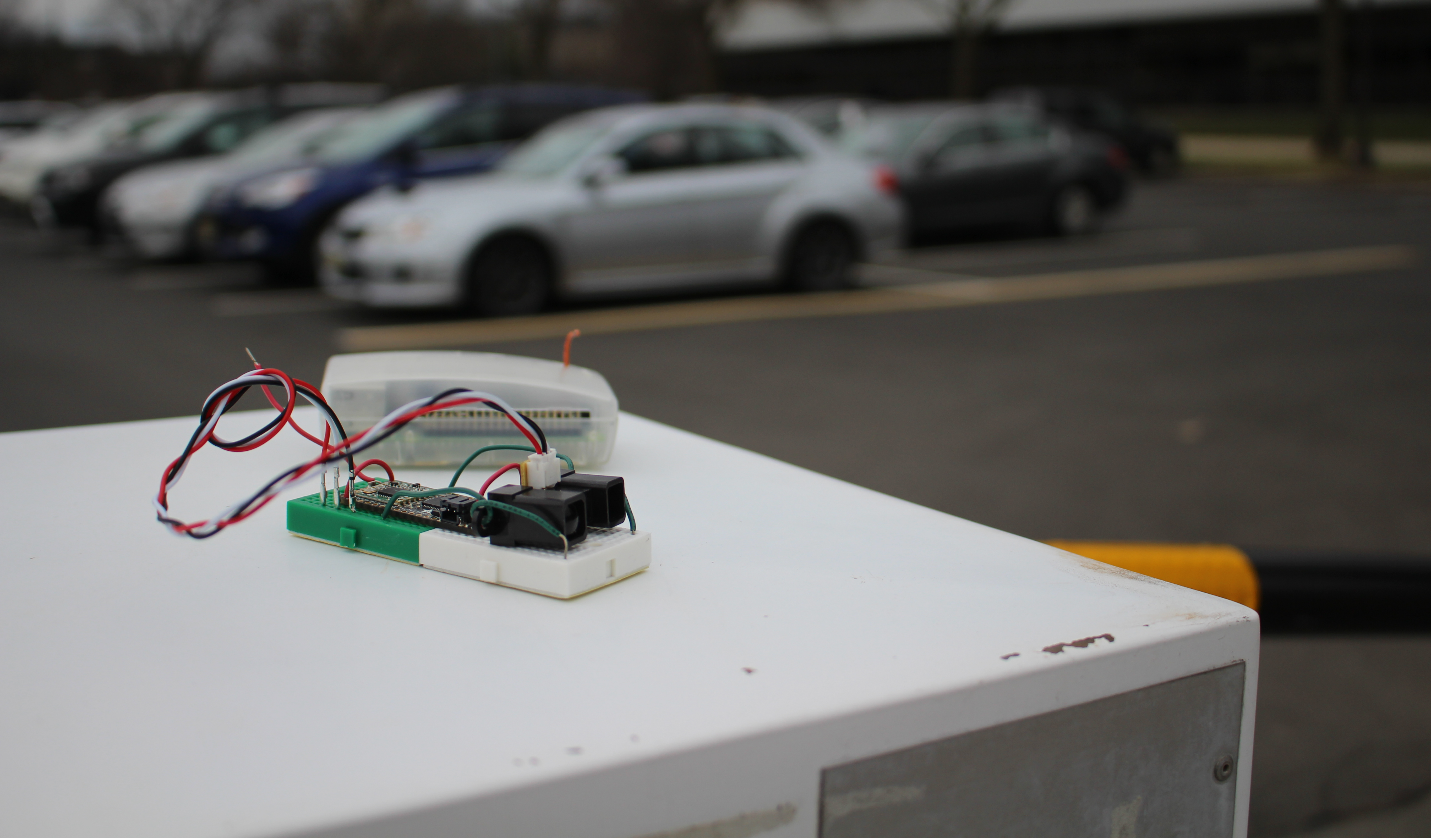


Parking Lot Availability System using a Campus-Wide Wireless Network

MATTHEW COOK,
NIKITA EISENHAUER,
STEPHANIE FOURNIER,
WARREN SETO

ADVISOR: DR. PEARLSTEIN

TCNJ
THE COLLEGE OF NEW JERSEY

PROBLEM

- Busy places often have busy parking lots
- Drivers spend lots of time driving around looking for a place to park
- Lots of time driving around leads to lots of extra emissions being sent into the atmosphere
- Leads to driver frustration and traffic congestion

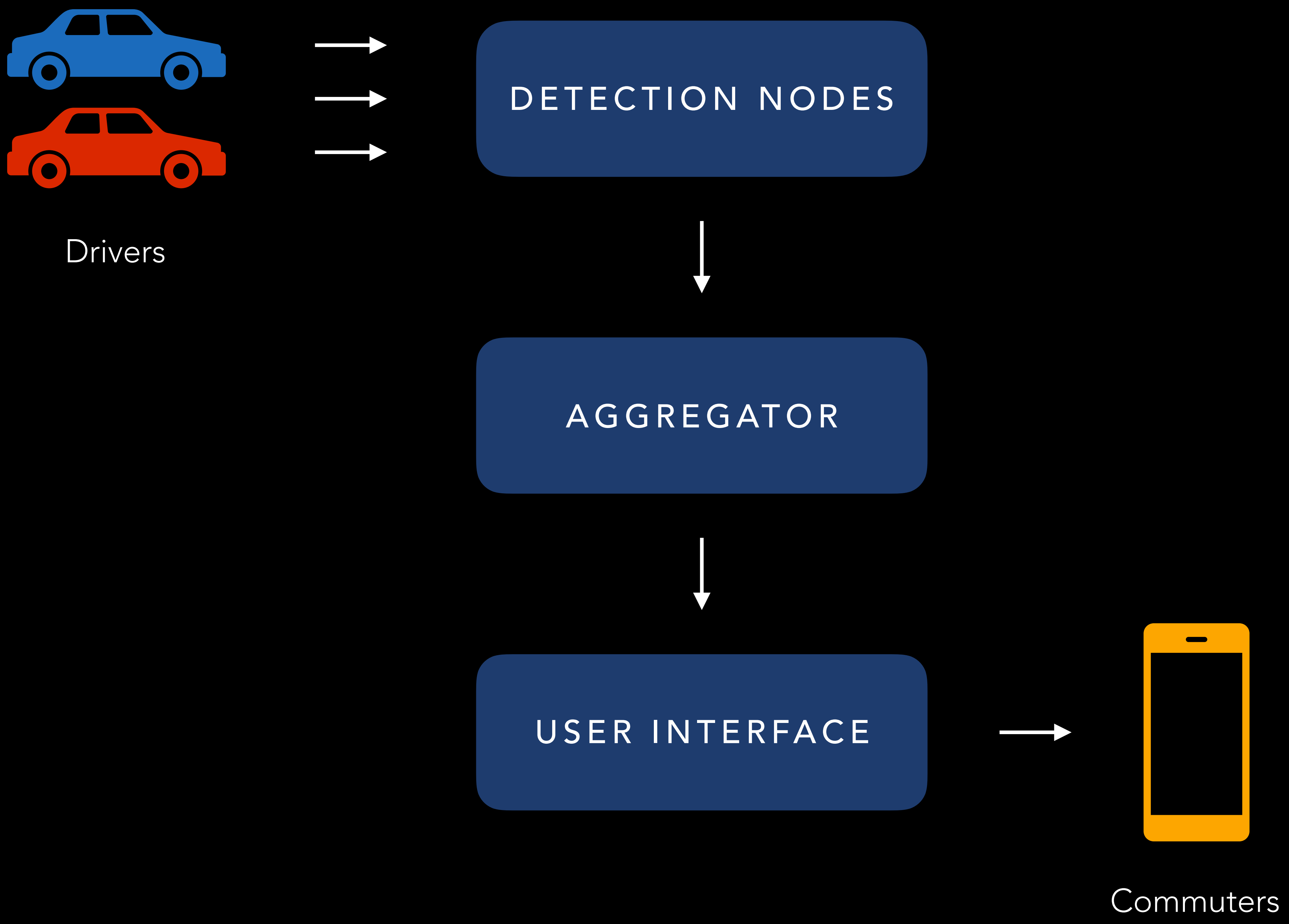
PRIOR ART

1. **Google Maps**
2. **Street Line**
3. **PocketParker**, a research project from the State University of New York at Buffalo
4. Los Angeles **Express Park**
5. **Disney** Theme Parks
6. Previous **Senior Projects**

REQUIREMENTS

1. Be able to **monitor the occupancy** for each type of parking lot in TCNJ
2. Be able to **present occupancy** information to potential stakeholders
3. Abide by **TCNJ's Privacy and Tracking Policy**
4. **Scalable**

GENERAL ARCHITECTURE



PLANNED TECHNOLOGIES

DETECTION NODES	AGGREGATOR	USER INTERFACE

SPECIFICATIONS

DETECTION NODES	AGGREGATOR	USER INTERFACE
ATmega32u4 @ 8MHz	Raspberry Pi B+	Amazon Web Services (AWS)
VL53L0x LiDar Time of Flight Sensor	Raspbian Stretch Light	nodeJS 8 & ECMAScript 2015
SemTech 915MHz LoRa Radio	300 MHz to 1100 MHz Telescopic Antenna	PostgreSQL 9.5.3
3.7V 4000 mAh LiPoly Battery	Socket.IO v2	Modern HTML5 and CSS Flexbox
2.5W 5V/500mAh Solar Panels	LoRaWAN	Statistical Analysis

ENGINEERS

Matthew Cook
Computer Engineer

Detection

Nikita Eisenhauer
Electrical Engineer

Power System

Stephanie Fournier
Electrical Engineer

Enclosure & Assembly

Warren Seto
Computer Engineer

Base Station &
Server

DETECTION REQUIREMENTS

1. Be able to detect cars of various shapes and sizes
2. Be able to determine what is and is not a car
3. Low Power Consumption
4. Transmit reliable data to the aggregator
5. Be ready to detect on moment's notice

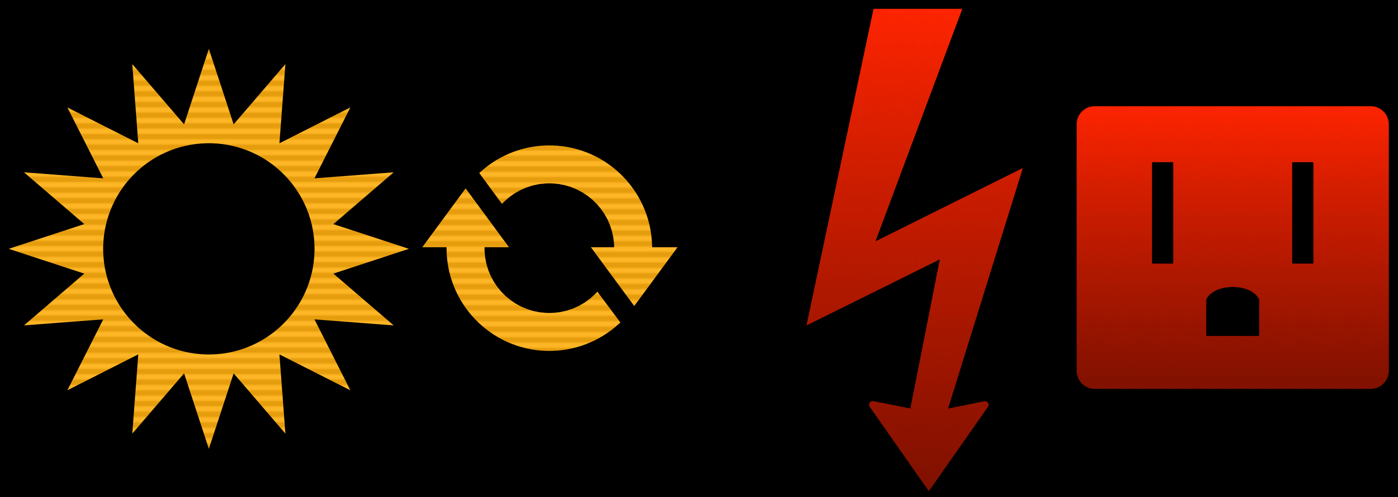
DETECTION SCENARIO

1. Car Drives Into Lot
2. Sensor 1 Detects Car
3. Sensor 2 Detects Car
4. Node tells Aggregator that a Car has Entered the Lot

POWER SYSTEM SPECIFICATION

1. Charges battery in under 5 hours
2. Capable of powering board and charging battery simultaneously
3. Run for approximately 5 days solely on battery power (assuming a typical traffic scenario)

POWER SYSTEM SCENARIO



1. Solar energy converted to electricity via solar panel

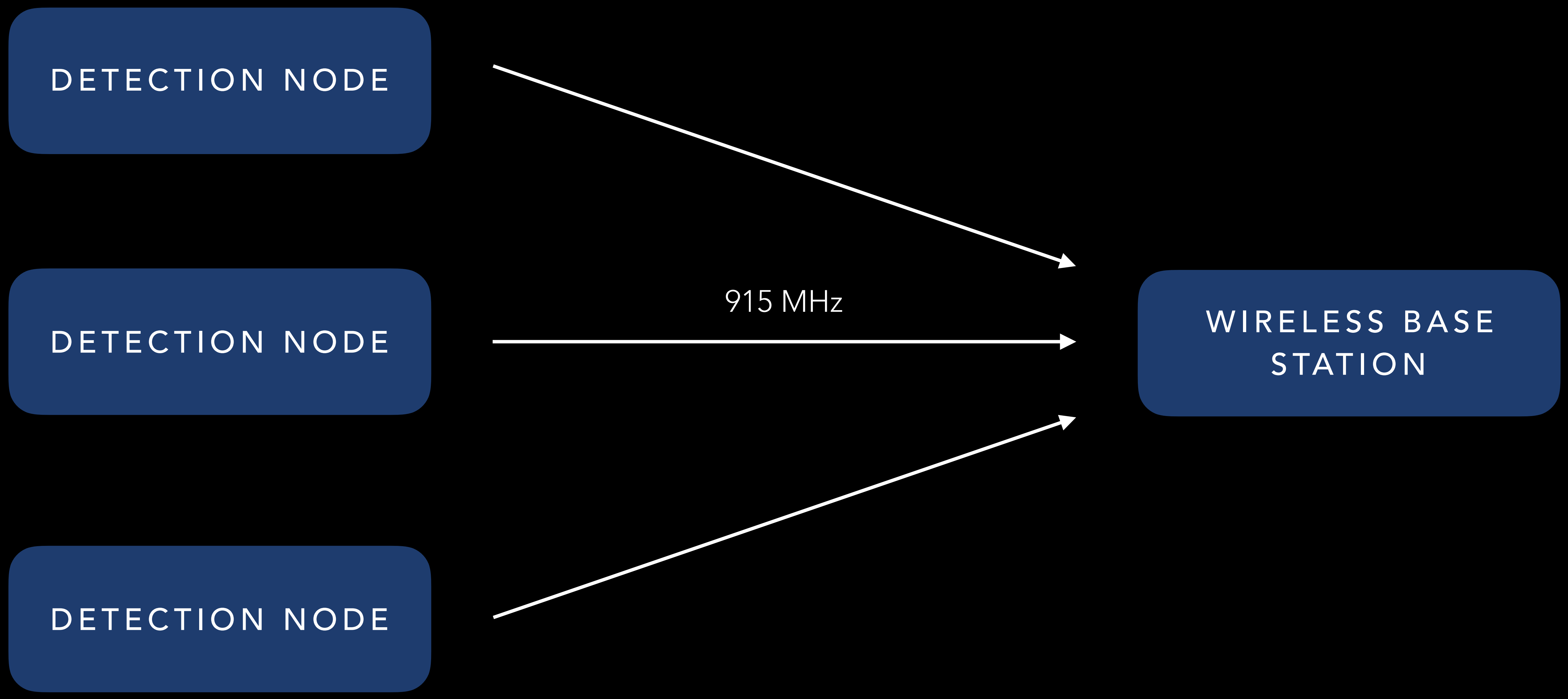
2. Electricity regulated, controlled and diverted as necessary

3. Battery charges during day when sunlight available and discharges at night or when sunlight is unavailable

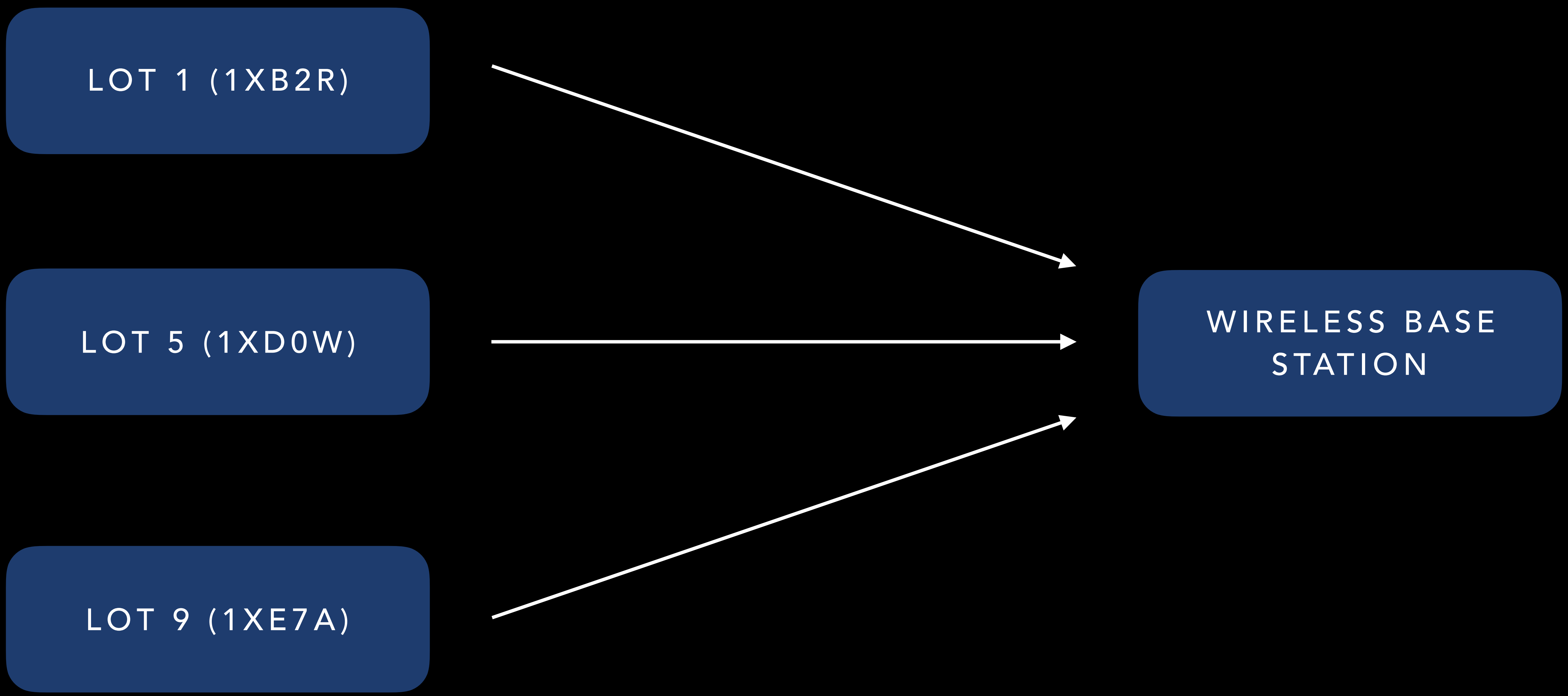
WIRELESS SPECIFICATION

1. **Long Range** - up to half a mile of range
2. **Power Efficient** - +5 to +20 dBm up to 100 mW Power Output Capability
3. **Reliable Datagram** - Addressed, acknowledged variable length messages
4. **Secure** - Advanced Encryption Standard (AES)
5. **License Free** - 915 MHz ISM Band for ITU "Americas"

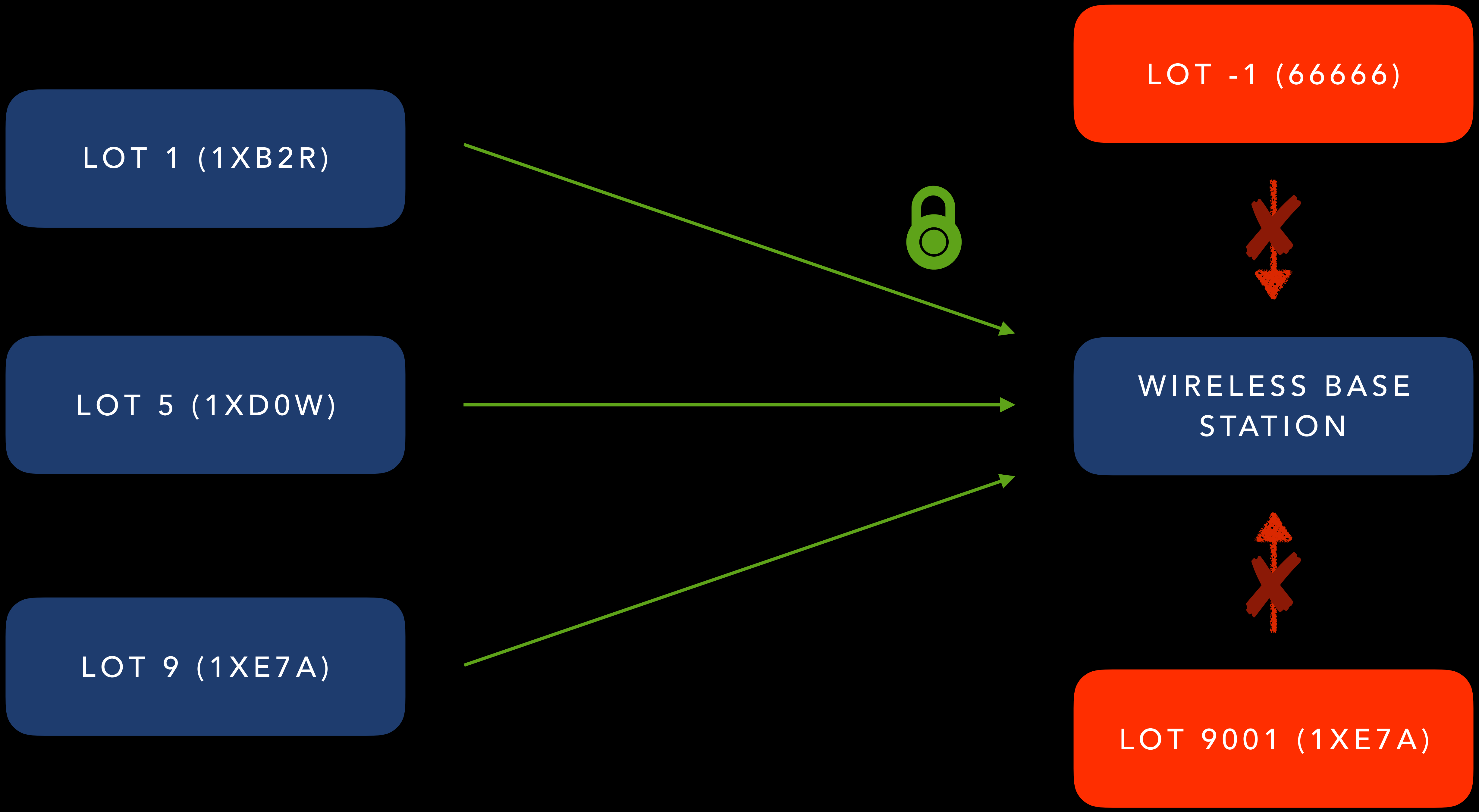
WIRELESS ARCHITECTURE



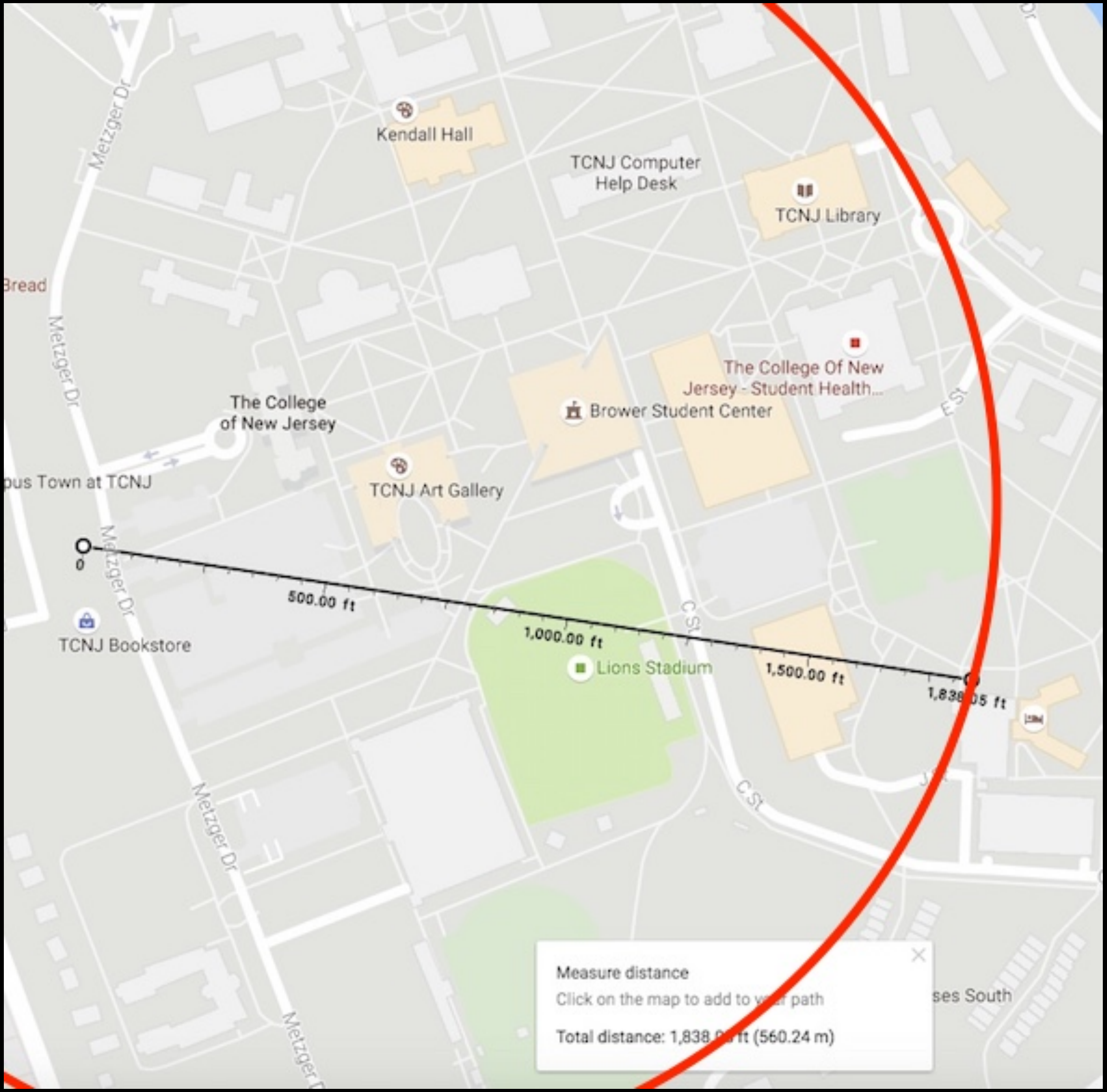
WIRELESS ARCHITECTURE



WIRELESS ARCHITECTURE



WIRELESS RANGE TEST

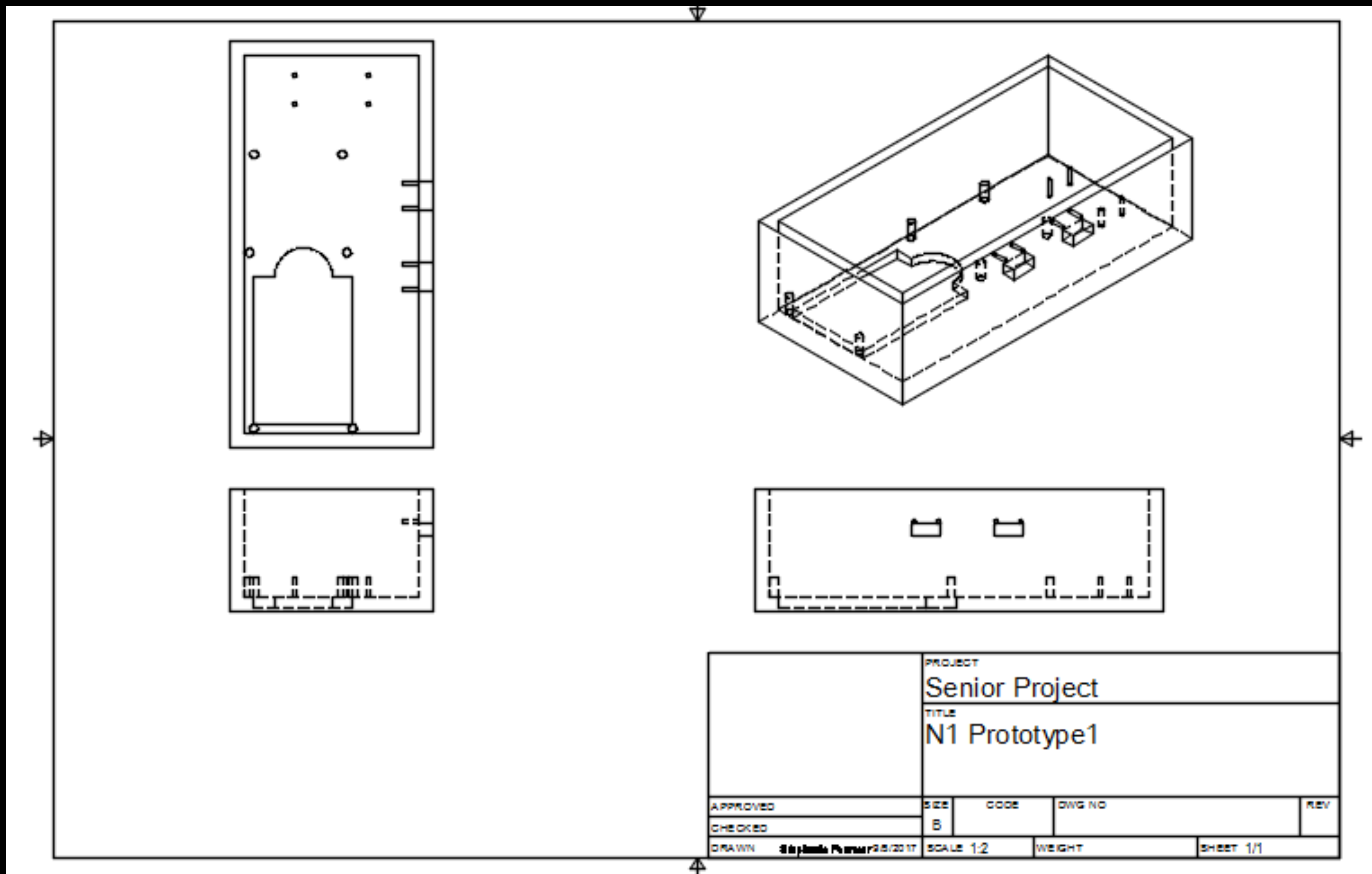


ENCLOSURE SPECIFICATION

There will be two different designs for cases to enclose microcontrollers. (Two cases for the two detection nodes and one enclosure for the aggregator.)

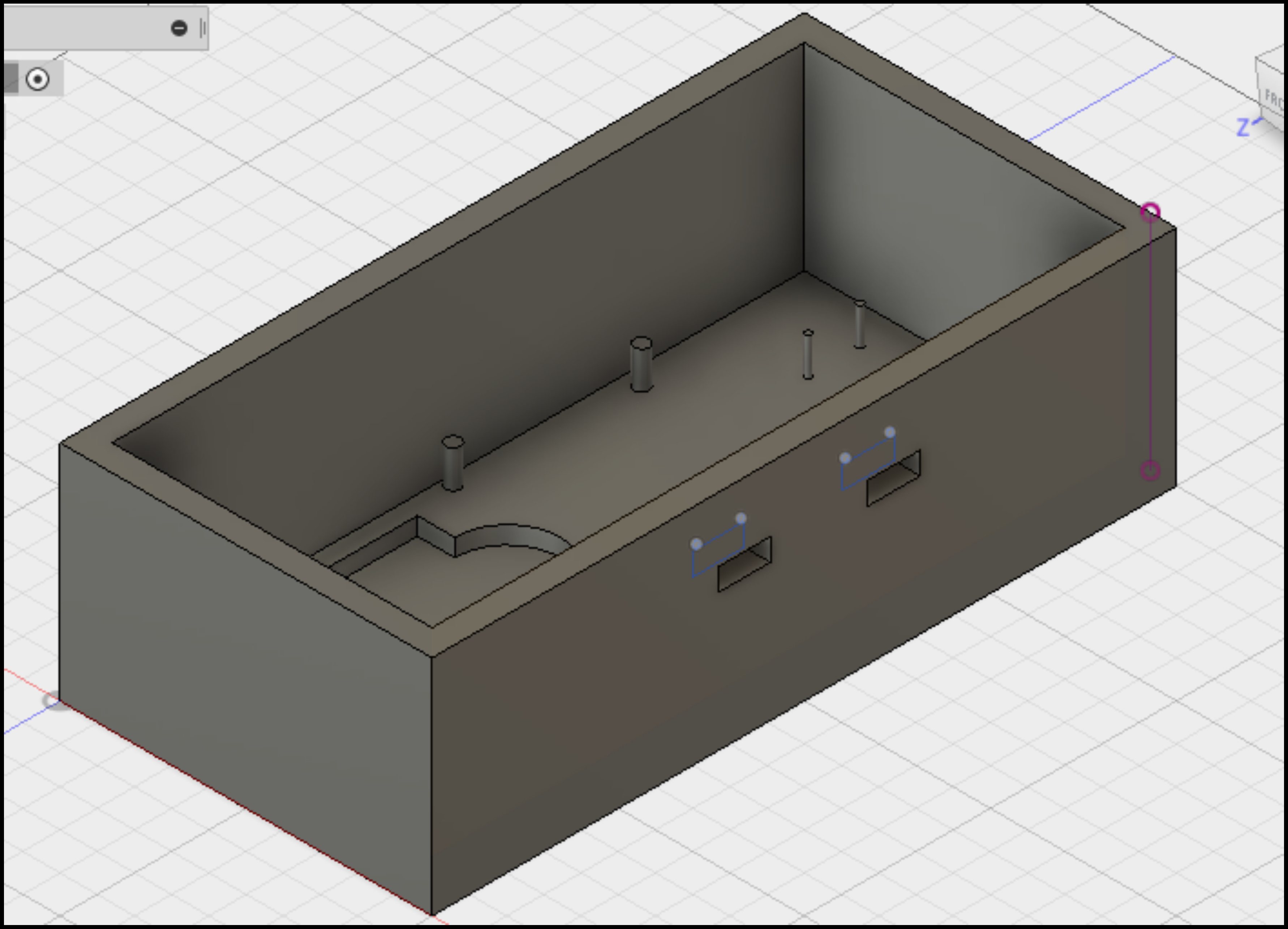
Pillars will be made within the cases to secure the placement of the microcontrollers. There will also be a groove on the surface so that the solar panel and battery can be placed.

ENCLOSURE DRAWING



Prototype 1

ENCLOSURE RENDER

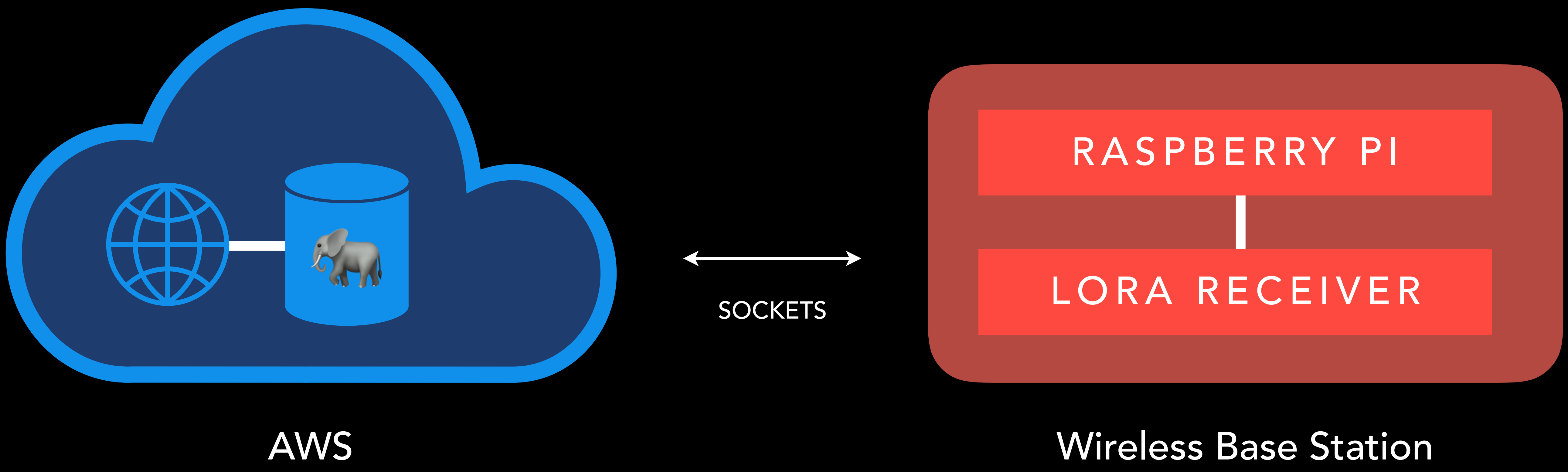


Prototype 1

FRONTEND SPECIFICATION

1. **Harden Server Environment** - nodeJS 8 & ECMAScript 2015
2. **Reliable Hosting** - Amazon Web Services (AWS)
3. **Store Occupancy Information** - PostgreSQL 9.5.3
4. **Present Occupancy Information** - HTML5 & CSS Flexbox
5. **Response Time** - Under 10 ms per request

FRONTEND SPECIFICATION



VERIFICATION

DETECTION

Consistently and Reliably detect cars entering and leaving the parking lot

POWER SYSTEM

Effectively regulate and distribute continuous, uninterrupted power to all modules

WIRELESS

Reliability Stress Test and Coverage Check

ENCLOSURE

Place the components inside to ensure a proper fit and that the components work efficiently within the enclosure.

ROADMAP

Mid September	Mid October	Mid November	End of Fall Semester	Spring 2018	Early May
Architecture	**Prototype 1**	**Prototype 2**	**Prototype 3**	**Validation Tests**	**Release**
Establish all parts and configurations in a complete block diagram and parts list.	All components must be ordered and assembled together.	Updates to the Wireless, Detection, and Power System should be incorporated	Final build of the software and hardware configuration needed before entering testing.	Engineering Validation, Design Validation, and Production Validation	Complete presentation and all specifications and stakeholder requirements met. Product is complete

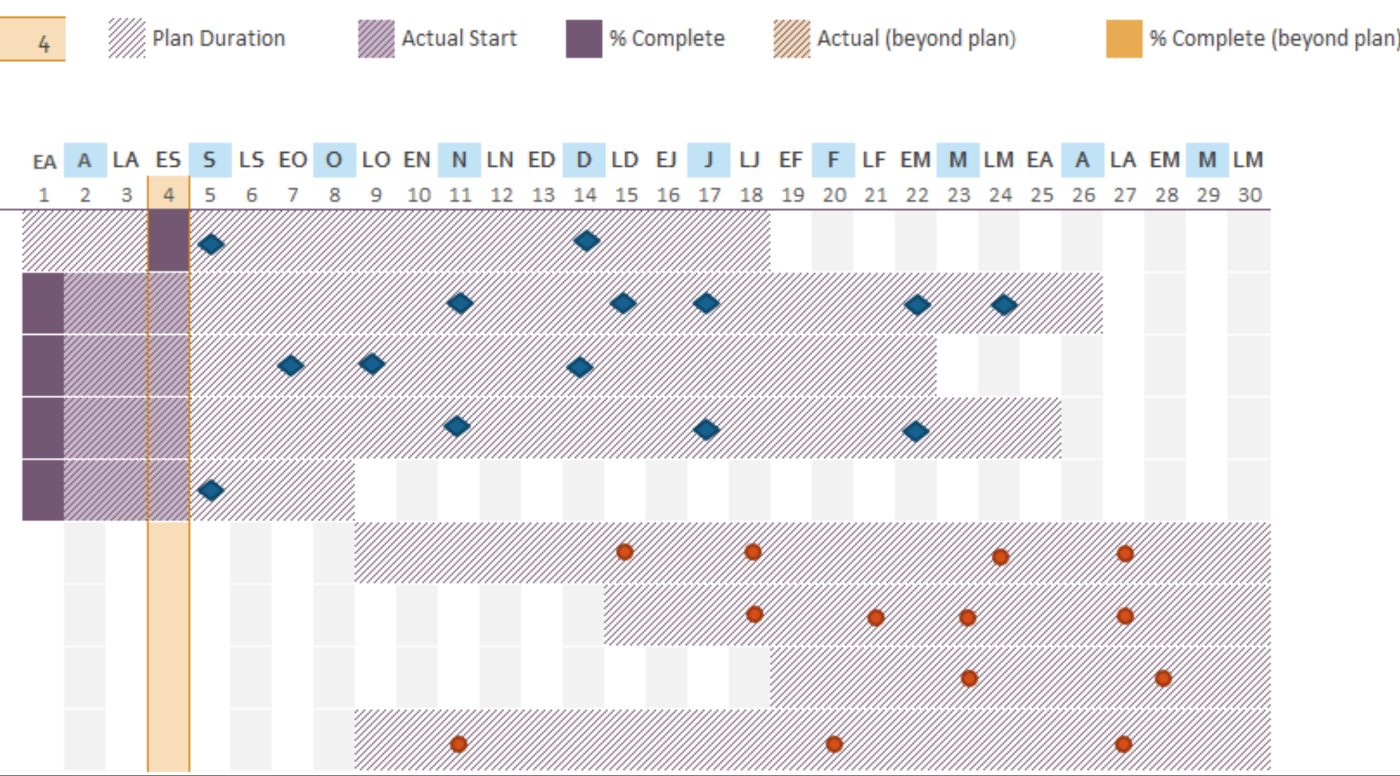
ACTION ITEMS

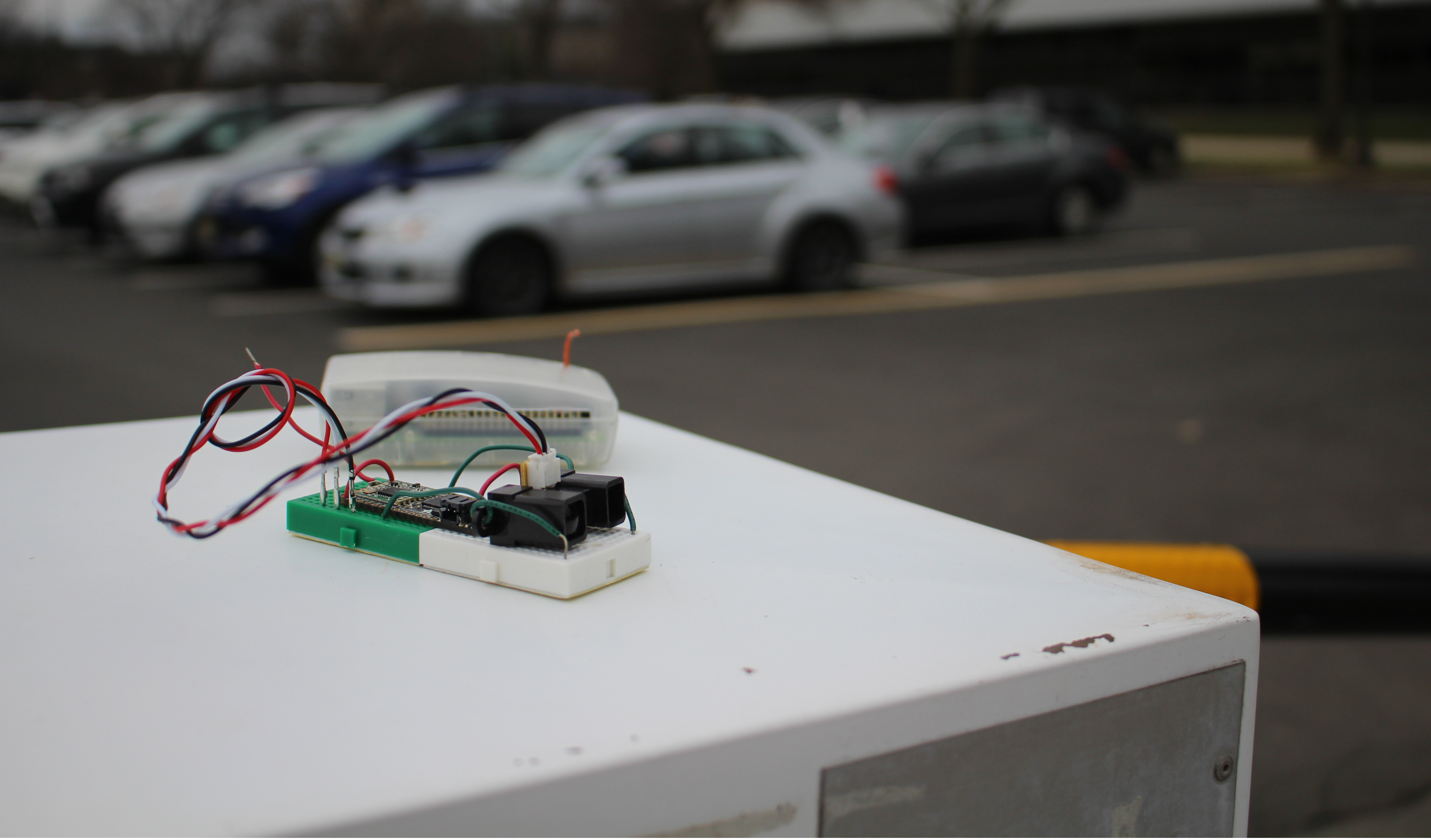
TASK 1	DESIGN ENCLOSURE
TASK 2	DEVELOP & MODEL DETECTION ALGORITHM
TASK 3	OUTDOOR NODE POWER SYSTEM
TASK 4	WIRELESS NETWORK
TASK 5	FRONTEND SERVER DEVELOPMENT
TASK 6	DETECTION VALIDATION
TASK 7	POWER SYSTEM VALIDATION
TASK 8	WIRELESS VALIDATION
TASK 9	FRONTEND UPTIME & STRESS VERIFICATION

PROGRESS

Semester Timeline

Tasks	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Design Enclosure	1	18	4	1	10%
Develop & Model Detection Algorithm	1	26	1	4	10%
Outdoor Node Power System	1	22	1	4	10%
Wireless Network	1	25	1	4	10%
Frontend Server Development	1	8	1	4	20%
Detection Validation	9	22	0	0	0%
Power System Validation	15	18	0	0	0%
Wireless Validation	19	12	0	0	0%
Frontend Uptime & Stress Verification	9	22	0	0	0%





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