signal to Guardian workstation
Device 2
Replace battery/standby mode
GPS tracking through website
Apprehend perpetrator
Perpetrator incapacitated
Disbursement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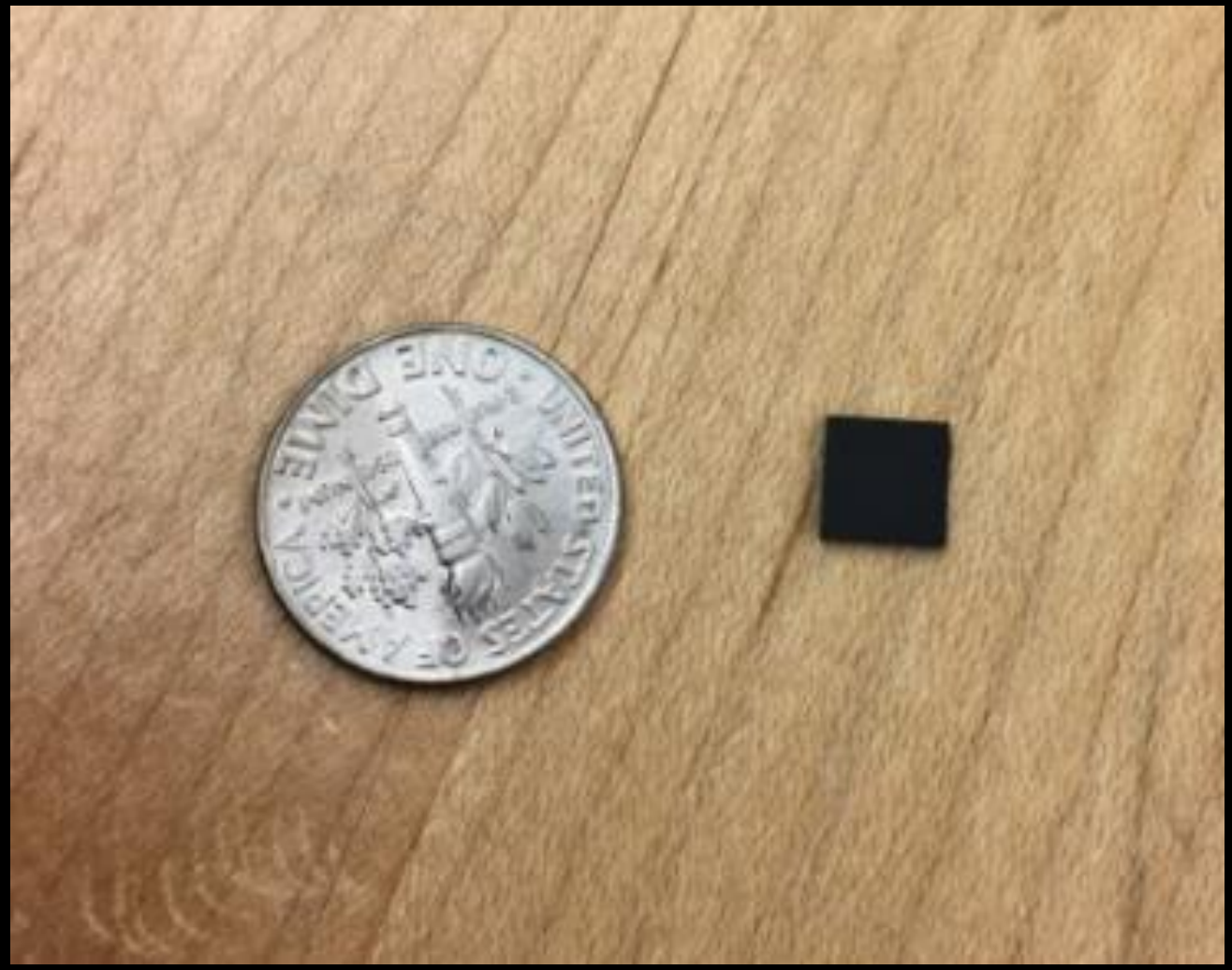
Hardware : MCU

- Nordic Semiconductors NRF1822
- 6x6 mm chip with Integrated Bluetooth
- 256 KB Flash

  32KB RAM
- Chosen over TI product and Atmel Chips due to small size and on board Bluetooth capabilities



	Voltage(V)	Amps(mA)	Temperature Range for operation(°C)	Pressure needed for operation(gF)	Size(mm^3)
Mini Switch	12	50	-40 to 85	250+-50	2*2*4.4
Sliding Switch	30	200	-20 to 70	250 +-100	11.6*4.0*12
Tactile Switch	24	50	-25 to 70	100 to 250	6*6*10.5
Capacitive Touch Sensor	5	10	-40 to 125	Determined by software	3*3*relatively small
Biometric Switch	24	200	-5 to 50	Finger print scanner	38*69*54

Hardware : Device 1 Activation Switch

- 4mmX3mm footprint
  2mm button height

- Can work up to 12 V

Hardware: Power Device 1

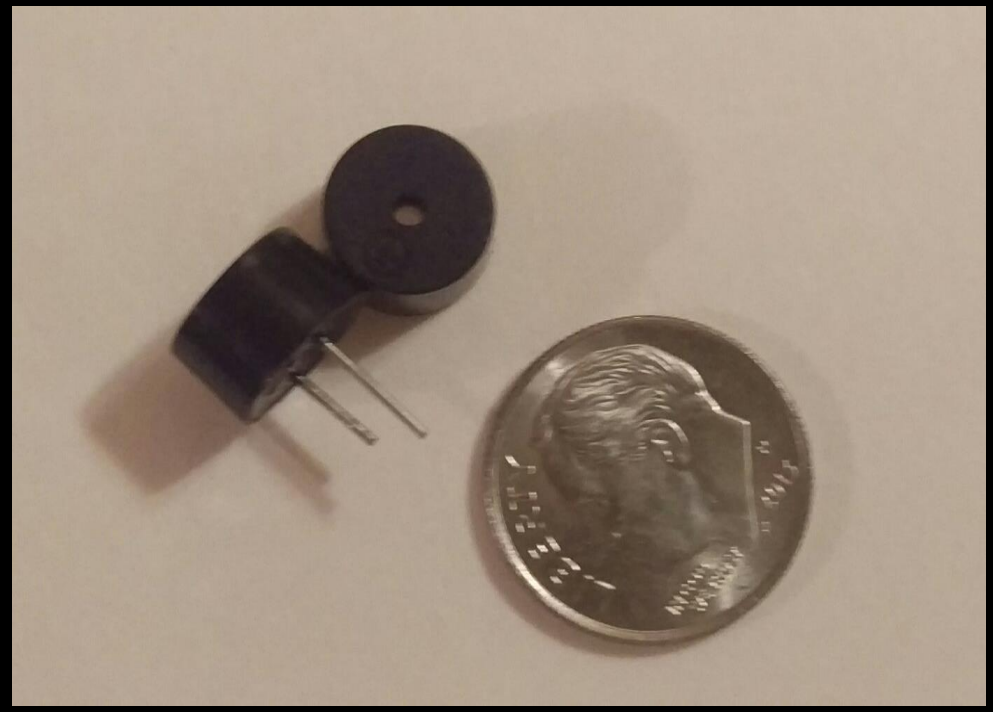
- CR1225 Button Cell Battery
- 3 V 48mAh
- 12.5mm diameter X 2.5mm tall
- Size did not affect depth of device, and width would fit under PCB

Hardware : Power Device 2

- LiPo Single Cell Battery
- 3.7 V 105mAh
- 4mmX12mmX30mm
- Chosen over NiCad or Alkaline due to size and charging circuit complexity

Hardware : Device
2 Magnetic Buzzer

- 2.5V DC
- 9mm Diameter
- Produces 2.3kHz Frequency
- Similar is loudness as standing near busy street
- Chosen for internal oscillating circuit and size

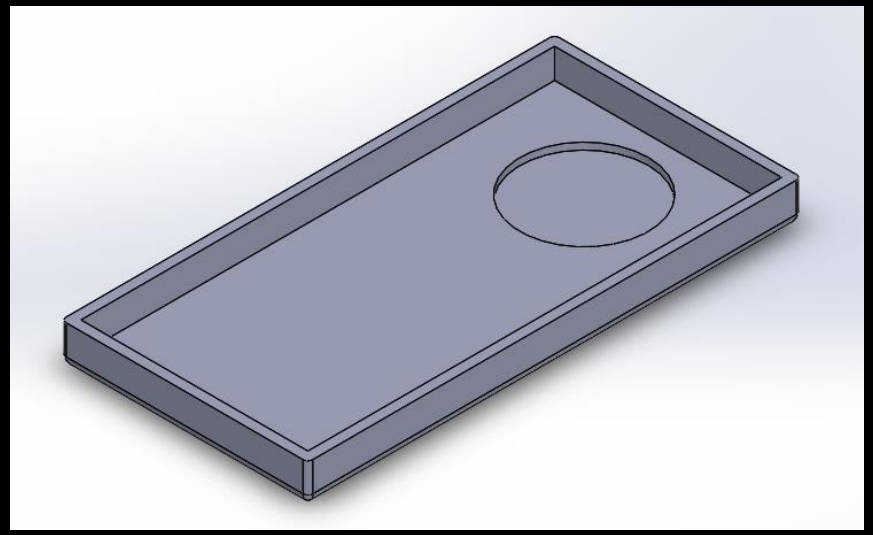


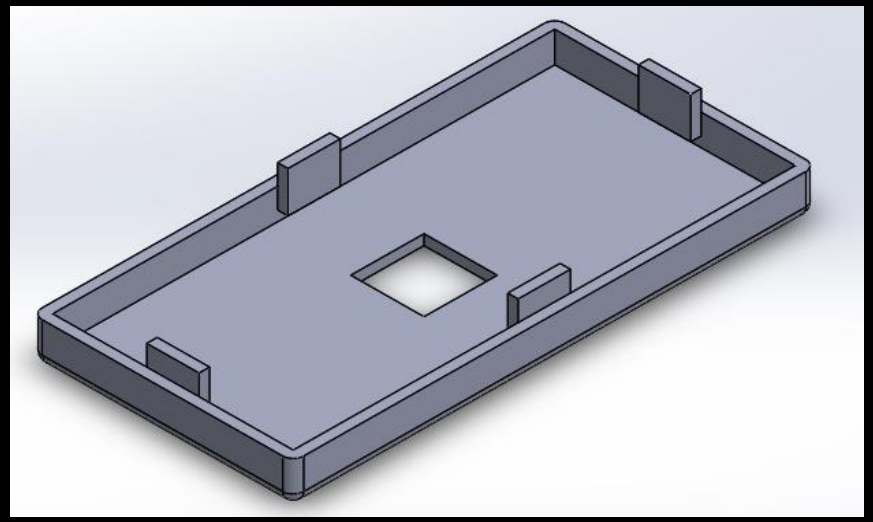
Hardware Housing:
3D printing

	ABS	PLA
Price	$25/kg	$25/kg
Molding Temperature	204-238 °C	178-240 °C
Heat Deflection Temperature	98 °C	49-52 °C
Flexural Strength (PSI)	10800	6950-16000

Hardware Housing: 3D design for Device 1

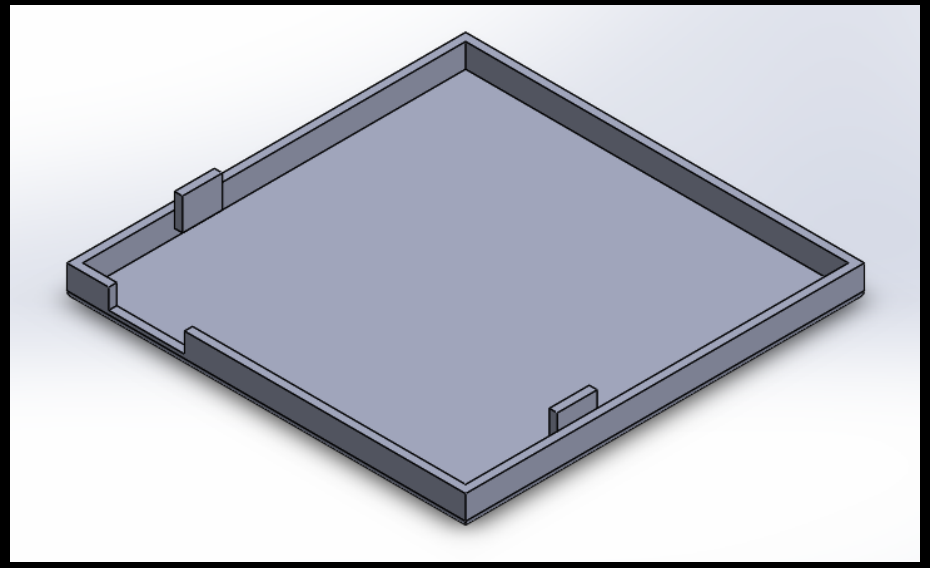
- Easily hidden from assailant
- Can hold PCB along with the battery
- Hidden activation points

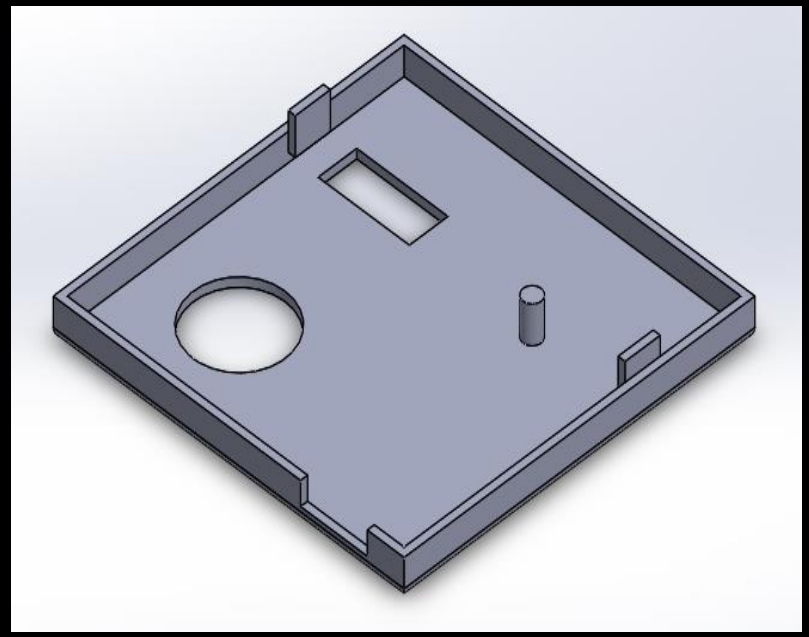




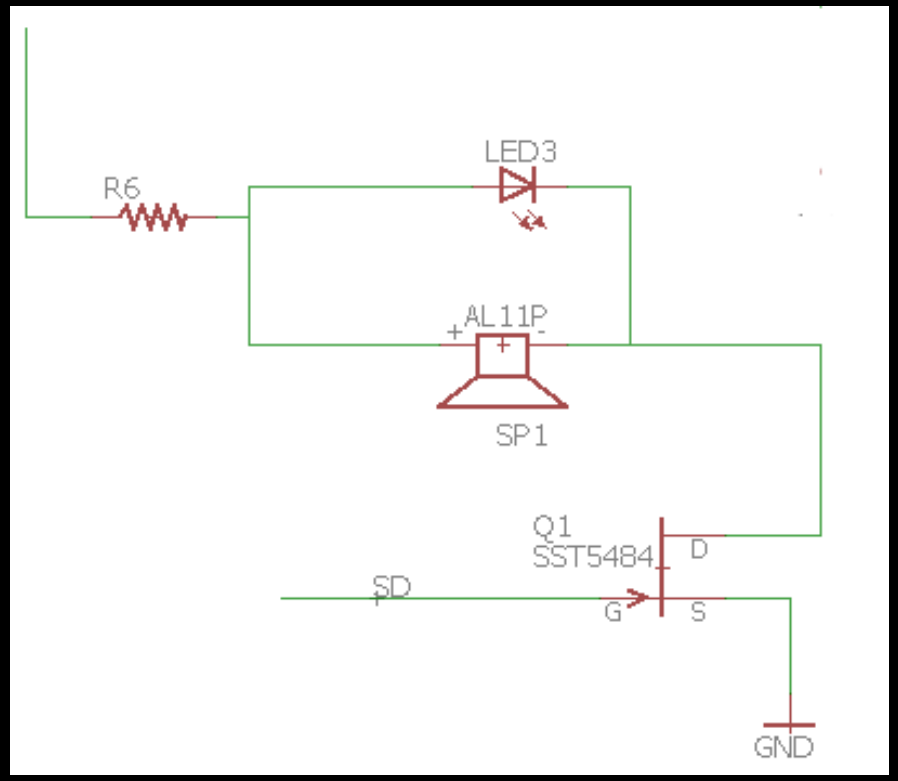
Hardware Housing: 3D design for Device 2

- Housing for main PCB
- Holes for LED, Buzzer, and charging port
- Two pieces, attached by clips



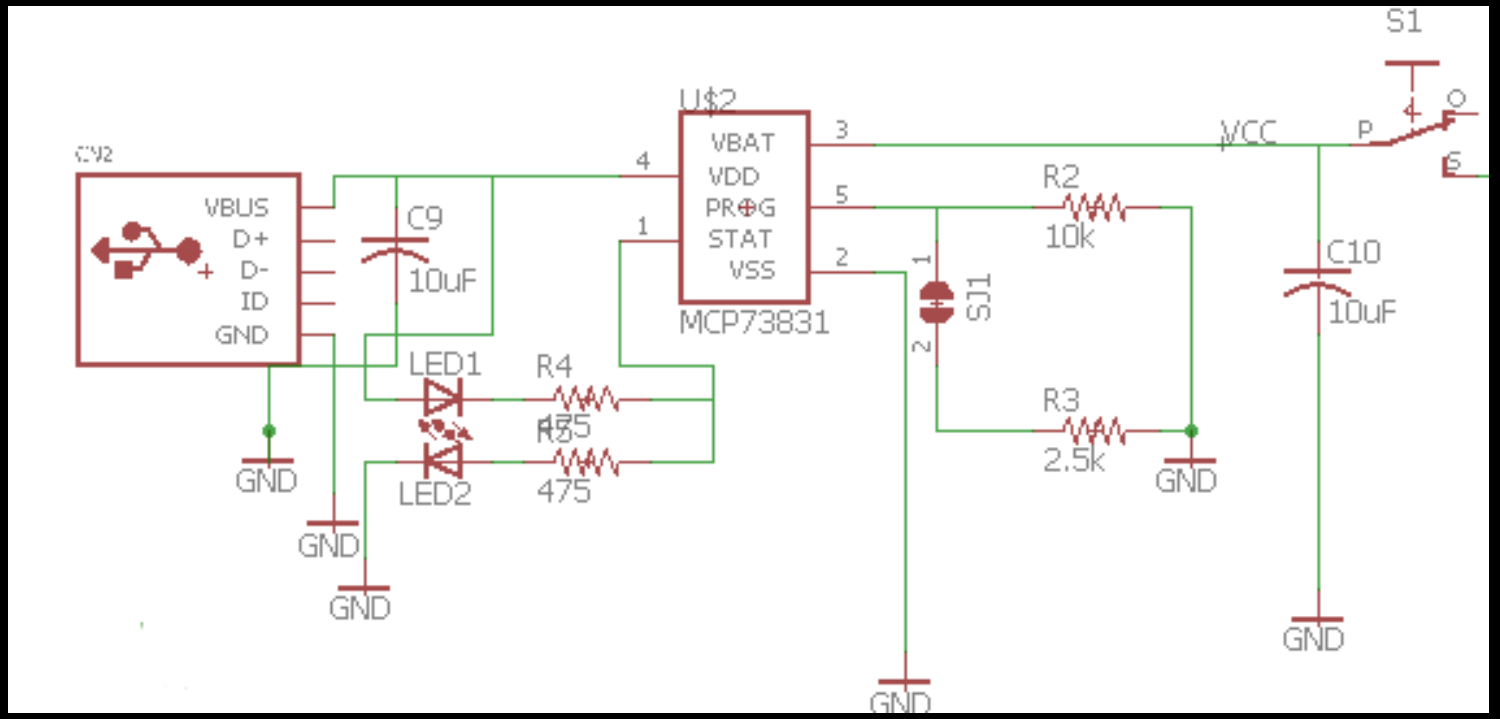


Hardware: Device 2



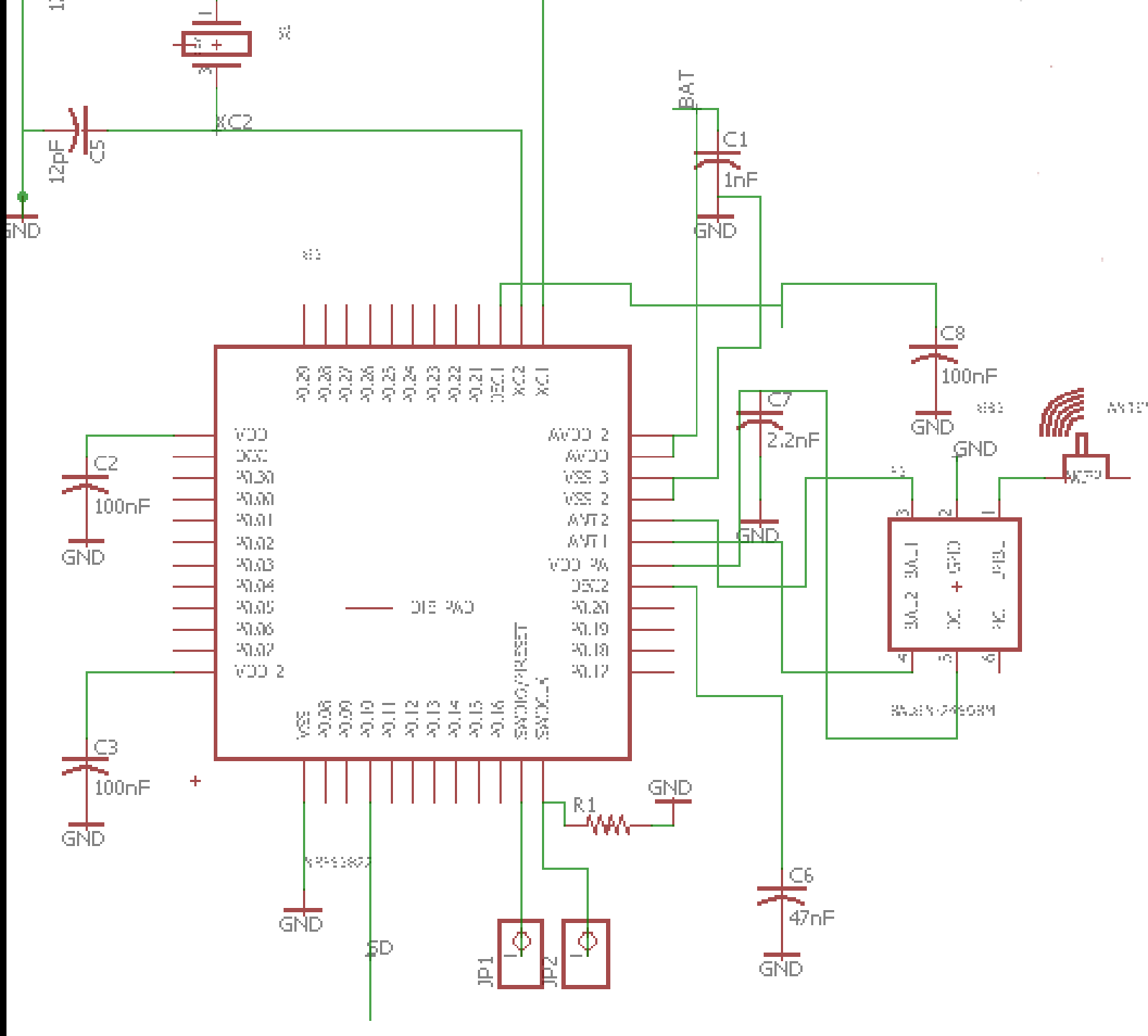
SELF-DEFENSE ALLAGORY

CHARGING CIRCUIT



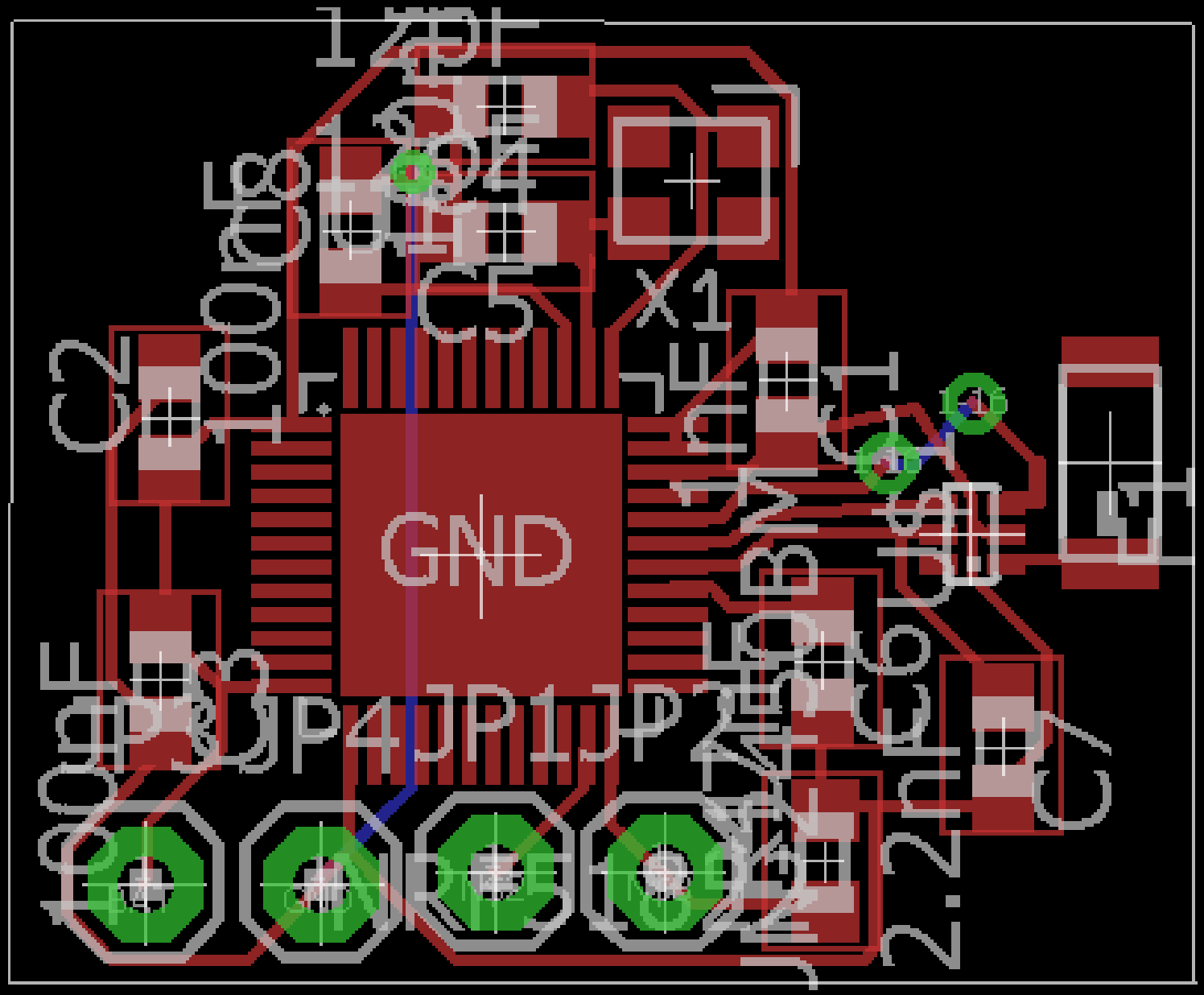
Hardware: Device

Primary Control Unit



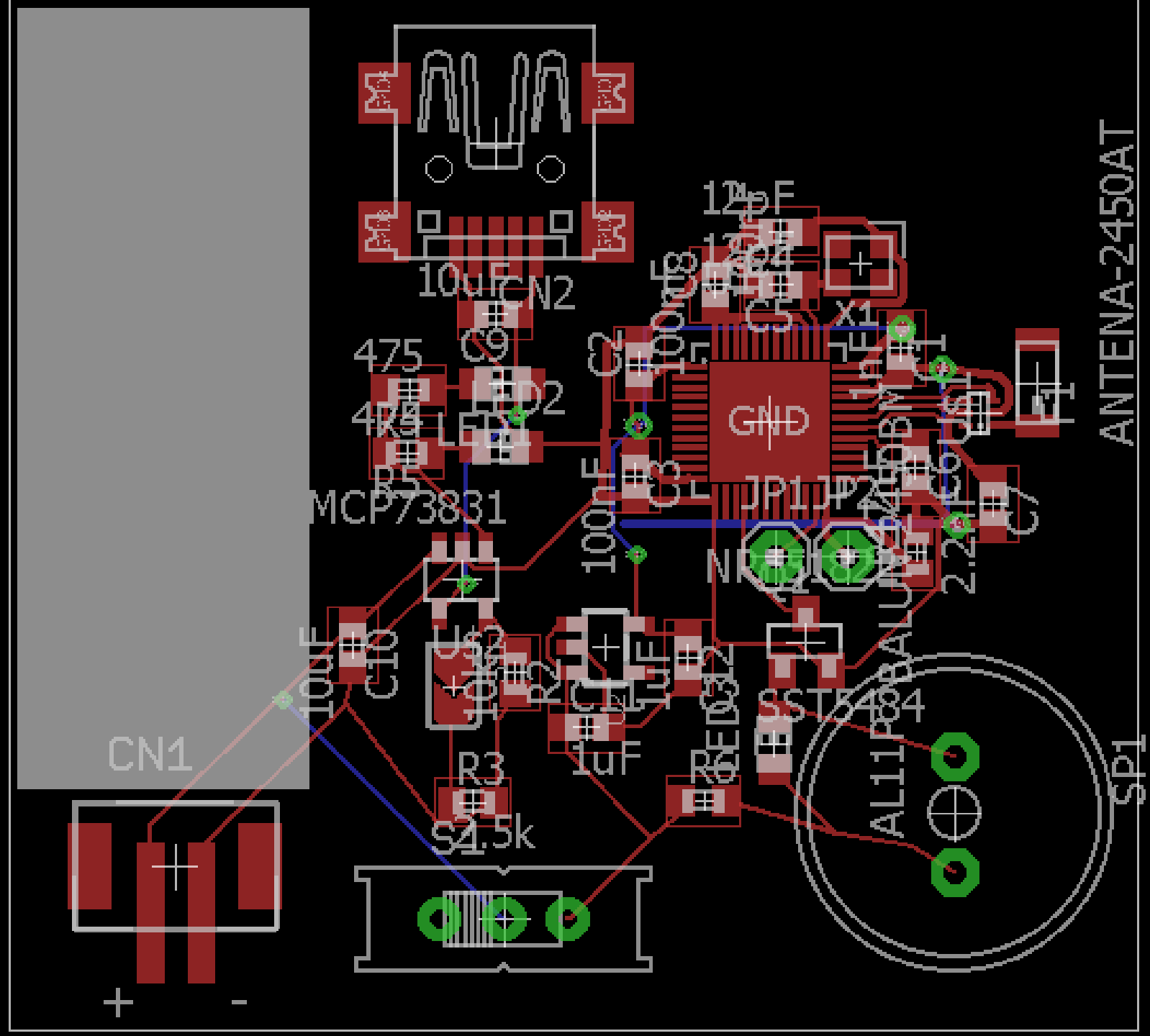
Hardware: Device 1

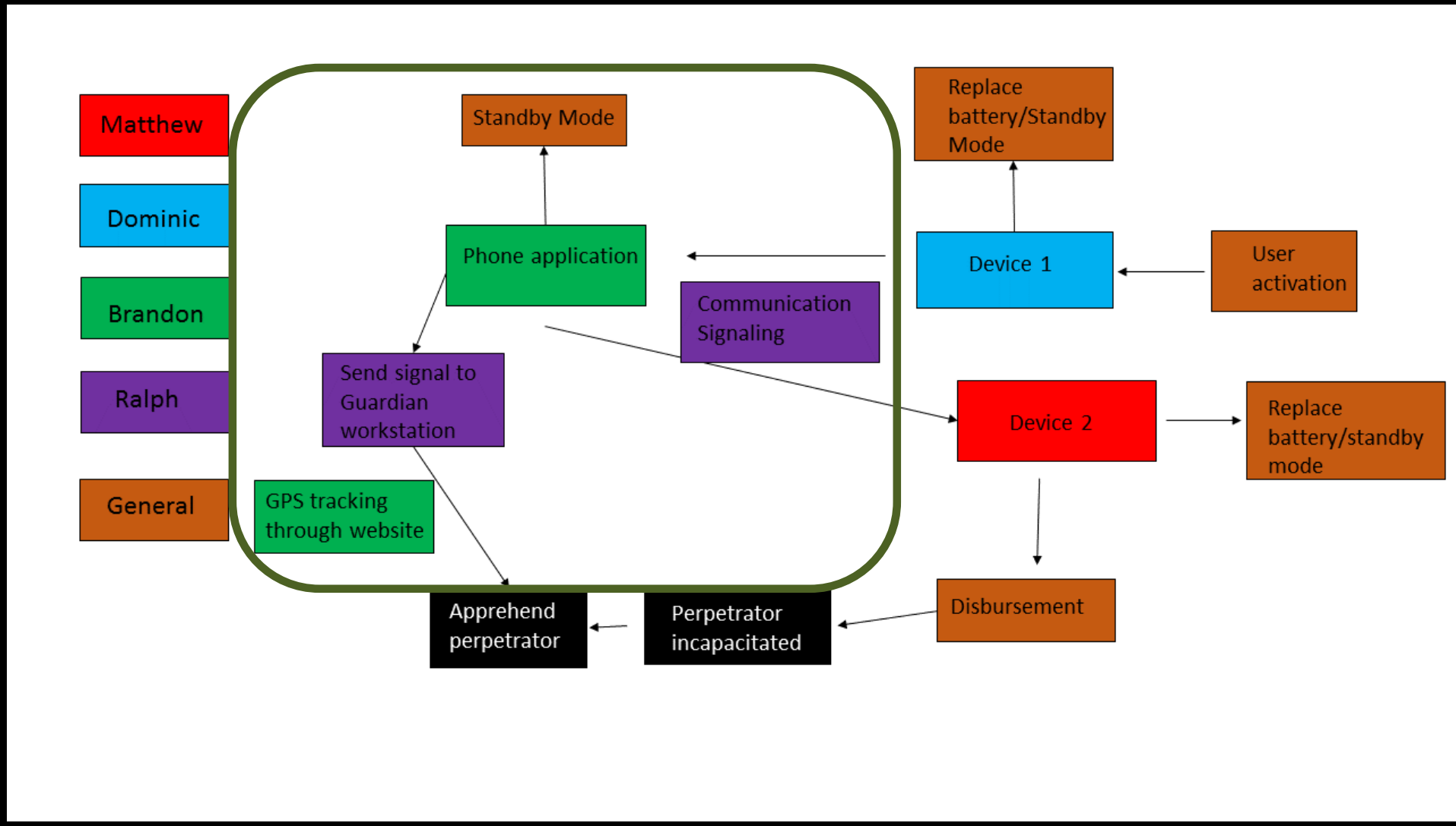
- Remote trigger
- Bluetooth transmission
- PCB Size: 19.88mm X 16.08mm



Hardware: Device 2

- MOSFET switch for buzzer and LED
- In standby mode until a signal is received
- PCB Size: 44mm X 46mm

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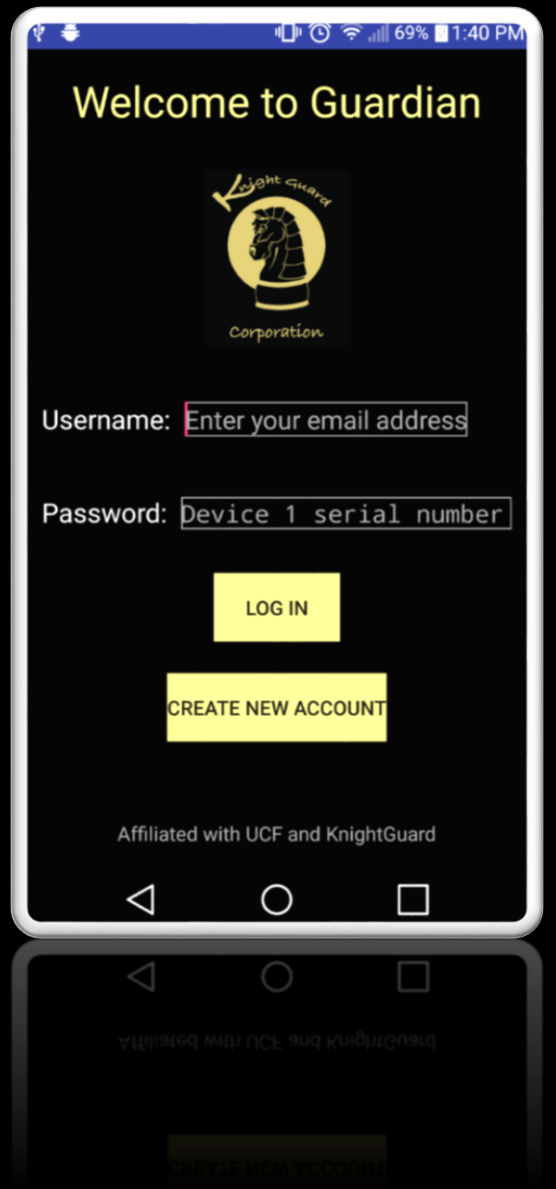
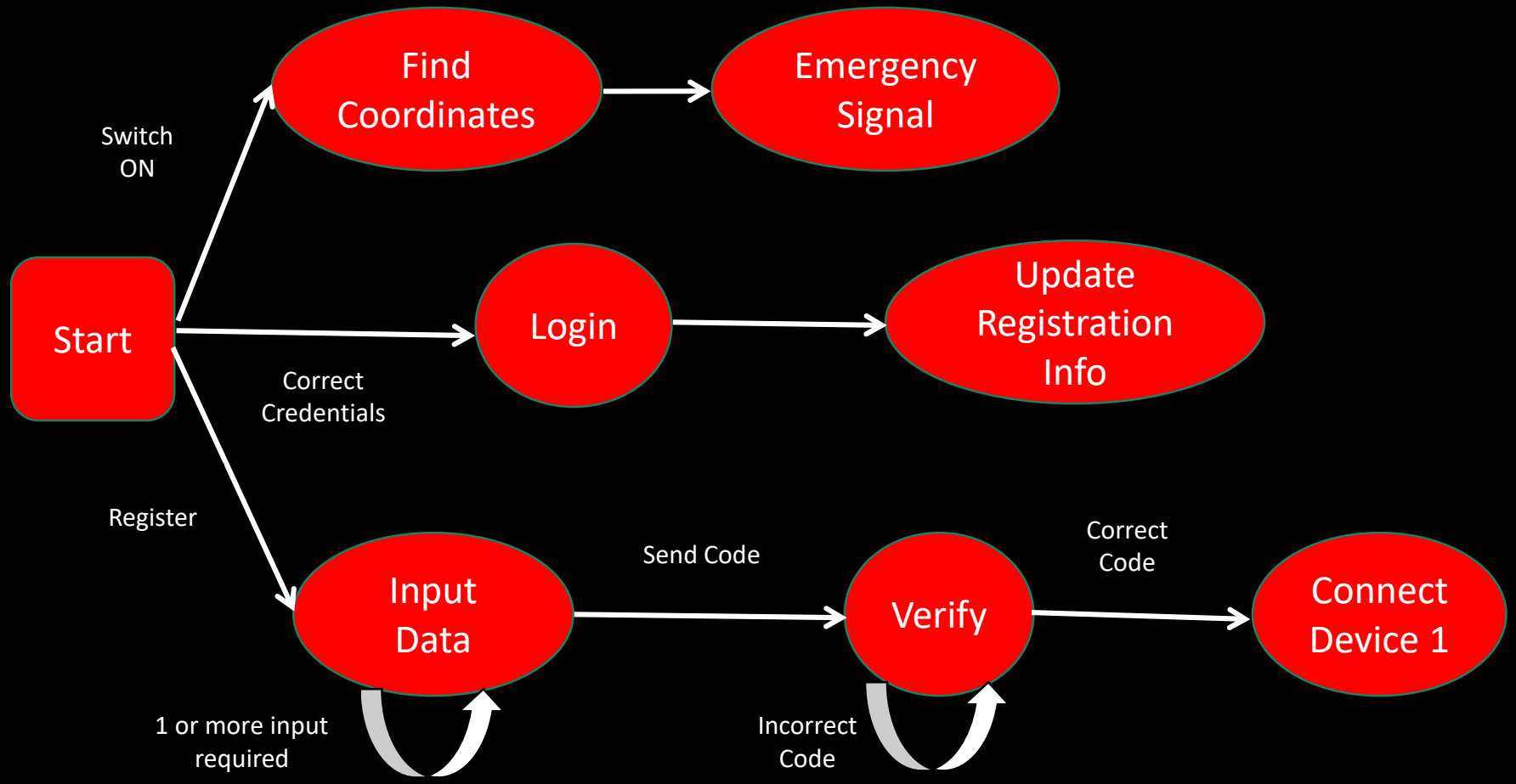
Features

- User Registration and Login
- Verification
- GPS Coordinates
- Emergency Distress Signal
- Bluetooth Connection

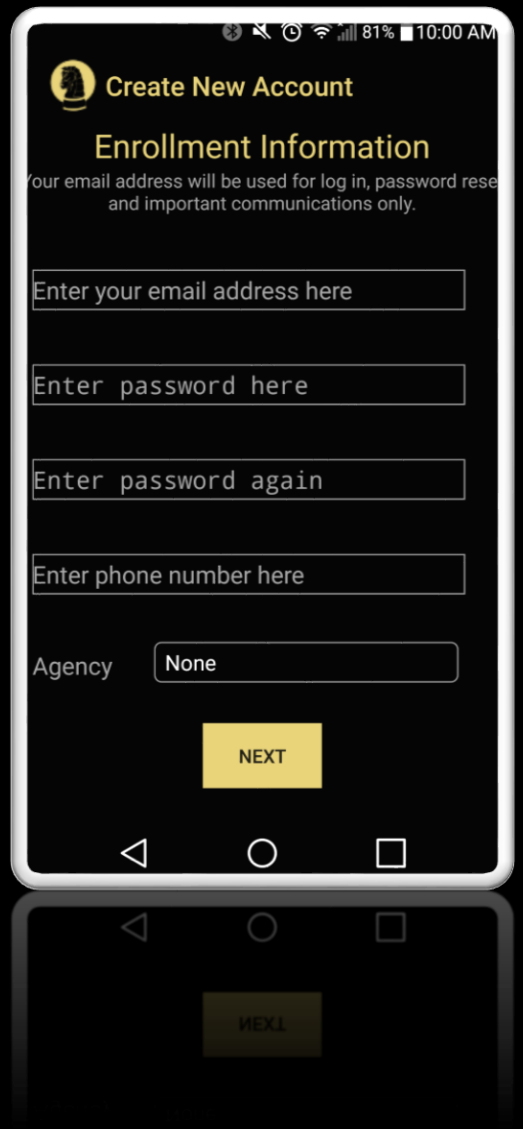


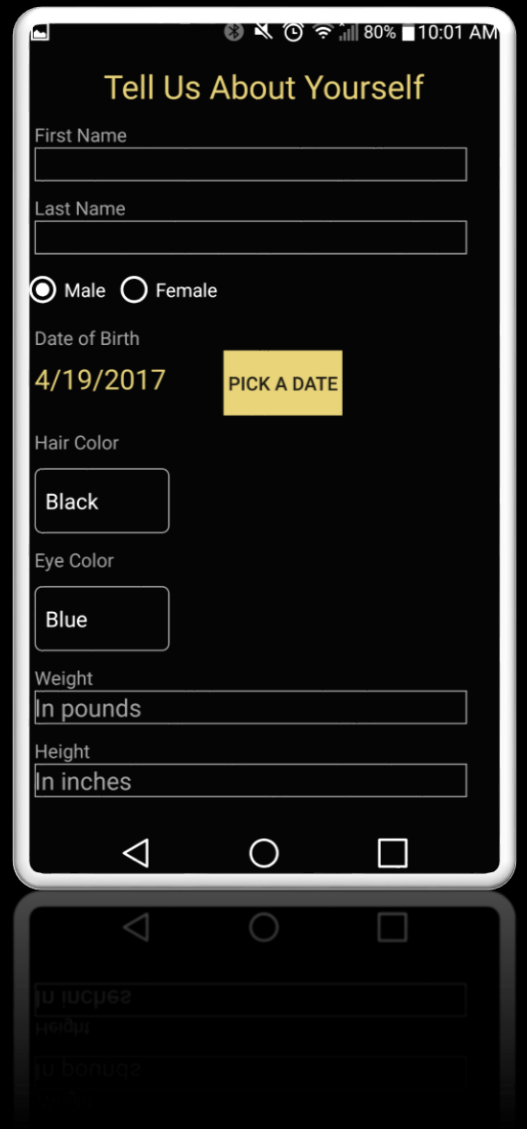
Phone Block Diagram



Registration

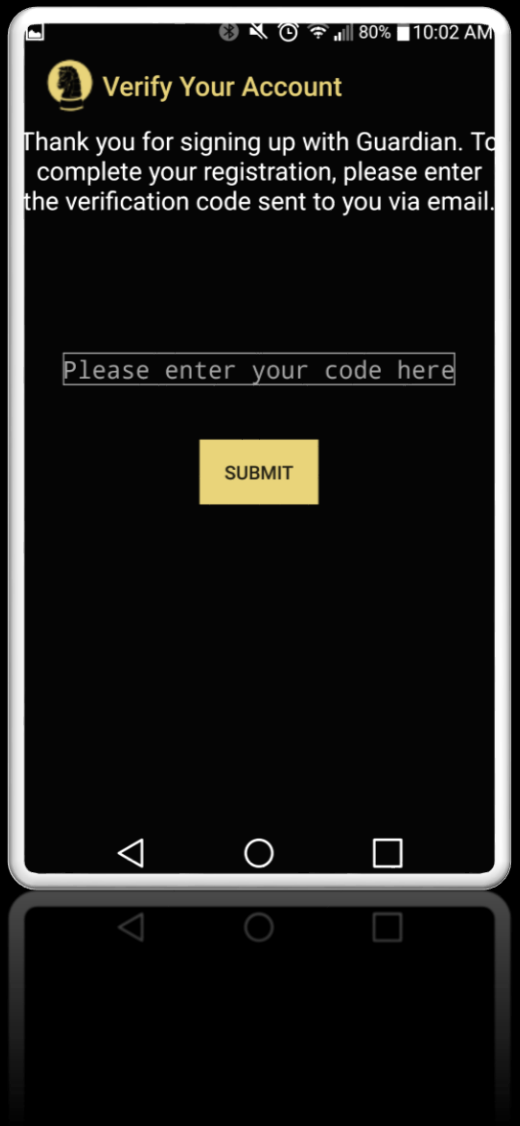
- Requires user information
  - Name
  - Date of Birth
  - Picture
  - Hair & Eye Color
  - Height & Weight





Verification

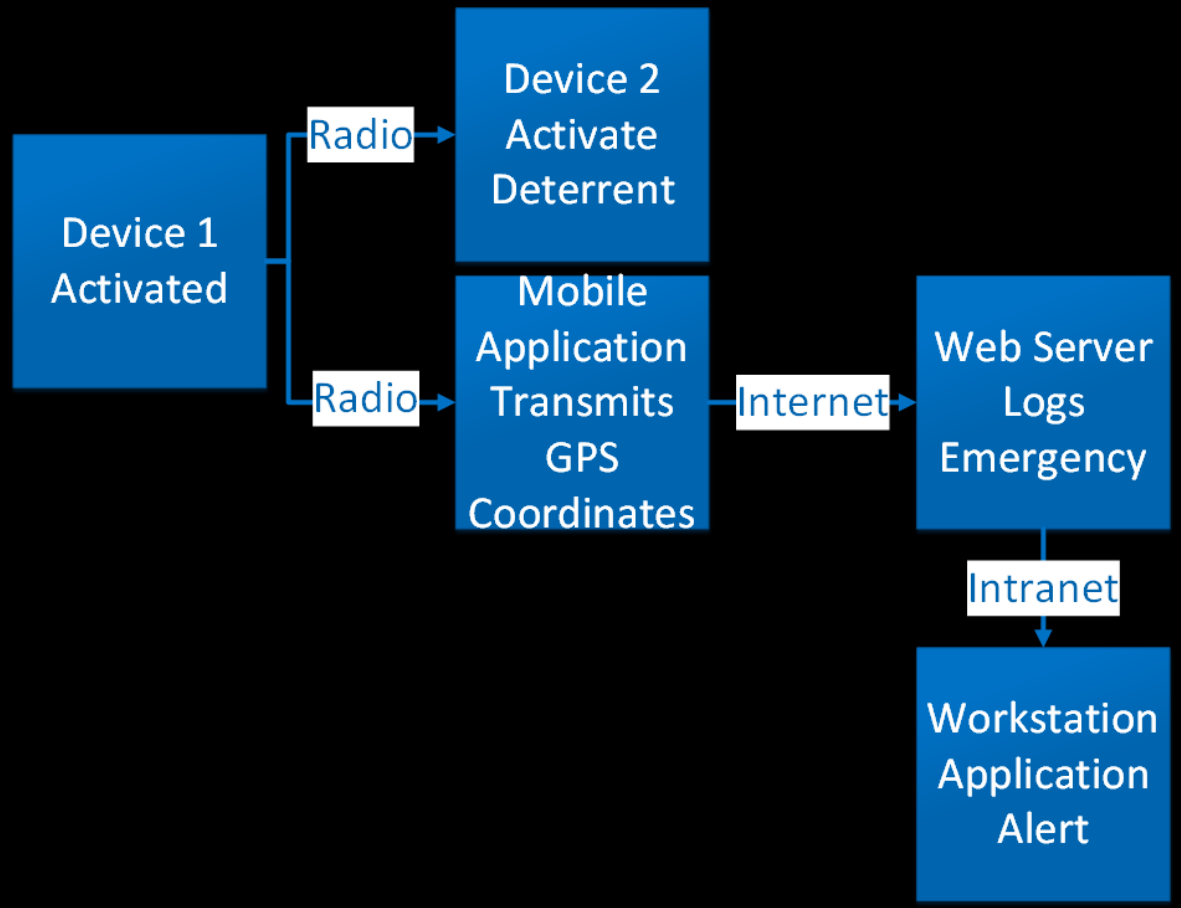
- Sends a code from a no reply email
  - 5 digit code
- If correct code, then pair phone to device 1
- If incorrect, another code will be sent to email



Emergency Distress Signal

- Send off the data from the database to the web app
- Longitude & Latitude coordinates will be presented
- Emit a sound from the phone to verify button pressed

Signaling


Device 1 Activated
Radio
Device 2 Activate Deterrent
Radio
Mobile Application Transmits GPS Coordinates
Internet
Web Server Logs Emergency
Intranet
Workstation Application Alert

Local Signaling Requirements

- Short range; all devices expected to be carried on the user's person; "Personal Area Network"
- Project scope, timeframe, and level of expertise required integration of "off-the-shelf" implementations of all wireless protocols
- Short response time requires active scanning; however, power consumption becomes a major factor
- Thus, Bluetooth 4.0 (Bluetooth Low Energy)

Bluetooth Support

- Microcontroller vendor provides binary “SoftDevices” implementing Bluetooth LE protocol in the central, peripheral, observer, and broadcaster roles
- Android provides central Bluetooth LE support since version 4.3 “Jellybean” on compatible hardware
- Android 5.0 “Lollipop” improved power consumption using ScanFilter objects: low-level hardware wakes the device only if specified advertisement packets are received

Bluetooth Implementation

- Both Device 2 and the Android application are programmed to monitor the advertisement channel
- Device 1 is programmed with a Broadcaster SoftDevice and is powered off when not activated. Acts as a Bluetooth beacon upon activation.
- Device 2 and the Android application react independently to the appearance of the matching beacon; neither is acting in a central role, allowing partial operation if one device is unviable despite conventional Bluetooth pairing limits of one-to-one device at a time.

Challenges

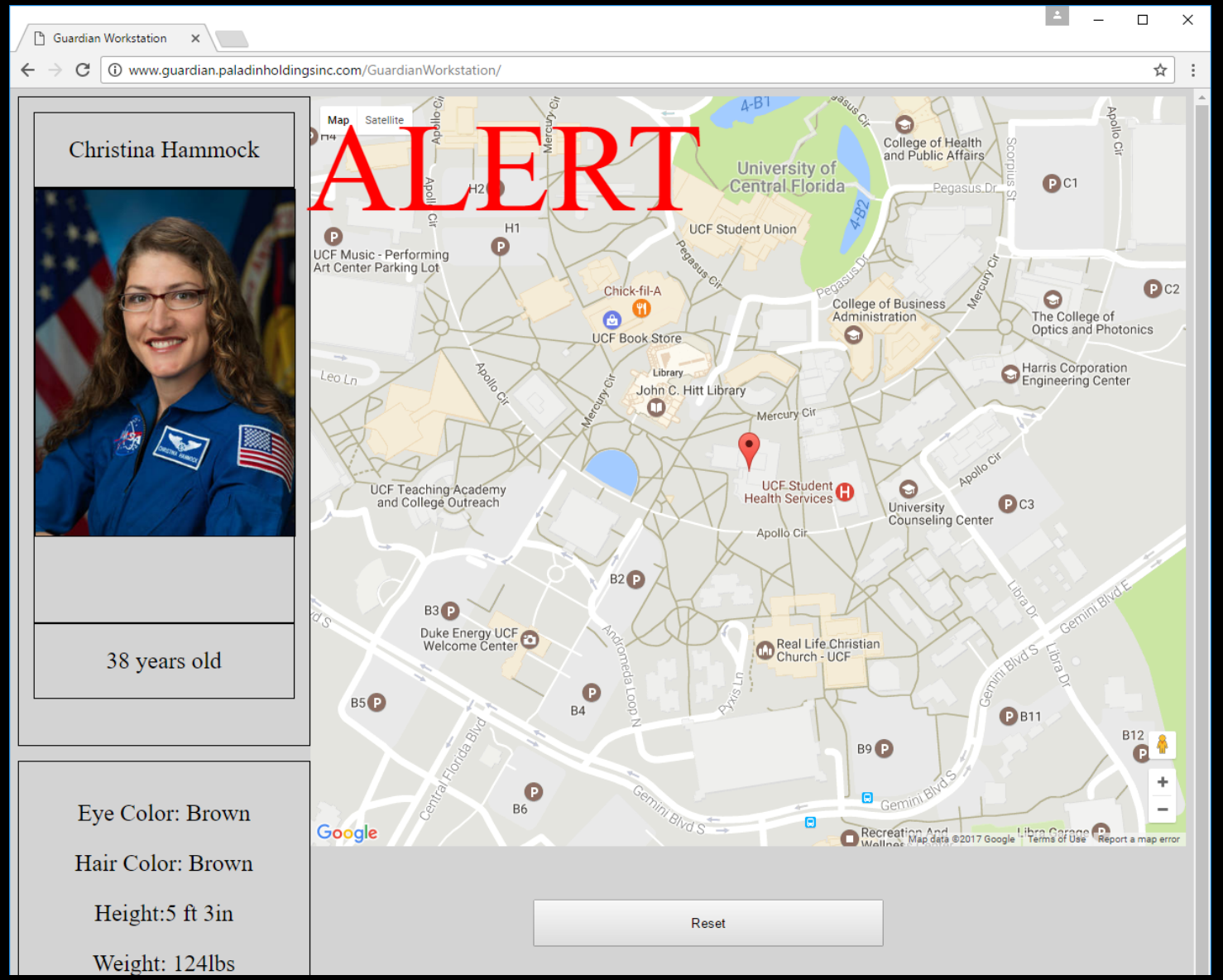
- Impact of active scanning by on power consumption needs to be measured and a tradeoff decided
  - Quickest response time: frequent/continuous scanning
  - Longest battery life: long intervals between scans
- Bluetooth pairing scheme: design requires vendor to hard code MAC addresses used by Device 1 and 2 but end-user pairing to mobile device is desirable
  - Will store device MAC address in database and providing it to mobile app after registration---selective response to correct beacon without pairing

Emergency Services Signaling

- Following any attack that results in the activation of the deterrent system, the victim will need swift response from emergency services
- The database server contains user photo and vital information from initial registration, while the mobile device can maintain current GPS location
- Providing this information immediately to emergency dispatch and first responders is crucial for the safety of the victim and the apprehension of the attacker
- Integrated using a Single-page Web App

Web App Layout

- Audio alarm and animated ALERT text (currently text just pulses in size)
- Displays vital user information
- Loads Google Maps with pushpin on latest user GPS coordinates



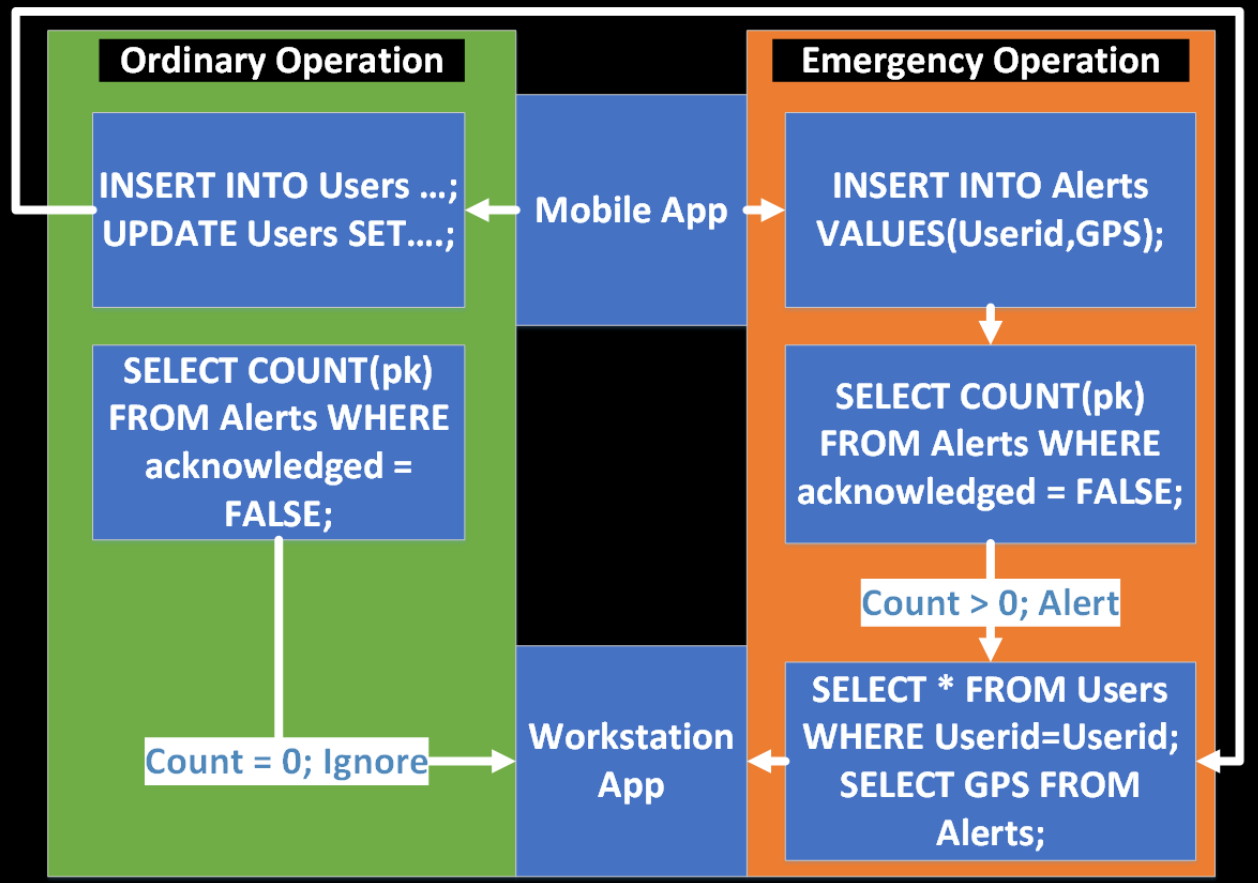
Web App Implementation

- Based on the Linux, Apache, MySQL, PHP “LAMP” stack
- Free and open-source software used widely across the web kept software and hosting budgets down while retaining access to a vast number of tutorials and examples to simplify the learning curve
- In particular, development and testing could proceed on local virtualized instances of the Web and Database servers before pushing to the open Internet
- Both the Android application and the Workstation application communicate with the database server through PHP requests coded in Java and JavaScript respectively using JSON encoding

Challenges

- PHP has no push notification ability; Android application pushes distress call to server but workstation client must initiate request
  - "Long-polling": Client-side JavaScript initiates request upon load and refresh, then server holds connection open, responding upon keepalive timeout or when it has new data, simulating push notification
- Two-way voice communication between user's mobile device and workstation software is highly desirable in an emergency application but we've found it unfeasible using current platform design

Web App Sequence



Budget

Item	Cost
PCBs (5 Each, 10 total)	$44.00
Components (5each)	$86.7
Test Boards	$39.00
3D Printing Spool	$25.00
Total	$194.7
Cost per Set	$26.14

Questions?