

June 4th, 2021

UC Santa Barbara

Goleta



# Smart Parking Lot

Presented by the Parkingbase Group

**Andrew L, Finn L, Jun C, Luyao H**

Senior CE Students  
College of Engineering, UC Santa Barbara



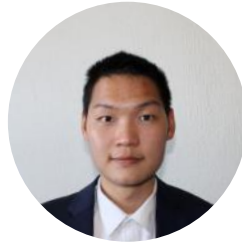


# Roles



**Andrew Lu**

Gateway Connection  
Web Application Frontend  
and Backend



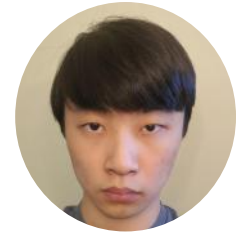
**Luyao Han**

Sensor Firmware  
PCB Design  
Wireless Charging



**Finn Linderman**

Wireless  
Communication  
Power Management



**Jun Cho**

LoRa Communication  
Virtual Demonstration  
Environment



## *Problem Statement*

Drivers spend too much time in parking lots trying to find an open space. Many parking lots only have per-floor capacity indicators, and existing solutions are prohibitively expensive.

**What if we could utilize low-cost sensors and a companion application to navigate drivers to empty parking spots faster, at a low cost to facility owners?**



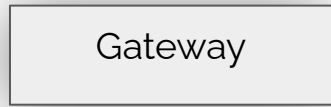
## *Parkingbase Overview*

The goal is to design a smart parking lot that will direct drivers to the nearest open parking space on campus in an efficient, accurate and clean manner.

We accomplish this using:

- Small, inexpensive parking lot sensors with long-distance and low-power transmission
- Modern, open-source, and cloud-based software solutions
- Easy-to-use mobile interfaces

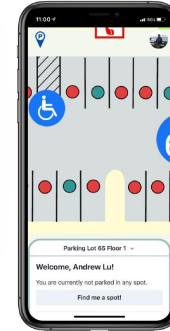
# System Overview



HTTP  
Post



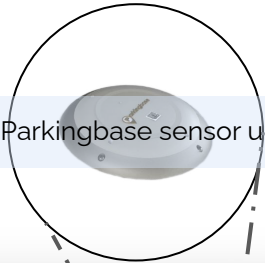
Backend  
Database



Mobile User  
Interface



Parkingbase sensor unit

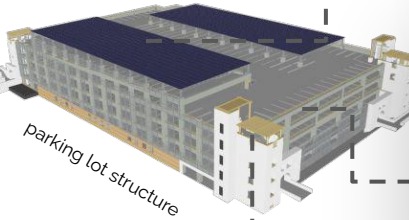




Sensor Unit



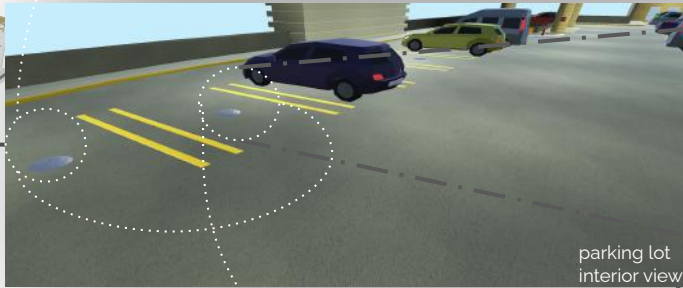
## Application Scene



parking lot structure



parking lot interior view



parking lot interior view



parking lot interior view

"Parkingbase Sensor Unit"

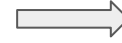




## Parkingbase Sensor Unit



immediate detection of parking status once a vehicle arrives/leaves



Sensing the car

1. Magnetic
2. Time-of-Flight



long battery life, easy to recharge

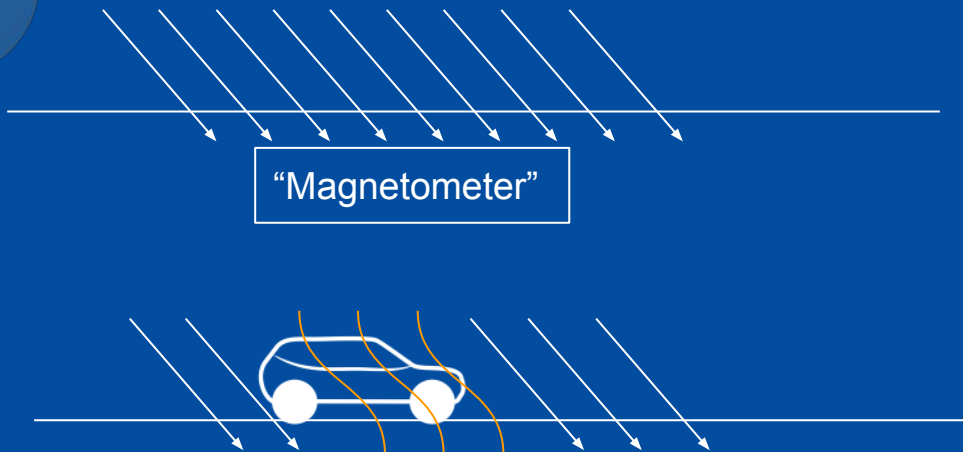


long range wireless capability



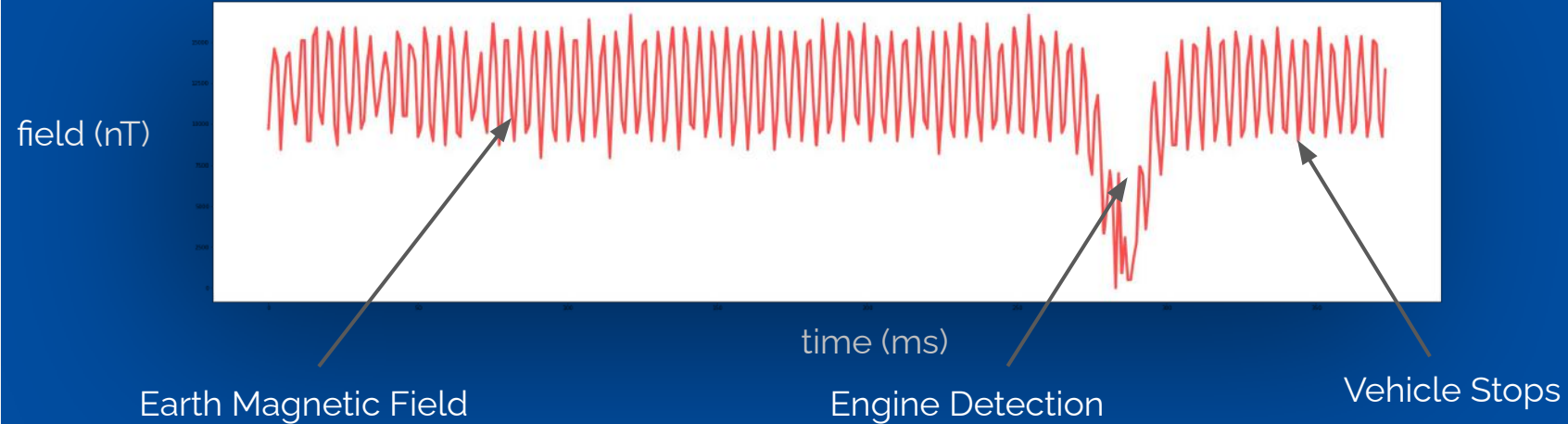


# Magnetometer Sensor Reading: Arrival of a Vehicle



# Magnetometer Sensor Reading: Arrival of a Vehicle

Magnetic Field Strength Reading

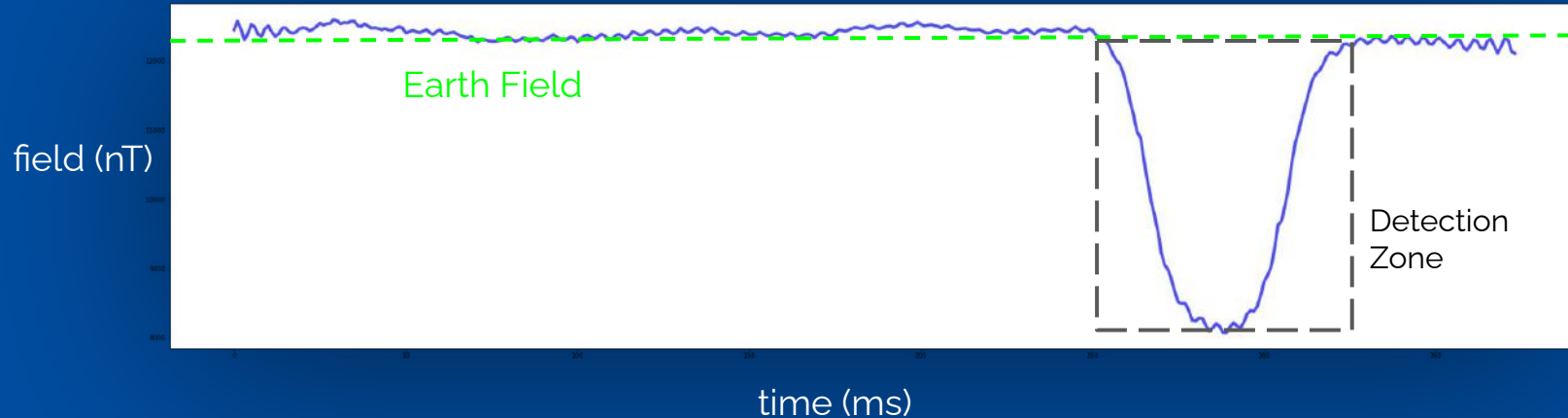


# Magnetometer Sensor Reading: Arrival of a Vehicle

Magnetic Field Strength Reading



Magnetic Field Strength Reading (after filtering)

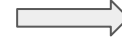




## Parkingbase Sensor Unit



immediate detection of parking status once a vehicle arrives/leaves



Sensing the car

1. Magnetic
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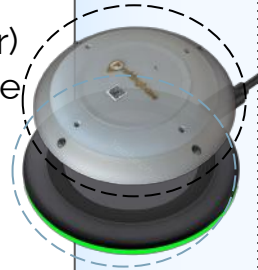


Low Power (3 year)  
Wireless Recharge



long range wireless capability

Parkingbase Sensor Unit

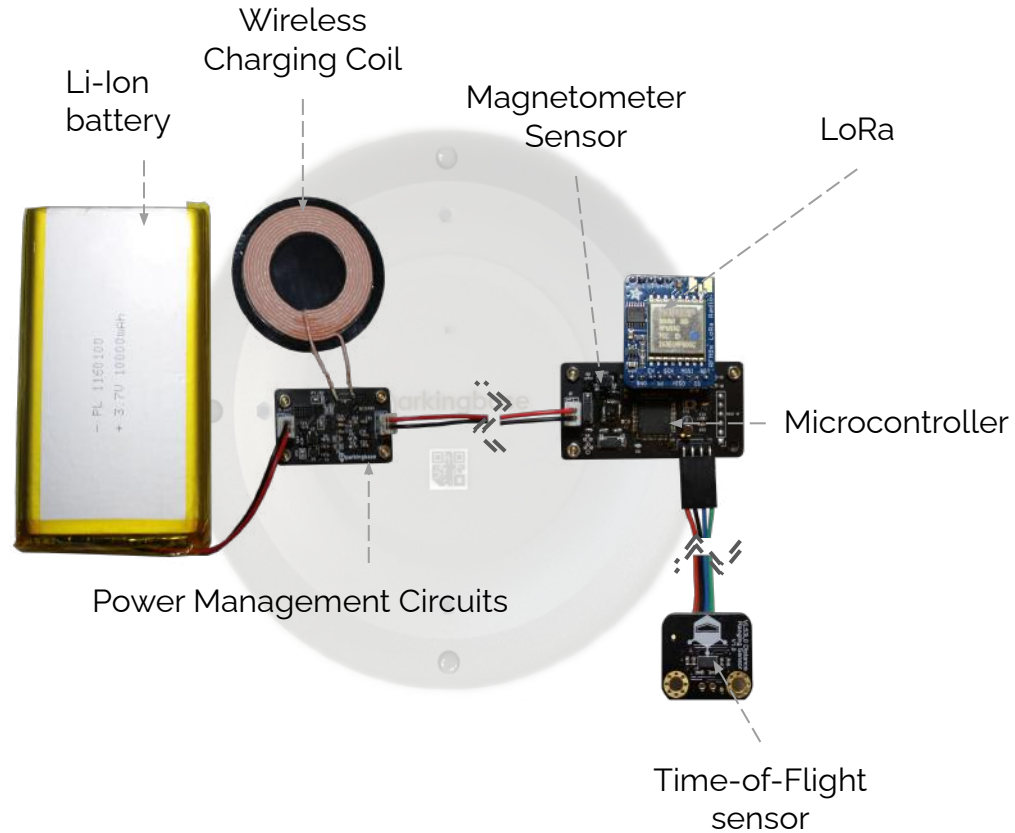
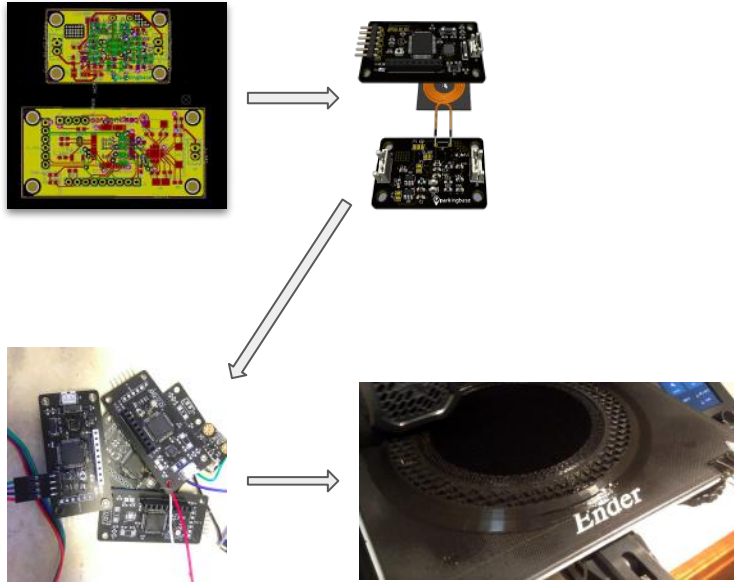


Off-market Wireless Charge

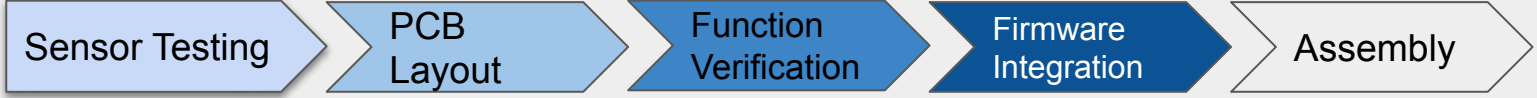
# PCB Assembly



- Designed with Kicad
- ~ 30 mm x 50 mm
- Estimated Power Consumption: 22 mA peak
- 4-layer PCB



# Parkingbase Sensor Unit - Decomposition View



Fall 2020

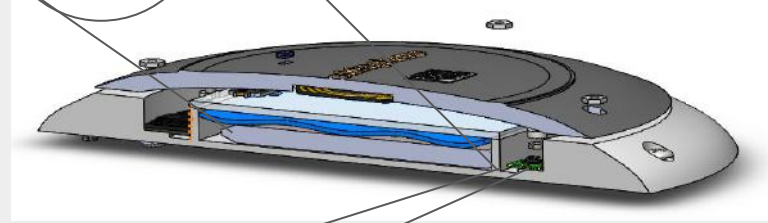
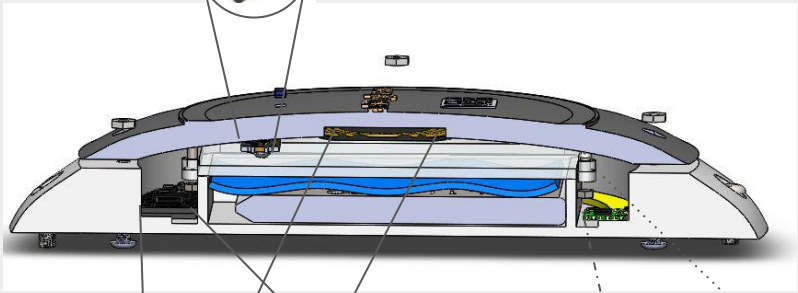
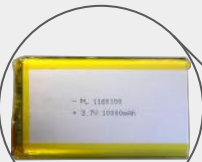
Winter 2021

Spring 2021

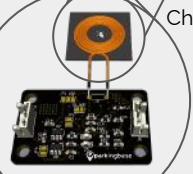
time-of-flight sensor



Li-Ion battery

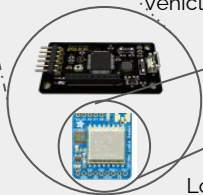


Wireless Charging Coil



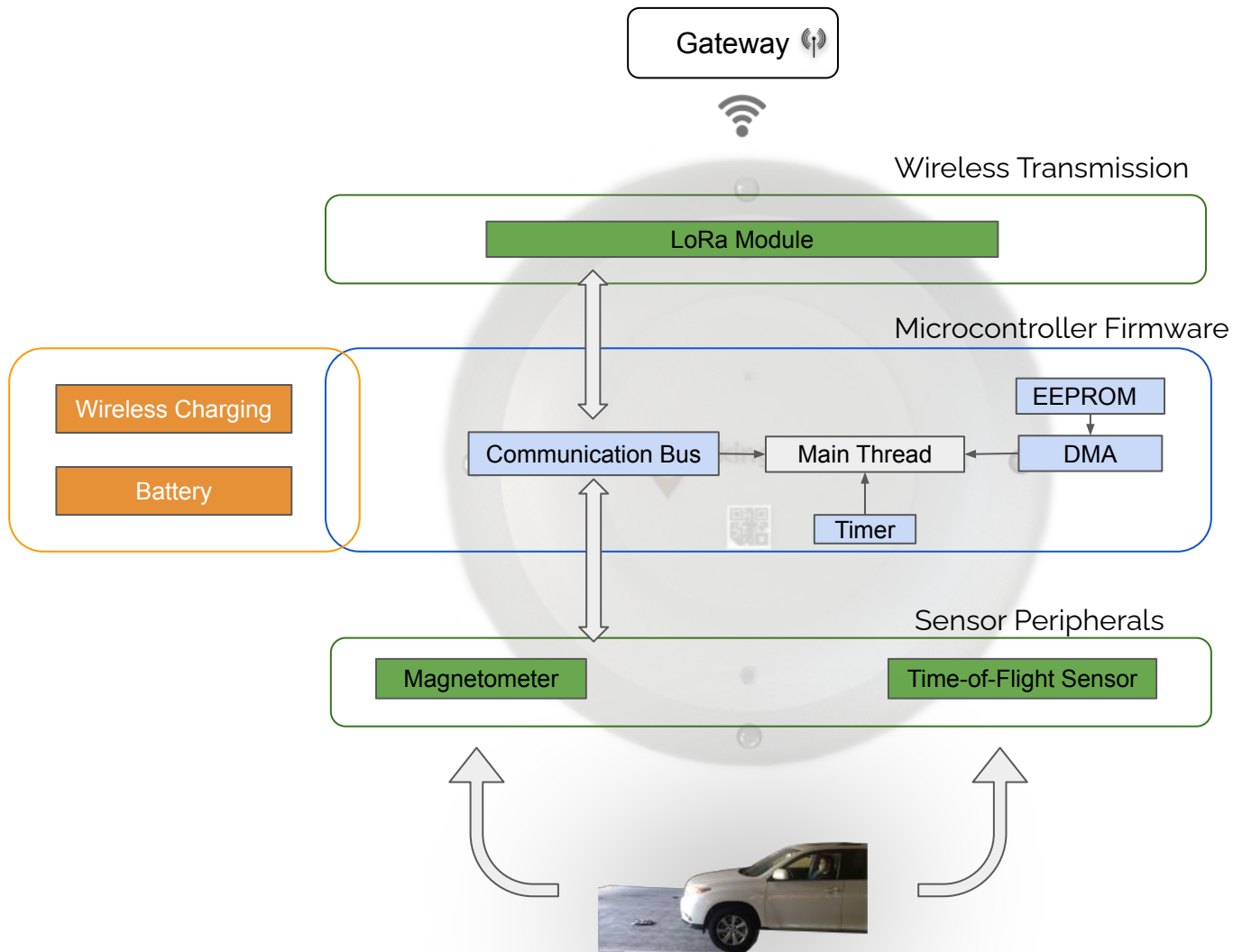
Power Management

Vehicle Sensing



LoRa Transceiver







## Parkingbase Sensor Unit



immediate detection of parking status once a vehicle arrives/leaves

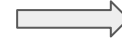


Sensing the car

1. Magnetic
2. Time-of-Flight



long battery life, easy to recharge



Low Power  
Wireless Recharge



long range wireless capability



LoRa





The slide features a central graphic consisting of two concentric circles. The inner circle is a medium blue, and the outer circle is a darker blue. The text "Wireless Communication" is centered within the inner circle in a white, sans-serif font. The background is a light blue gradient with a pattern of small, faint location pin icons scattered across it. A larger, semi-transparent location pin icon with a white letter 'P' is positioned in the top right corner.

# Wireless Communication



# *Selection Criteria*

## Problem Requirements

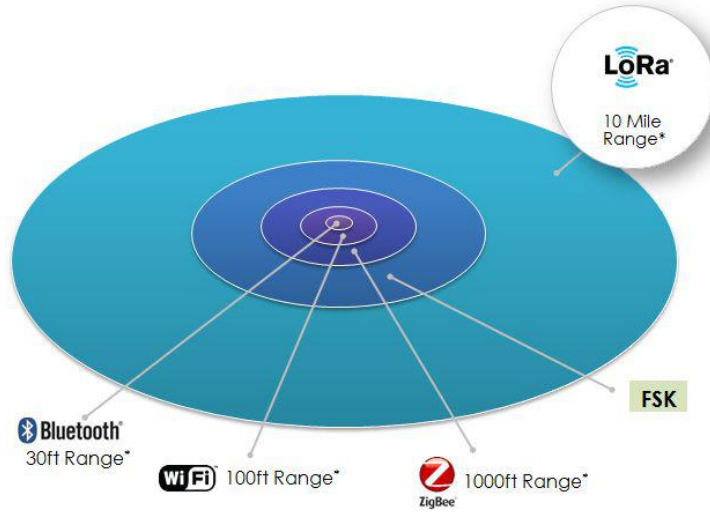
- Long range
- Low power consumption
- High scalability

Our Solution: LoRa





# LoRa - Range



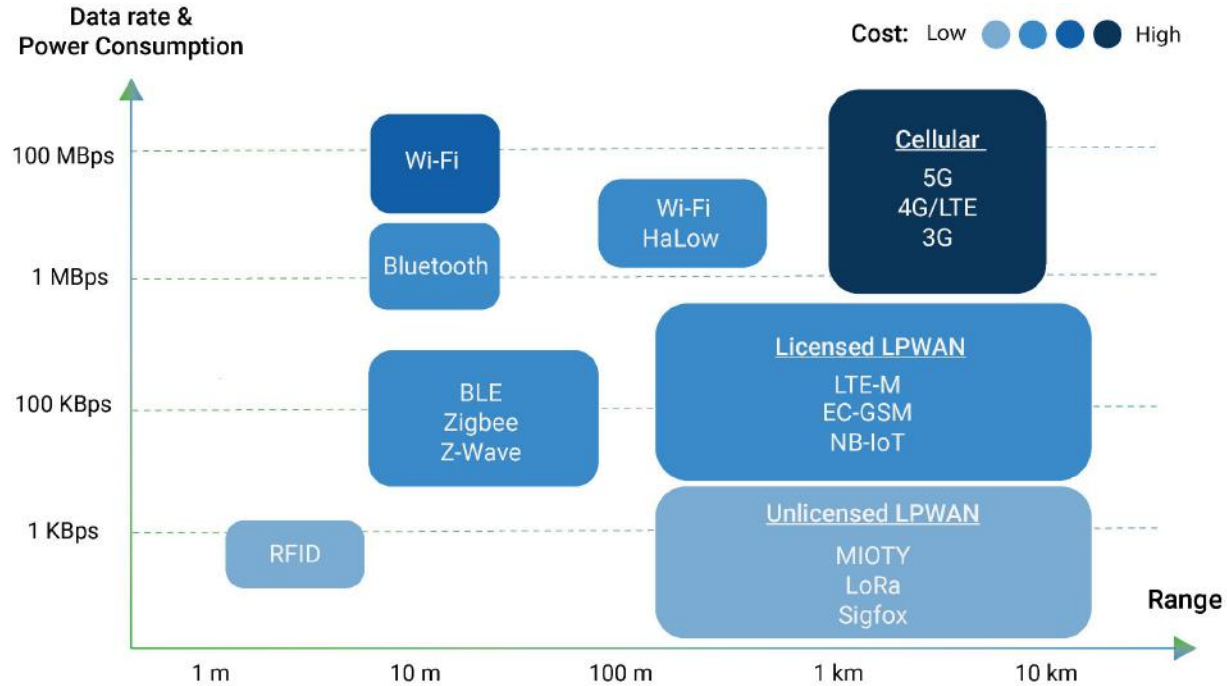
Theoretical range comparison



Live testing in parking structure



# Wireless Communication Comparison



Wireless Communication Methods Comparison

# Gateway

- Raspberry Pi Version 4
- Using RFM9x Library
- Connected to MongoDB backend
- Transmits:
  - Parking Space
  - Status
  - Time Stamp

RFM95 Module



LCD





# Data Flow to Gateway

End Node  
lora\_001

915 MHz

Data

Data

ACK

Gateway @ 915 MHz

Data

HTTP  
Post

Database





User  
Interface

# Driver User Interface

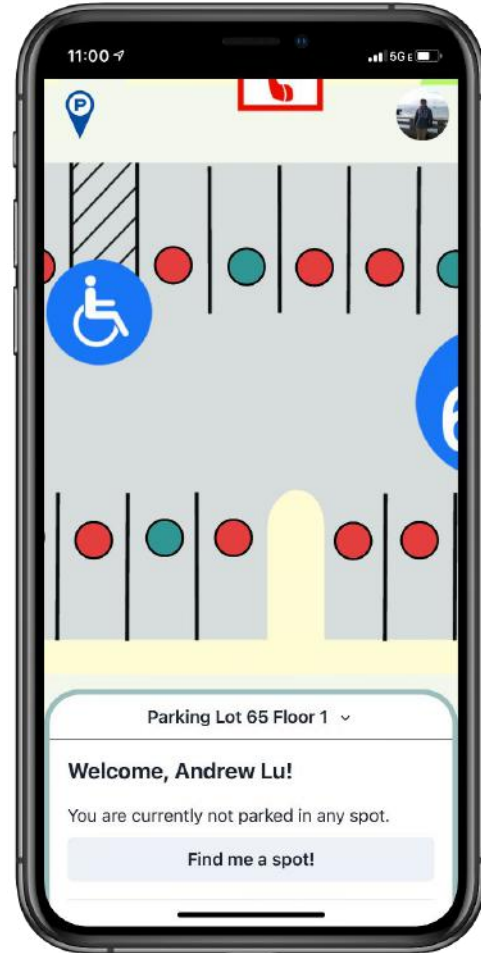
View the status of all spots  
within a parking lot





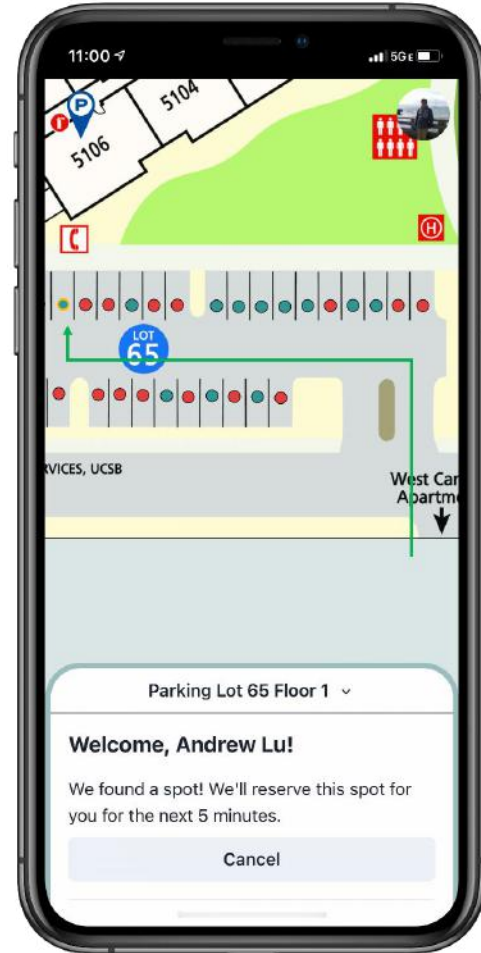
# Driver User Interface

One tap to find and reserve  
an open spot



# Driver User Interface

App will navigate you to  
your reserved spot



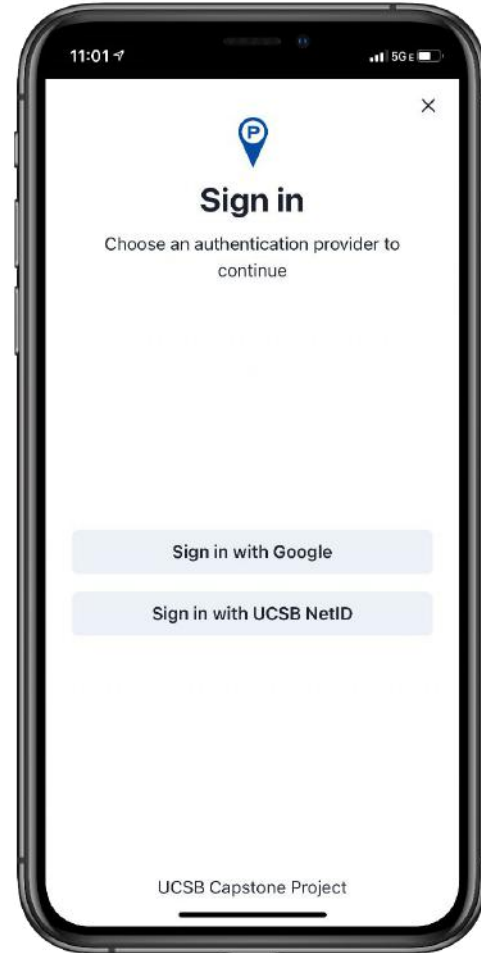
# Driver User Interface

Remembers where you parked -  
view your parking history



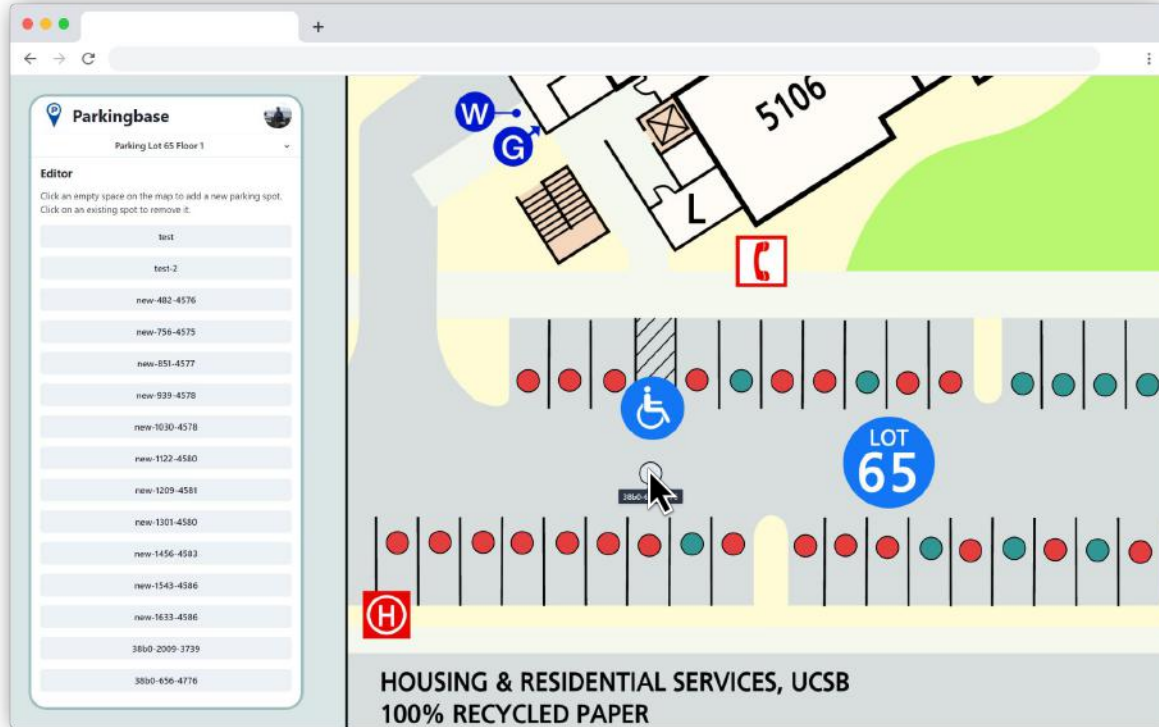
# *Driver User Interface*

Supports Google and  
UCSB NetID login





# Admin User Interface



Add and remove parking lot sensors with one click on the map.

Usable on any web browser.



# Software Frameworks / Technologies

- Progressive Web Application (PWA)
  - Works on all iOS and Android devices and looks like a native app
- Frontend built using React and Chakra UI
- Backend built using Next JS and deployed on Vercel
- Application database built using MongoDB

NEXT.JS





# Questions

Acknowledgements

Professor **Yogananda Isukapalli**

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**CACI**  
EVER VIGILANT

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ODM SOLUTIONS