



*Scooter*  *ab*

# Introduction to ScooterLab

ScooterLab Workshop 2026

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Postdoctoral Fellow, UT San Antonio

# At a Glance

01 Overview

02 Architecture

03 Vehicle & Sensing

04 Operations

05 Collaborations

06 Next Steps

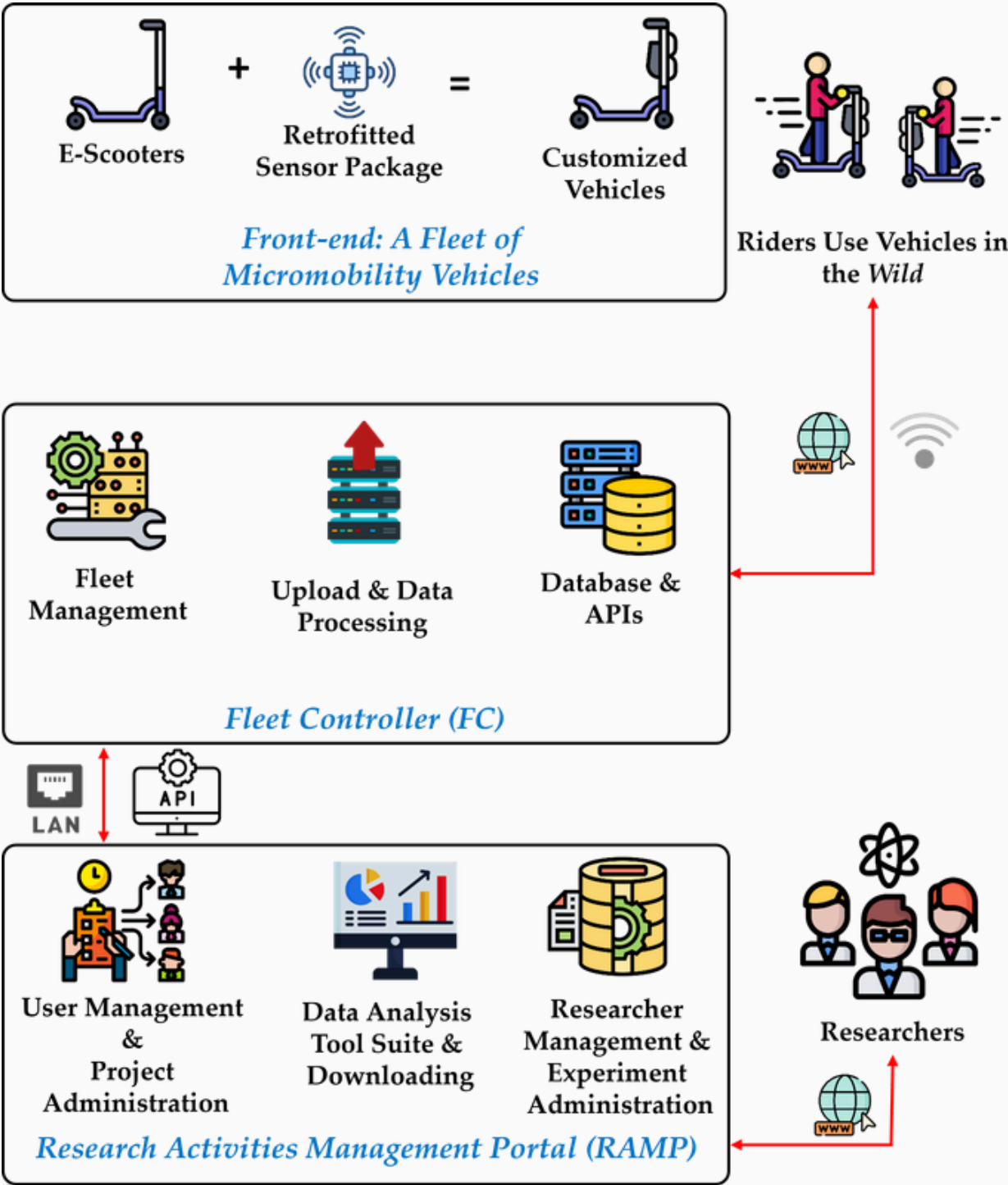


# Overview

A community research testbed providing a programmable and participatory micromobility-supported sensing platform

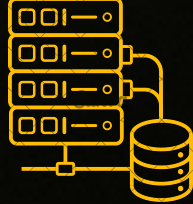
Advance research at the intersection of Computer and Information Science and Engineering and interdisciplinary domains such as urban planning, mobility analytics, privacy and security, environmental sensing, and smart city infrastructure.

# Architecture



## Front-end: E-scooters & sensing

Fleet of e-scooters retrofitted with onboard sensor packages for continuous data collection during real-world rides.



## Fleet Controller

Operational backbone manages the fleet, ingests sensor data from scooters, preprocesses and de-identifies streams, and integrates external context.



## Research Activities Management Portal (RAMP)

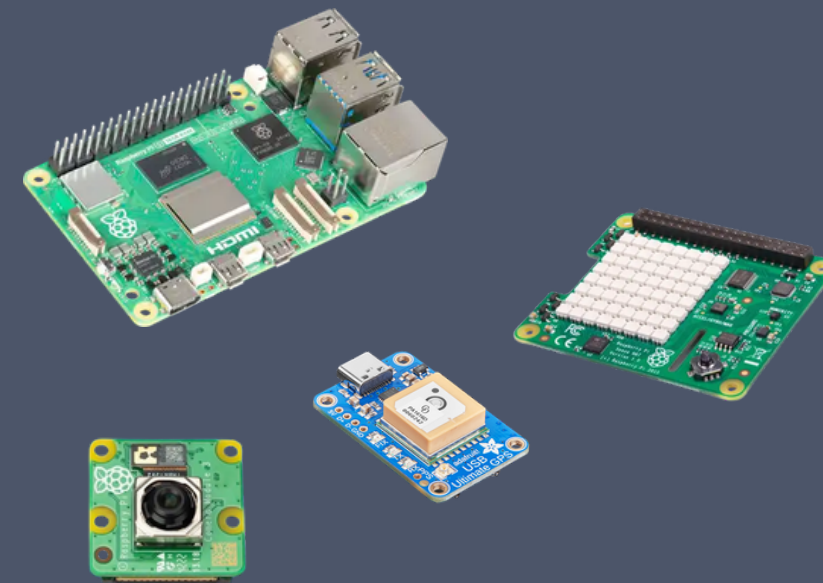
Web interface for the research community. Researchers request projects, manage experiments, and access curated data through built-in visualization and analysis tools.

# Vehicle & Sensing Design Goals



## Source E-Scooters

Procure commercially available e-scooters suitable for retrofitting.



## Develop a Sensor Suite

Design and engineer a custom sensor package to collect mobility, environmental, and contextual data.

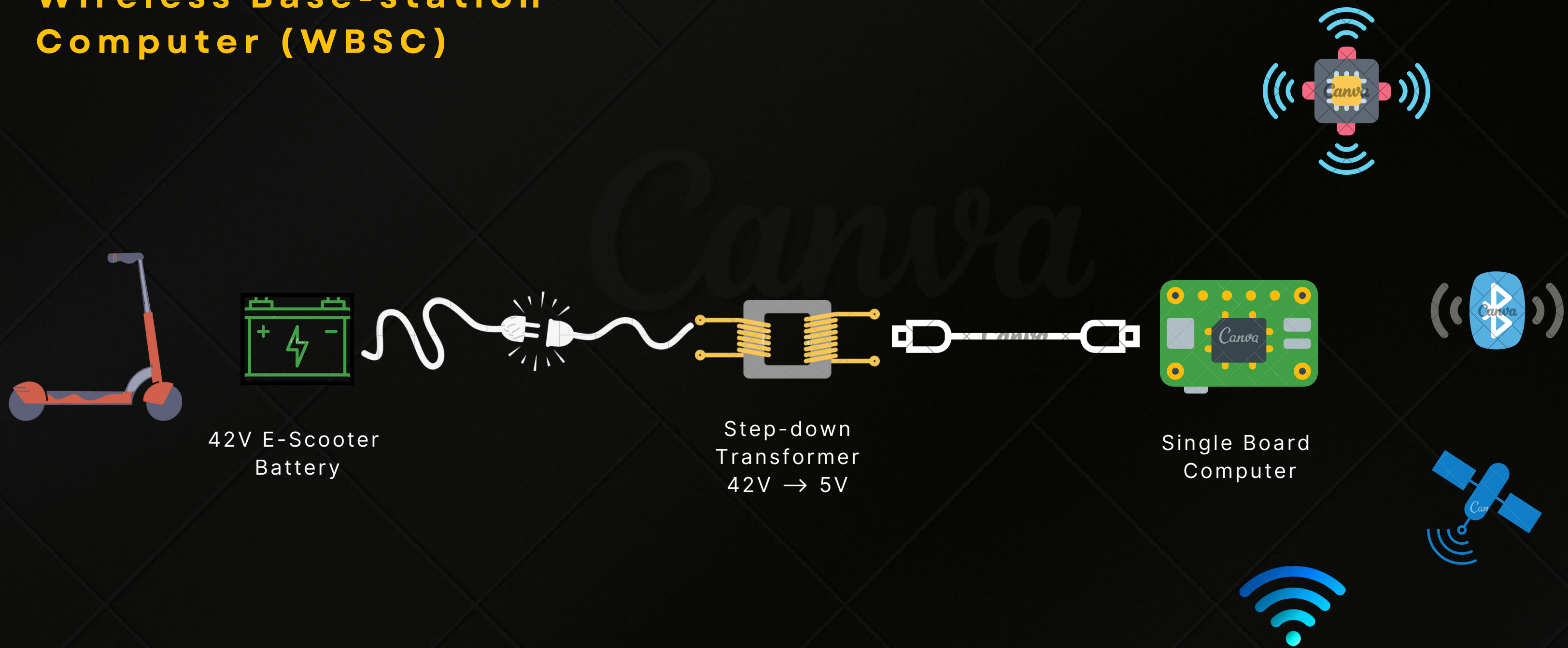


## Retrofit & Integrate

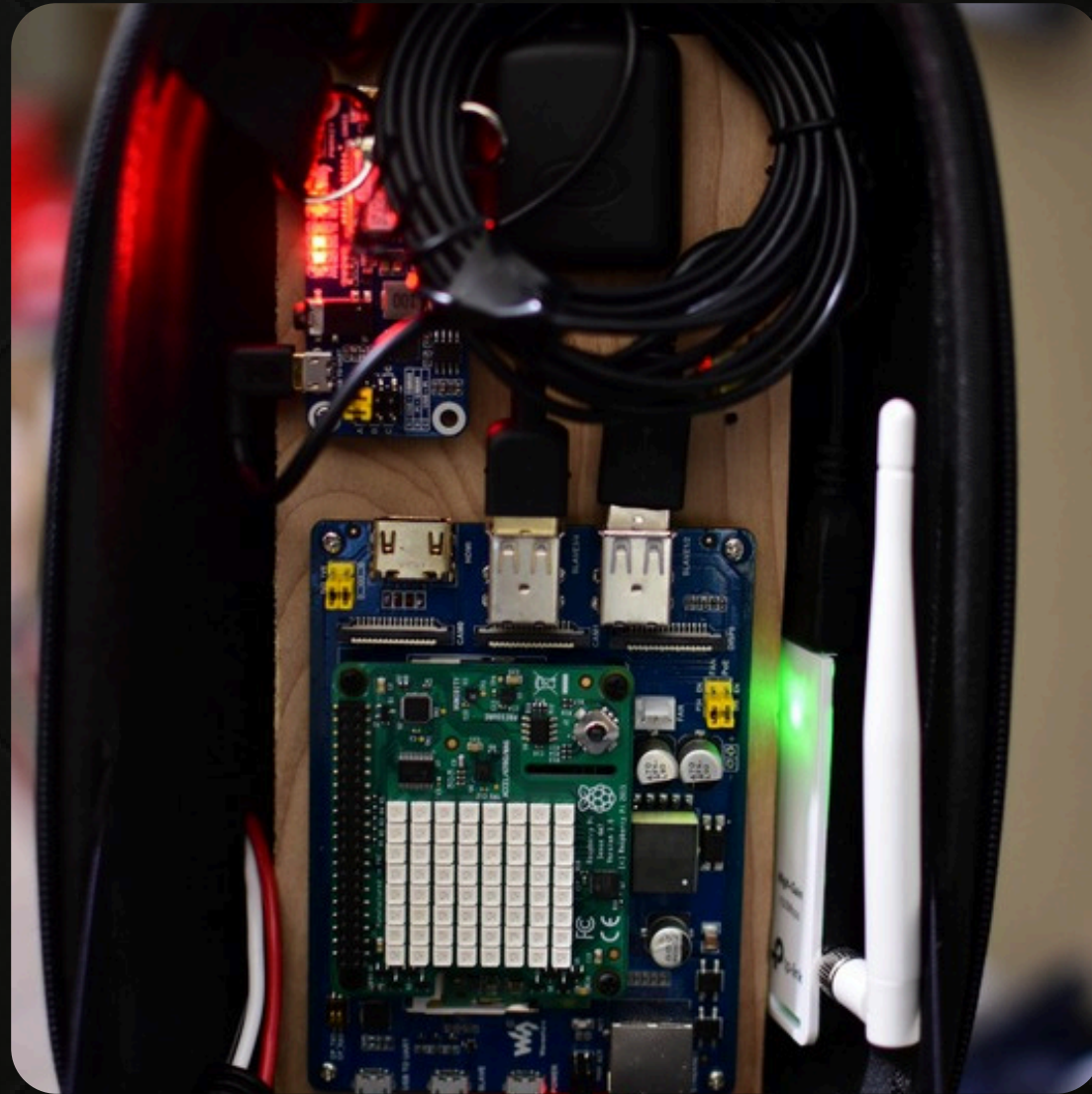
Attach the sensor suite to e-scooters to create programmable research vehicles.

# Sensor Suite

## Wireless Base-station Computer (WBSC)



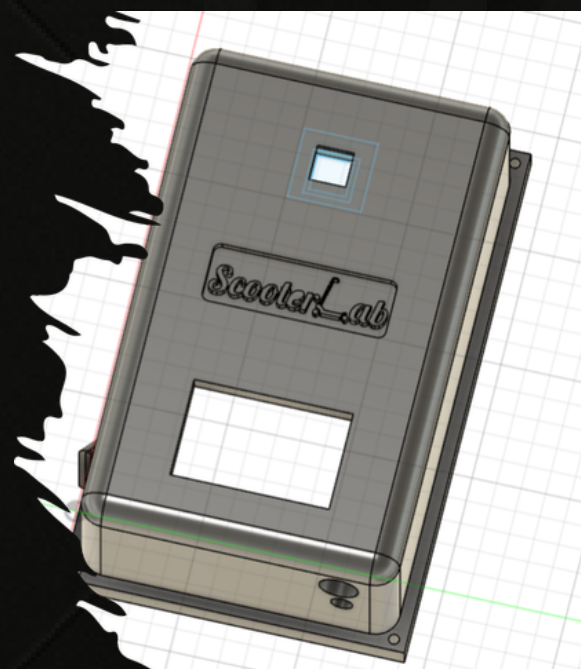
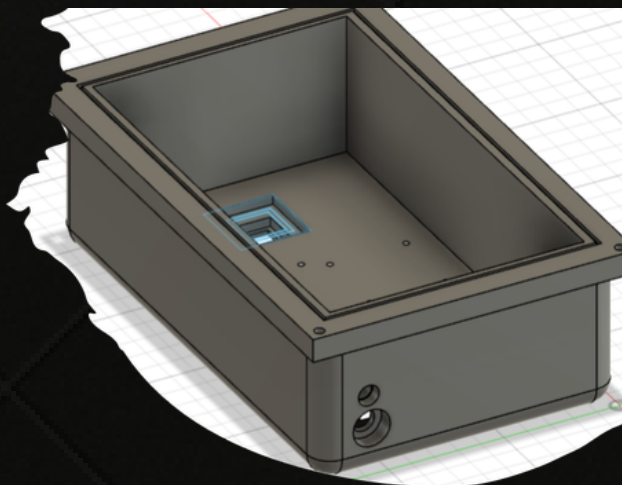
# Initial Prototypes



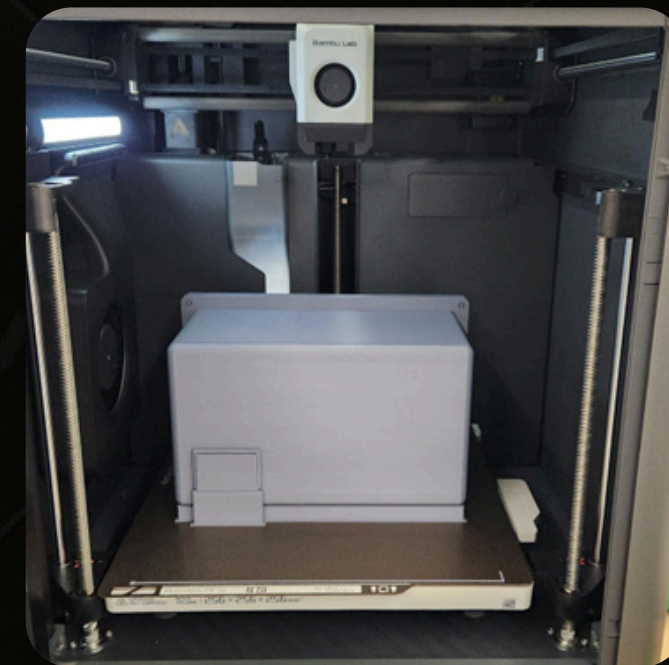
# WBSC Enclosure

## In-House Modeling

- Modeled for modularity and weather protection
- Custom fit for scooter stem dimensions
- Easily replaceable and upgradable



## 3D Printed In-House



# Deployed Setup



## E-Scooter

- Segway Ninebot G30P MAX
- 18.6mph max speed
- 40-mile range



## Wireless Base-station Computer

- Raspberry Pi 5, SenseHAT v2
- Sensors: Light, Temperature, Pressure, Humidity, Accelerometer, Gyroscope, Orientation, Magnetometer
- GPS, Bluetooth, WiFi
- Camera, Microphone

## Sensor Service

1. Create and edit the `startsensor.service` file:

```
sudo nano /etc/systemd/system/startsensor.service
```

2. Start the `startsensor.service` :

```
sudo systemctl start startsensor.service
```

3. Stop the `startsensor.service` :

```
sudo systemctl stop startsensor.service
```

## Software

- Configurable per-sensor sampling rates
- BLE connection to E-Scooter firmware
- Data upload to backend server (FC).

# Operations

- Riders onboard through a structured five-step process, with all steps now available through the ScooterLab mobile app.
- An IRB was approved for the base-experiment.
- Future experiments may either require modifications or new IRBs based on the experiment criteria.



## 1. Participant Onboarding

In-person check-out appointment at a designated campus location.



## 2. Consent, Terms & Conditions

IRB-approved consent form covering usage terms, data collection, and rider responsibilities.



## 3. Safety Video

Mandatory video covering safe e-scooter operation before first ride.



## 4. Travel Survey

Demographic and travel-behavior survey capturing rider context over the prior 14 days.



## 4. Return/Renew

Participants either return the e-scooter or renew it for another 14-days.

# Recruitment

**ScooterLab** | NSF | **UTSA** | 

IRB#: FY23-24-11


## NEED A RIDE?

We are looking for **UTSA students interested in riding e-scooters.**  
(UTSA employees including GRAs, GTAs, GAs, and Student Assistants are ineligible)



An e-scooter will be given to you for short/long term rental where you can use it as your own personal e-scooter at no charge.

**Interested? Scan the QR**



Eligible participants will complete surveys and document travel habits.  
Safety training and waiver required

[scooterlab@utsa.edu](mailto:scooterlab@utsa.edu) | [scooterlab.utsa.edu](https://scooterlab.utsa.edu)  
San Pedro I, Room 108 | NPB, Room 2.238

UT San Antonio  
FY23-24-11  
Approved on 11-11-2024  
Expires on 7-1-2025

### ScooterLab

Service Provider

1 Service & Provider | 2 Date & Time | 3 Your Info | 4 Confirmation

#### Ready to Ride a ScooterLab E-Scooter?

If you are a UTSA student looking to rent a scooter from ScooterLab, please read the instructions below and continue scrolling to schedule your pickup or return appointment.

#### ScooterLab E-Scooter Appointments

Follow the steps below to book your scooter appointment.

#### Which Service Should I Choose?

- **First time borrowing** → choose an E-Scooter Checkout option (NPB or SP1—pick the location where you will pick up your scooter).
- **Returning or renewing** → choose an E-Scooter Return option (NPB or SP1) if you are returning your scooter or extending your loan.

#### What is a Provider?

The Provider is a ScooterLab staff member who will assist you during your appointment. You may choose any available provider; all of them can help with checkouts, renewals, and returns. If no dates or times are available for a specific provider, please select a different provider to see additional appointment slots.

#### Service & Provider

Service \*  
Please Select

Provider \*  
Please Select

**NEXT**

# Fleet Management

**ScooterLab**

## Admin Dashboard

Last updated: 5/18/2025, 3:37:00 PM

Total Scooters <b>12</b>	Rented Scooters <b>0</b>	Available Scooters <b>9</b>	In Maintenance <b>0</b>
Total Student Employees <b>2</b>	Total Riders <b>5</b>	Active Riders <b>3</b>	Riders Waiting <b>0</b>

**ScooterLab**

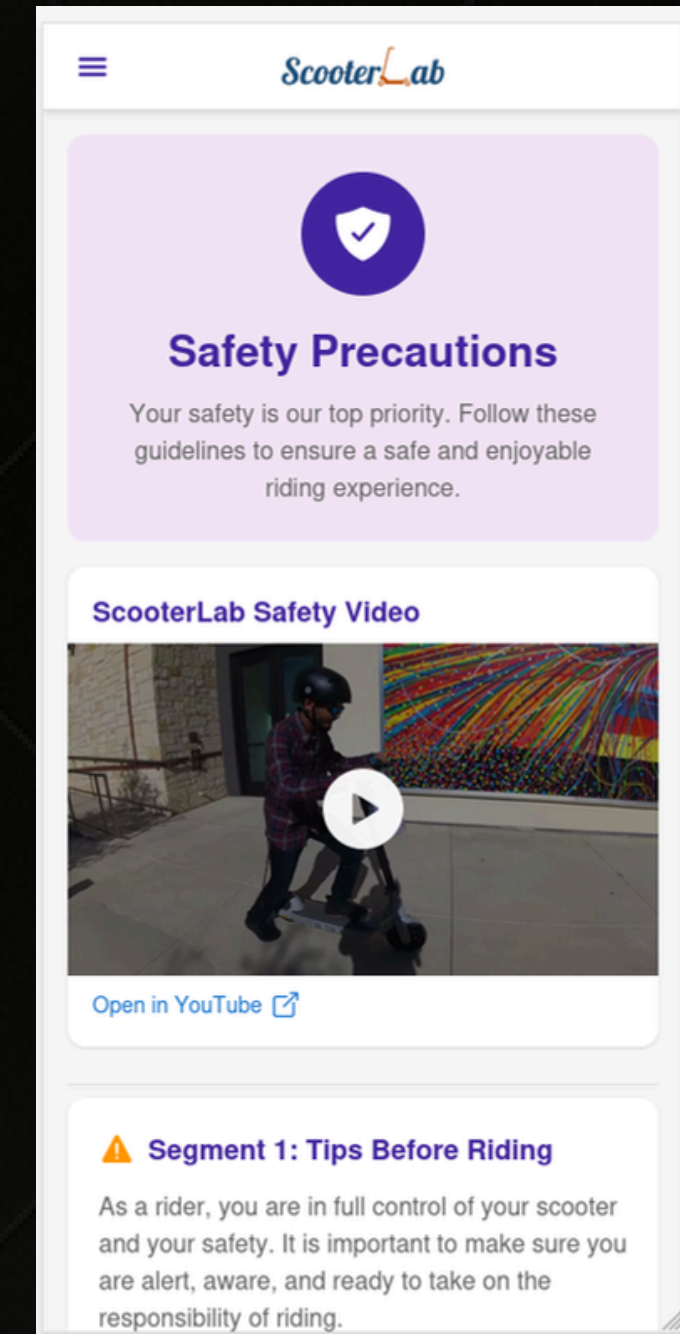
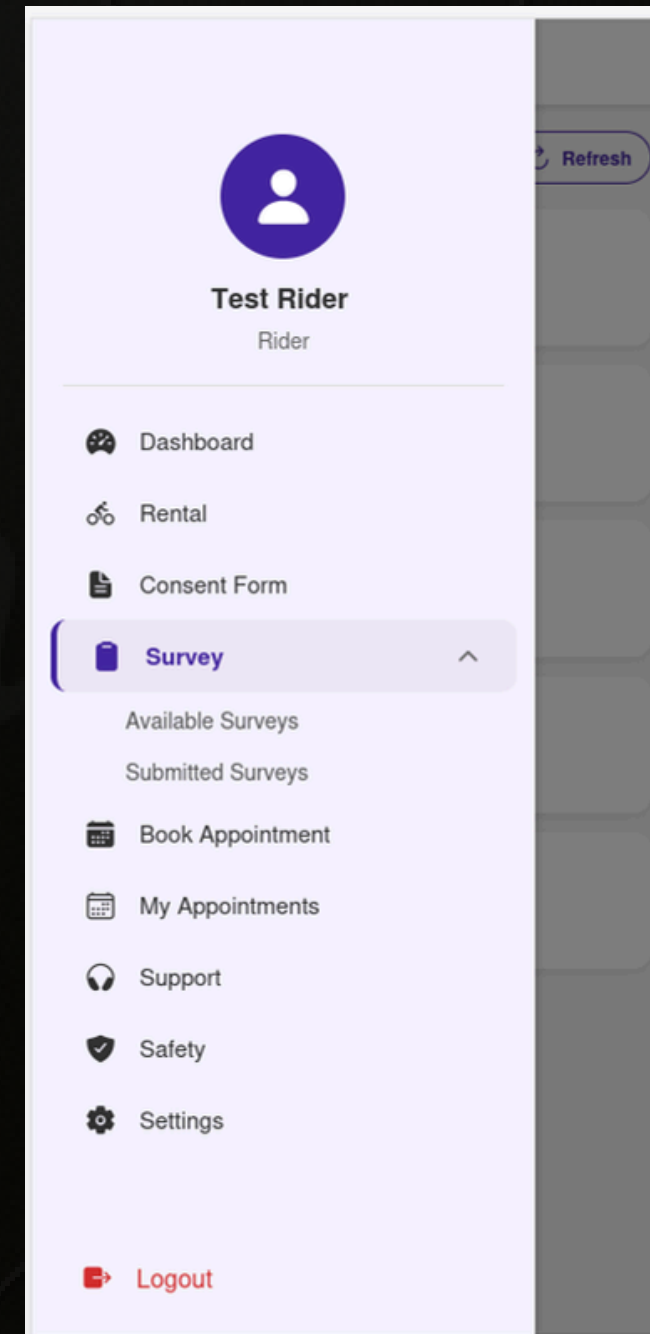
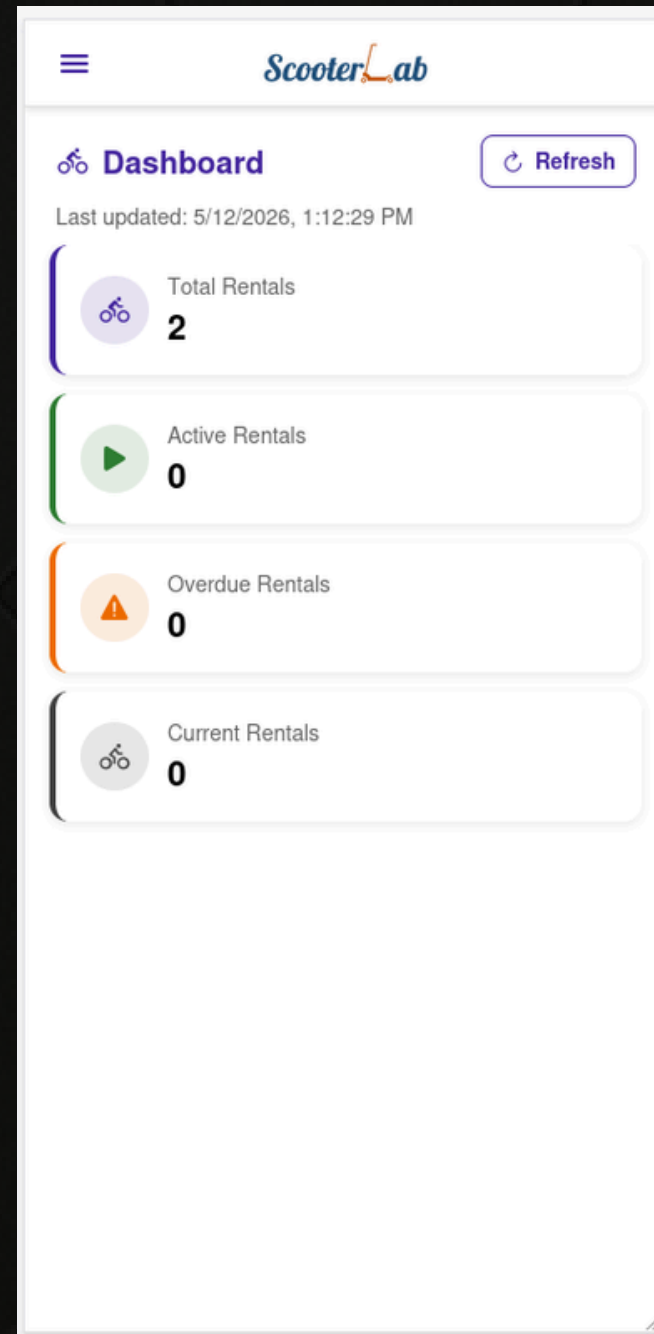
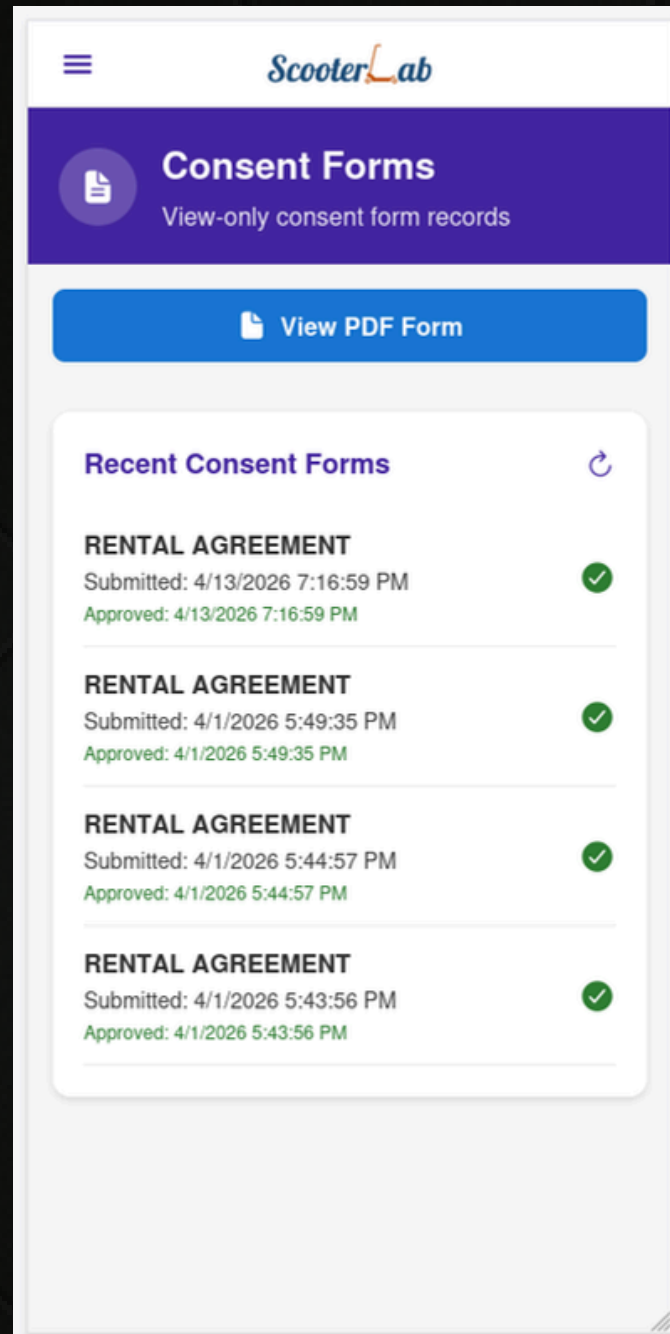
## Scooter Fleet

Manage and track your scooter inventory

[+ NEW SCOOTER](#)

Scooter	Model	Status	Battery	Last Service	Actions
1	N/A	Rented	50%	5/12/2025	<a href="#">Edit</a> <a href="#">Delete</a>
3	N/A	Available	0%	N/A	<a href="#">Edit</a> <a href="#">Delete</a>
4	N/A	Rented	50%	5/5/2025	<a href="#">Edit</a> <a href="#">Delete</a>

# Participant (Rider) Mobile App



# Stats So Far



Total Trips: ~ 1500



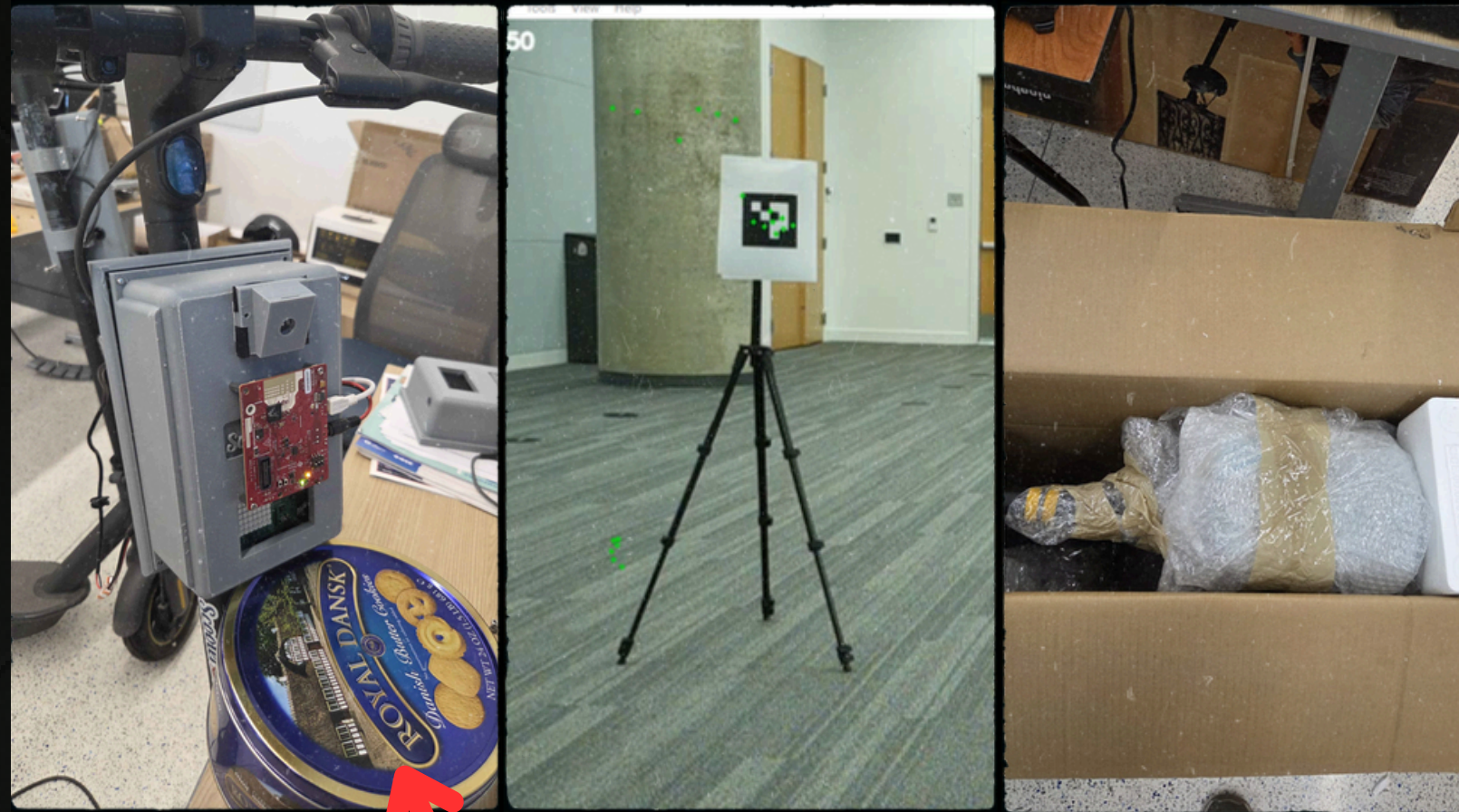
Total Miles: ~ 2300 mi

# Collaborator-Driven Experiments



- Research collaborations spanning environmental sensing, accessibility and micromobility safety.
- Several of these collaborations requested new sensor integrations on the testbed.

# mmWave Radar for MyPath



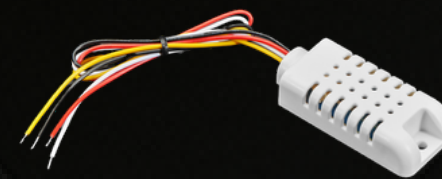
Our lab sewing kit...

- The MyPath team at Miami University requested ScooterLab to integrate mmWave radar
- MyPath studies accessible routing by mapping sidewalk and path conditions for wheelchair and mobility-impaired users.
- Texas Instruments AWR1843BOOST
- We integrated the sensor into the WBSC, tested it, and shipped the e-scooter to Ohio.

# Temperature & Air Quality for Heat and AQ Research



- Teams from Georgia Tech and UT San Antonio Urban & Regional Planning
- SHT-30 (temperature, humidity) and Adafruit/Plantower Adafruit PMSA003I air quality sensor into the WBSC
- Working with collaborators: calibration trials against reference instruments; Kestrel weather meters and PurpleAir



# LiDAR for Urban Sensing

- In collaboration with a team from UT San Antonio Urban and Regional Planning
- GPS integration with Ouster LiDAR
- Supporting mobile LiDAR data collection workflows
- Comparing high-end Ouster LiDAR with lower-cost sensing options such as LD19



# Out There with LiDAR



- Scooter-mounted LD19 alongside Ouster ground truth for crowd monitoring
- Field trials
  - walking
  - scooter LiDAR vs Ouster
  - vehicle-mounted



# And during one of those downtown drives...



# And during one of those downtown drives...

Waymo



Us

# What's Next?

## A Distributed Sensing Platform



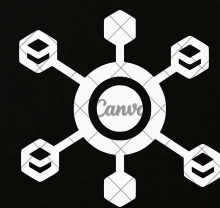
### From a single testbed to a global sensing network

Publish the hardware and sensor box software; 3D models, BOM, assembly/integration guides.



### Assemble your own sensor box

Researchers anywhere; Tokyo, Sydney, Berlin can assemble their own sensor box, mount it on micromobility vehicles they own (e-scooter, e-bike etc.)



### ScooterLab as the central data hub

ScooterLab becomes the coordination and data hub. The community gets a multi-city, multi-context dataset no single lab could build alone.

# Short-term Road Map



## Continue to Support Collaborators

Work with current and new collaborators to conduct their experiments on the testbed



## Increase the Fleet

Expand the active fleet and streamline operations

## Open the Platform

Publish hardware designs, BOM, and integration documentation. First step toward the distributed network vision



**Coming Up Next:**

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**Fleet Controller**



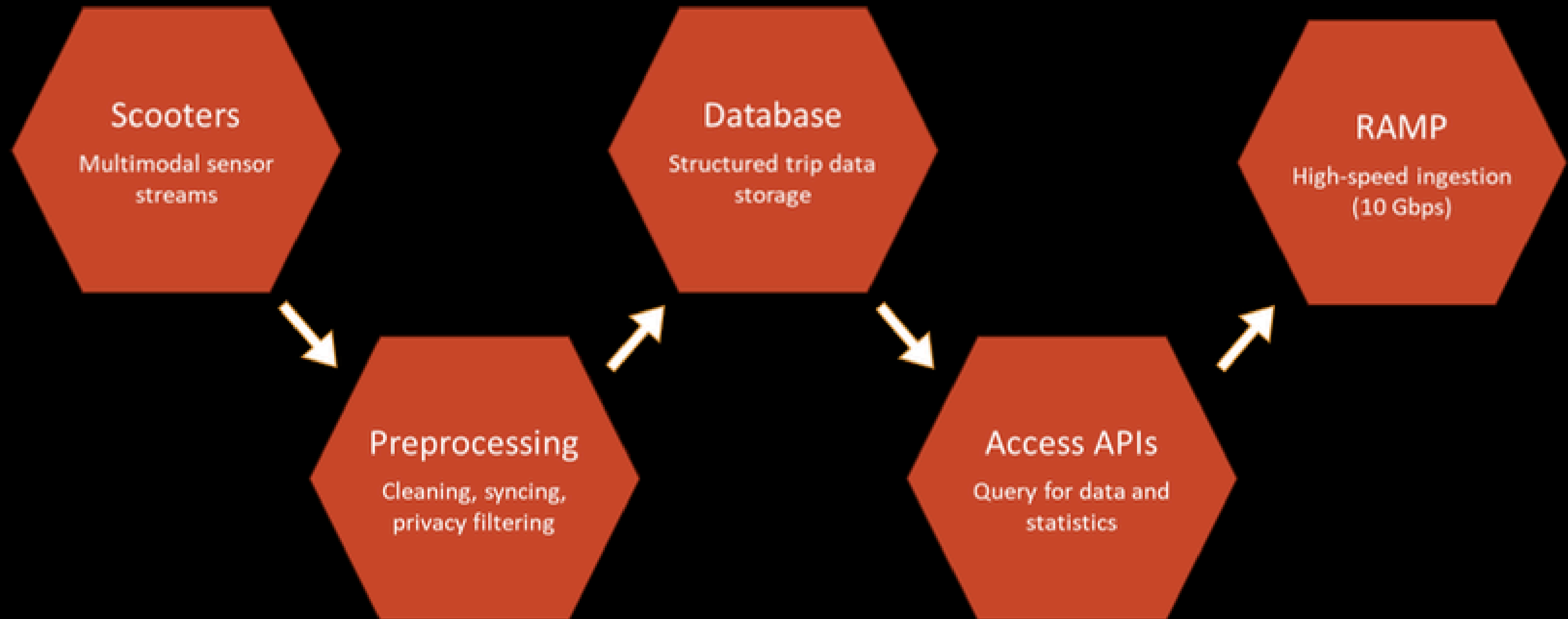
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# Fleet Controller

ScooterLab Workshop 2026

Anindya Maiti  
Assistant Professor, University of Oklahoma

# Fleet Controller - System Architecture



# Fleet Controller – Infrastructure

- Dual Intel Xeon 12-core CPUs
- 512 GB RAM
- 720 TB storage
- 10 Gbps LAN for FC–RAMP communication

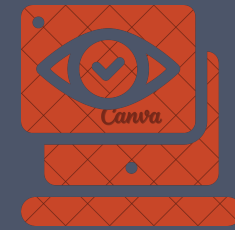


# Fleet Controller Data (Pre)Processing



## Cleaning and Syncing

- Remove noisy sensor readings
- Align timestamps from modalities



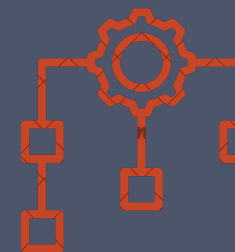
## Privacy Filtering

- Sensitive data blurring:
  - Face
  - House number
  - License plate



## Trip Reconstruction

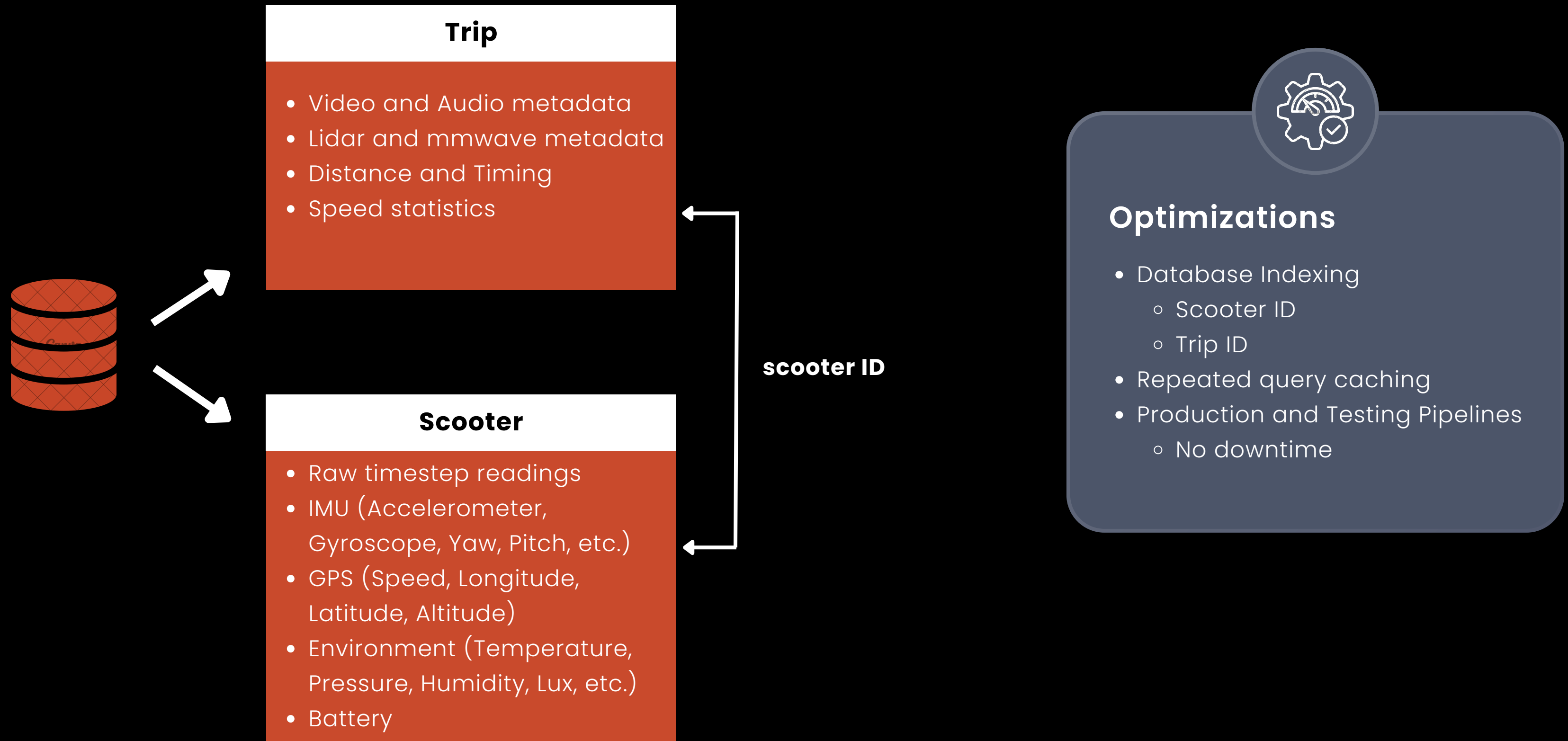
- Segmented data pieced into continuous trips



## Structured Output

- Filtered trip/scooter data
- Trip/scooter data statistics

# Fleet Controller - Database Storage



# Fleet Controller – System Scale & Integration

## Comprehensive API Documentation



~10

Sensors



~1500

Trips Logged



~1.4TB

Data

Search...

- GET Retrieve GPS trip data with advanced filtering
- GET Retrieve paginated GPS trip data with filters
- GET Retrieve detailed sensor and trip data for a given trip ID
- GET Download trip media
- GET Retrieve trips grouped by scooter ID within a time range**
- GET Retrieve scooter IDs based on active status
- GET Retrieve trip summaries for a set of scooters within a time range
- GET API root
- GET Refresh aggregated cache
- GET Refresh MBR cache
- GET Return aggregated cached data

### Retrieve trips grouped by scooter ID within a time range

Returns trips for the requested scooter IDs within the specified start and end times.

QUERY PARAMETERS

scooter_ids	string	List of scooter IDs (e.g. ['SLES001','SLES002']). Required.
start_time	string <date-time>	Start timestamp (YYYY-MM-DDTHH:MM:SS).
end_time	string <date-time>	End timestamp (YYYY-MM-DDTHH:MM:SS).

Responses

- 200 Success
- 400 Missing or invalid parameters
- 500 Internal Server Error

**Coming Up Next:**

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**Research Activities  
Management  
Portal (RAMP)**