

CO326 - Computer Systems Engineering: Industrial Networks
Assignment - Preliminary Project Design

Group 19 - LoRa Protocol

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The LoRa Protocol

LoRa, (short for Long Range), is a wireless communication standard that uses radio frequency signals to transfer data across great distances. It is designed and mainly used for low-power, wide-area networks (LPWANs) and offers long-range, low-bandwidth communication. This makes it an ideal option for Internet of Things (IoT) applications that require remote sensing and control.

LoRa operates on a sub-gigahertz frequency band, (which is typically around 433 MHz in Sri Lanka). This allows it to achieve long-range communication with minimal power consumption. LoRa uses a chirp spread spectrum (CSS) modulation technique that enables the signal to travel over long distances without being disrupted by noise or interference.

A standard LoRa device is generally composed of two parts: a LoRa modem and a microcontroller.

LoRa modem - Accountable for sending and receiving data through the wireless network

Microcontroller - Handles the data and performs any required processing.

Moreover, LoRa devices can also be equipped with sensors that enable them to gather and transmit information about different environmental aspects, such as temperature, humidity, and air quality.

LoRaWAN establishes the communication protocol and system architecture for LoRa technology. It is a Media Access Control (MAC) layer protocol that operates on top of the LoRa modulation. LoRaWAN is basically a software layer that governs how devices employ the LoRa hardware, including transmission timing and message structure. The LoRa Alliance is responsible for developing and maintaining the LoRaWAN protocol.

LoRa and LoRaWAN collaborate to form a Low Power, Wide Area (LPWA) networking protocol that facilitates wireless connections between internet networks and battery-operated devices on a regional, national, or global scale. This protocol is specifically designed to meet the essential requirements of the Internet of Things (IoT), including bi-directional communication, end-to-end security, mobility, and localization services. Unlike a wireless WAN that connects users or businesses and transmits more data with higher power, this type of network stands out due to its low power consumption, low bit rate, and IoT applications.

LoRa protocol with ESP32

The ESP32 is a highly versatile microcontroller module that can be used for a variety of applications, including Wi-Fi and Bluetooth communication, as well as LoRa communication. Some ESP32 modules do have an inbuilt LoRa chip, such as the Heltec WiFi LoRa 32 and the TTGO LoRa32, which have an inbuilt SX1276 LoRa chip that allows for long-range wireless communication. These modules can be programmed using the Arduino IDE or other programming environments to interface with LoRaWAN networks or to create custom LoRa applications. Or else we can buy a separate LoRa module and a pinout, which is explained below.

Semtech SX1278 LoRa Module

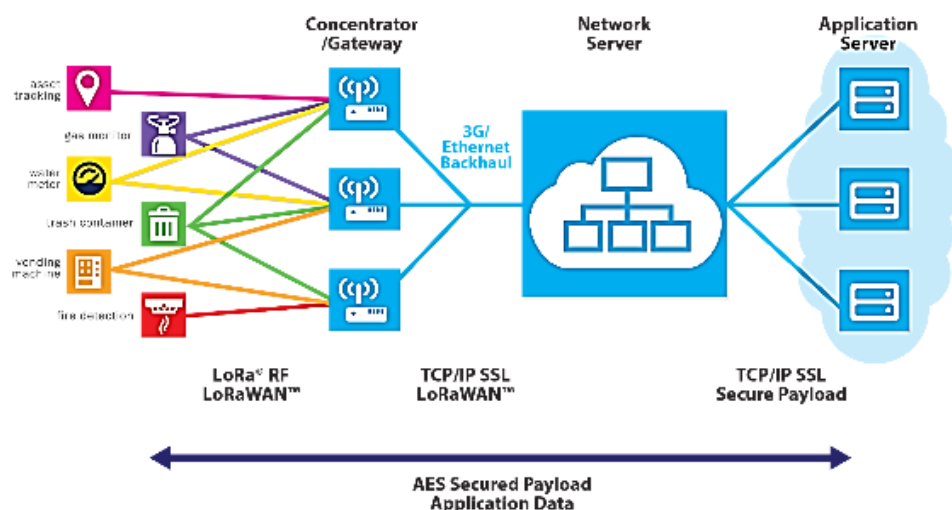
The SX1276/77/78/79 transceivers feature the LoRa® long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption.

Semtech SX1278 Pinout

There are different versions and types of SX1278 breakout board available in the market. But basically all of them have the same pinout as the LoRa SX1278 SPI module.

The Things Network

The Things Network is a global, decentralized network for Internet of Things (IoT) devices based on the LoRaWAN protocol. It provides a platform to build, deploy, and operate IoT devices and applications. The network is built using a distributed infrastructure, where we can contribute by deploying LoRaWAN gateways that receive and transmit data from IoT devices. The gateways connect to a cloud-based network server that manages the communication between the devices and applications.



Implementations of LoRa Protocol using ESP32, ESP8266

1. Wireless weather station for agriculture

This system can be deployed anywhere (even in the more remote orchards and fields) that regularly monitors weather conditions and notifies the farmer when immediate action is required to prevent crop loss.

2. Lora Based Wireless Weather Station using ESP32

Generally, this weather station can monitor environmental parameters such as temperature, humidity, pressure, altitude, dew point, rainfall, and light intensity. You can monitor data from a few kilometers (up to 5 kilometers) using LoRa Module SX1278 / RFM95. The device operates on a 3.7V lithium-ion battery and power consumption is low.

3. Smart irrigation system

LoRa based IoT Smart Agriculture Monitoring and Automatic Irrigation System using ESP8266 NodeMCU. This system interfaces multiple sensors like capacitive soil moisture sensor v1.2 to measure the quantity of water present in the soil. DS18B20 waterproof temperature sensor to measure the temperature of the soil.

4. Tree poaching detection

Tree poaching detector using Arduino UNO, LoRa Module with PIR sensor, Vibration sensor, and Sound sensor.

5. Control relay for gate control with Lora, MQTT

A simple device to control the mains line via a relay and controlling that device remotely.

6. Lora Based Smart City Air Quality Monitoring

This project is monitoring a few most important environmental parameters like noise, temperature, humidity, and air quality. It transmits real-time data through wireless communication protocol to a cloud platform. The equipment fully runs on solar power with a battery backup. The data from the device is accessible on a dashboard that visualizes and analyzes the data in the desired formats.

Project Idea - Air Quality Monitoring System

We are planning to build an Air Quality Monitoring System using the LoRa Protocol. It monitors and measures the level of pollutants and other harmful substances in the air. It consists of various sensors and instruments that detect the presence of gasses and particulate matter in the surrounding environment. These systems are essential for monitoring air quality and providing accurate data to help understand the level of pollution and its impacts on human health and the environment. This can be installed in various settings, including indoor and outdoor environments. In this system ESP8266/ESP32 communicates with the hardware module using the LoRa protocol.

References

- [Wireless weather station for Agriculture](#)
- [Lora Based Wireless Weather Station using ESP32](#)
- [smart irrigation system](#)
- [tree poaching detection](#)
- [Control relay for gate control with Lora, MQTT](#)
- [Lora Based Smart City Air Quality Monitoring](#)