



UNIVERSITY OF  
**ILLINOIS**  
URBANA - CHAMPAIGN

# Item-Tracking Backpack

## Team 66

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Date: 4/30/2024

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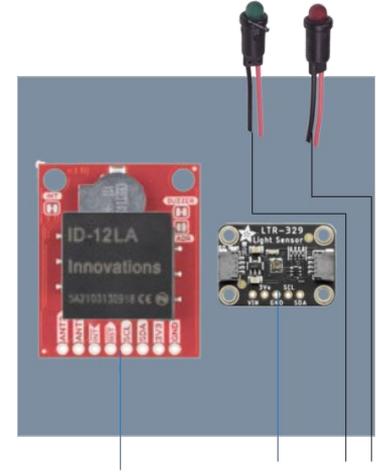
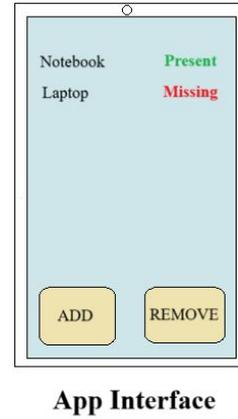
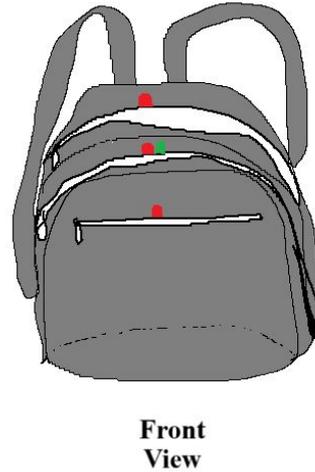
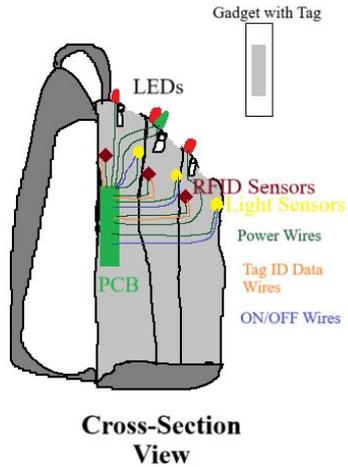


# Introduction



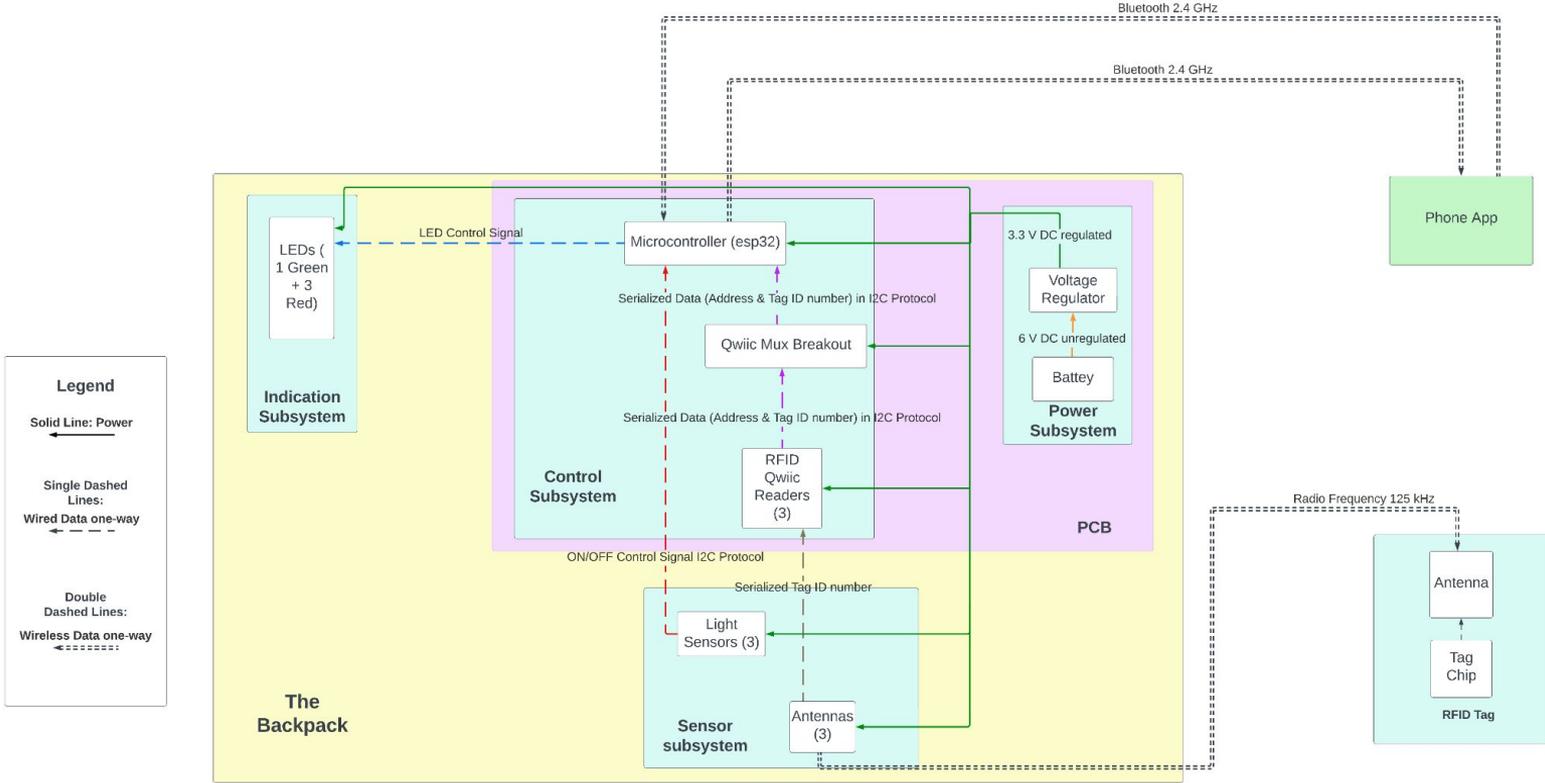
- 80% of Students Lose Belongings
- Students Forget Items At Home
- Backpacks Can Store Many Items





- Tracking in 3 Compartments
  - Maximum of 5 items/compartment
- Status monitored using application
- LEDs will allow for status-monitoring
  - LEDs turn off to conserve power

# Block Diagram





# Subsystems



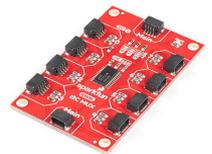
- **This subsystem consists of:**
  - ESP32-S3-WROOM-1
  - Qwiic RFID Reader
  - Qwiic Mux Breakout
- **This subsystem interfaces with the other subsystems:**
  - Uses I2C protocol
  - Uses 2.4 GHz Bluetooth to communicate with the phone app
- **It keeps track of the registered items**
  - Tag ID Number
  - Location



ESP-32-S3-WROOM-1

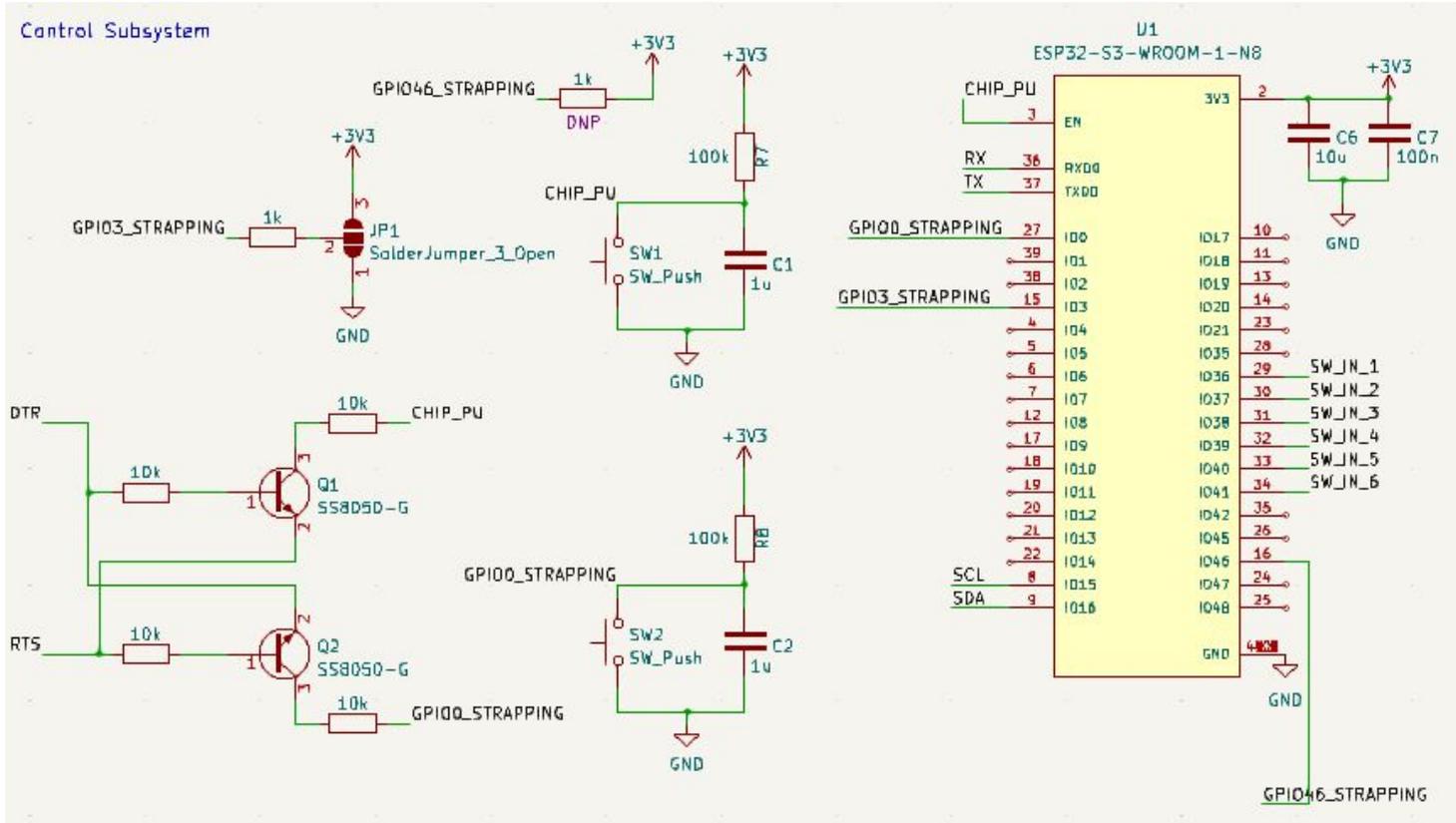


Qwiic RFID Reader



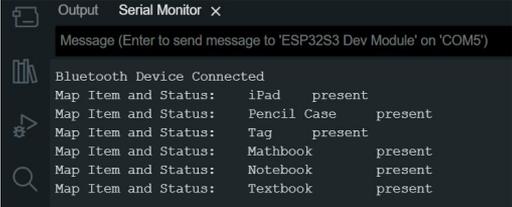
Qwiic Mux Breakout

# Control Subsystem Schematic



- **Requirements:**

- Sends Bluetooth 2.4 GHz signals
- Receives data from the sensors using the I2C protocol
- Tracks all item locations
- Switches the LED of the correct compartment ON/OFF



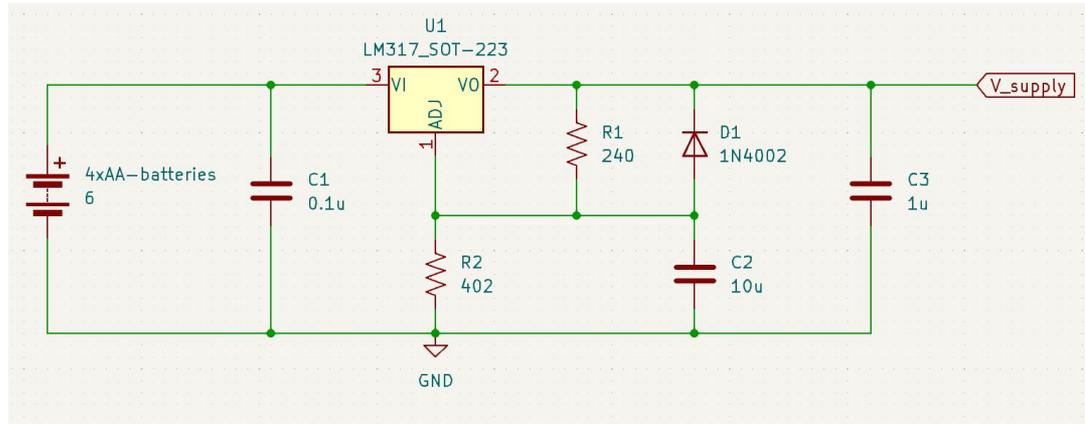
```
Output Serial Monitor x
Message (Enter to send message to 'ESP32S3 Dev Module' on 'COM5')

Bluetooth Device Connected
Map Item and Status: iPad present
Map Item and Status: Pencil Case present
Map Item and Status: Tag present
Map Item and Status: Mathbook present
Map Item and Status: Notebook present
Map Item and Status: Textbook present
```

- **Results:**

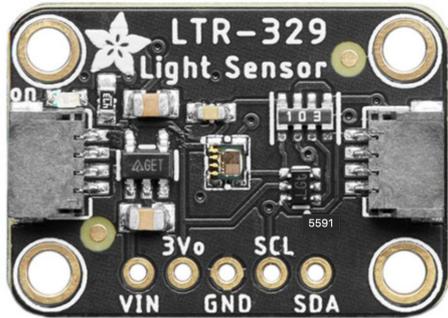
- Bluetooth Works (Verified using nRF Connect testing app)
- Serial data received (Verified using Serial Monitor in Arduino IDE)
- Used maps for tracking (Verified using nRF Connect & Serial Monitor)
- Signals to switches (Verified using a digital multimeter)

- Delivers power to the rest of the subsystems in 3.3 V DC
  - Uses LM317 voltage regulator
  - Output voltage ripple should be less than 3 mV peak-to-peak.



- **Requirements:**
  - The DC component is  $3.3 \pm 0.1$  V
  - The voltage ripple is less than 3 mV peak-to-peak
- **Results (Verified using a digital multimeter):**
  - The DC component is 3.336 V
  - The ripple is less than 1 mV peak-to-peak

- RFID ID-12LA Sensors
  - 125 kHz Frequency
- Light Sensors



LTR-329 Light Sensors



RFID Tag



ID-12LA RFID Sensor

- **Requirements:**
  - No interference between readers
  - RFID scanning must occur within two seconds
  - Light sensors detect when backpack closed
- **Results:**
  - Small actual read range
    - Around 5 cm (verified using ruler)
  - Immediate reads obtained
  - Light sensors successful
    - Closed: <10 lux

```
CH0 Visible + IR: 9
```

```
CH1 Infrared: 0
```

```
CH0 Visible + IR: 178
```

```
CH1 Infrared: 116
```

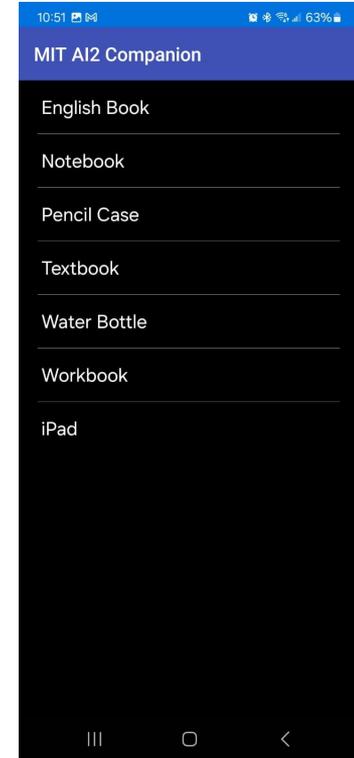
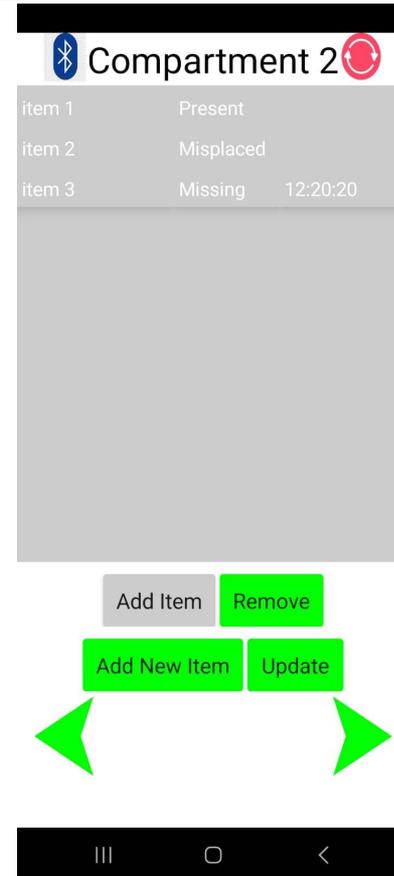


- **Item-Tracking in 3 different compartments**
  - Maximum of 5 items/compartment
  - Lists for each compartment
  
- **Status displayed**
  - **Present:** in correct compartment
  - **Missing:** outside of backpack
  - **Misplaced:** in incorrect compartment

- Addition of new items
  - Update item names
- Addition and removal of registered items
- Status updates within ten seconds

- Number of tracked items successful
- Item addition using scanning
- Registered items accessed using list
- Status updates in less than 10 seconds (verified using stopwatch)

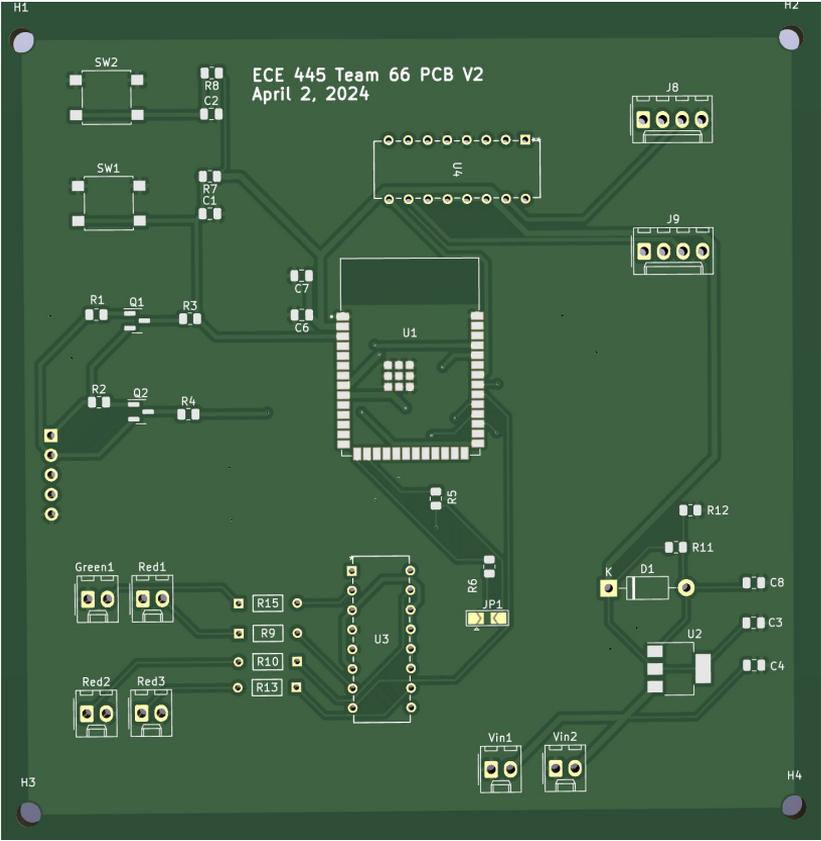
Number of Items	1	2	3	4	5
Update Time (s)	< 1	1.12	1.57	2.30	2.83

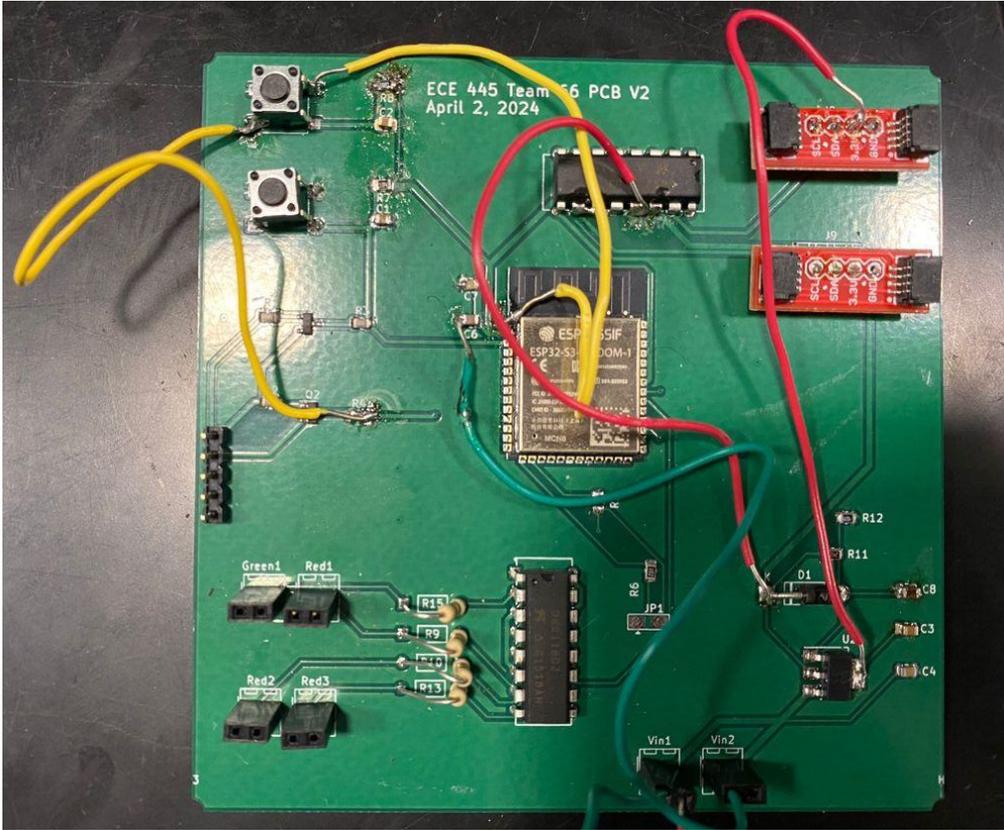




# Final Design and Conclusions





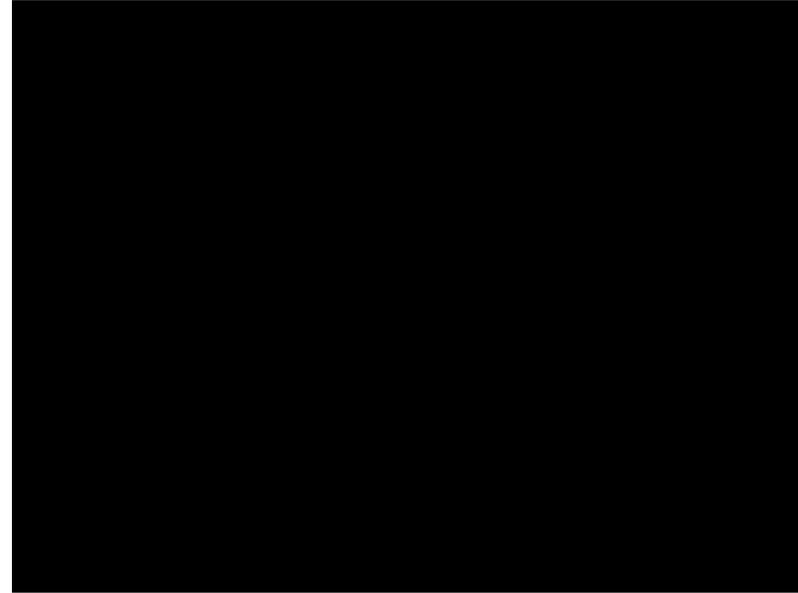
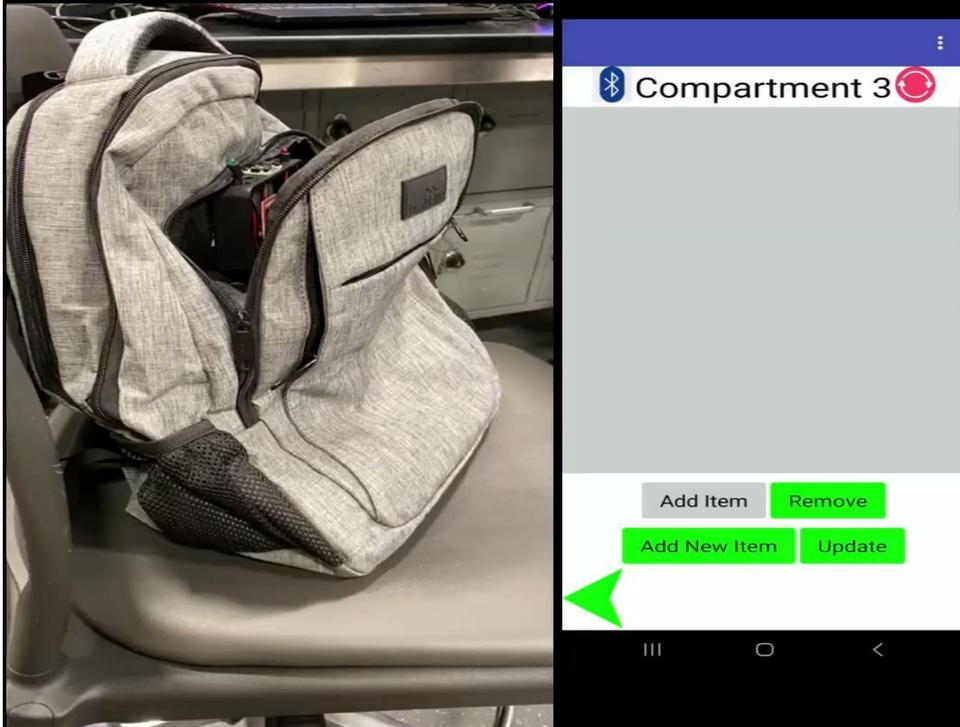


# Final Build and Changes

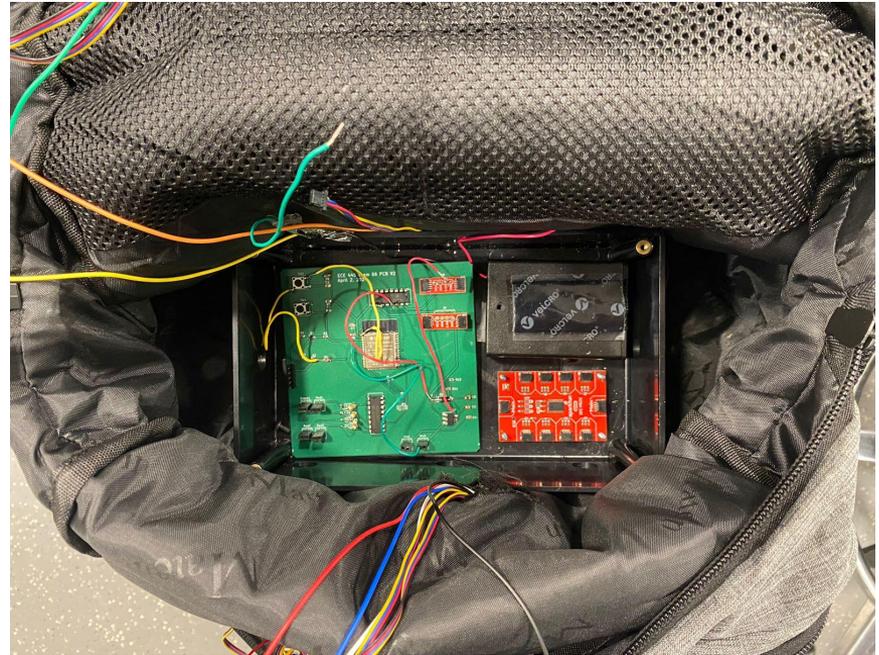


- LEDs Inside Backpack
- RFIDs Always Active
- LEDs blink





- AA batteries
- PCB and sensors in containers
- Data stored locally



## Successes:

- Application tracking was successful
- LED tracking was successful
- Microcontroller signal speed was as desired
- PCB functional

## Failures:

- Multiplexers (MUX) failed (we connected the batteries in the reverse direction)
- Imperfect PCB connections
- Packaging not ideal

## What we learned:

- Bluetooth development skills
- PCB design and debugging skills
- Project scheduling

## What we would change:

- Better power source connector
- Better component prototyping
- Better packaging

- Improve the range of the RFID
- Make the phone application more responsive
  - Auto Refresh
  - Add colors to the status
- Encryption of bluetooth data

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<https://www.ziprecruiter.com/Salaries/Graduate-Electrical-Engineer-Salary--in-Illinois#:~:text=How%20much%20does%20a%20Graduate.be%20approximately%20%2449.36%20an%20hour.>
- [2] “\*Parents Spend \$26.7 Billion in Back-to-School; 80% of Children Will Lose Pricey Supplies, Lunch Boxes and Clothing,”  
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<https://www.prnewswire.com/news-releases/parents-spend-267-billion-in-back-to-school-80-of-children-will-lose-pricey-supplies-lunch-boxes-and-clothing-219434601.html> (accessed Feb. 15, 2024).
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# Thank You For Listening

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