

# GEM

## Geographic Environmental Module

CE Capstone

# Development Team

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	<b>Alejandro Diera</b>	Software Development
	<b>Larry Mai</b>	PCB Design
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# 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

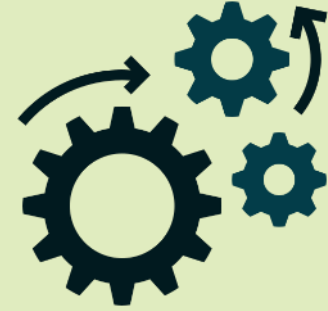
Collect data using various sensors and interfaces



**2**

## Transmission

Send raw data to the cloud



**3**

## Processing

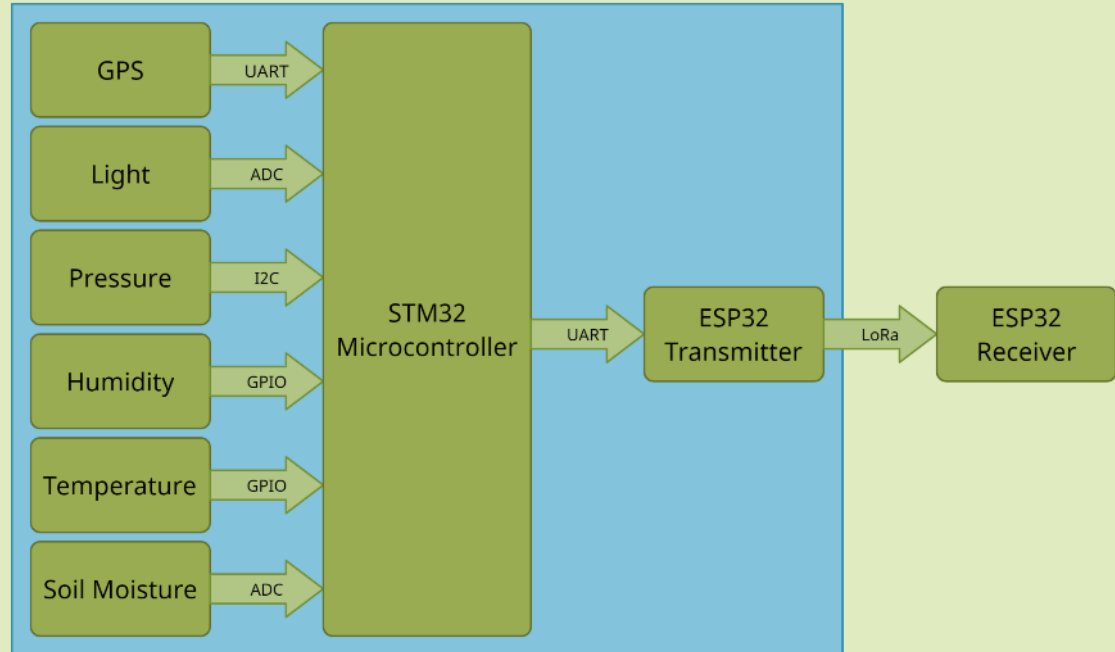
Process data for presentation



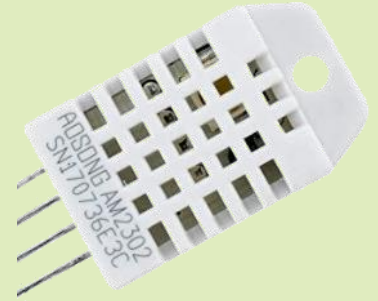
**Sensor Node**

# Block Diagram

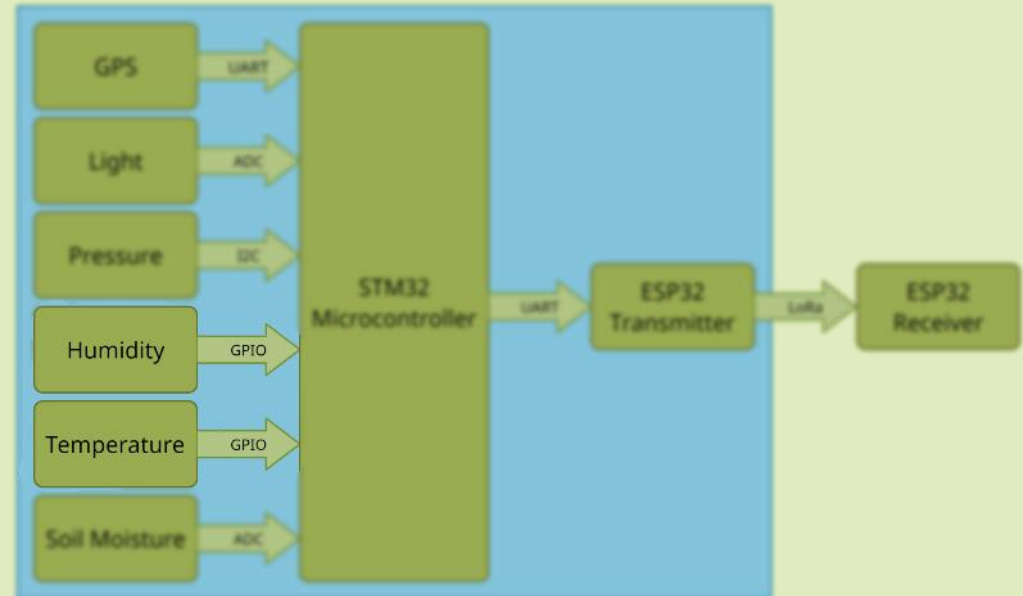
- Multiple Nodes
- Single Receiver



# Temperature & Humidity



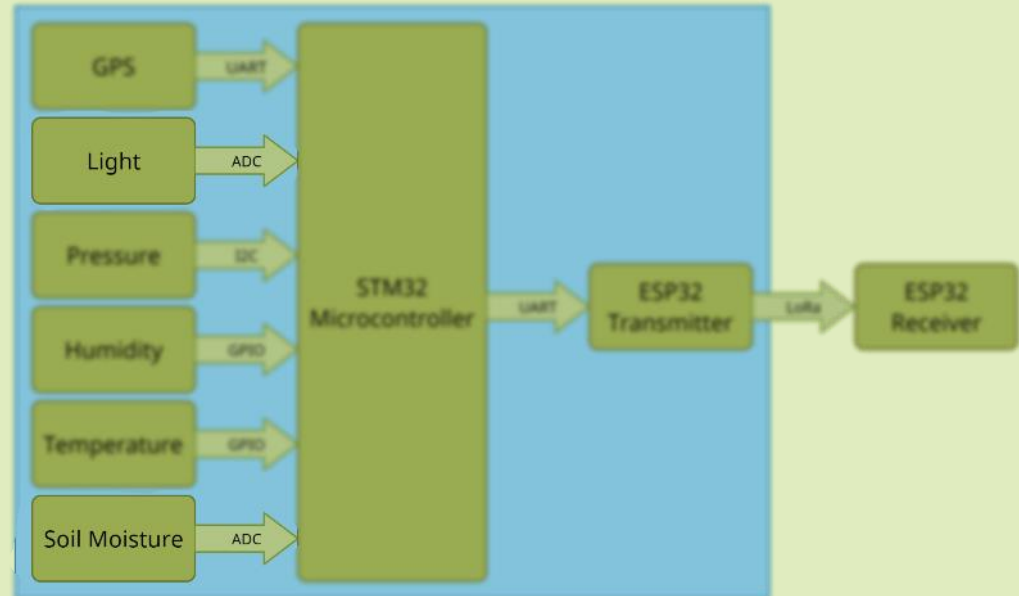
- DS18B20
  - External Temperature
  - Waterproof
- DHT22
  - Internal Temperature and Humidity
- 1-Wire GPIO interface
  - Bidirectional half duplex
  - Millisecond timer
- Programmable resolution
  - 9 to 12 bits



# Light & Moisture

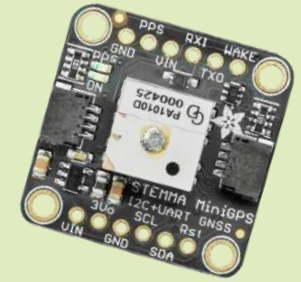


- SparkFun Soil Moisture Sensor
- PCELL2 Photoresistor
  - Calibration
    - Lux meter
    - Lookup table
- Shared ADC input
  - Distinct channels
- Corrosion resistant

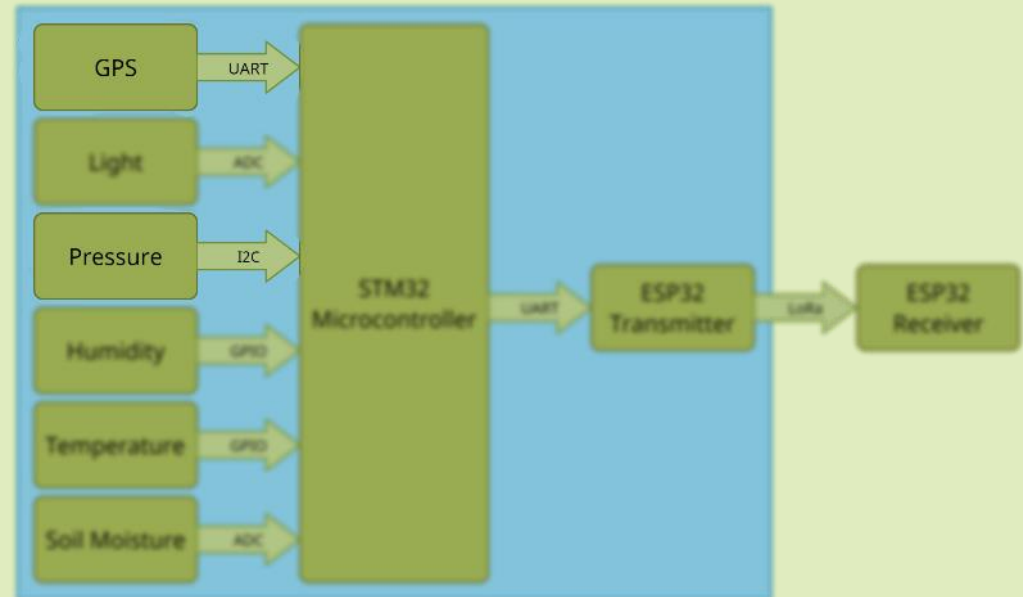




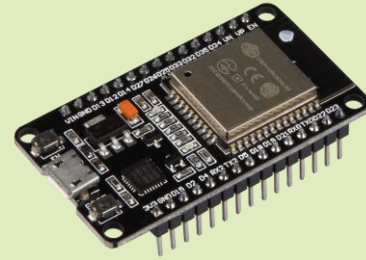
# Pressure & GPS



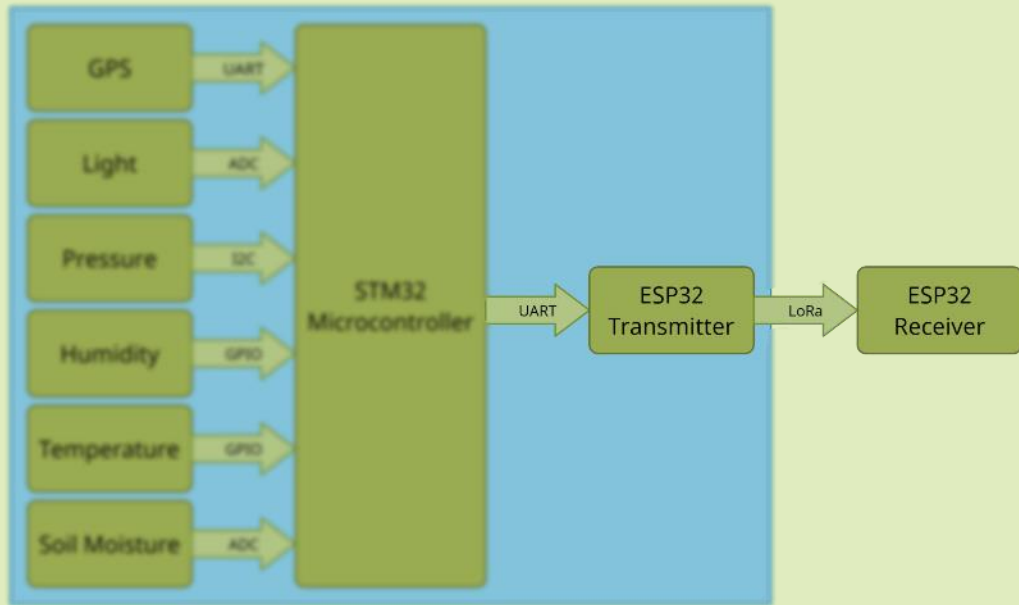
- PAI01D
  - GPS NMEA Sentences
  - Longitude & Latitude
  - UART Interface
- BMP180
  - Barometric Pressure
  - Altitude
  - High/Low Pressure Systems
  - I2C Interface



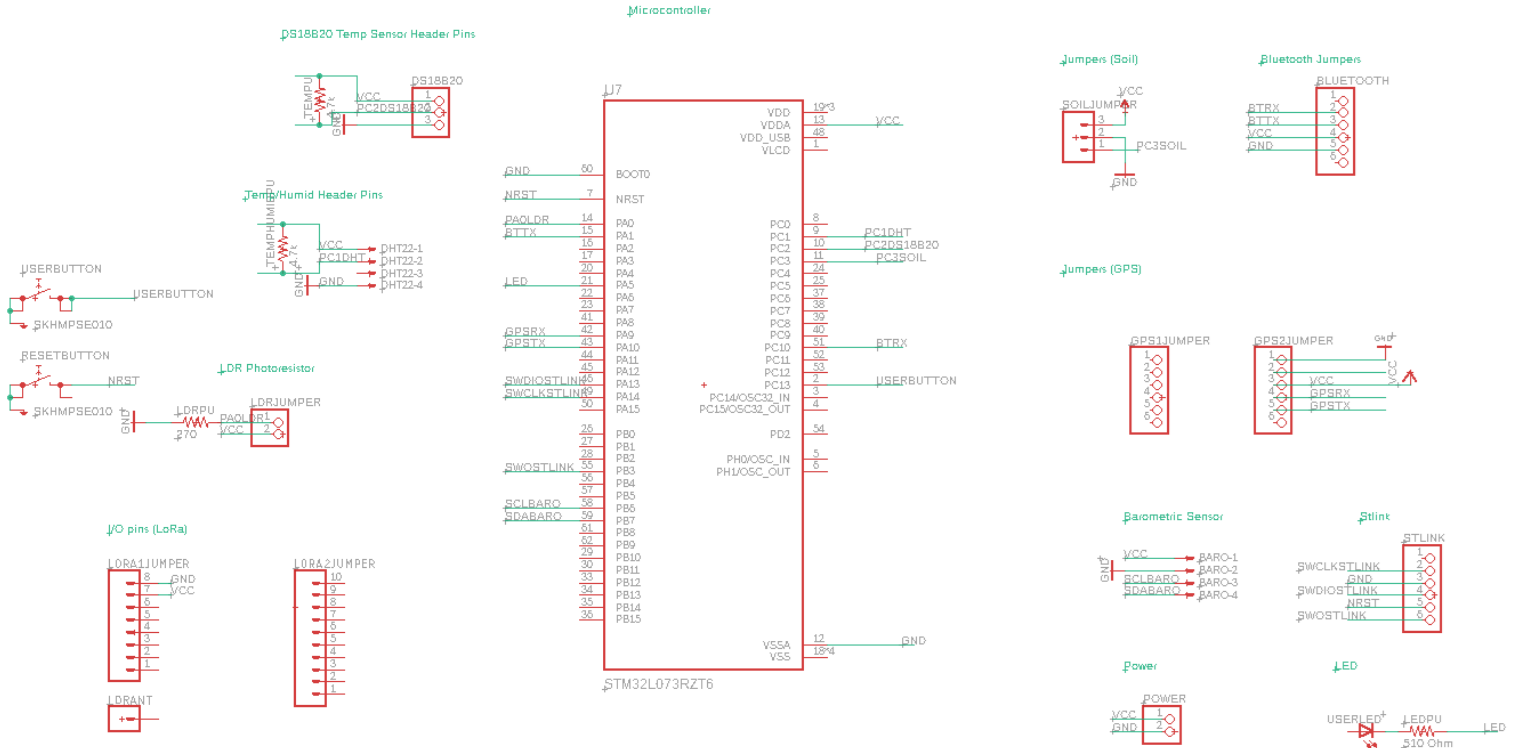
# ESP32 LoRaWAN Gateway



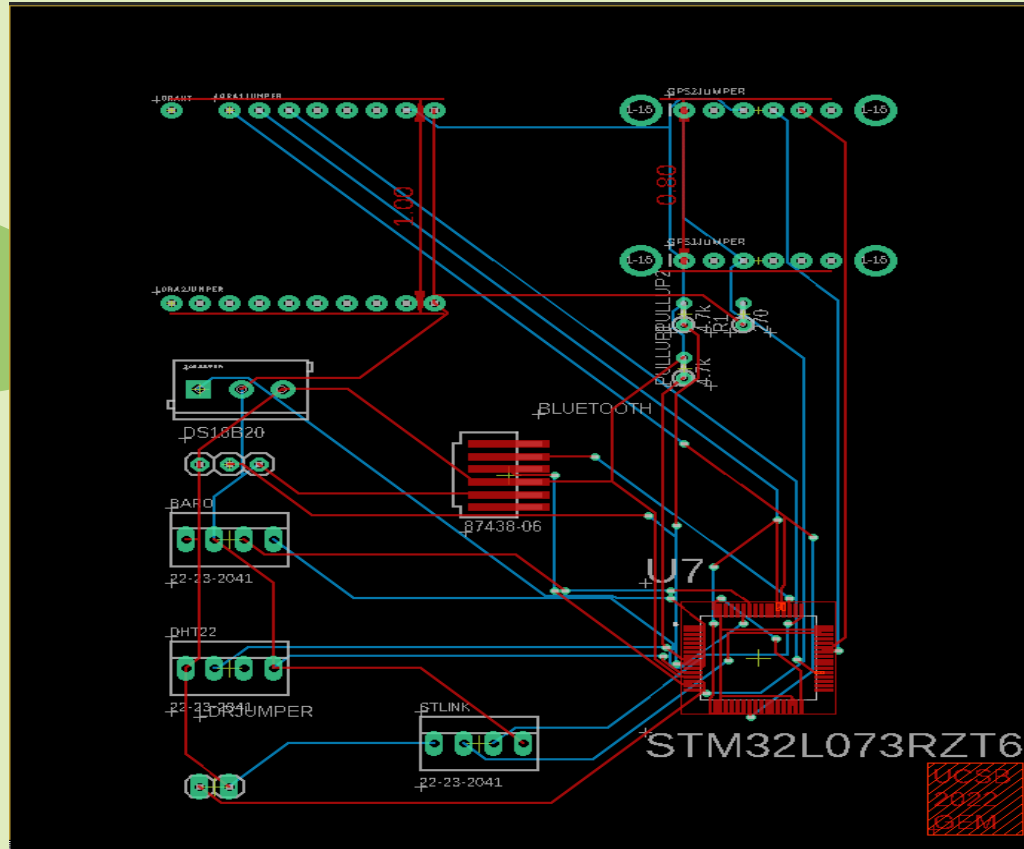
- ESP32-WROOM-32E
  - ESP32 is a multi-network devices that offers connectivity with UART, I2C, SPI, and WiFi
- RFM95W LoRa modem
  - handles 915 MHz spectrum for LoRa transmissions
- Together, it forms a low cost tool for monitoring up to a dozen LoRa devices.



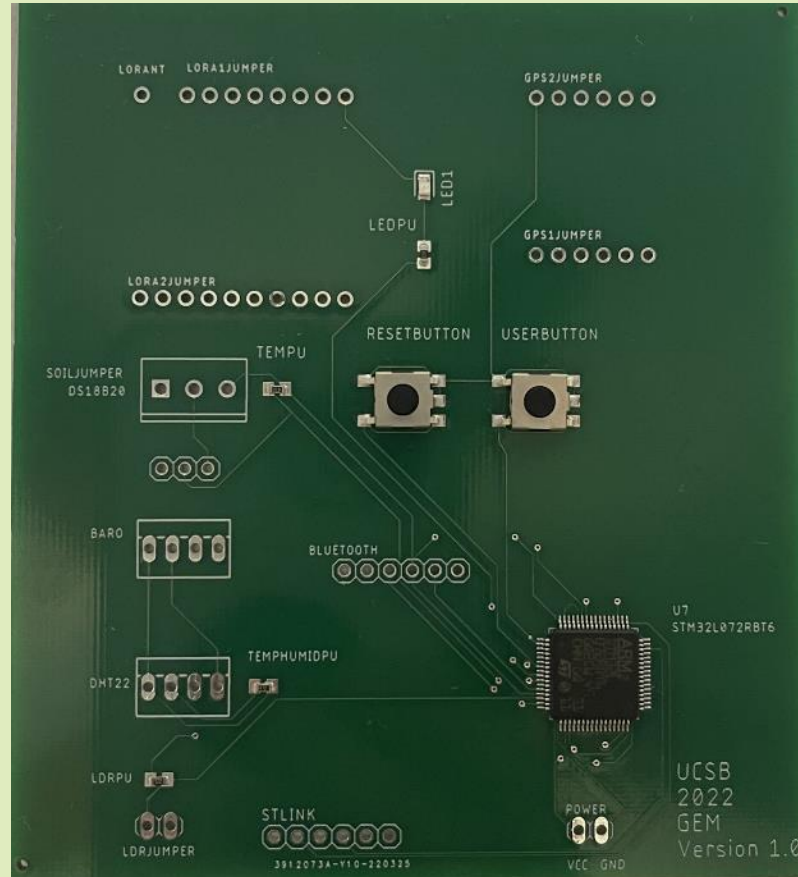
# Schematic



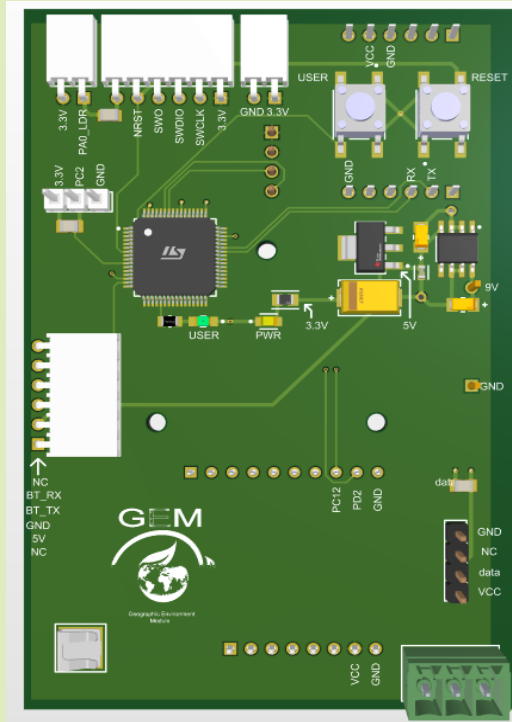
# PCB Layout



# Assembled PCB



# Second Design



**Integrated Power Supply**

**More compact**

**Restructured**



**Transmission**

# Long Range Wide Area Network

**Low Power**

**Long Range**

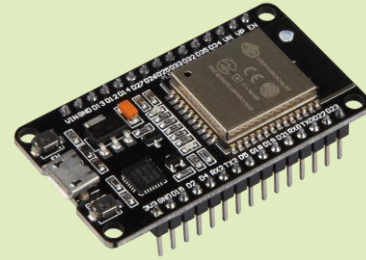


**Standardized**

**Low Cost**

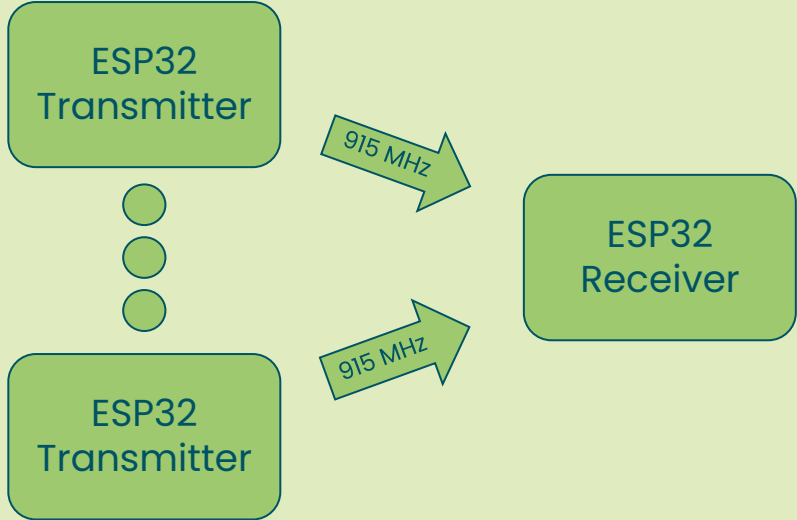


# LoRaWAN Infrastructure

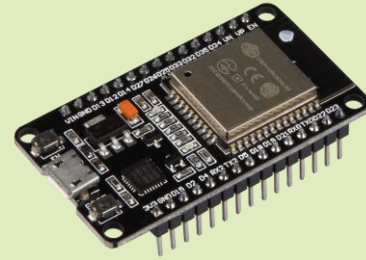


For the transmitter:

- 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

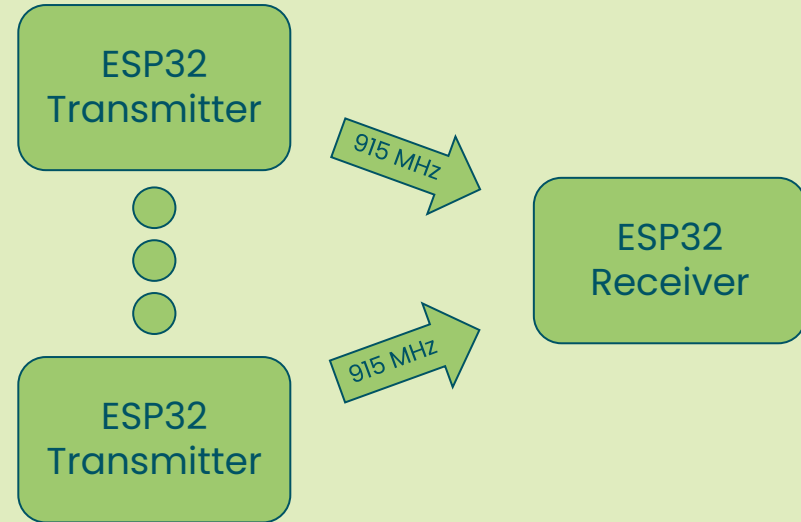


# LoRaWAN Infrastructure



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



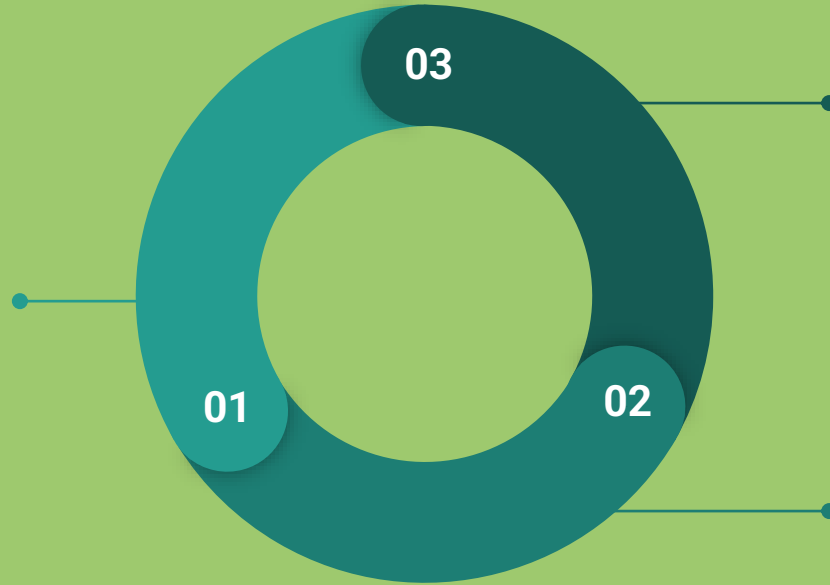


**Processing**

# Data Analysis

## Read COM Port

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



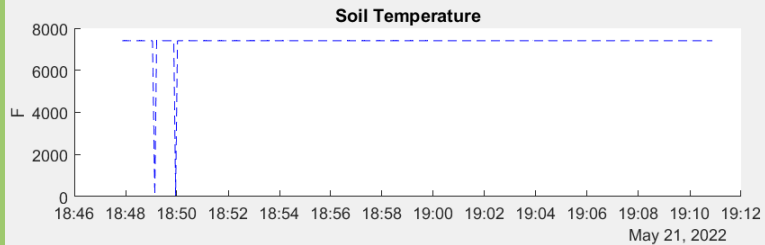
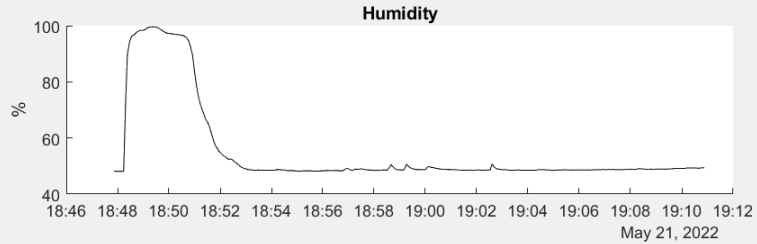
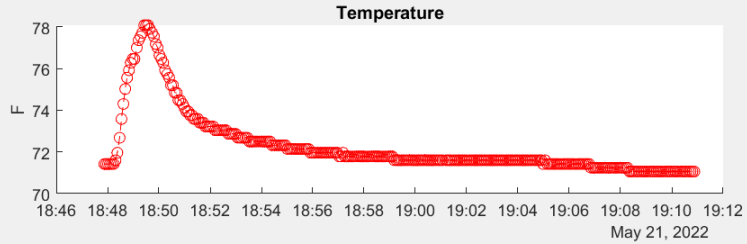
## Plot

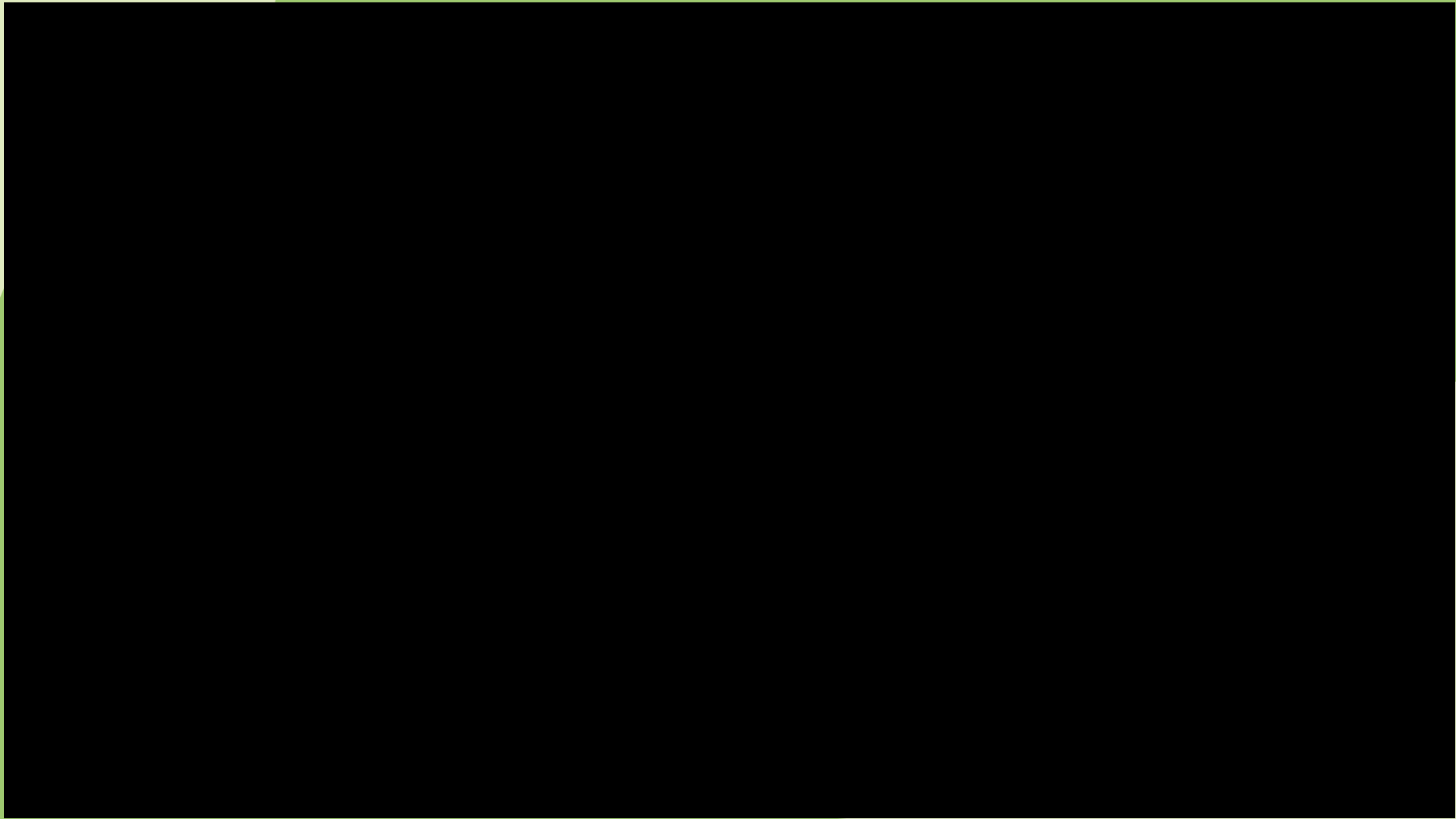
The data is plotted and displayed to the user

## 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



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