LoRaWan tutorial : Register a device on TTN

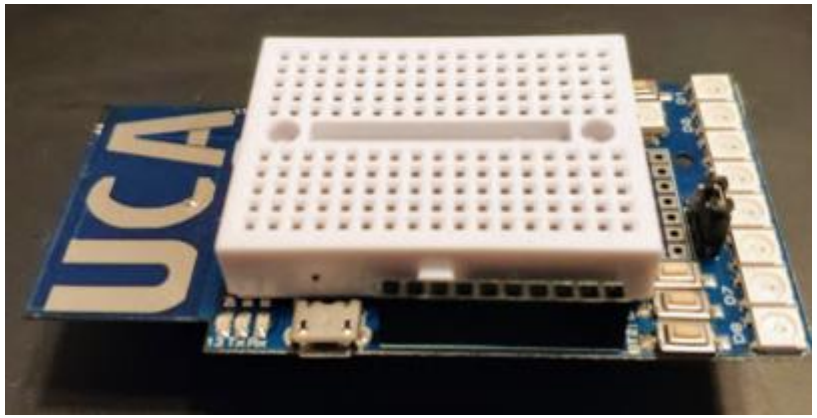
F. Ferrero, Professor @UCA

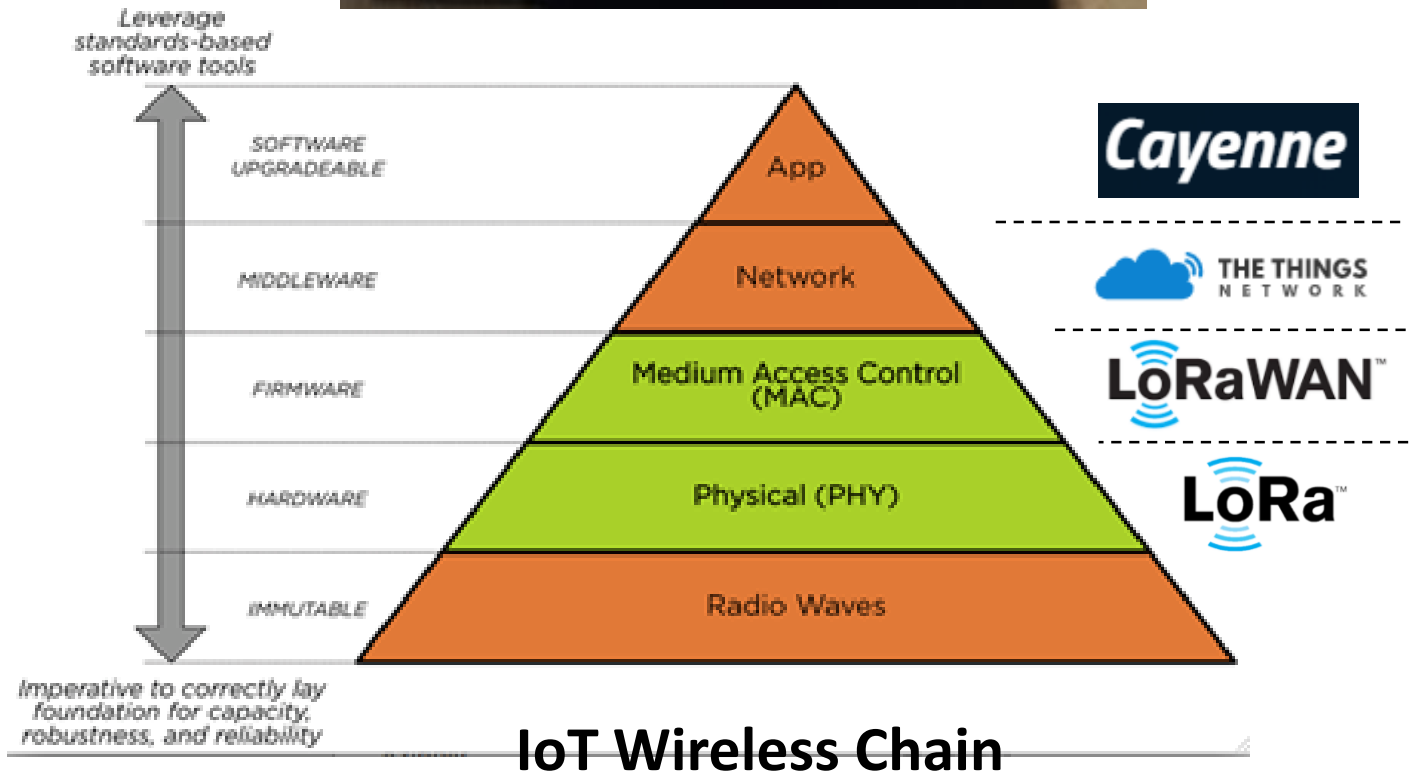
UNIVERSITÉ CÔTE D'AZUR

LoRaWan Tutorial Objectives

In this tutorial, you will :

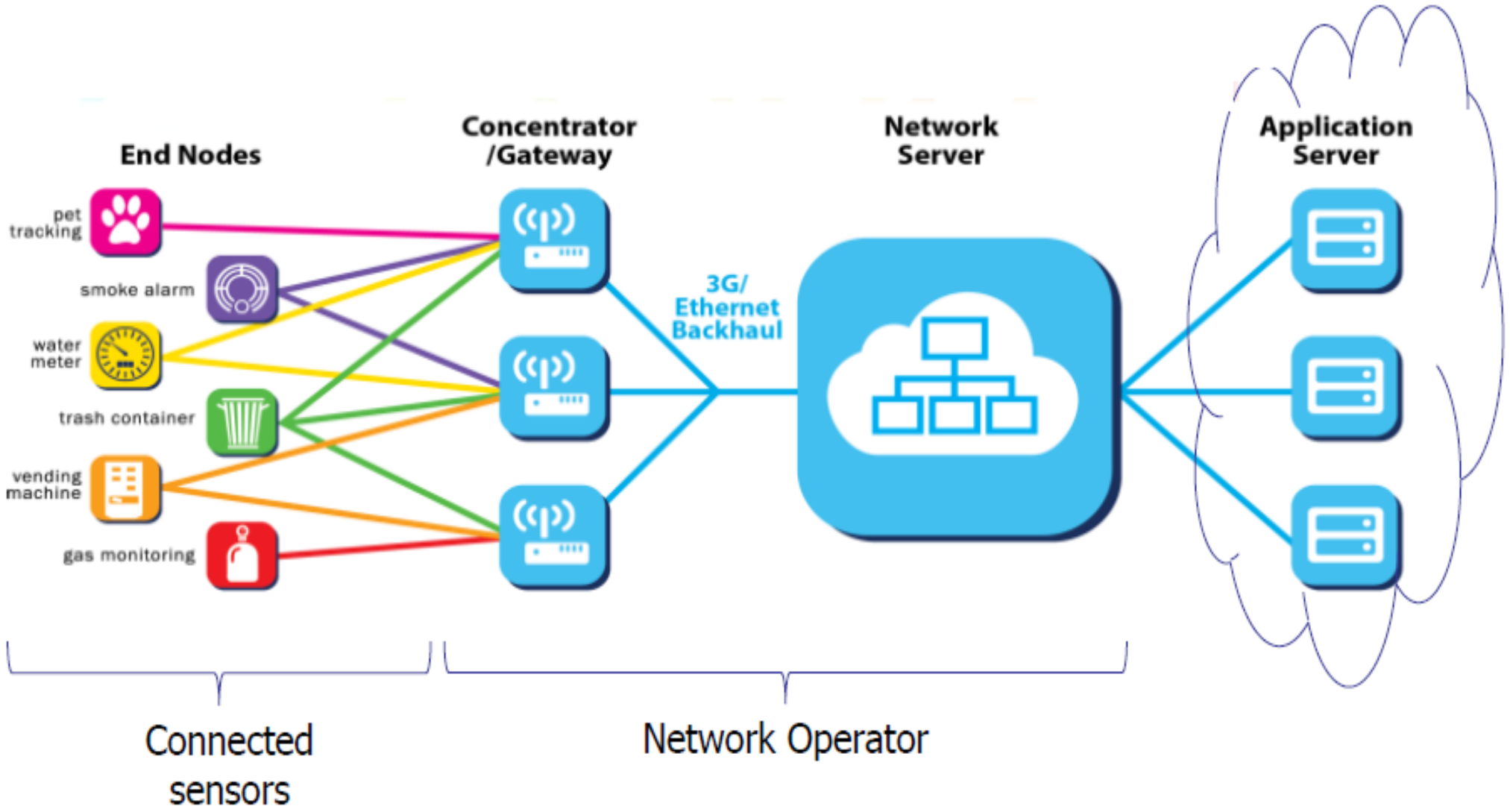
- Use the UCA Education Board
- Program a microcontroller in C with Arduino IDE
- Register the board to a network server
- Transmit data with LoRa modulation
- Push data to an application server





IoT Wireless Chain

LoRaWan Tutorial Objectives

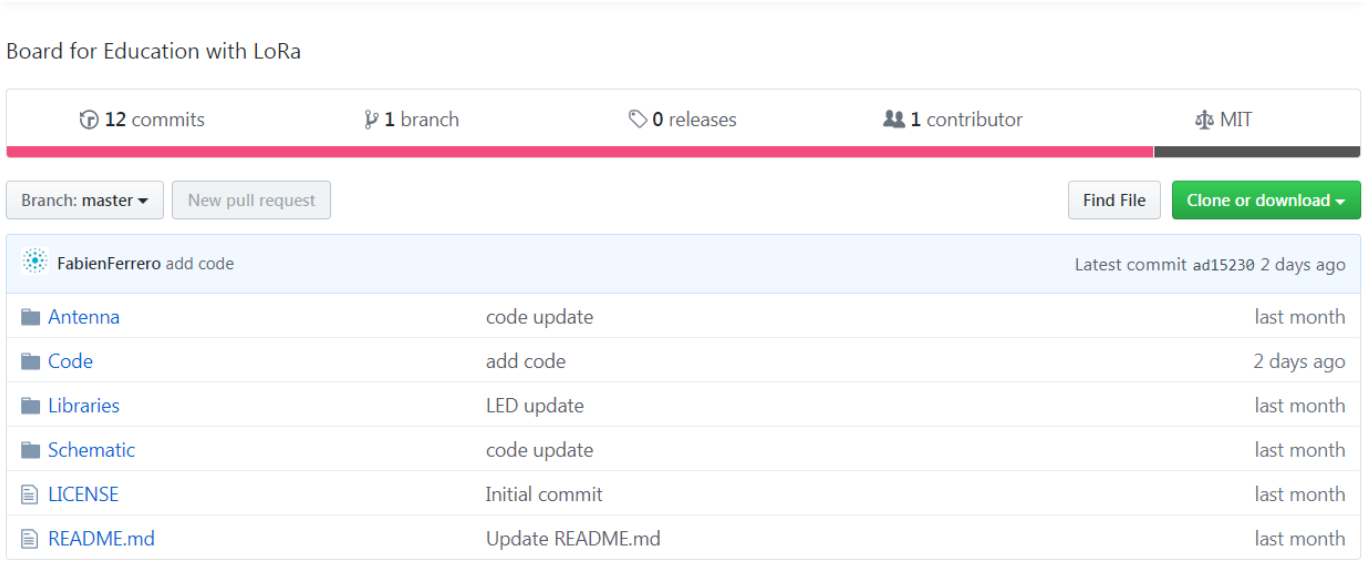


Downloading Arduino code on Github

- For this tutorial, your are going to use Arduino codes
- Codes are available on :

https://github.com/FabienFerrero/UCA_Education_Board

- You can click on “Clone or Dowload” and “download zip”
- Then unzip it
- If you are using Github Desktop, you can use “open in Desktop”

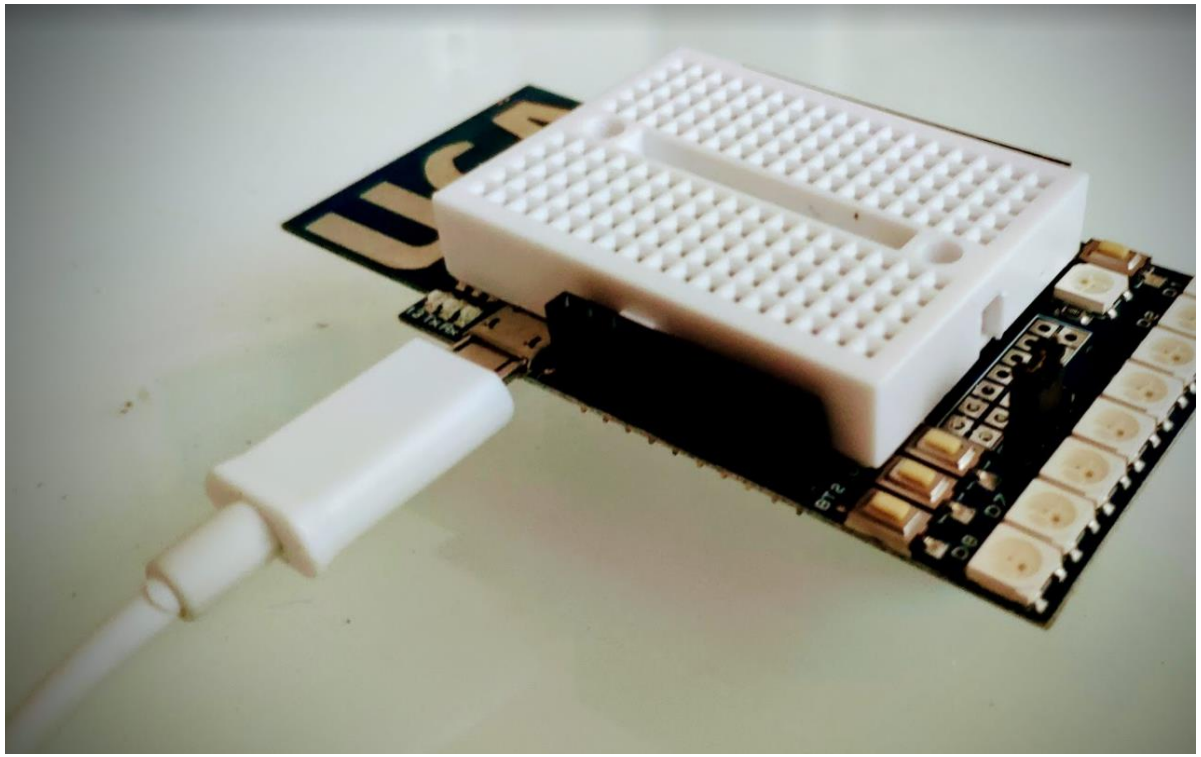


Configuring your Arduino IDE

- After downloading the archive (.zip) and extracting the archive
- Copy the file from UCA_Education_Board\Libraries to /Document/Arduino/ Libraries/

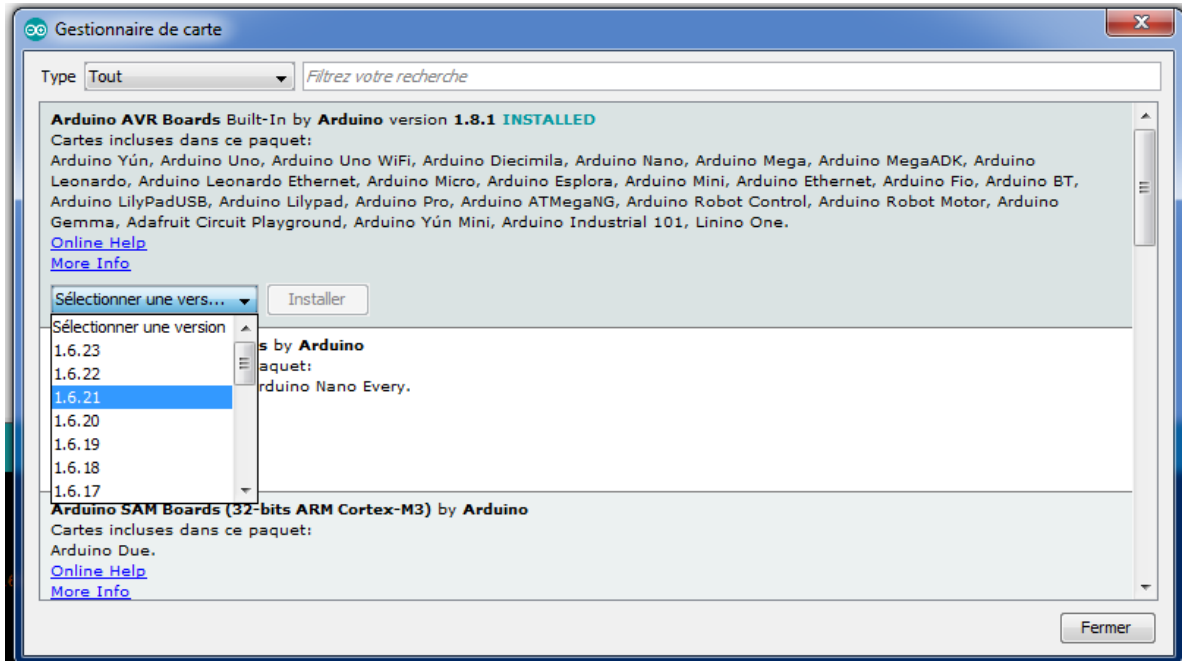
It will install the libs needed during the tutorial

- If your using Windows or Mac, your may need to install the board USB driver (CH340C) : drivers are available here
- If Arduino IDE select in Tools (Outils)
  - Board : Arduino Pro or Pro Mini
  - Processor : AT328p 8MHz 3.3V
  - Port : Select your serial port



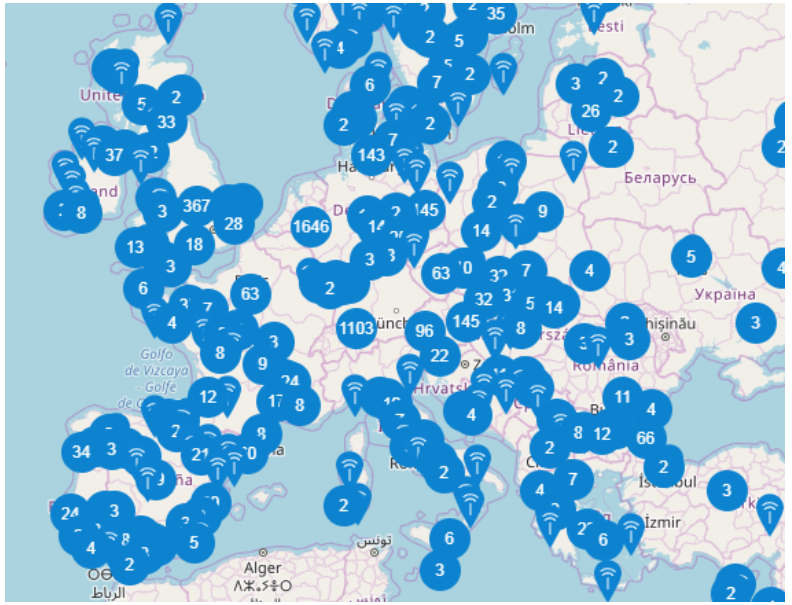
Configuring your Arduino IDE

- !Important! We have an unsolved bug in Arduino
- To avoid it, you have to go to:
  - Tools\Board\Boards Manager
  - In Arduino AVR Boards, select **1.6.21** version and **Install**
  - You will probably need to close and re-open Arduino IDE



LoRaWan with The Thing Network

- The Things Network is a **global**, open, crowd-sourced Internet of Things data network.
- **The Things Network Backend** route messages from Nodes to the right Application, and back
- TTN is free
- 10000 LoRa gateways are connected to TTN around the world
- Any TTN can use any GWs, it is a collaborative network

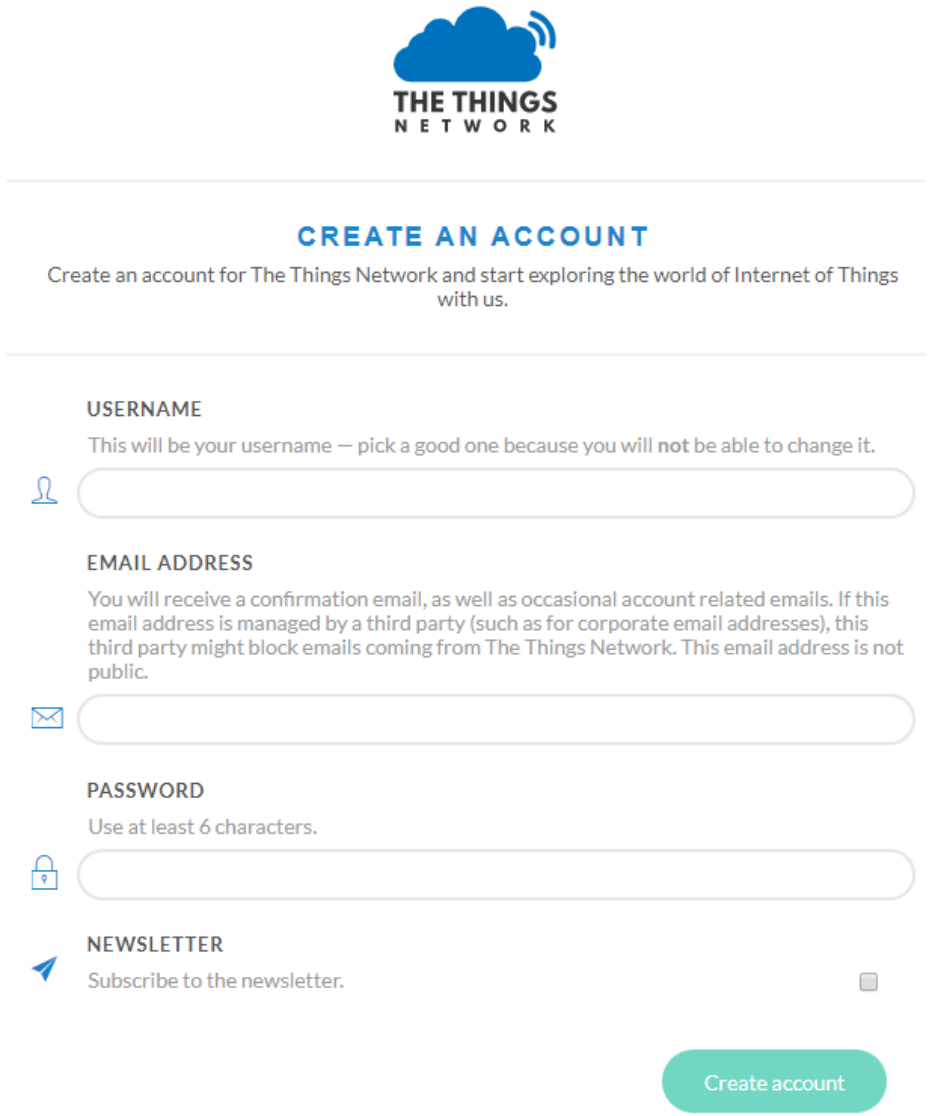


Create a TTN account

- First, you have to register to https://www.thethingsnetwork.org/
- Then, give me your USERNAME, I will add you as a collaborator in our application
- You can also join a local community :

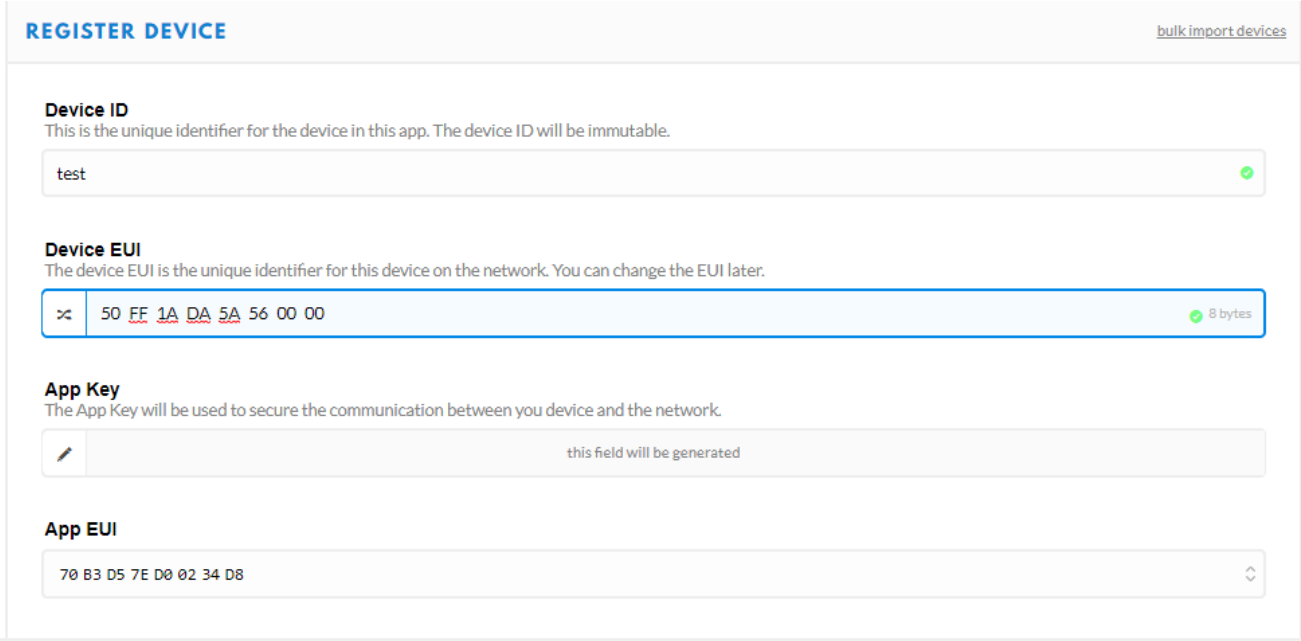
TTN Côte d'Azur

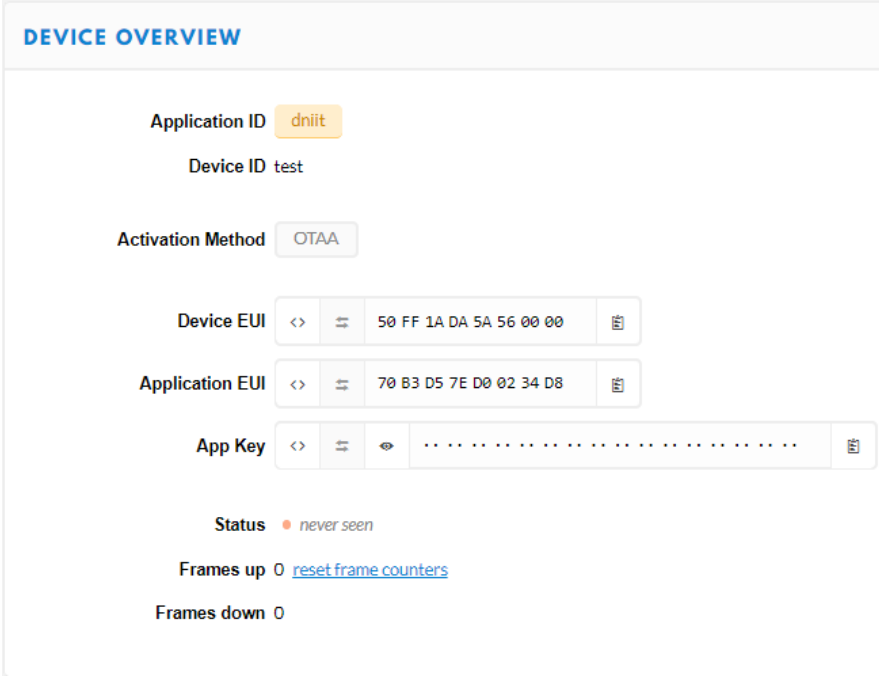
TTN Da Nang



Adding a new device

- Go to « application » and choose the available appliation
- Click on « register device »
- For ID and EUI, use the N° 50ff1aDA5A560XX and just incremant XX.
- To remember it : « 50ff1a » is for « SOPHIA » and « DA5A56 » is for DaNang
- In DEVICE OVERVIEW, you get usefull information on your device. Of course, status is : « Never Seen »
- First we will connect using ABP (Activation by Personalization)





Activation by Personalization (ABP)

- Go to settings
- Select ABP and save
- Go back to Overview
- You have now the Device Address and the two 128 AES keys
- You can click on Hex-C Style to have the key in the right format

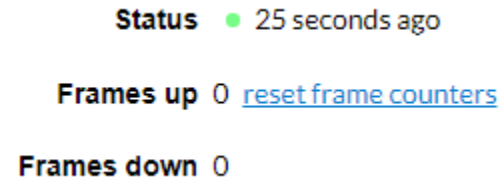
Activation by Personalization (ABP)

- Open the code UCA_Education_Board\Code\LORAWAN\ABP\Basic\UCA-ABP_Basic\UCA-ABP_Basic.ino
- Copy/Paste DEVADDR from your TTN window with « 0x » for Hex style
- Copy/Paste NWKSKEY and APPSKEY using C-style from your TTN window

```
#include <lmic.h>
#include <hal/hal.h>
#include <SPI.h>

// LoRaWAN end-device address (DevAddr)

static const u4_t DEVADDR = 0x00000000;

// LoRaWAN NwkSKey, network session key
// This is the default Semtech key, which is used by the early prototype TTN
// network.
static const PROGMEM u1_t NWKSKEY[16] = {  0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 };


// LoRaWAN AppSKey, application session key
// This is the default Semtech key, which is used by the early prototype TTN
// network.
static const u1_t PROGMEM APPSKEY[16] = {  0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 };
```

Activation by Personalization (ABP)

- Compile and download the code on your board
- Look at the TTN device overview
- Frames up should increment each half minute as your board is sending an uplink each 30s (« TX_INTERVAL »)
- Have look on Data
- For each uplink, you can look many details as RSSI, SNR, airtime, modulation, coding rate, GW ID, etc …
- Click on the blue triangle



time	counter	port		
21:45:35	3	1		payload: 48 65 6C 6C 6F 2C 20 77 6F 72 6C 64 21
21:44:29	2	1		payload: 48 65 6C 6C 6F 2C 20 77 6F 72 6C 64 21
21:43:22	1	1		payload: 48 65 6C 6C 6F 2C 20 77 6F 72 6C 64 21
21:42:16	0	1	*retry*	payload: 48 65 6C 6C 6F 2C 20 77 6F 72 6C 64 21

Activation by Personalization (ABP)

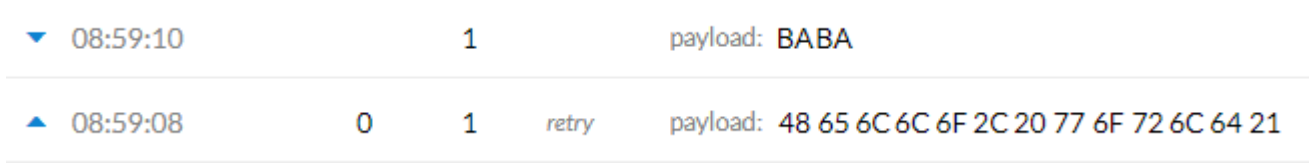
Frame counter security

- Now reset you board (click on the right button on your board)
- TTN is no more receiving the data
- Click on « reset frame counters » and reset you board again
- As you can see, frame counter is a security features to avoid replay attack (done by capturing and re-transmitting the messages)
- Frame counter can be disabled for debug test in Settings

Downlink

- Open your serial monitor
- In TTN overview, go to downling, add a payload like « BABA » and click on send, and go to Data
- After the next uplink, you should see the number of byte received in downlink

```
Starting
Packet queued
150865: EV_TXCOMPLETE (includes waiting for RX windows)
Received
2
 bytes of payload
BABA
```



Activation by Personalization (ABP)

Change SF, power, payload …

- At the end of the arduino code, you can find :

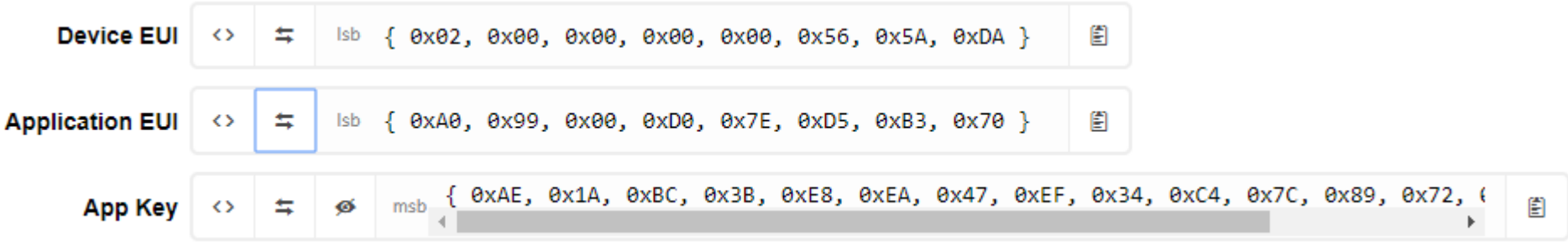
LMIC_setDrTxpow(DR_SF12,14);

- You can change Spreading Factor(SF) from DR_SF7 to DR_SF12
- You can change the power from 2 dBm to 20 dBm
- Payload is in mydata[], and you can change the text.
- You can convert the payload in Hex to normal text using this online tool

- Change SF and Payload text ! What is the effect on Time on Air ?

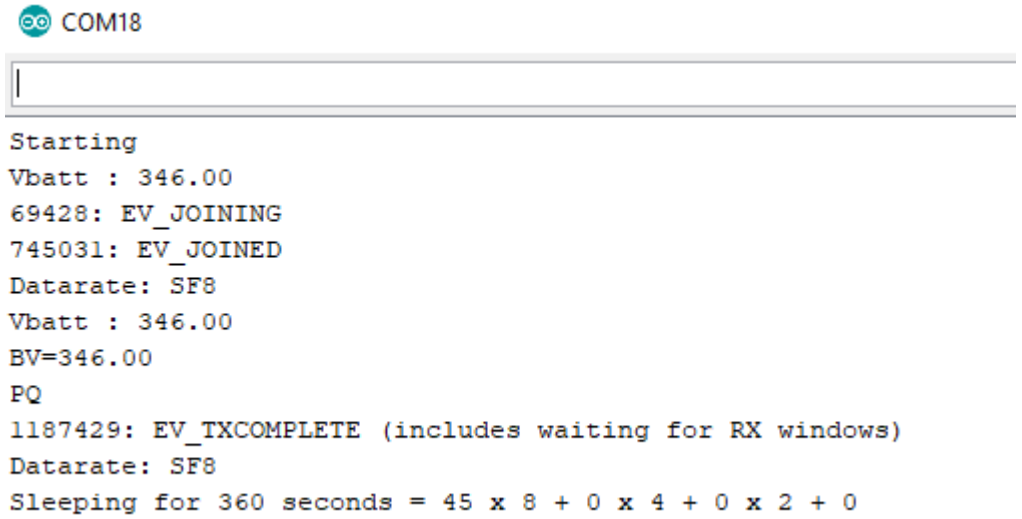
Over the Air Activation (OTAA)

- In TTN Settings of your device, select OTAA and save
- Open the code UCA_Education_Board\Code\LORAWAN /OTAA/LP_Basic/UCA-OTAA_Basic.ino
- Copy paste after clicking on hexa-style the DEV-EUI, APP-EUI and App Key
- Be carefull !!!
  - Device EUI and Application EUI are **lsb**
  - App Key is **msb**



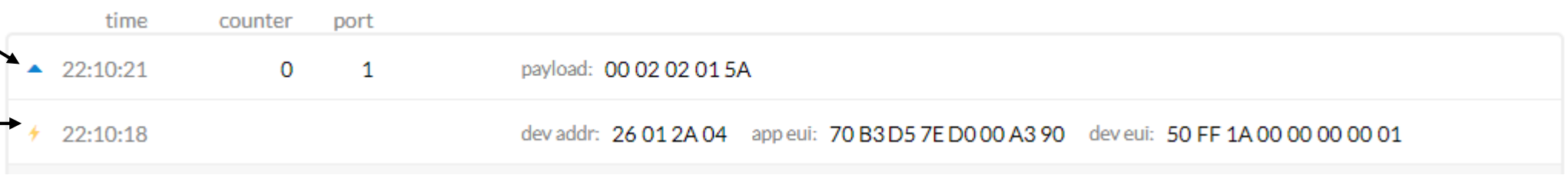
Over the Air Activation (OTAA)

- Look in data
- You should see a first uplink that request the connection
- And a second packet witht the first data
- On the serial monitor you can see the Joining process and then Joined and Tx.
- The device go to sleep after the Tx



First packet with data

Board request for connection

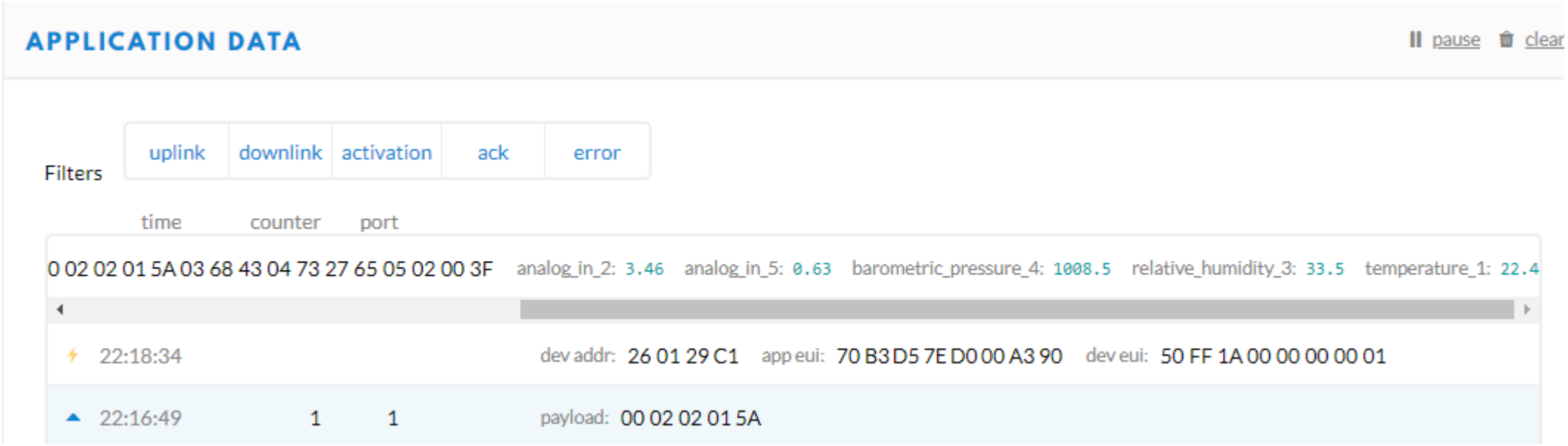


Over the Air Activation (OTAA) and sensor

- You are now going to use a sensor
- Depending on the sensor available from your instructor, you may use :
  - BME280 : T°c, Humidity and Pressure with I2C connection
  - SI7021 : T°c and Humidity with I2C connection
  - TEMT6000 : Ambiant light with analog output
  - SRC4+ : Distance with digital connection
  - Or else …
- You have to wire the sensor on the breadboard on the UCA board

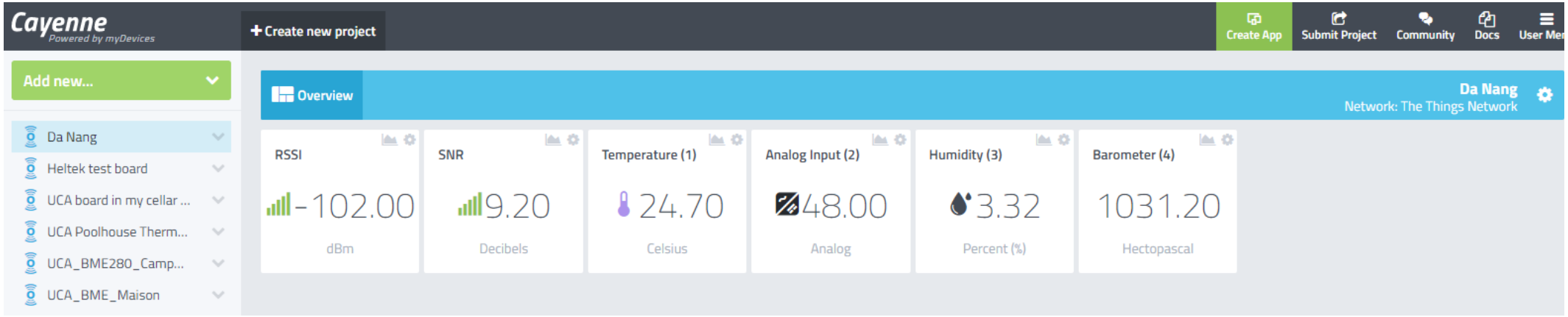
Over the Air Activation (OTAA) and data

- Select in UCA_Education_Board\Code\LORAWAN\OTAA\ the code that correspond to your sensor
- The code is using Cayenne LPP format
- Now you can see sensor data in the uplink packet



Using Cayenne to see you data

- Go to https://developers.mydevices.com/cayenne/features/ and sign up
- Add a device by selecting LoRa/TheThingsNetwork and Cayenne LPP.
- Just add your device EUI
- You should see your data



Downlink with LoRaWAN

- You are now going to control the LED color from CAYENNE.
- Use the code in : LORAWAN/OTAA/LED_CONTROLLER/
- Change APPEUI, DEVEUI and AppsKey

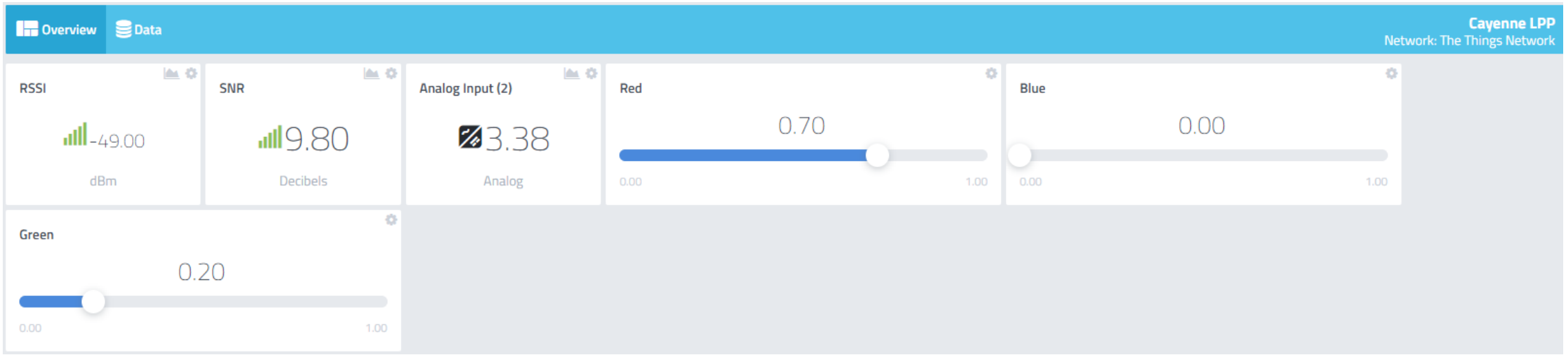
In LoRaWAN Class A, a downlink can be scheduled from the network server.

When the node make an uplink, the downlink is realized 1 second after the uplink.

Then the downlink latency depends on the uplink pace.

Downlink with LoRaWAN

- Upload the code
- It will send uplink all 15 seconds
- The LED are controlled by a value between 0 and 1
- Change the value in your slider to change the LED colors
- What is the control latency ?

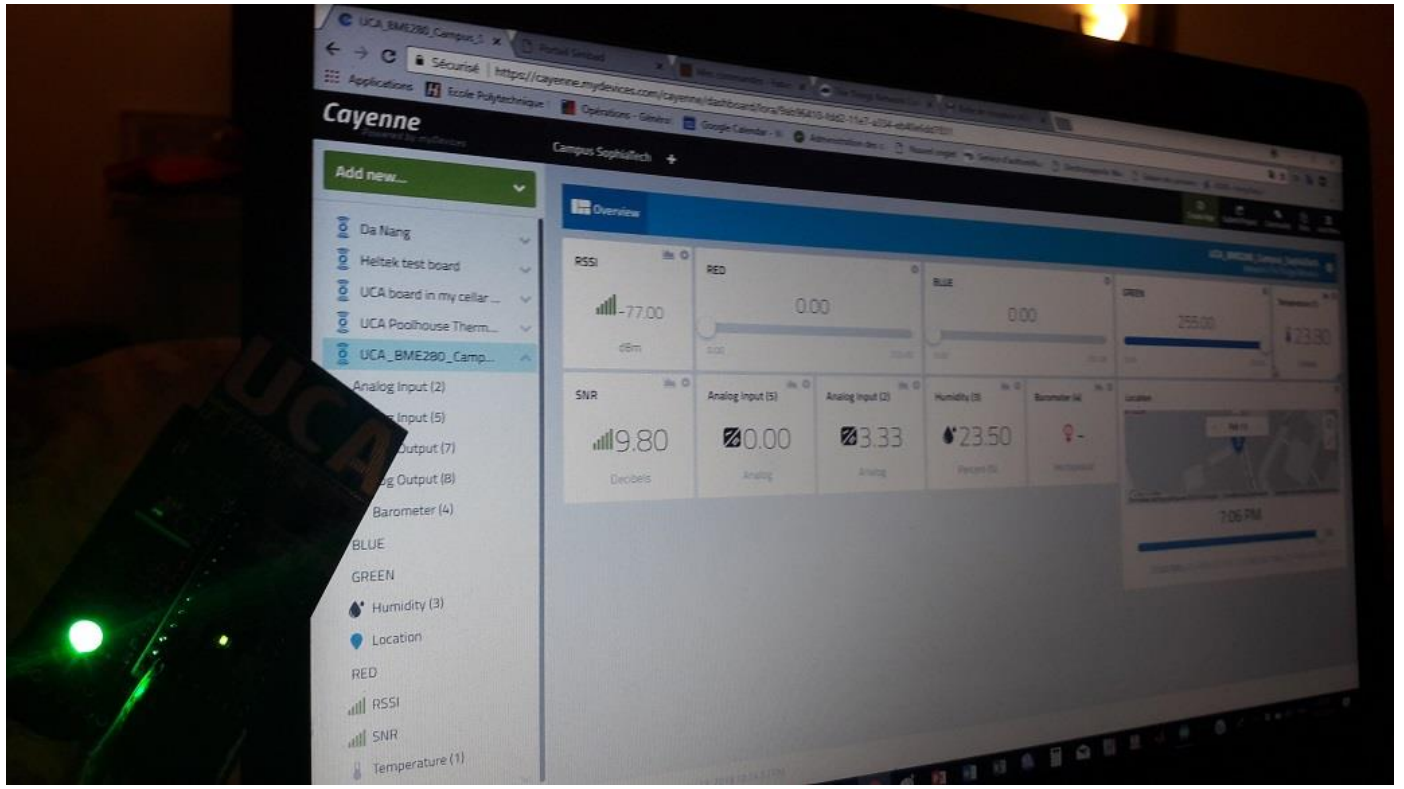


Downlink with LoRaWAN

- When you change the slider value, look at your data in TTN
- You should see that the downlink is scheduled
- Then it is confirmed and the node send an ack

Downlink with LoRaWAN

- After each uplink, the node open a received window for downlink
- With Cayenne, only one color can be updated at the same time



Good luck for you projects !

This board as been funded by UCA

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