Congduc Pham, **http://cpham.perso.univ-pau.fr**

http://www.waziup.eu

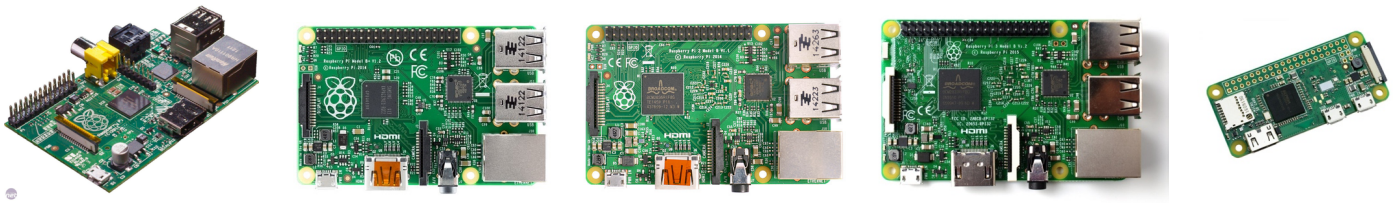
Preparing your Raspberry Pi

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

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

Write the SD card image

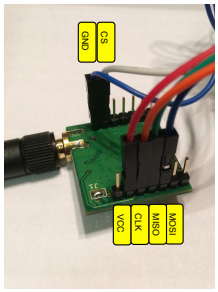
Use a class 10 8GB minimum SD card
See instruction from https://www.raspberrypi.org/documentation/installation/installing-images for various OS

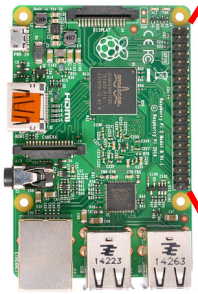


You can use RaspberryPI 1 model B/B+, RaspberryPI 2 model B, RaspberryPI 3 model B/B+ and RaspberryPI Zero (W). The most important usefull feature is the Ethernet interface for easy Internet connection. You can add WiFi with a WiFi USB dongle to use access-point features. With the RPI3 & RPI0W, WiFi 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 CE0_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

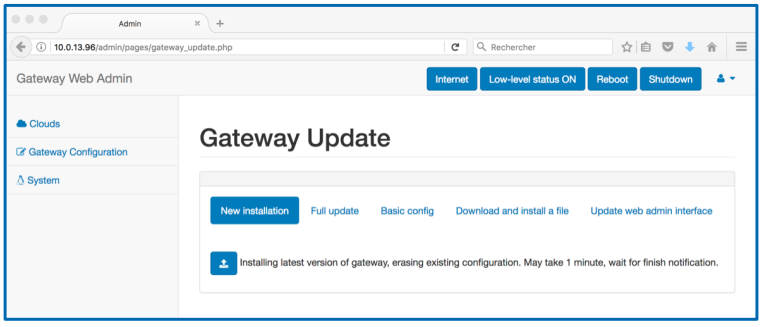
Login: admin Password: loragateway

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

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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

Range

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

Throughput

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*	-	-	-	-

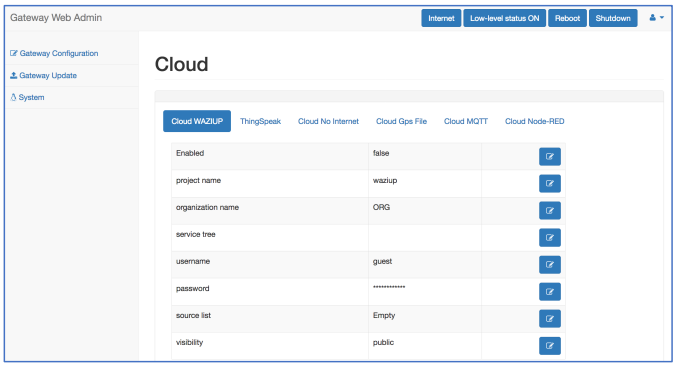
The default frequency at the end-device depends on the selected band, check and set the operating frequency of the gateway accordingly with the web admin interface.

Uploading to WAZIUP

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

WAZIUP cloud uses FIWARE platform with the possibility to define domains. The domain will be defined as **project_name**+'-'+**organization_name**+**service_tree**, e.g. **waziup-UPPA-TESTS** if:

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



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

Device id will be **organization_name**+**service_tree**+"_Sensor"+device_addr. For instance, for sensor 6 hosted by UPPA: **UPPA-TESTS_Sensor6**

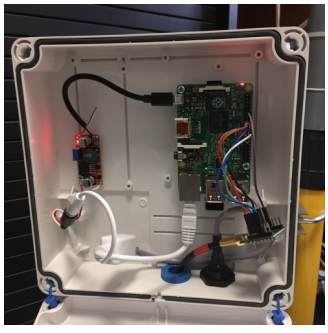
Retrieving values from WAZIUP platform (v2)

Using curl command

Assuming device 6 from UPPA (service_tree is –TESTS) sends **TC/22.5** which means a temperature of 22.5°C

```
curl -X GET https://api.waziup.io/api/v2/devices/UPPA-TESTS_Sensor6/sensors/TC
```

In addition, go to https://dashboard.waziup.io and search for your sensor name (e.g. UPPA-TESTS_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=peHkDhiH3IE**

Congduc Pham, **http://cpham.perso.univ-pau.fr**

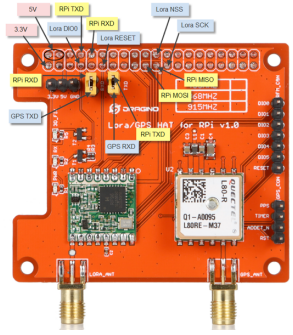
http://www.waziup.eu

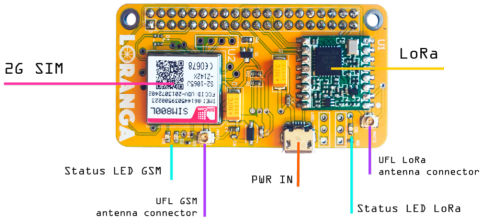
Using integrated LoRa radio shield/hat

Shield/hat with integrated LoRa radio modules

There are some shields/hats that integrate a LoRa radio, mostly the HopeRF RFM95(W) radio module

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



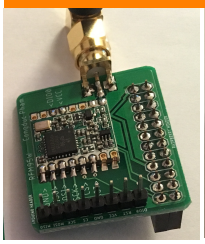


Dragino LoRa/GPS hat For Raspberry PI

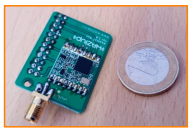
La Fábrica Alegre Loranga LoRa/2G/3G board

We designed a very simple PCB to host the RFM95 radio module with headers for both the Raspberry and Arduino boards. It is freely available at

https://github.com/CongducPham/LowCostLoRaGw#pcbs



WAZIUP also proposes the WaziHat shield

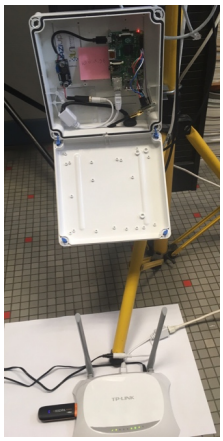


Connecting the gateway to the Internet

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.

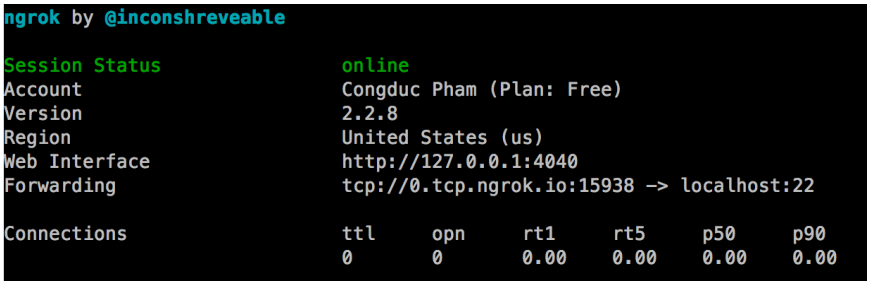
To use ngrok you first need to create an account on https://ngrok.com/signup. Then go to https://dashboard.ngrok.com to get your authentication token. On the gateway, log in using ssh and use the text command interface to enter the authentication token and start the ngrok tunnel. The text command interface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

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**

Default 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, e.g. UPPA)

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

The device id will be ***UPPA*_Sensor+device_addr**, e.g. from sensor 6: ***UPPA*_Sensor6**

The username is **guest** (you should create an account on https://dashboard.waziup.io)

The visibility is **public**

When username is **guest** or organization name is **ORG** then the gateway id MD5 hash is appended to the device id

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