Intel-IrriS

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION
IN THE MEDITERRANEAN AREA

Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

Intel-IrriS

Building the INTEL-IRRIS LoRa IoT platform
Part 3: the INTEL-IRRIS starter-kit

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UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

LIUPPA

WAZIUP
IoT – from idea to reality
WAZIHUB

INTEL-IRRIS starter-kit

- "Intelligent Irrigation in-the-box", "plug-&-sense"
- From idea to reality!

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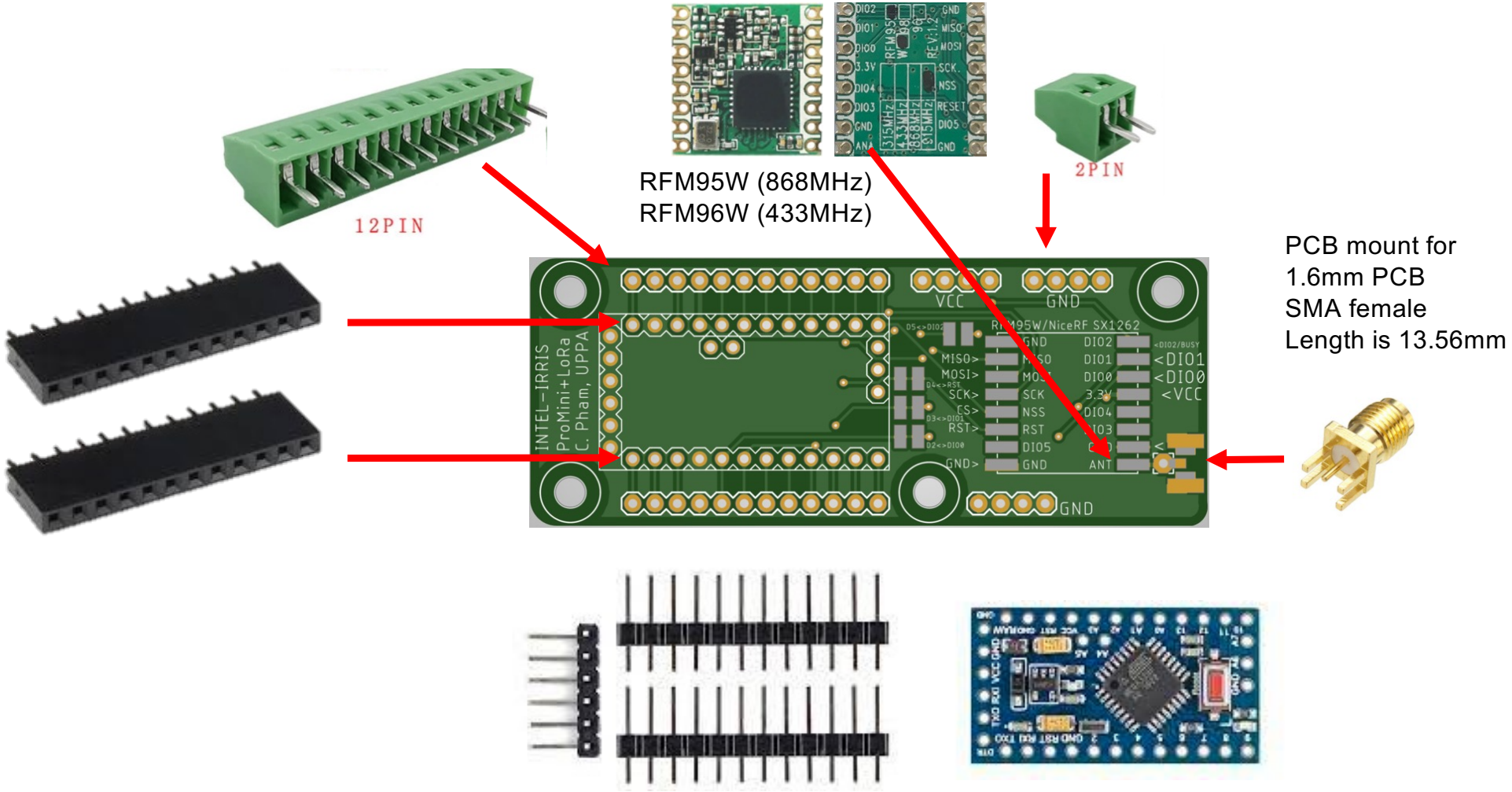
Preparing the starter-kits at UPPA

This non-technical video shows the preparation of the kits
https://youtu.be/5nznRcIoe40

Soil sensor: electronic parts

starter-kit version



Arduino ProMini 3.3V 8MHz

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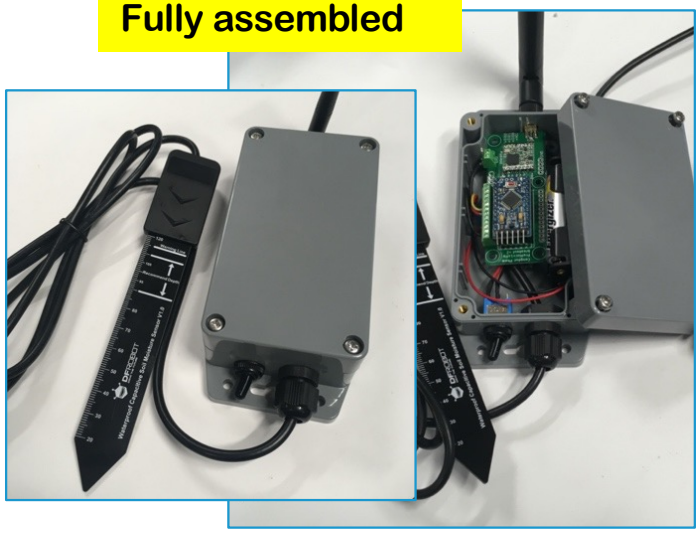
Soil sensor device

Fully assembled



Packaging in enclosure

To be assembled

2 versions of the soil device

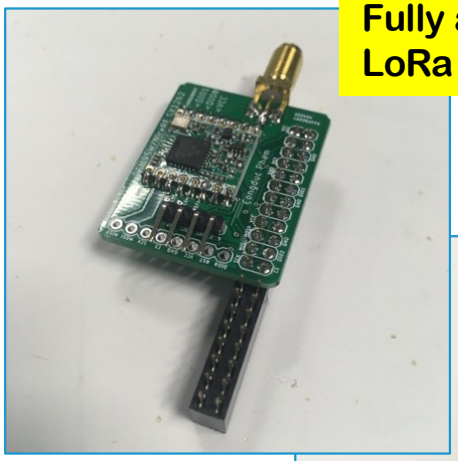
SEN0308
capacitive sensor

Watermark WM200
Water tension sensor

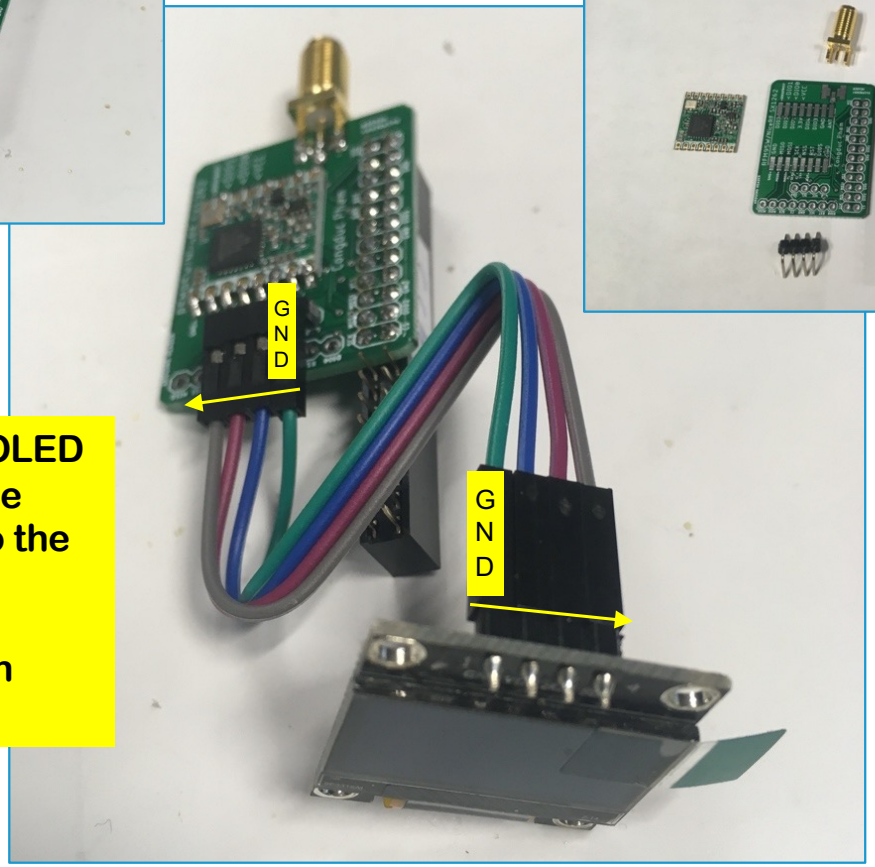
A soil temperature sensor can be added

Gateway (WaziGate)

Fully assembled LoRa radio hat



To be assembled



An optional OLED screen can be connected to the radio hat

Check the pin order

First round of starter-kits

- 1 fully assembled & configured soil sensor device
- NEED TO INSTALL 2-AA BATTERIES
- 4 soil sensor devices to be assembled & configured
- 1 fully assembled radio LoRa hat
- 4 radio LoRa hats to be assembled
- INTEL-IRRIS WaziGate image to be downloaded & flashed
- **IMPORTANT**
  - 1 starter-kit= 1 soil sensor + 1 INTEL-IRRIS WaziGate gateway
  - 1 starter-kit / farm to be deployed and tested
  - The WaziGate is only pre-configured for 1 soil sensor / farm
  - If there are several soil sensors in a farm, see advanced configuration
- All tutorials & videos: http://intel-irris.eu/tutorials-slides

Assembling starter-kit

Algeria (UORAN1), Morocco (ENSA Safi)

- Soil sensor device
  - Tutorial slides on building & assembling the outdoor LoRa IoT soil sensor device
  - Video n°1. YouTube tutorial video showing how to build the IoT microcontroller platform for the LoRa IoT soil sensor device. https://youtu.be/3jdQ0Uo0phQ
  - Video n°2. YouTube tutorial video showing how to build the outdoor LoRa IoT soil sensor device. https://youtu.be/zcazzDbXvHk
  - Video n°3. YouTube tutorial video showing how to wire the SEN0308 capacitive sensor. https://youtu.be/zcazzDbXvHk
- INTEL-IRRIS WaziGate
  - Tutorial slides on preparing the INTEL-IRRIS WaziGate IoT gateway
  - Video n°4. YouTube tutorial video demonstrating the INTEL-IRRIS soil sensor device & WaziGate framework. https://youtu.be/zcazzDbXvHk

Preparing Wazigate

- Plug the LoRa radio hat on the Raspberry, screw in the antenna

- Download SD card image from http://intel-irris.eu/results
- Image uses EU433 frequency band (Algeria, Morocco, France)
- Flash SD card (min 8GB): Video n°4 at t=124s, https://youtu.be/j-1Nk0tv0xM?t=124, then insert SD card

WaziGate power consumption

- RPI3B consumes less than 300mA
- There can be peak up to 800mA when booting
- However, a 2.5A micro USB charger is needed to avoid undervoltage

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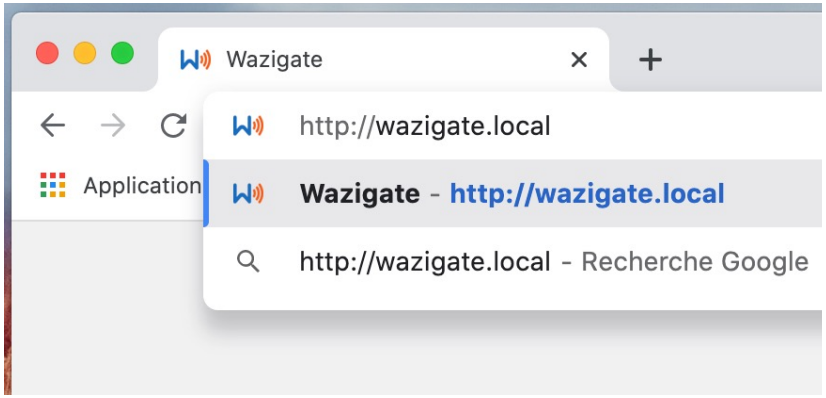
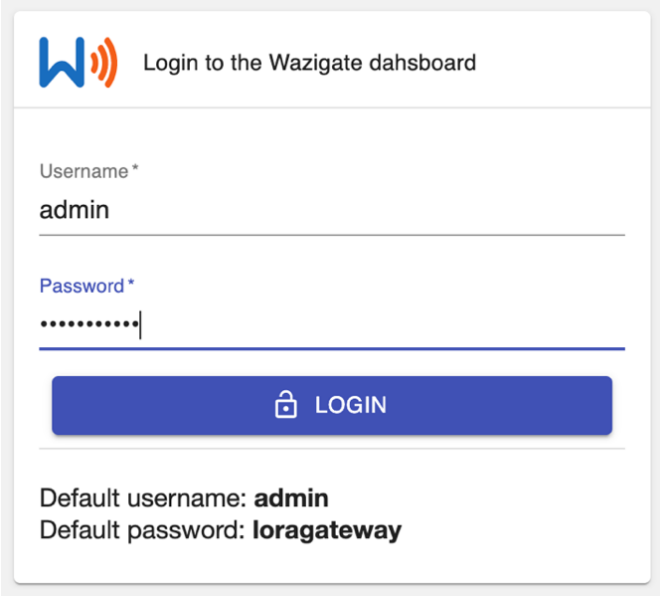
Checking the WaziGate

- Power the WaziGate, no Internet is required, wait 3-4mins (boot)
- Connect to WAZIGATE_XXXXXXXXXXXX WiFi network
  - default WiFi password is loragateway
- Open web navigator. Go to http://wazigate.local or http://10.42.0.1



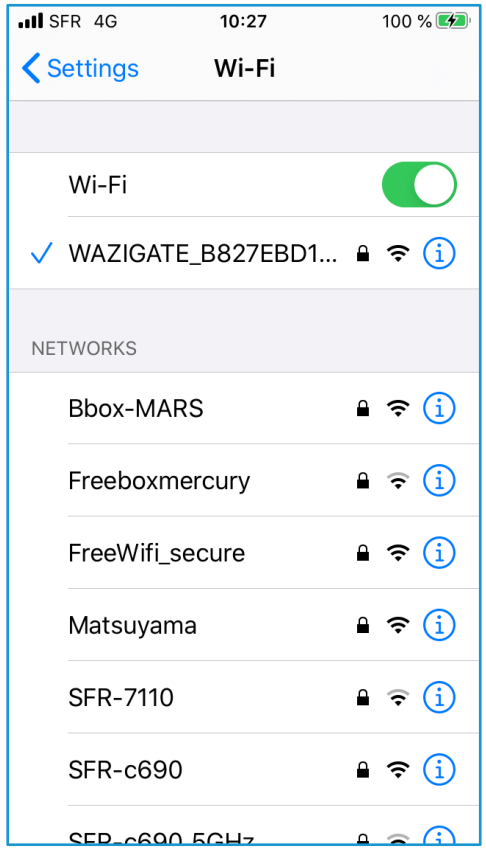
http://wazigate.local

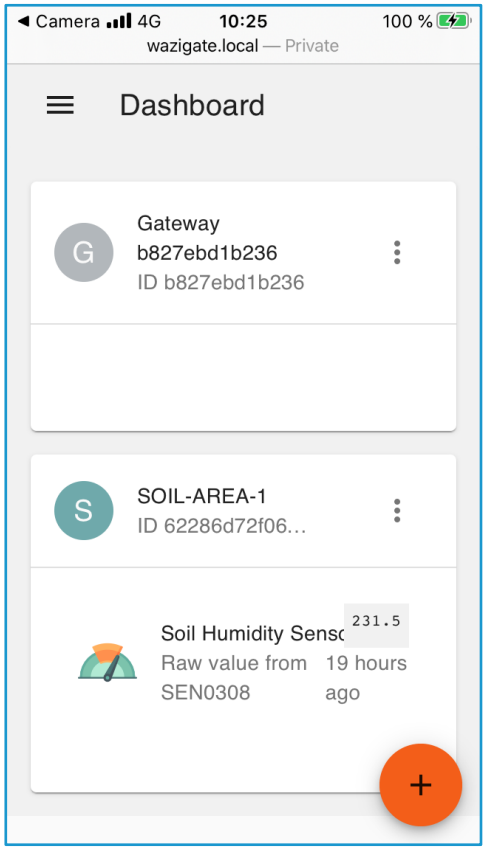
http://10.42.0.1

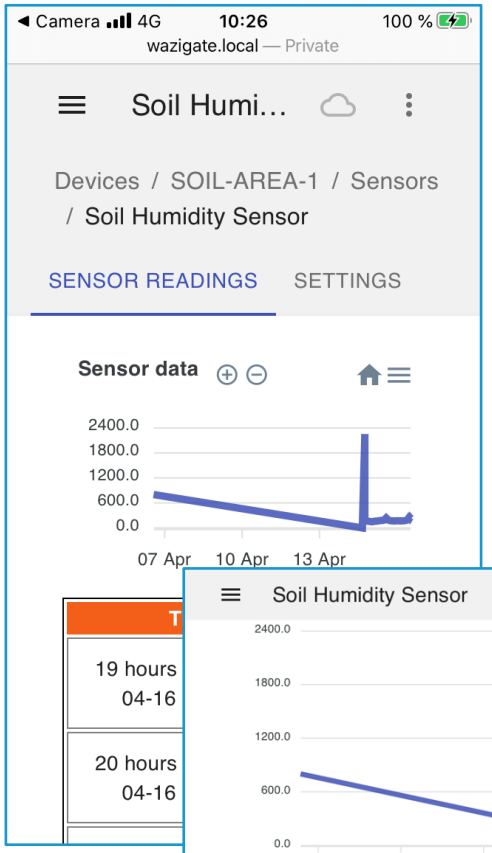


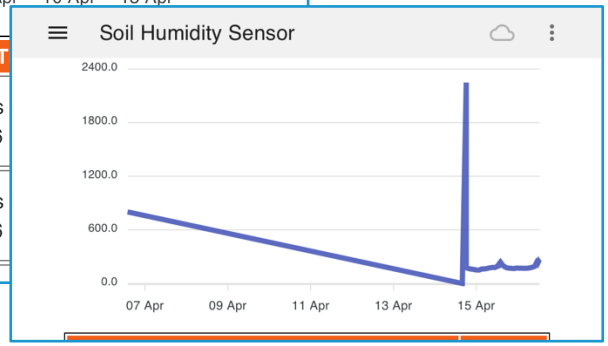
- Use default login to connect
  - User: admin
  - Password: loragateway

WaziGate's dashboard









http://wazigate.local

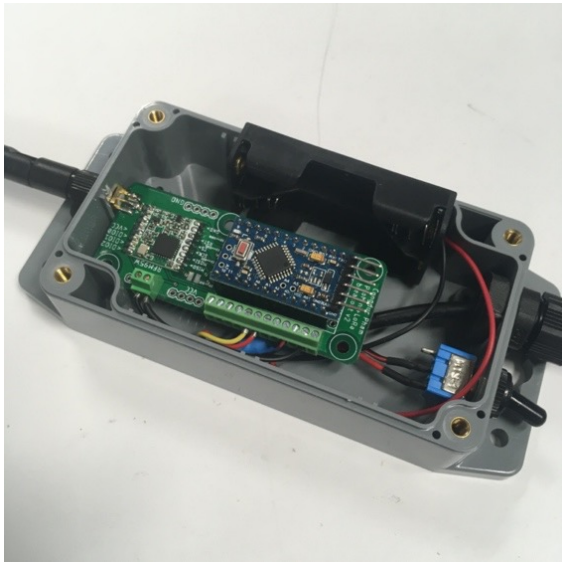
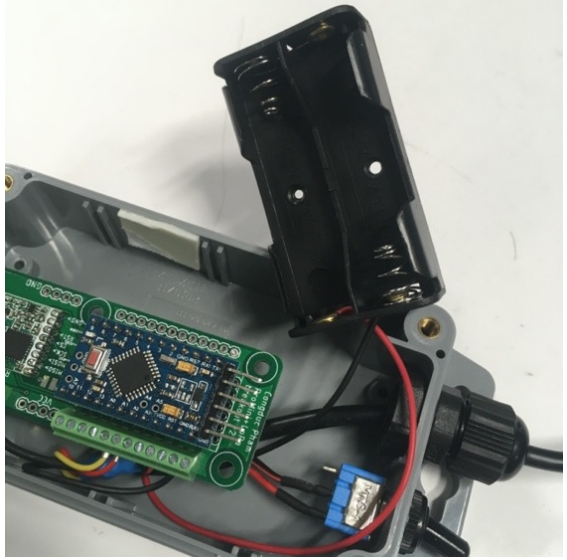
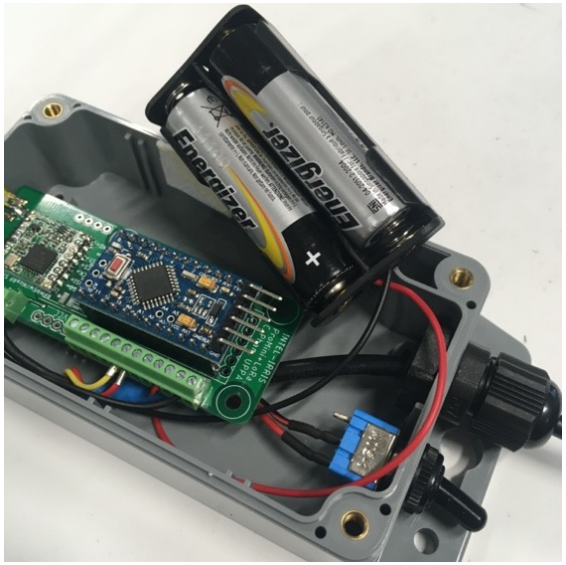
http://10.42.0.1

Look at Video n°4 at t=239s

https://youtu.be/j-1Nk0tv0xM?t=239

Preparing soil sensor device
install batteries

- Remove cover & install 2-AA batteries in battery holder
- Best way is to detach the battery holder

- Put back cover and be sure to tighten the cover
- Procedure is the same if you need to replace the batteries

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Take good AA batteries

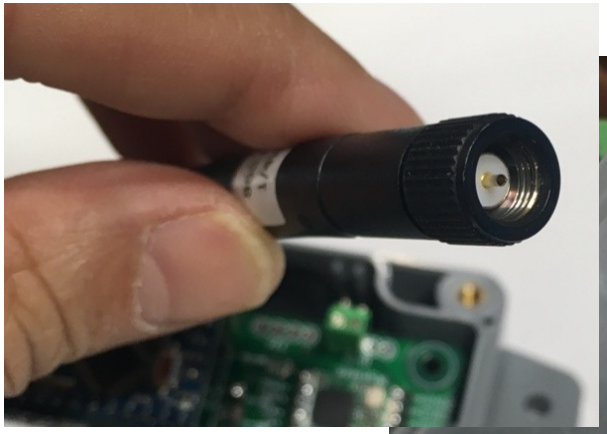
- Install new & high-grade alkaline AA batteries to allow for at least 2 years of autonomy
- Take a well-known brand

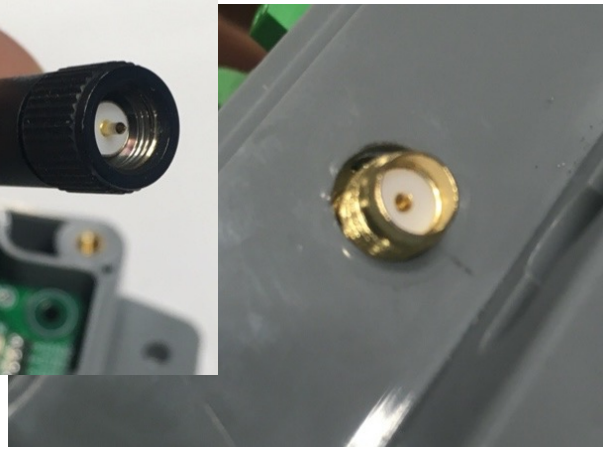
Never transmit without antenna

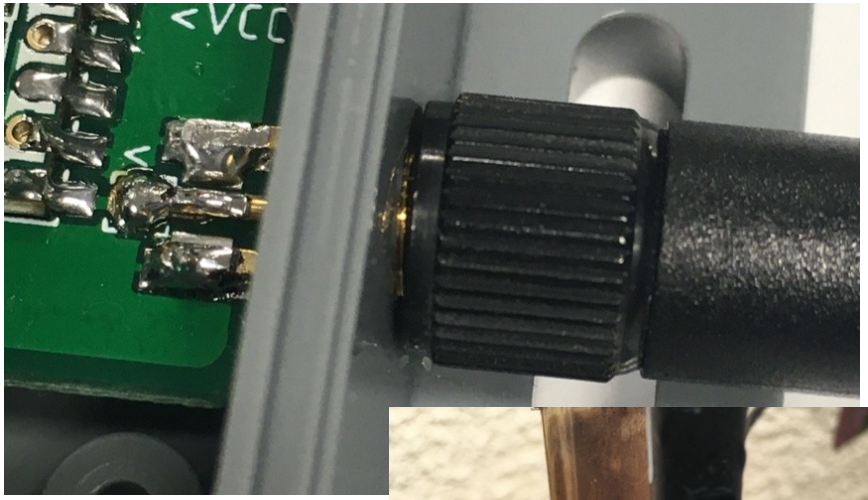
- NEVER, NEVER transmit without an antenna
- Doing so can damage the radio module
- If your board is already connected to the radio module and you need to flash the board, connect the antenna
- If you need to update the existing code and your device already run a code that transmit data, connect the antenna
- It is safer when programming the device to remove the Arduino board from the PCB and program it disconnected from the radio module
- If you deploy a device, make sure that the antenna is correctly connected before powering on the device and realizing any transmission test

Preparing soil sensor device

screw in the antenna



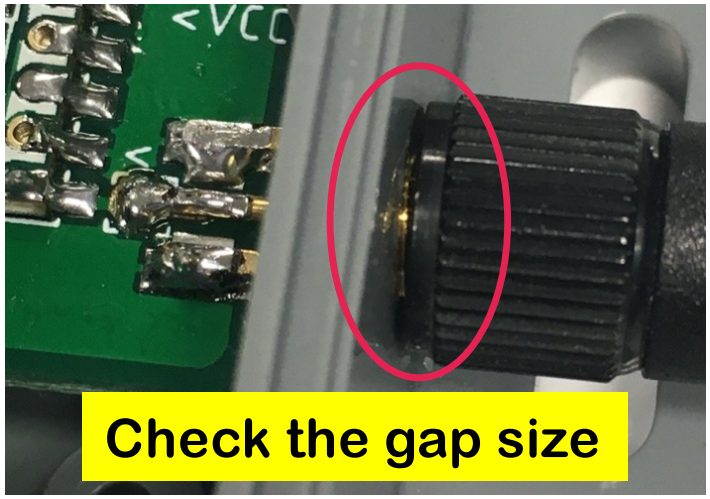


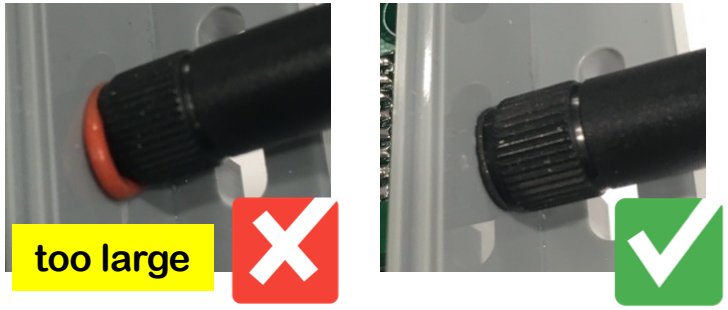


Be sure to connect the matching antenna
Here, SMA female with SMA male antenna
Need to screw the antenna in all the way

The antenna junction is critical because this is where rain water can come in

The antenna junction





Even when the antenna is screwed in all the way, there might still be a gap

Even with no apparent gap, it is necessary to waterproof the junction

Take an o-ring for that purpose, but do not take it too thick or too large!

Too thick: the antenna will not be screwed in all the way!

There are o-ring for SMA connector but the gap size is an indication

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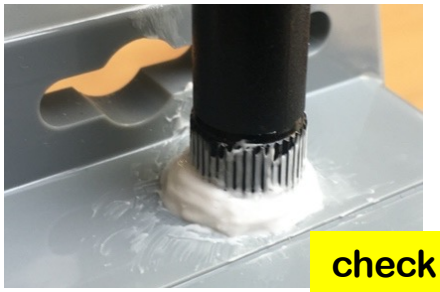
Do not have or can not use o-ring?

Maybe the gap is too big? Use silicon joint sealant

First, screw in the antenna all the way

Put small amount of silicon around the antenna junction (use a flat screw driver or other flat tool)

Use a wet toothpick to finish and clean the silicon all around the antenna junction



check especially the back side

Even with o-ring, it is safer to add silicon!

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Put the device sticker

- Put the INTEL-IRRIS device sticker on the device cover
- See how the OFF and ON position are indicated
- You may use a waterproof marker to write the device address

Testing transmission to WaziGate

- Test with the fully assembled & configured soil sensor device
  - Check that antenna is connected
  - Switch ON the soil sensor device to get data transmission
  - Wait for about 10s, then switch OFF the soil sensor device
  - Check reception of data on WaziGate's dashboard
  - You need to refresh the web page on the web navigator

Look at Video n°4 at t=331s

https://youtu.be/j-1Nk0tv0xM?t=331

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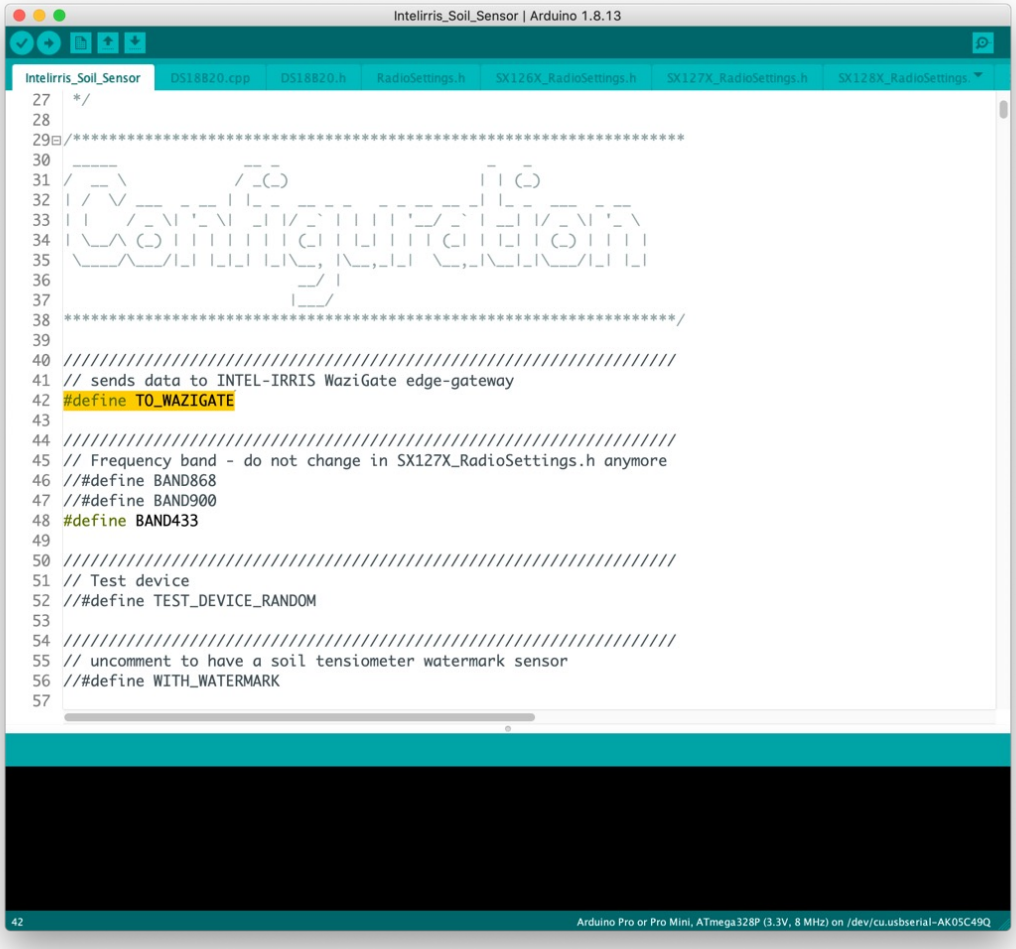
Transmission to WaziGate

Parameters for
INTEL-IRRIS WaziGate
(default in red)

LoRaWAN
SF12BW125
868.1MHz | 433.175MHz
Node id is 26011DAA
1 msg/60mins
1 sensor
XLPP data

This dedicated video will show all these steps, from connecting the SEN0308 to testing transmission to the WaziGate
Video n°4: https://youtu.be/j-1Nk0tv0xM

Configure soil device for WaziGate



Be sure that

`#define TO_WAZIGATE`

is uncommented

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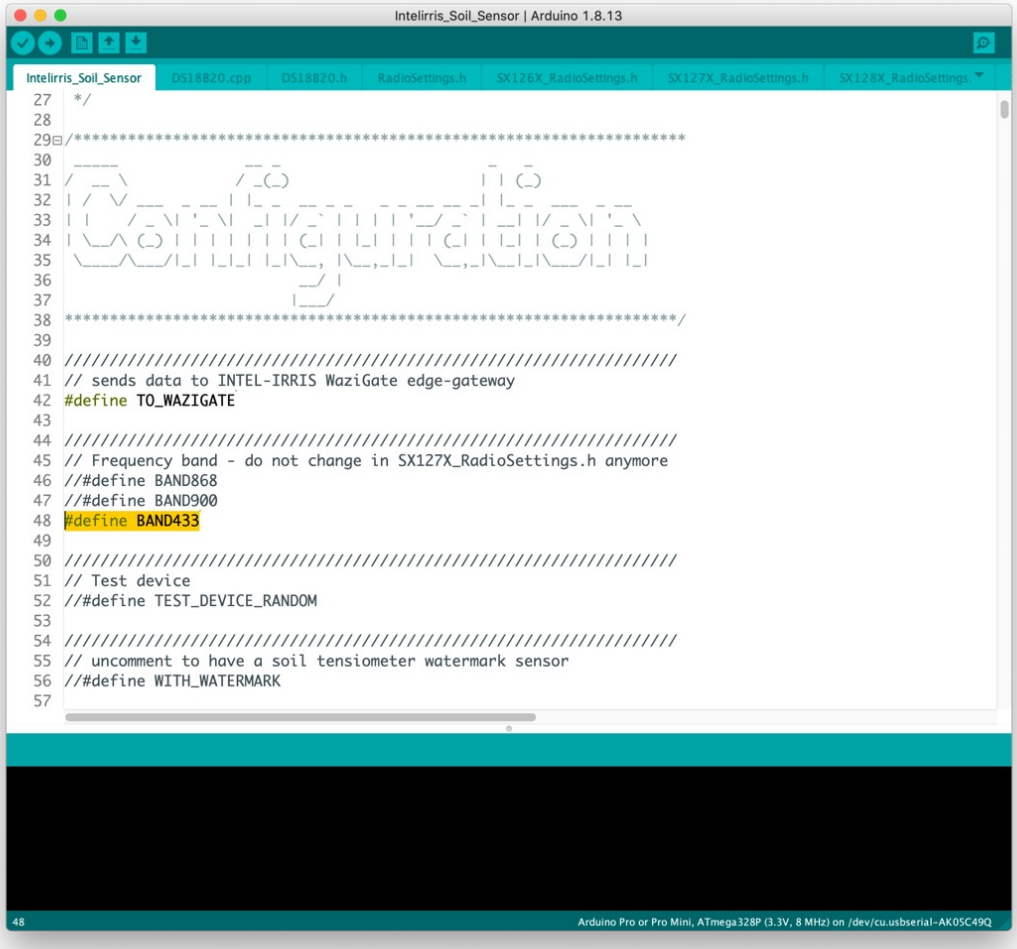
Configuring for EU433 band



If you use the EU433 band

make sure that

`#define BAND433`

is the only uncommented band option

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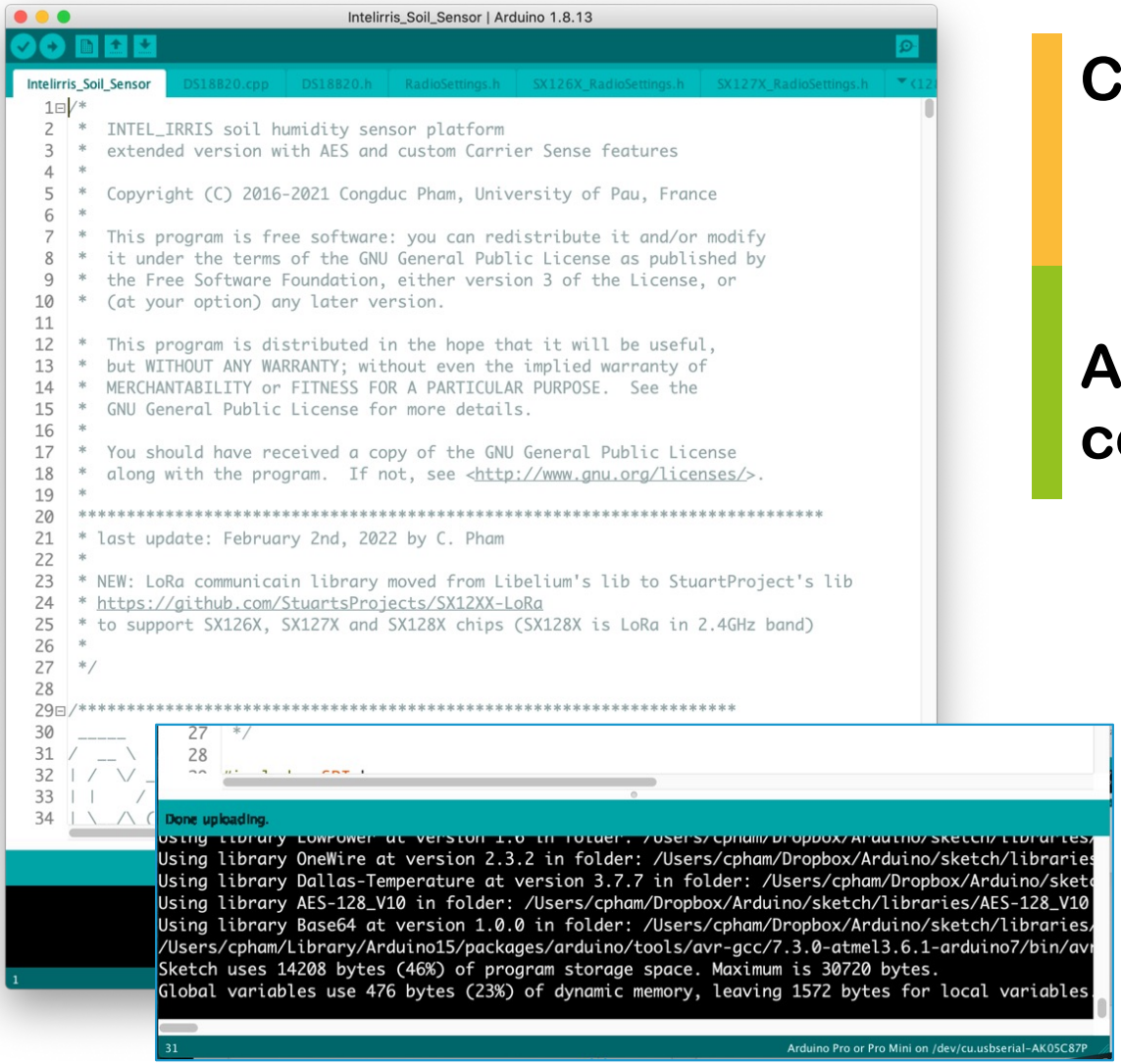
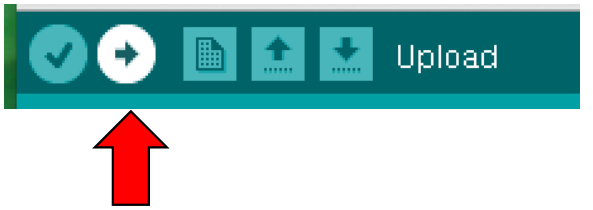
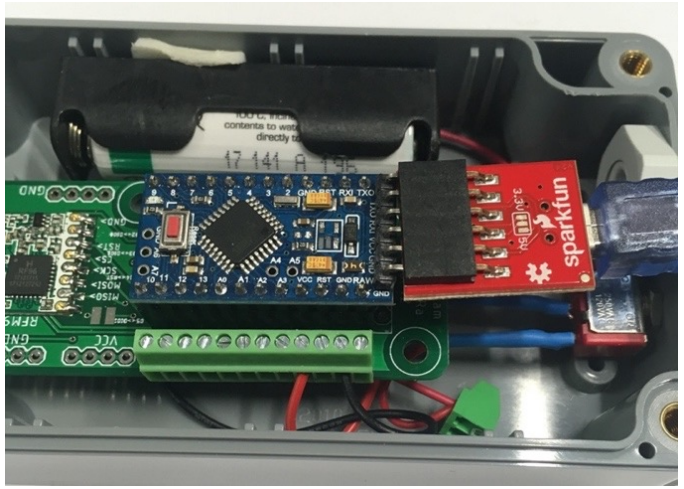
Uploading to your board



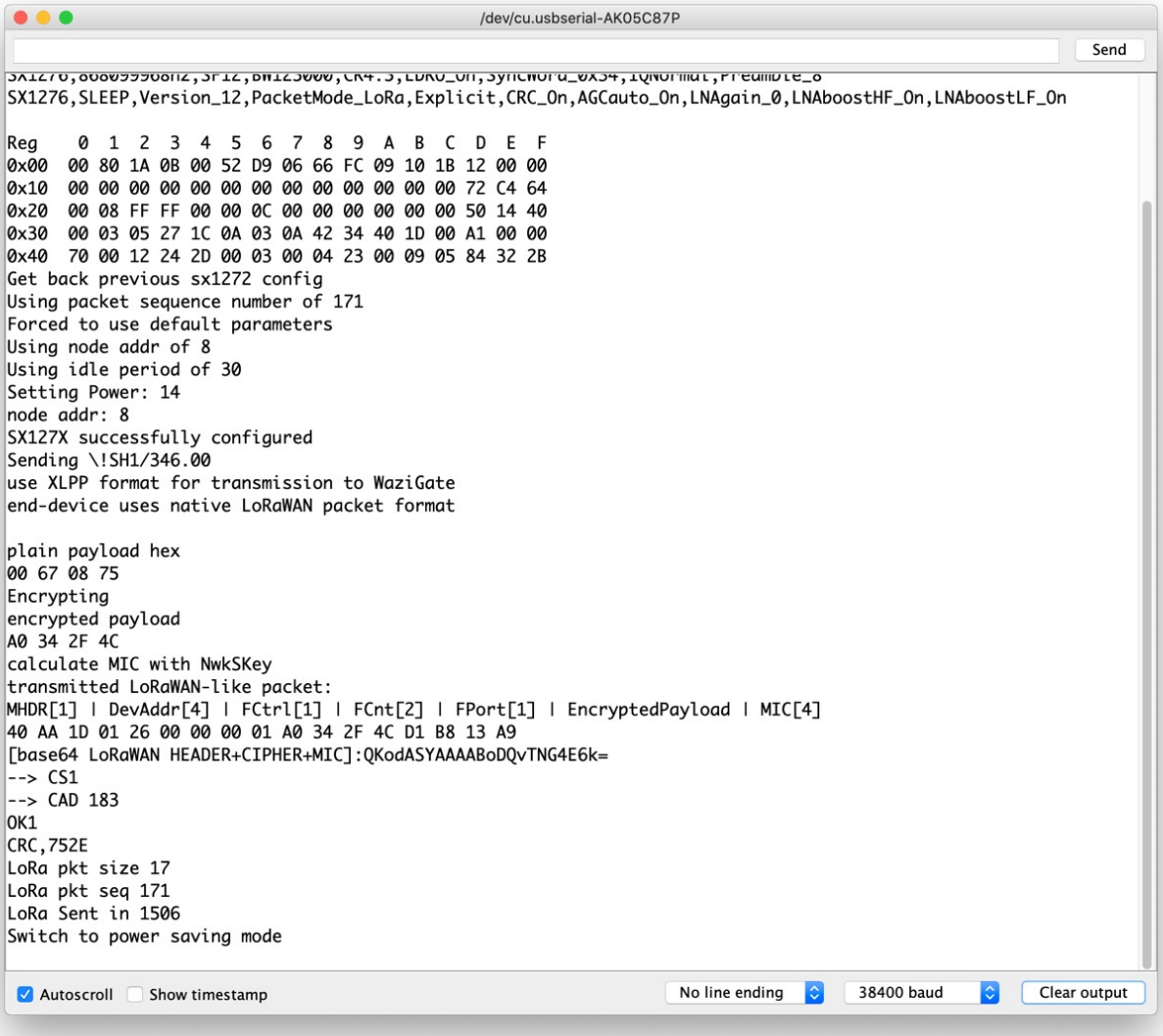
Click on the "upload" button



And wait until upload is completed



Checking that device is operational



- Open serial monitor
- Set baud rate to 38400
- See output from board
- Check that transmission is OK

Deploying the starter-kit (1)

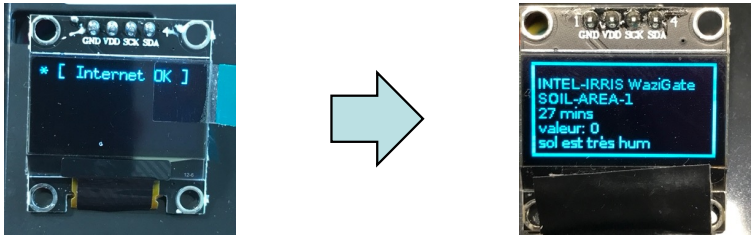
- Install the soil sensor device in the field
  - See dedicated slides/videos [to come]
- Install the WaziGate in the farmer's office/home/premise
  - Just power the WaziGate, no Internet is required
  - Test access to WaziGate's dashboard with farmer's smarphone
- NEVER TRANSMIT WITHOUT AN ANTENNA
- Test correct data reception on WaziGate
  - Switch ON the soil sensor device to get data transmission
  - Check reception of data on WaziGate's dashboard or OLED screen

Deploying the starter-kit (2)

- Connect RTC module to Raspberry (recommended)
  - With an additional RTC module, the Raspberry WaziGate working without Internet can keep the correct date & time
  - Connect the RTC module to the LoRa hat which should have been soldered with longer header pins

Deploying the starter-kit (3)

- Sync the gateway clock (recommended)
  - As WaziGate will run without Internet access, its internal clock should be synced at the first boot. With an RTC module, date & time will be saved
  - To do so, you can use your laptop that should itself be connected to the Internet (using your smartphone's WiFi sharing feature for instance)
  - Then make sure that your laptop will share its Internet connection to devices connected on its Ethernet port. See how to do so: https://www.waziup.io/documentation/wazigate/v2/install/#connect-with-ethernet-cable-to-pc
  - **Before powering WaziGate, connect it to your laptop by Ethernet cable**
  - Then power the WaziGate and you should see the first [Internet OK] screen. Wait until the main INTEL-IRRIS OLED screen appears



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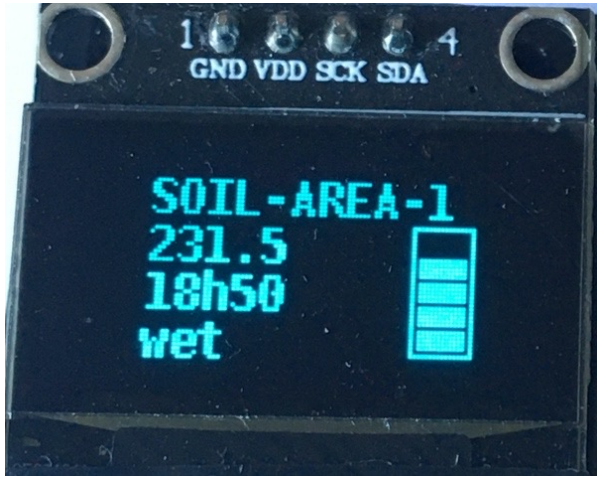
With the OLED screen

- With a small .96" OLED screen, information summary is displayed for the end-user: the device name, the time of last received data, the sensor raw value and the soil condition
- The main screen is displayed for 6s every 30s. Then a screen saver display will show a shorter version of these information with a 5-bar visual
- 5 bars: very wet | 4 bars: wet
- 3 bars: wet-dry | 2 bars: dry-wet
- 1 bar: dry | 0 bar: very dry



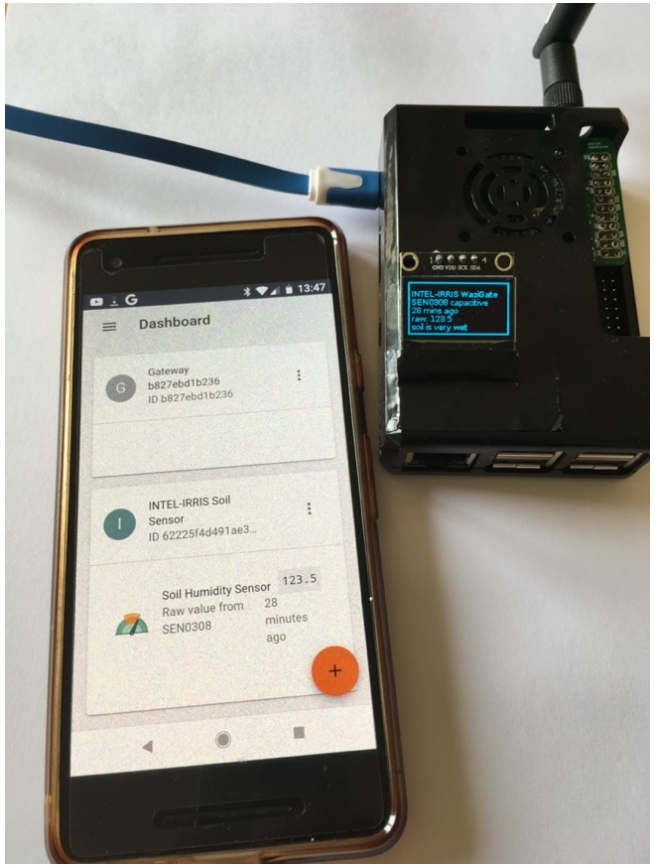
QR code for connecting to WiFi

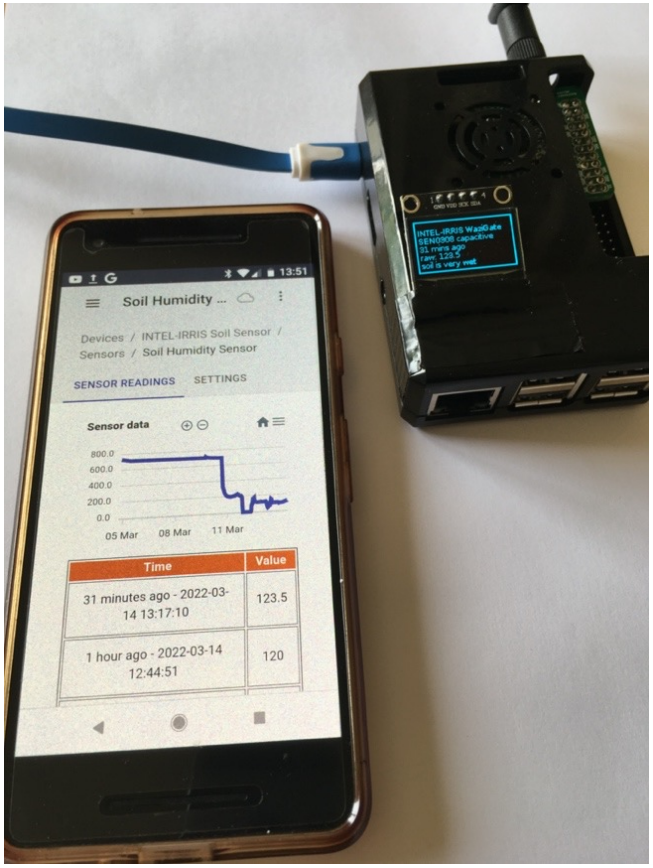
- The WaziGate WiFi is WAZIGATE_XXXXXXXXXXXX where XXXXXXXXXXXX is the MAC address of the Raspberry
- For instance WAZIGATE_B827EBD1B236
- With the OLED, a QR code for joining the WiFi network is generated dynamically at boot time and displayed for 10s before the main screen so that users can automatically join with a smartphone
- Then, users can scan the static QR code on the WaziGate sticker to connect to the WaziGate's dashboard or the INTEL-IRRIS WaziApp

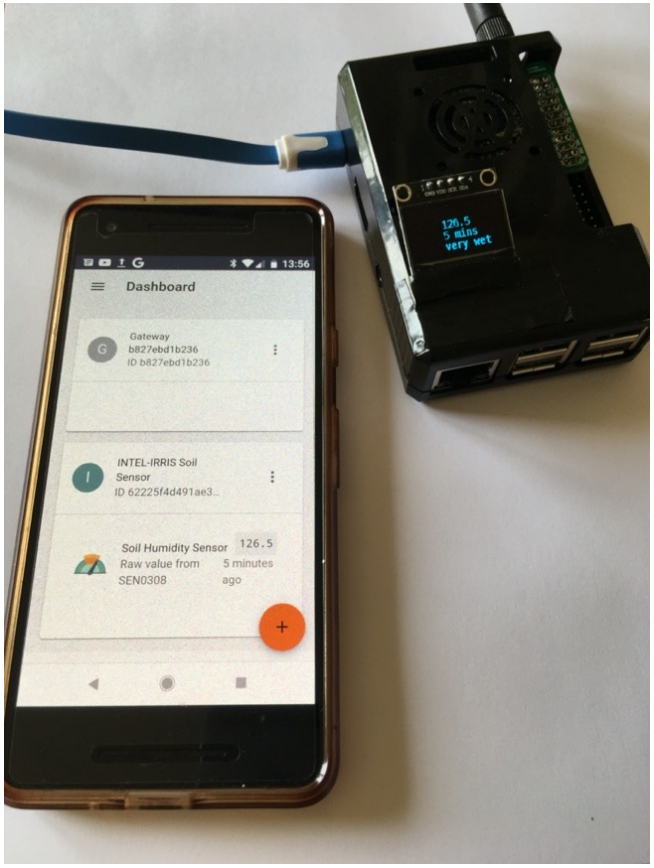
WAZIGATE_B827EBD1B236

WAZIGATE_DCA6325C2A7A

WaziGate User Interface





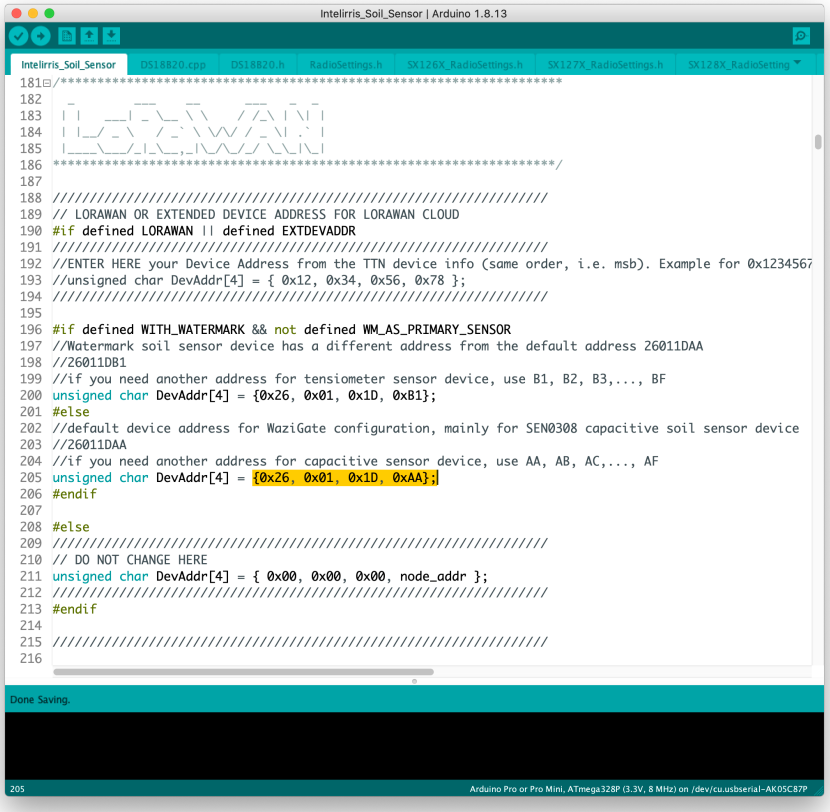


- The WaziGate provides the simple OLED interface but also more advanced features through the WaziGate dashboard and embedded application interface (WaziApp)
- A dedicated INTEL-IRRIS Irrigation WaziApp is currently being developed

Advanced configuration

1/ To have several capacitive soil sensor devices

- Only to have several capacitive soil devices on 1 Wazigate – change the device address in the soil device Arduino code



Default address for capacitive sensor is

```
{0x26, 0x01, 0x1D, 0xAA};
```

Just increase the last byte

```
{0x26, 0x01, 0x1D, 0xAB};
```

Compile and upload the code to the soil sensor device

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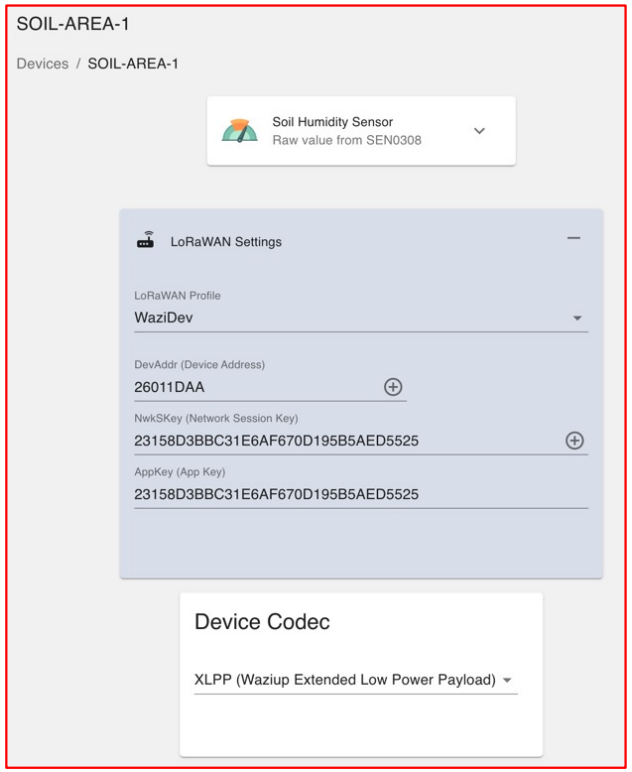
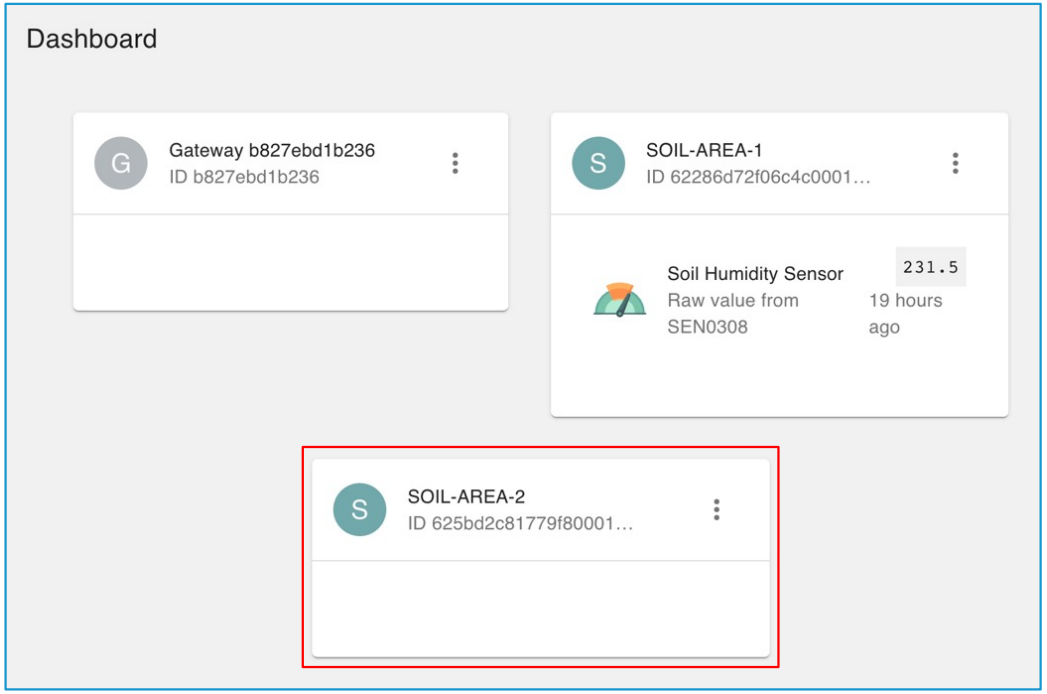
Advanced configuration

1/ To have several capacitive soil sensor devices, con't

- Left figure shows configuration of the default soil sensor device
- Create a new device, e.g. device name SOIL-AREA-2
- Avoid space, limit to 12 characters for correct display on OLED

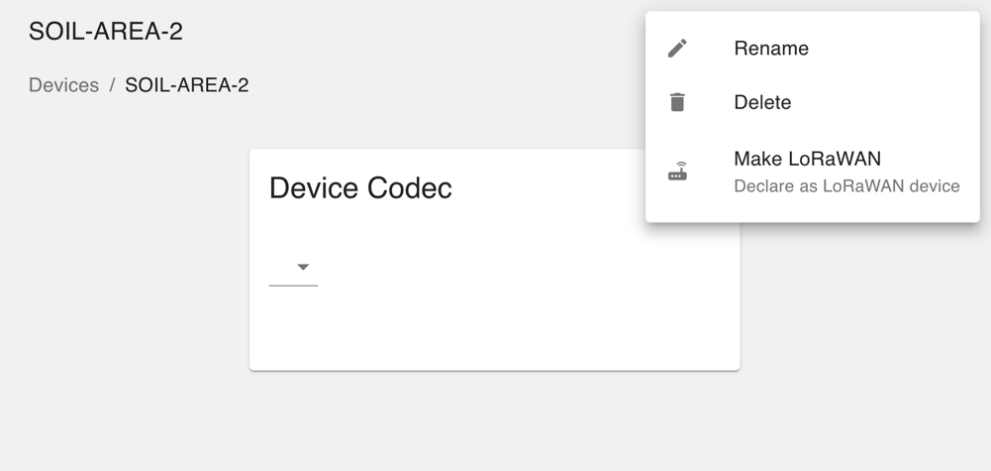




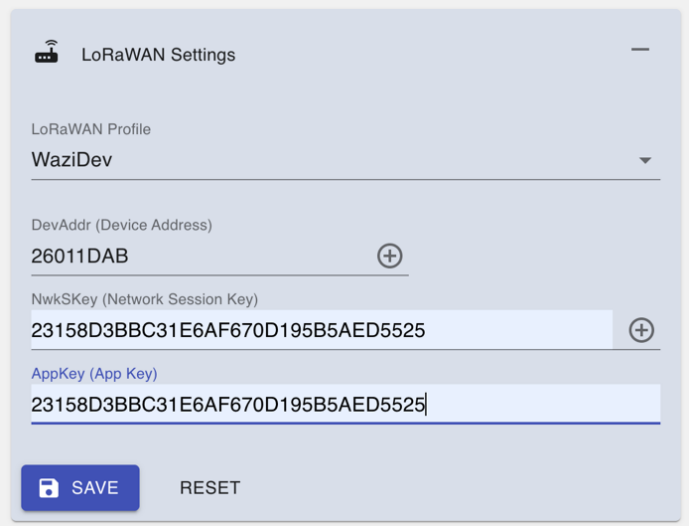
Advanced configuration

1/ To have several capacitive soil sensor devices, con't

- Select the new device and make it as LoRaWAN device



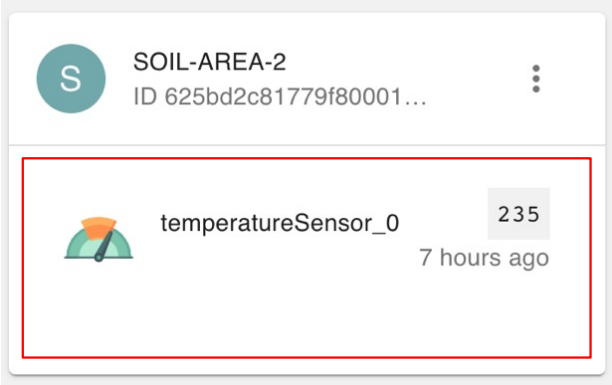
- Set the new address, matching the one of the Arduino code: 26011DAB
- keep same encryption keys
- Select XLPP as codec

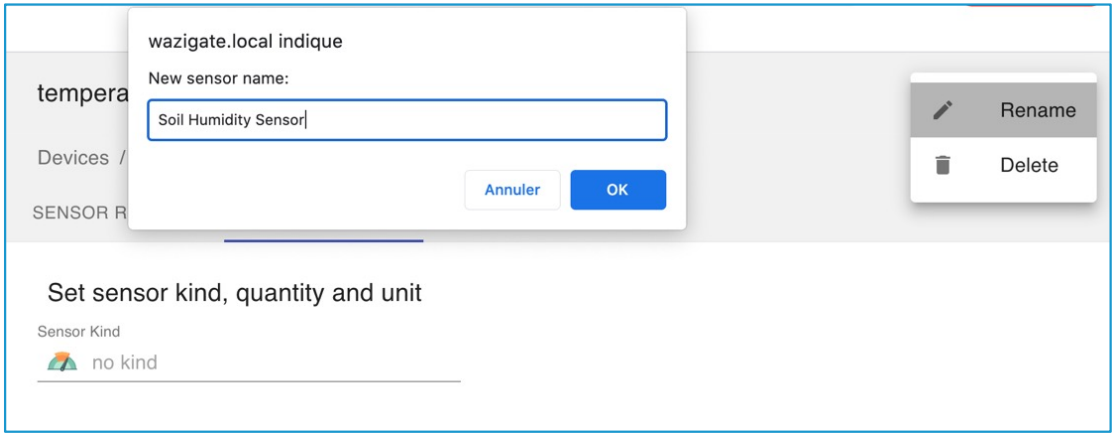


Advanced configuration

1/ To have several capacitive soil sensor devices, con't

- DO NOT manually create a sensor. Instead,…
- … power on the new soil sensor device for data transmission
- Refresh the WaziGate dashboard, the new data should appear
- New sensor name is "temperatureSensor_0"
- Click on "temperatureSensor_0" and then rename it, e.g. "Soil Humidity Sensor"

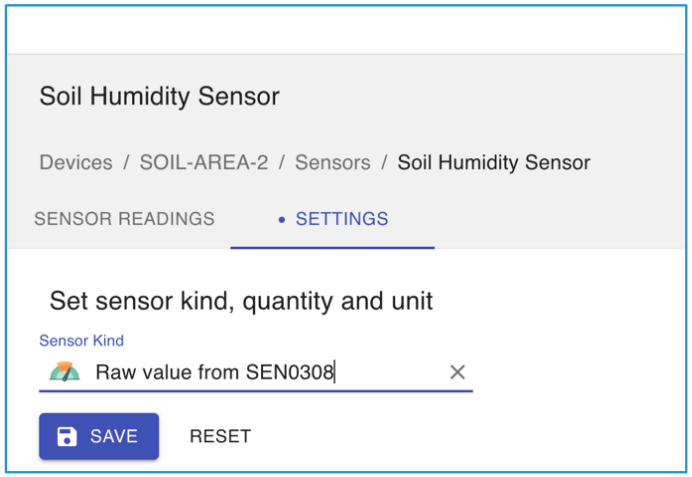


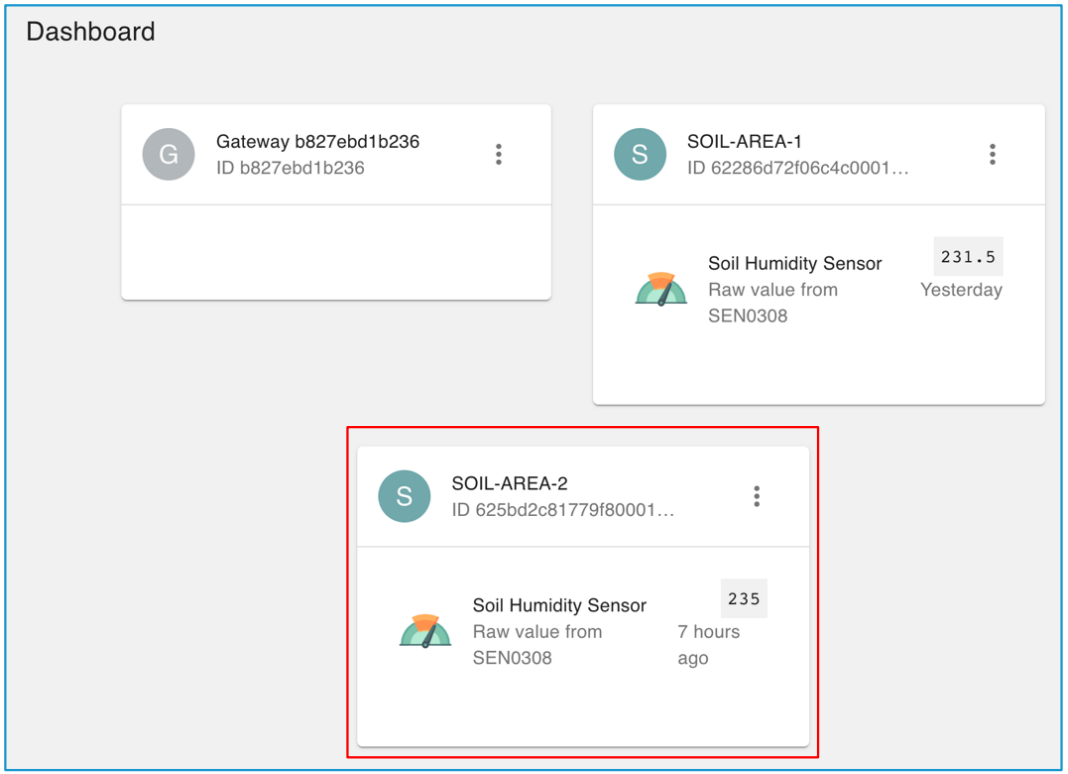


Advanced configuration

1/ To have several capacitive soil sensor devices, con't

- Change Sensor kind to "Raw value from SEN0308"



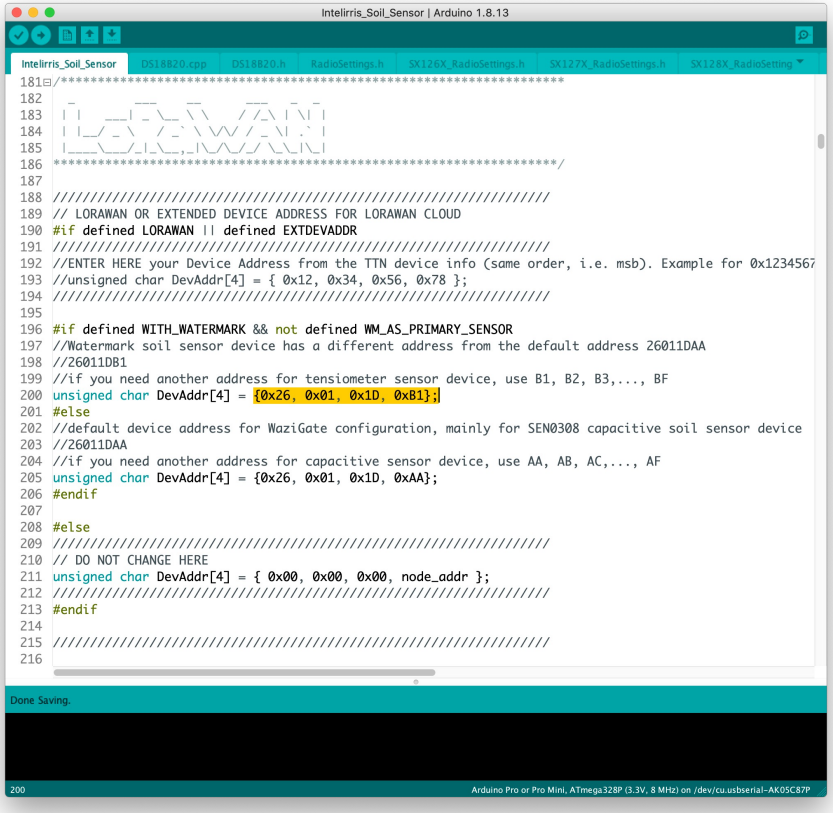


- The dashboard now displays correctly the new device with its sensor

Advanced configuration

2/ To have several tensiometer soil sensor devices

- Only to have several tensiometer soil devices on 1 Wazigate – change the device address in the soil device Arduino code



Default address for tensiometer sensor is

```
{0x26, 0x01, 0x1D, 0xB1};
```

Just increase the last byte

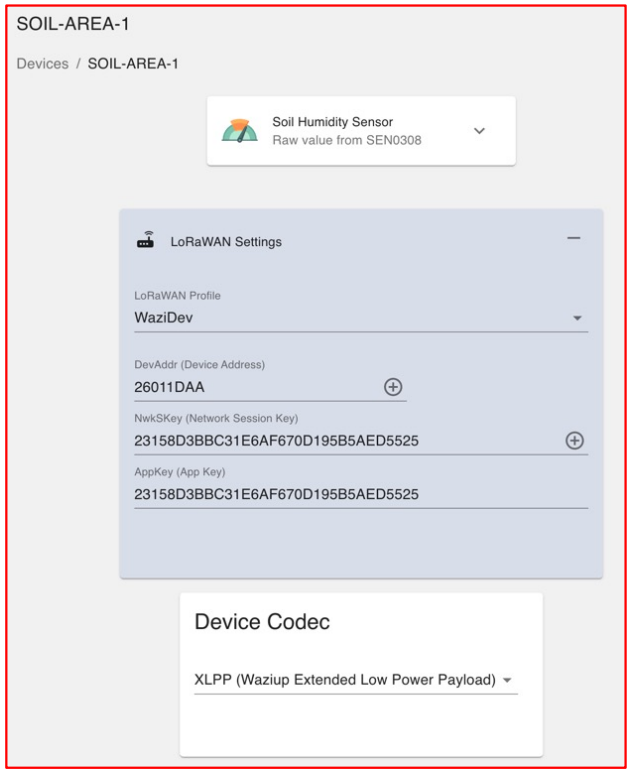
```
{0x26, 0x01, 0x1D, 0xB2};
```

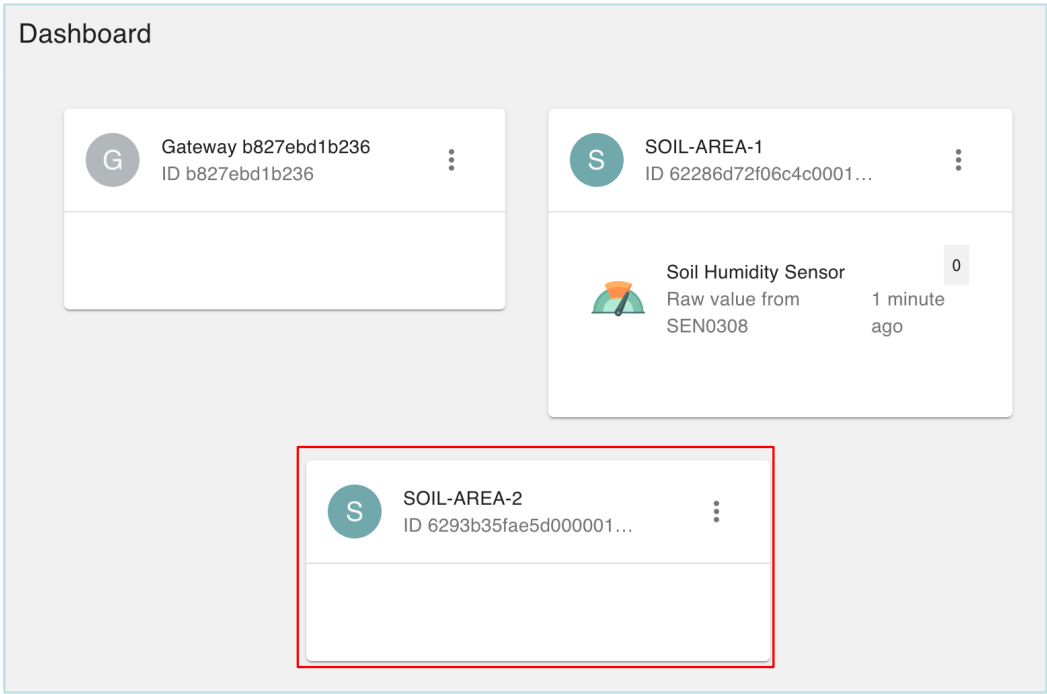
Compile and upload the code to the soil sensor device

Advanced configuration

2/ To have several tensiometer soil sensor devices, con't

- Left figure shows configuration of the default soil sensor device
- Create a new device, e.g. device name SOIL-AREA-2
- Avoid space, limit to 12 characters for correct display on OLED

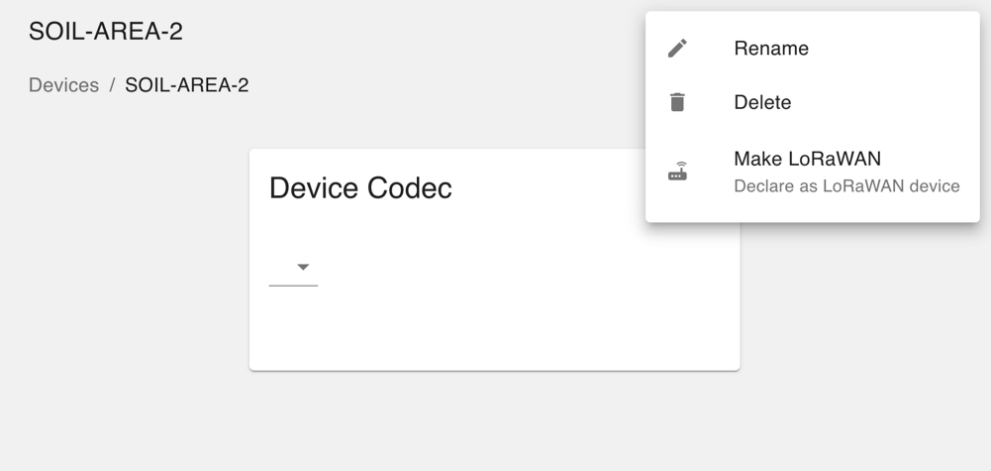




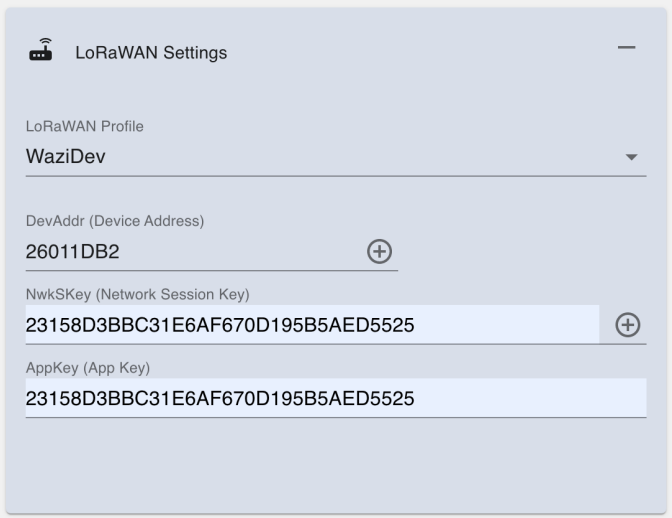
Advanced configuration

2/ To have several tensiometer soil sensor devices, con't

- Select the new device and make it as LoRaWAN device



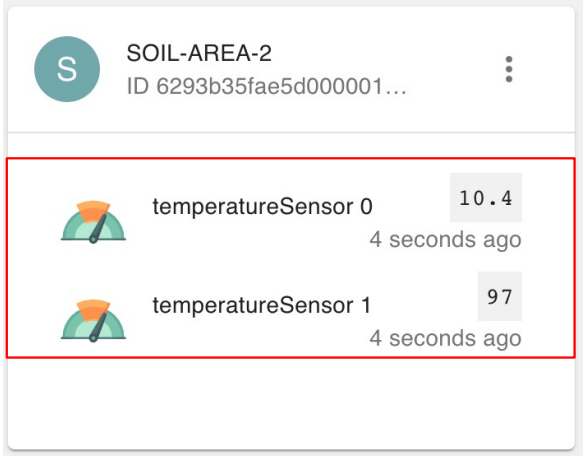
- Set the new address, matching the one of the Arduino code: 26011DB2
- keep same encryption keys
- Select XLPP as codec

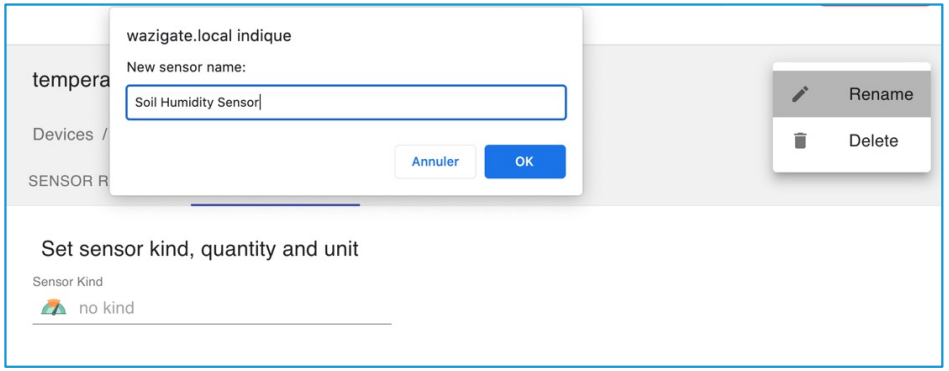


Advanced configuration

2/ To have several tensiometer soil sensor devices, con't

- DO NOT manually create a sensor. Instead,…
- … power on the new soil sensor device for data transmission
- Refresh the WaziGate dashboard, the new data should appear
- There should be 2 new sensor names
  - "temperatureSensor_0" & "temperatureSensor_1"
- Click on "temperatureSensor_0" and then rename it, e.g. "Soil Humidity Sensor"
- Do the same for "temperatureSensor_1"

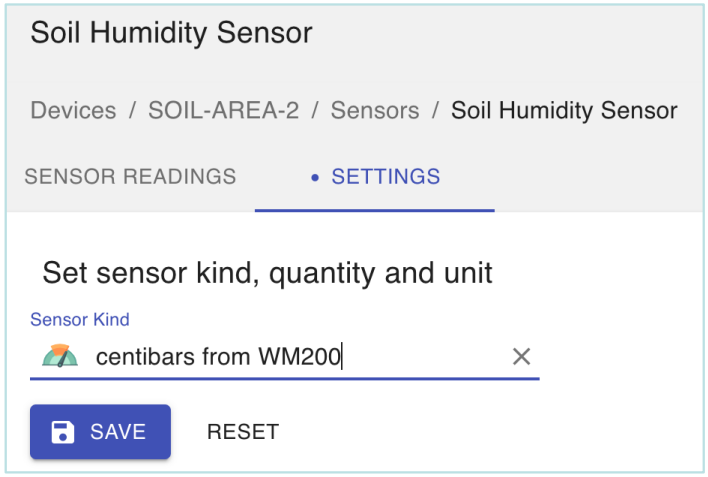


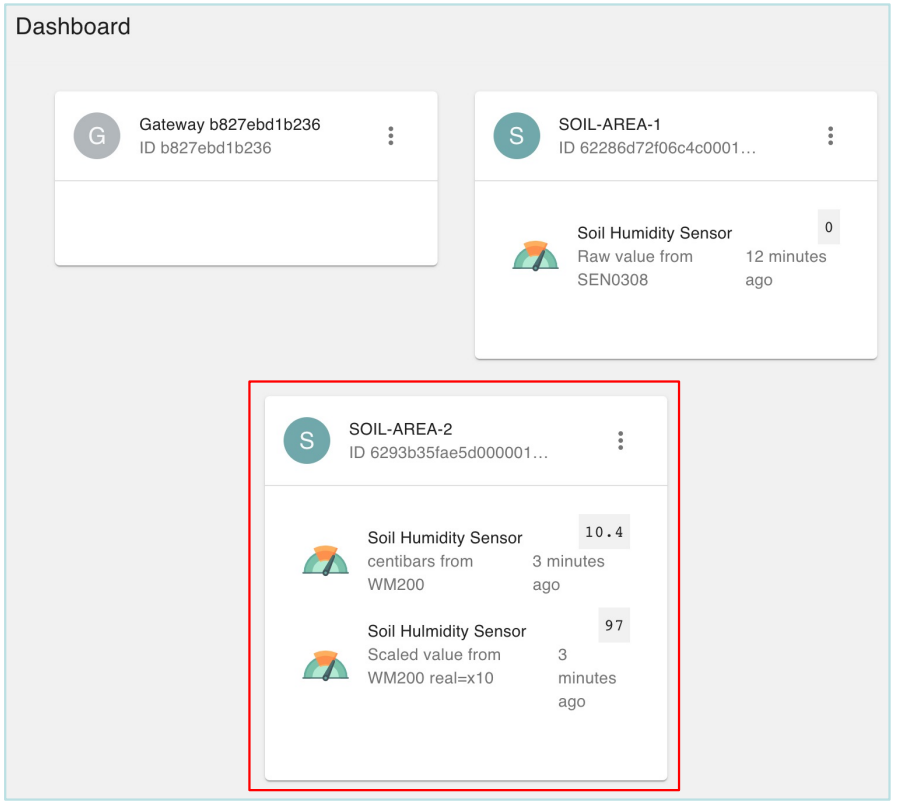


Advanced configuration

2/ To have several tensiometer soil sensor devices, con't

- For first sensor, change Sensor kind to "centibars from WM200"
- For second sensor, use "scaled value from WM200 real=x10"



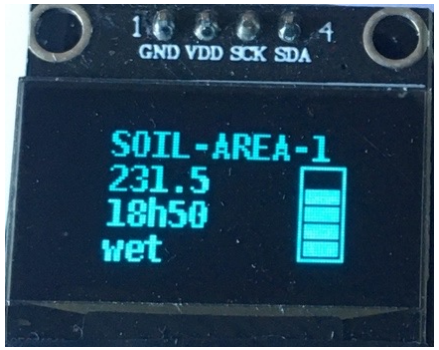


- The dashboard now displays correctly the new device with its sensors

Advanced configuration

1&2/ To have several soil sensor devices, end

- When there are more than 2 devices declared on the WaziGate, the OLED screen will cycle sequentially through all of them
  - Main screen device 1 (5s) -> screen saver device 1 (12s) ->
  - Main screen device 2 (5s) -> screen saver device 2 (12s) -> …
- For the OLED **to detect correctly the devices**, the sensor name (here "Soil Humidity Sensor") or the sensor kind (here "Raw value from SEN0308") **MUST contain** "SEN0308" or "WM200" for respectively a capacitive or a tensiometer sensor

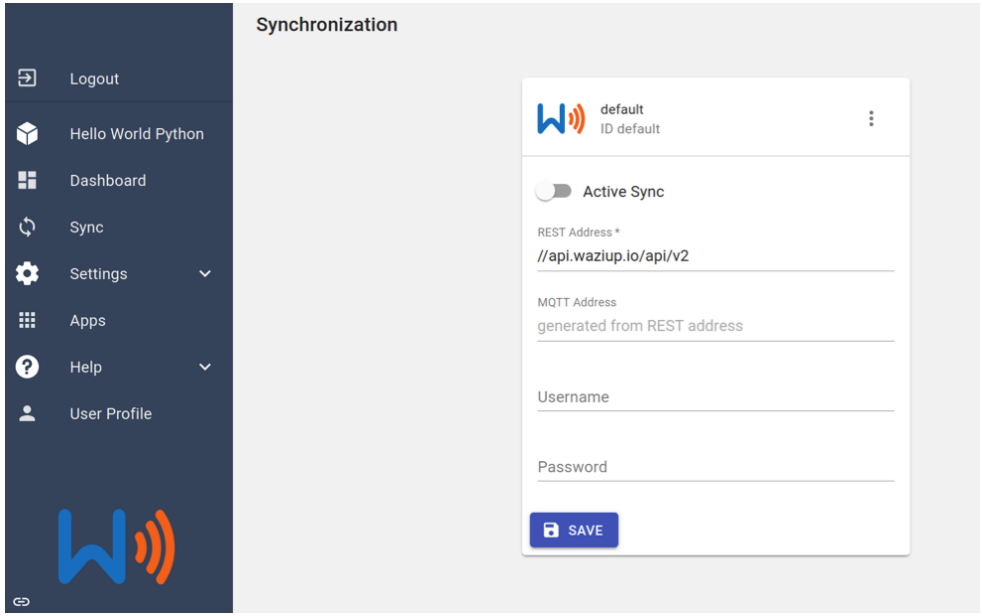


Advanced configutation

3/ To sync WaziGate and its devices to the cloud

- If you want to sync your WaziGate to the WAZIUP Cloud, look at this tutorial page to see what it means
  - https://www.waziup.io/documentation/wazigate/v2/install/#registration-with-the-cloud

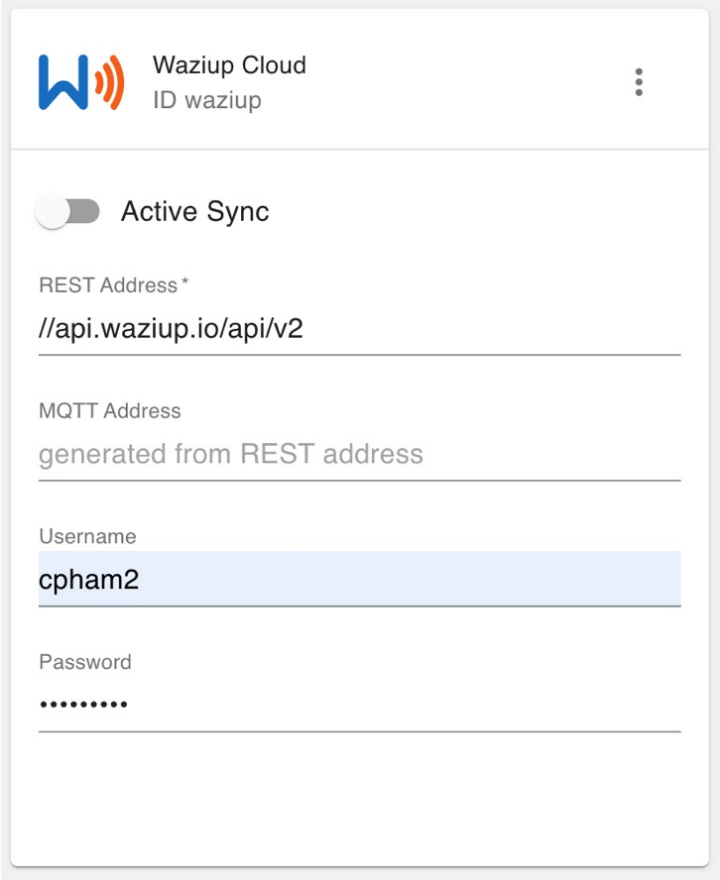
- You will need an account on WAZIUP Cloud dashboard
- If you don't have one, you need to create one first
- https://dashboard.waziup.io/



Advanced configuration

3/ To sync WaziGate and its devices to the cloud, end

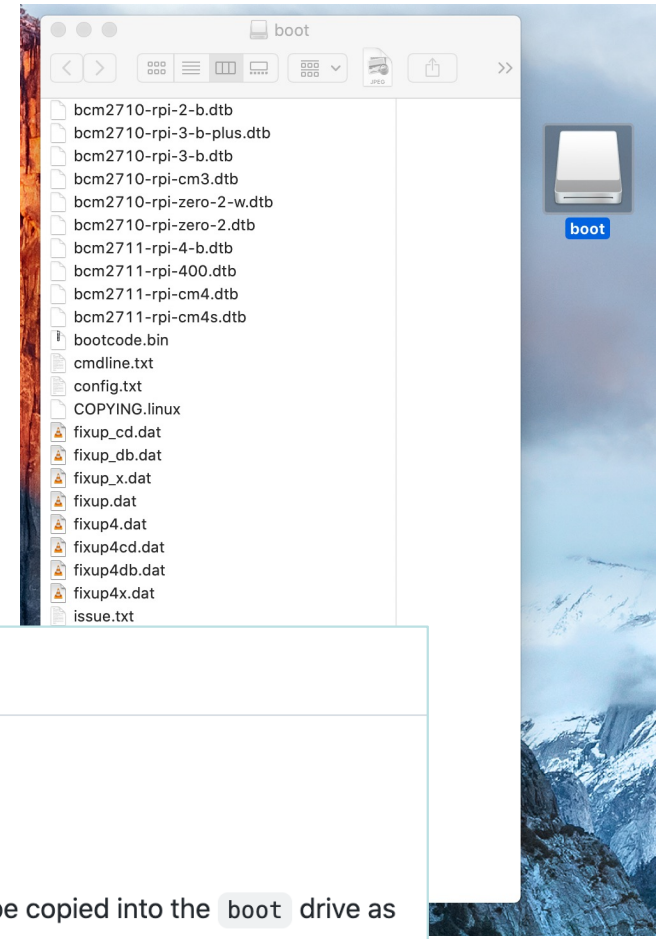
- Then, enter your WAZIUP account
  credential in the sync menu
- And enable "Active Sync"
- Log in the WAZIUP Cloud dashboard
  and check that you see your gateway
  and your device



Advanced configuration

4/ Use 868MHz frequency band

- The default SD card image uses EU433 frequency band
- To set to 868MHz, use the auto-configuration mechanism
  - https://github.com/CongducPham/PRIMA-Intel-IrriS/tree/main/Gateway/boot#auto-configuration-on-boot-for-the-intel-irris-wazigate



Example 1: set INTEL-IRRIS WaziGate in 868MHz version

- flash the INTEL-IRRIS WaziGate SD card image
- insert the SD card in any computer (Windows, Linux, MacOS)
- open the `boot` drive that should appear on your computer
- download from INTEL-IRRIS GitHub (`Gateway/boot`) `intel-irris-band-868.txt` to be copied into the `boot` drive as `intel-irris-band.txt`
- be sure that there is no `intel-irris-auto-config.done` file in the `boot` drive, otherwise delete the file
- safely eject the `boot` drive
- insert the SD card in the RPI and power the RPI

Advanced configuration

5/ Execute automatic custom device configuration

- The default SD card image defines 1 capacitive sensor
- To add/change devices, use the auto-configuration mechanism
  - https://github.com/CongducPham/PRIMA-Intel-IrriS/tree/main/Gateway/boot#auto-configuration-on-boot-for-the-intel-irris-wazigate

Example 4: have the INTEL-IRRIS WaziGate working with a customized setting

- flash the INTEL-IRRIS WaziGate SD card image
- insert the SD card in any computer (Windows, Linux, MacOS)
- open the `boot` drive that should appear on your computer
- download from INTEL-IRRIS GitHub (`Gateway/boot`) `create-custom-example/intel-irris-auto-config.sh` and see how the script creates one capacitive and one tensiometer device (SOIL-AREA-1/26011DAA and SOIL-AREA-2/26011DB1)
- based on this example, you can create on your computer an `intel-irris-auto-config.sh` script that actually creates and configures devices according to your setting
- copy the file into the `boot` drive as `intel-irris-auto-config.sh`
- be sure that there is no `intel-irris-auto-config.done` file in the `boot` drive, otherwise delete the file
- safely eject the `boot` drive
- insert the SD card in the RPI and power the RPI

Advanced configuration

5/ Execute automatic custom device configuration, con't

- Some of auto-configuration options (GitHub: `Gateway/boot`)
  - create-default-capacitive: default capacitive configured in SD card image
    SOIL-AREA-1, 26011DAA
  - create-default-watermark: replace default capacitive by default WM
    SOIL-AREA-1, 26011DB1
  - create-default-watermark-st: default WM + 1 soil temperature
    SOIL-AREA-1, 26011DB1
  - create-default-2-watermark: 2 default WM (on same device)
    SOIL-AREA-1, 26011DB1
  - create-default-2-watermark-st: 2 default WM + 1 soil temperature
    SOIL-AREA-1, 26011DB1
  - create-4-watermark: 4 devices, each with 1 default WM
    SOIL-AREA-[1, 2, 3, 4], 26011D[B1, B2, B3, B4]
  - create-custom-example: 1 capactive & 1 WM
    SOIL-AREA-1, 26011DAA & SOIL-AREA-2, 26011DB2

NOTICE ON THE STARTER-KIT

- NEVER TRANSMIT WITHOUT AN ANTENNA
- 1 FULLY ASSEMBLED & CONFIGURED SOIL SENSOR
  - NEED TO INSTALL 2-AA BATTERIES
  - TAKE HIGH-GRADE BATTERIES
  - DO NOT SWITCH ON WITHOUT ANTENNA ATTACHED
  - ALREADY CONFIGURED FOR WAZIGATE
- STARTER-KIT= 1 SOIL SENSOR + 1 WAZIGATE
- INTEL-IRRIS WAZIGATE IMAGE TO BE DOWNLOADED FROM **http://intel-irris.eu/results**
- FLASH IMAGE ON 8GB SD CARD (OR 16GB OR 32GB)
- THE WAZIGATE IS ONLY PRE-CONFIGURED FOR 1 SOIL SENSOR PER FARM
- STARTER-KIT TUTORIAL : http://intel-irris.eu/tutorials-slides