

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

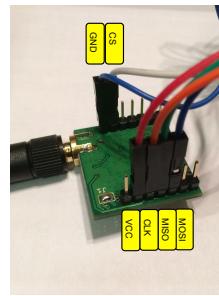
See instruction from <https://www.raspberrypi.org/documentation/installation/installing-images> for various OS



You can use RaspberryPi 1 model B/B+, RaspberryPi 2 model B, RaspberryPi 3 model B/B+ and RaspberryPi Zero (W). The most important useful 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	TXDD (UART)	14
	GND	9	10	RXDO (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	CEO_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

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

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.

LoRa mode	Range		
	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*	-	-	-	-

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

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 http://api.waziup.io/api/v1/sensors/UPPA-TESTS_Sensor6/measurements/TC
```

In addition, go to <https://dashboard.waziup.io> and search for your sensor name (e.g. UPPA-TESTS_Sensor6)



Additional resources & 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

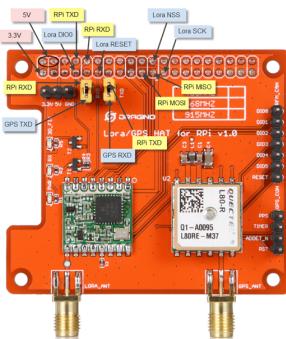
Gateway video <https://www.youtube.com/watch?v=peHkDhiH3IE>

Using integrated LoRa radio shield/hat

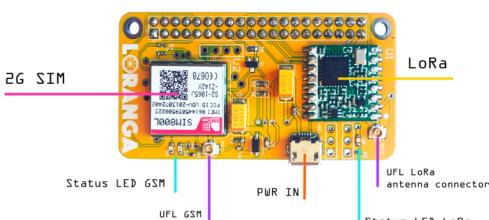
Shield/hat with integrated LoRa radio modules

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>

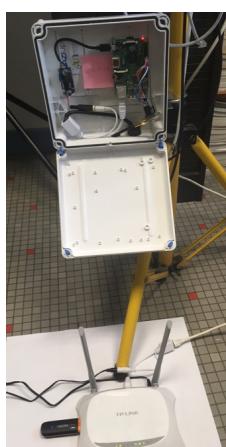


Connecting the gateway to the Internet

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 permanent 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
jHyeJKIt6jz567jkUGTzgztstsj_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:

```
ngrok by @inconshreveable

Session Status      online
Account            Congduc Pham (Plan: Free)
Version             2.2.8
Region              United States (us)
Web Interface       http://127.0.0.1:4040
Forwarding          tcp://0.tcp.ngrok.io:15938 -> localhost:22

Connections        ttl     opn     rt1     rt5     p50     p90
                  0       0      0.00    0.00    0.00    0.00
```

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**

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>