Workshop location tracking using different techniques

(WiFi and LoRaWAN)

Building a localisation node (using different technologies for localisation)

Identifying the components

- Wemos Lora PCB= RFM Module RFM95W (868 Mhz)
(https://github.com/hallard/WeMos-Lora)
- Wemos D1 mini v3 – ESP8266
- Micro USB cable
- 3D print

Starting up the Arduino Environment and login

You may skip this step if you have:
- Arduino installed with ESP8266 support
- LMIC 'Charles' version installed
- Account made on The Things Network (please do this well before. There is a waiting period)
  https://thethingsnetwork.org
- Account made on LoRaCLOUD (please do this well before. There is a waiting period)
  https://www.loracloud.com
- Account made on FRED (for NODE-RED)
  https://fred.sensetecnic.com
- Account made on HERE developers portal(for WiFi geolocation services)
  https://developer.here.com

Arduino

Setup the Arduino Environment. To use the ESP8266 we need the ESP toolchain. Installation instructions can be found here: https://github.com/esp8266/Arduino/

Installing with Boards Manager
Starting with 1.6.4, Arduino allows installation of third-party platform packages using Boards Manager. We have packages available for Windows, Mac OS, and Linux (32 and 64 bit).
- Install the current upstream Arduino IDE at the 1.8 level or later. The current version is at the Arduino website .
- Start Arduino and open Preferences window.
- Enter http://arduino.esp8266.com/stable/package_esp8266com_index.json into Additional Board Manager URLs field. You can add multiple URLs, separating them with commas.
- Open Boards Manager from Tools > Board menu and install esp8266 platform (and don't forget to select your ESP8266 board from Tools > Board menu after installation).

Close your Arduino IDE software. Remove (if already installed) the current LMIC library. We will use the 'Charles' version of the library. This one is compatible with your other projects, but has some special functionality needed for the WeMos LoRa board (supporting one input pin for the three DIO pins).

Download the new library and install the .zip file with library manager:
1. Goto https://github.com/ch2i/arduino-lmic or https://github.com/turtlecrazy/WorkshopLocationWiFiLoRaWAN2020/
2. Choose 'Clone or download'
3. Download ZIP
4. Mark the location
5. Go to Arduino IDE
6. Select 'Sketch->Include Library->Add .ZIP Library'
7. Select the downloaded Arduino-lmic-master.zip file from your download location

Change the 'lmic_project_config.h' file in the project_config folder (remove the remark from CFG_eu868 and add them to CFG_us915):

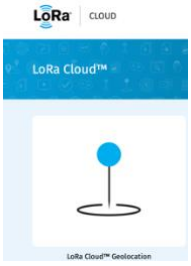
```
//#define CFG_us915 1
#define CFG_eu868 1
#define CFG_sx1276_radio 1
```

The Things Network account

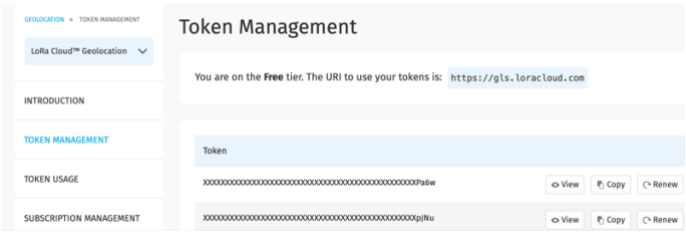
To use the Things network data dashboard. dashboard, you need a The Things Network account. You can create an account here: https://account.thethingsnetwork.org/users/login .

You can also create an application in which we will later add devices.

LoRaCloud



After obtaining login information from https://www.loracloud.com/ you can apply for “token keys” From geolocation➔token management. You need these keys in this workshop.

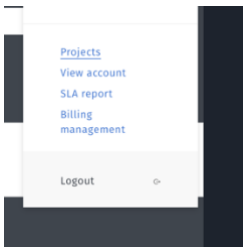


FRED

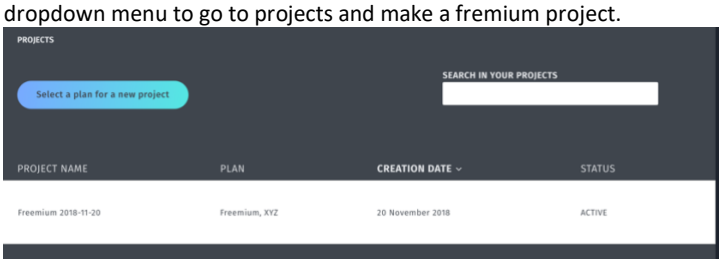
FRED is for running Node-red. You need this login to so some codeless programming. You can ask for a login at:
https://fred.sensetecnic.com and make an node-red instance

HERE (if you want to get your location only with WiFi and test the service of HERE)

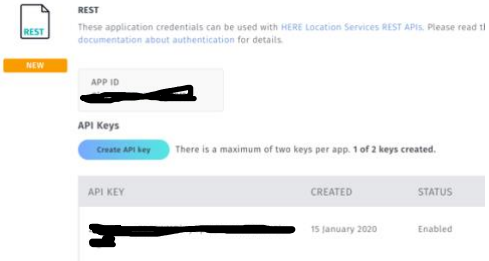
HERE is for asking yourself where you are… (HERE);-) You can apply for a login at: https://developer.here.com



In the right top corner where your initials of your username are shown you can use the dropdown menu to go to projects and make a fremium project.



Create a REST API key. You need this Key and APP ID during the workshopz



WORKSHOP START

Introduction

In this workshop we will show you all the steps how you will get from sensor (microprocessor) to display results on a online dashboard.

This workhop will use Node-red as the dashboard source. With integrations of The Things Network there are however a lot more possibilities of visualizing and analysing your sensor data.

First we will start at configuring the sensor.

Sensor configuration

If you have done your homework you can easily download the sketch I prepared for you at: https://github.com/ttnnijmegen/locationwithwifiandlora/blob/master/CrazyTurtleTrackerUpload.ino

As you will see in the sketch, you will need to fill in keys in order for the sensor to communicate with the things network.

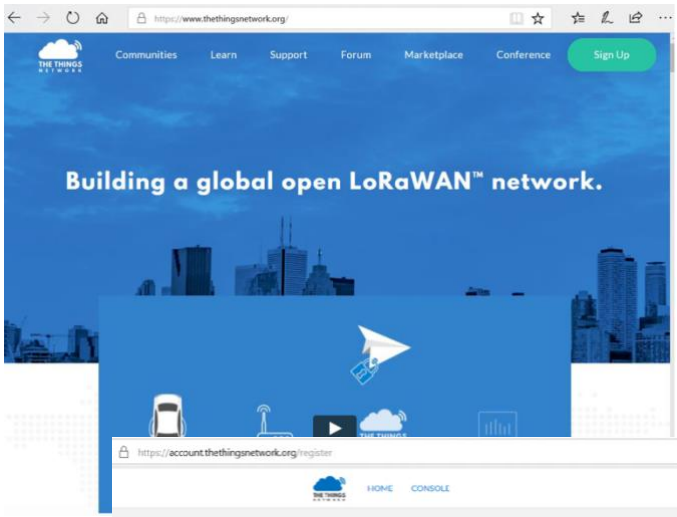
For this you need to make an application and add devices to it on the things network account.

That's going to be the next step.

The Things Network Dashboard

In order for the nodes to be able to communicate with the things network backend via the gateways. You need to have an account on the things network to be able to add devices.

Your applications and devices can be managed by The Things Network Dashboard.

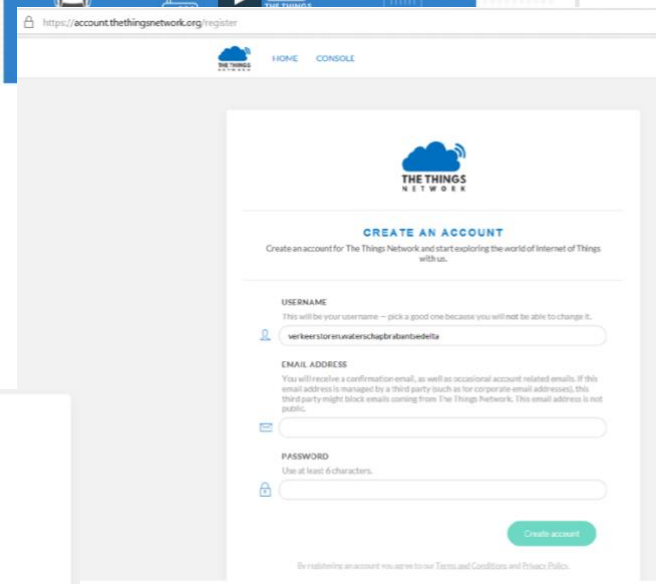


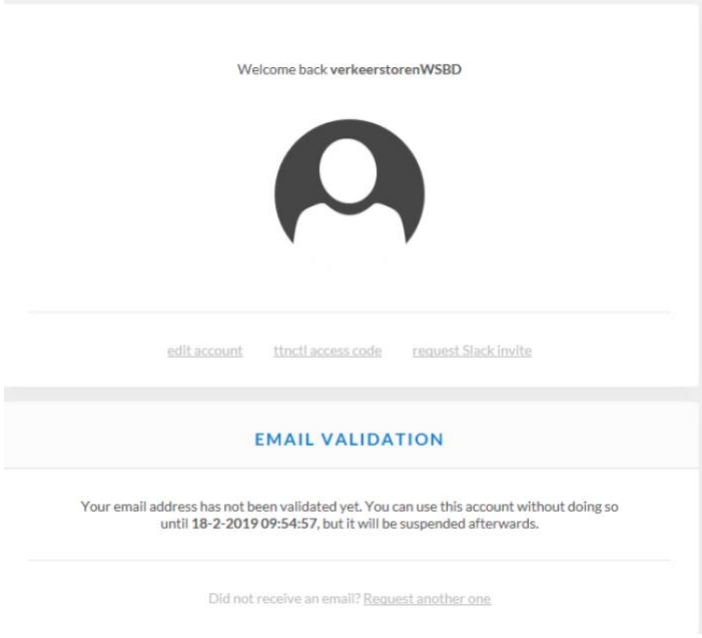
Create an Account

To use the dashboard, you need a The Things Network account. You can create an account here

https://account.thethingsnetwork.org/users/login .

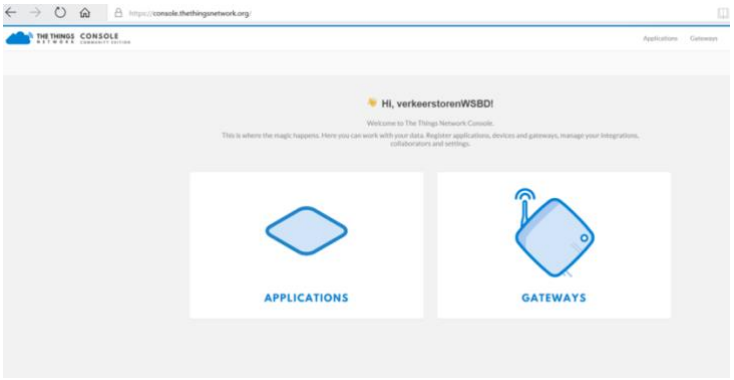
After registering and validating your email address, you will be able to log in to The Things Network
Dashboard.





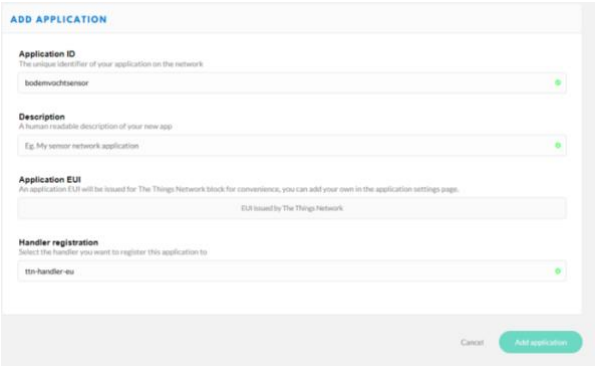
Create an Application

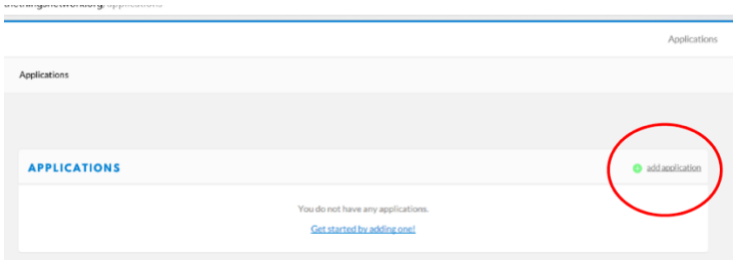
https://console.thethingsnetwork.org/applications



Choose ‘add application’
Give your Application a unique ID. You can use ONLY lowercase! You can add a unique number to get uniqueness over the TTN network (this is a global ID). If you already use an application you better add another one, because of the specific Payload Function needed here.

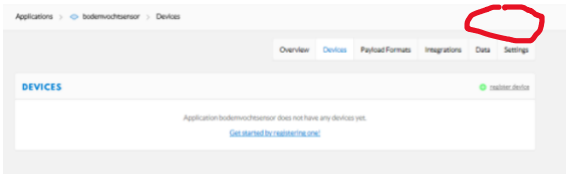
Your description can be any description you like.



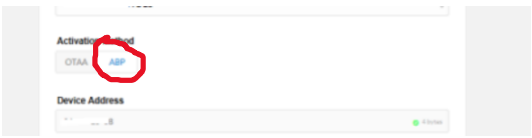


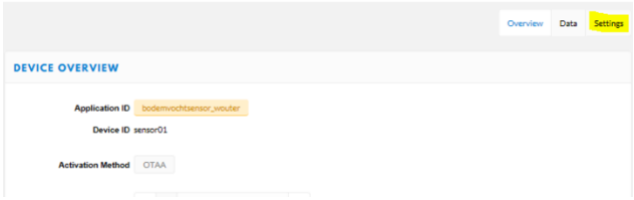
Registering a device (as an ABP Node)

Activation by Personalization (ABP) is a method where the security keys are stored in the device. Not as safe as the OTAA method, but for experiments it works OK. There is no join procedure, nodes will work right away. Choose Register the device.



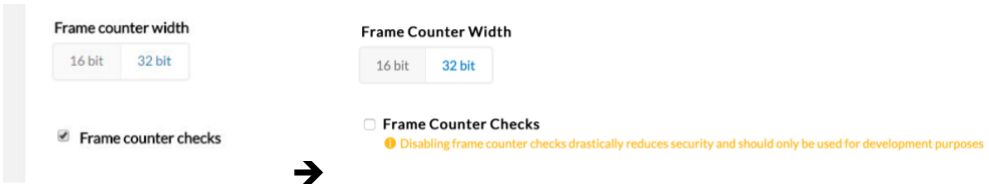
Now edit the settings of the device and choose ABP (OTAA will be selected by default)





You might want to uncheck the frame counter check.

If the frame counter is checked, you must respect the sequence number, and probably copied packages are refused on the network. Though restarting you node, and thereby resetting the frame counter, will disable your node. So to get this working, you have to disable this check by unchecking this box.



The addresses found can be added in the right format to the arduino sketch as stated earlier.

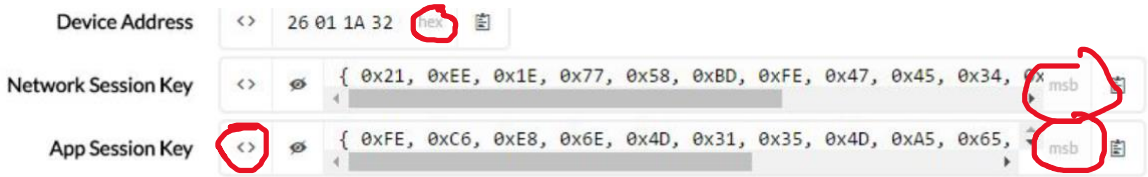


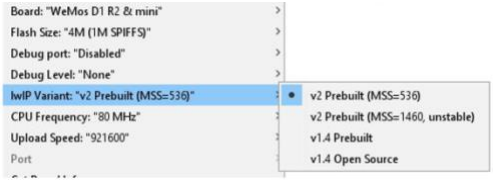
Figure 1: TTN console ABP device keys

- Copy the Device Address as a HEX value to DEVADDR in the example, so 26 01 1A 32 will be 0x26011A32.
- Copy the Network Session Key as MSB to NWSKEY.
- Copy the App Session Key as MSB to APPSKEY.

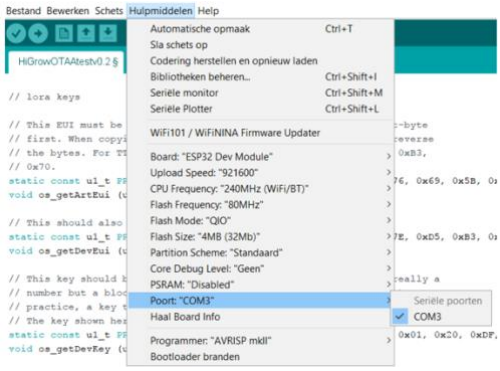
```
// LoRaWAN NwkSKey, network session key, AppSKey, application session key, end-device address
static const PROGMEM u1_t NWKSKEY[16] = { 0x21, 0xEE, 0x1E, 0x77, 0x58, 0xBD, 0xFE, 0x47, 0x4
static const PROGMEM u1_t APPSKEY[16] = { 0xFE, 0xC6, 0xE8, 0x6E, 0x4D, 0x31, 0x35, 0x4D, 0xA
// LoRaWAN end-device address (DevAddr)
static const u4_t DEVADDR = 0x260[illegible]2 ; // <-- Change this address for every node!
```

Figure 2: Invoer in de Arduino sketch

In the Arduino IDE apply the right settings for the device:
Select the Wemos board in the Arduino IDE (no debug port, lwIP v2 Prebuilt, CPU 80 Mhz, Upload speed 921200)



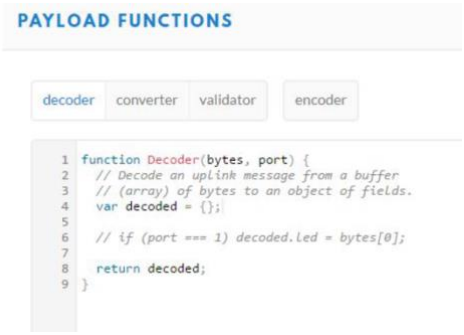
Also check if the right comport is in use for the upload of the sketch.
After this: Compile and upload the code. Check in the dashboard the working.



Payload functions

Privacy first… We don't want people to know where we are ofcourse. It's level 2 privacy information. Luckily, The Things Network enrolled Stack V3 of the LoRa Alliance this year which adds to more secure data exchange. We will not go into this before everyone has a working dashboard.

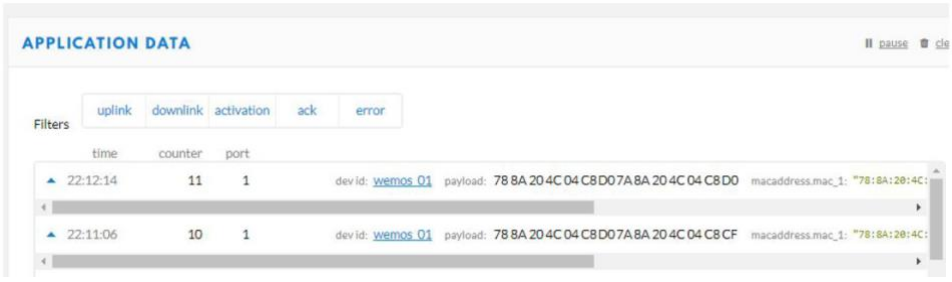
To get the right display format, we can create a decoder in our application. Select your application and open the 'Payload Functions':



And overwrite the payload function with the text to be found here:

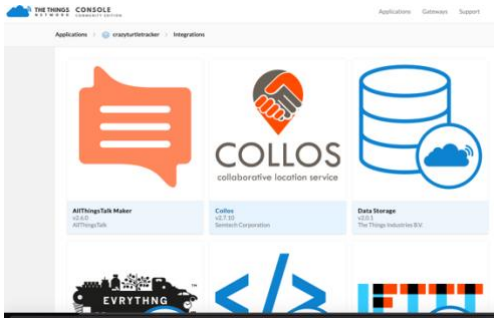
https://github.com/ttnnijmegen/locationwithwifiandlora/blob/master/TTN_payloadfunction_LoRaCLOUD_API_v2

First test the function with two dummy bytes CE D0, And then Save the function.
Return to your data and look what happens:

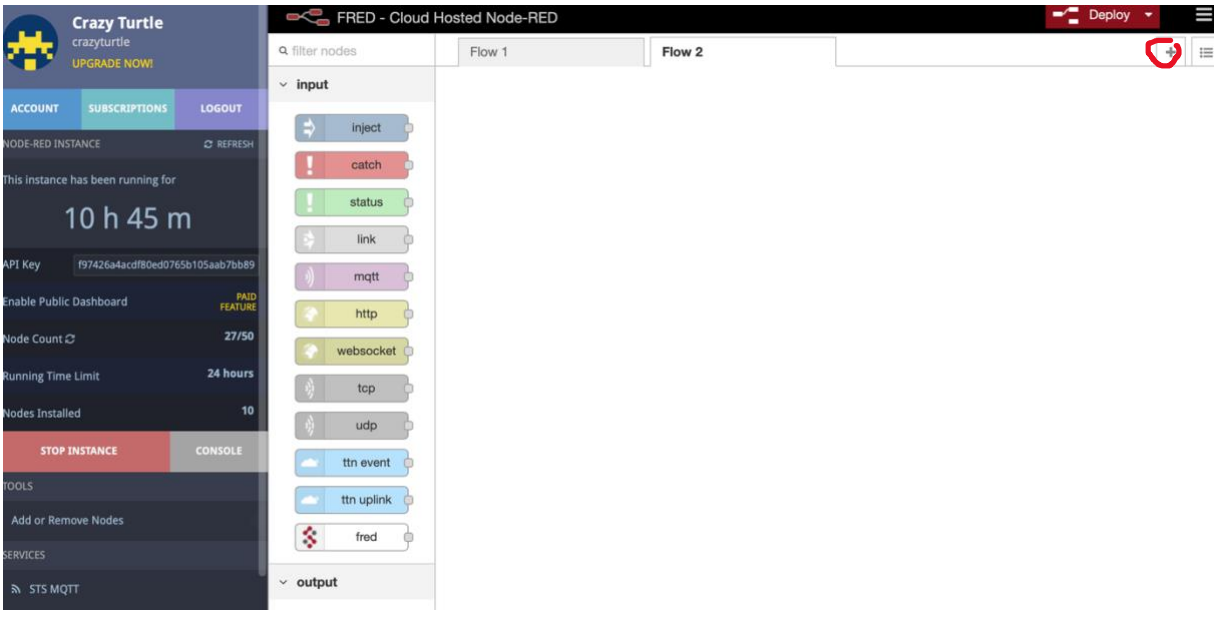


Application setup

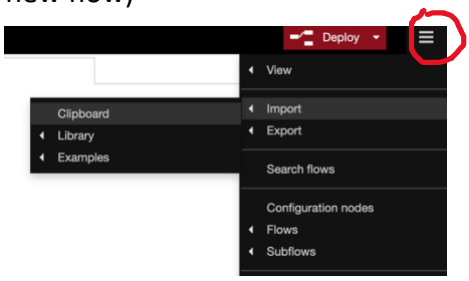
As stated earlier, with The Things Network, there are a lot of possibilities to add dashboard visualisations and analysis of the data via integrations.
In this workshop we chose Node-red. You can have a look yourself at your application integrations which possibilities there are.
We will not discuss possibilities in this workshop. In other workshops we might use different options.



The node-red integrations we use via MQTT. A communication protocol for sensors. If you did your homework you already have a node-red instance received from FRED.



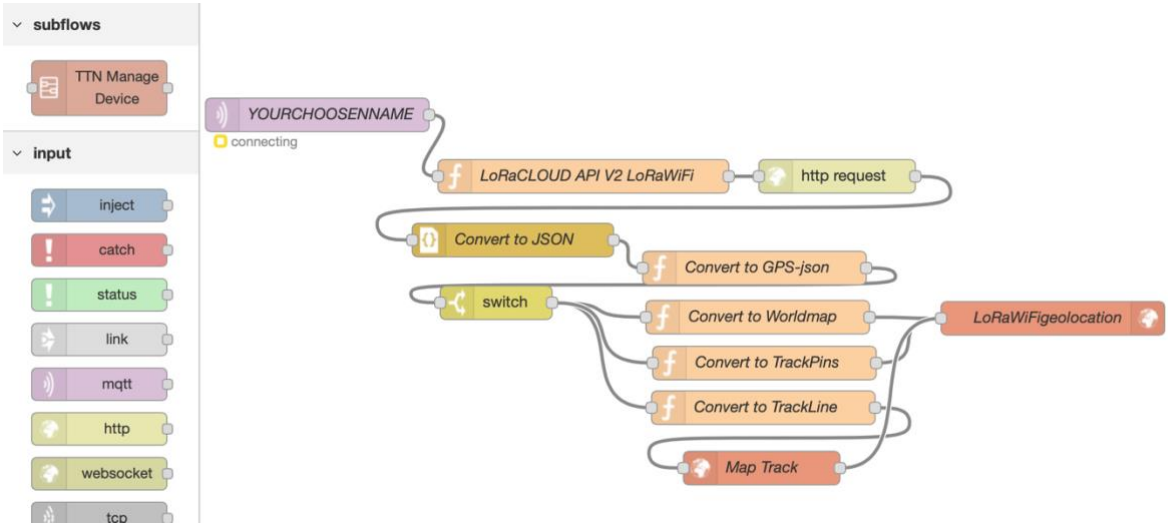
Via clicking on the laminated icon a dropdown menu opens with the possibilities to import a clipboard. (after you push on the + button to make a new flow)
Select this option and import the text from this link



https://github.com/ttnnijmegen/locationwithwifiandlora/blob/master/node-red_LoRaCLOUD_APIv2

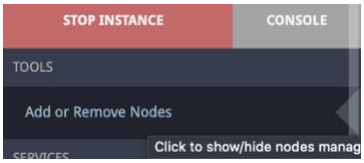
Here we use only the LoRaCLOUD API v2 sollution. Because unlike the V3 sollution this one also gets it's location via Wifi. So we can use the code we programmed the node with.
You can use any node sending any payload to get the location if you start using the API v3 sollution. How to do this can be found in the documentation of LoRaCLOUD.

If your import succeeded correctly you should see the following sequence in node-red:

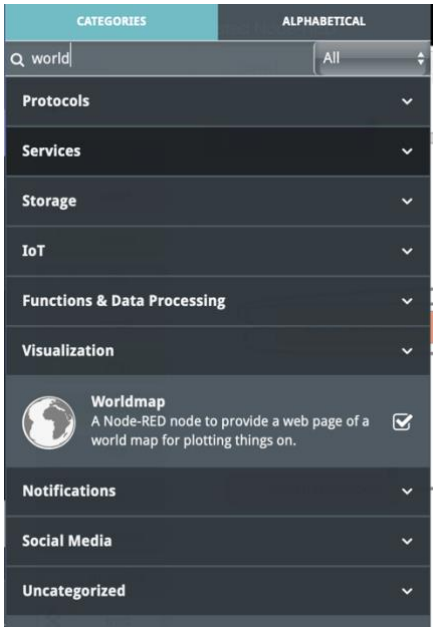


It is possible some nodes are giving errors. This is because they are not installed by default by FRED.

You can do this via add or remove nodes



And search for the name of the node you are missing. (probably worldmap)

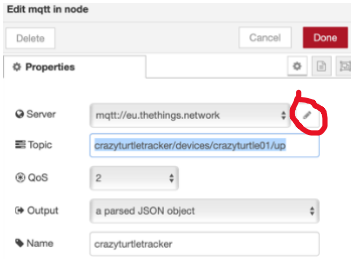


Also the credentials of the different services from The Things Network, HERE and LoRaCLOUD need to be applied for the "mindmaps" to be able to run.

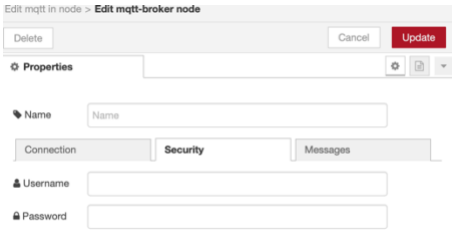
If you click on the MQTT node a menu opens for you to fill in credentials.
First fill in the right topic. My topic for mqtt to retrieve data from YOURAPPLICATION/devices/YOURDEVICE/up

Which consists of MYAPPLICATION/devices/MYDEVICE/up.

Please apply your own application and device name here.

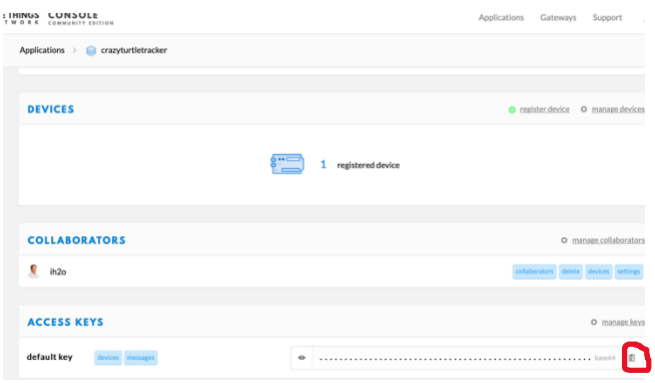


Off course you also need to apply your security settings. This can be done by clicking on the pencil. A new screen will open.



For username you can use your application name and the password consists of the access keys.

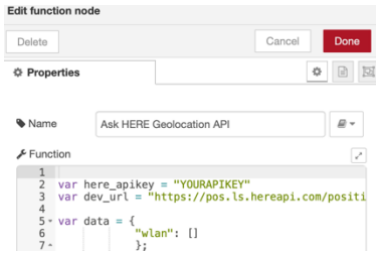
You can copy them from the console at your application on the bottom of the page.



Once you managed this and clicked on deploy.

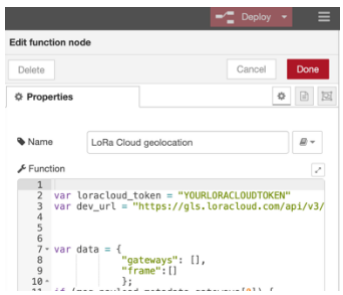
You will see the MQTT node displaying “connected”.
Now we connected The Things Network with MQTT. We still need to apply keys for LoRaCLOUD location services to work.

(only with the here sequence)
You Obtained the HERE key as described in the homework assignment and can paste is at the “YOURAPIKEY” tekst of you openup the ASK HERE Geolocation API function.



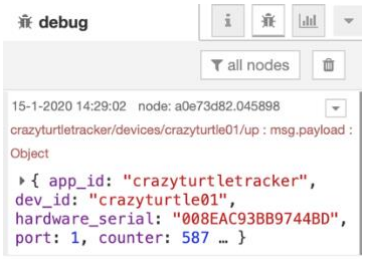
Same procedure applies to connecting to the LoRaCLOUD geolocation service. Here the keys are called tokens.

If all goes well you will see the MQTT nodes connected as well as the HERE geolocation and the LoRaWAN geolocation.

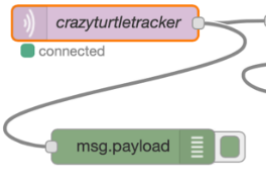


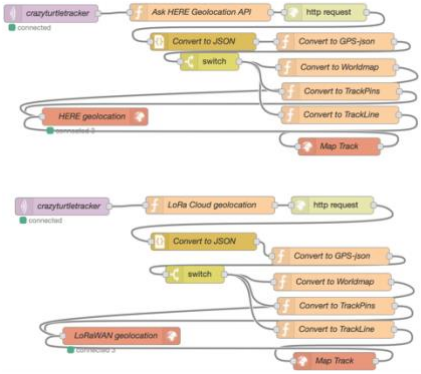
If not, there are probably bugs need to be exterminated by using

The debug node.. In the screen on the right plane with the bug you can find information for extermination



involved…. Which tools…





However if all goes well and you worked clean, there will be no bugs involved. If you click on eighter the LoRaWAN geolocation node (worldmap nodes) or the HERE geolocation ot open the nodes. And click: `⌘⇧m - ctrl-shift-m` . You will see the maps displaying the nodes location using the different techniques. (Left a map with wifi locations and right with LoRaWAN locations)

P.s. you might have to have some patience before node-red starts showing the dots on the maps.