***LoRa Node with LoRa Shield***

## Preamble

LoRa Technology is a wireless modulation for long-range, low-power, low-data-rate applications. By achieving a range of more than 15 kilometres in a suburban environment and more than 2 kilometres in a dense urban environment, LoRa technology solutions target multiple application domains, such as Internet-of-Things (IoT), metering, security, and machine-to-machine (M2M).

This single channel LoRaWAN gateway is a proof-of-concept implementation, that can be used for development and node testing. It is not a replacement for a real multi-channel/multi SF gateway! It supports some LoRaWAN features, but due to its static nature (single channel) it is not fully LoRaWAN compatible (and will never be).

By default, it works with the TTN backend, for testing and development.

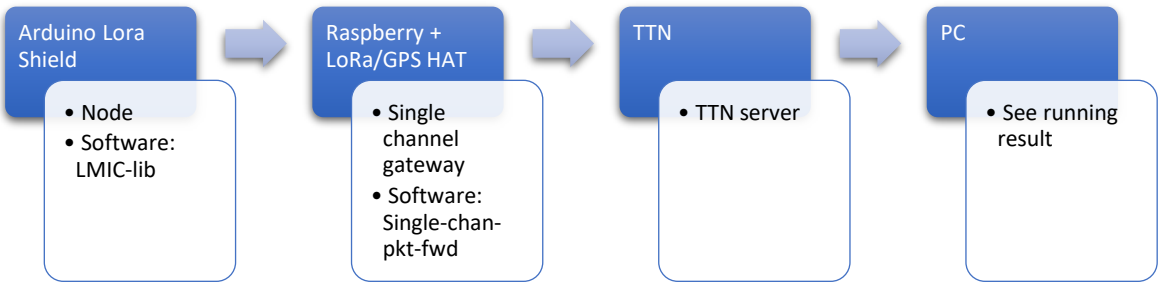
## Introduction

In this document, we will talk about:

- How to use LoRa/GPS HAT to set up single channel gateway for TTN network.
- How to use LoRa Shield to set up a LoRa Node.
- How is the communication between the LoRa Node and LoRa Gateway.

We will use the LoRa Shield + Arduino UNO and LoRa/GPS HAT + Raspberry pi 3 to build a single channel LoRaWAN gateway.

## Network structure



The construction of the network is as graphic above.

***LoRa Node:***
The Arduino UNO will get sensor data and control the LoRa Shield to send this data to the RPi Lora Gateway via LoRa wireless protocol.

***LoRa Gateway:***
The RPi LoRa Gateway will receive this data and upload it to the TTN network via the Internet.

***TTN Server:***
The TTN Server will get the data packets from the RPi LoRa Gateway and the data will be stored in the corresponding place, so users can take what they need from the Internet.

***PC:***
We can use the PC to get the data and check the status of this LoRa Gateway network.

## Build a single channel LoRaWAN gateway

In this step, we will use the RPi and the LoRa/GPS HAT to build a single channel LoRaWAN Gateway. We should configure the RPi and connect it with the LoRa/GPS HAT.

### Configuration

- Connect the Raspberry Pi to the Internet.
- Use *sudo raspi-config* to ensure that SPI can be used on RPi.
- Use *sudo apt-get install wiringpi* to install the GPIO access library written in C for the BCM2835 used in the Raspberry Pi.
- Get the single channel Lora Gateway source code with this command :
  *Git clone https://github.com/tftelkamp/single_chan_pkt_fwd.git*
  *Sudo chmod 777 single_chan_pkt_fwd*
- Edit the 'main.cpp' to change configuration (look for: "*Configure these values!*").

```
// SX1272 - Raspberry connections
int ssPin = 6;
int dio0  = 7;
int RST   = 0;

// Set spreading factor (SF7 - SF12)
sf_t sf = SF7;

// Set center frequency
uint32_t  freq = 868100000; // in Mhz! (868.1)

// Set location
float lat=0.0;
float lon=0.0;
int   alt=0;

/* Informal status fields */
static char platform[24]    = "Single Channel Gateway";  /* platform definition */
static char email[40]       = "";                        /* used for contact email */
static char description[64] = "";                        /* used for free form description */

// define servers
// TODO: use host names and dns
#define SERVER1 "10.6.2.24"    // The Things Network: croft.thethings.girovito.nl
//#define SERVER2 "192.168.1.10"      // local
#define PORT 1700                 // The port on which to send data
```

You just need to *SERVER1*, put the public IP of your router.

Connect the Dragino LoRa/GPS HAT and the RPi, run packet forwarder as root. To do this use this command:

*Make*

*./single_chan_pkt_fwd*

Then we can get a Gateway ID and see the running result on the RPi as below picture.

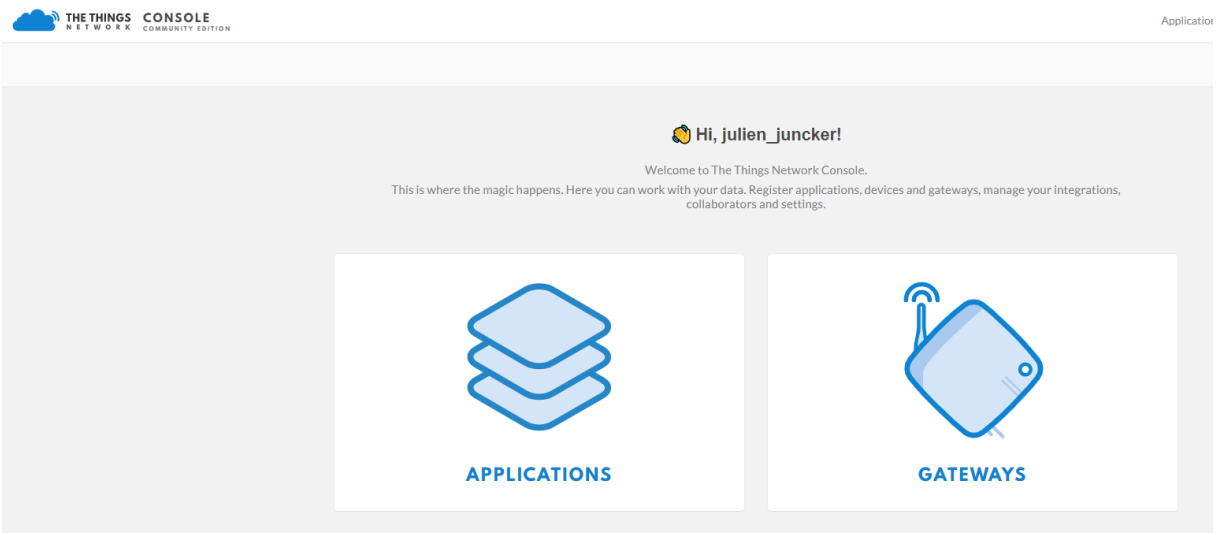
```
pi@pi:~/Desktop/LoRa/single_chan_pkt_fwd $ ./single_chan_pkt_fwd
SX1276 detected, starting.
Gateway ID: b8:27:eb:ff:ff:c2:2b:70
Listening at SF7 on 868.100000 Mhz.
-----------------
stat update: {"stat":{"time":"2019-12-05 16:22:03 GMT","lati":0.00000,"l
"Single Channel Gateway","mail":"","desc":""}}
```

Keep this ID for the next step.

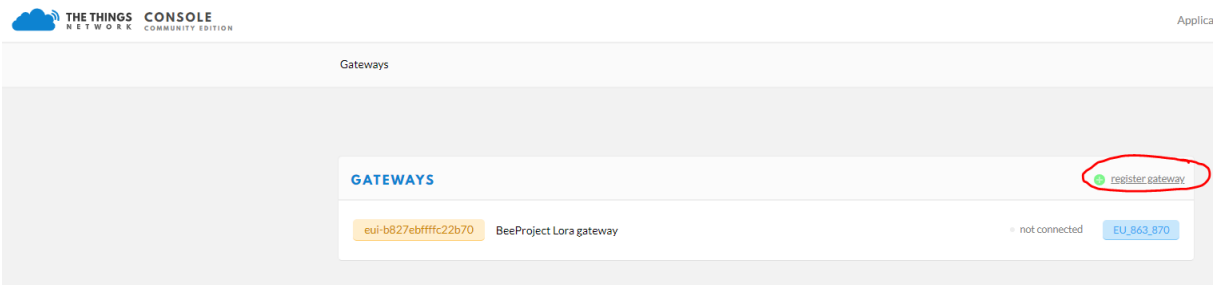
## Create a Gateway on TTN network

Before we start this project we must have a TTN account, we can create one at this page: [https://account.thethingsnetwork.org/register](https://account.thethingsnetwork.org/register).

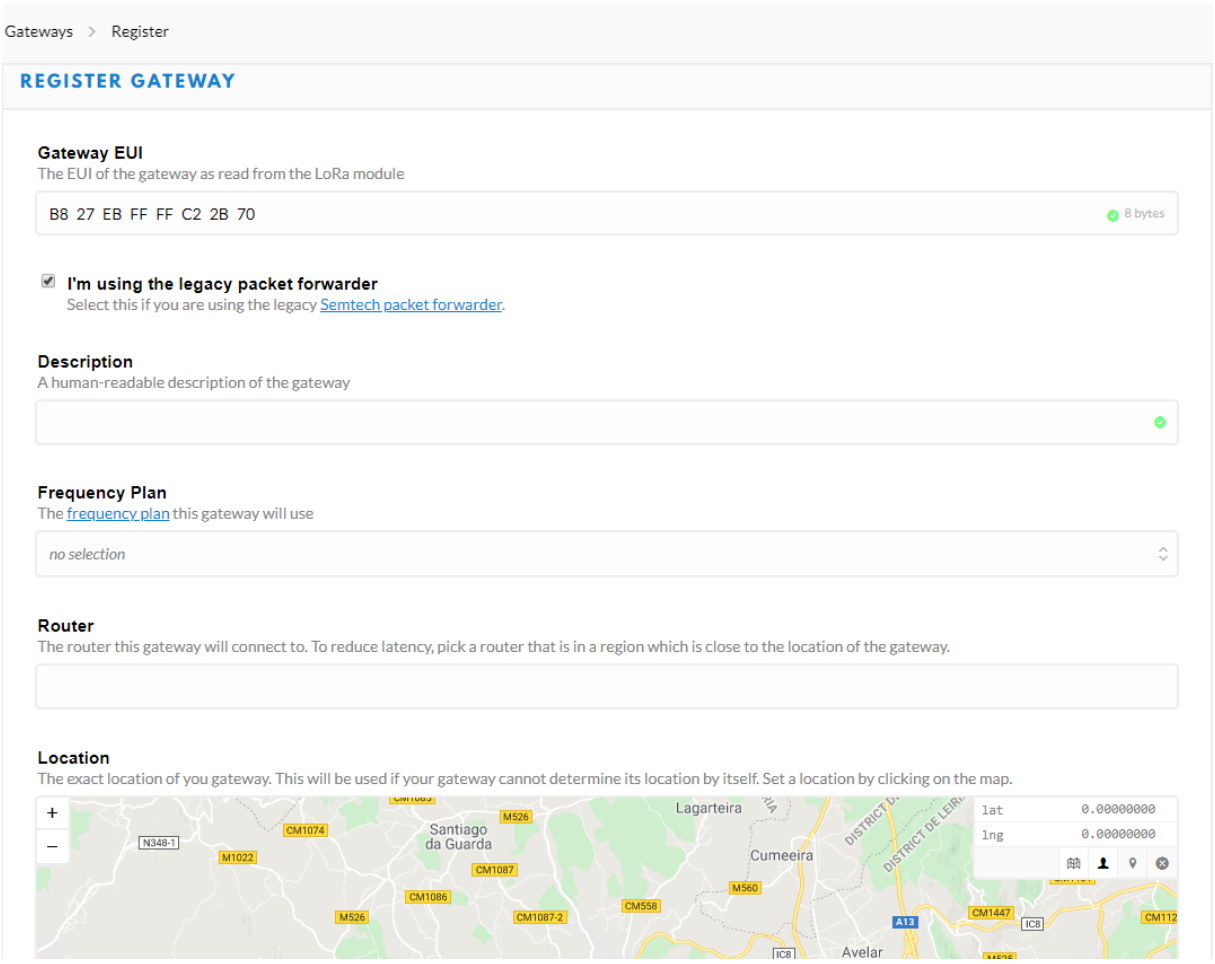
After registration, you need to go on *console* part, you will see this page:




Click on *gateway* and click on *register gateway* link:

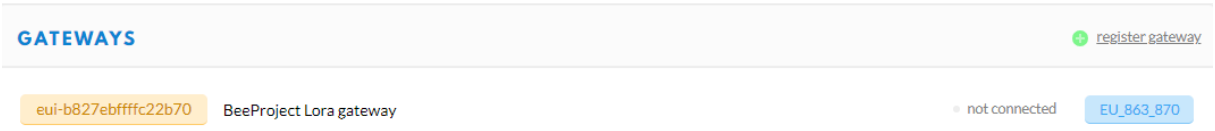



You will see gateway registering page:



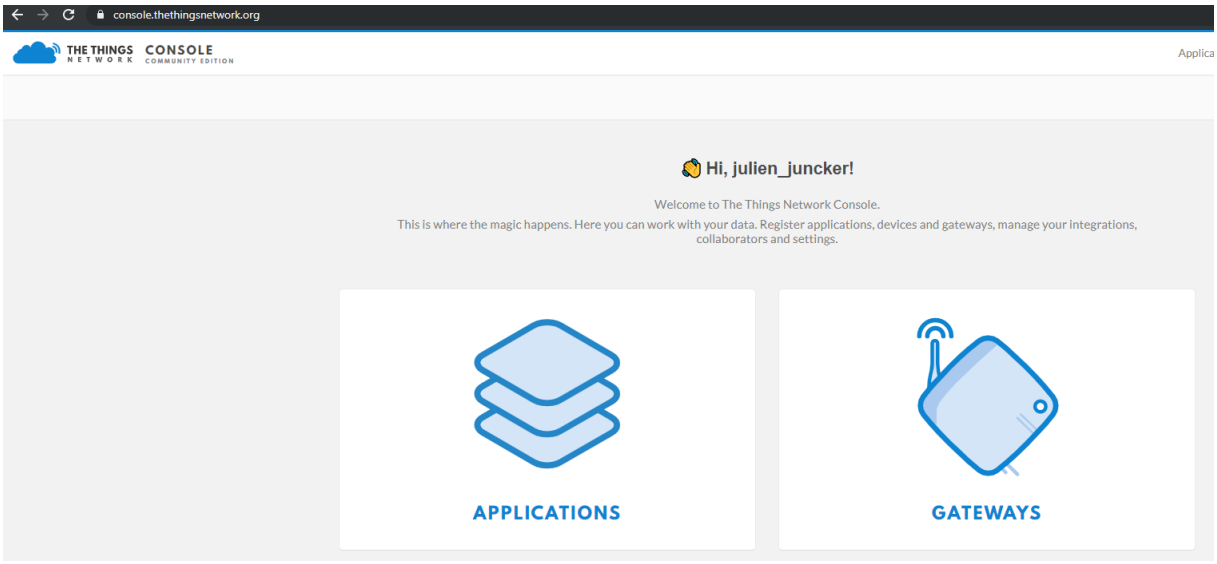

- Click on checkbox « *I'm using the legacy packet forwarder* ».
- Fill the *Gateway EUI* label with your own Gateway ID that you take on last part.
- You can put description if you want.
- For *Frequency Plan*, put European frequency, it's *868MHz*.
- For *Router*, put *ttn-router-eu*.
- Select your location on the map and precise if the gateway is *indoor* or *outdoor*.
- When you finish, click on *Register Gateway* button.

Now you can see your private gateway:

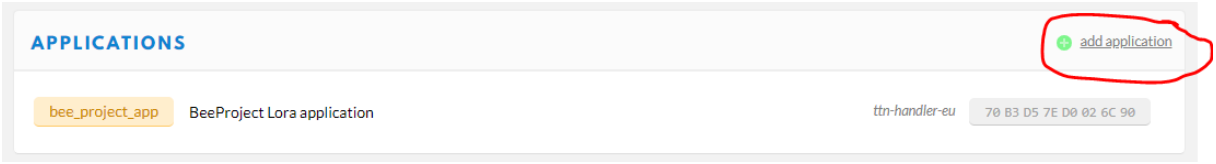


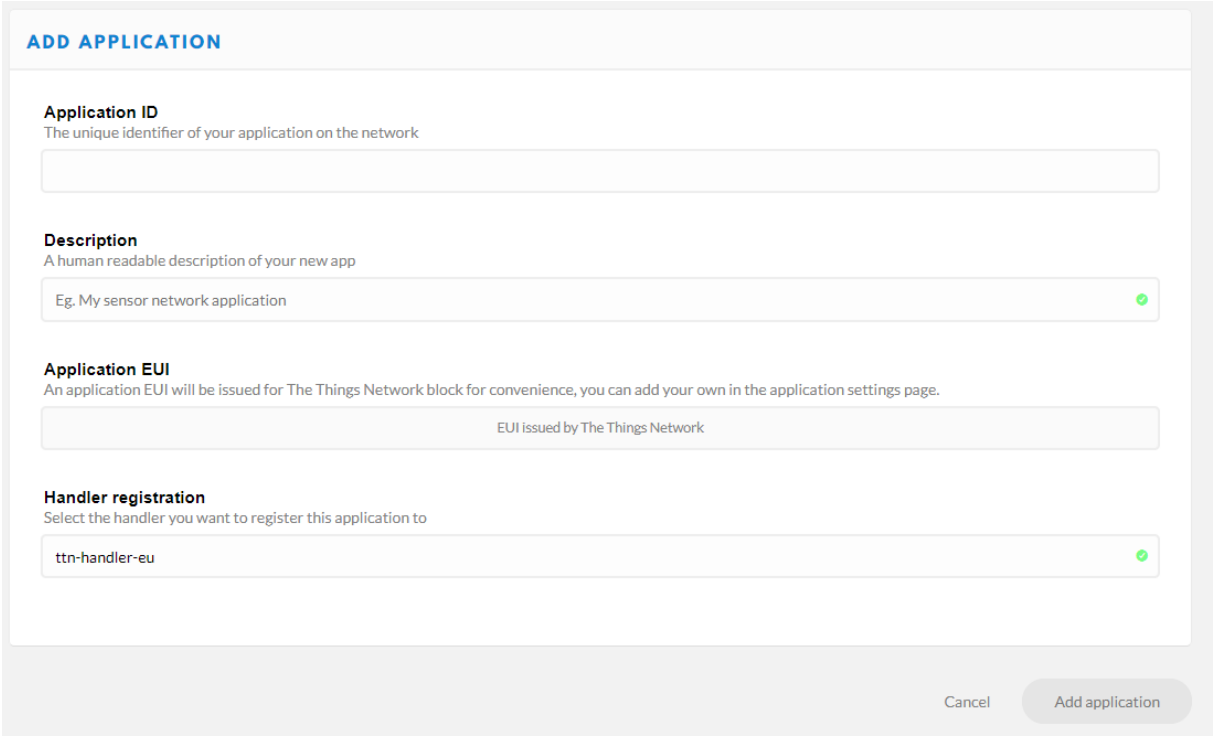

## Create application for LoRa Node (Arduino UNO)

Before connecting LoRa shield on Arduino UNO, you need to register it on TTN server. To do this, go on your console page of your account in TTN :




Go to *applications* part and click to *add application* link:



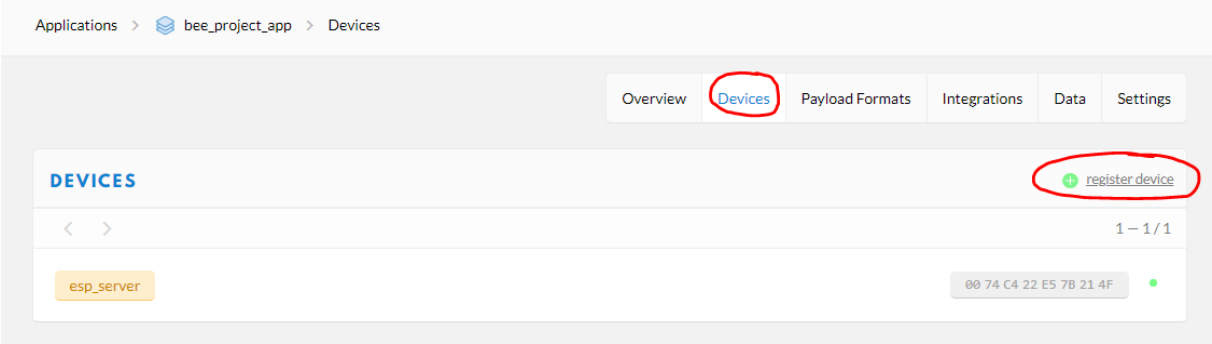




In this page you need to register all the information of your application:

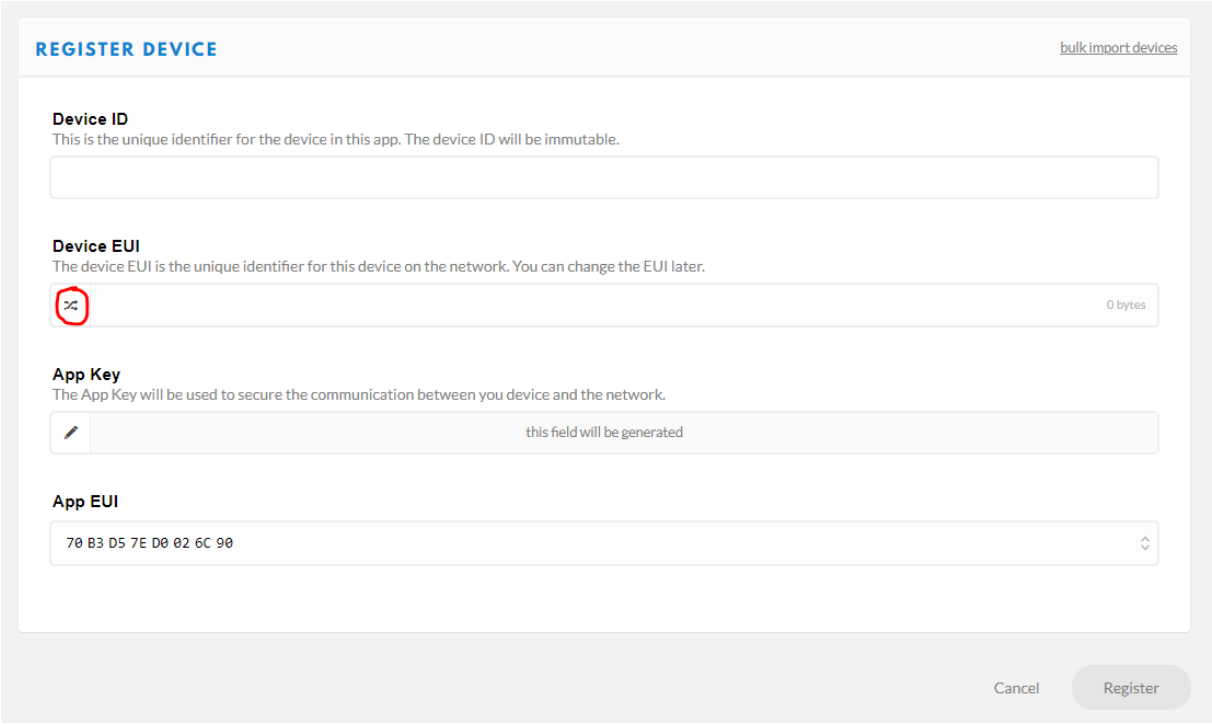
- Application ID: You can put what you want.
- Description: Put description or not.
- Application EUI: Automatically generation.
- Handler registration: Stay by default *ttn-handler-eu.*

Click to *Add application* button to register new application.

After you create your new application, go on *Devices* tab and click to *register device:*




You will create your link to your Arduino device.




In this form, you have:

- Device ID: Put name for your new Device.
- Device EUI: Click the button who is surrounded in red on the last picture to generate random number.
- App Key: Stay this label in blank, automatic generation.
- App EUI: Link your device to the application you created before.

Click to *register* button to register new device.

Now, you can link your Arduino UNO to TTN server.

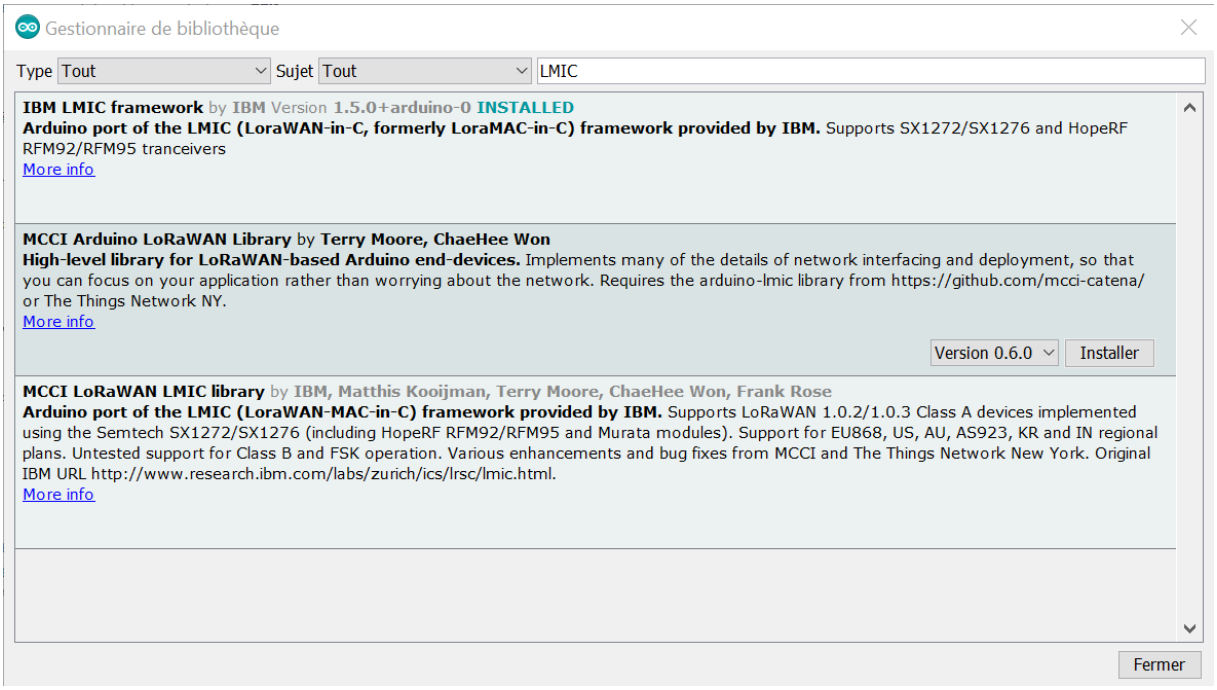
## Connect the LoRa Shield on arduino UNO

Connect the LoRa Shield and Arduino UNO. Put the 868MHZ antenna on it. Connect them to the computer via an USB cable.

Over here, we use the Arduino IDE1.68, we need to install this Arduino-LMIC library. This repository contains the IBM LMIC (LoraMAC-in-C) library, slightly modified to run in the

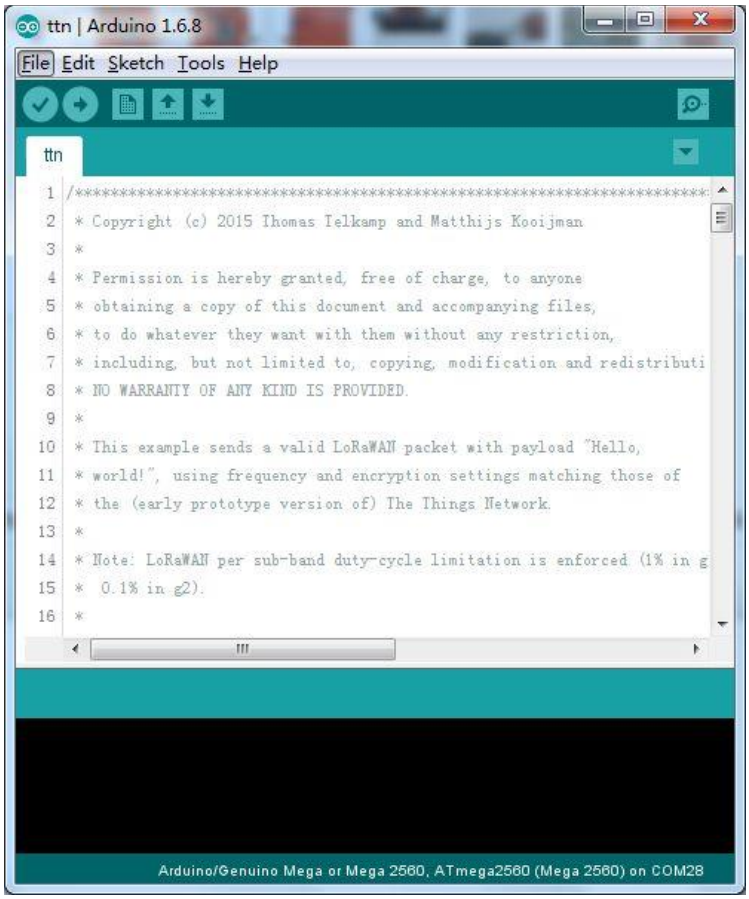
Arduino environment, allowing using the SX1272, SX1276 transceivers and compatible modules.

To install this library go on *Sketch -> include a library -> manage libraries*




Search *LMIC* and install *IBM LMIC framework.*

After do that, we download the ttn sketch from this link.

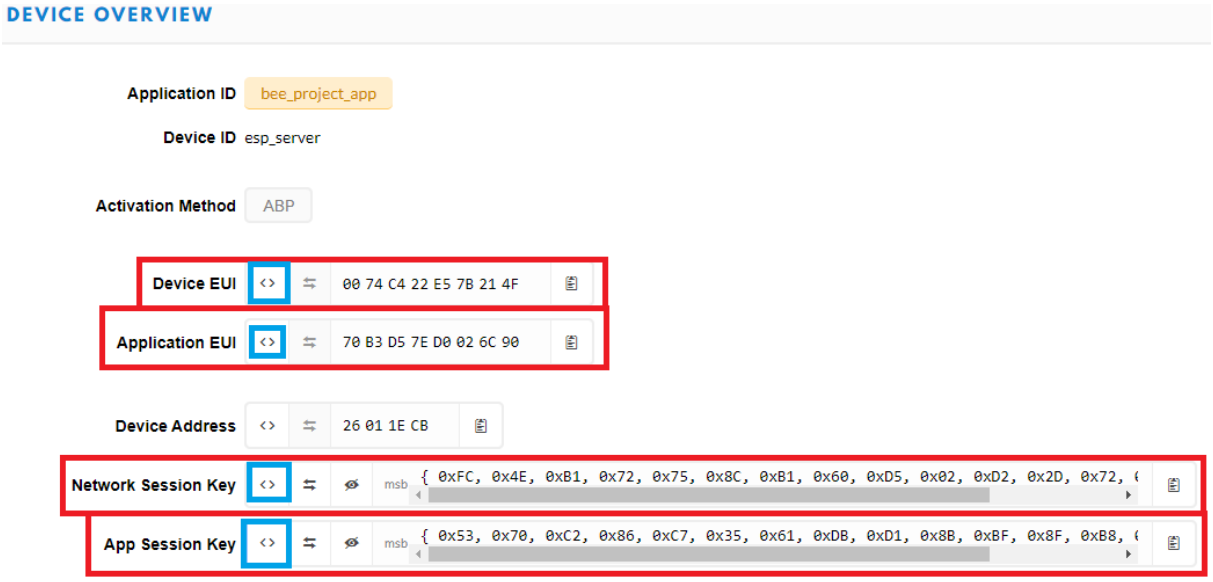


Open and modify this sketch, change:

- NWKSKEY as your own Network session key
- APPSKEY as your own App session key
- DEVADDR as your node_eui.

You can see this information on your application page on TTN website, go to

*Applications -> YOUR_APP_NAME -> Devices -> YOUR_DEVICE_NAME*

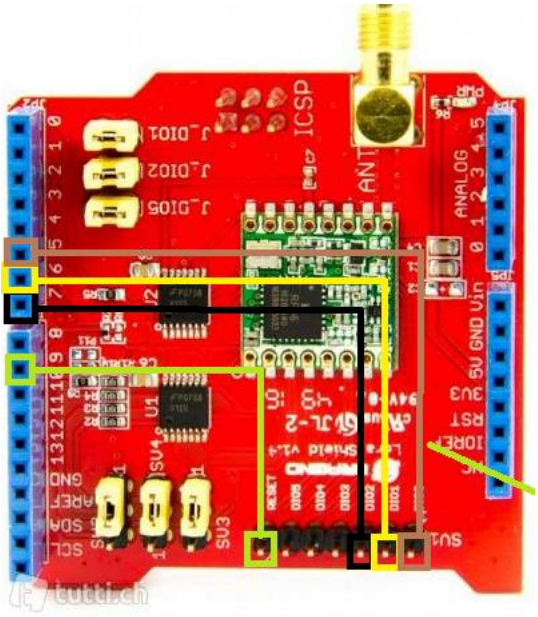



You need to put this information as same format you can see on picture. To change the format of this strings, click on button who are underlined in blue on picture.

Also, change the pins:

```
// Pin mapping
const lmic_pinmap lmic_pins = {
    .nss = 10,// Connected to pin D10
    .rxtx = LMIC_UNUSED_PIN,// For placeholder only, Do not connected on
RFM92/RFM95
    .rst = 9,// Needed on RFM92/RFM95? (probably not)
    .dio = {5, 6, 7},// Specify pin numbers for DIO0, 1, 2
// connected to D2, D6, D7
};
```

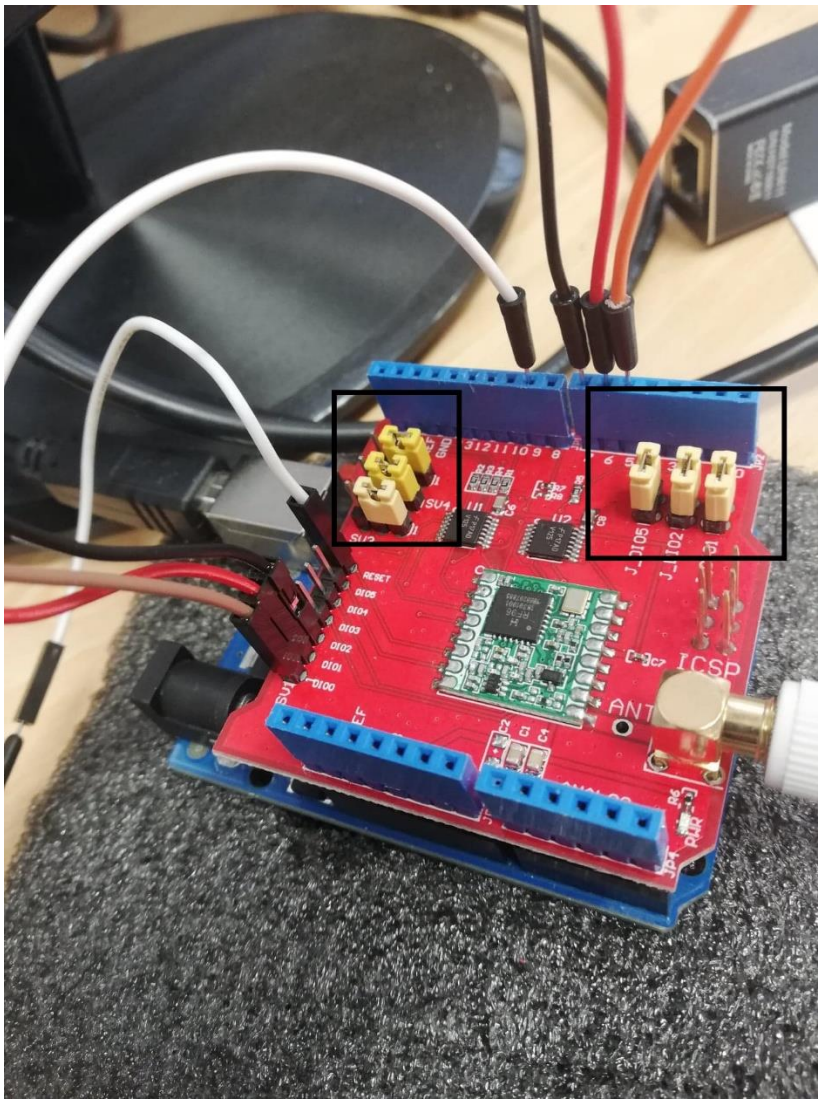
In your Arduino UNO, put the LoRa shields at the top of your Arduino and wire like that:



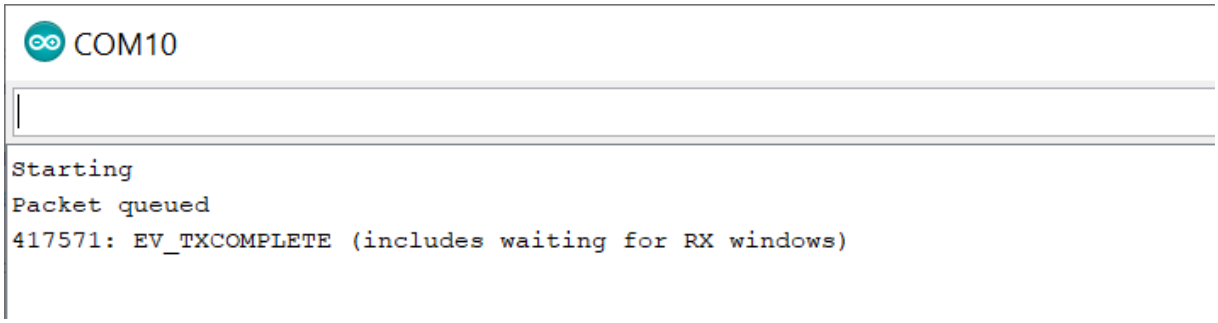

Pins:

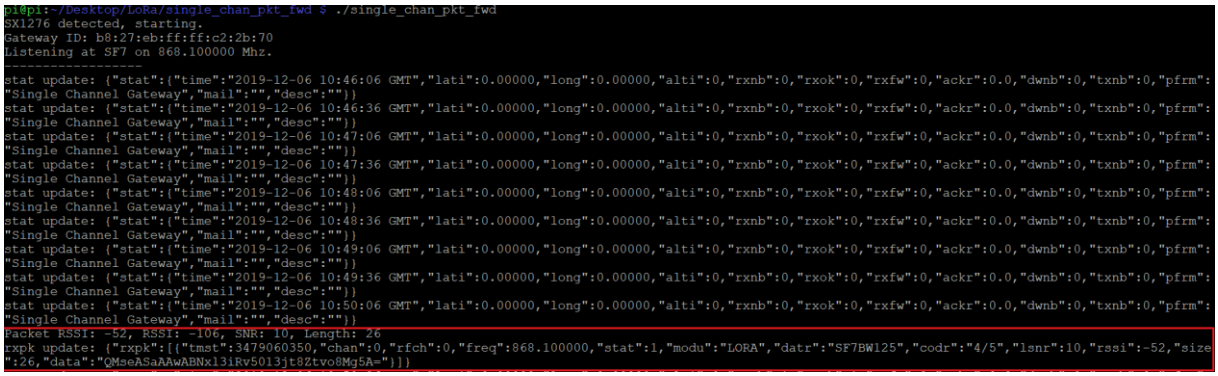
- D10: reset
- D7: DI02
- D6: DI01
- D5: DI00

After that, put the jumpers as you can see on this picture:




Choose the right port and right board to upload the sketch. Upload the program and if this works, you can see on serial monitor:




pi@pi:~/Desktop/LoRa/single_chan_pkt_fwd $ ./single_chan_pkt_fwd
SX1276 detected, starting.
Gateway ID: b8:27:eb:ff:ff:c2:2b:70
Listening at SF7 on 868.100000 Mhz.
------------------
stat update: {"stat":{"time":"2019-12-06 10:46:06 GMT","lati":0.00000,"long":0.00000,"alti":0,"rxnb":0,"rxok":0,"rxfw":0,"ackr":0.0,"dwnb":0,"txnb":0,"pfrm":
"Single Channel Gateway","mail":"","desc":""}}
stat update: {"stat":{"time":"2019-12-06 10:46:36 GMT","lati":0.00000,"long":0.00000,"alti":0,"rxnb":0,"rxok":0,"rxfw":0,"ackr":0.0,"dwnb":0,"txnb":0,"pfrm":
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Packet RSSI: -52, RSSI: -106, SNR: 10, Length: 26
rxpk update: {"rxpk":[{"tmst":3479060350,"chan":0,"rfch":0,"freq":868.100000,"stat":1,"modu":"LORA","datr":"SF7BW125","codr":"4/5","lsnr":10,"rssi":-52,"size
":26,"data":"QMseASaAAwABNxl3iRv5013jt8Ztvo8Mg5A="}]}