IntelliBus Proposal 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

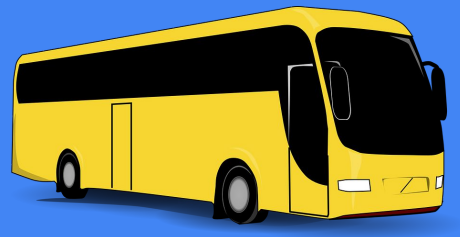
IntelliBus provides **real-time** passenger data capture and analytics, so that transportation authorities can **better utilize resources and provide a better service** to their customers.

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
• Infrared Sensors • Microcontroller • LTE-M module • GPS antenna	• AWS IoT gateway with public IP address • noSQL database on AWS • Website with QuickSight dashboards and OpenLayers maps API

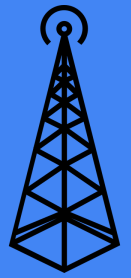
Customer Requirements



Target User - Transportation Departments without passenger data

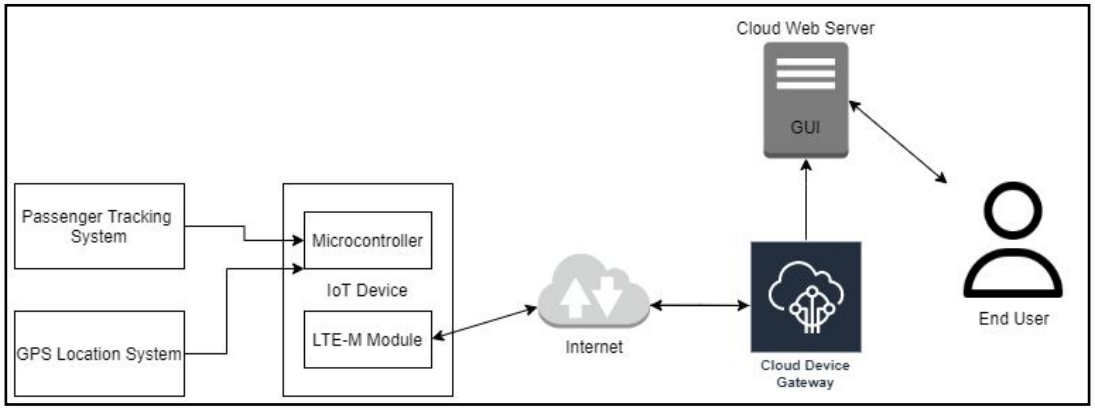
Requirement	Priority
Accurate display of passenger counts	HIGH
Easy to Install	HIGH
Cost less than $800	MEDIUM
Timely web application response	MEDIUM

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

OpenLayers

Power BI

Data Processing

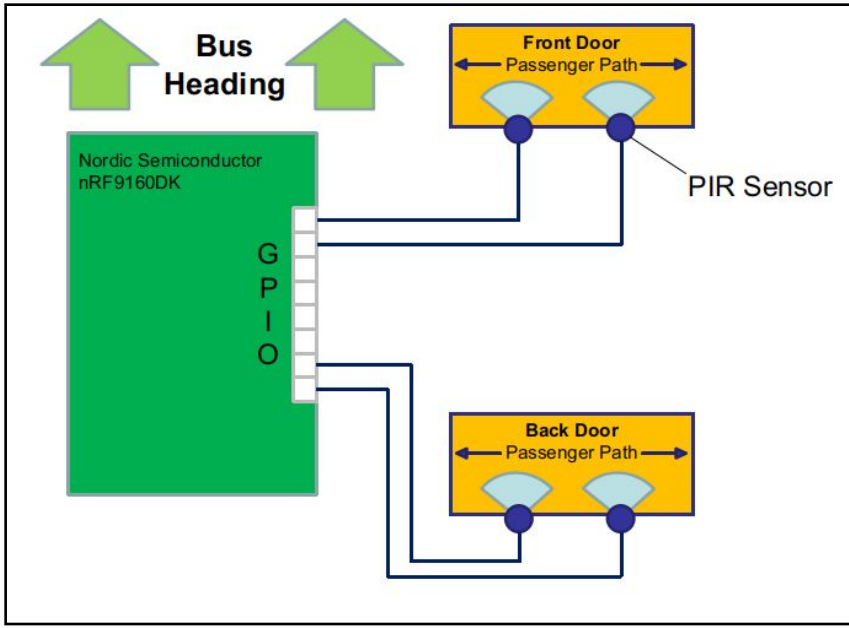
aws

NORDIC SEMICONDUCTOR

4G LTE

On-bus Hardware Organization

- Jumper wires connect the microcontroller to the sensors
- GPIO ports are used for communication as sensors produces a digital 1 or 0
- Two PIR sensors for each door
- PIR sensors are placed facing the passing passengers



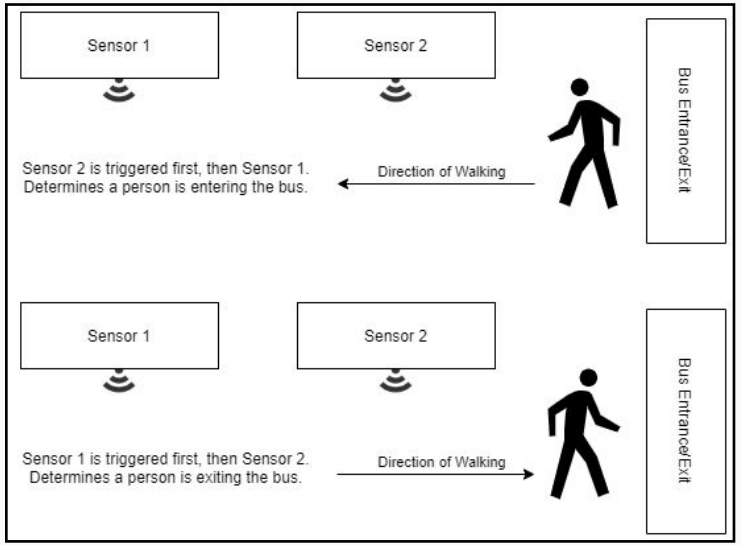
PIR Sensor

Passive InfraRed sensors

- Common practice for motion detectors
- Differential detection units
- Adjustable ambient threshold
- Low cost

Passenger Counting Mechanism

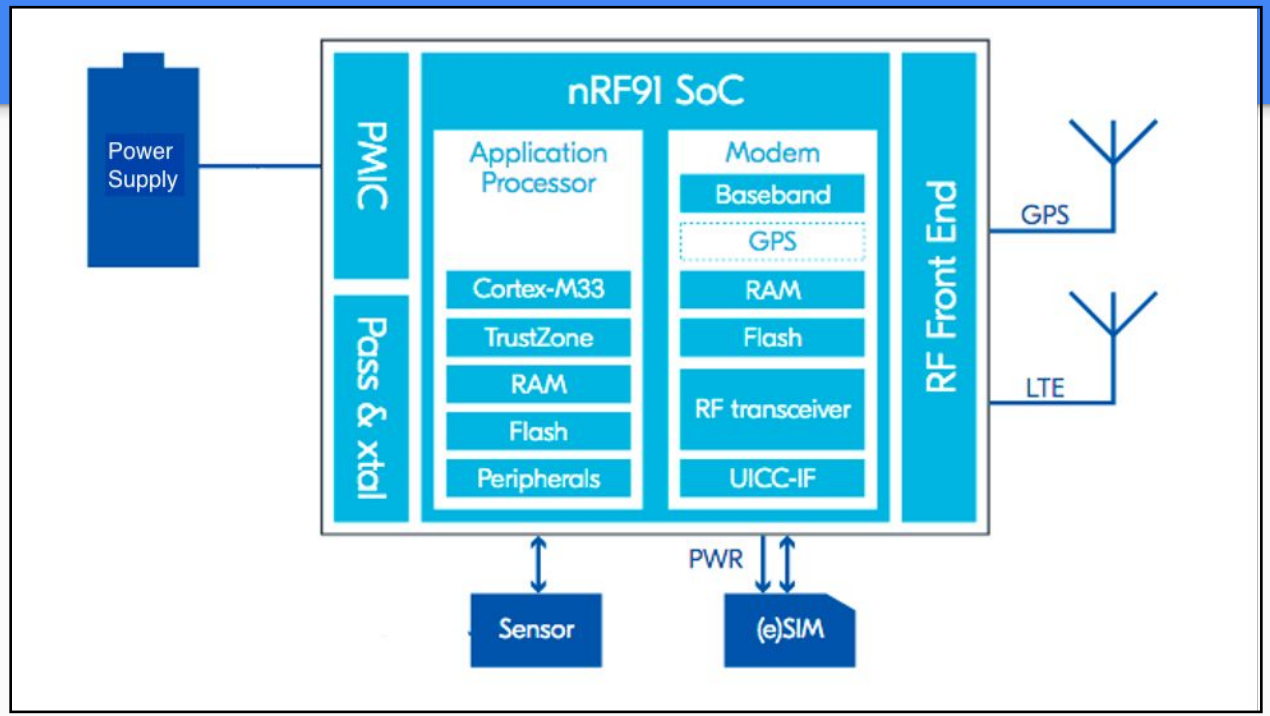
- Two PIR sensors will face the path of passenger's entry and exit
- When passenger moves in / out of the bus, the two sensors triggers at different times
- We will design an algorithm that updates the passenger counts based on the time at which each sensor triggers, as well as handle possible edge cases.



Microcontroller Options

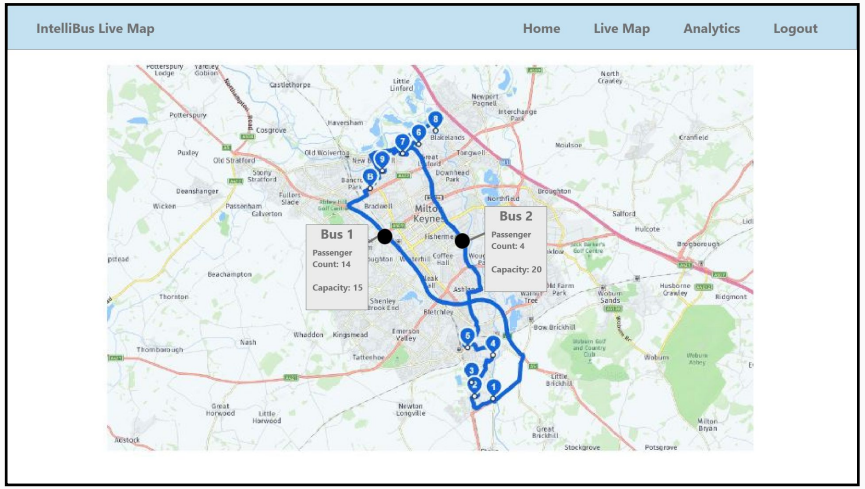
Product	Connectivity	Price
Nordic Semiconductor nRF9160	LTE-M, NB-IoT, Bluetooth, GPS	$139.00
BeagleBone Rev C	WiFi, Ethernet	$89.99
Raspberry Pi 4	WiFi, Ethernet	$75.00

Microcontroller Diagram

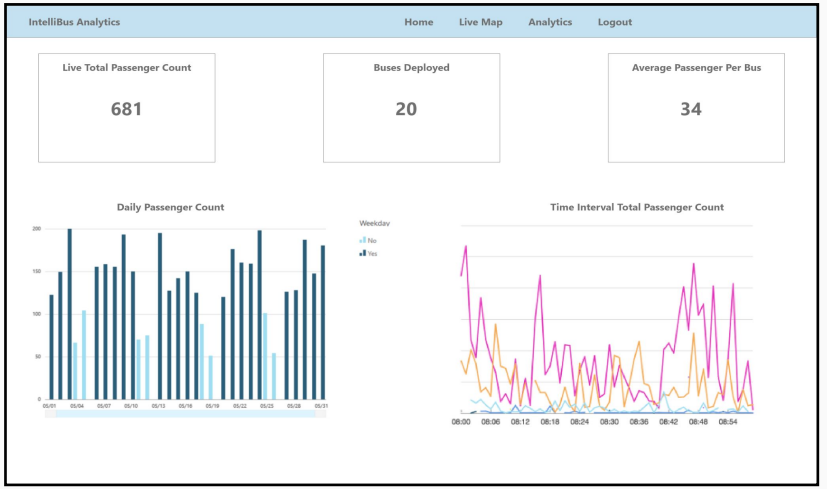


nRF9160 DK cellular IoT development kit with dedicated LTE and GPS antennas

Project Demonstration

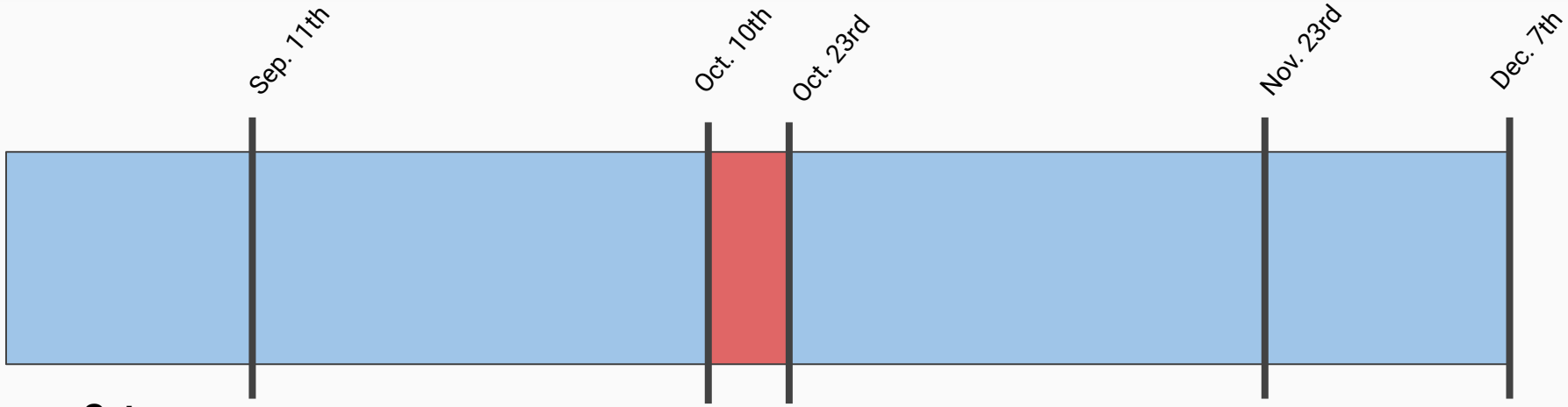


Live-Feed Webapp



Analytics Dashboard

Schedule



Setup

Local Environments

Hardware setup

Small-Scale Integration

Hardware and IoT communication

WebApp and Visualization integration

Total System Integration

Sensor → IoT → Backend → Visualization → WebApp

Presentation

Package repo & demo

Expo Presentation

Budget

Product	Cost
Cellular IoT Development Kit	$139.00
Infrared Sensors	$10.00
Wires and Connectors	$10.00
Total Parts Expense	**$159.00**

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

Funding ($125 per student): $500
\- Parts Expense: ($159)
$341

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?