

SECURITY THREATS AND COUNTER MEASURES

FINAL ORAL PRESENTATION
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TEAM #8

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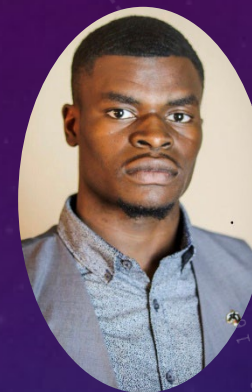
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INTRODUCTION :

Problem Statement:

Low Power Wide Area Networks (LPWAN) protocols such as LoRa are receiving increased attention from industry and academia to offer accessibility for Internet of Things (IoT) connected end devices. The popularity has exposed that there are many known security vulnerabilities.

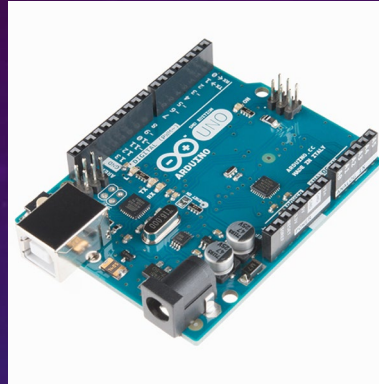
Objective:

Analyze and assess the vulnerabilities of LoRaWan v1.1 and security risks of the Internet-of-Things network.

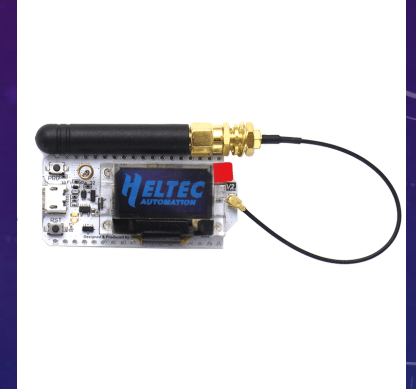
PRELIMINARY HARDWARE DESIGN CONCEPT



HC-SR04 Ultrasonic
Ranging Sensor Module



Arduino Circuit Board
(Microcontroller)



2- Heltec Lora 32 (V2)
Sender and Receiver



IOT Cloud



LoRaWAN Gateway

Marketing Requirement

- Secure and make difficult to hack network
- Having a long-range access to the data
- Accurately detects threat to network
- Able to perform with minimal maintenance
- Low maintenance and inexpensive sensing network.
- Prevent components exposure to the environment

Engineering requirements

- Troubleshoot the existing code and develop secure access.
- Use a LoRa module
- Use trustworthy LoRaWAN join server with access to the root keys
- Use Arduino microcontroller operated by 9V battery
- Battery operated sensor, with a minimum 1 year+ battery life will be used to send data back to network
- 3D print a rigid case to protect the components

Justification

- All sensitive information is kept safe
- This is a device that is designed for long range data transfer
- Enables verification and authentication testing
- Devices will not have to be maintained and replaced
- The cost to set up a network can be affordable in a large areas
- This will minimize the damage if any to the sensitive components within

Project Impact Summary

<i>Category</i>	<i>Project Applicability</i>
Public Health, Safety, and Welfare	★
Global	
Cultural	
Social	★
Environmental	★
Economic Factors	★
Technical	★

PROJECT IMPACT – *ENVIRONMENTAL*

- As indicated by the United States Environmental Protection Agency (EPA), motor vehicles listed from the years 1980-2020 indicate the percentage change in emissions.
- Our project will be a part of assisting the next generation of the percentage drop in emissions from 2021 to 2030.

Percent change in Emissions	1980-2020	1990-2020	2000-2020	2010-2020
Carbon Monoxide	-75%	-70%	-57%	-29%
Lead	-99%	-87%	-76%	-30%
Nitrogen oxide	-70%	-68%	-64%	-46%
Volatile Organic Compounds	-60%	-48%	-29%	-20%
Sulfur Dioxide	-93%	-92%	-89%	-76%

PROJECT IMPACT – *ECONOMIC FACTORS*

- In this implemented scenario, our project will decrease the money and time spent on finding parking.
- INRIX is a SAAS and DAAS company which provides a variety of internet services and mobile applications pertaining to road, traffic and driver services.

Rank	U.S. City	Average 2-hour Parking Cost (One mile of city Center)	On-Street Search Time (mins/trip)	Off-Street Search Time (mins/trip)	Annual Search Time (hours/driver/year)
1	New York	\$33	15	13	107
2	Los Angeles	\$14	12	11	85
3	San Francisco	\$12	12	11	83
4	Washington DC	\$18	10	9	65
5	Seattle	\$10	9	8	58
6	Chicago	\$22	9	8	56
7	Boston	\$26	8	8	53
8	Atlanta	\$6	8	8	50
9	Dallas	\$6	8	8	48
10	Detroit	\$9	6	6	35
	US	\$4	2	2	17

Source: www.parking-net.com/parking-news/inrix/searching-for-parking-us

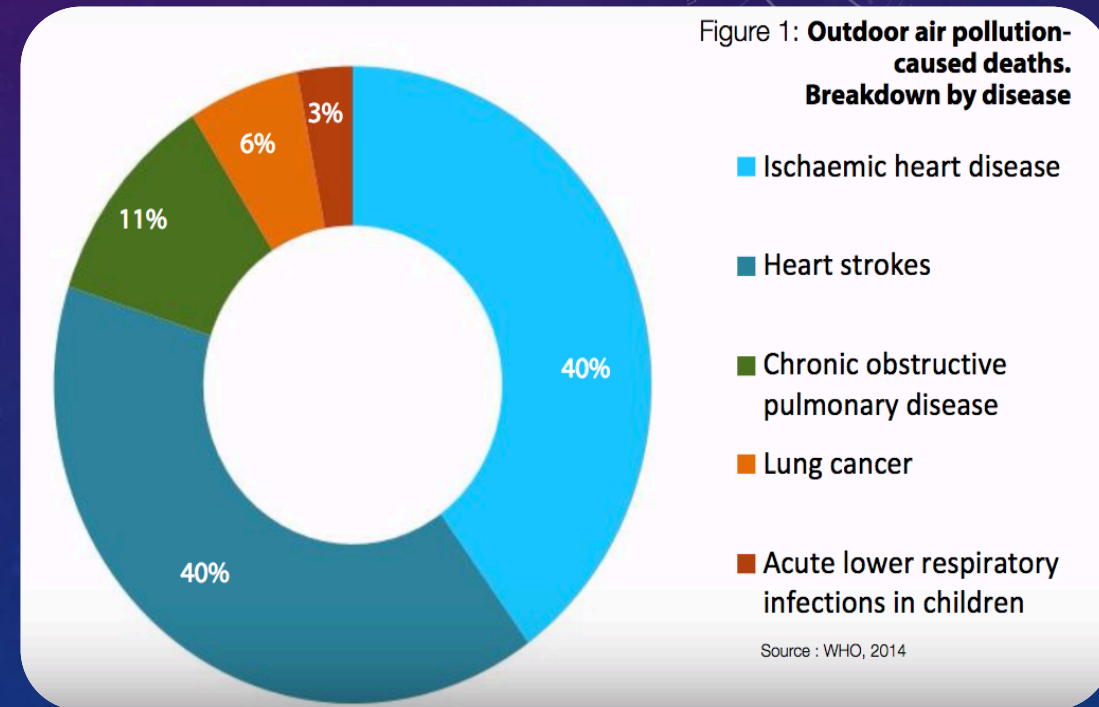


PROJECT IMPACT – *SOCIAL (CULTURAL)*

- Commuter students and faculty will know how many open spaces are left beforehand instead of driving around to find parking.
 - Helps all students by not wasting time in the lot, which creates time to arrive on time for a class or meeting.
 - Faculty/Employees can avoid being late to work with the time saved.
- The system can be implemented into society through stadiums, large corporations, apartments, etc.
 - Expanding the parking detection system in a global scale can significantly help society.

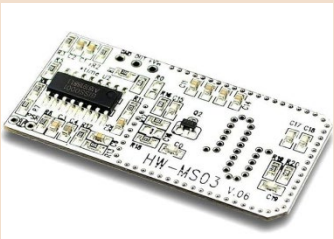
PROJECT IMPACT – *PUBLIC HEALTH, SAFETY, AND WELFARE*

- Implementing a parking space detector can greatly reduce emissions and stress levels for everyday drivers.
- By reducing the driving time of the population, the percentage of **carbon monoxide emissions will be reduced**. Lowering global greenhouse gas emissions will slow climate change and prevent millions of premature deaths due to air pollution over the next decades.
- People that use parking garages or campus parking lots will benefit from **reduced stress** levels because they will no longer have to deal with uncertainty and hassle of planning ahead to arrive extra early.



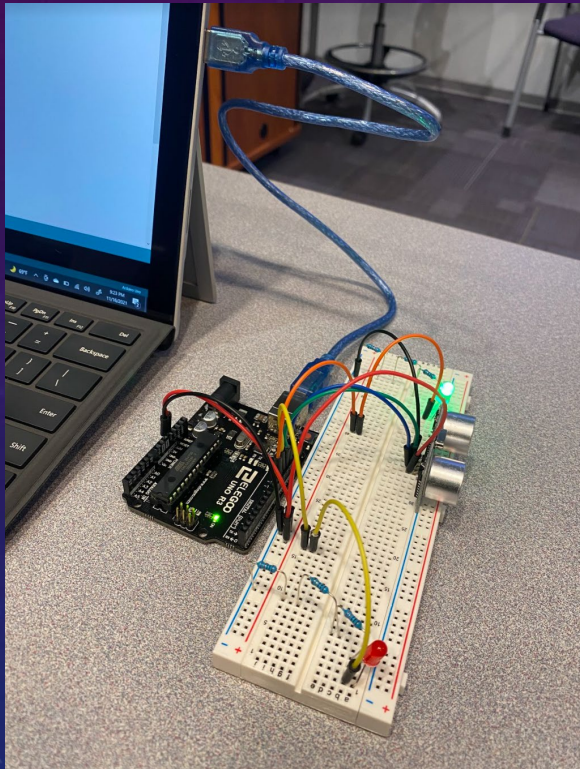
Source: World Health Organization (WHO)

PROJECT COMPARISON

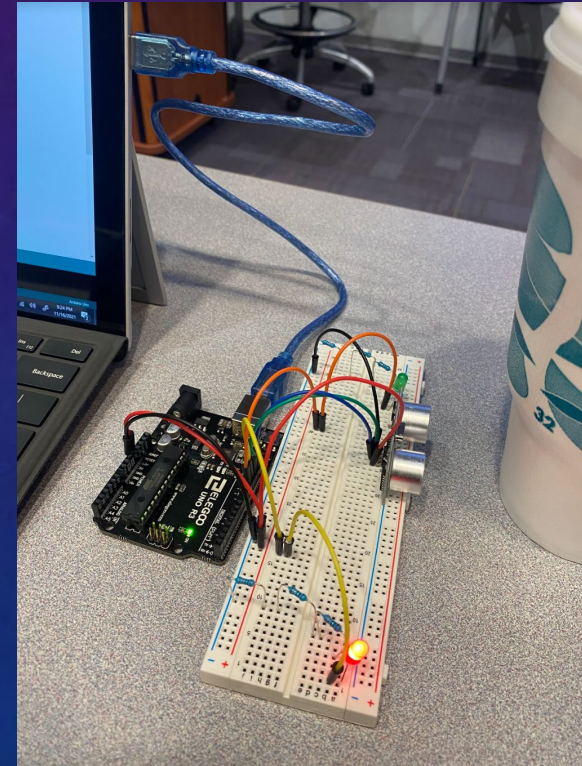
DESIGN OPTIONS	ESTIMATED COST	PROS	CONS	REFERENCE IMAGE	REFERENCE SOURCES
Radar Sensor 	\$8 per sensor	- Detect objects through wood, plastic, or even thin walls - Works in all direction	Work at a distance of at least 4 meters		https://www.amazon.com/HW-MS03-Performance-Motion-Microwave-Arduino/dp/B09LMVCNY7/ref=mp_s_a_1_4?crid=1HPLFH0UY73U4&keywords=hw-ms03&qid=1637012793&qsid=140-0224905-2590768&sr=8-4&sres=B09CH8SL1G%2CB09LMVCNY7%2CB08H4VW13K%2CB082V88SF9%2CB07FZ8S74R%2CB08VWPBBTF%2CB08WYSZTBJ%2CB00571M910%2CB07FZZCHC5%2CB017NI17HQ%2CB07DG3DQCZ%2CB08PP2NZMD%2CB075YCG4K3%2CB07NWMBB6N#immersive-view_1637012818398
Infrared Sensor 	\$15.99 for a pack of 10	- Works at 2 V- 12 V - Works in temperatures ranging from - 20 to 60 degrees Celsius	Works at a distance of 3-5 m		https://www.amazon.com/Weewooday-Pyroelectric-Infrared-Detector-Temperature/dp/B08PVB7VHQ/ref=mp_s_a_1_4?keywords=pir+sensor&qid=1637011908&qsid=140-0224905-2590768&sr=8-4&sres=B012ZZ4LPM%2CB08PVB7VHQ%2CB07KBWVJMP%2CB07KZW86YR%2CB07GZLS9RW%2CB07R5Q2QKN%2CB077Z88M8Y%2CB07NPKMH58%2CB01HTC5920%2CB07CSM3K63%2CB081YQX81P%2CB00JOZTAC6%2CB076273VDM%2CB07GJDJV63&srpt=MOTION_DETECTOR_DEVICE
Ultrasonic Sensor 	\$3.95 per sensor	- Works at 5V - Range can extend to 2 cm - 4 m	Cannot operate less than 5V		https://www.sparkfun.com/products/15569

PARTIAL NODE ASSEMBLY

Open to occupied space as indicated by the Led's

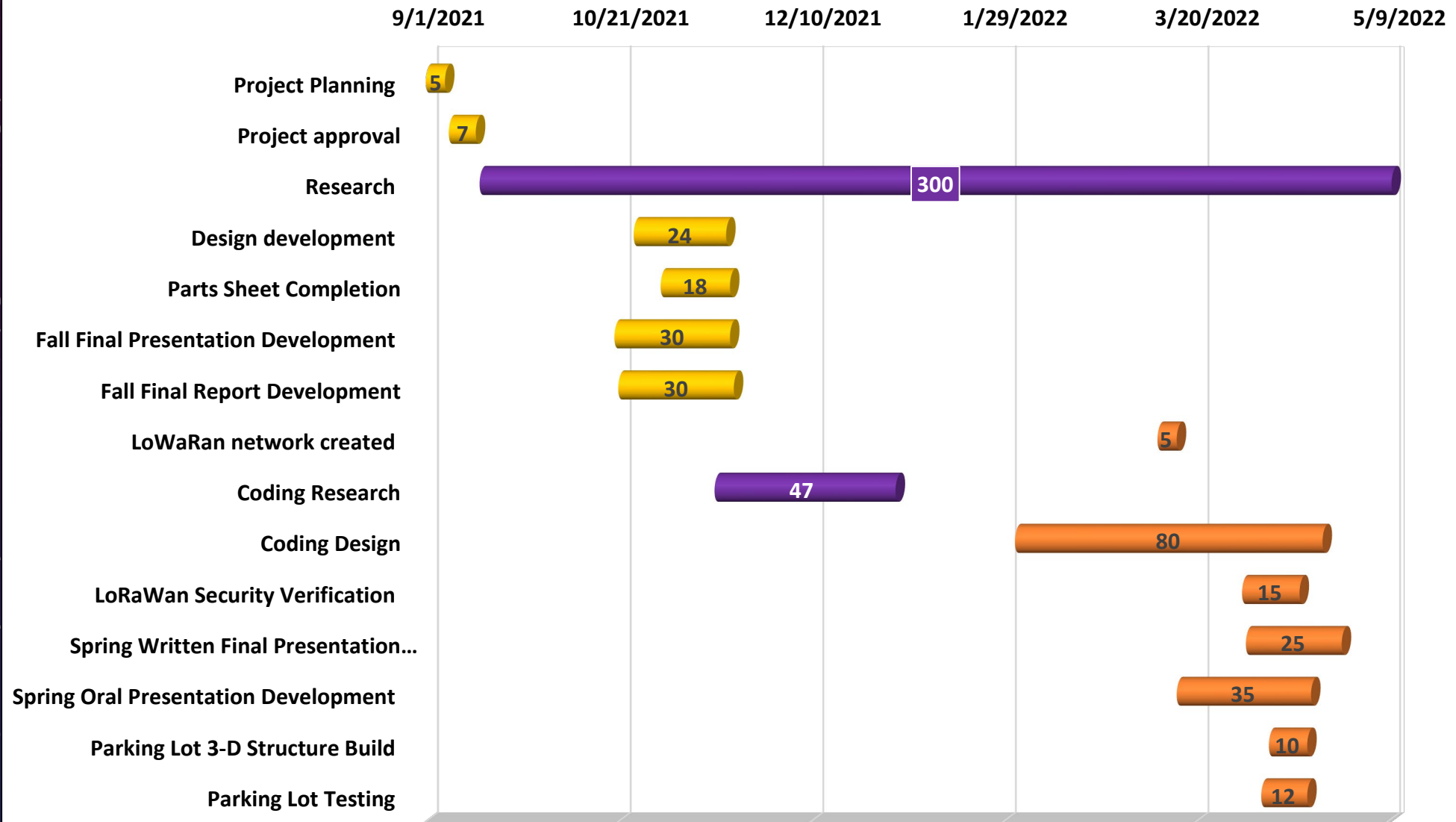


Green LED representing open space



Red LED representing occupied space

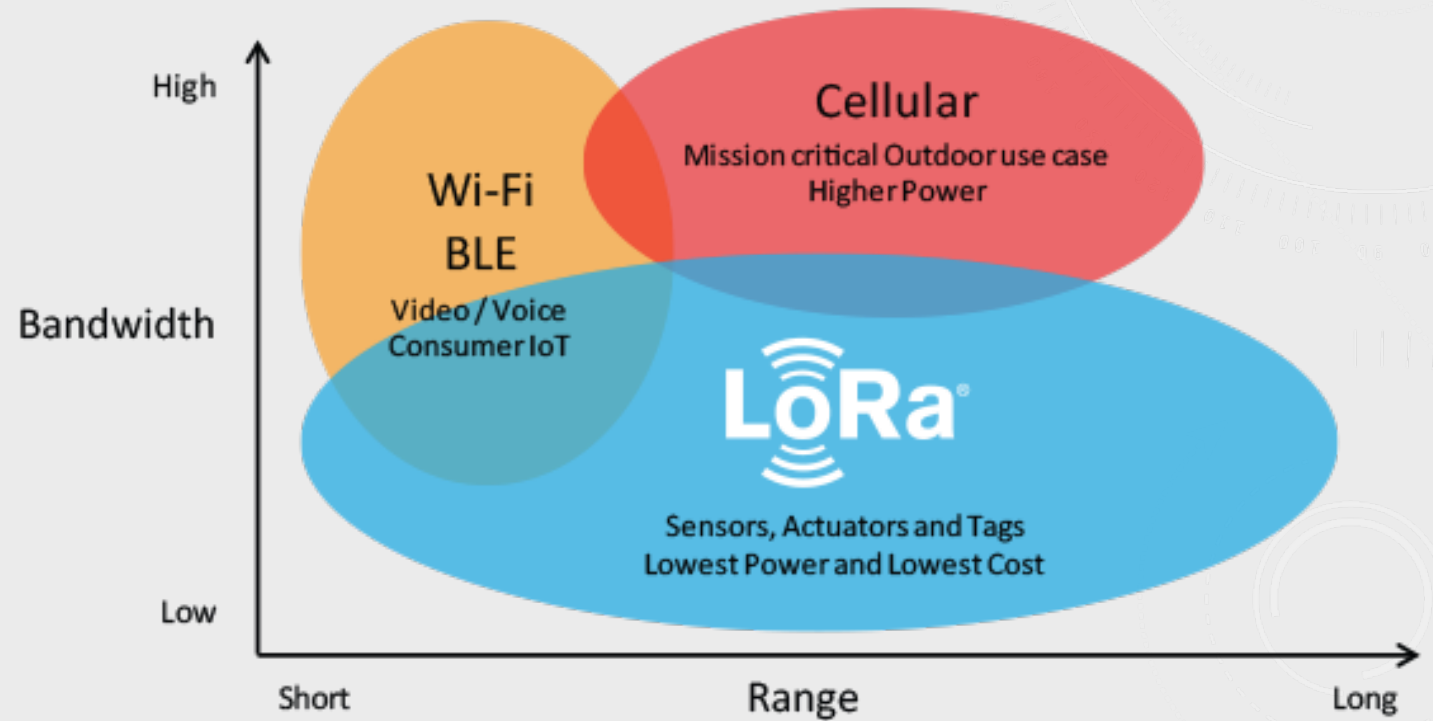
Team 8 Schedule



SCHEDULED TIMELINE

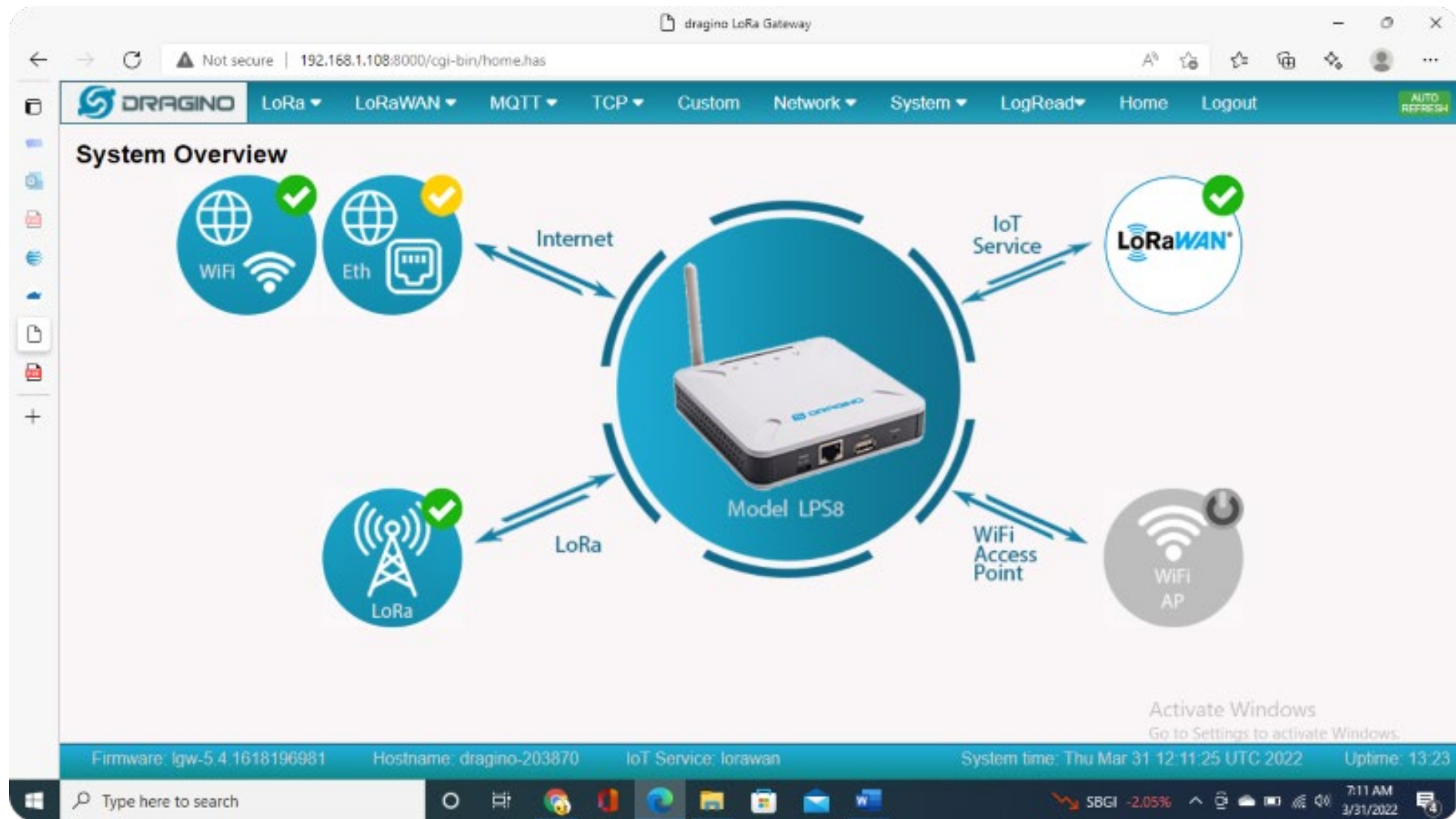
PROJECT IMPACT- TECHNICAL

- LoRaWAN has been the go-to network for IoT devices, especially in the industrial setup. These are devices that can reliably send very small data packets, from temperature to humidity.
- Lora devices are ideal to send small packets of data over a long range that does not include images or video.



Time	Type	Data preview	Event details
🔊 15:50:40	Receive gateway status	Metrics: { ackr:	1 {
🔊 15:50:10	Receive gateway status	Metrics: { ackr:	2 "name": "gs.status.receive",
🔊 15:49:40	Receive gateway status	Metrics: { ackr:	3 "time": "2022-04-18T20:44:09.948286090Z",
🔊 15:49:10	Receive gateway status	Metrics: { ackr:	4 "identifiers": [
🔊 15:48:40	Receive gateway status	Metrics: { ackr:	5 {
🔊 15:48:10	Receive gateway status	Metrics: { ackr:	6 "gateway_ids": {
🔊 15:47:40	Receive gateway status	Metrics: { ackr:	7 "gateway_id": "sd22-ips8-pv8-gateway"
🔊 15:47:10	Receive gateway status	Metrics: { ackr:	8 }
🔊 15:46:40	Receive gateway status	Metrics: { ackr:	9 },
🔊 15:46:10	Receive gateway status	Metrics: { ackr:	10 {
			11 "gateway_ids": {
			12 "gateway_id": "sd22-ips8-pv8-gateway",
			13 "eui": "A840412038704150"
			14 }
			15 }
			16],
			17 "data": {
			18 "@type": "type.googleapis.com/ttn.lorawan.v3.GatewayStatus",
			19 "time": "2022-04-18T20:44:09Z",
			20 "versions": {
			21 "ttn-lw-gateway-server": "3.19.0-rc1-SNAPSHOT-393d538a2"
			22 },
			23 "ip": [

SET UP OF THE LORA GATEWAY

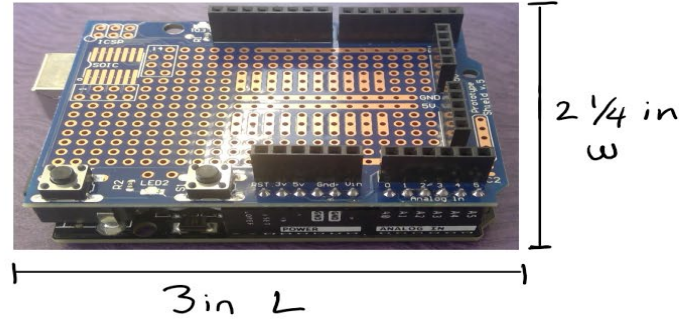


SENSOR HOUSING- PRELIMINARY MEASUREMENTS

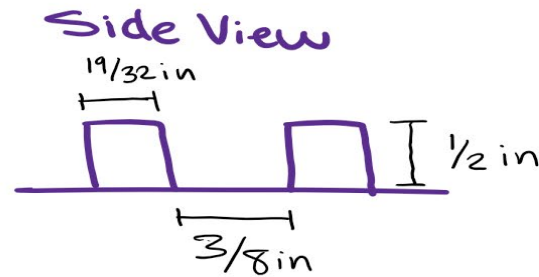
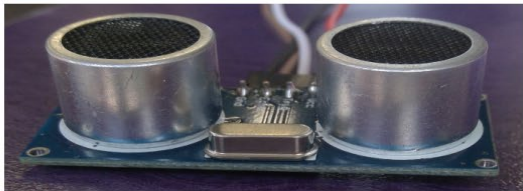
Battery with connector attached



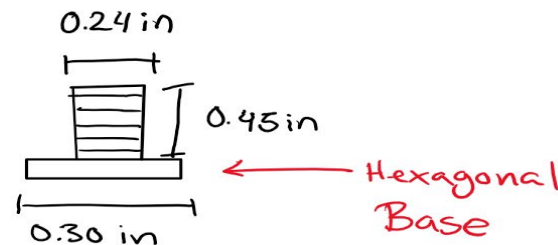
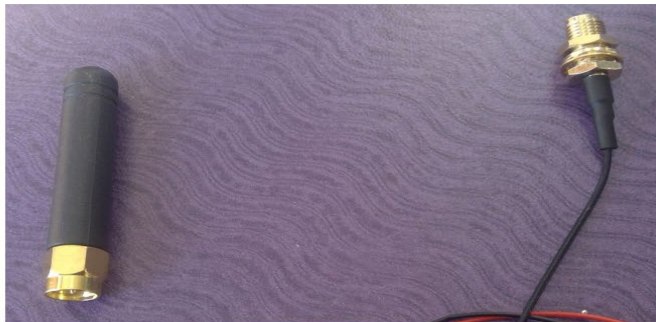
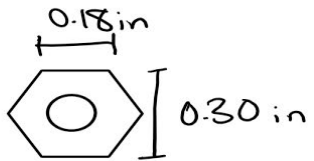
Microcontroller and prototype development board



- To design our parking lot sensor housing, we used a digital caliper that allowed us to get accurate measurements in order to get the appropriate dimensions required for the housing.



Bottom View



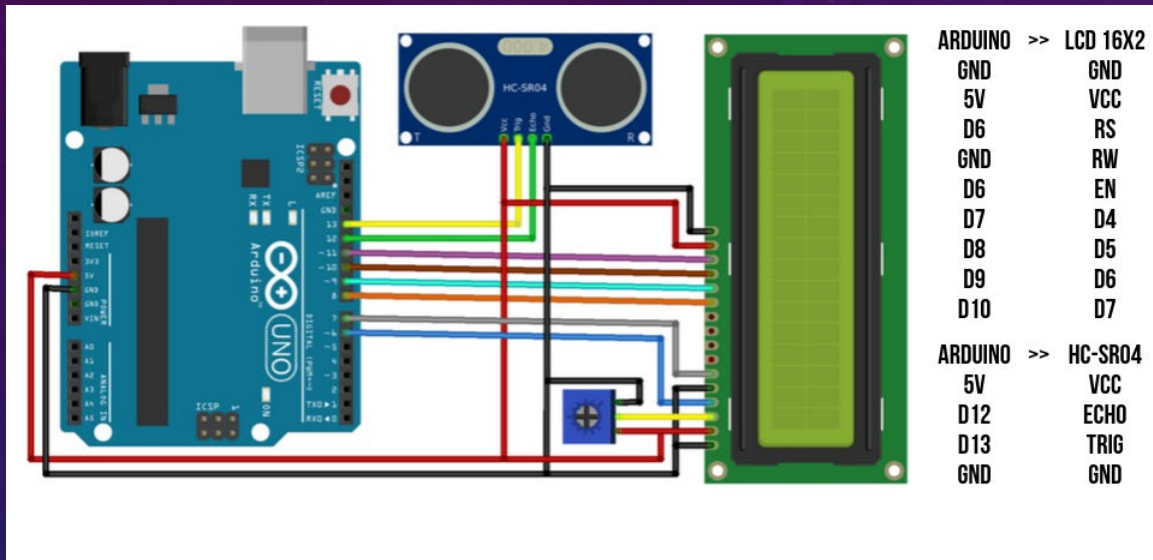
DIGITAL DIAGRAM OF THE SENSOR HOUSING- BASE



DIGITAL DIAGRAM OF THE SENSOR HOUSING- TOP LID



ITERATION STORY- PHASE 1 COMPONENTS



Microcontroller connected to the ultrasonic sensor along with LCD screen.



Lora transceiver pin out diagram

ITERATION STORY-PHASE 1



ITERATION STORY-PHASE 2



Q&A

You have

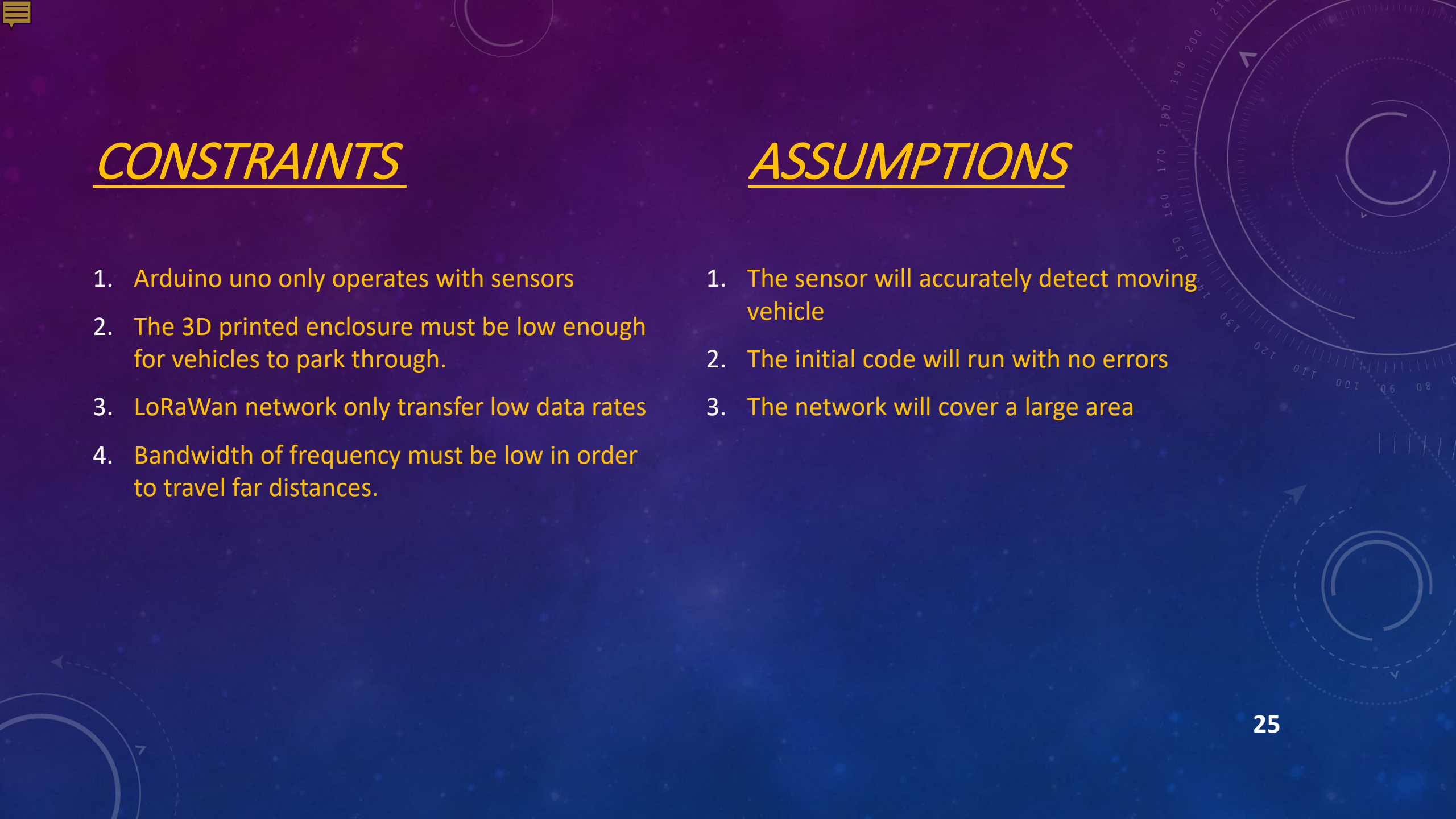
Questions

We have

Answers

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BACK UP SLIDES



CONSTRAINTS

1. Arduino uno only operates with sensors
2. The 3D printed enclosure must be low enough for vehicles to park through.
3. LoRaWan network only transfer low data rates
4. Bandwidth of frequency must be low in order to travel far distances.

ASSUMPTIONS

1. The sensor will accurately detect moving vehicle
2. The initial code will run with no errors
3. The network will cover a large area

ENGINEERING DESIGN METHODOLOGY

***Idea:** Mitigate security risk in LoRaWan platform*

***Concept:** Design a working network to debug*

***Planning:** Determine variables, research parts, and schedule accordingly*

***Design:** Choose hardware, draw preliminary design and make parts list.*

***Development:** Construct network, install code for Arduino, run the sensor, analyze results and redesign if necessary.*

***Launch:** Prepare data, report results, and deliver product*

PARTS LIST

Item Number	Equipment Name	Link to Acquire Item	Unit Cost (\$)	Quantity	Total Cost ((\$)
1.	LoRaWAN Gateway	https://www.amazon.com/DRAGINO-Indoor-LoRaWAN-Gateway-MHZ915/dp/B08N9JWFCS	220.00	1	220.00
2.	ELEGOO UNO Project Super Starter Kit with Tutorial and UNO R3 Compatible with Arduino IDE	https://www.amazon.com/ELEGOO-Project-Tutorial-Controller-Projects/dp/B01D8KOZF4	38.99	1	38.99
3.	LoRa Transceiver	https://www.amazon.com/DIYmalls-Transceiver-Antenna-Battery-Connector/dp/B086ZG25DZ	54.95	1	54.95
Totals				3	313.94

CODES AND STANDARDS

IEEE 802.5 Standards for token ring access and for communications between LANs and MANs

IEEE 802.6 Standards for information exchange between systems

IEEE 802.7 Standards for broadband LAN

IEEE 802.10 Standards for LAN/MAN security

IEEE 802.11 Wireless Networking - "WiFi"

IEEE 1625 Standard for Rechargeable Batteries for Multi-Cell Mobile Computing Devices

RESOURCES

- [1] Amazon. (n.d.). *Ultrasonic Sensor AM312* . Retrieved November 15, 2021, from https://www.amazon.com/Weewooday-Pyroelectric-Infrared-Detector-Temperature/dp/B08PVB7VHQ/ref=mp_s_a_1_4?keywords=pir+sensor&qid=1637011908&qsid=140-0224905-2590768&sr=8-4&sres=B012ZZ4LPM%2CB08PVB7VHQ%2CB07KBWVJMP%2CB07KZW86YR%2CB07GZLS9RW%2CB07R5Q2QKN%2CB077Z88M8Y%2CB07NPKMH58%2CB01HTC5920%2CB07CSM3K63%2CB081YQX81P%2CB00JOZTAC6%2CB076273VDM%2CB07GJJDV63&srpt=MOTION_DETECTOR_DEVICE.
- [2] Butun, Ismail & Pereira, Nuno & Gidlund, Mikael. (2018). Analysis of LoRaWAN v1.1 security: research paper. 1-6. 10.1145/3213299.3213304.
- [3]Dynamic Product Page,” *Microchip.com*. [Online]. Available: <https://www.microchip.com/en-us/product/ATECC608A-TNGLORA>. [Accessed: 01-Oct-2021].
- [4] “FAAC B680H Automatic Barrier L Kits,” Allsecurityequipment.com. [Online]. Available: https://allsecurityequipment.com/products/faac-b680h-automatic-barrier-l-kits?variant=40444798369965¤cy=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gclid=CjwKCAjwzOqKBhAWEiwArQGwaLh2tZh_fH1TeOE5-gGibbRmVBC762lusRHmeuEekZCdh4oFoOPEYhoC8j4QAvD_BwE. [Accessed: 01-Oct-2021]
- [5] “Parking Today,” *www.parkingtoday.com*. <https://www.parkingtoday.com/blog/2019/03/stress-and-uncertainty-of-finding-parking/>.
- [6] T. of UsePrivacyCopyrightTrademarksNon-DiscriminationAccessibility, “COVID lockdown causes record drop in carbon emissions for 2020,” *Stanford Earth*, Dec. 10, 2020. <https://earth.stanford.edu/news/covid-lockdown-causes-record-drop-carbon-emissions-2020#gs.cfr03r> (accessed Oct. 01, 2021).
- [7] *Ultrasonic distance sensor - HC-SR04*. SEN-15569 - SparkFun Electronics. (n.d.). Retrieved November 15, 2021, from <https://www.sparkfun.com/products/15569>.

PROJECT OVERVIEW

- **Mission Statement:**

To design a parking lot detection network that uses Long Range Wide Area Network (LoRawan) technology in order to transmit communication signals and mitigate attacks.

- **Problem Statement:**

Unfortunately, at present times, Internet of Things (IOT) devices are easily exploited by attackers, and they present many new challenges for security including system constraints, scalability, and enlarged attack surfaces.

PROSPECTIVE PLAN

- **Target Audience:**
 - ▶ Any end user of an Internet of Things (IoT) device
- **Budget:**
 - ▶ Project Budget: **\$600**
 - ▶ Amount Spent: **\$375**
- **Proposed Deliverables:**
 - ▶ Check the security of Lora OTA (Over the Air) activation using (SYTHER) a formal security analysis tool and focuses on the key exchange portion.
 - ▶ Send messages along the bandwidth
 - ▶ Create a functioning parking detection device

Customer requirements and Engineering Solutions:

- ▶ Analyze security vulnerabilities of Lora WAN and detect the security risks
- ▶ Develop new solutions to mitigate major security risks in the LoRa platform
- ▶ Use different codes to strengthen the security of the Lora
- ▶ Make sure stronger security key sets can be established when completing the over the air communications.

Major constraints:

- Using LoRa on college campus may arise potential connectivity problems
- The team has limited knowledge on computer coding
- The team has limited knowledge on 3-D printing operations

BENEFICIAL IMPACTS

- Environmental
- By implementing our project, we will be a part of assisting the next generation of percentage drop in emissions from 2021 to 2030

Percent change in Emissions	1980-2020	1990-2020	2000-2020	2010-2020
Carbon Monoxide	-75%	-70%	-57%	-29%
Lead	-99%	-87%	-76%	-30%
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ECONOMIC & SOCIAL

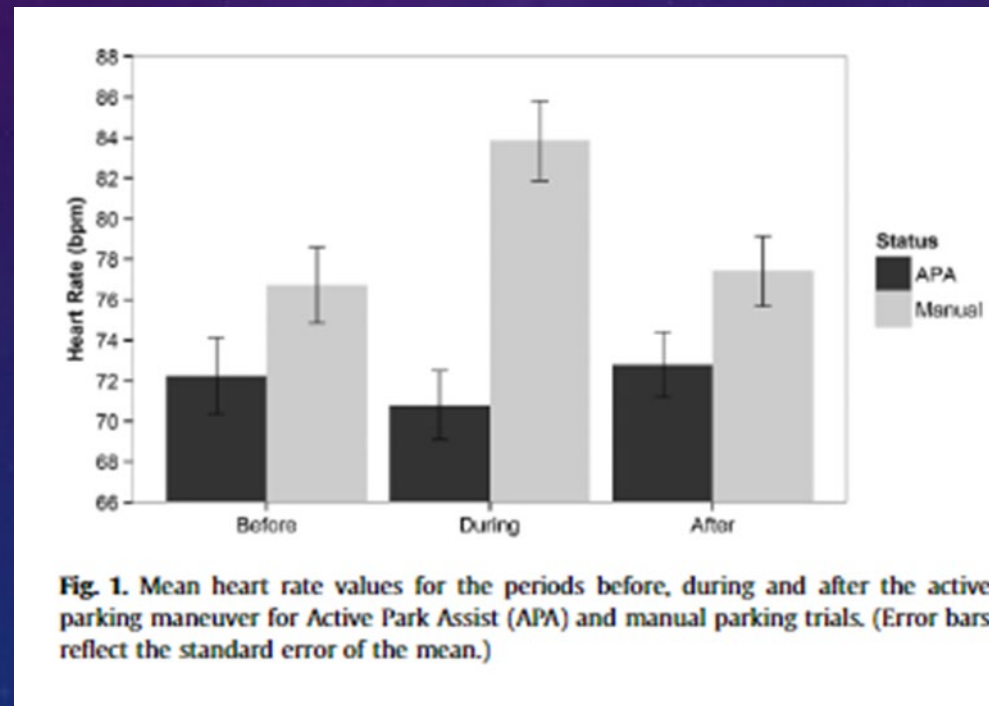
- The goal of this project is to decrease the money and time spent on finding parking
- Commuter students and faculty will know how many open spaces are left beforehand instead of driving around to find parking. Creates the opportunity to arrive on time for a class or meeting. Faculty/Employees can avoid being late to work with the time saved
- *APA: Assistive Parking Assembly

Summary of parking performance variables for parks with and without APA.

Measure	Manual	APA
Average parking time (sec)	44.90 (21.60)	35.22 (11.91)
Average number of direction changes (count)	3.72 (2.24)	1.87 (1.27)
Average parking performance (cm from curb)	6.82 (3.50)	4.23 (1.93)
Turn signal use (% of parks)	84.9 (28.7)	61.9 (37.3)

PUBLIC HEALTH, SAFETY, AND WELFARE

- Implementing a parking space detector can greatly reduce emissions and stress levels for everyday drivers.



RECOMMENDATIONS AND CONCLUSION

- **Recommendation**

- When setting up the environment make sure the script is correct
- Do thorough research on what security verification protocol would be the best to use
- Use as much time as possible to verify security measures

- **Conclusion**

Testing the security environment of the LoRa takes a lot of trial and error. Revision of the code is fundamental. As a team we will make sure to work as a team and continue to troubleshoot frequently.