

GEM

Geographic Environmental Module

CE Capstone

Development Team

	Michael Sanchez	Software Development
	Alejandro Diera	Software Development
	Larry Mai	PCB Design
	Yuen Ming Pang	PCB Design
	Sawyer Essabhoy	Testing

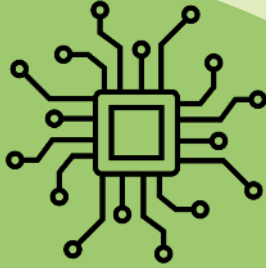


Problem Description

- Climate change
 - 8,000+ wildfires in CA, 2021
 - 2.6 million acres destroyed
- Agriculture
 - Over 2 million US farms
 - Over 100,000 farms lost in the past 10 years
- GEM can monitor environmental conditions and determine agricultural sustainability



Data Flow



1

Sensor Node

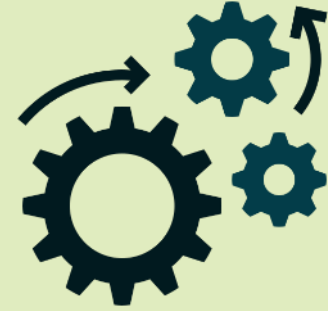
Collect data using various sensors and interfaces



2

Transmission

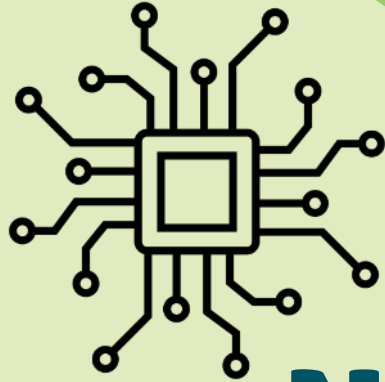
Send raw data to the cloud



3

Processing

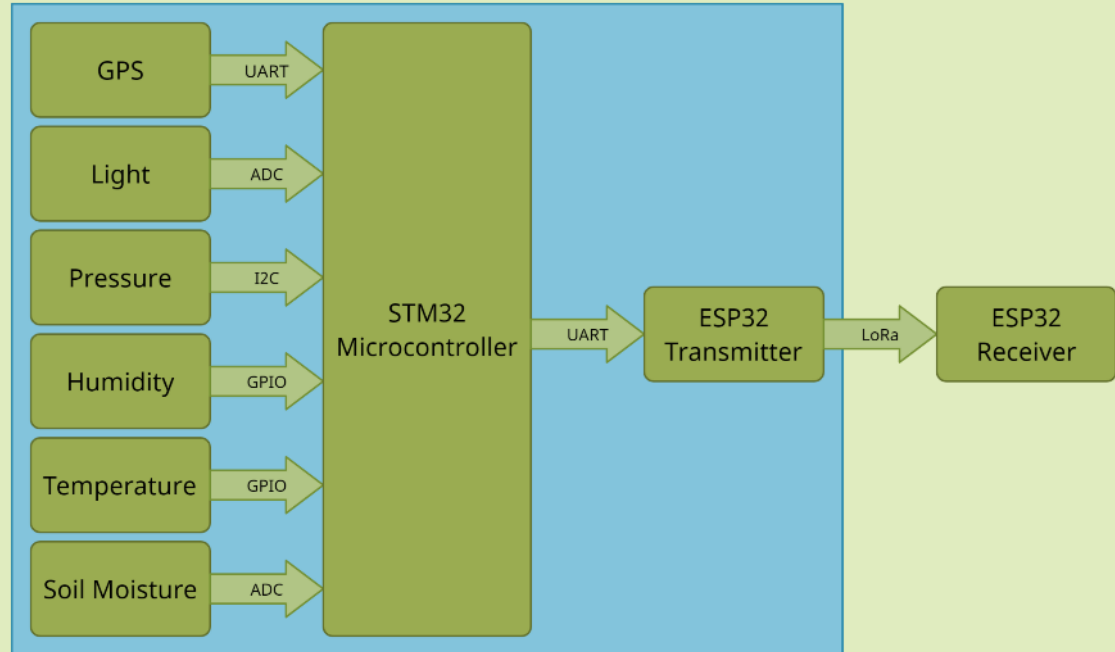
Process data for presentation



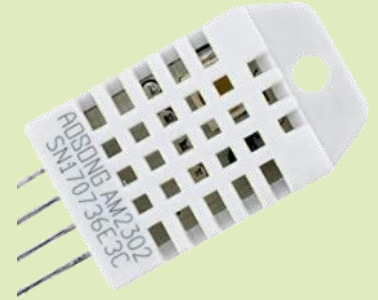
Sensor Node

Block Diagram

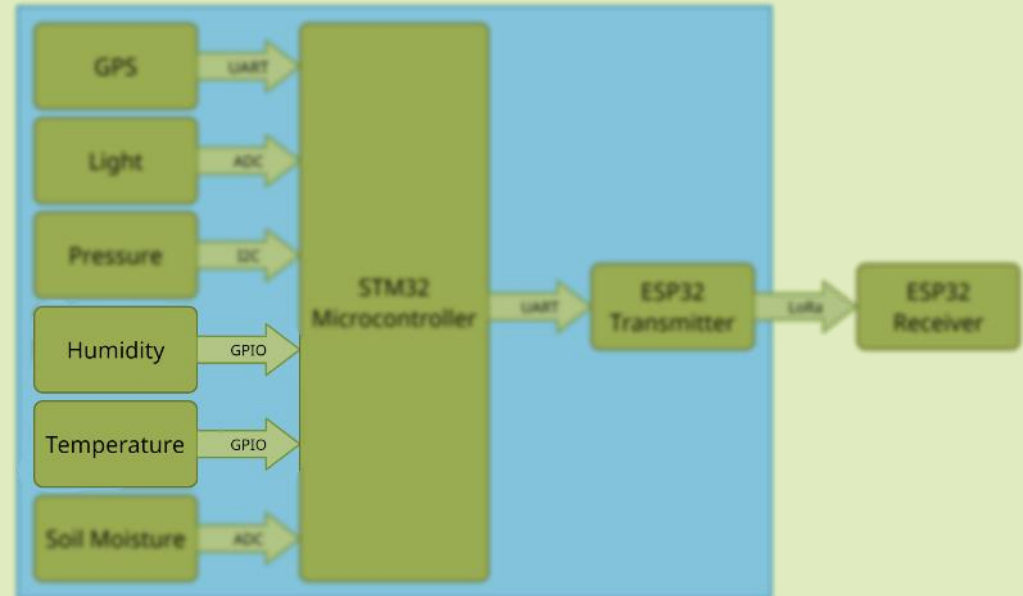
- Multiple Nodes
- Single Receiver



Temperature & Humidity



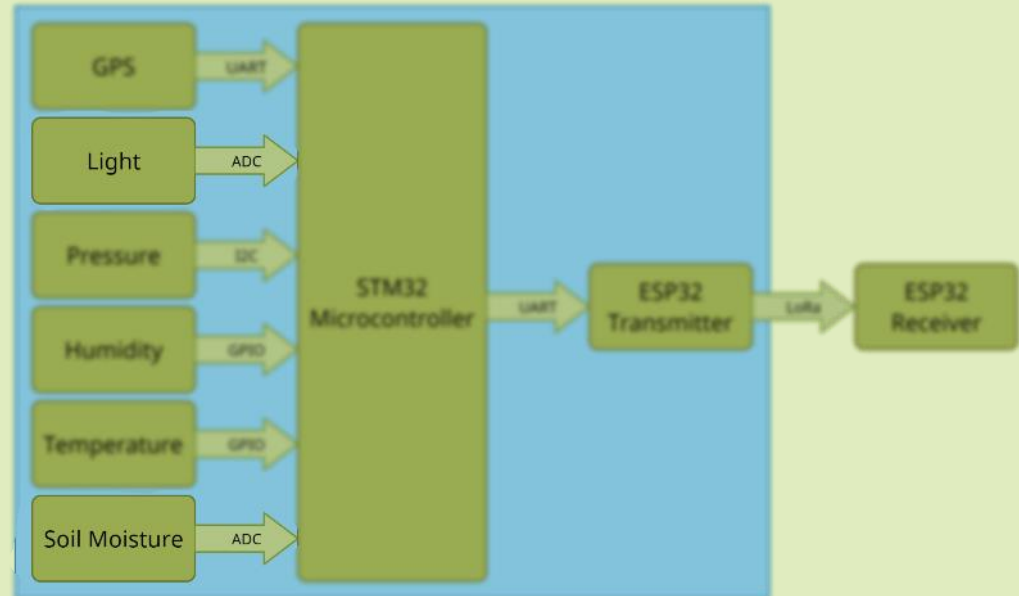
- DS18B20
 - External Temperature
 - Waterproof
- DHT22
 - Internal Temperature and Humidity
- 1-Wire GPIO interface
 - Bidirectional half duplex
 - Millisecond timer
- Programmable resolution
 - 9 to 12 bits



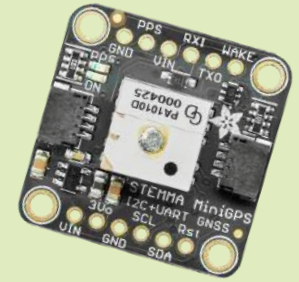
Light & Moisture



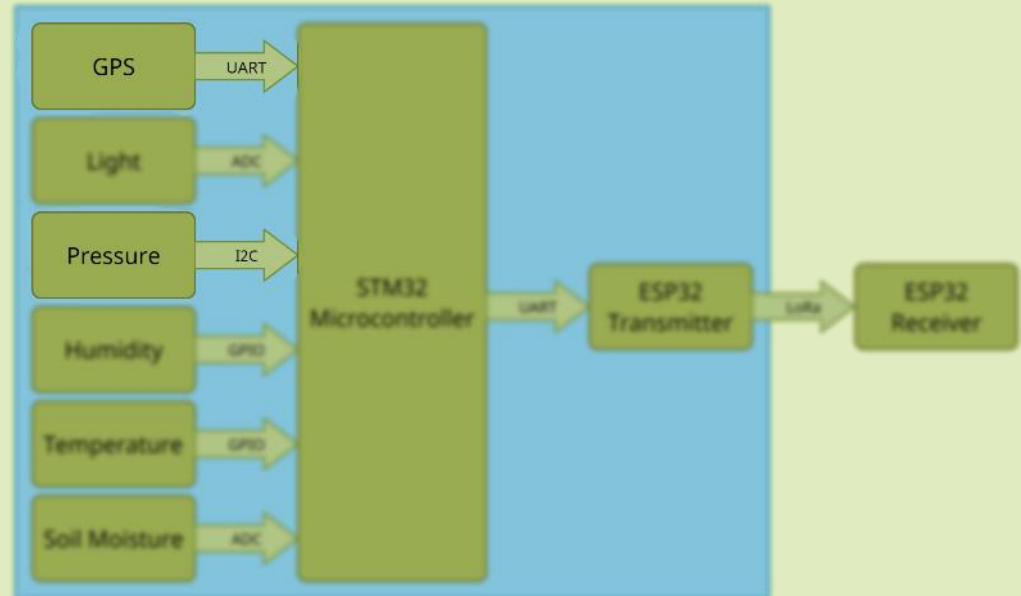
- SparkFun Soil Moisture Sensor
- PCELL2 Photoresistor
 - Calibration
 - Lux meter
 - Lookup table
- Shared ADC input
 - Distinct channels
- Corrosion resistant



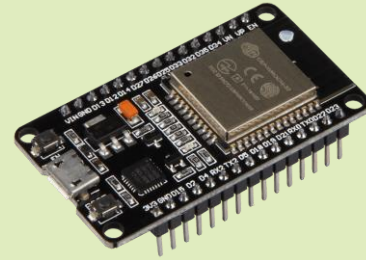
Pressure & GPS



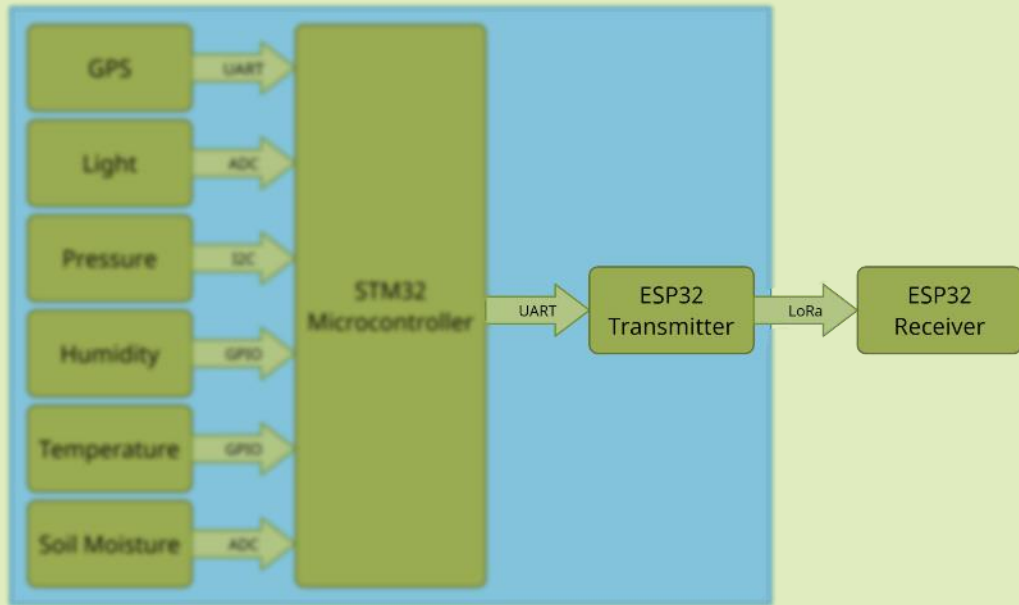
- PAI01D
 - GPS NMEA Sentences
 - Longitude & Latitude
 - UART Interface
- BMP180
 - Barometric Pressure
 - Altitude
 - High/Low Pressure Systems
 - I2C Interface



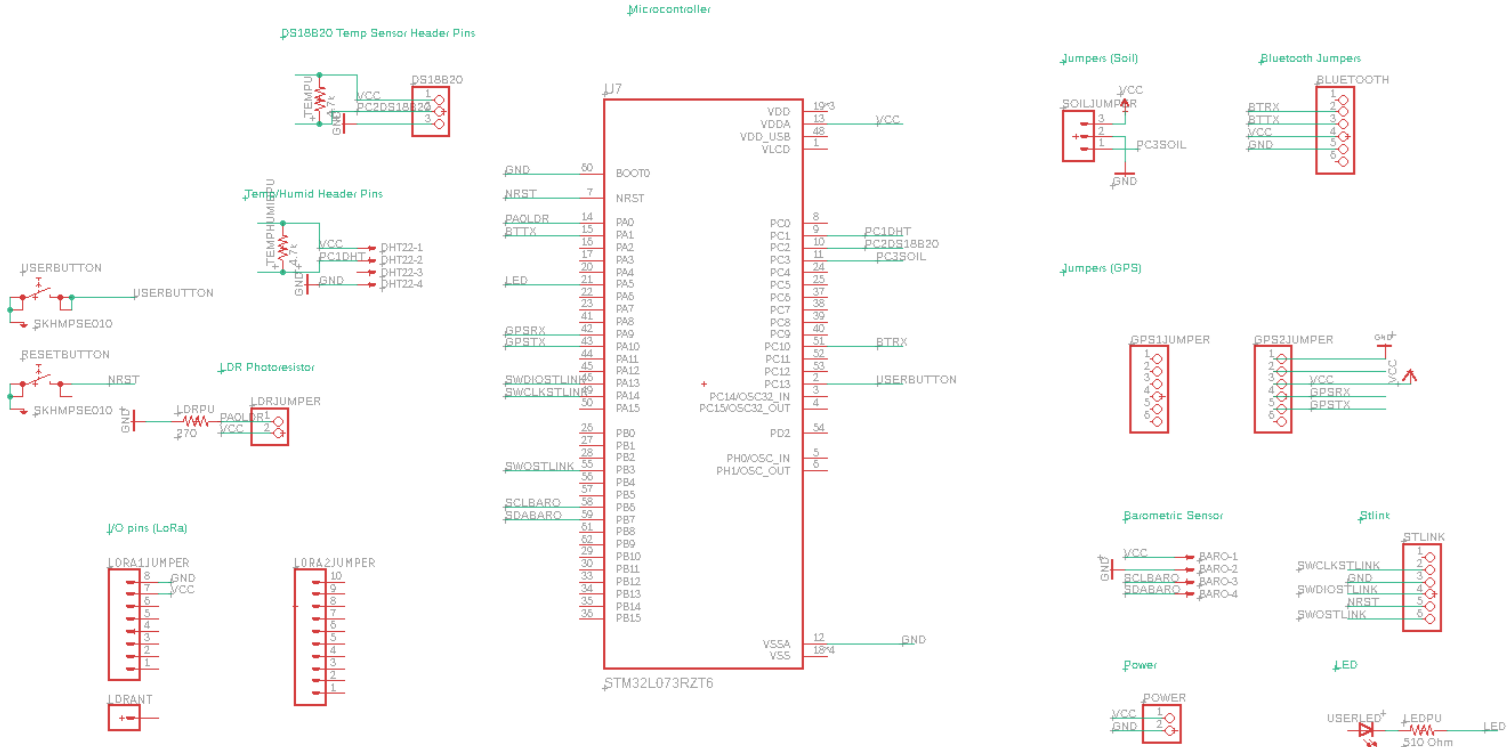
ESP32 LoRaWAN Gateway



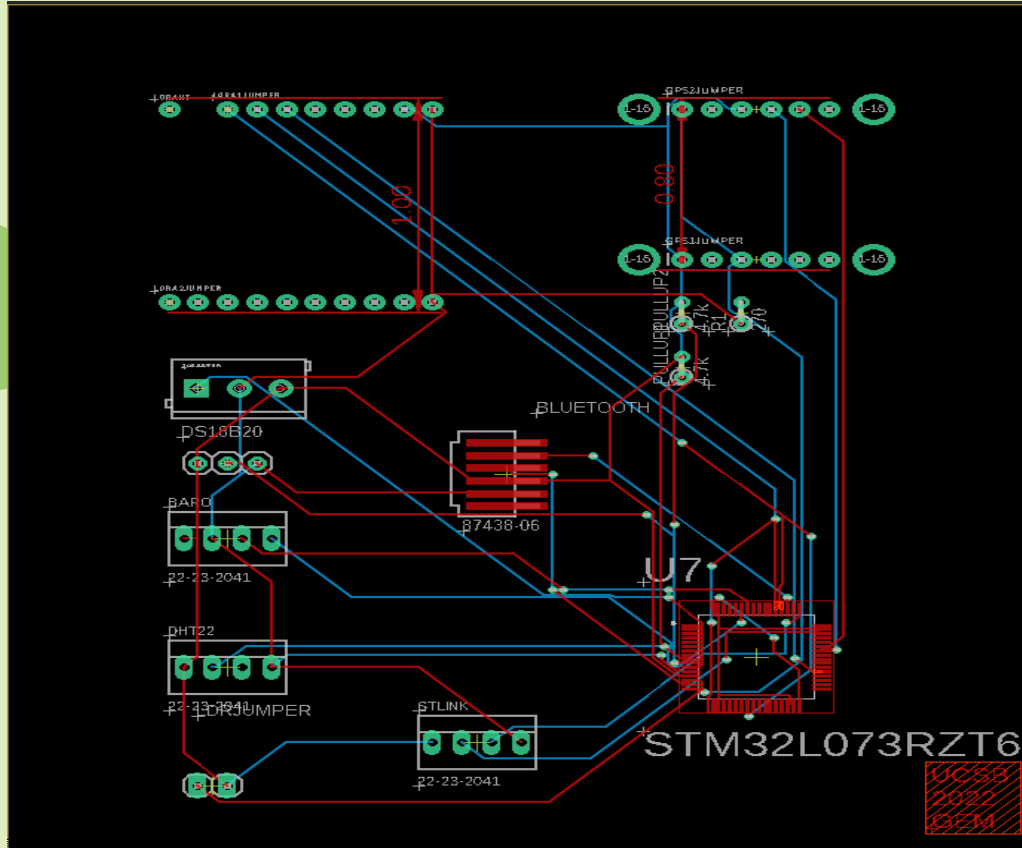
- ESP32-WROOM-32E
 - ESP32 is a multi-network devices that offers connectivity with UART, I2C, SPI, and WiFi
- RFM95W LoRa modem
 - handles 915 MHz spectrum for LoRa transmissions
- Together, it forms a low cost tool for monitoring up to a dozen LoRa devices.



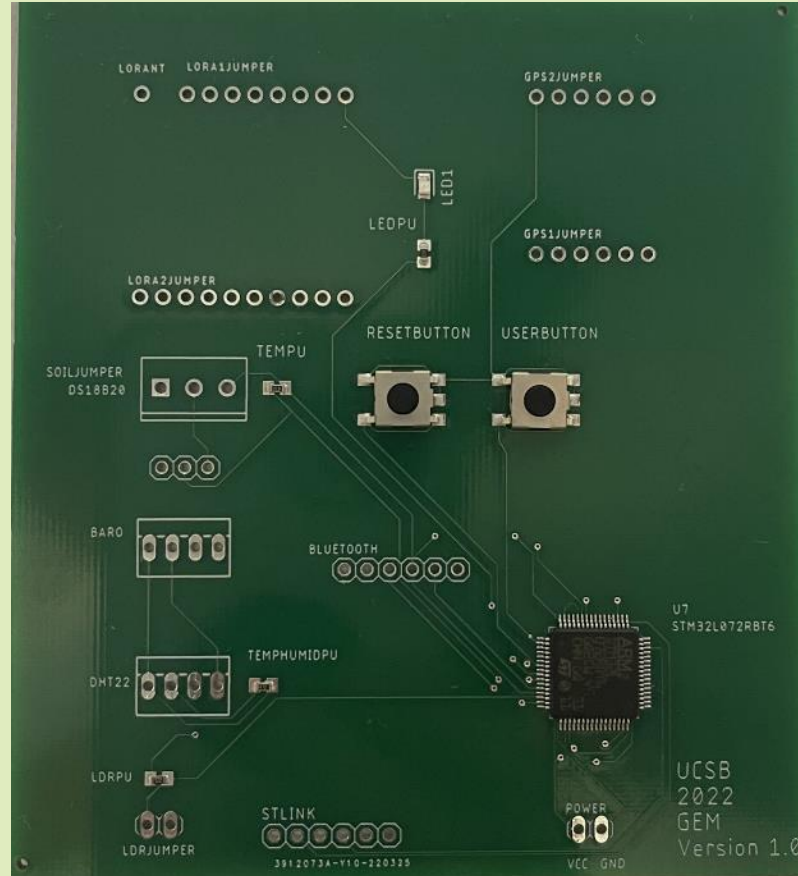
Schematic



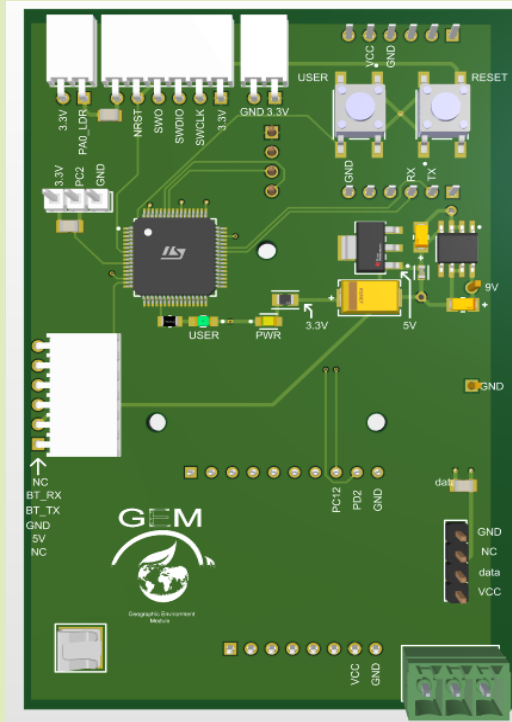
PCB Layout



Assembled PCB



Second Design



Integrated Power Supply

More compact

Restructured



Transmission

Long Range Wide Area Network

Low Power

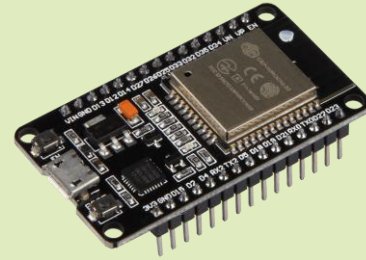
Long Range



Standardized

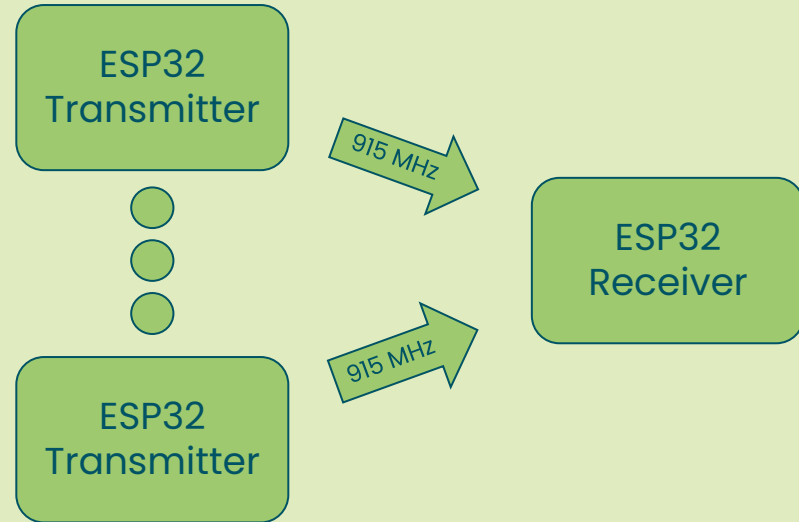
Low Cost

LoRaWAN Infrastructure

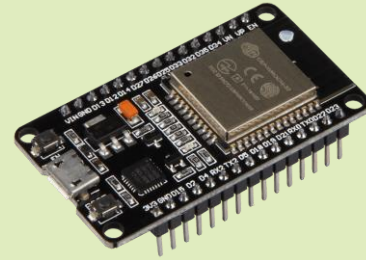


For the transmitter:

- They are set up as individual nodes, each PCB has one ESP32 that will receive messages from the STM32 processor via UART
- It then transmits the message over the LoRaWAN protocol on the 915 MHz spectrum

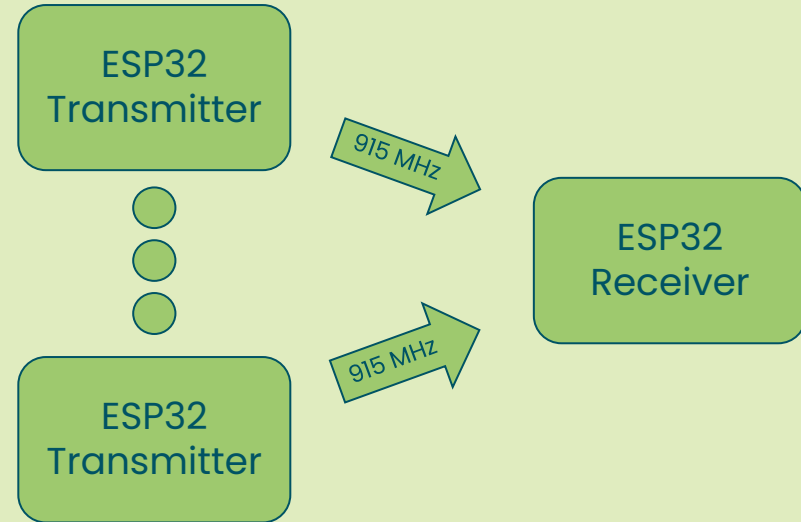


LoRaWAN Infrastructure



For the receiver:

- A single gateway could connect up to 12 LoRa transmitters.
- Programmed to read for transmissions that are periodically sent from the transmitters.
- LoRaNow Library
 - Unique node identification
 - Checksum
 - Used to verify if data is corrupted



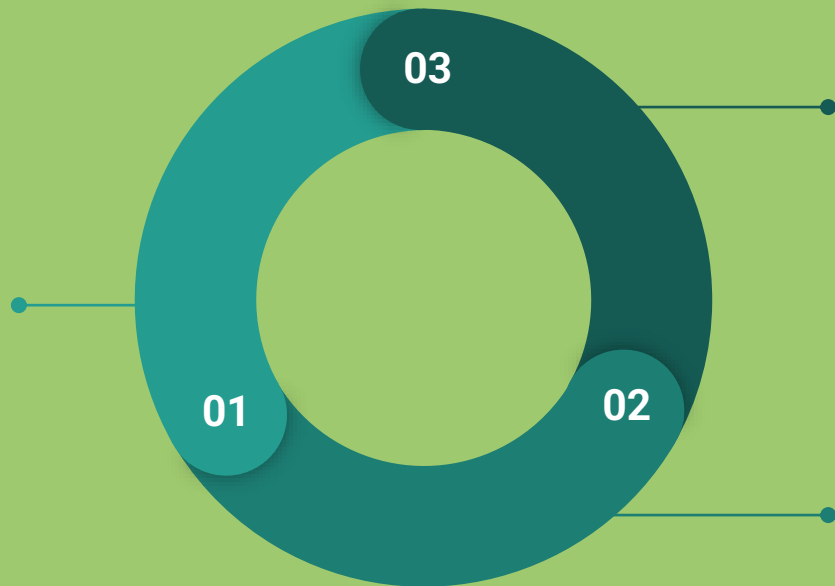


Processing

Data Analysis

Read COM Port

LoRa messages are received by the gateway and displayed on the terminal via UART



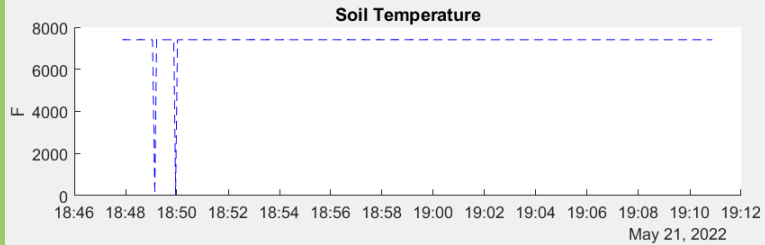
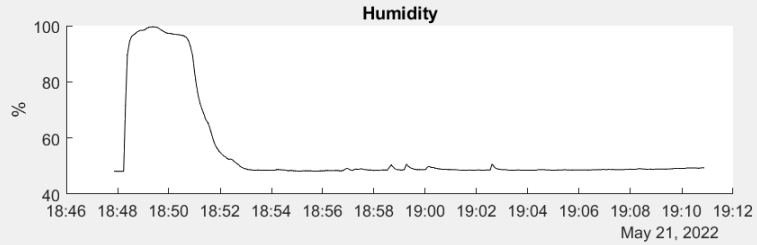
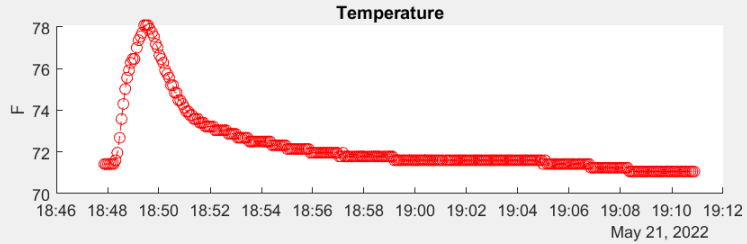
Plot

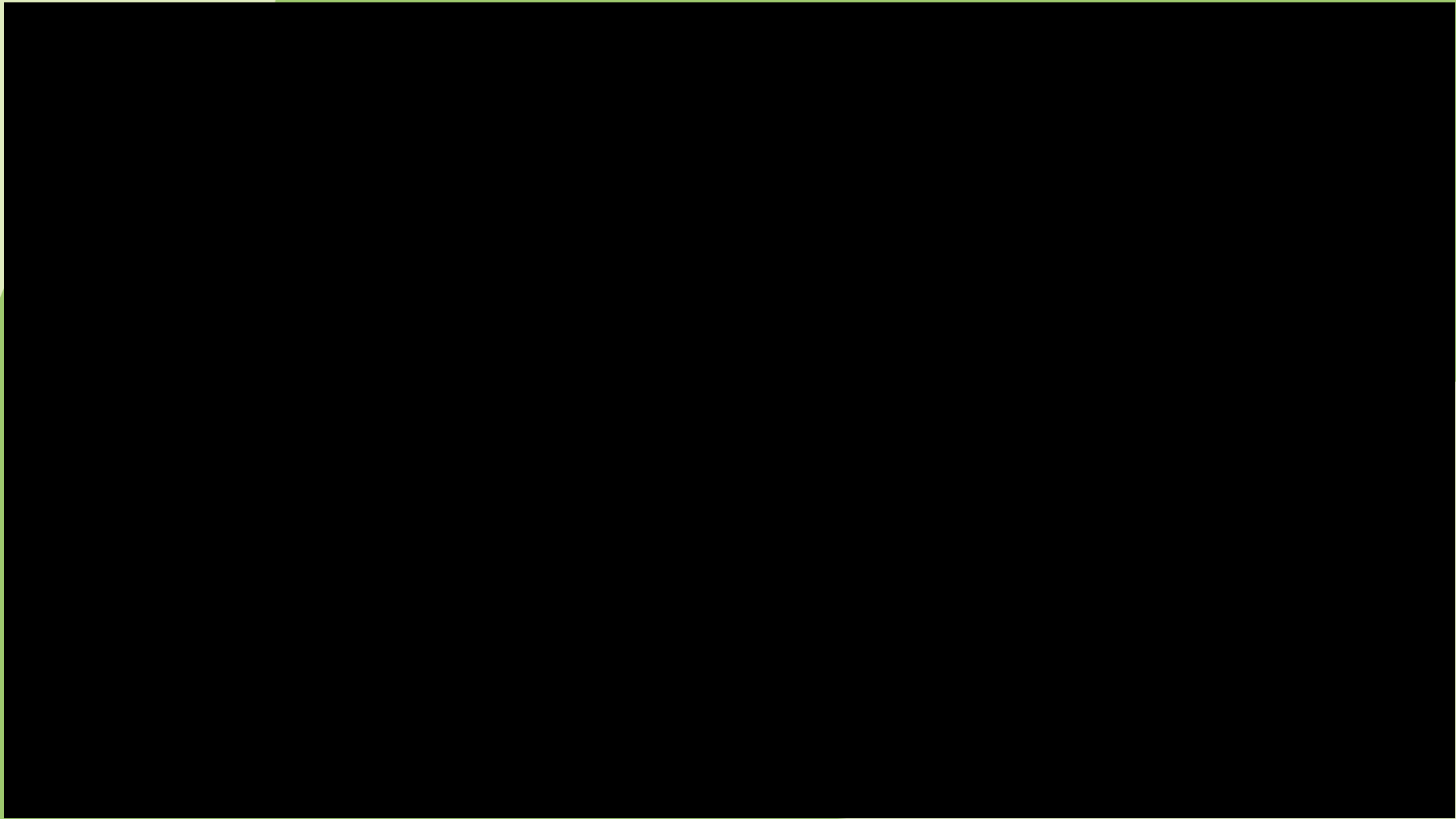
The data is plotted and displayed to the user

Unpack Data

MATLAB opens the COM port and begins to unpack the data, remove delimiters, etc.

Sample Plots





Acknowledgements

- Dr. Yoga Isukapalli
- Christopher Cheney
- Brycen Westgarth



Lead sponsor of CE Program