LoRa based communication for Smart Home IoT implementation

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Abstract: With the advancement of new communication technologies like LoRa that have long-range, good throughput and low consumption[1], and the environmental crisis that all we lived through, we need to search for ways to decrease our power consumption and implement technology that follows this principle. For this reason, we need people in Chile and all over the world that may work in implementation of this technology if they want to make smarthomes and smart cities. In this case the project is about a smart house that could contain a lot of sensors like power consumption, humidity, temperature, among others. All this networking architecture will use microcontrollers units with LoRa modules for sending or receiving information of other objects with sensors on it. The centralized system implemented in a Raspberry Pi, will have a web server with API and app web for monitoring the status of sensors. Meanwhile, some devices will supply their electric consumption with solar energy. Finally, we prove that using LoRa for Smart Home is a good option after all.

1. Introduction

The environmental crisis induced by humans is a big problem of our days. This problem has been the principal cause of interest for searching for new technologies with low environmental impact, that means low consumption of energy or other natural resources. In this case, using a communication technology as LoRa in future technologies projects may help to the cause.

In Chile the people don't know how much energy spend at month, because any house don't have Smart Meters or systems to read the real power consumption, they consumption is metering manually for some guy that go to read legacy meters to the houses and this data are meaning with previous data and that is the energy that they show you in bills. Furthermore, just 17.2% of electric power produced in Chile is generated by a non conventional renewable source[2]. For these reasons, and for the actual problems with the implementation of Smart meters in Chile, we decided to work on a new implementation of Smart Homes and read the electric consumption locally for every house in the country.

The purpose of this work is to prove that LoRA technology works for SmartHomes implementation. First we need to try with a basic implementation with just a couple of sensors, communicate LoRA devices between them and finally with a server that could be a RaspberryPi or some PC. This server will implement API and DataBase for information management. Then we will prepare future work for implementation of a complete SmartHome system. With the communication working our purpose for this project will finish and we will prove that LoRA is a good option to implement an efficient data transfer and receiver with a low consumption and very low interference[3].

2. Design and investigation

The communication technologies used in Smart Homes implementations are a lot, but the most used are Bluetooth, Ethernet, WiFi, Zigbee and LoRa. Four of these technologies are wireless and WiFi is the only one that doesn't fulfill the low power consumption condition. On the other hand, LoRa is the only one technology that has high interference immunity and long distance coverage(1km) between the others, this last feature can be needed for houses with large backyards for example, very useful.

Table 1. Comparison of communication technologies used in smart homes and buildings.

Reference	Network Segment	Communication Technology	Monitoring Parameters
[4]	HAN	Bluetooth, LoRA	Door Status, Fans status, Light status
[5]	HAN	LoRa, Ethernet	Temperature, humidity, gas, dust, noise, solar, among others.
[6]	HAN	WiFi, ZigBee, Z-Wave and Wireless M-Bus	Motion, brightness, humidity, smoke, window sensors, temperature, CO2, voltage, current, consumed energy.
[7]	HAN	LoRa, WiFi	Current, voltage.

Table 1 shows four papers that use different technologies for implementation of Home Area Network for Smart Home and LoRa is in the last few years frequently quoted and studied in many scenarios with good results. For this reason and all these features, people believe that LoRa is the technology of the future.

For the implementation some devices and sensors will be used, one of them is Heltec 32 WiFi-LoRa-Bluetooth. Heltec 32 is an embedded system based in ESP32 that contains a microcontroller unit more powerful than Arduino or ESP8266. The difference between ESP32 and Heltec 32 is basically the LoRa module integrated and an OLED display among others littles differences.

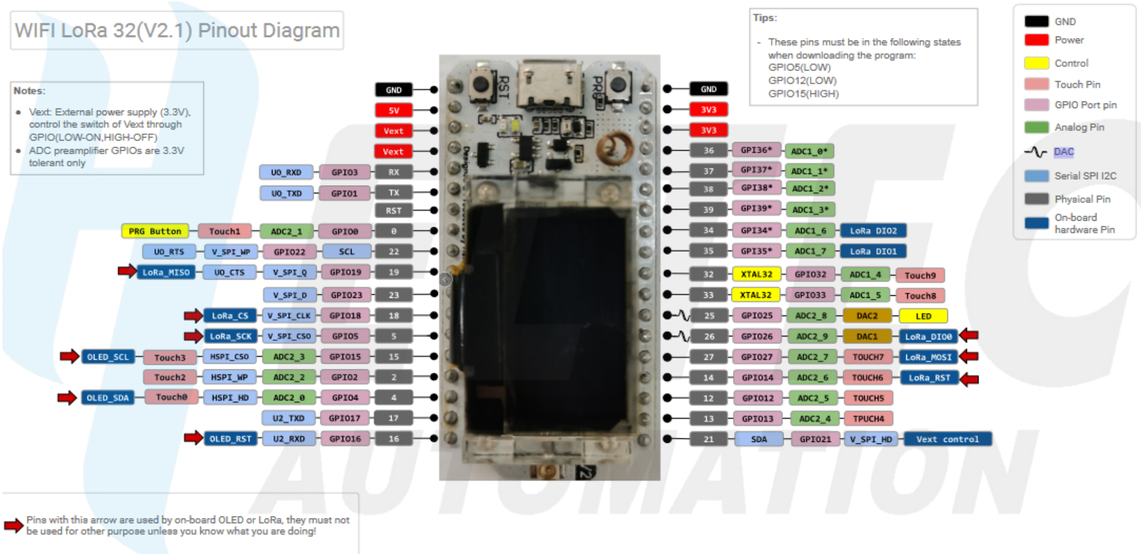

Fig 1. Heltec 32 Pinout Diagram

Figure 1 shows the pinout diagram of Heltec 32 and gives more information about the embedded system.

This device will recollect data of sensors and will send using LoRa to other Heltec 32. When the data is received by this device then it will be sent again but using WiFi as communication technology to the router that will send the packets to the server.

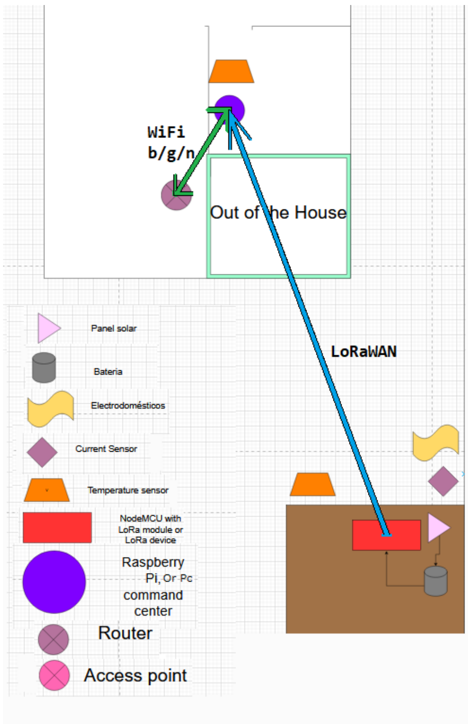

Fig 2. Network schema.

Figure 2 shows how the network is implemented, nonetheless it doesn't show the distance or signal intensity between Heltec 32 devices. For this reason the "Received Signal Strength Indicator"(RSSI) of the signal will be measured along the "Line of sight"(LOS) of the LoRa antennas.

RSSI is a relative value that depends on the scale that the manufacturer decided to use. Although that, RSSI can show how the signal behavior and mostly of cases just is the same that dBm scale, namely is the logarithmic relation between LoRa signal power of Tx and 1 milliWatts of power.

Finally, the API server must be listening to HTTP requests sent by Heltec 32 device via WiFi. And this API will be implemented in a Raspberry Pi or some PC allowable. The technology chosen for implementing API was Node.js and Express.js for its good documentation and support. On the other hand, this API will need a database too, then Firebase is a perfect option with regard to fast implementation in a cloud, finally React.js for web user interface for keeping all this software in only one programming language, in this case, Javascript.

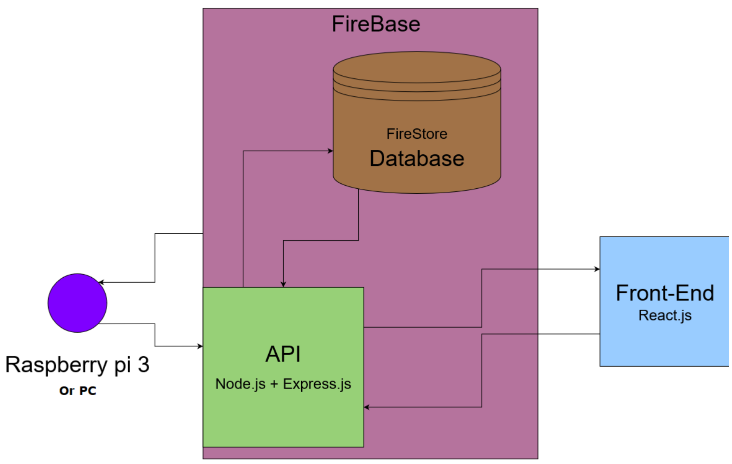

Fig 3. Server implementation

Figure 3 shows how the future implementation will be. The API server will be hosted by Firebase, same as FireStore, one of the Firebase databases.

3. Implementation and Results

For complications of time and equipment some features of the project will can't be, but the base structure of the project was implemented successfully.

First of all, Heltec 32 devices must be programmed with Arduino IDE to send and receive data using LoRa. After that, implement sensors in the sender device, in this case just a sensor of humidity and temperature known as DHT11, implementation is shown below in figure 4.

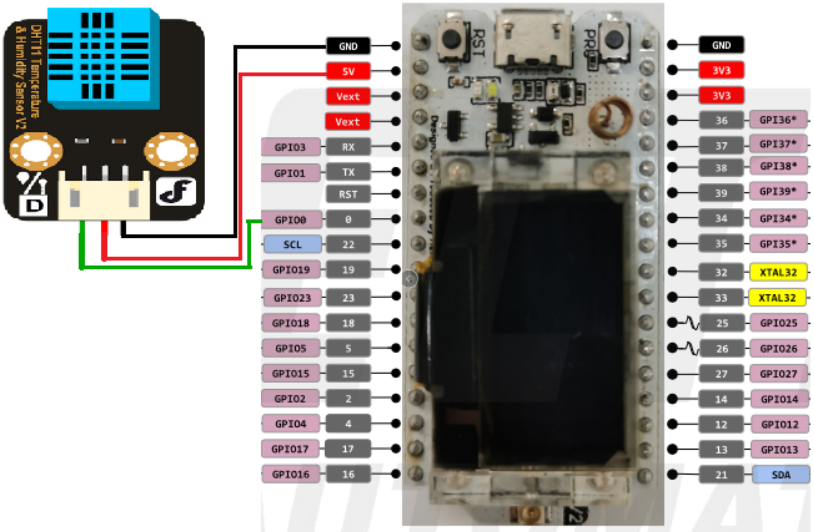

Fig 4. DHT11 implemented in Heltec 32

DHT11 is just connected to the ground, 5 volts source and GPIO 0 for transmitting data to the device. After that, the Heltec 32 device is connected to a solar panel to feed its energy needs as shown in figure 5 below.

Fig 5. Solar panel feeding Heltec 32 device.

Now the antenna and DHT11 sensor must be connected to the device.

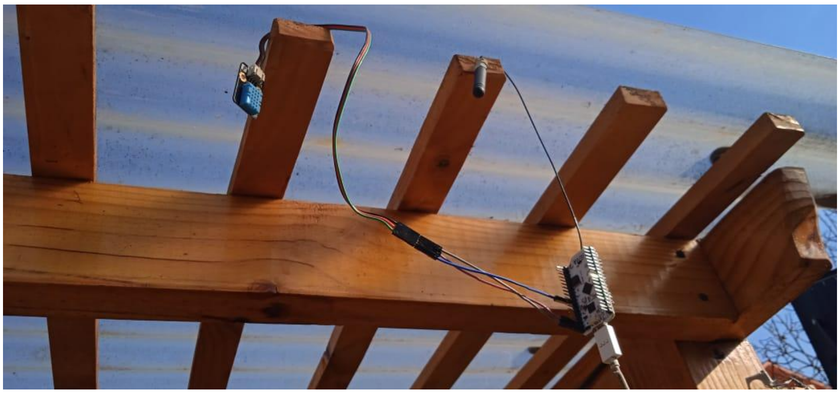

Fig 6. Antenna and DHT11 sensor connected.

Figure 6 shows a fast installation of sensor and antenna for Heltec 32 device.

Meanwhile, the sender sends data to the receiver, the RSSI is measured. Below, Table 2 shows RSSI behavior along to LOS of the two antennas.

Table 2. Mean RSSI of LoRa signal in LOS versus distance in meters.

Meters	RSSI
1	-47
2	-49
3	-51
4	-55
5	-56
6	-61
7	-59

For values in Table 2, RSSI has good intensity specially for LoRa modules that have very high sensibility, namely can listen to signals with very low energy.[8]

On the other hand, the receiver shows received data in Heltec 32 display as shown in figure 7.

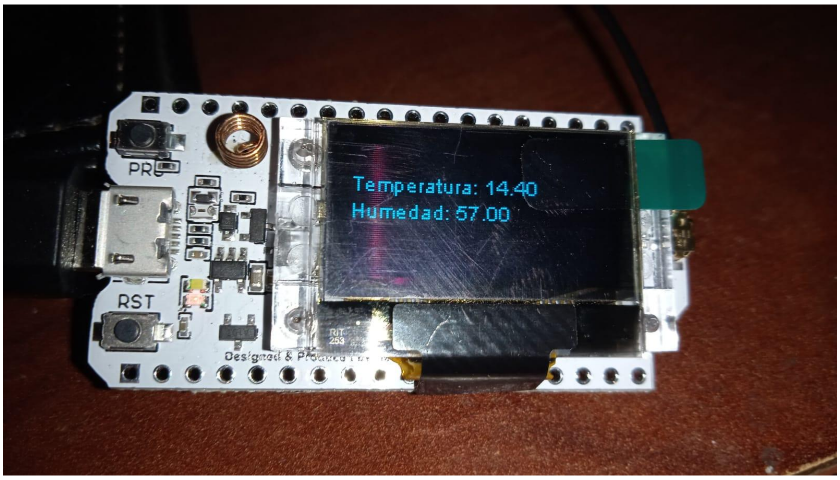

Fig 7. Receiver device displaying data.

The data sent and received also can be displayed in the serial console of Arduino IDE as figure 8 shows below.

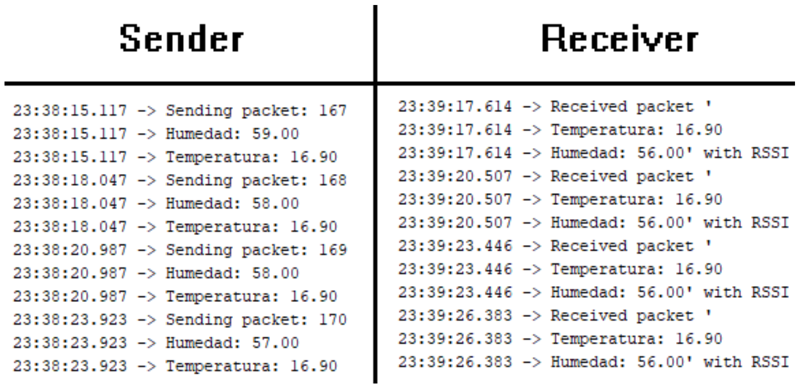

Fig 8. Data in sender and receiver serial console.

Then, when the data reaches the receiver device is sent as Json encapsulated as an HTTP POST request using WiFi to the API server. After that the data is processed in API and displayed as Json in a web site that is locally visible using an HTTP GET request to the API server, as figure 9 shows below.

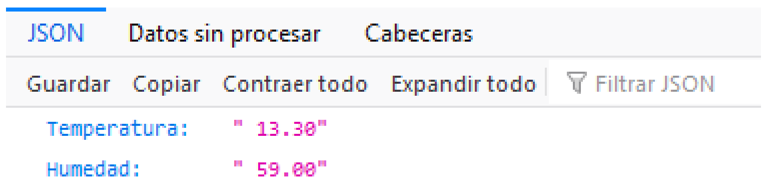

Fig 9. Json with data displayed in a web site.

Next, the entire system and implementation is summarized with the figure 10.

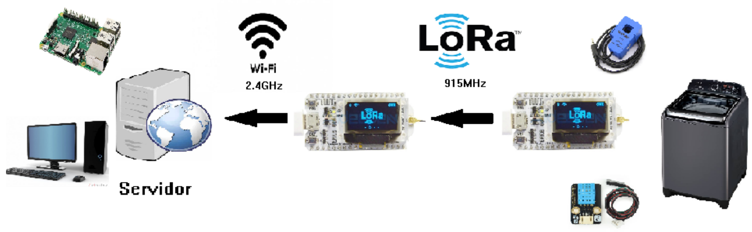

Fig 10. System proposed to implementation.

For the case of this project and as figure 11 shown below, el work implemented in this report is represented in a "Home area network"(HAN).

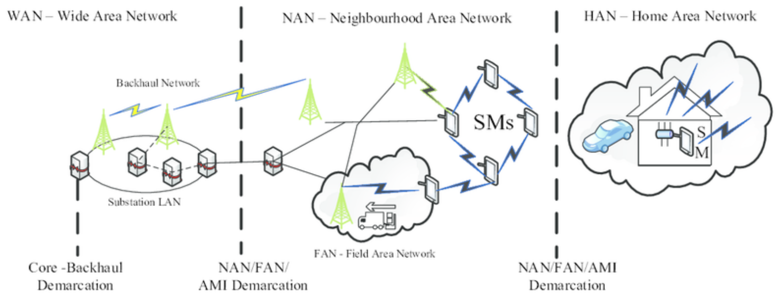

Fig 11. House, Neighbourhood and Wide area network.

Finally, all the implementation can be consulted in a github repository that is in references[9].

Some of the features that couldn't be implemented will be in Future work sección.

4. Conclusions

After all the implementation explained until here, LoRa works fine in everything. Almost all packets are received and signal intensity is good inside and outside the house, allowing the data flows without problem everywhere inside the property. LoRa is low consume of energy and is feeded by solar energy and that works well, if a complete SmartHouse is implemented with devices that have LoRa modules is possible to feed all this devices and sensors only with the sun, saving some energy and leave to contribute a little with the contamination of the planet.

5. Future work

For future work, SCT 013-000 analog sensor will be implemented for current monitoring, Front-End with React.js for user interface will be implemented and FireStore(Firebase database) too. Also hosting the API server in Firebase cloud.

6. References

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