

IntelliBus Final Presentation

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ECE-4872-L10

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Problem

Human congestion in public areas and transportation leads to **money spent on inefficient public transportation** and **higher rates of virus transmission and exposure.**

Local governments are looking for ways to **reduce costs** and **more efficiently utilize public transit.**

Solution

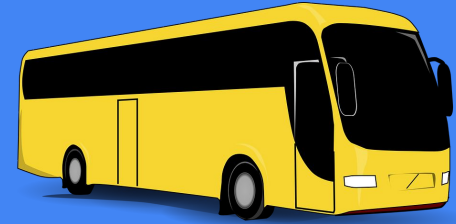
IntelliBus provides **real-time** passenger data capture and analytics, so that transportation authorities can **better utilize resources and provide a better service** to their customers.

Description

Project Goal - design and prototype an IoT device that will track bus location and the aggregate number of riders.

Passenger Counting System	Cloud-Based Web Application
<ul style="list-style-type: none">● Infrared Sensors● LIDAR Sensors● Microcontroller● LTE-M module● GPS antenna	<ul style="list-style-type: none">● AWS IoT gateway with public IP address● noSQL database on AWS● Website with chart JS dashboards and OpenLayers maps API

Customer Requirements



Target User - Transportation Departments without passenger data

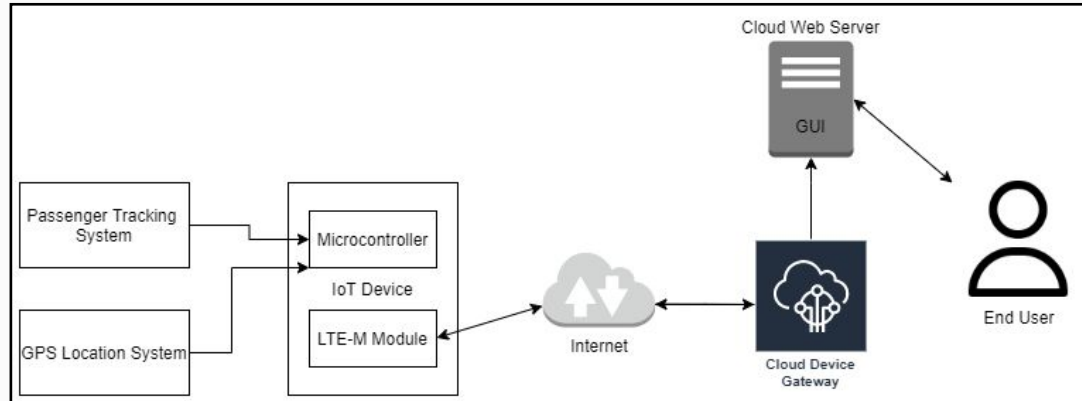
Requirement	Priority
Accurate display of passenger counts	HIGH
Easy to Install	HIGH
Cost less than \$800	MEDIUM
Timely web application response	MEDIUM



Engineering Requirements

Requirement	Priority	Customer Need
Transmit to the cloud with a minimum throughput	HIGH	Accuracy & Timeliness
Respond HTTP requests within 5 s	HIGH	Accuracy & Timeliness
Area < 680 cm ²	HIGH	Ease of Installation
Charge using 5V USB	HIGH	Ease of Installation
Embedded device cost under \$200	MEDIUM	Cost & Scalability

System Overview



- Low SWaP IoT Devices & Sensors
- Cloud-based IoT Endpoint and Processing
- Visualization with Open-source GIS software
- End-User access through a web-portal

System Overview - Technologies

Visualization



Map Framework



AJAX HTTP



ChartJS

Data Processing

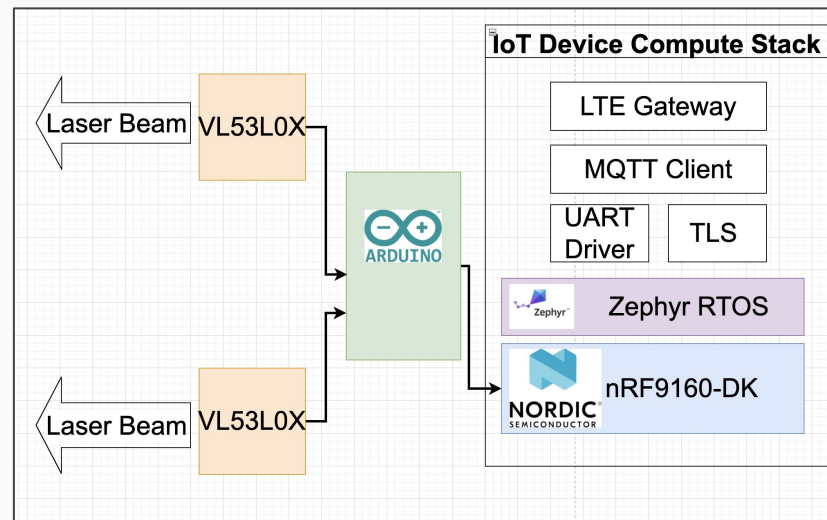


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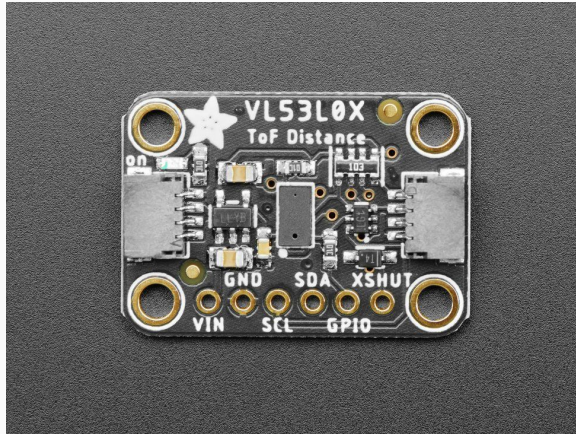


On-Bus Hardware Organization

- A pair of LiDAR sensors for each bus door
- Sensors are placed facing the passing passengers and set a GPIO pin high when passenger walks by
- Arduino Nano reads LiDAR sensors
- nRF9160 transmits count over LTE-M



LIDAR Sensor



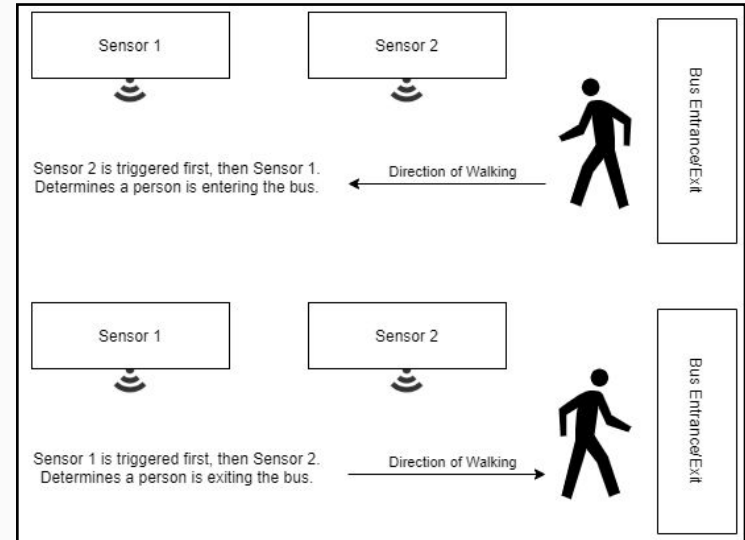
- VL53L0X LIDAR ToF sensor
- Time of flight sensors use the travel time of a solid state laser to detect distance
- Range: 50mm - 1200mm
- 33ms delay
- I2C communication
- Dimensions: 21.0mm x 18.0mm
- \$14.95

Passenger Counting Mechanism

- Two sensors will face the path of passenger's entry and exit
- When passenger moves in / out of the bus, the two sensors triggers at different times

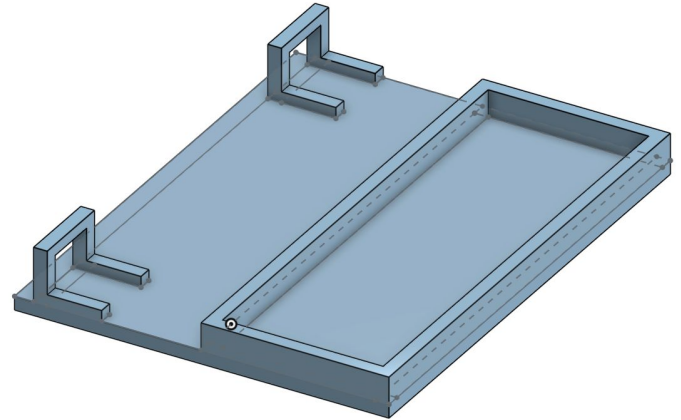
Edge Cases to Consider:

- Capturing invalid data while the bus is moving
- Person standing in front of the sensors
- Preventing double counts
- Reliability and timeliness of the sensors

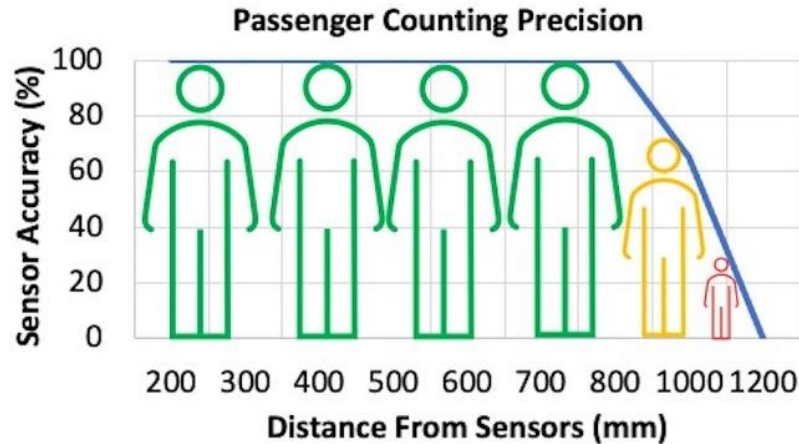


3D LiDAR Sensor Housing

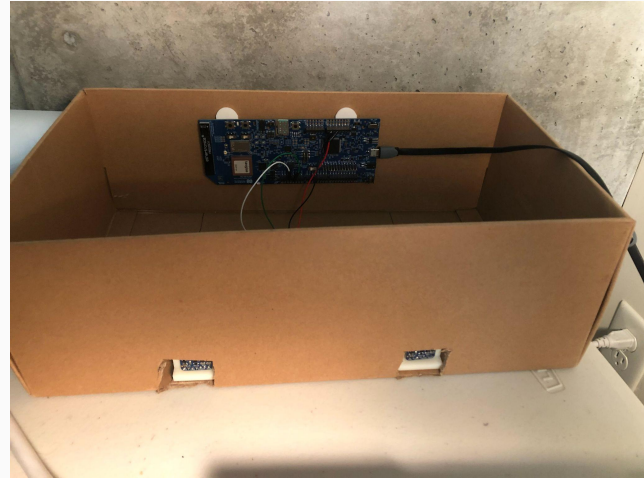
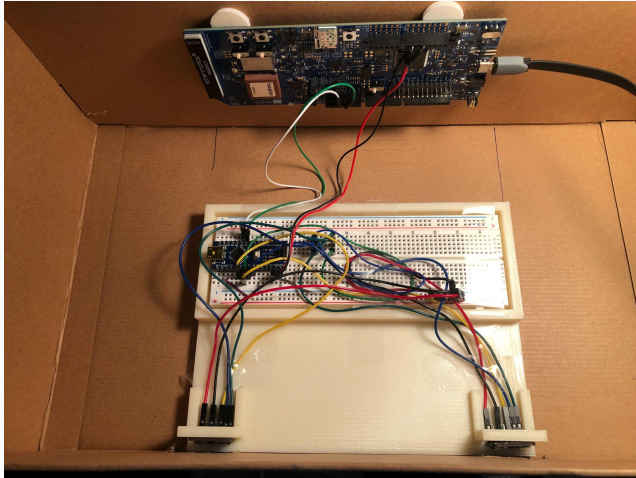
- Rectangle with 13.75 cm width and 17.9 cm length
- ABS material
- Separate housing for Nordic board



Passenger Counting Precision Results

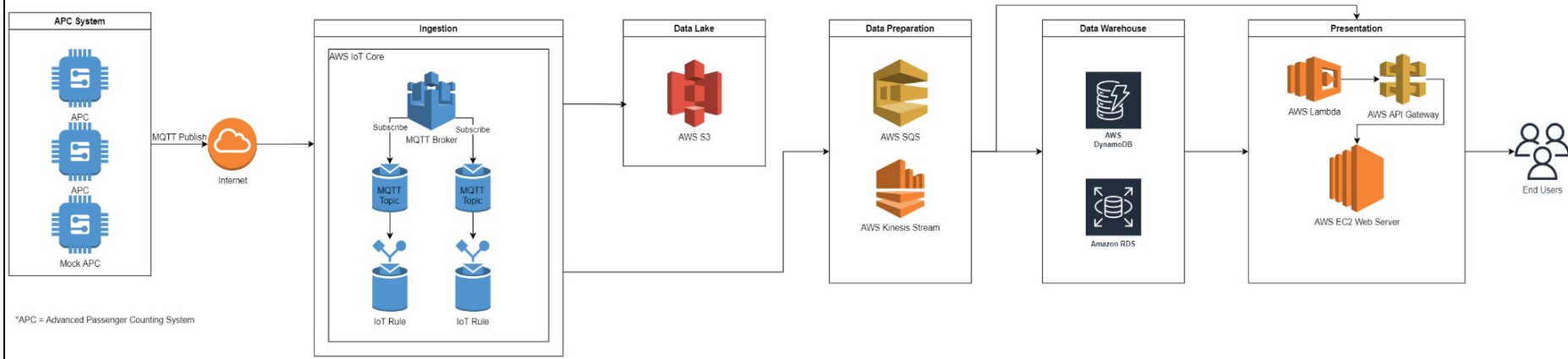


On-Bus Hardware Prototype



Prototyping Data Pipeline

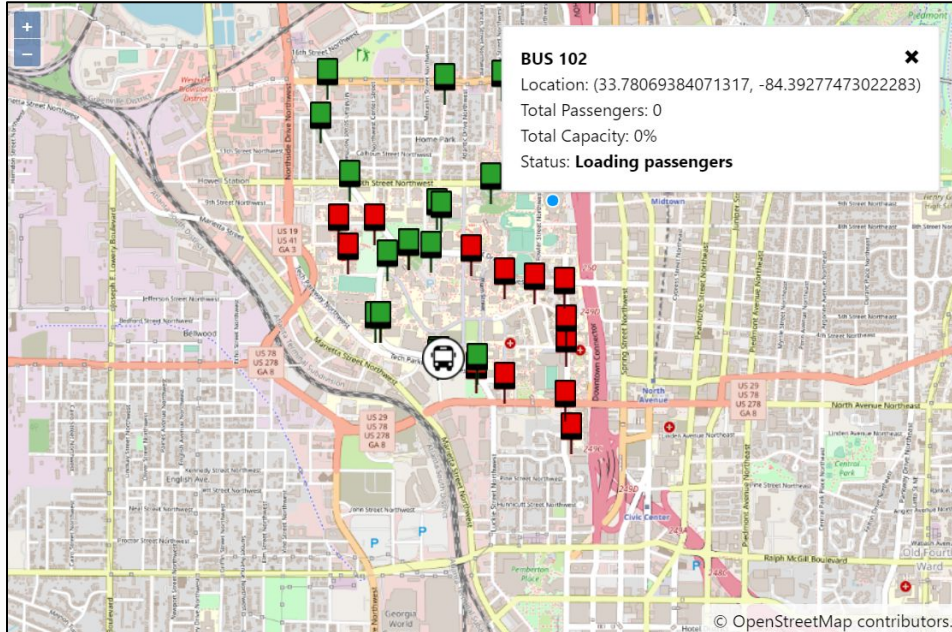
Team IntelliBus: Data Pipeline Prototyping Stage



Enterprise Data Pipeline (Scaled Deployment)

- Auto Scaling Group -- DynamoDB
- Load Balancing -- EC2 Instance
- Data Lake -- Archiving to Glacier
- Machine Learning -- AWS SageMaker or AWS EMR

Map Display



- Catalog of all bus stops
- HUD of bus/route information
 - Total passengers
 - Total capacity
 - Current bus status

Analytics Dashboard

Buses Deployed

4

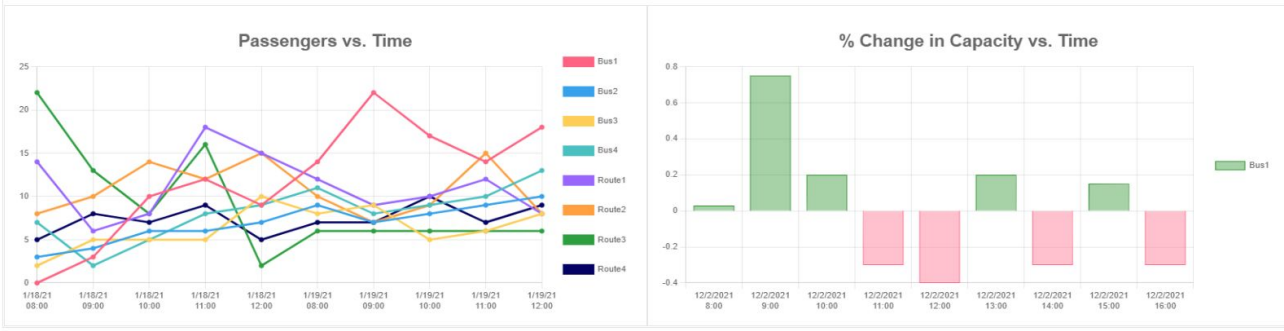
Live Total Passenger Count

218

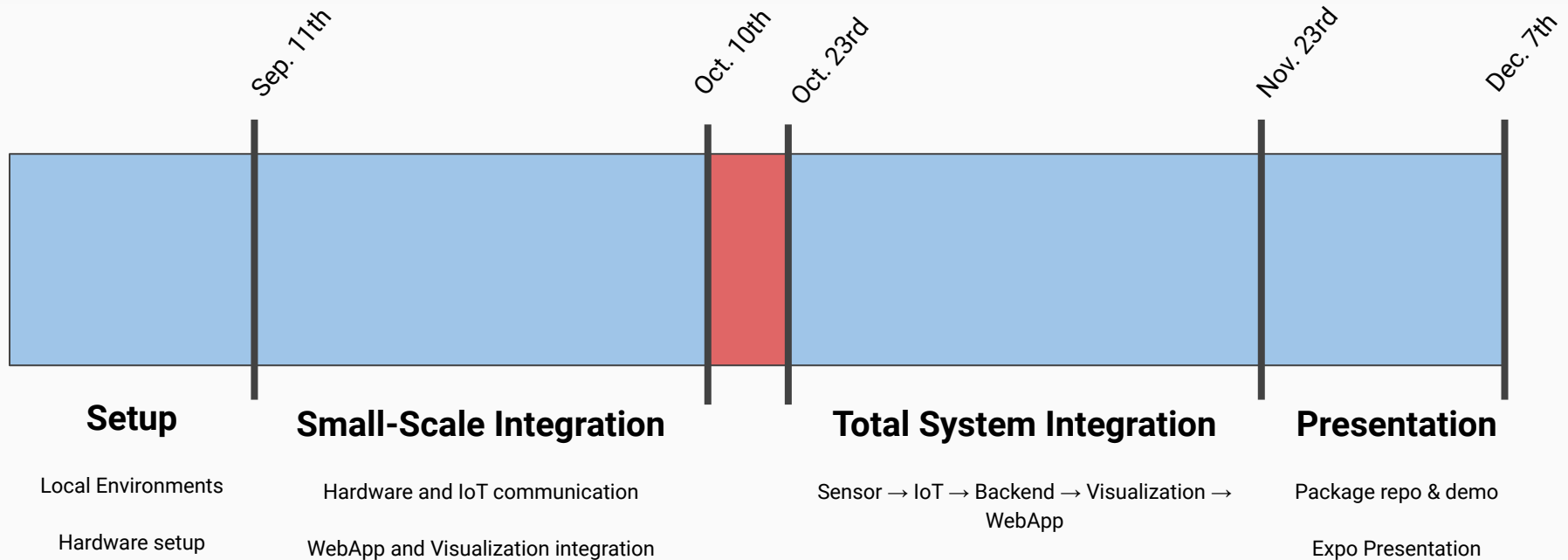
Average Passengers per Bus

54

Device ID	Last Checkin	Device Type	Battery Level
101	0	Mock APC - Route Synthesizer	NULL
102	Tuesday, November 23, 2021 5:56:54.943 PM	Dev Test Unit	4950
103	0	Dev Test Unit	NULL
104	0	Mock APC - Route Synthesizer	NULL



Schedule



Updated Budget



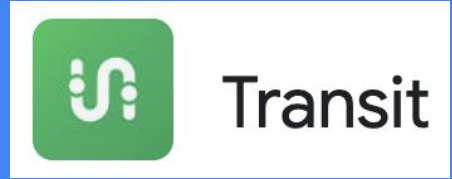
Product	Cost
Cellular IoT Development Kit x2	\$276.00
Infrared Sensors	\$10.00
LIDAR Sensor x4	\$0.00 (from lab)
Wires and Connectors	\$10.00
External GPS antenna	\$11.00
Total Parts Expense	\$307.00

Using open-source software tools and AWS free-tier helped save on cost.

Funding (\$125 per student): \$500
- Parts Expense: (\$307.00)

\$193.00

Applications & Competitors



- Public Transportation
- Airlines
- Predictive maintenance
- Shopping centers
- The Transit Bus App
- The Smart Transit People Counting Camera from Beijing Vion Technology
- Passio Technologies APC

Leadership Roles

Noah Chong - Webmaster, Frontend Software Lead, Expo Coordinator

Shadman Ahmed - Project Leader, Backend Software Lead

David Pan - Financial Manager, Embedded Systems Co-Lead

Thomas Talbot - Embedded Systems Co-Lead, Documentation Lead

Any Questions?

References

- [1] Transit, “What do bus riders want? Crowding info.,” 31-Aug-2020. [Online]. Available: <https://archive.transitapp.com/what-do-bus-riders-want-crowding-info-db89b6d0b5ec>. [Accessed: 18-Oct-2021].
- [2] “Smart Transit People Counting Camera,” *Vionvision*. [Online]. Available: <http://vion-tech.com/en/industry/27.html>. [Accessed: 18-Oct-2021].
- [3] “Passenger Counting,” *Passio Technologies*, 03-Apr-2020. [Online]. Available: <https://passiotech.com/passenger-counting/#>. [Accessed: 26-Oct-2021].