

# Team C0: Backpack Buddy

A smart inventory system for on-the-go students

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Presented by: Joon Cha

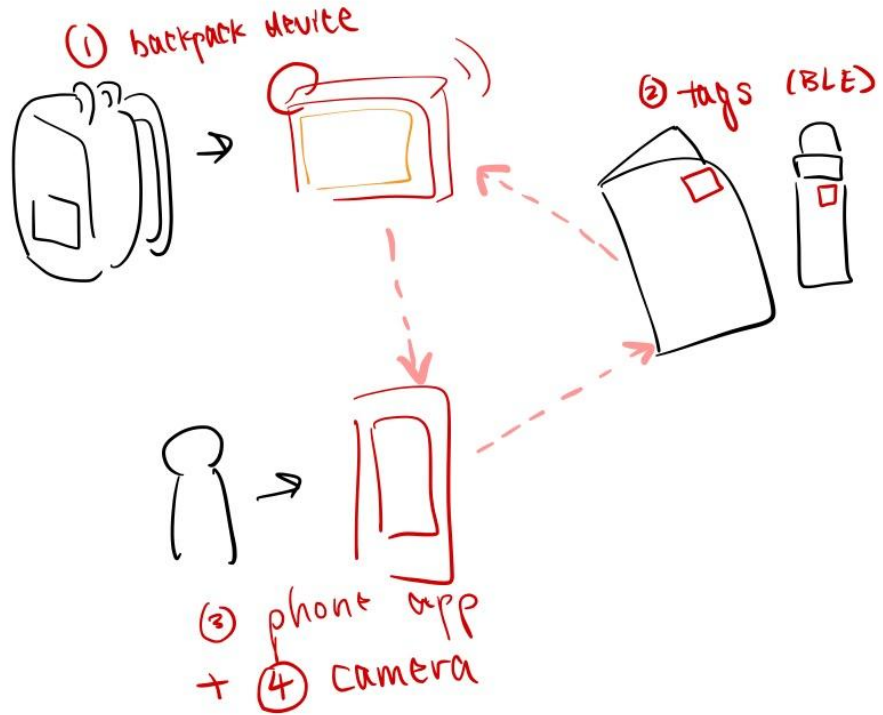
# Project Proposal

## Problem:

Students often lose track of their items between multiple events

## Solution:

An all-in-one system for active item tracking and management



# Existing Solutions & Use Case



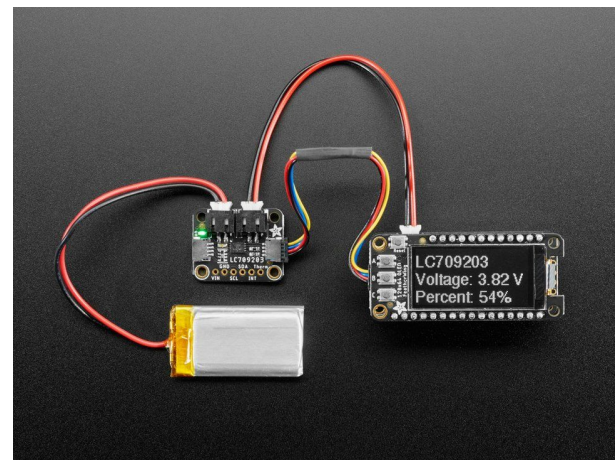
- What makes Backpack Buddy unique
  - Provides support for managing collections of items
    - Other products (i.e. Tile) only focus on locating individual items
  - Associates a collection of items with a user's schedule
  - Allows a user to get prepared for the scheduled event without forgetting the item
- Use Case:
  - Smart inventory system for students and young adults
- Improve active asset tracking while also providing an entire system for asset management
- ECE Areas Covered
  - Software Systems, Signals and Systems (Image Processing, CV)

# Metrics & Requirements

Functionality	Requirements
Tag communication & detection	< 1s delay for tag recognition (when scanner recognizes ID of a specific tag) <b>Detect 10 items within a 0.5-meter range with 100% accuracy</b>
Item visual recognition	60% item recognition accuracy
Event creation & assignment	Handle 25 weekly events
Interface display	< 3s delay for interface update (when the item shows up or disappears on the phone app's checklist)
Scanner battery	Last 18 hours w/o recharge

# Solution Approach: Tags & Hardware

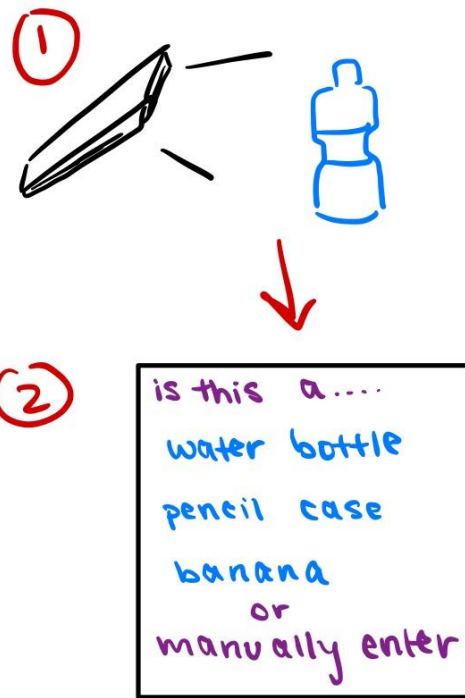
- Bluetooth Low Energy (BLE) tags on every item
  - Adhesive or ring-attachable
- Backpack-based Bluetooth scanner
  - iBeacon protocol
- Distance-based location gating
  - Limit list of items to items within 0.5m
- Battery
  - 18 hours of battery life



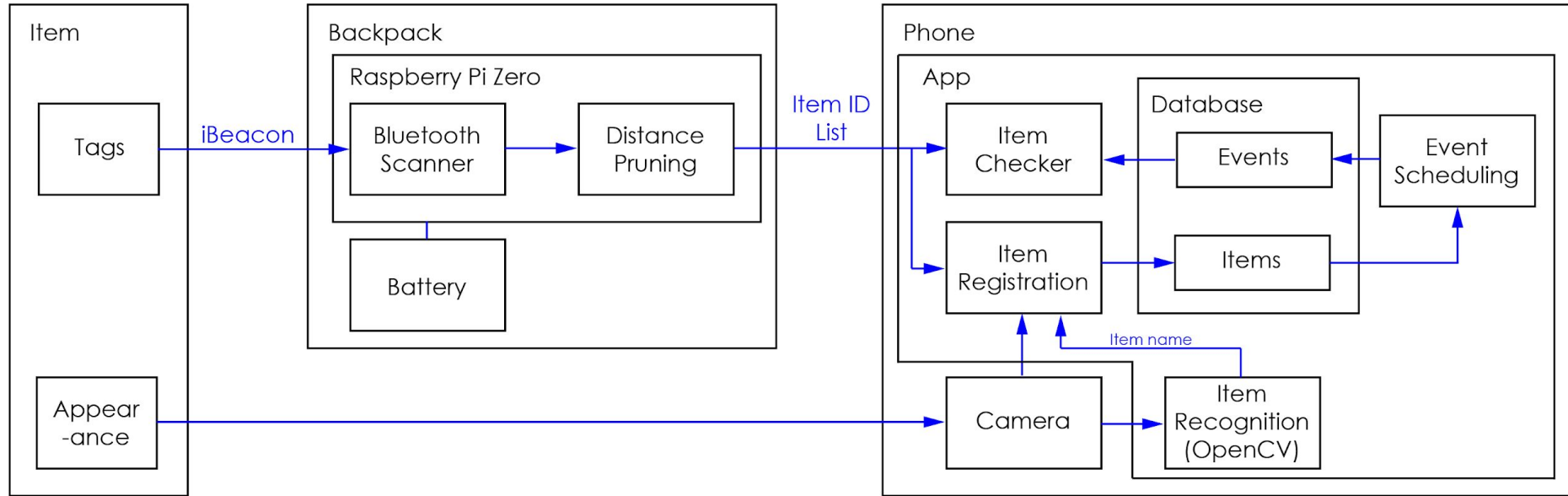
	Active RFID (RSSI LF)	Bluetooth Mesh (RSSI)	Ultra Wide Band (TDOA)	AOA/BLE
Accuracy	1 m	5 - 10 m	0.1 - 1 m	0.1 - 1 m
Refreshing period	<1 sec.	> 1min.	<1 sec.	<1 sec.
Tag battery consumption	Low	Medium	High	Low
Installation cost	Medium	Low	High	Medium/high*
Acquisition cost	Medium	Low	High	Medium/high*

# Solution Approach: Software

- Registration
  - Ask user to place then remove tag from backpack
    - ID is difference between before and after item lists
  - Suggest item name using computer vision item recognition
    - OpenCV, PyTorch, ImageNet dataset
- Scheduling
  - Database storage and retrieval
  - Associate items with every event
    - Ex. Soccer practice - soccer cleats
  - Sync with user's calendar using GCal API
- Notification
  - 5 minutes before event time, notify user of missing items
    - Customizable timings

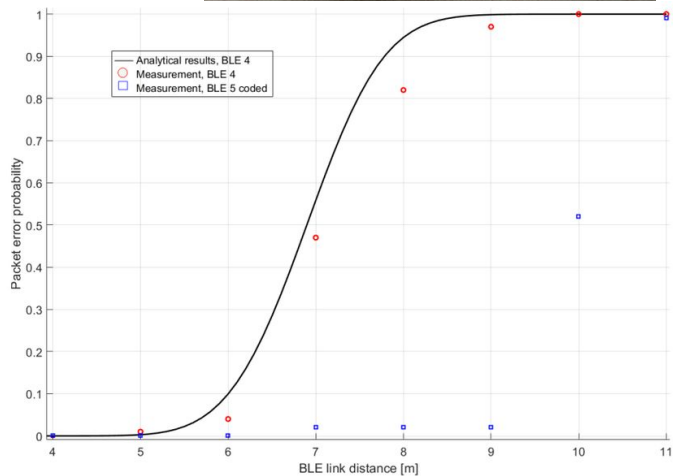
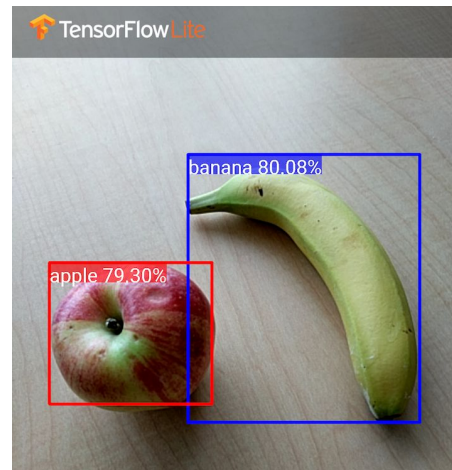


# Solution Approach: Block Diagram



# Technical Challenges

- Low item recognition accuracy
  - Large number of possible answers to the question “What item is this?”
  - Mitigated by user manually entering name
- Interference between multiple tags
  - As number of tags increases, chance of collisions goes up
  - May fail to detect items
  - Mitigated by additional scanners
- High power consumption
  - Cannot attach a power cord to backpack
  - If the battery dies, the system fails
  - Mitigated by sleeping RPi, additional batteries





# Testing, Verification, and Metrics

Functionality	Tests
Tag communication & detection	Timing ID received from scanner after tag broadcasting (MS: < 2s)
Item visual recognition	Record recognition accuracy from dataset of common items (MS: 50%)
Event creation & assignment	Creating 25 events on app (MS: 10 events)
Interface display	Timing difference between tag recognition on scanner to updated checklist interface on app (MS: <4s)
Scanner battery	SOLI (State-of-Life-Indicator) (MS: 10 hours)

# Tasks and Division of Labor

Area	Task	Joon	Aaron	Janet
Signals	Image processing (CV) for item recognition	✓		
Software	Scheduling		✓	✓
	Item registration	✓		✓
Hardware	Scanner		✓	
	Transmitting tag information to app		✓	✓



# Conclusion

- Keeping track of items is hard
  - Notebooks won't help at soccer practice, and soccer cleats are useless at debate club
- Never forget an important item again
  - Get a notification when you're about to leave
- Backpack Buddy is unique
  - Other tools focus on locating individual items such as car keys
  - Backpack Buddy is designed with students in mind, meant for bulk tracking of items in a small area
  - Backpack Buddy grows and changes with the user's schedule