Congduc Pham, http://cpham.perso.univ-pau.fr
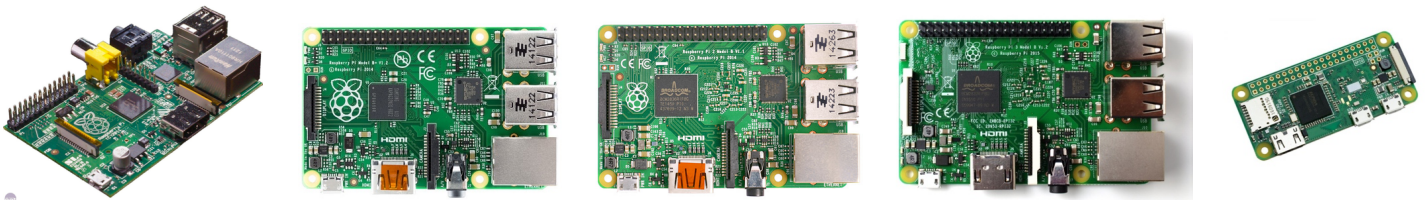
http://www.waziup.eu

Preparing your Raspberry Pi

Get our ready-to-use Raspbian Jessie SD card image

Download from **http://cpham.perso.univ-pau.fr/LORA/WAZIUP/raspberrypi-jessie-WAZIUP-demo.dmg.zip**

Write the SD card image
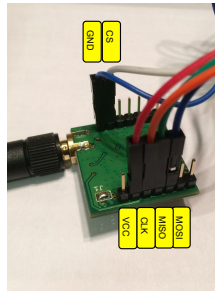
Use a class 10 8GB minimum SD card
See instruction from https://www.raspberrypi.org/documentation/installation/installing-images for various OS

You can use RaspberryPI 1 model B/B+, RaspberryPI 2 model B, RaspberryPI 3 model B/B+ and RaspberryPI Zero (W). The most important usefull feature is the Ethernet interface for easy Internet connection. You can add WiFi with a WiFi USB dongle to use access-point features. With the RPI3 & RPIOW, WiFi and Bluetooth are embedded on the board.

Connect the LoRa radio module

Depending on the model, you can have the « short » or the « long » GPIO interface. However, the SPI pins are at the same location therefore it does not change the way you connect the radio module if you take pin 1 as the reference. Connect the SPI pins (MOSI, MISO, CLK, CS) of the radio to the corresponding pins on the RPI. Note that CS goes to CEO_N on the RPI.

GPIO#	2nd func.	Pin#	Pin#	2nd func.	GPIO#
	+3.3 V	1	2	+5 V	
2	SDA1 (I2C)	3	4	+5 V	
3	SCL1 (I2C)	5	6	GND	
4	GCLK	7	8	TXD0 (UART)	14
	GND	9	10	RXD0 (UART)	15
17	GEN0	11	12	GEN1	18
27	GEN2	13	14	GND	
22	GEN3	15	16	GEN4	23
	+3.3 V	17	18	GEN5	24
10	MOSI (SPI)	19	20	GND	
9	MISO (SPI)	21	22	GEN6	25
11	SCLK (SPI)	23	24	CE0_N (SPI)	8
	GND	25	26	CE1_N (SPI)	7
(RPI 1 Models A and B stop here)					
EEPROM	ID_SD	27	28	ID_SC	EEPROM
5	N/A	29	30	GND	
6	N/A	31	32		12
13	N/A	33	34	GND	
19	N/A	35	36	N/A	16
26	N/A	37	38	Digital IN	20
	GND	39	40	Digital OUT	21

Update your gateway

Read more instruction at https://github.com/CongducPham/LowCostLoRaGw

Connect your RPI to Internet (with Ethernet sharing from laptop or DHCP router). Use a browser to display the web admin interface: e.g. 192.168.2.8/admin
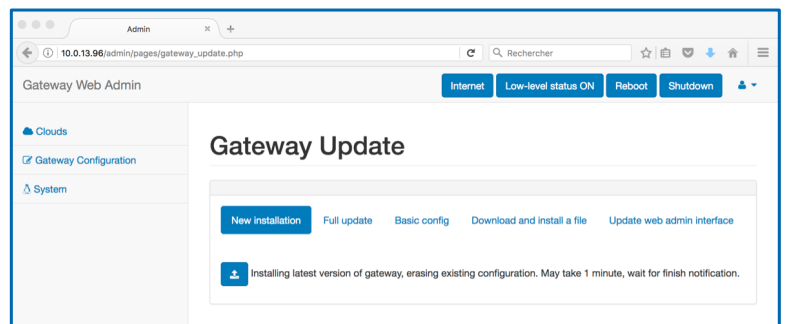
Login: admin Password: loragateway

Check Internet connection with the **Internet** button

Select the **Gateway update** menu and click on **New installation** (or **Full update**). Then click on the download icon button

Perform **Basic config** and **Update web admin interface**

Reboot your RPI with the **Reboot** button

You can also use the gateway WiFi to display the web admin interface, see page 4

Your LoRa gateway is ready to receive packets and upload data to clouds

http://www.waziup.eu

Receiving LoRa messages

Gateway default configuration

Default configuration uses BW=125kHz, CR=4/5, SF=12

This configuration allows for the longest range

The gateway uses BW & SF combinations to define 10 LoRa modes. Default mode is then mode 1

Default frequency in each band (868, 900, 433) is indicated in red

LoRa mode	BW	CR	SF
1	125	4/5	12
2	250	4/5	12
3	125	4/5	10
4	500	4/5	12
5	250	4/5	10
6	500	4/5	11
7	250	4/5	9
8	500	4/5	9
9	500	4/5	8
10	500	4/5	7

ch	F(MHz)	ch	F(MHz)	ch	F(MHz)
04	863.2*	00	903.08	00	433.3*
05	863.5*	01	905.24	01	433.6*
06	863.8*	02	907.40	02	433.9*
07	864.1*	03	909.56	03	434.3*
08	864.4*	04	911.72	-	-
09	864.7*	05	913.88	-	-
10	865.2	06	916.04	-	-
11	865.5	07	918.20	-	-
12	865.8	08	920.36	-	-
13	866.1	09	922.52	-	-
14	866.4	10	924.68	-	-
15	867.7	11	926.84	-	-
16	867.0	12	915.00	-	-
17	868.0	-	-	-	-
18	868.1*	-	-	-	-

The default frequency at the end-device depends on the selected band, check and set the operating frequency of the gateway accordingly with the web admin interface.

Uploading to WAZIUP

Use the **Clouds** menu and **Cloud WAZIUP** tab

WAZIUP cloud uses FIWARE and adopts a domain approach: the domain will be defined as **project_name**+'-'+**organization_name**+**service_tree**, e.g. **waziup-UPPA-OFFICE1-TESTS** if:

- project_name=**waziup**,
- organization_name=**UPPA**
- service_tree=**-OFFICE1-TESTS**

service_tree can be empty otherwise it must begin with a '-'

Device id will be **organization_name**+"Sensor"+device_addr. For instance, for sensor 6 hosted by UPPA: **UPPA_Sensor6**

Using domain approach, the URL will be for instance http://api.waziup.io/domains/waziup-UPPA-OFFICE1-TESTS/sensors
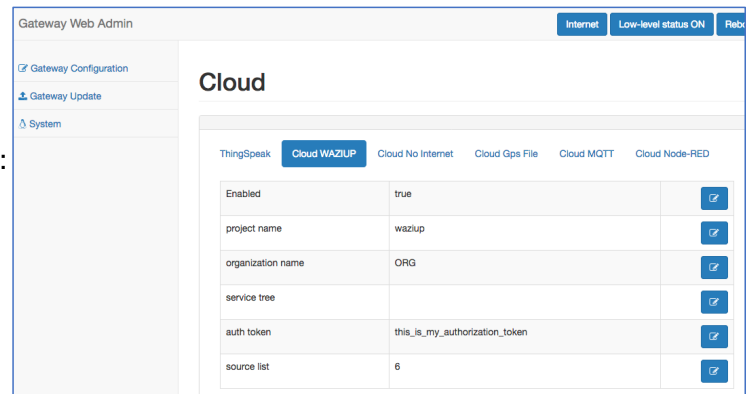
Retrieving values from WAZIUP platform

Using curl command

Assuming device 6 sends **TC/22.5** which means a temperature of 22.5°C

curl -X GET http://api.waziup.io/api/v1/domains/waziup-UPPA-OFFICE1-TESTS/sensors/UPPA_Sensor6/measurements/TC

Additionally, go to dev.waziup.io:3000 and search for your sensor name (e.g. UPPA_Sensor6)

Additional ressources & tutorials

The general github repository **https://github.com/CongducPham/LowCostLoRaGw**
The WAZIUP github **https://github.com/Waziup**
IoT device video **https://www.youtube.com/watch?v=YsKbJeeav_M**
Gateway video **https://www.youtube.com/watch?v=peHkDhiH3lE**

Using integrated LoRa radio shield/hat

Shield/hat with integrated LoRa radio modules

There are some shields/hats that integrate a LoRa radio, mostly the HopeRF RFM95W radio module

Many of these board also propose additional features such as GPS or 2G/3G connectivity
2G/3G connectivity is definitely a good choice if cellular-based Internet is the only solution in isolated areas
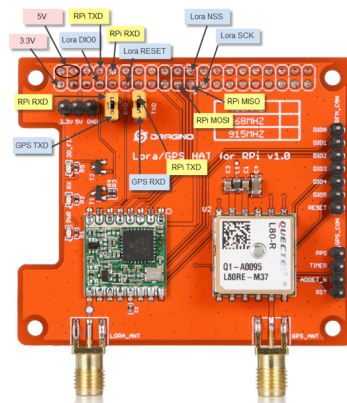

Dragino LoRa/GPS hat
For Raspberry PI
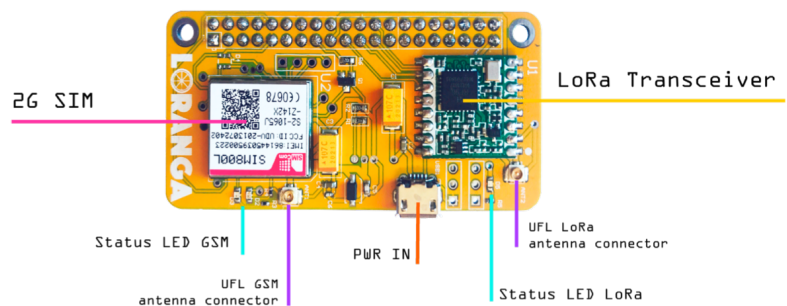
La Fábrica Alegre Loranga LoRa/2G/3G board
For Raspberry PI

Connecting the gateway to the Internet

The best way to provide Internet to the gateway is through Ethernet via a DSL router for instance

The DSL router can be replaced by a 3G router. This solution is better than using a USB 3G dongle because of power issues.

The Loranga hat mentioned above is a great solution that provides high flexibility of deployment. We have collaboration with the Loranga development team and support of the board is included in the github distribution
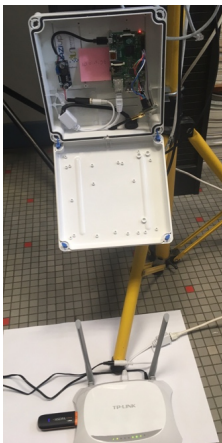
External 3G router
+ Ethernet

3G USB dongle

2G/3G Loranga hat

Loranga hat on an RPI0

Remote ssh access to a deployed gateway

Using the `ngrok` tunneling tool

A deployed gateway is usually connected to a local LAN, behind a firewall or Internet box without a public IP address. `ngrok` is a very simple and convenient tunneling tool to enable remote access to such deployed gateways. The latest version of the gateway software already includes the `ngrok` command in the `lora_gateway` folder.

Note that this service is normally not intended for permanent remote access to a gateway but rather to allow your tech person to temporarily get access with `ssh` to a deployed gateway for maintenance or troubleshooting. This is because local access to the gateway is still needed to start the `ngrok` tunnel, at least with a free `ngrok` account. If you need permament access, consider a paid `ngrok` plan or use a VPN server.

To use `ngrok` you first need to create an account on https://ngrok.com/signup. Then go to https://dashboard.ngrok.com to get your authentication token. On the gateway, log in using `ssh` and use the text command interface to enter the authentication token and start the `ngrok` tunnel. The text command interface has been extended with 3 commands:

```
-------------------------------------------------------* ngrok *--+
M- get and install ngrok                                          +
N- ngrok authtoken                                                +
O- ngrok tcp 22                                                   +
-----------------------------------------------------------------+
```

Use option **N** to provide (copy/paste) the auth token.

```
Enter your choice:
N
-----------------------------------------------------------------------
BEGIN OUTPUT
Enter you ngrok authtoken
jHyeJKIt6jz567jkUGtzgzgstsj_heyetuFR348euyH
Authtoken saved to configuration file: /home/pi/.ngrok2/ngrok.yml
END OUTPUT
Press RETURN/ENTER...
```

Then use option **O** to start the `ngrok` tunnel for enabling remote access with `ssh` (TCP port 22). You should then see a screen similar to this one:

What you have to provide to your tech person is the URL `0.tcp.ngrok.io` and the port number `15938`. He will then be able to use `ssh` to access to your gateway (provided that he has the `pi` user password) with:

```
> ssh -p 15938 pi@0.tcp.ngrok.io
```

INFORMATION ON YOUR GATEWAY: default configuration

Connecting to your gateway

Connect your gateway to a DHCP network to have Internet connectivity

Your gateway also acts as a WiFi access point. Search for WAZIUP_PI_GW_XXXXXXXXXX

Connect to this WiFi, password is **loragateway**

Use a web browser (you can use a smartphone or tablet for instance) and open http://192.168.200.1/admin

Login: **admin** Password: **loragateway**

Test Internet connectivity and update your gateway using **Full update** as explained in page 1 of the gateway booklet

LoRa radio configuration

LoRa **mode 1** (BW=125kHz, CR=4/5, SF=12)

This configuration allows for the longest range

Frequency is **865.2MHz** (CH_10_868)

Configured clouds

Your gateway has 2 enabled clouds defined in `clouds.json`: **WAZIUP cloud** and **ThingSpeak cloud**

The default device: Arduino_LoRa_Simple_temp

The end-device that comes with your gateway also use **LoRa mode 1** on **865.2Mhz** frequency. **Its address is 6**.

When powered on, the device will send the measured temperature (TC) **every 10 minutes**

Configuration of WAZIUP cloud

The project name is **waziup**

The service-tree is empty

The organization name is **ORG** (you must change this field to your organization name)

The domain will therefore be **waziup-ORG**

The device id will be **ORG_Sensor+device_addr**

e.g. from sensor 6: **ORG_Sensor6**

Go to dev.waziup.io:3000, log in for testing purpose. Login: **waziup**   Password: **waziup**

Search for your sensor name, e.g. ORG_Sensor6

Configuration of ThingSpeak cloud

The ThinkSpeak channel is https://thingspeak.com/channels/66794. Data with the default end-device will be on chart 3.

It is our Test LORA Gateway channel for testing so there can be a lot of strange value, the last one may be yours

The write key is **SGSH52UGPVAUYG3S**

You can create/use your new/existing ThingSpeak channel and enter your own write key using the **Cloud** menu of the gateway web interface. Then reboot your gateway

Recommended tutorials

The gateway web admin interface
https://github.com/CongducPham/tutorials/blob/master/Low-cost-LoRa-GW-web-admin.pdf

The gateway presentation and tutorial
https://github.com/CongducPham/tutorials/blob/master/Low-cost-LoRa-GW-step-by-step.pdf