OFF-GRID EMERGENCY COMMUNICATION SYSTEM

INTRODUCTION

Goal: Robust communication solution using LoRa technology for remote areas or scenarios without reliable internet connectivity.

Our system enables multiple devices to communicate with each other using text messages.

By leveraging the RA-01S LoRa module and ESP8266, we have created a compact, all-in-one device.

What is LoRa?

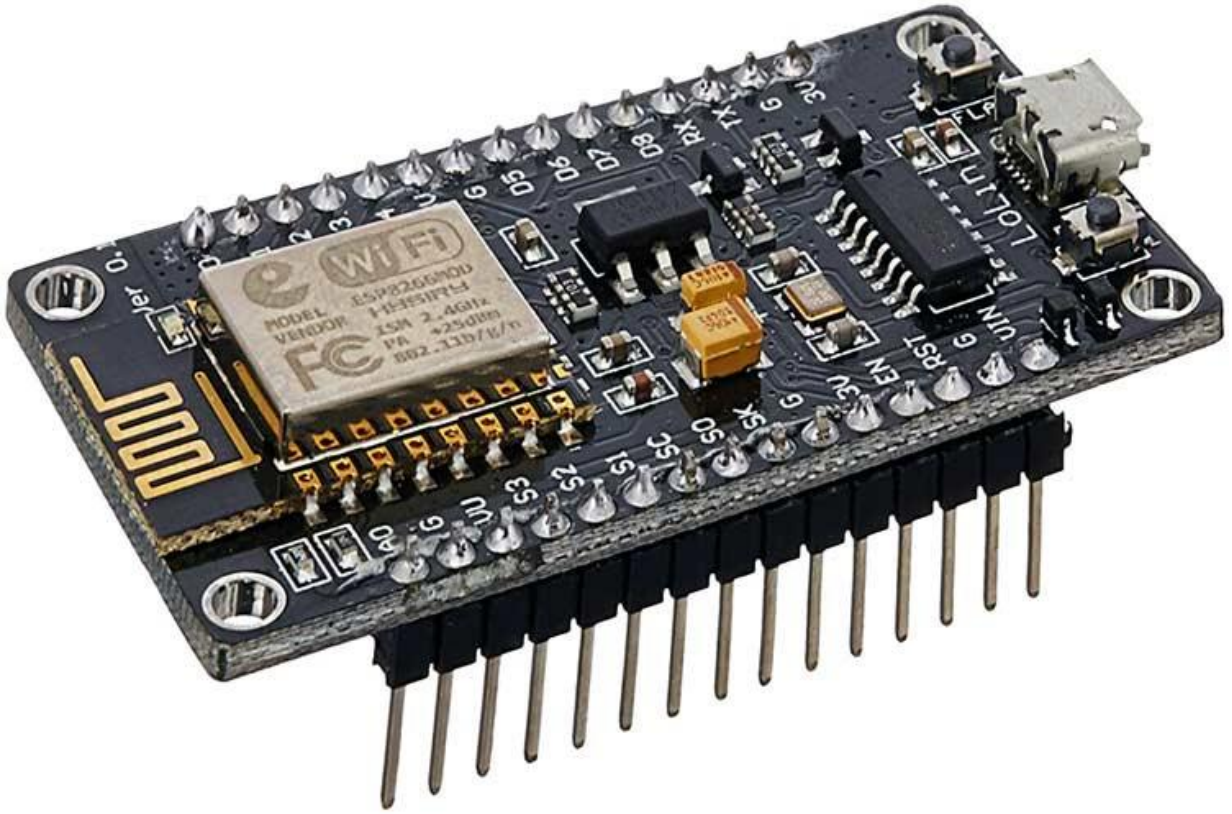
- LoRa stands for Long Range
- A low-power wide-area network (LPWAN) technology.
- It enables long-range communication between low-power devices, even in challenging environments.
- Operates in the unlicensed Industrial, Scientific, and Medical (ISM) bands.
- Supports direct communication between LoRa devices or through a LoRaWAN infrastructure.

LoRa Advantages

- long-range Internet of Things (IoT) applications.
- Low power consumption
- Scalable
- Operates on unlicensed ISM frequencies
- Cheap
- Widely used in smart cities, agriculture, asset tracking, environmental monitoring, industrial automation

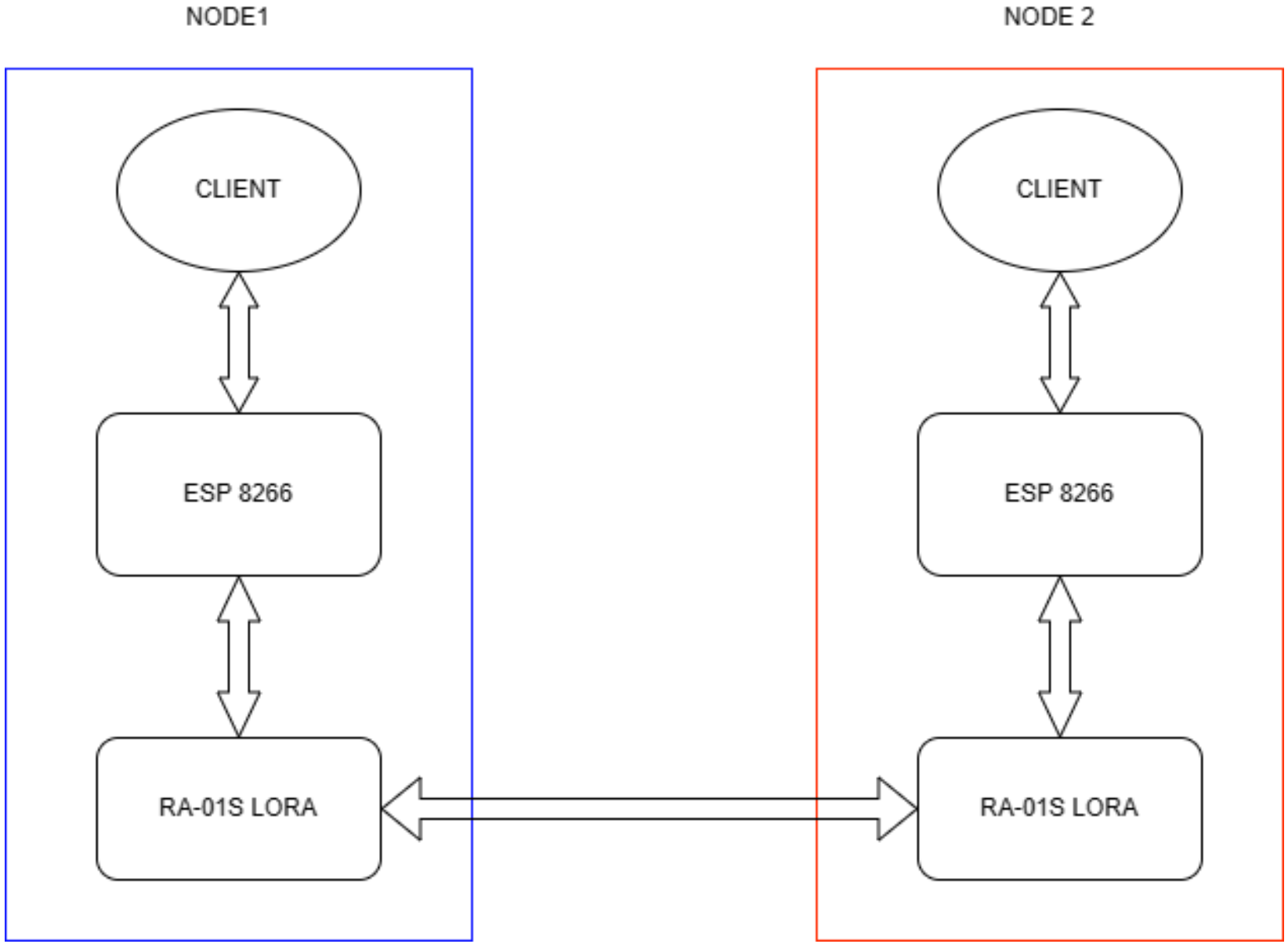
ESP8266

- Designed by Espressif Systems
- 32-bit RISC processor
- 17 GPIO pins
- Wifi



System Architecture

- The off-grid LoRa-based communication system consists of the following components:
  - ESP8266 microcontroller: Wi-Fi access point and UI.
  - RA-01S LoRa module: long-range wireless communication
  - Client Devices: Laptops, smartphones, or any device with Wi-Fi capability


NODE1
NODE 2
CLIENT
CLIENT
ESP 8266
ESP 8266
RA-01S LORA
RA-01S LORA

Applications of LoRa

Smart Cities: Smart metering, parking management, waste management, environmental monitoring, street lighting control.

Agriculture: Precision farming, soil monitoring, irrigation control, livestock tracking, environmental sensing.

Smart Buildings: Building automation, occupancy sensing, energy management, security systems.

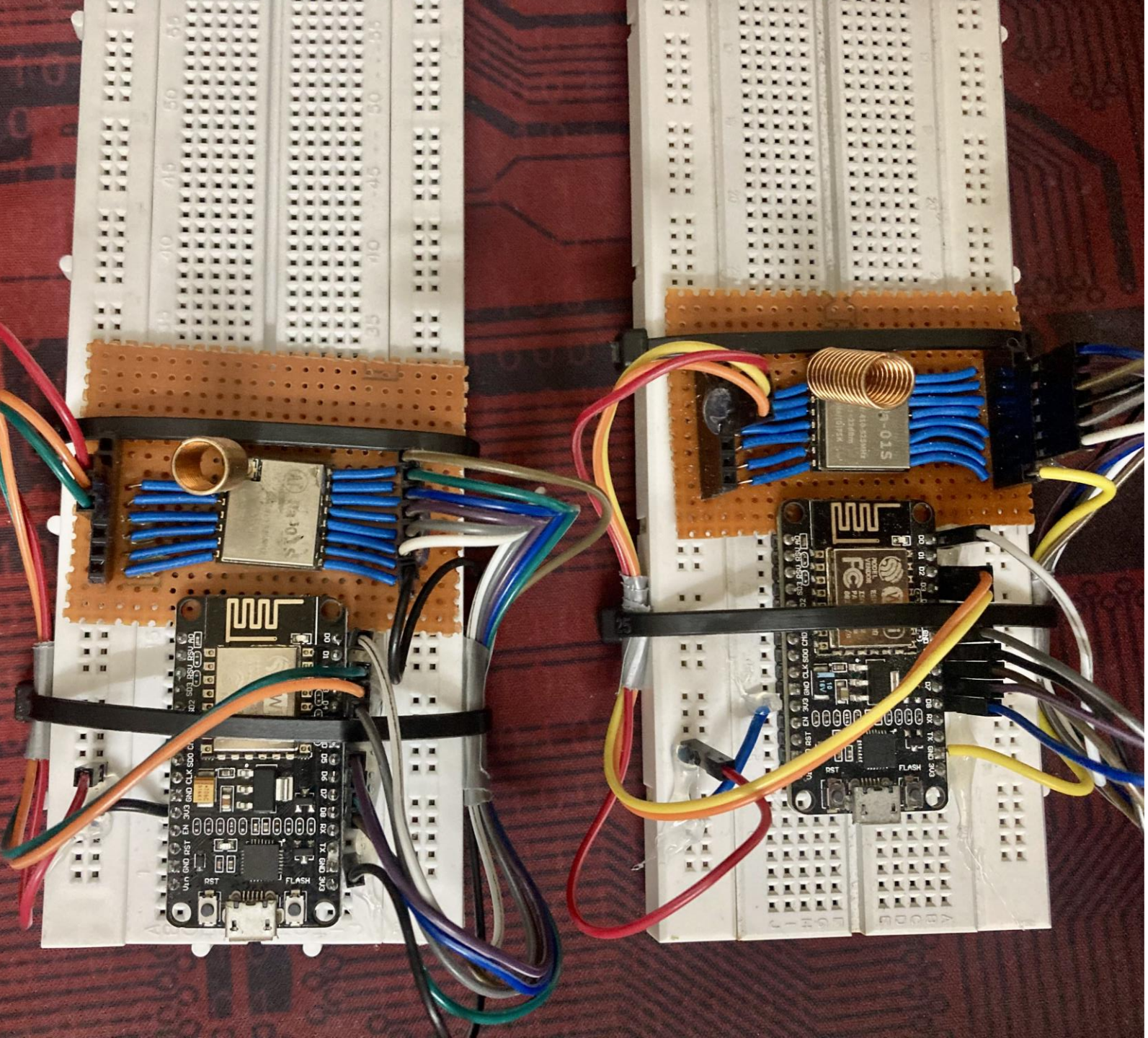
Asset Tracking: Tracking and monitoring assets in logistics, transportation, and supply chain management.

Environmental Monitoring: Real-time monitoring of air quality, water quality, pollution levels.

Healthcare: Remote patient monitoring, asset tracking in hospitals, medication management.

Utilities: Remote metering and monitoring of electricity, water, gas.

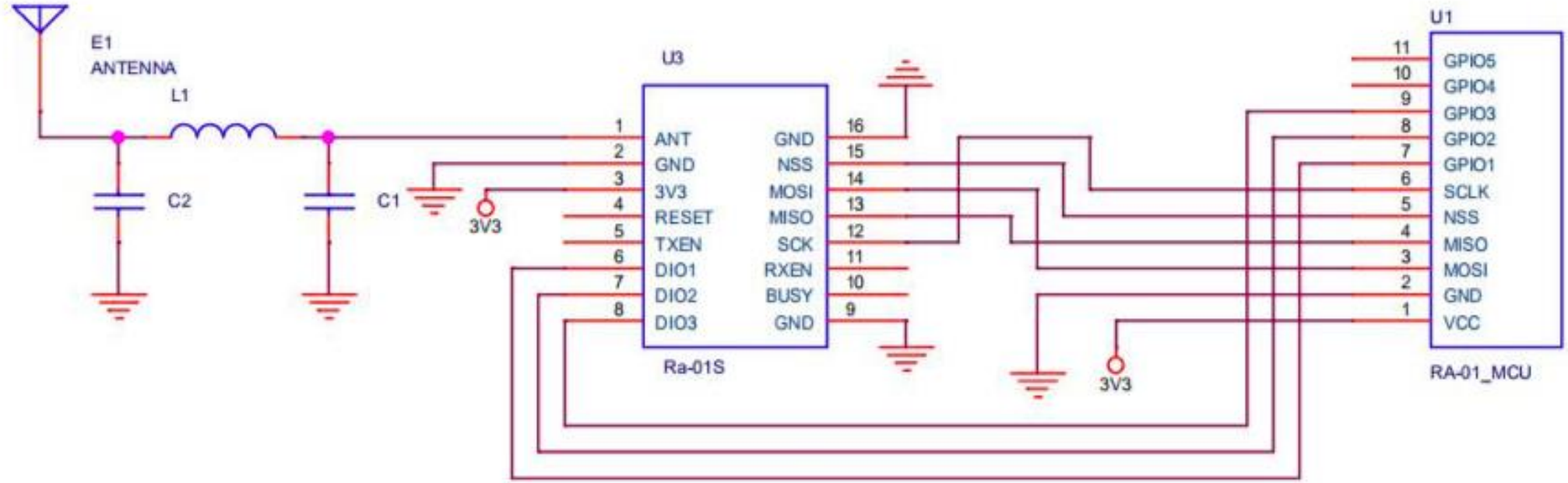
Wildlife Monitoring: Tracking wildlife movement, habitat monitoring, conservation efforts.



Hardware Implementation

- 2 devices
- ESP8266 paired with RA-01S
- Each device acts as a node

Application Circuit



Software Implementation

- Lora Initialization:

```
#include <Ra01S.h>
#define RF_FREQUENCY 433000000 // Hz frequency
#define TX_OUTPUT_POWER 2 // dBm tx output power (0-25)

#define LORA_BANDWIDTH 4 // bandwidth

#define LORA_SPREADING_FACTOR 7 // spreading factor [SF5..SF12]

#define LORA_CODINGRATE 1 // [1: 4/5,
#define LORA_PREAMBLE_LENGTH 8 // Same for Tx and Rx

#define LORA_PAYLOADLENGTH 0 // 0: Variable length packet (explicit header)


SX126x lora(15, 0, 16, 4, 2);
```

Sending

```
void txWrapper(String buff, uint8_t mode)
{
        int len = buff.length() + 1;
        buff.toCharArray(data, len);
        uint8_t *txData = (uint8_t *)data;

        if (lora.Send(txData, len, SX126x_TXMODE_SYNC))
        {
                Serial.println("Send success");
                updateDb(cid, text);
        }
        else
        {
                Serial.println("Send fail");
        }
}
```

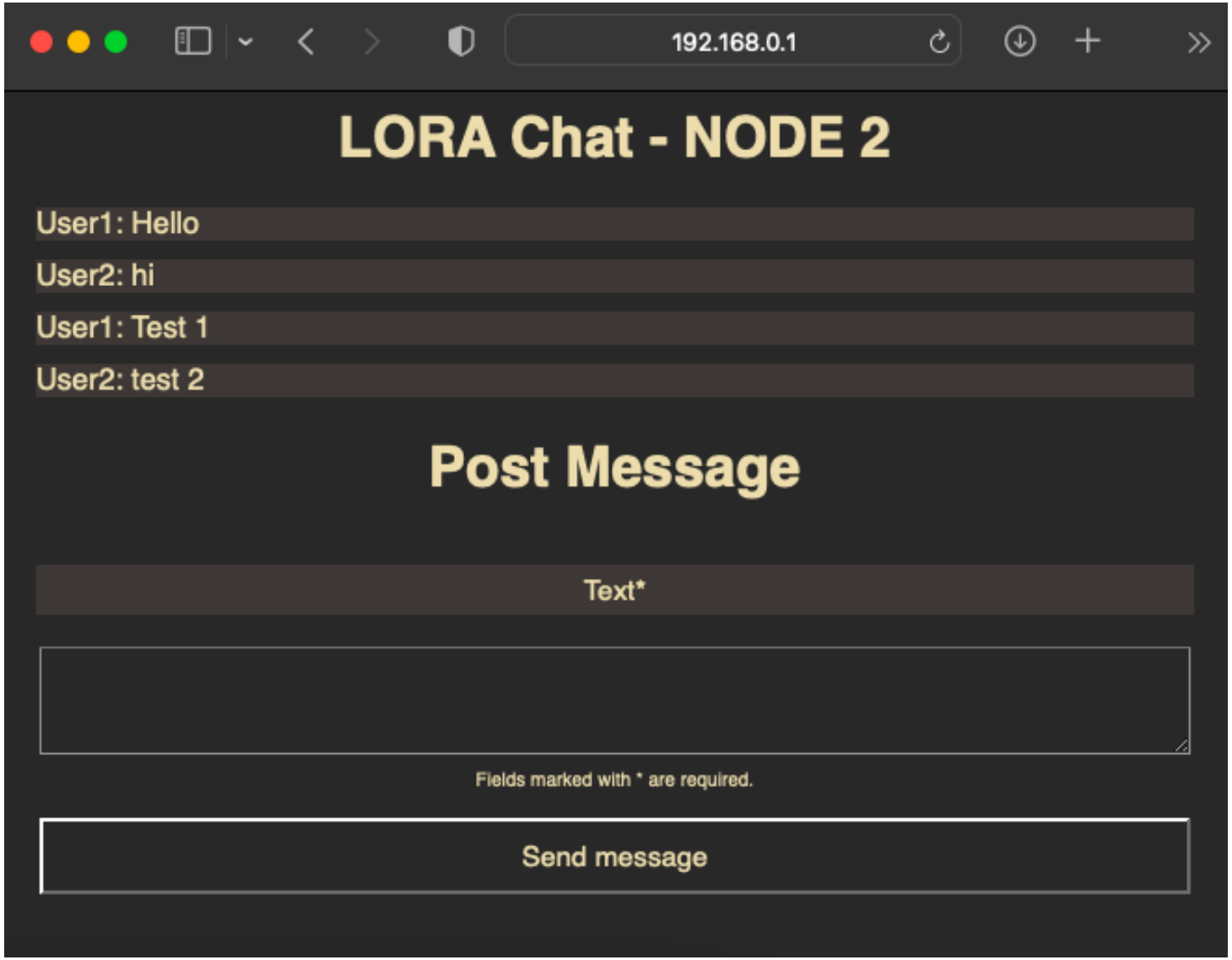
Receiving

```
void receiveWrapper(uint8_t *dataP, int len)
{
        uint8_t rxLen = lora.Receive(dataP, 255);
        char rcvBuff[len]={'\0’};
        // Split data into usename and message
        updateDb(rcvUser, rcvBuff);

}
```

User Interface

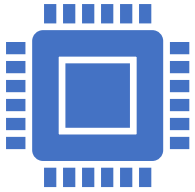
- Web interface
- IP: 192.168.0.1



Applications

- No Communication infrastructure needed. Suitable for:
  - Indoor Comms
  - Remote Regions
  - Disaster Scenarios
  - Infrastructure Failure

Possible Improvements



Improved Microcontroller (ESP32)

Location based features

Retrieve location data from client

Integrate stand-alone GPS module

Improved range with better antenna

THANK YOU