LoRaWan tutorial : Register a device on TTN V3

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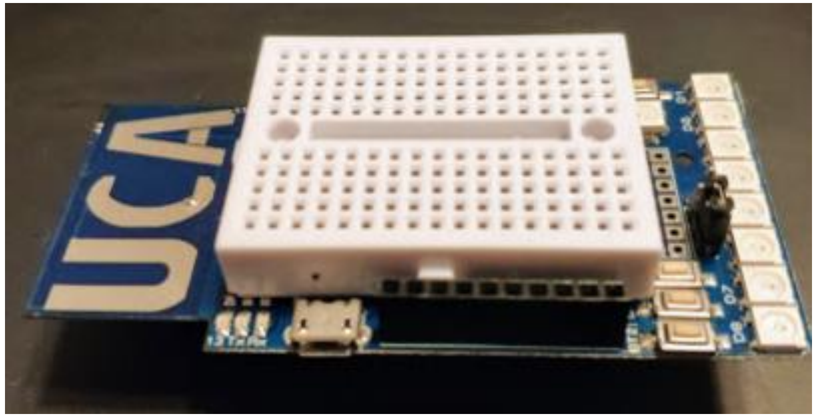
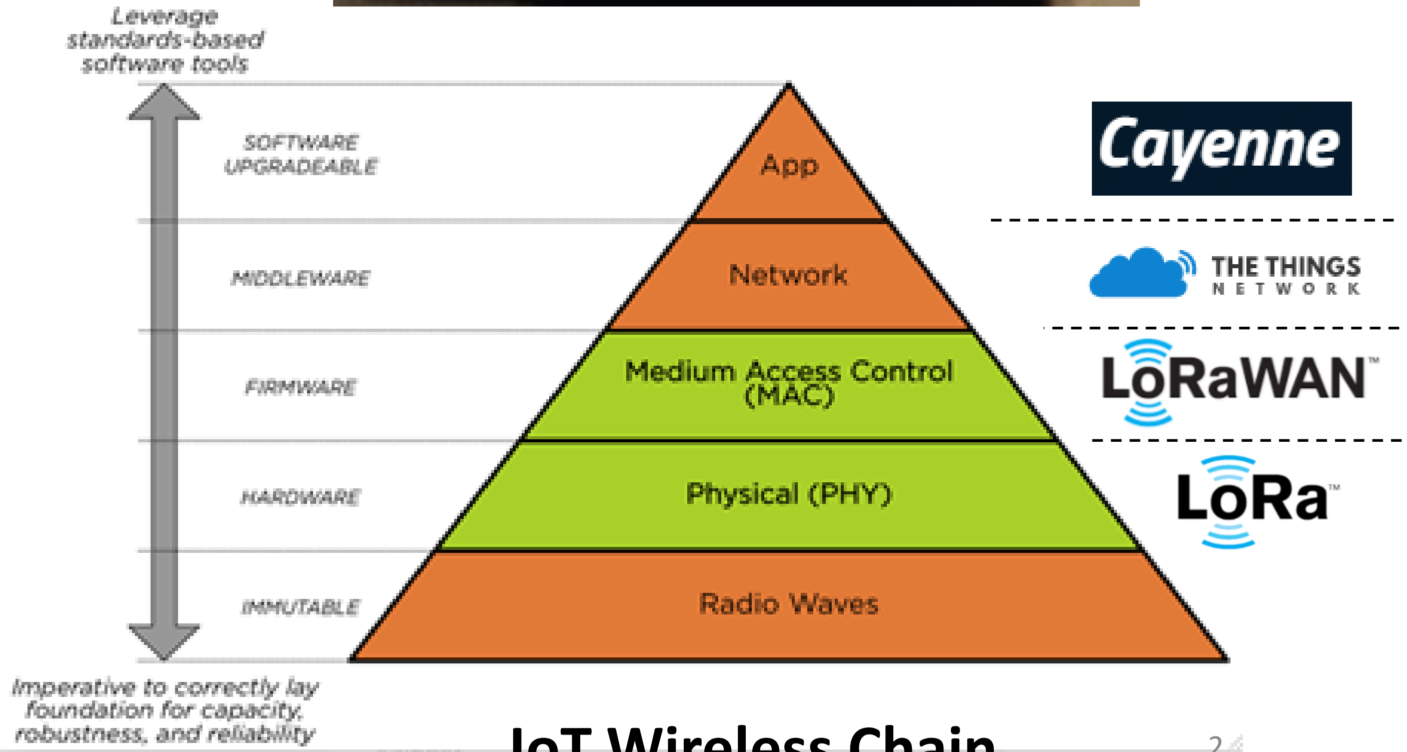
UNIVERSITÉ CÔTE D'AZUR

LoRaWan Tutorial Objectives

In this tutorial, you will :

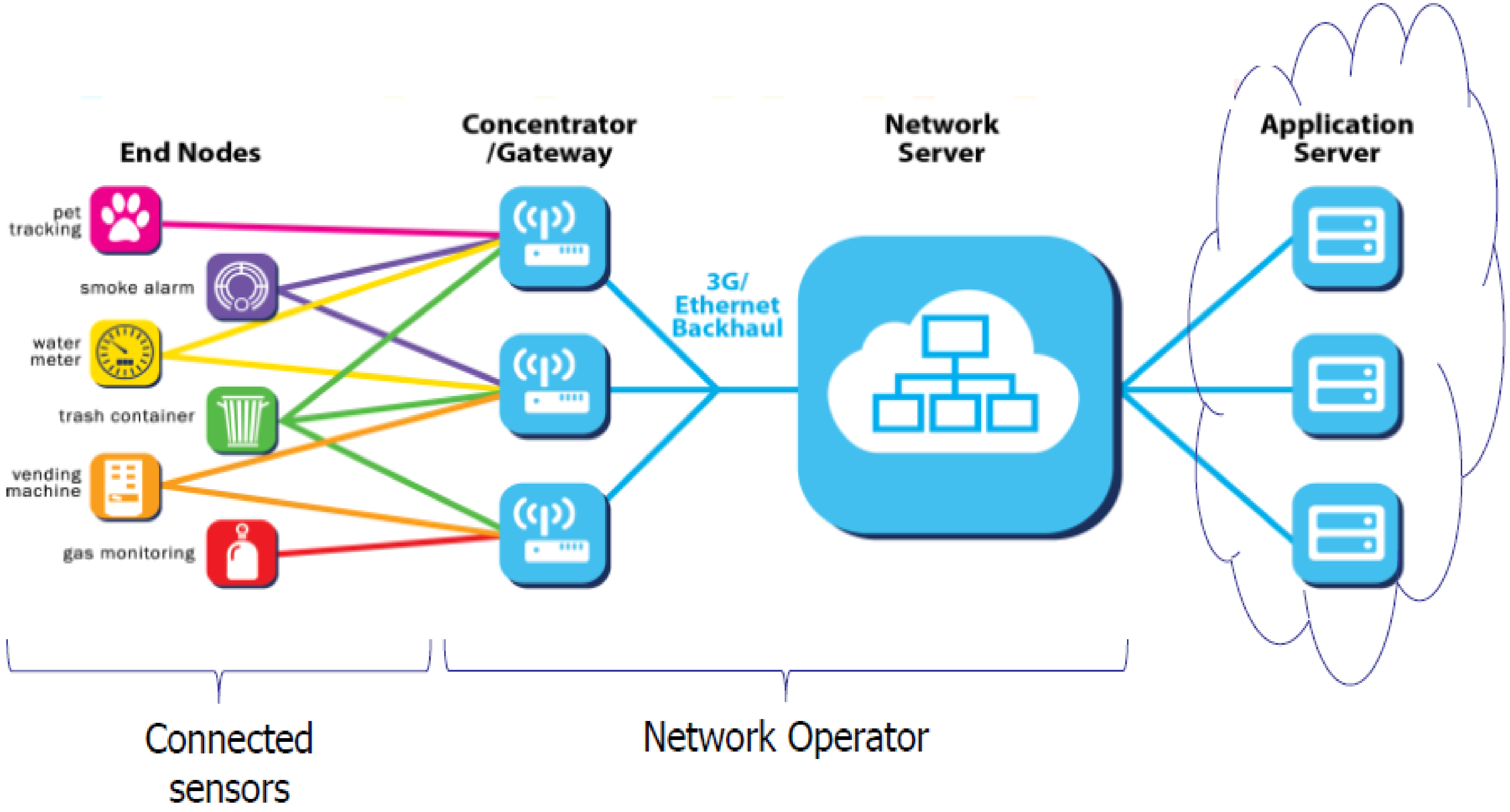
- Use the UCA Education Board
- Program a microcontroller in C with Arduino IDE
- Register the board to a network server
- Transmit data with LoRa modulation
- Push data to an application server




Leverage standards-based software tools
SOFTWARE UPGRADEABLE
MIDDLEWARE
FIRMWARE
HARDWARE
IMMUTABLE
Imperative to correctly lay foundation for capacity, robustness, and reliability
App
Network
Medium Access Control (MAC)
Physical (PHY)
Radio Waves
Cayenne
THE THINGS NETWORK
LoRaWAN
LoRa

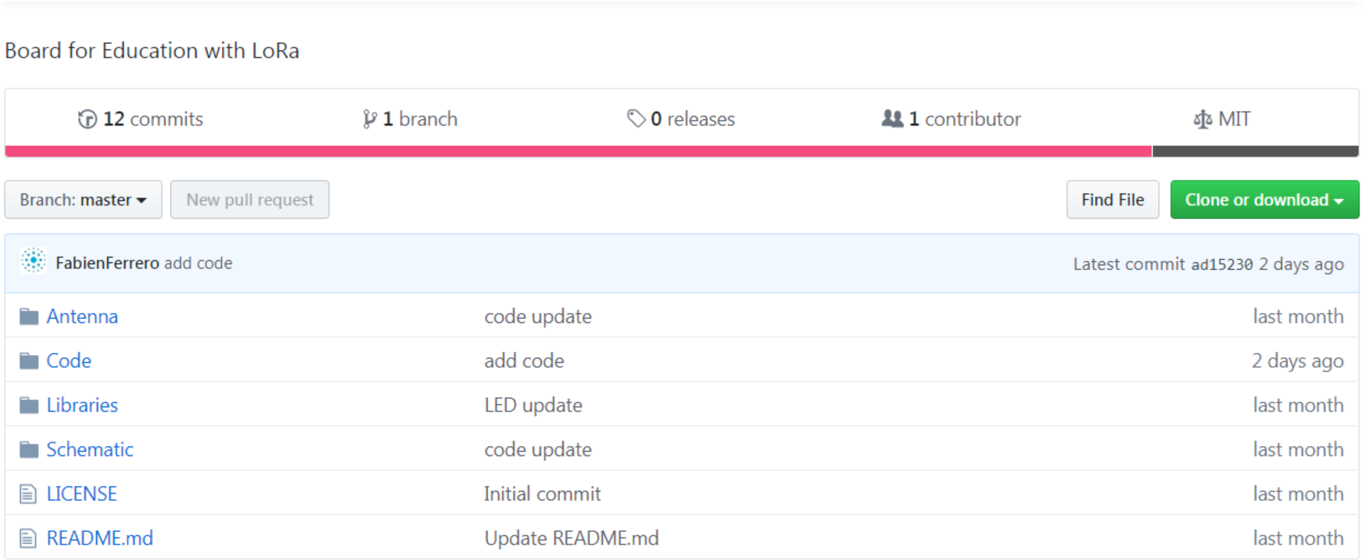
IoT Wireless Chain

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/UCA21
- 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"



Board for Education with LoRa

FabienFerrero add code Latest commit ad15230 2 days ago

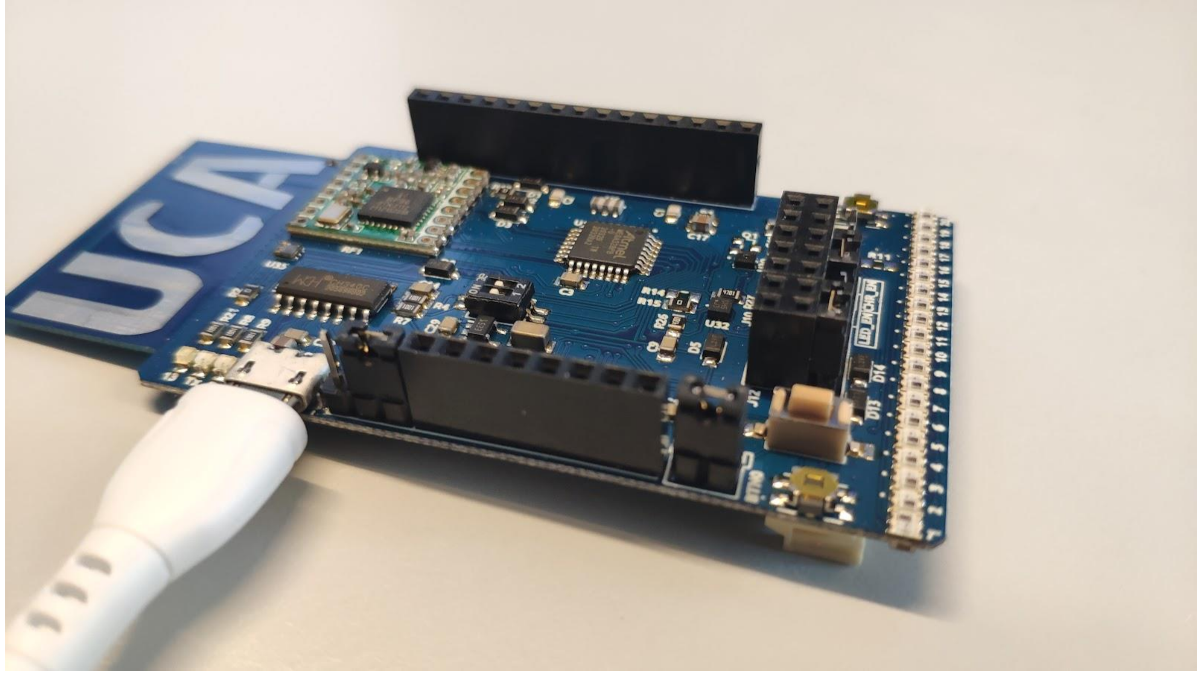
Antenna	code update	last month
Code	add code	2 days ago
Libraries	LED update	last month
Schematic	code update	last month
LICENSE	Initial commit	last month
README.md	Update README.md	last month

Configuring your Arduino IDE

- After downloading the archive (.zip) and extracting the archive
- Copy the file from : UCA21\Libraries to /Document/Arduino/ Libraries/

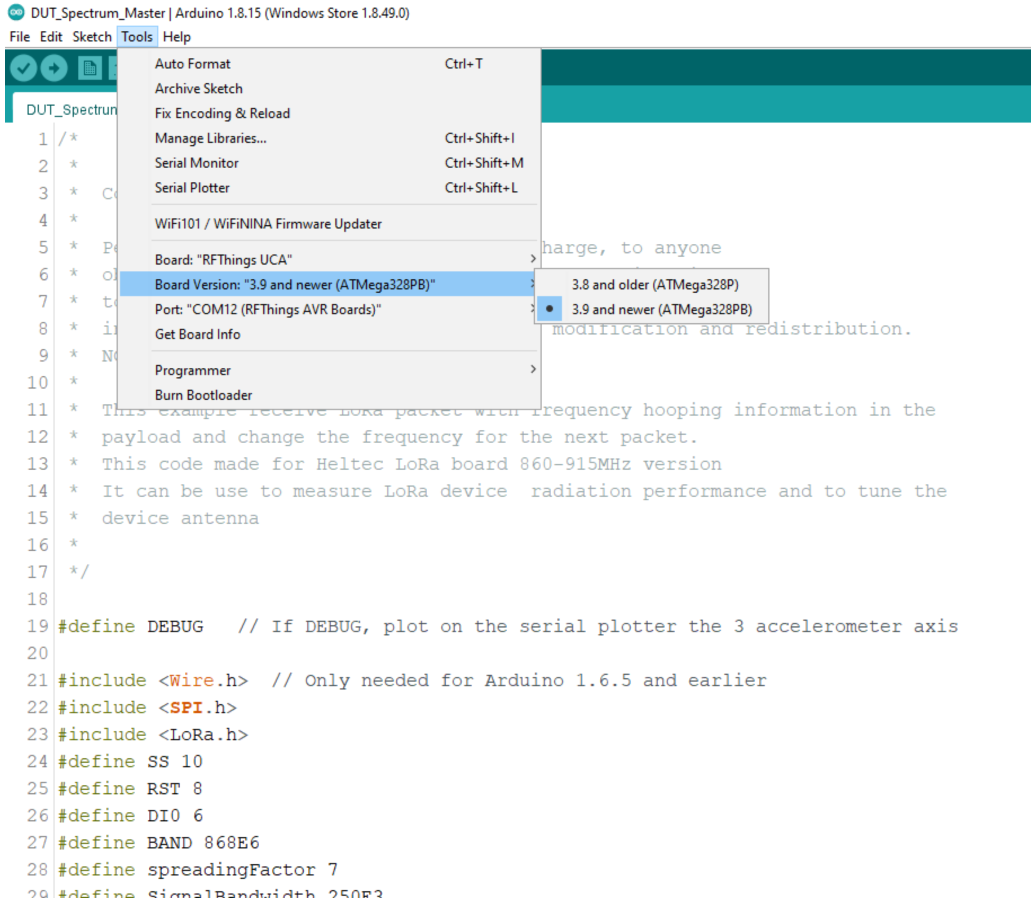
It will install the libs needed during the tutorial

- If your using Windows or Mac, your may need to install the board USB driver (CH340C) : drivers are available here



Configuring your Arduino IDE

- Start the Arduino IDE
- Go into Preferences
- Add “***https://rfthings.com.vn/wp-content/uploads/package_rfthings-avr_index.json***” as an "Additional Board Manager URL"
- Open the Boards Manager from the Tools -> Board menu and install "RFTHings AVR Boards by RFThings Vietnam"
- Select your RFTHings UCA board from the Tools -> Board menu
- Select Board version "3.9 and newer : AT328PB" from the Tools -> Board menu
- Select the port



DUT_Spectrum_Master | Arduino 1.8.15 (Windows Store 1.8.49.0)

Board: "RFThings UCA"

Board Version: "3.9 and newer (ATMega328PB)"

Port: "COM12 (RFThings AVR Boards)"

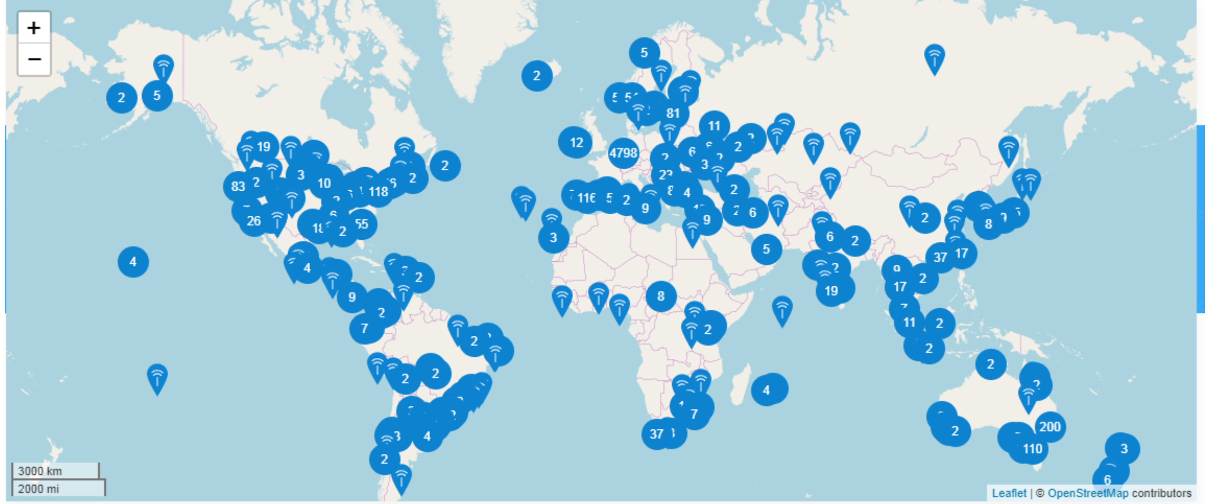
3.8 and older (ATMega328P)

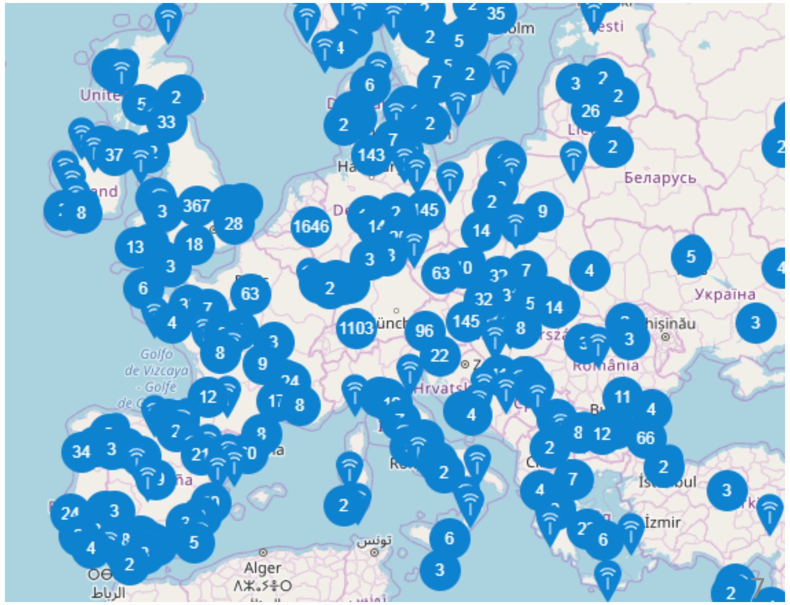
● 3.9 and newer (ATMega328PB)

```
/*
 *
 * C
 *
 * P                                        harge, to anyone
 * o
 * t
 * i                                         modification and redistribution.
 * N
 *
 * This example receive LoRa packet with frequency hooping information in the
 * payload and change the frequency for the next packet.
 * This code made for Heltec LoRa board 860-915MHz version
 * It can be use to measure LoRa device  radiation performance and to tune the
 * device antenna
 *
 */

#define DEBUG   // If DEBUG, plot on the serial plotter the 3 accelerometer axis

#include <Wire.h>  // Only needed for Arduino 1.6.5 and earlier
#include <SPI.h>
#include <LoRa.h>
#define SS 10
#define RST 8
#define DIO 6
#define BAND 868E6
#define spreadingFactor 7
#define SignalBandwidth 250E3
```

LoRaWan with The Thing Network

- The Things Network is a **global**, open, crowd-sourced Internet of Things data network.
- **<u>The Things Network Backend</u>** 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



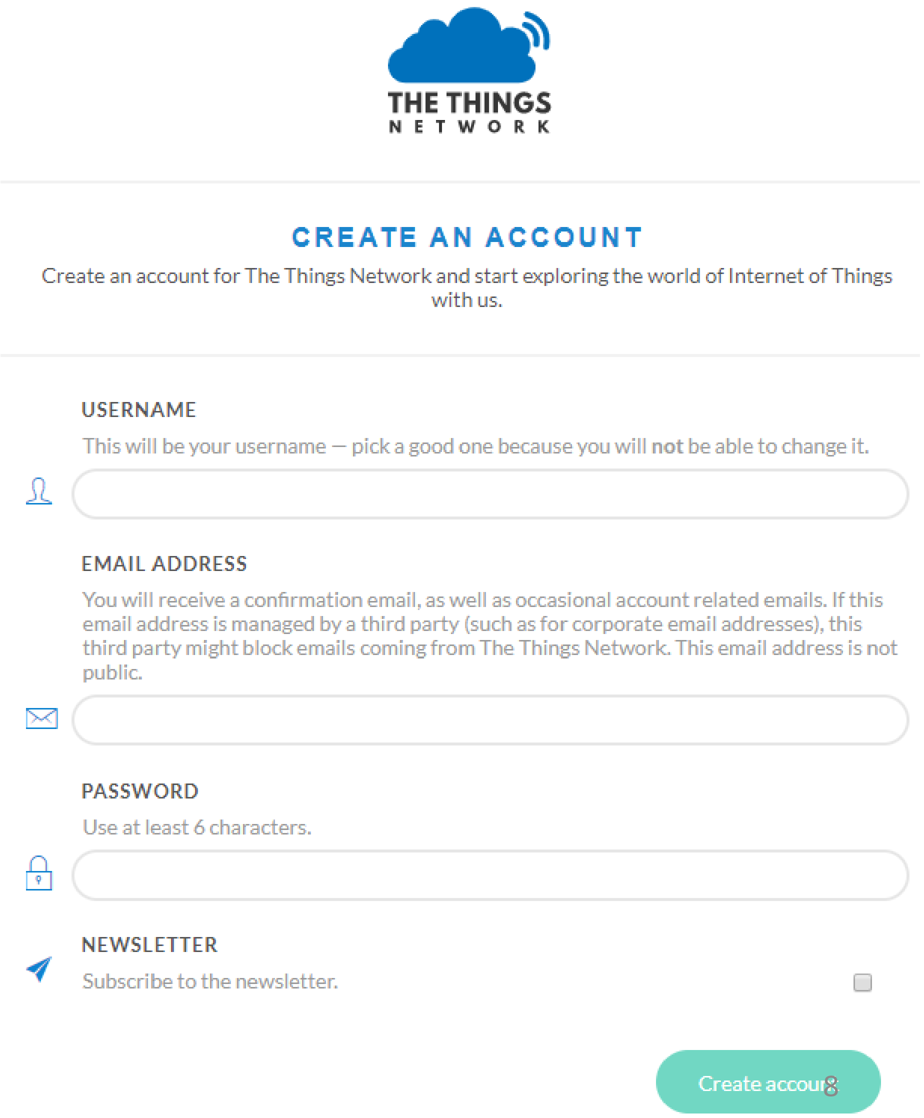


Create a TTN account

- First, you have to register to https://www.thethingsnetwork.org/
- You can choose a student account
- You can also join a local community :

TTN Côte d’Azur

TTN Da Nang



CREATE AN ACCOUNT

Create an account for The Things Network and start exploring the world of Internet of Things with us.

USERNAME

This will be your username — pick a good one because you will **not** be able to change it.

EMAIL ADDRESS

You will receive a confirmation email, as well as occasional account related emails. If this email address is managed by a third party (such as for corporate email addresses), this third party might block emails coming from The Things Network. This email address is not public.

PASSWORD

Use at least 6 characters.

NEWSLETTER

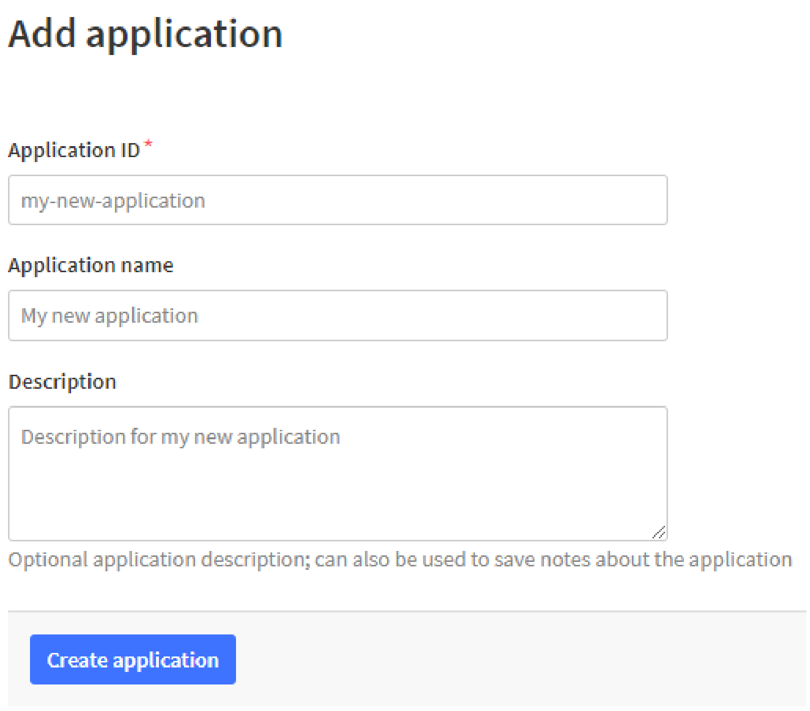
Subscribe to the newsletter. □

Create an TTN application

- Click on +Add Application
- Choose an application ID and name
- Click on create application

- In the application, click on :

  payload formater -> Uplink
- Choose CayenneLPP as formatter type



Add application

Application ID *

my-new-application

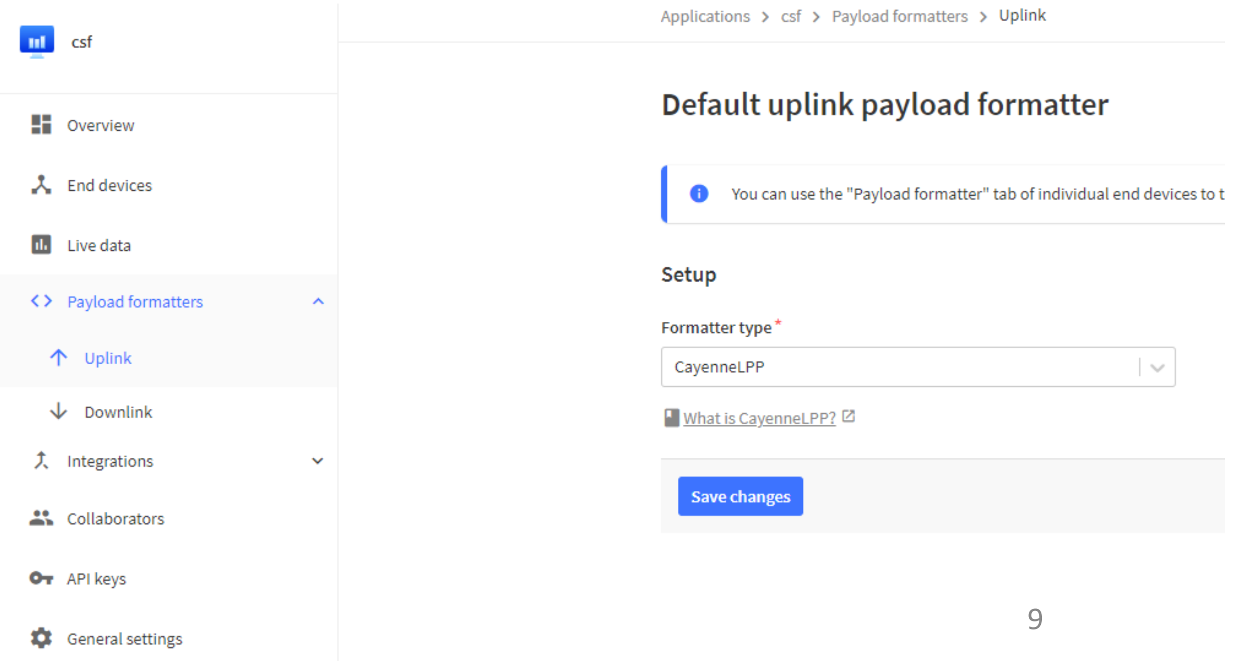
Application name

My new application

Description

Description for my new application

Optional application description; can also be used to save notes about the application



Default uplink payload formatter

You can use the "Payload formatter" tab of individual end devices to t

Setup

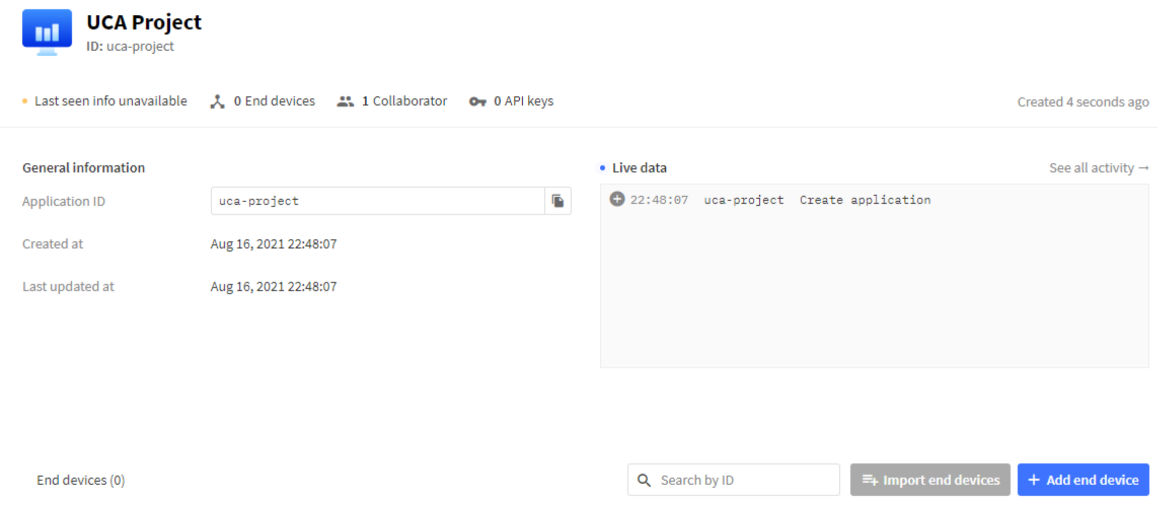
Formatter type *

CayenneLPP

What is CayenneLPP?

Adding a new device

- Click on « + Add end device »
- Select « Manually » for configuration
- Click on « Show advanced activation, LoRaWAN class and cluster settings”_ testeui-70b3d57ed0046a5a
- Select « ABP »
- Generate DevEUI, Dev Adr, AppSkey, NetwSkey
- Choose a name for End Devide ID
- Click on « Register end device » ! It’s done



UCA Project
ID: uca-project

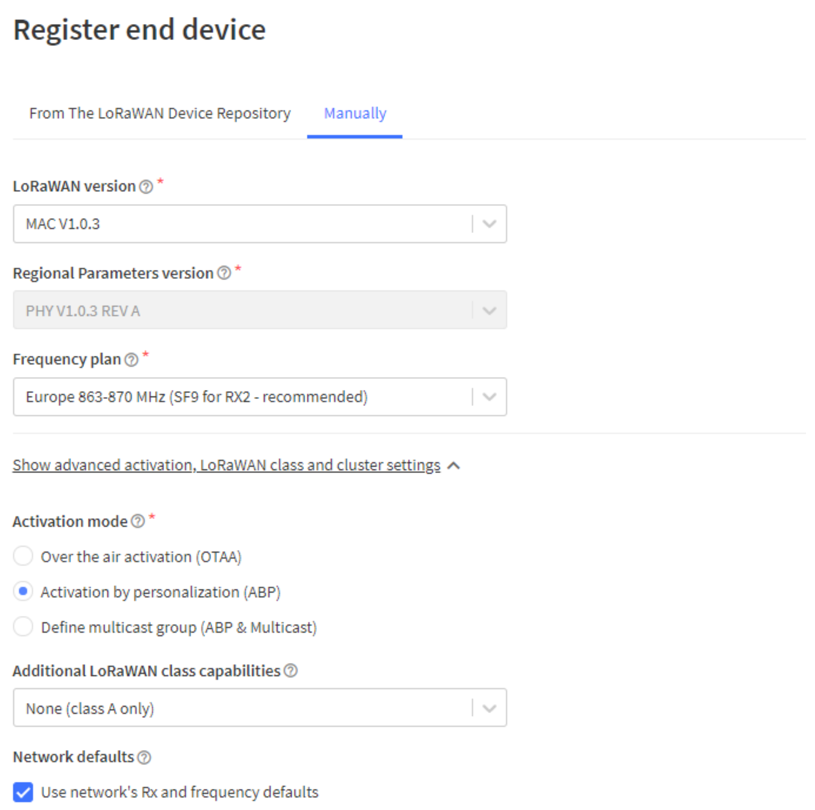
Last seen info unavailable · 0 End devices · 1 Collaborator · 0 API keys · Created 4 seconds ago

General information

Application ID	uca-project
Created at	Aug 16, 2021 22:48:07
Last updated at	Aug 16, 2021 22:48:07

Live data — See all activity →

```
22:48:07  uca-project  Create application
```



Register end device

LoRaWAN version *: MAC V1.0.3

Regional Parameters version *: PHY V1.0.3 REV A

Frequency plan *: Europe 863-870 MHz (SF9 for RX2 - recommended)

Show advanced activation, LoRaWAN class and cluster settings

Activation mode *

○ Over the air activation (OTAA)

● Activation by personalization (ABP)

○ Define multicast group (ABP & Multicast)

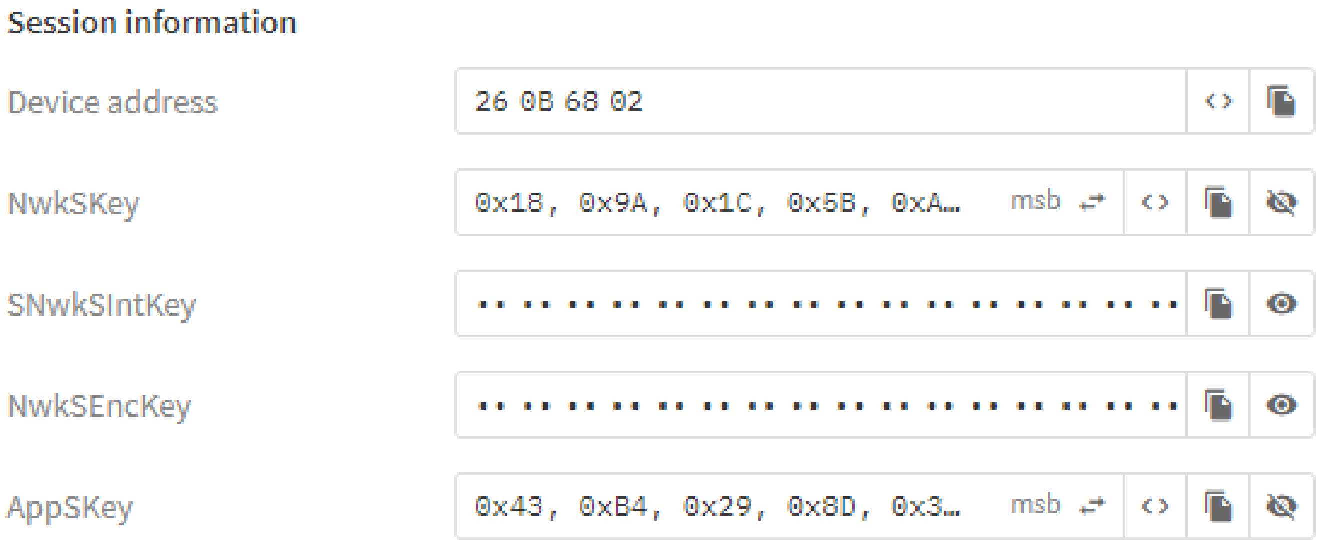
Additional LoRaWAN class capabilities: None (class A only)

Network defaults

☑ Use network's Rx and frequency defaults

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

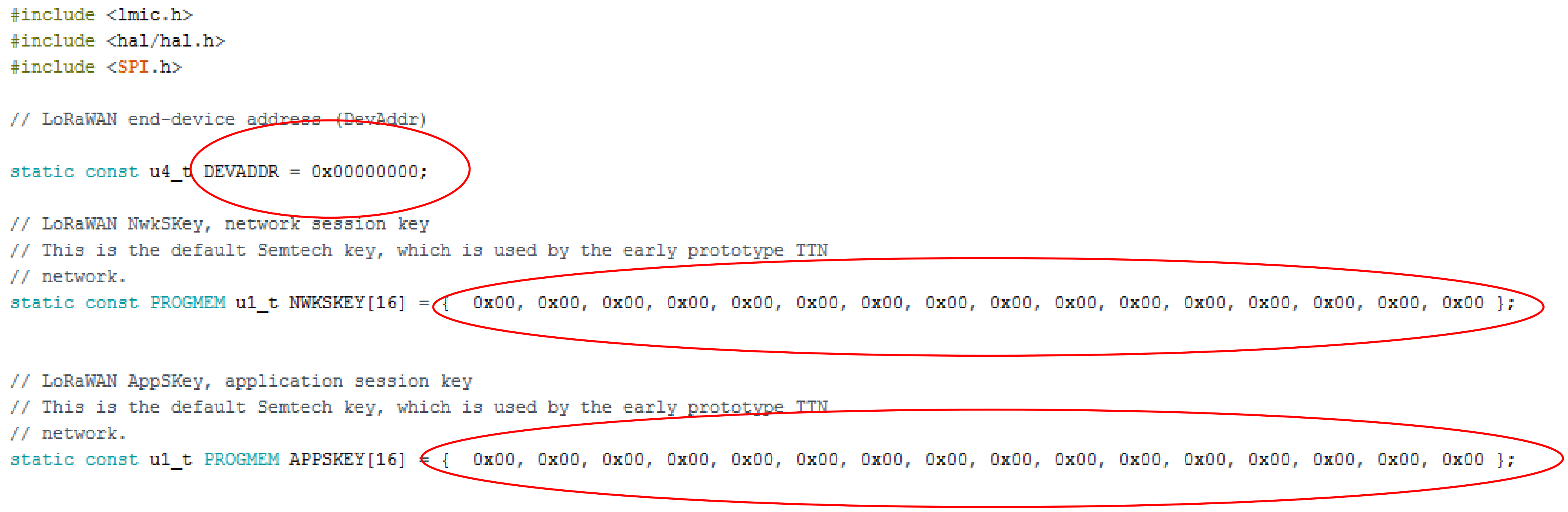


Session information

Device address	26 0B 68 02
NwkSKey	0x18, 0x9A, 0x1C, 0x5B, 0xA… msb
SNwkSIntKey	•• •• •• •• •• •• •• •• •• •• •• •• •• •• •• ••
NwkSEncKey	•• •• •• •• •• •• •• •• •• •• •• •• •• •• •• ••
AppSKey	0x43, 0xB4, 0x29, 0x8D, 0x3… msb

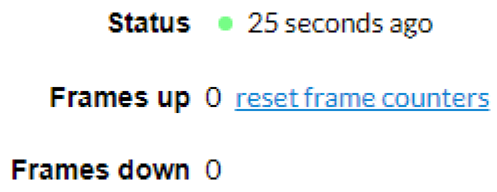
Activation by Personalization (ABP)

- Open the code UCA21\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)



Status ● 25 seconds ago

Frames up 0 reset frame counters

Frames down 0

- 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

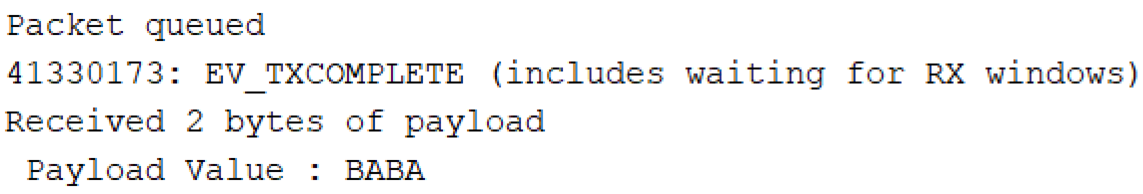
Activation by Personalization (ABP)

Frame counter security

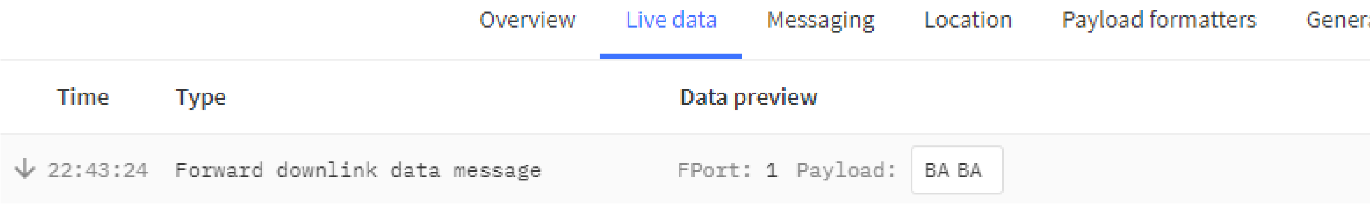
- Now reset you board (click on the right button on your board)
- TTN is no more receiving the data
- Click on « General setting» and expand « Network layer », expand « Advanced MAC settings »
- Enable « Reset Frame counter » options
- As you can see, frame counter is a security features to avoid replay 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 messaging, go to downlink, add a payload like « BABA » and click on « Schedule downlink», and go to Data
- After the next uplink, you should see the number of byte received in downlink



```
Packet queued
41330173: EV_TXCOMPLETE (includes waiting for RX windows)
Received 2 bytes of payload
 Payload Value : BABA
```



Time	Type	Data preview
↓ 22:43:24	Forward downlink data message	FPort: 1 Payload: BA BA

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

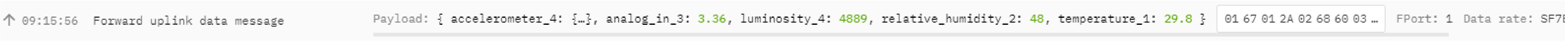
- Change SF and Payload text ! What is the effect on Time on Air ?

ABPand sensor

- You are now going to use a built-in sensor
- Select in UCA_Education_Board\Code\LORAWAN\ABP\UCA-ABP_Sensor

ABP and data

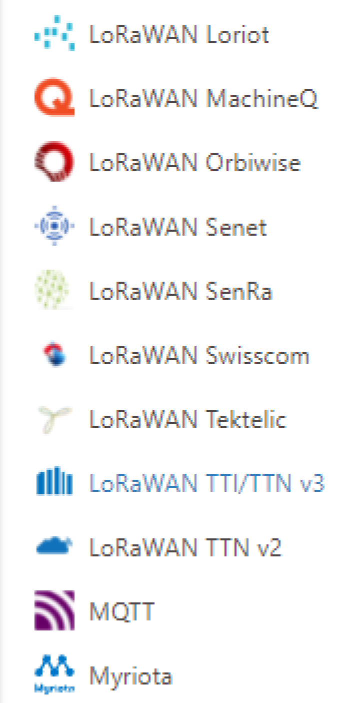
- Select in UCA_Education_Board\Code\LORAWAN\ABP\UCA-ABP_Sensor
- The code is using [Cayenne LPP format]
- Now you can see sensor data in the uplink packet

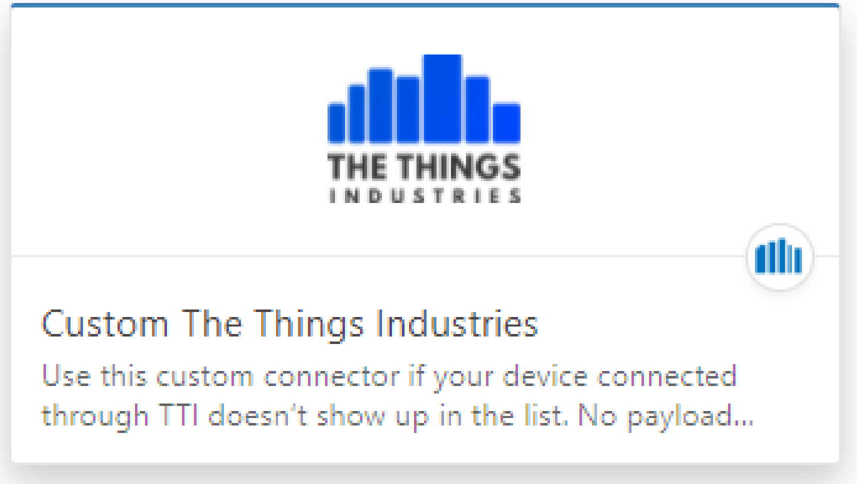


```
↑ 09:15:56  Forward uplink data message        Payload: { accelerometer_4: {…}, analog_in_3: 3.36, luminosity_4: 4889, relative_humidity_2: 48, temperature_1: 29.8 }  01 67 01 2A 02 68 60 03 …  FPort: 1  Data rate: SF7
```

Using TagoIO to see you data

- Go to https://tago.io/ and sign up
- Add a device by selecting LoRa/TheThingsNetwork and Cayenne LPP.
- Add a device and select « LoRaWAN TTI/TTN v3 »
- Select « Custom The Things Industries



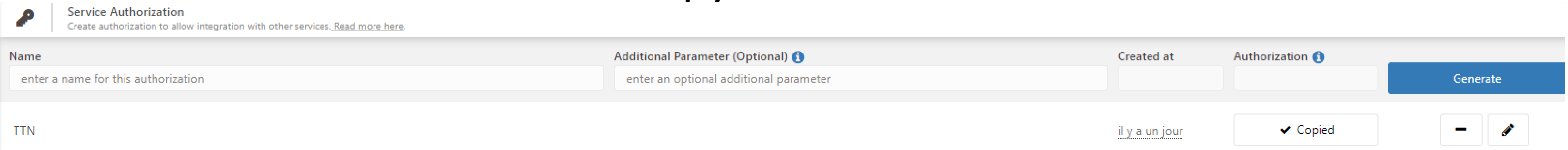


Custom The Things Industries

Use this custom connector if your device connected through TTI doesn't show up in the list. No payload...

Using TagoIO to see you data

- Give a name to your device
- Add Device EUI
- Create an authorization and copy authorization

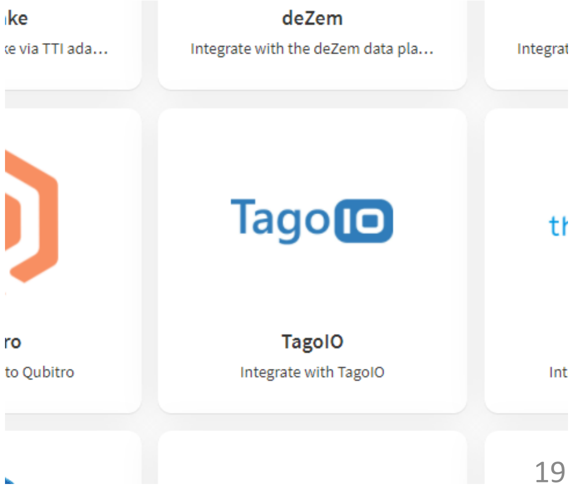


Service Authorization

Create authorization to allow integration with other services. Read more here.

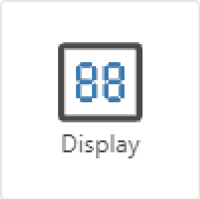
Name	Additional Parameter (Optional) ℹ	Created at	Authorization ℹ	
enter a name for this authorization	enter an optional additional parameter			Generate
TTN		il y a un jour	✓ Copied	

- Go to TTN and click on Integration/Webhooks
- Click on « Add a Webhooks »
- Select TagoIO
- Enter a Webhooks ID (what you want) and copy authorization

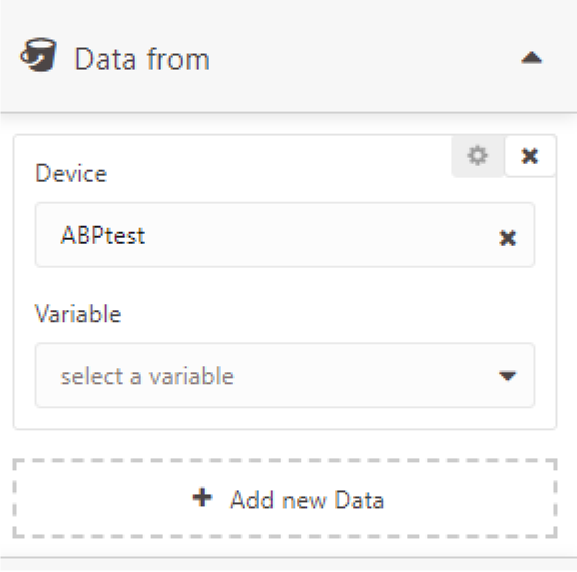


Using TagoIO to see you data

- Go to your dashboard and create a new normal dashboard
- Add a widget like a display

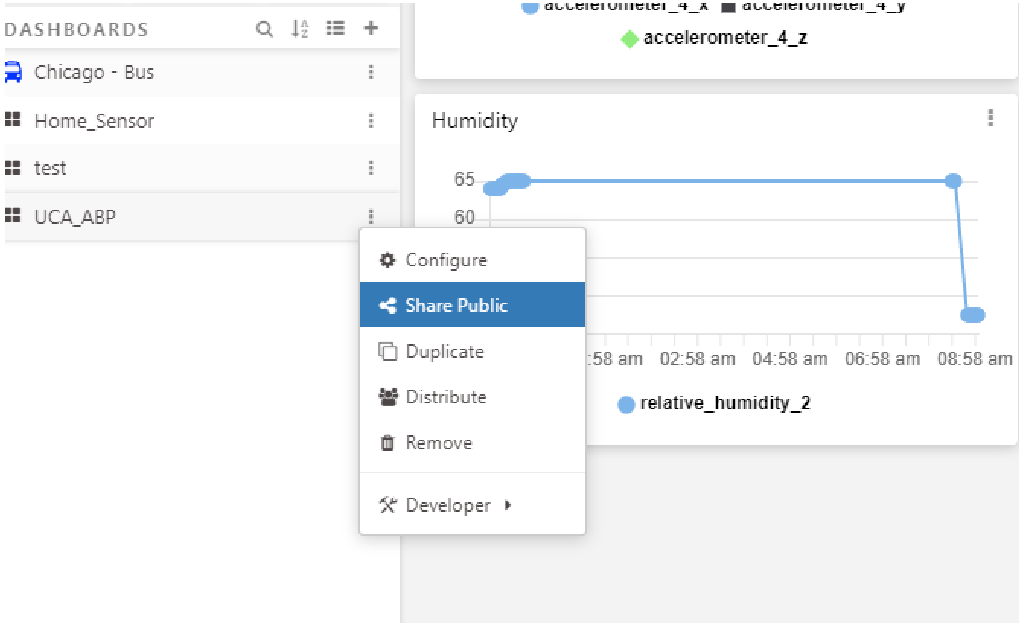


- Choose your Device and select a variable
- You can customize any widget and your dashboard.
- You can share your dashboard with « Share Public »

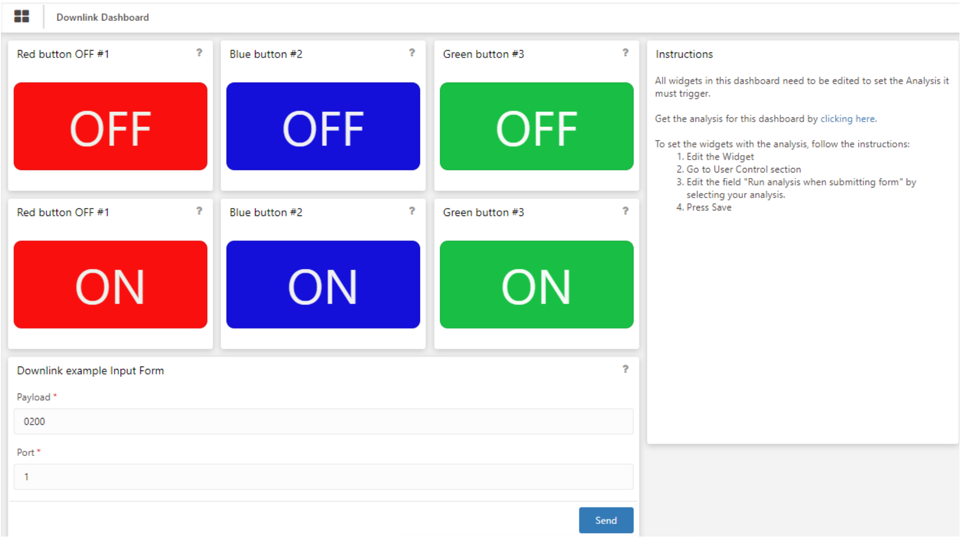

Data from

Device: ABPtest

Variable: select a variable



Downlink using TagoIO



Instructions

All widgets in this dashboard need to be edited to set the Analysis it must trigger.

Get the analysis for this dashboard by clicking here.

To set the widgets with the analysis, follow the instructions:

1. Edit the Widget
2. Go to User Control section
3. Edit the field "Run analysis when submitting form" by selecting your analysis.
4. Press Save

Payload *: 0200

Port *: 1

- We are going to control LED color from a dashboard :

https://docs.tago.io/en/articles/221

- Upload the code : UCA21\Code\LORAWAN\OTAA\LED_CONTROLLER
- Install a « analysis » code using this link :

http://admin.tago.io/template/5f513aabd4555600277f858c

- Install a dashboard template :

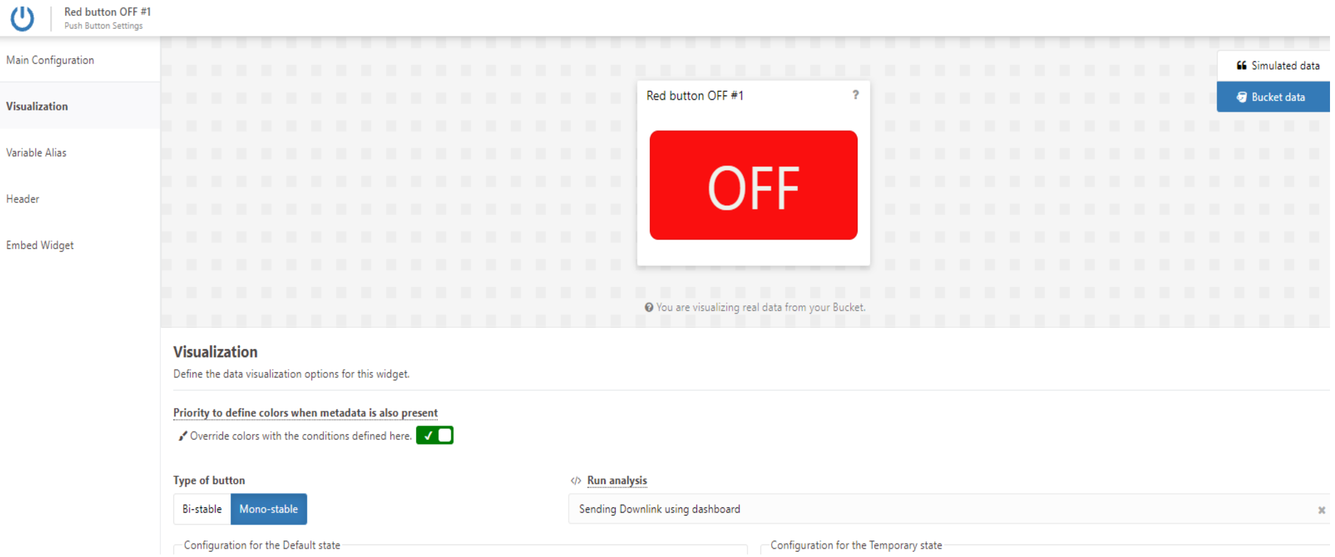
https://admin.tago.io/template/615a93447b004f0019227064

Downlink using TagoIO

- Move to edit mode
- Edit every buttons,

In Visualisation, update Run Analysis to « Sending Downlink using Dashboard »

- You need to create a Token from TagoIO account/Profile/Generate Token
- Copy/Paste to « account_token » environment variables in «Sending downlink using dashboard » analysis
- Check with live data in TTN



You are visualizing real data from your Bucket.

Visualization

Define the data visualization options for this widget.

Priority to define colors when metadata is also present

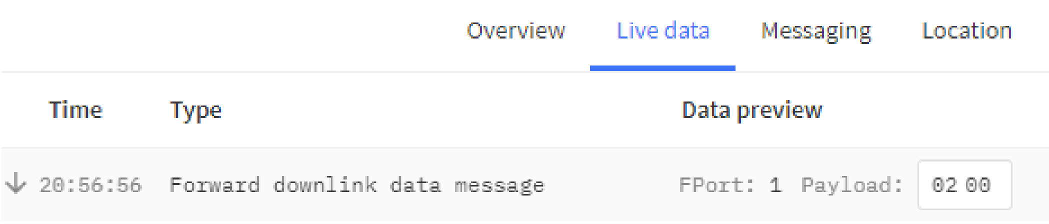
Override colors with the conditions defined here. ✓

Type of button: Bi-stable [✓ Mono-stable]

Run analysis: Sending Downlink using dashboard

Configuration for the Default state

Configuration for the Temporary state



Time	Type	Data preview
↓ 20:56:56	Forward downlink data message	FPort: 1 Payload: 02 00

Good luck for you projects !

This board as been funded by UCA

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