Agriculture IoT

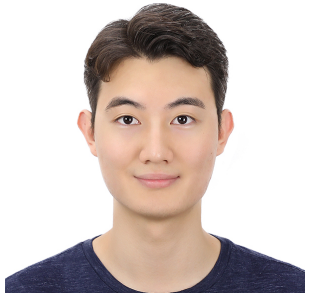
Team 8corn

PURDUE UNIVERSITY | IITP

CONTENTS

- Team AgIoT
- Introduction
- Feasibility of LoRa versus APRS in AgIoT
- Smart Farm using LoRa/APRS & MQTT
- QnA

1 Team 8Corn



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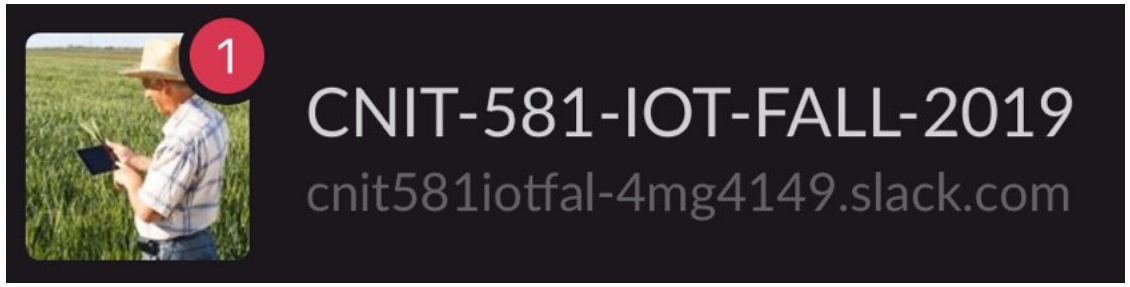
2 Introduction

Project Background



Feasibility of LoRa versus APRS in AgIoT

CONTENTS

Feasibility
of LoRa versus APRS
in AgIoT

- Introduction
- Design
- Result
- Conclusion
- Future Works

1 Introduction

LoRa and APRS

Long Range

915 MHz

Low Power Wide Area Network (LPWAN)

Long-range transmissions with low power consumption
(more than 10km in open area)

1 Introduction

LoRa and APRS

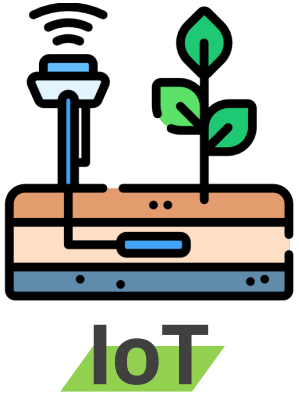
Automatic **P**acket **R**eporting **S**ystem

144.39 MHz

Amateur radio based system for real time digital communications of immediate value in the local area

1 Introduction

LoRa and APRS



LoRa

APRS

2 DESIGN

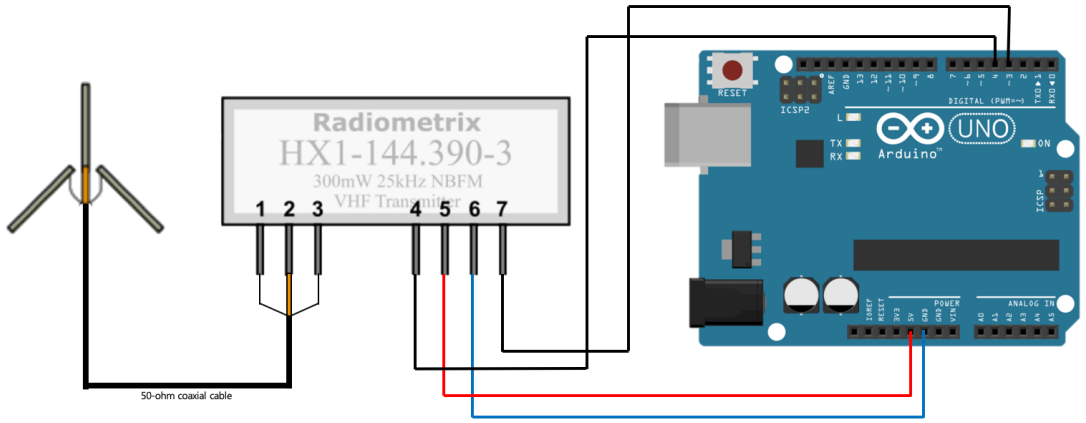
LoRa Circuit

Transmitter

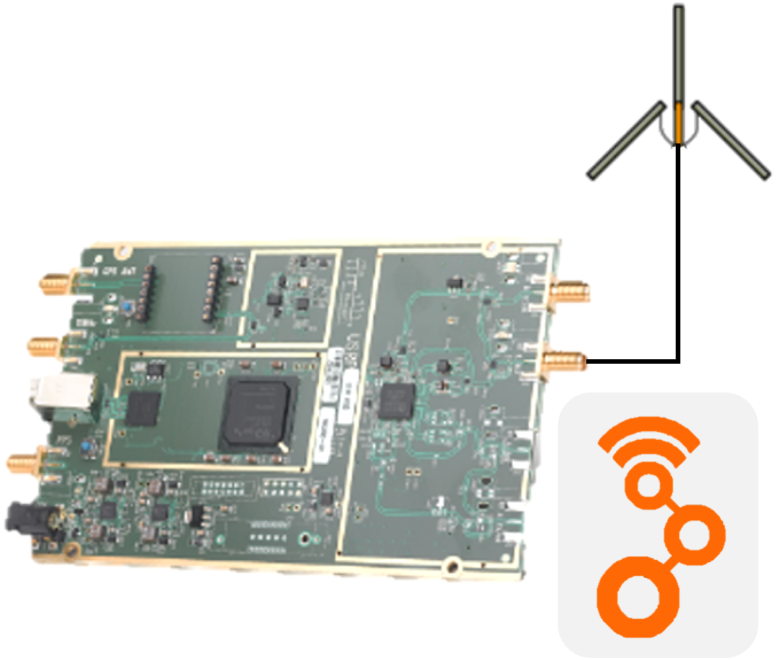
Receiver

2 DESIGN

APRS



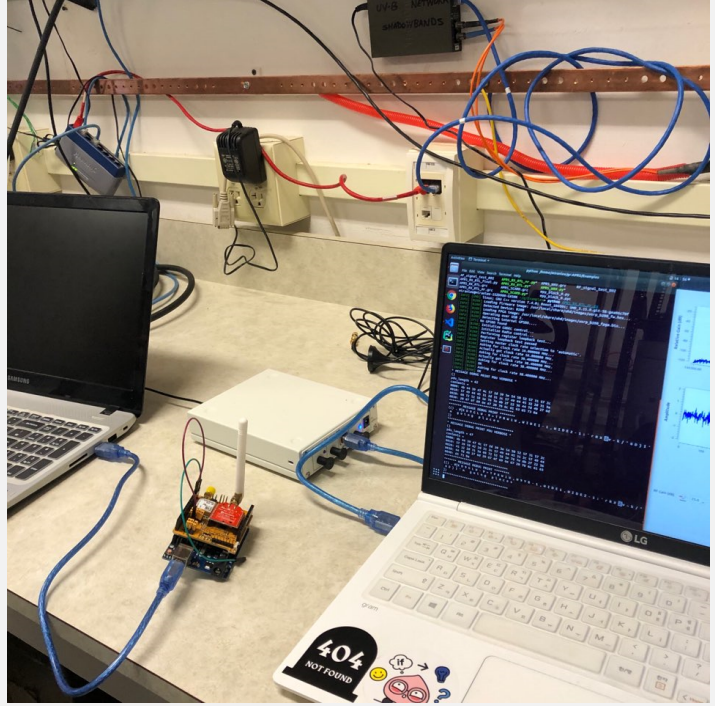
Transmitter

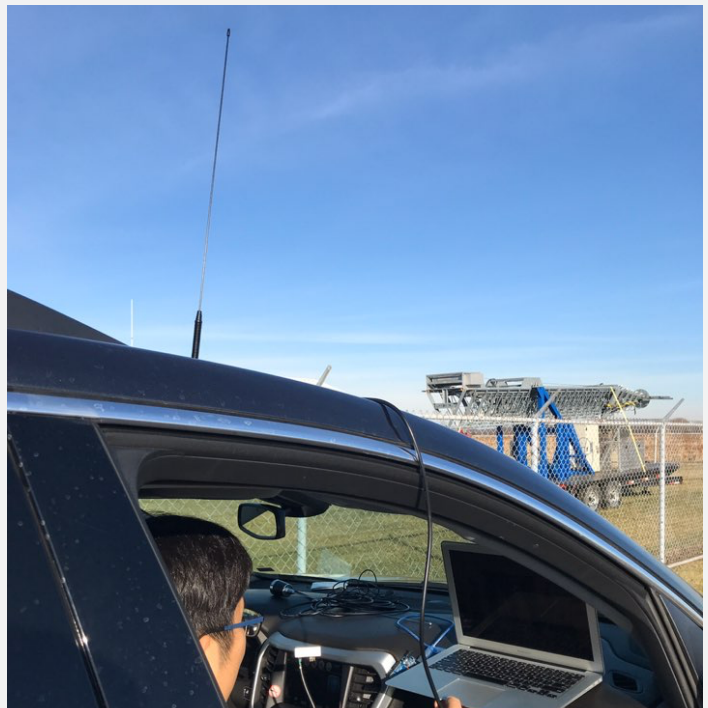


Receiver

3 Result

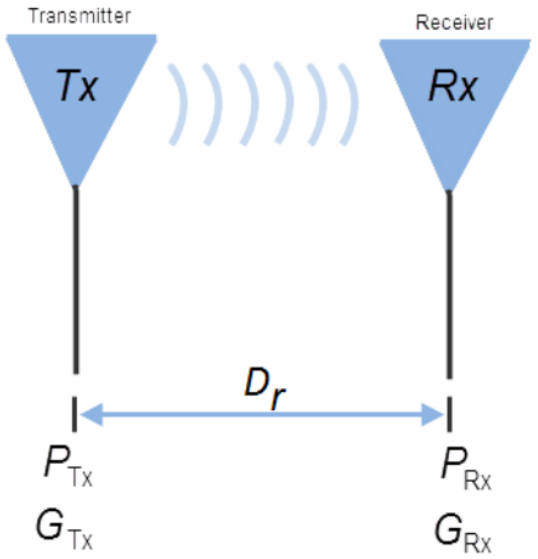
Test





3 Result

Friis transmission equation



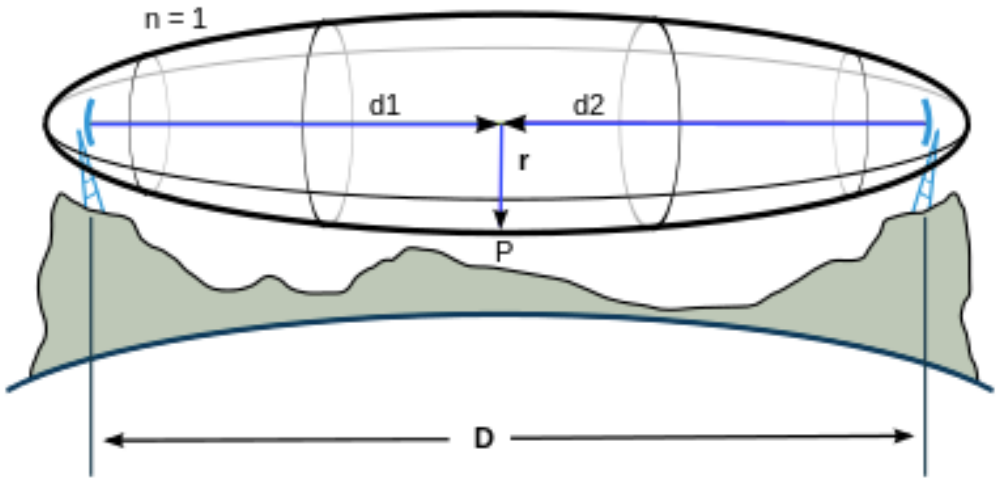
$$P_{rx} = P_{tx} G_{tx} G_{rx} \left(\frac{c}{4\pi D_r f_0}\right)^2$$

$$D_r = \frac{c\sqrt{P_{tx} G_{tx} G_{rx}}}{4\pi f_0 \sqrt{P_{rx}}}$$

Friis transmission equation

3 Result

Fresnel Zone



Fresnel Zone

$$r_n = \sqrt{n \frac{d_1 d_2}{d_1 + d_2} \lambda}$$

$(d_1, d_2 \gg n\lambda)$

3 Result

Test Result

LoRa

Transmitter Power	16 dBm
Transmitter Gain	9 dBi
Receiver Gain	6 dBi
Theoretical Distance	9.3 km (5.78 mile)
Height Needed	27.79m (91.17 ft)

Transmitter Antenna Height	2.1 m (6.89 ft)
Receiver Antenna Height	2.7 m (8.86 ft)
Tested Distance	4.2 km (2.6 mile)
Efficiency Constrained by Height	45.16%

“

for distance 4.2 km
antenna height should be 18.67m

”

APRS

Transmitter Power	24 dBm
Transmitter Gain	1.17 dBi
Receiver Gain	7 dBi
Theoretical Distance	67.1 km (41.70 mile)
Height Needed	186.58m (612.14 ft)

Transmitter Antenna Height	2.1 m (6.89 ft)
Receiver Antenna Height	3.2 m (10.50 ft)
Tested Distance	0.84 km (0.52 mile)
Efficiency Constrained by Height	1.25%

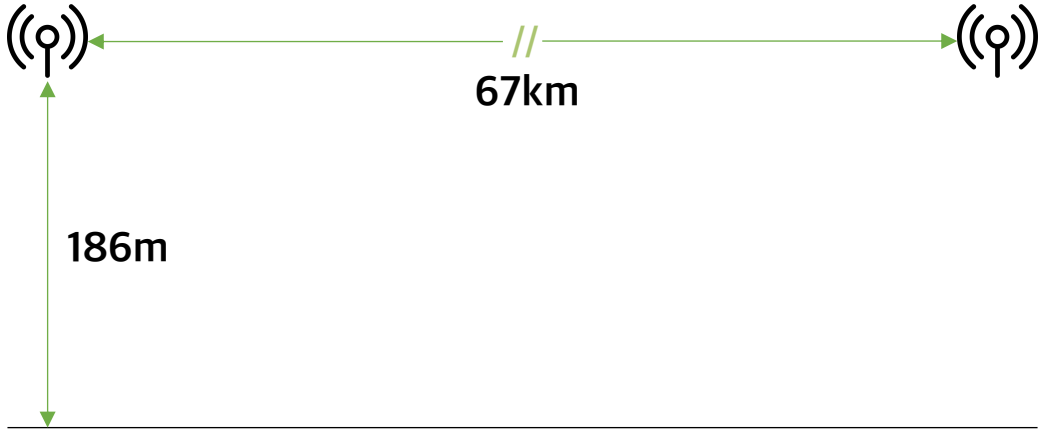
“

for distance 0.84 km
antenna height should be 20.88m

”

4 Conclusion

Limitation and Conclusion



Transmitter and Receiver place 186m height for 67km coverage distance by Fresnel Zone

LoRa

★ ★ ★ ★ ★

5 Future Works

APRS and LoRa

- Test LoRa and APRS distance coverage with same gain antennas
- Install antennas on taller structure and test

Smart Farm using LoRa/APRS & MQTT

CONTENTS

Smart Farm using
LoRa/APRS & MQTT

- Introduction
- Design
- Data & Algorithm
- Result
- Future Works

Key Factors of Smart Farm:

1. Low-cost
2. Low power consumption
3. High convenience for management
4. Lightweight messaging protocol
5. High reliability

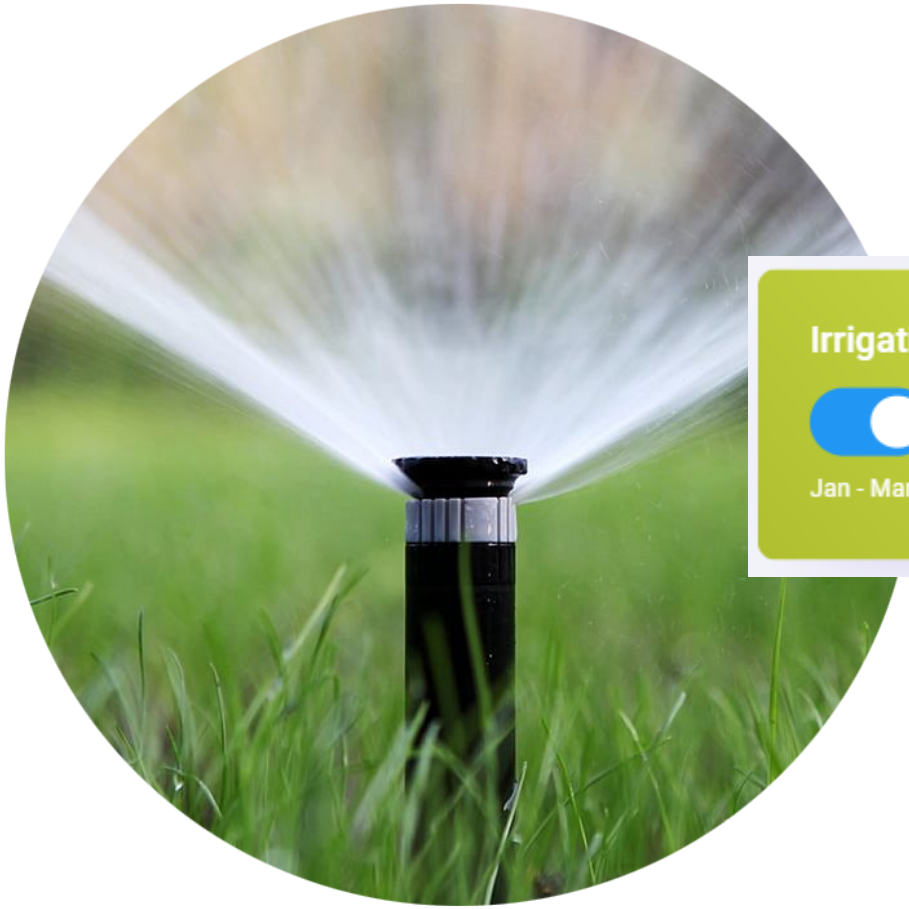
1 Introduction

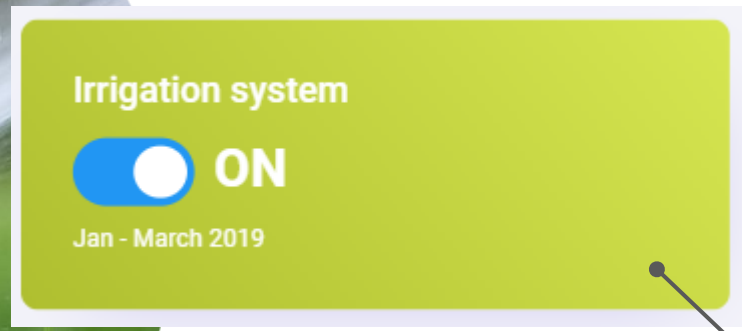
MQTT

MQTT is a machine-to-machine (M2M)/"Internet of Things" connectivity protocol.
It was designed as an extremely lightweight publish/subscribe messaging transport.
It is useful for connections with remote locations where a small code footprint is required and/or network bandwidth is at a premium.

Irrigation System

: Use wireless to control the sprinklers



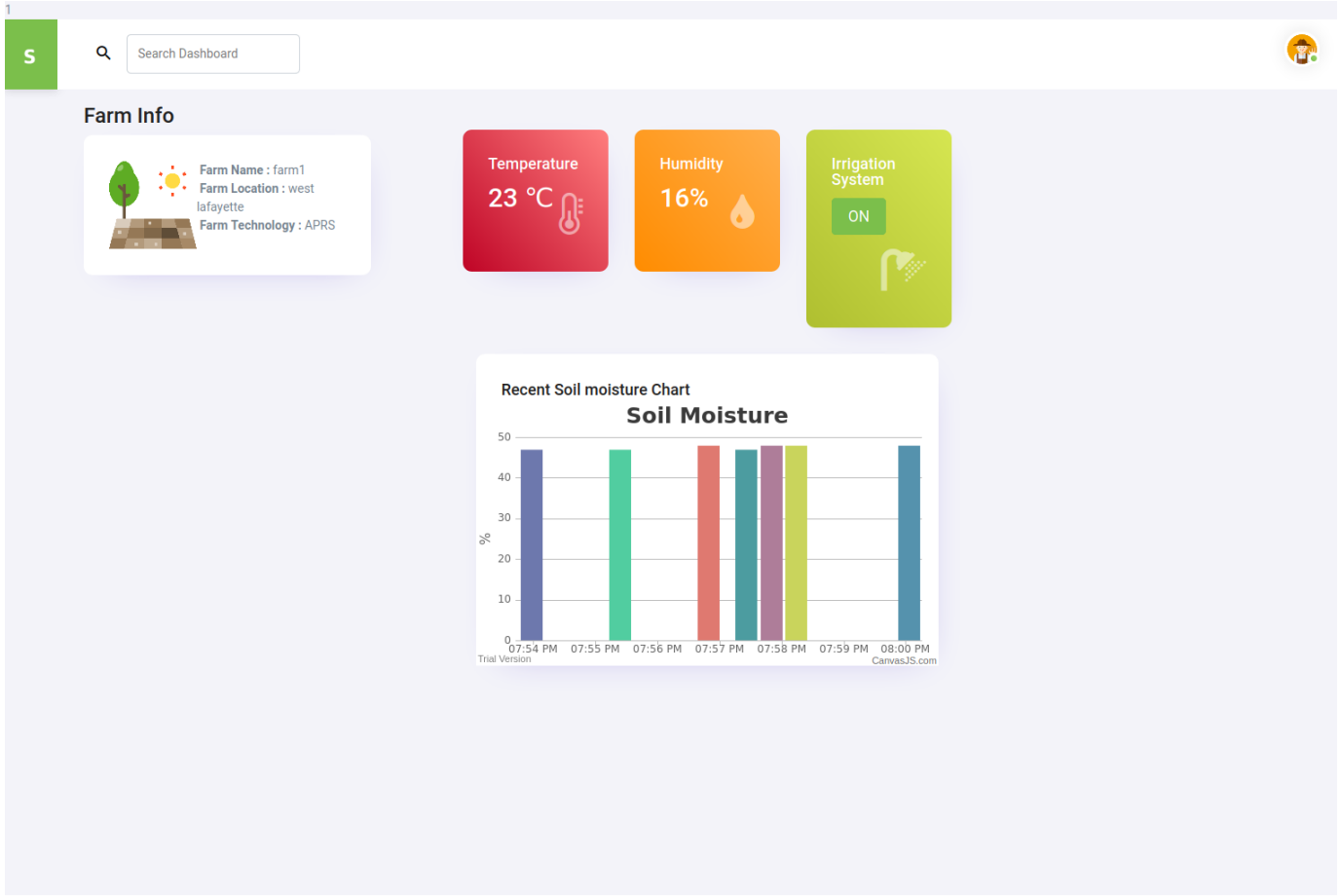


1 Introduction

Our Part

Smart Farm Web Interface

: Checking the status of the farm



~~Use only edge computing without using cloud~~

~~Use MQTT sn over LoRa communication~~

Send packets by using UDP to TTN(Cloud) & use edge computing

Use LoRa and MQTT separately

~~Build APRS Transmitter with Raspberry Pi and HX1~~

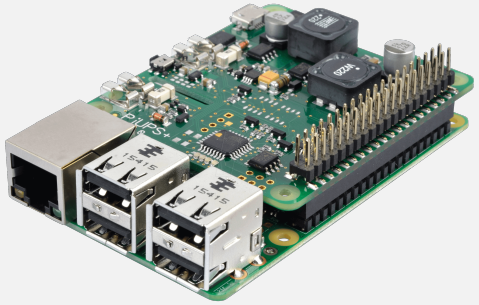
~~Use MQTT on APRS network~~

Connect APRS Transmitter using Arduino and HX1 to Raspberry Pi

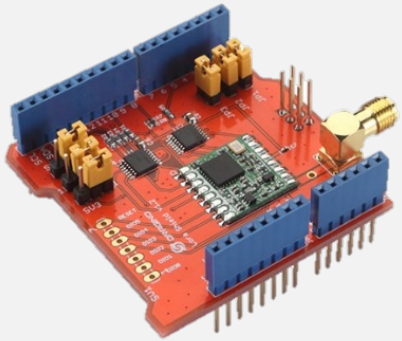
Use APRS and MQTT separately

2 DESIGN

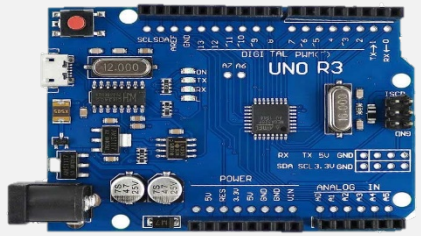
LoRa Hardware



Raspberry pi

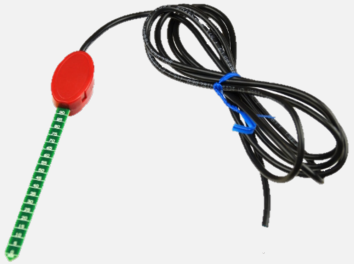


LoRa Shield



Arduino Uno

Temp & Humidity Sensor



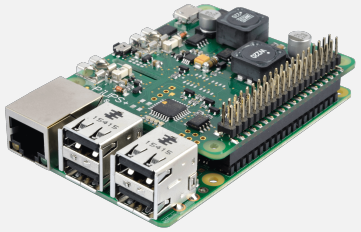
Soil Humidity Sensor

Solenoid valve

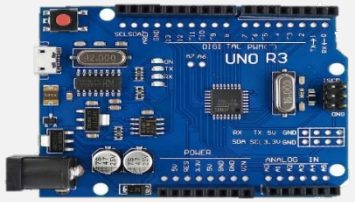
High level trigger

2 DESIGN

APRS Hardware



Raspberry pi

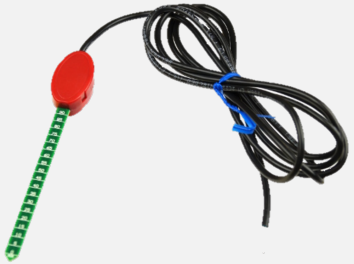


Arduino Uno

HX1 transmitter

RTL SDR dongle

Temp & Humidity Sensor



Soil Humidity Sensor

Solenoid valve

High level trigger


THE THINGS
NETWORK


mosquitto


Open
Weather
Map

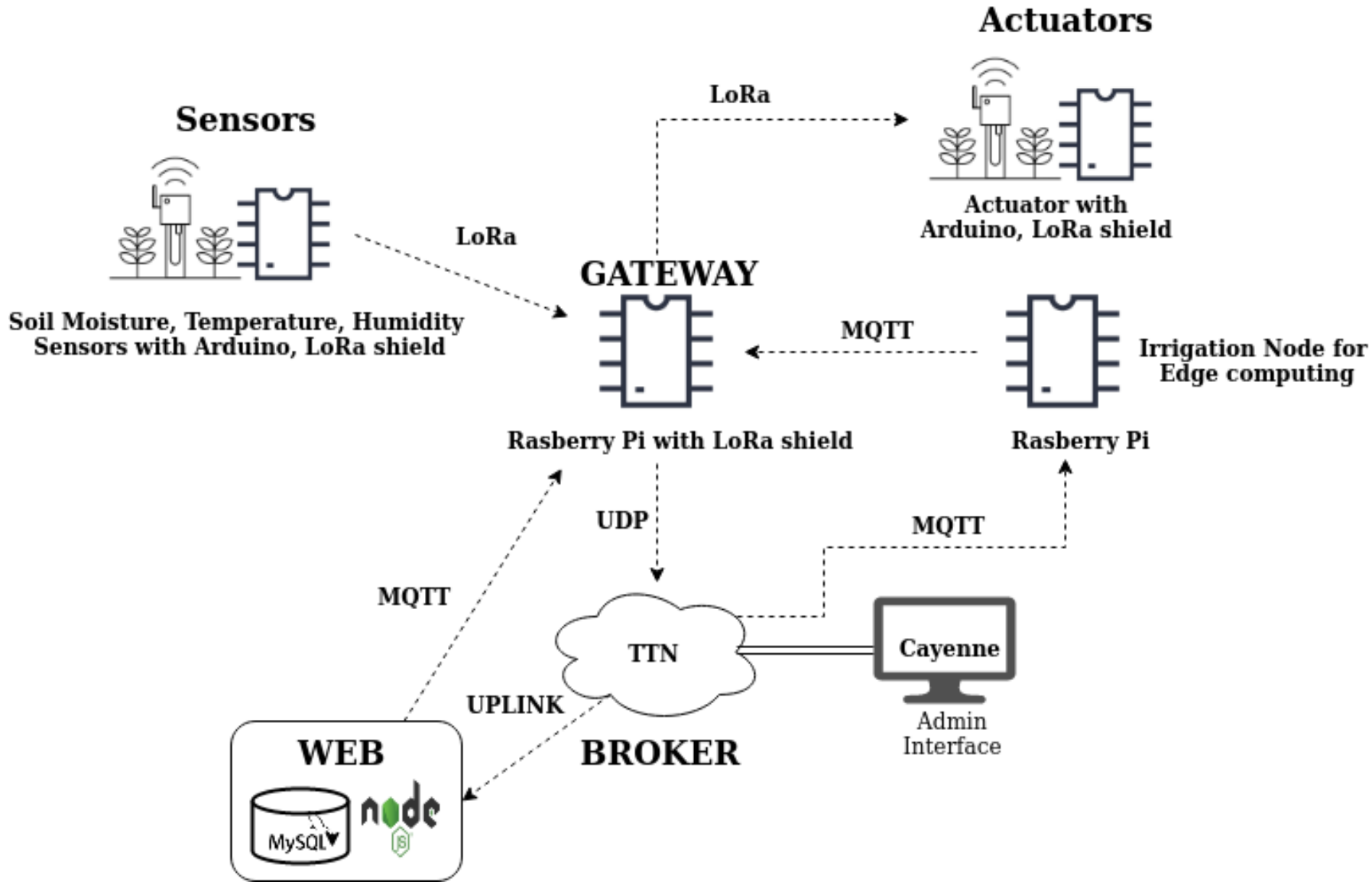

Cayenne

2 DESIGN

APRS Software

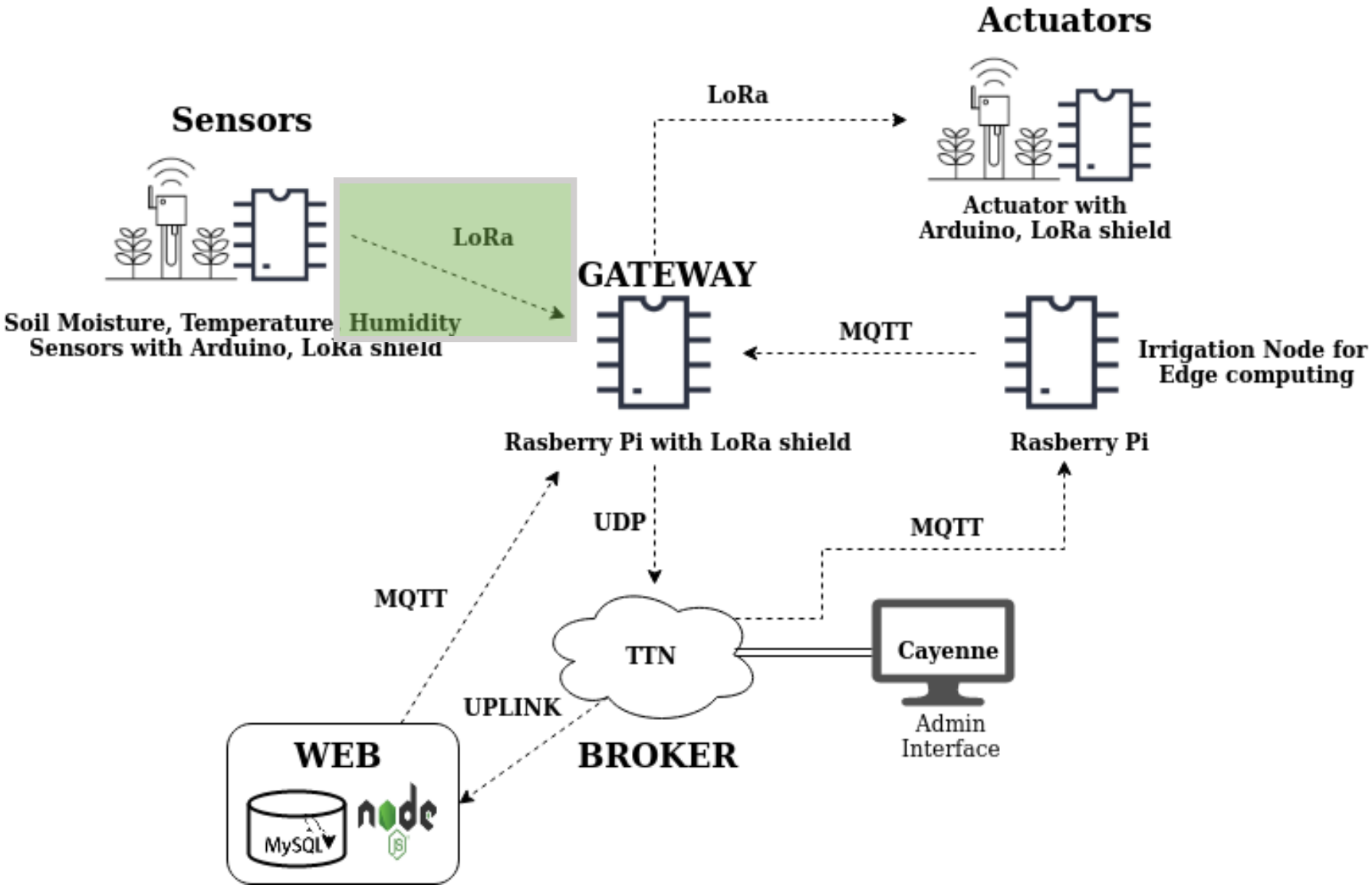
2 DESIGN

LoRa Diagram



2 DESIGN

LoRa Diagram



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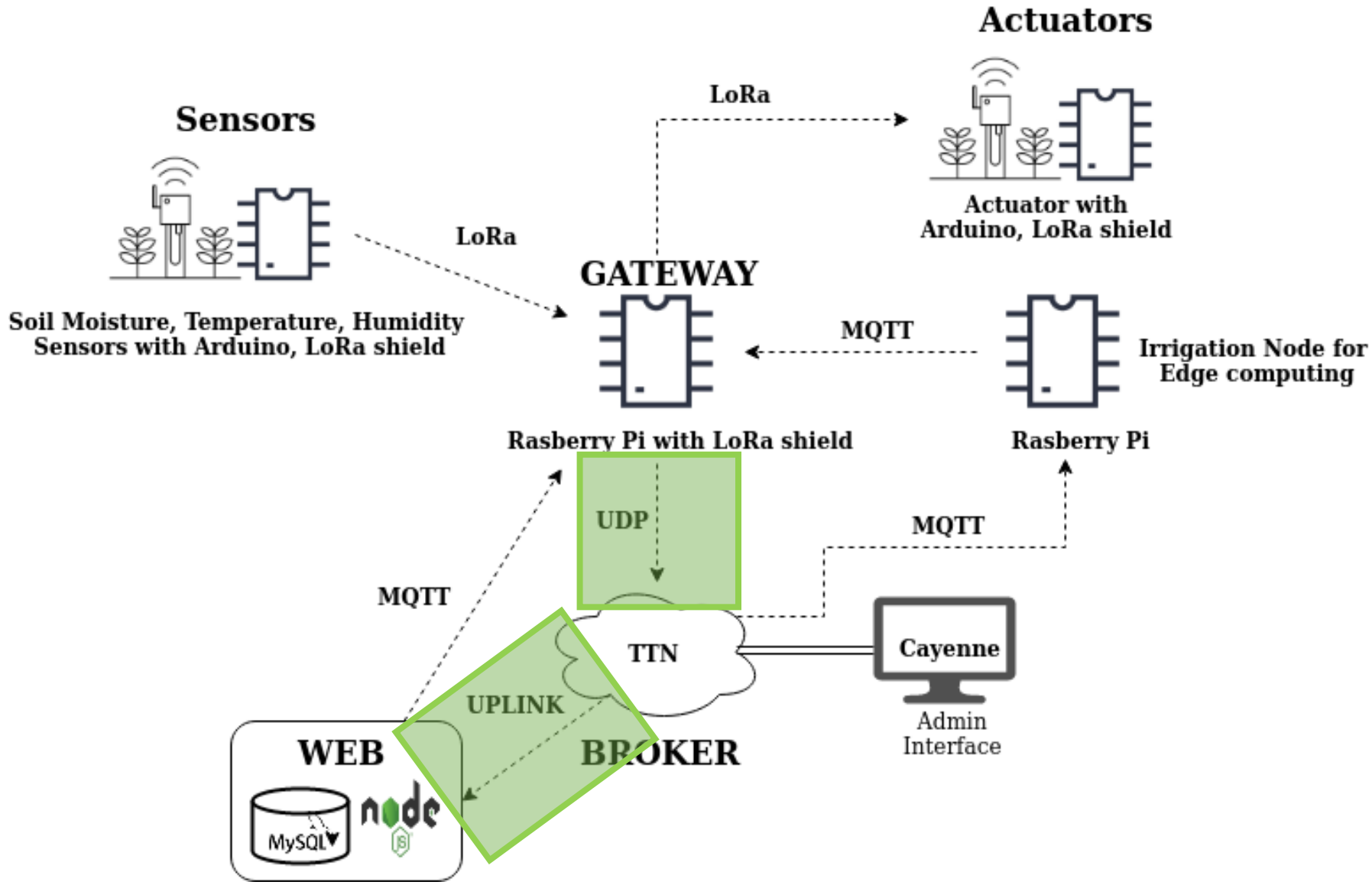
LoRa Diagram



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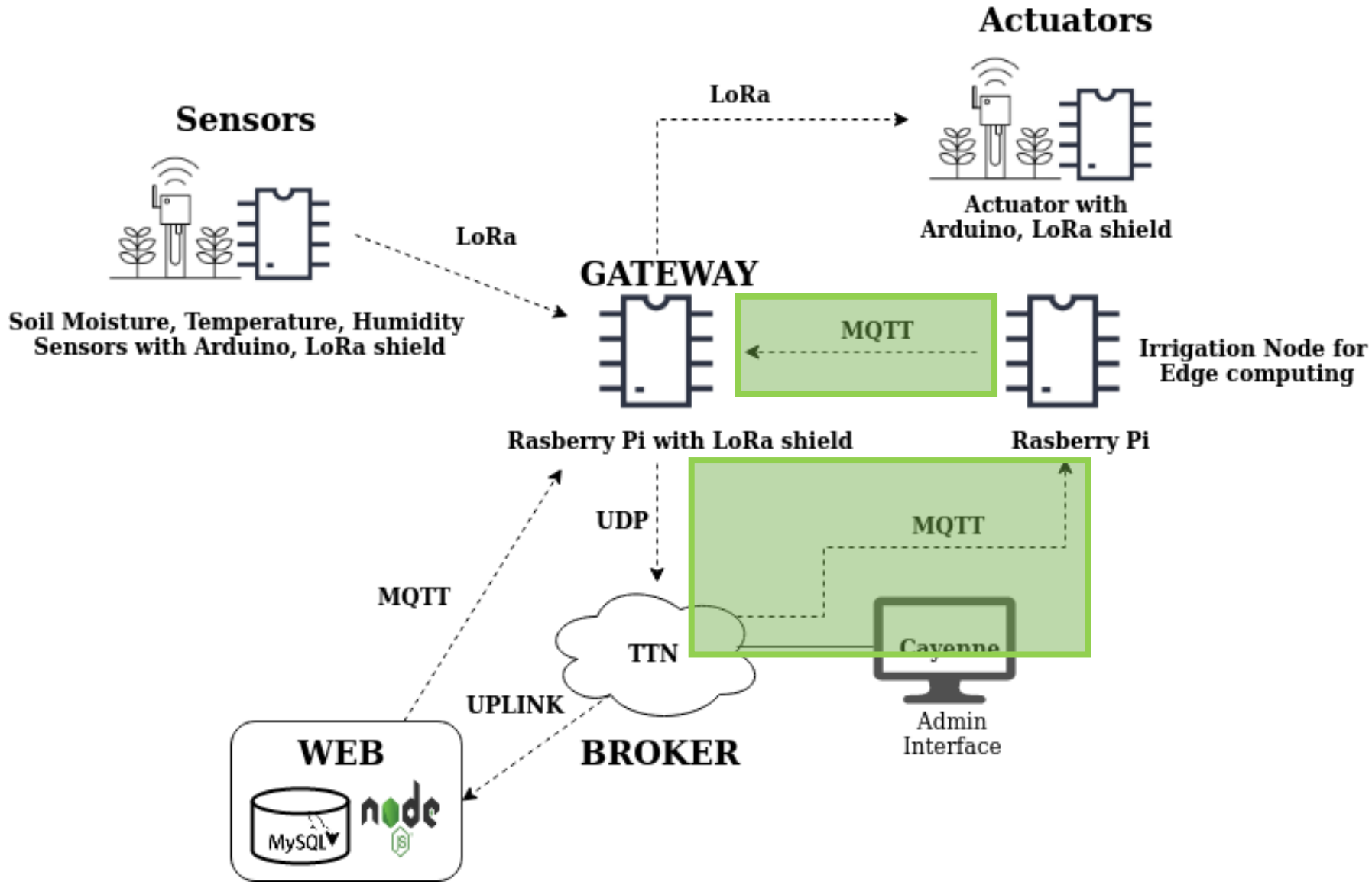
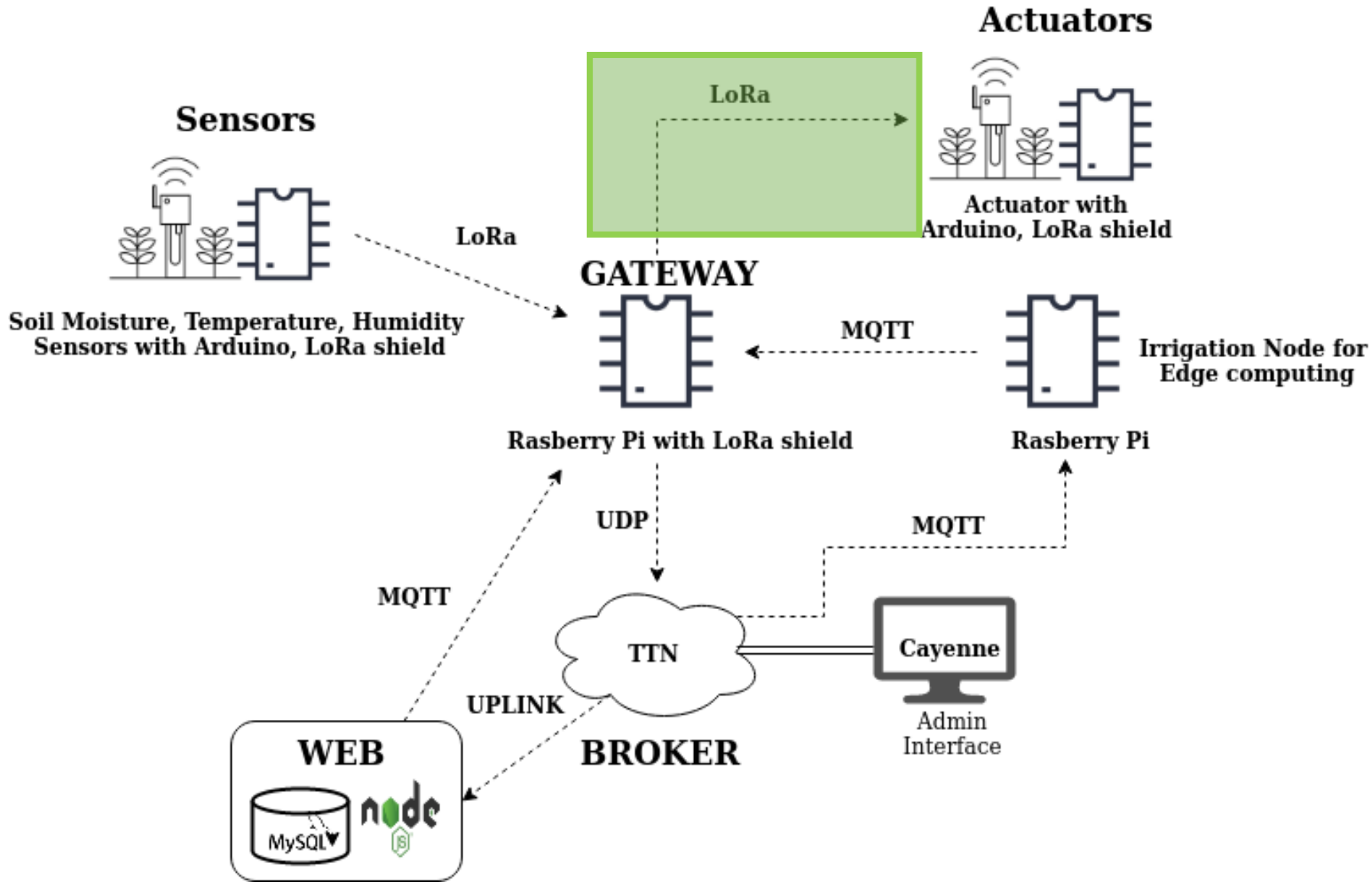
LoRa Diagram



2 DESIGN

LoRa Diagram



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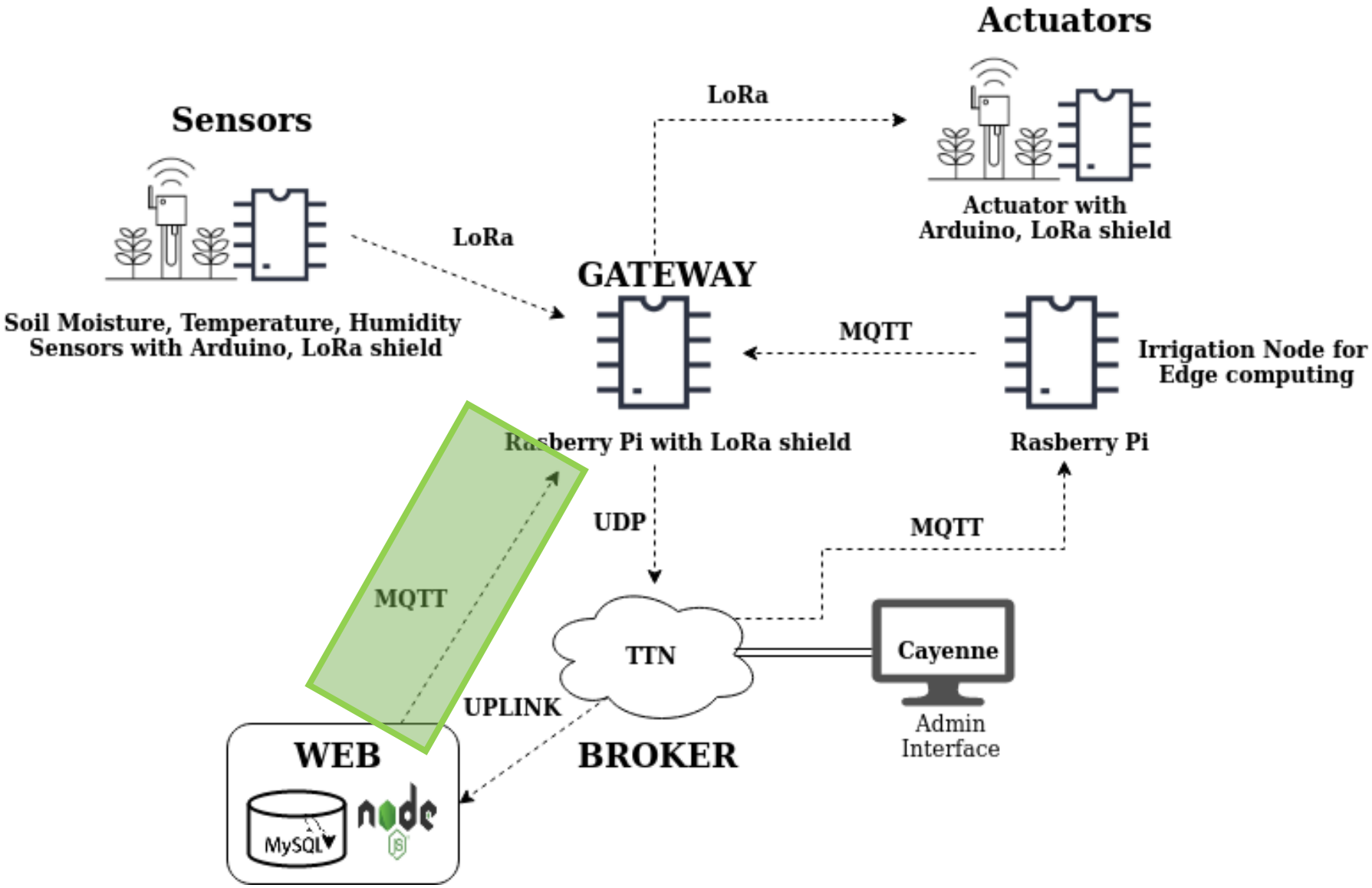
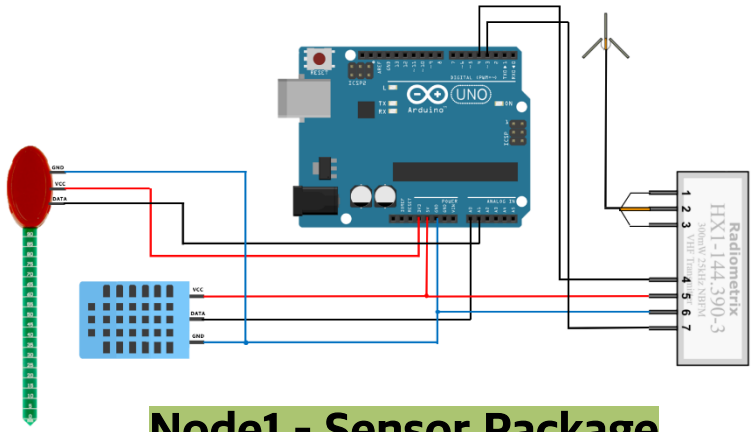
LoRa Diagram



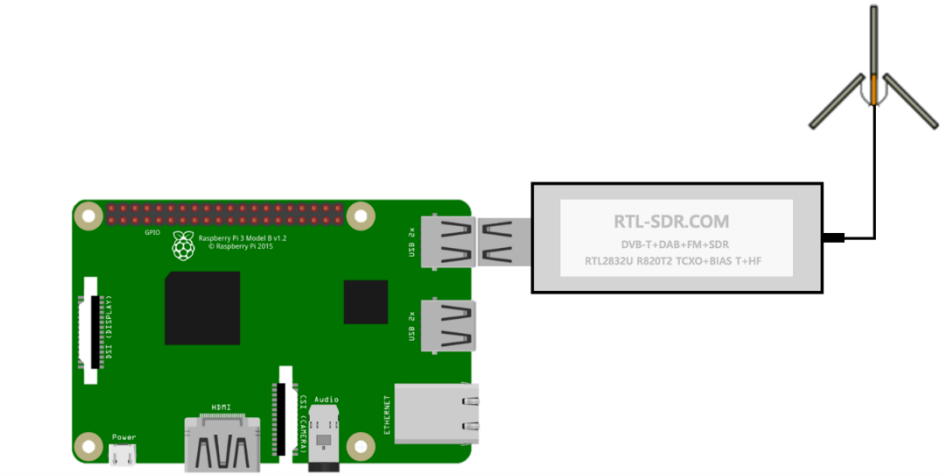
2 DESIGN

APRS Node Circuit



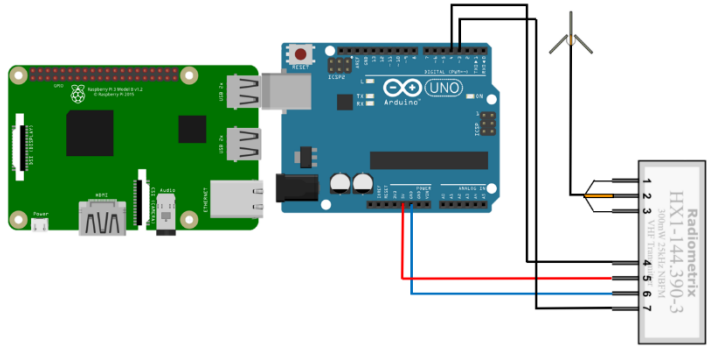
Node1 - Sensor Package

APRS Transmitter



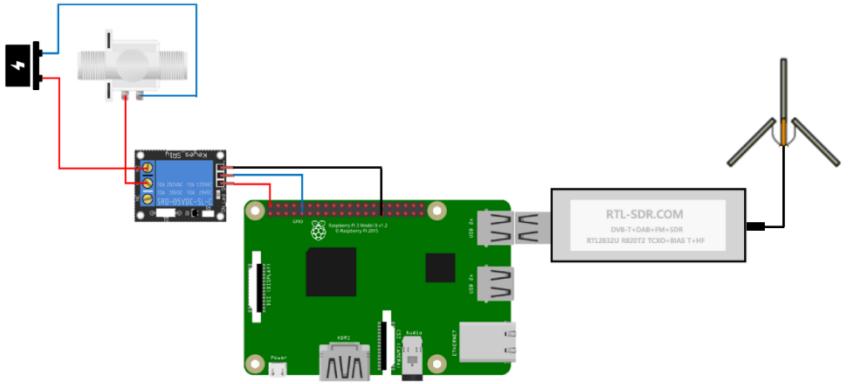
Node2 - GATEWAY

APRS Receiver & MQTT Publisher



Node3 - BROKER

MQTT Broker & MQTT Subscriber & APRS Transmitter

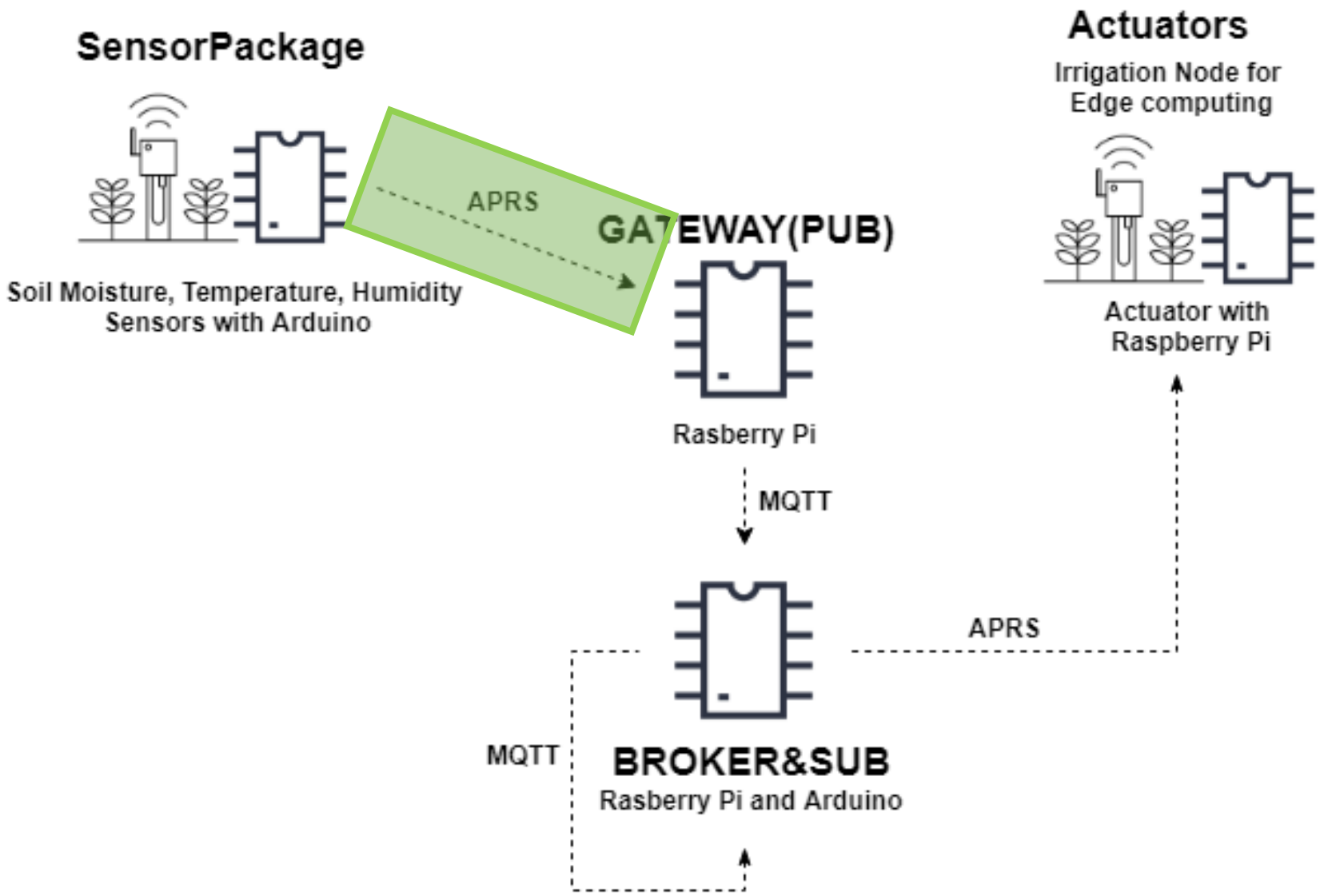


Node4 - Actuator

APRS Receiver

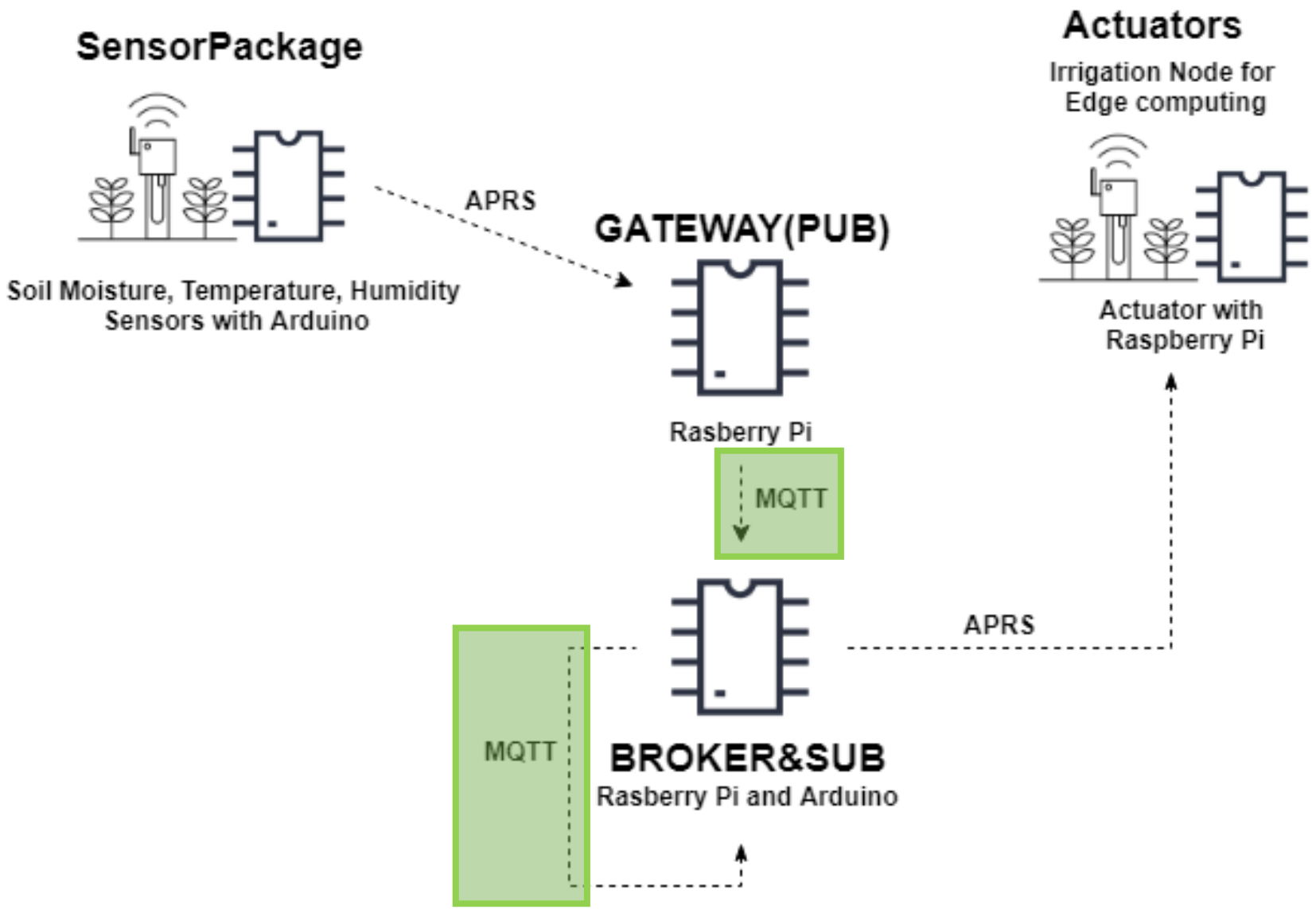
2 DESIGN

APRS Diagram



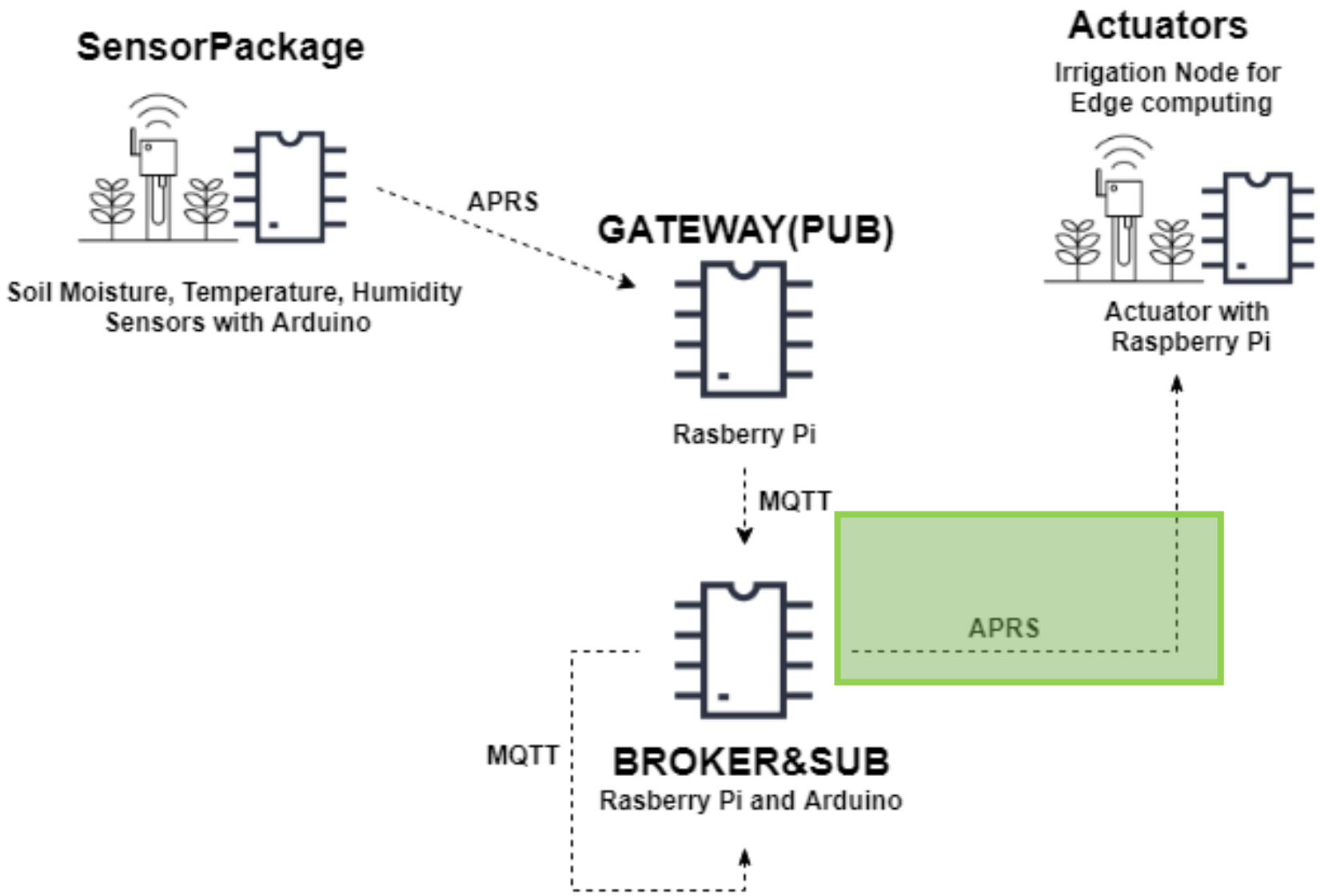
2 DESIGN

APRS Diagram



2 DESIGN

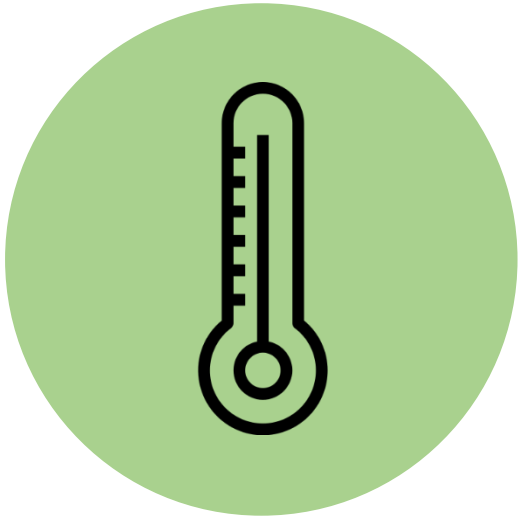
APRS Diagram



3 Data & Algorithm

Collected Data

Humidity



Temperature

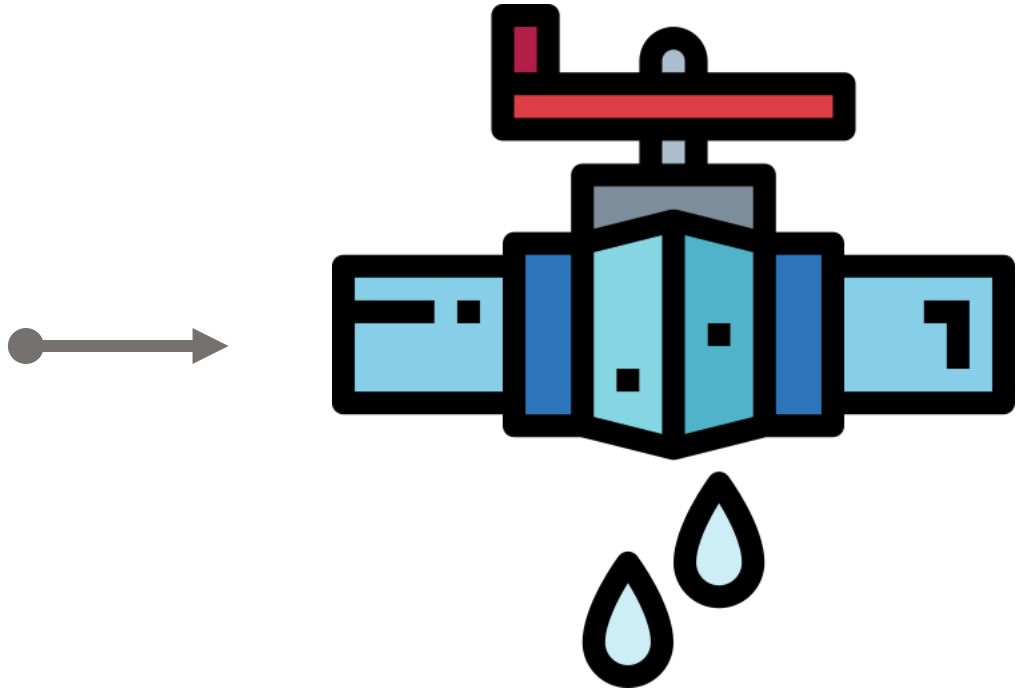
Weather

Soil moisture

Data & Algorithm

Algorithm

```
if int(datas) < 200:
    ser.write('1')
    print("1")
else:
    ser.write('0')
    print("0")
```



Soil Moisture Data
MIN: 0 MAX : 696

3 Result

LoRa Demo

3 Result

APRS Demo

5 Future Works

LoRa

Build without the Internet

Increase the accuracy of the weather prediction

Make sensor monitoring system

Ex) sensor malfunction, battery consumption …

5 Future Works

APRS

Build without the Internet

Build APRS transmitter with Raspberry Pi and HX1

Control multi node

> using GPS
> meaning of Broker

QnA

Thank You !