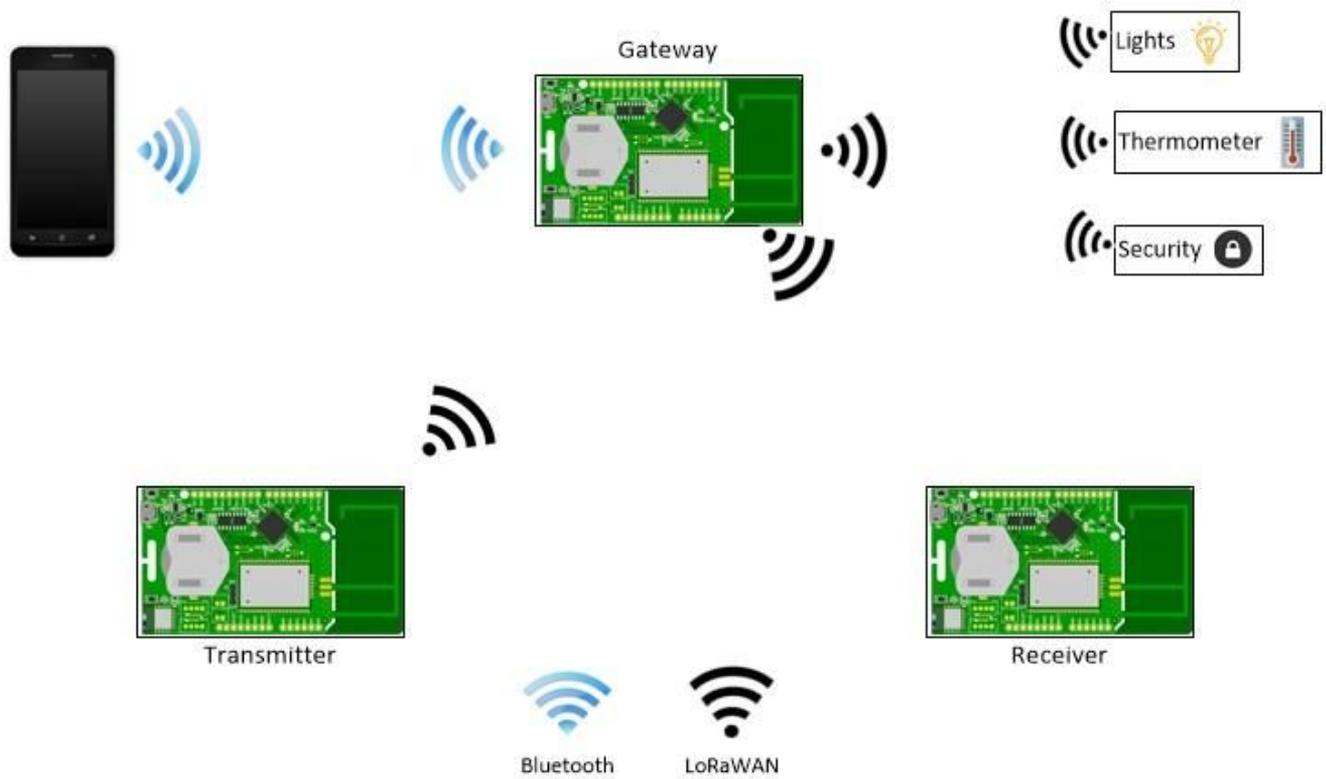


LORA Local Area Network

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Introduction

As a starting project for our internship at SODAQ, we, Joost Kouijzer and Remy van der Pol, had the idea to make a small local area network with LORA. The idea behind the project is to set up a simple gateway which can be placed in the middle of a house or terrain. The gateway can be used by multiple LORA modules, which for an example, are able to open your garage door or switch some lights. Another idea which can be achieved is a sensor network in the gateway reception area to fetch different kind of sensor values.

For this project we used multiple SODAQ Explorer boards. One board functions as the gateway. The other ones we used as modules which were able to send or receive data from the gateway.

In this document you can find how we set up the modules and some information test data of what can be achieved with a LORA P2P network.

Configuration of the RN2483 LORA module

To configure the LORA RN2483 chip it is possible to send commands over the serial connection.

Every command needs to be closed with a carriage return.

There are a couple of settings that need to be changed to be able to send data from point to point.

To be able to setup the chip for an point to point connection we need to:

- disable the LORA MAC overhead;
- give send and receive commands and
- make use of the watchdog timer (optional)
- Setting the spreading factor (optional)

Doing a system reset

To be sure every other setting is properly set it is possible to do a system reset. This can be done with the following command:

```
"sys reset"
```

This will set the configuration to factory default.

Disabling the LORA MAC functions

Some LORA overhead settings are setup in the MAC settings. To disable these settings the MAC can be paused. Before we are able to give send or receive commands we need to pause the MAC each time we do this. The MAC can be paused with the following command:

```
"mac pause" .
```

Sending and receiving commands

It is possible to send or receive data with the following commands:

To send data use "radio tx <data>"

The chip gives a reply if the data is going to be send, and if it is send or not.

To receive data use "radio rx <rxWindowSize>"

The rxWindowSize represents the number of symbols to receive.

The module stays in receiving mode as long as there is nothing received and as long as the watchdog timer hasn't run out of time.

Using the watchdog timer

By default the watchdog timer is set to 15000 ms (15 s). It is possible to change this value or to completely disable the watchdog timer. The command to do this is the following:

```
"radio set wdt <watchdog> "
```

The value "watchdog" represents the time-out length in ms. When set to 0 the timer is disabled.

Setting the spreading factor

By changing the spreading factor it is possible to send faster or further. The lower the faster and the higher the further.

To change the spreading factor the following command needs to be send:

```
"radio set sf <spreadingfactor>"
```

Here the value "spreadingfactor" can be anything from "sf7" to "sf12".

The standard value is "sf12".

Small LORA local area network

To achieve a local area network the data needs to be send with some kind of protocol. The protocol has been kept simple.

Protocol

To be able to send and receive data between different modules over a larger area we made a small protocol. The protocol makes use of a gateway which is able to send and receive the data from the surrounding modules.

LORA P2P Gateway Protocol				
Overhead	Gateway address	Destination address	Source Address	Data
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte

LORA P2P Gateway to connected Modules Protocol			
Overhead	Destination address	Source Address	Data
1 Byte	1 Byte	1 Byte	1 Byte

The protocol makes use of a small overhead to be sure the received message is following this protocol. This was necessary because the module also receives the standard LORA protocol which is going to the LORAWAN network.

To send a message from a module to the gateway the gateway it is necessary to include the gateway address. We left out this address from the gateway to a module because the gateway address is already known by the module. When there is a need for more gateways the protocol needs to be changed so that the module knows if the message is from its connected gateway.

Testing

To test what can be achieved with a P2P connection between the SODAQ Explorer boards we did some limitation tests. The most important tests we could do was to find out some things about the maximum range inside a building and outside on an open field.

To find out the possibilities we did the following tests:

- try to receive with a sending device under water;
- look at the range with the sending device 30cm underground;
- look at the range in a building.

All tests where done with two SODAQ Explorer boards with the onboard antenna, one sending and one receiving. To test if the message was received correctly the sending module was sending the hexadecimal value "FF". If the receiver was receiving "FF" it showed a green light. If the receiver received anything else it showed a blue light.

Most of the tests were done with a spreading factor of 12 and transceiver power of 1.

Sender under water

To get an idea of the possibility for receiving data from a sender in highly water saturated ground we put a sending module under water. During this test the sending module was put in a IP66 enclosure to keep it dry. The sending module was kept at 5cm under water.

The test was done with the following settings:

Spreading factor: 12

Transceiver power: 1

During the test all messages where being received by the receiving module. Because the test was being held inside the office it was not possible to measure the maximum distance from the sender to the receiver.



Buried in the ground (long distance test)

The test was executed with two Explorer boards. We put one underground at 30cm and with the other we tested the distance. There has been tested between Hilversum and Laren (figure 1). Two different spreading factors where used to see which one is better. It was sunny and the last snow was melting, so the ground was wet.



Figure 2: Testing area

- Spreading Factor 12

With spreading factor 12 the Explorer came 903 meter. On that distance we sometimes had a receive signal. From a distance of 685 meters we had a good signal. When the Explorer came one meter to the ground the signal was not received.

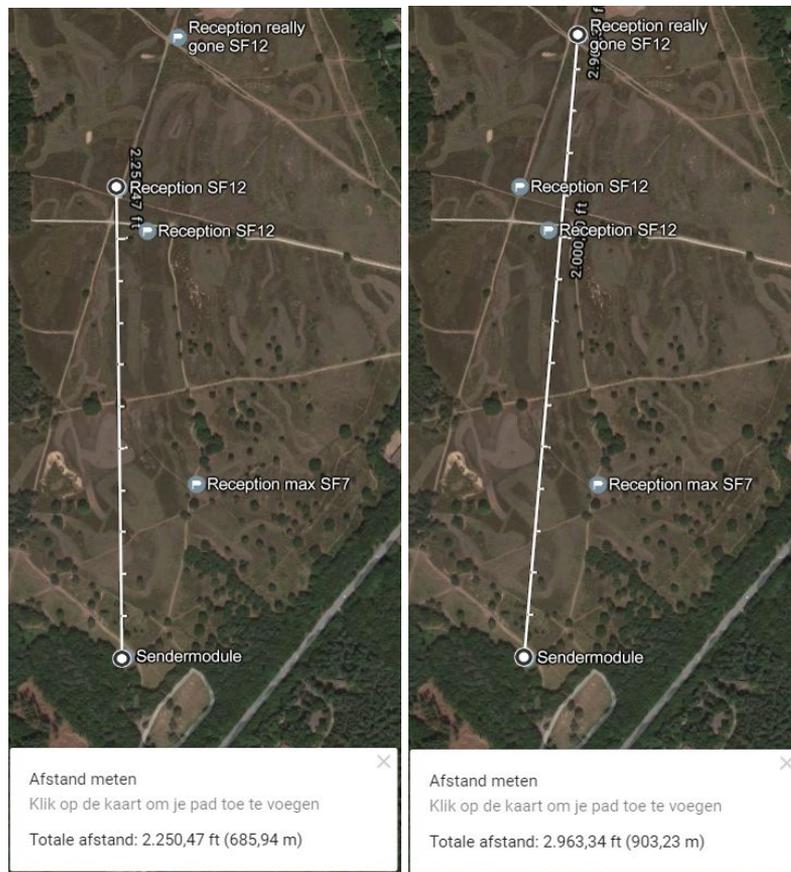


Figure 3: Max reliable distance and distance gone

- Spreading Factor 7

When the spreading factor is 7, the Explorer came 273 meter. The Explorer was sending a lot faster but came not so far as with a spreading factor of 12.



Figure 4: Max distance SF7

Building range test

We were also curious at the range we could get in a building. Therefore we did a test in the office building.

We put a sending module on the ground floor and started walking upstairs.

The test was done with the following settings:

Spreading factor: 12

Transceiver power: 1

Without the IP66 enclosure.

We still got pretty reliable reception at the third floor of the building. When we got higher the reception became unreliable (sometimes reception).

Although this result is probably pretty building specific, this may mean that it is possible to use the explorer as a small in home LORA local area network.

Conclusion

With the test results we saw that a P2P connection between multiple LORA enabled devices could be useful.

With the use of an centered gateway and multiple devices around the gateway it is possible to collect all the data from the connected devices in a radius up to 650 meters with a line of sight.

The P2P connection could also be useful for small in home applications like switching some lights or opening the garage door.