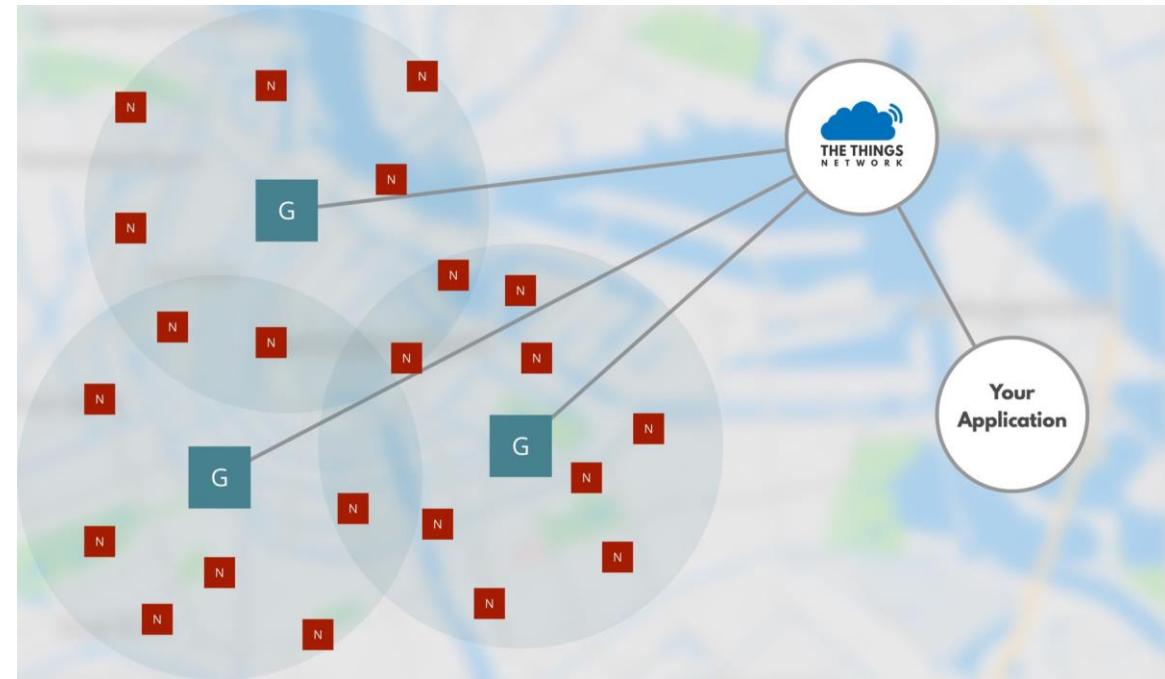


LoRaWan Register a device on TTN in Vietnam

F. Ferrero

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
- First, you have to register to <https://www.thethingsnetwork.org/> , when it is done, tell me your ID, I will add you as a collaborator on the Polytech' application
- You can also join the [Da Nang TTN community](#) :



Adding a new device

- Go to « Sensor Test Da Nang » application and register device
- For ID and EUI, use the N° da5a5600000000XX and just increment XX.
- To remember it : « da5a56 » is for « DANANG »
- It will provide Device EUI, Application EUI and App Key

Activation Method OTAA

Device EUI <> ↕ DA 5A 56 00 00 00 00 02 📋

Application EUI <> ↕ 70 B3 D5 7E D0 00 99 A0 📋

App Key <> ↕ 👁 📋

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 Method **ABP**

Device EUI

Application EUI

Device Address

Network Session Key

App Session Key

Activation by Personalization (ABP)

- Go to my Github : https://github.com/FabienFerrero/UCA_Board
- Download the archive (.zip) and extract the archive
- Copy the file from Arduino_Code/Libraries/ to /Document/Arduino/Libraries/
- Open the code Arduino_Code/LORAWAN/ABP/Basic/UCA-ABP_Basic.ino
- Copy/Paste NWKSKY, APPSKY and DEVADDR with your IDs from TTN

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

// LoRaWAN end-device address (DevAddr)

static const u4_t DEVADDR = 0x00000000;
```

Activation by Personalization (ABP)

- Select the 923MHz Vietnamese band (AS923)
- In /Document/Arduino/ Libraries/arduino-lmic-custom/src/lmic
- Edit config.h file
- Comment the #define CFG_eu868 1 line
- Uncomment the #define CFG_as923 1 line

```
#ifndef _lmic_config_h_
#define _lmic_config_h_

// In the original LMIC code, these config values were defined on the
// gcc commandline. Since Arduino does not allow easily modifying the
// compiler commandline, use this file instead.

// #define CFG_eu868 1
// #define CFG_us915 1
#define CFG_as923 1
// This is the SX1272/SX1273 radio, which is also used on the HopeRF
// RFM92 boards.
// #define CFG_sx1272_radio 1
// This is the SX1276/SX1277/SX1278/SX1279 radio, which is also used on
// the HopeRF RFM95 boards.
#define CFG_sx1276_radio 1
```

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 ...

Status ● 25 seconds ago

Frames up 0 [reset frame counters](#)

Frames down 0

	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 red button on the Arduino mini pro)
- 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
```

▼ 08:59:10	1	payload: BABA
▲ 08:59:08	0	1 retry payload: 48 65 6C 6C 6F 2C 20 77 6F 72 6C 64 21

Activation by Personalization (ABP)

Change SF, power, payload ...

- At the end of the arduino code, you have :

`LMIC_setDrTxpow(DR_SF12,14);`

- You can change 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.
- Do some test, what is the effect on the RSSI ?

Over the Air Activation (OTAA)

- In TTN Settings of your device, select OTAA and save
- Open the code Arduino_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**

Device EUI	<>	⇄	lsb	{ 0x02, 0x00, 0x00, 0x00, 0x00, 0x56, 0x5A, 0xDA }	📋
Application EUI	<>	⇄	lsb	{ 0xA0, 0x99, 0x00, 0xD0, 0x7E, 0xD5, 0xB3, 0x70 }	📋
App Key	<>	⇄	👁	msb { 0xAE, 0x1A, 0xBC, 0x3B, 0xE8, 0xEA, 0x47, 0xEF, 0x34, 0xC4, 0x7C, 0x89, 0x72, (📋

Over the Air Activation (OTAA)

- Look in data
- You should see a first uplink that request the connection
- And a second packet with 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

COM18

```
Starting
Vbatt : 346.00
69428: EV_JOINING
745031: EV_JOINED
Datarate: SF8
Vbatt : 346.00
BV=346.00
PQ
1187429: EV_TXCOMPLETE (includes waiting for RX windows)
Datarate: SF8
Sleeping for 360 seconds = 45 x 8 + 0 x 4 + 0 x 2 + 0
```

First packet
with data

Board
request for
connection

	time	counter	port	
First packet with data	▲ 22:10:21	0	1	payload: 00 02 02 01 5A
Board request for connection	⚡ 22:10:18			dev addr: 26 01 2A 04 appeui: 70 B3 D5 7E D0 00 A3 90 dev eui: 50 FF 1A 00 00 00 00 01

Over the Air Activation (OTAA) and data

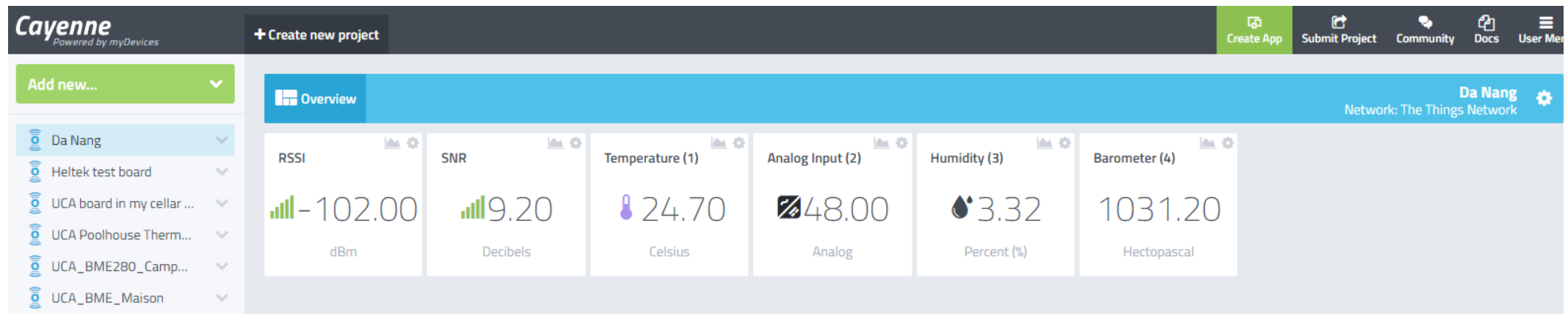
- Try now the code
Arduino_Code/LORAWAN/OTAA/LP_BME280/UCA-BME280.ino
- It use the sensor BME280 that measure T°C, Humidity and Pressure
- The code is using [Cayenne LPP format](#)
- Now you can see sensor data in the uplink packet

The screenshot displays the 'APPLICATION DATA' section of a Cayenne LPP format interface. At the top right, there are controls for 'pause' and 'clear'. Below this, a 'Filters' section contains buttons for 'uplink', 'downlink', 'activation', 'ack', and 'error'. The main data area shows a table of sensor readings with columns for 'time', 'counter', and 'port'. The data is presented in a scrollable format, showing a sequence of packets. The first packet is highlighted in light blue and contains the following data: '0 02 02 01 5A 03 68 43 04 73 27 65 05 02 00 3F' followed by sensor readings: 'analog_in_2: 3.46', 'analog_in_5: 0.63', 'barometric_pressure_4: 1008.5', 'relative_humidity_3: 33.5', and 'temperature_1: 22.4'. Below the data, there is a timestamp '22:18:34' and device information: 'dev addr: 26 01 29 C1', 'app eui: 70 B3D5 7ED000 A3 90', and 'dev eui: 50 FF 1A 00 00 00 00 01'. The second packet is also highlighted in light blue and contains the following data: '22:16:49', '1', '1', and 'payload: 00 02 02 01 5A'.

time	counter	port
0 02 02 01 5A 03 68 43 04 73 27 65 05 02 00 3F		
analog_in_2: 3.46 analog_in_5: 0.63 barometric_pressure_4: 1008.5 relative_humidity_3: 33.5 temperature_1: 22.4		
22:18:34		
dev addr: 26 01 29 C1 app eui: 70 B3D5 7ED000 A3 90 dev eui: 50 FF 1A 00 00 00 00 01		
22:16:49	1	1
payload: 00 02 02 01 5A		

Using Cayenne to see you data

- Go to <https://mydevices.com/> and create an account
- Add a device by selecting LoRa/TheThingNetwork and Cayenne LPP.
- Just add your device EUI
- You should see your data



Downlink with LoRaWAN

- You are not going to control the color of a LED from CAYENNE.
- Use the code in :
https://github.com/FabienFerrero/UCA_Board/tree/master/Arduino_Code/LORAWAN/OTAA/LED_CONTROLLER

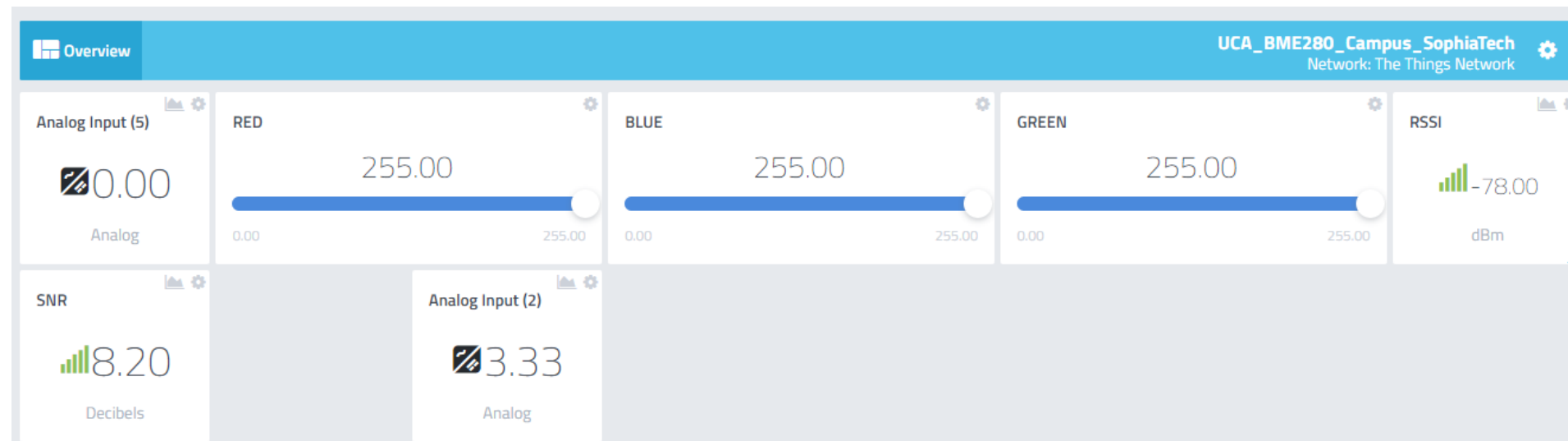
Downlink with LoRaWAN

- You are now going to control the color of a LED from CAYENNE.
- Use the code in :
https://github.com/FabienFerrero/UCA_Board/tree/master/Arduino_Code/LORAWAN/OTAA/LED_CONTROLLER



Downlink with LoRaWAN

- Upload the code
- It will send uplink all 15 seconds
- The LED are controlled by a PWM with 255 states
- Change in your Cayenne Dashboard to have the slider from 0 to 255



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

Filters

uplink

downlink

activation

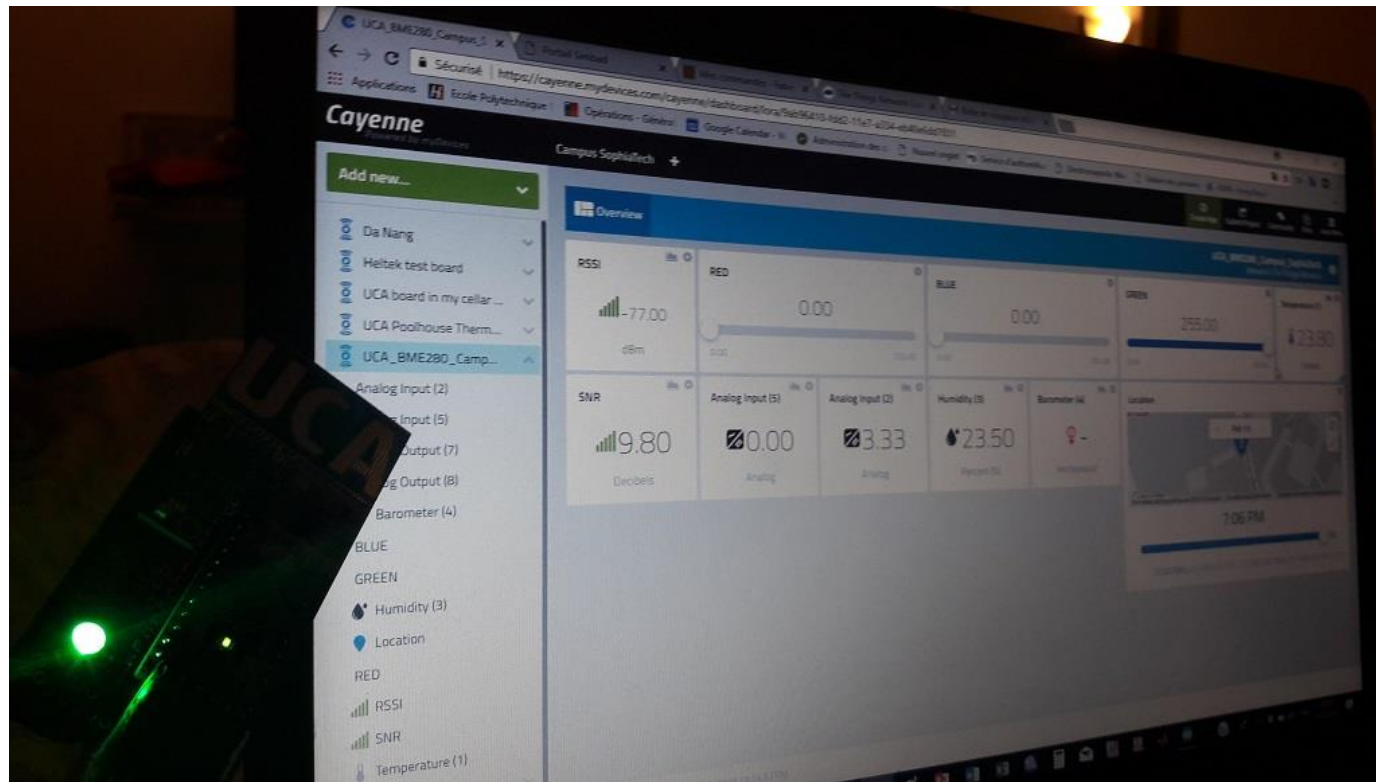
ack

error

	time	counter	port		
▲	14:13:28	8	1	payload: 02 02 01 51 06 03 00 00 07 03 00 FF 08 03 00 00	analog_in_2: 3.37 analog_out_6: 0 analog_out_
✓	14:13:28		99	confirmed ack	app id: campus_sophiatech
▼	14:13:16		99	confirmed	payload: 07 63 9C FF
▲	14:13:15	7	1	payload: 02 02 01 52 06 03 00 00 07 03 00 00 08 03 00 00	analog_in_2: 3.38 analog_out_6: 0 analog_out_
▼	14:13:11		99	scheduled confirmed	payload: 07 63 9C FF
▲	14:13:03	6	1	payload: 02 02 01 51 06 03 00 00 07 03 00 00 08 03 00 00	analog_in_2: 3.37 analog_out_6: 0 analog_out_

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 !

