



INTEL-IRRIS

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



INTELLIGENT IRRIGATION SYSTEM FOR LOW-COST AUTONOMOUS WATER CONTROL IN SMALL-SCALE AGRICULTURE



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

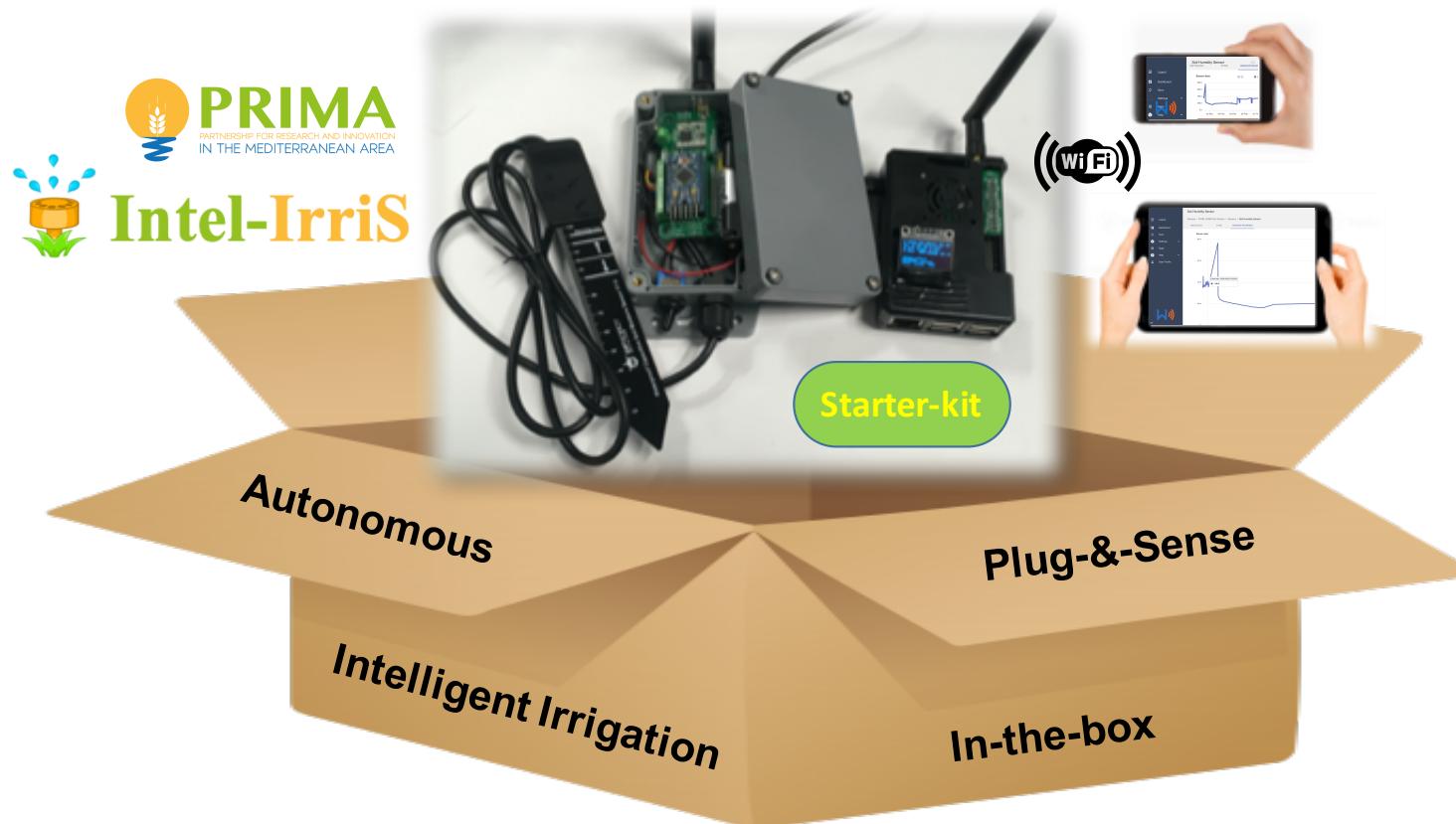


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INTEL-IRRIS starter-kit

- "Intelligent Irrigation in-the-box", "plug-&-sense"



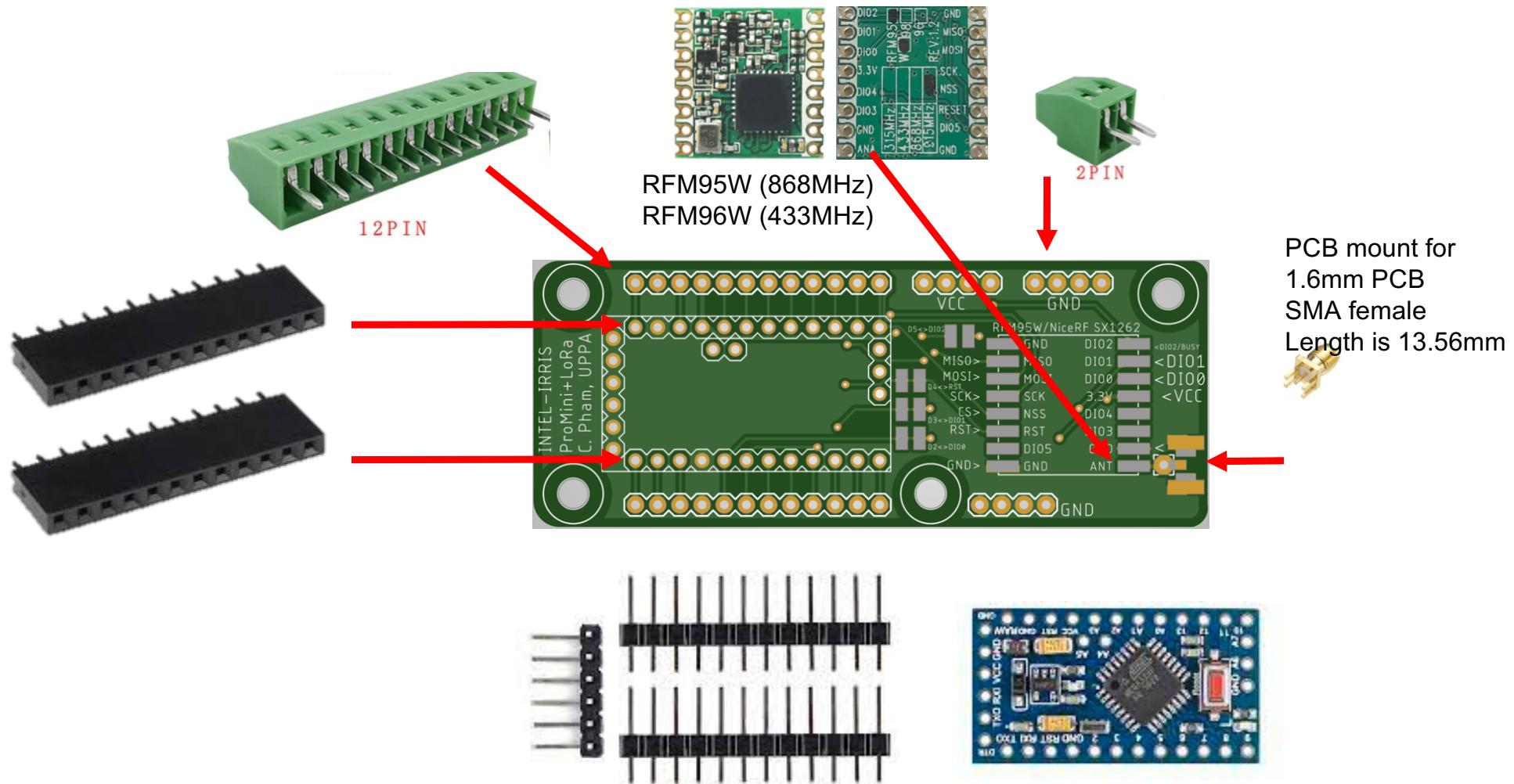
Preparing the starter-kits at UPPA



This non-technical video shows
the preparation of the kits
<https://youtu.be/5nznRcloe40>

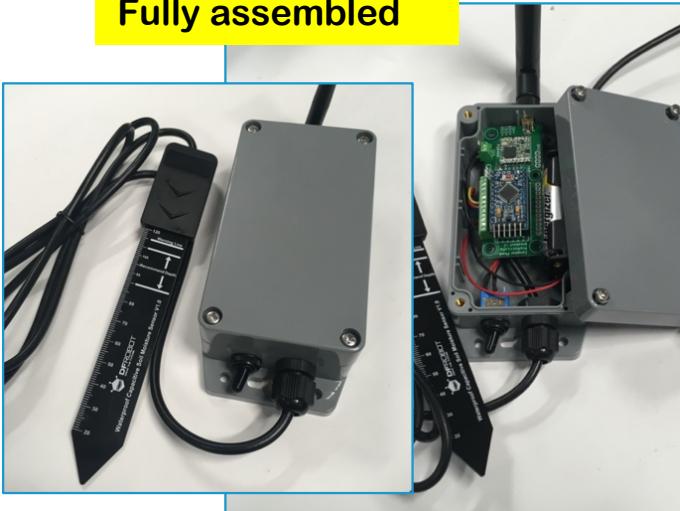


Soil sensor: electronic parts starter-kit version



Soil sensor device

Fully assembled

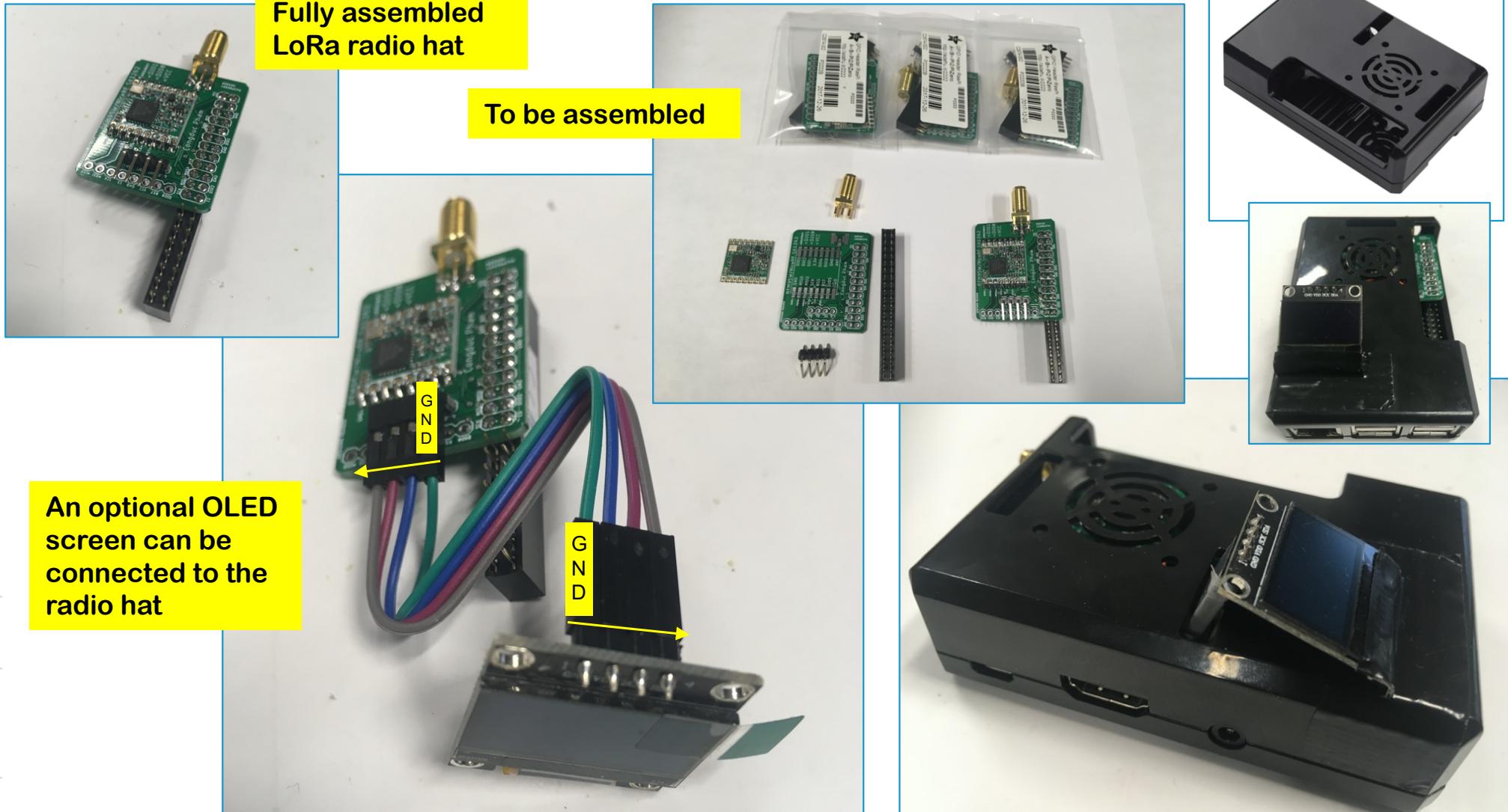


Packaging in enclosure



To be assembled

Gateway (WaziGate)



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**

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](#)
 - [Video n°2. YouTube tutorial video showing how to build the outdoor LoRa IoT soil sensor device](#)
 - [Video n°3. YouTube tutorial video showing how to wire the SEN0308 capacitive sensor](#)
- 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](#)

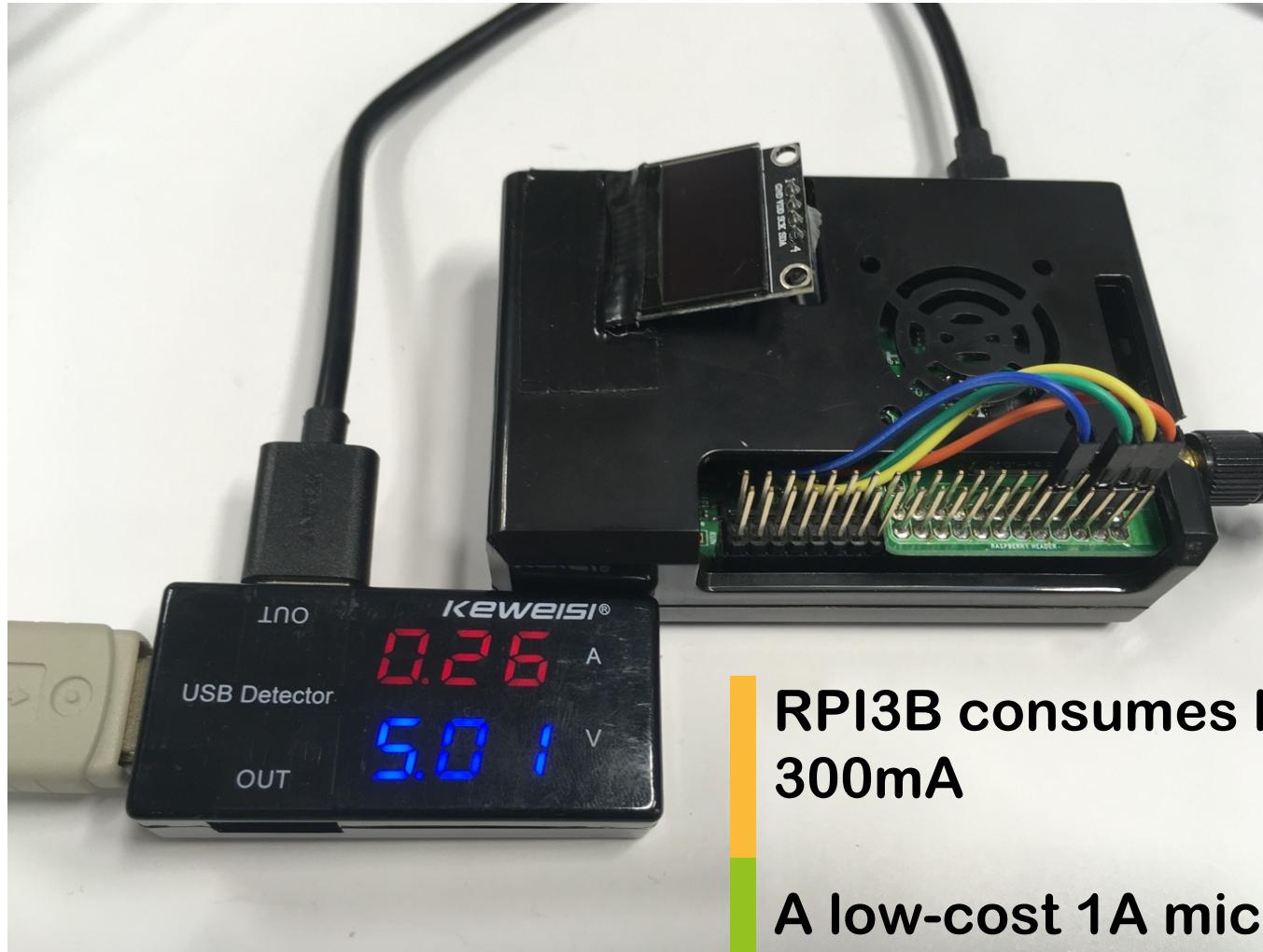
Preparing Wazigate

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



- Download SD card image, select EU433 (Algeria, Morocco) or EU868 (France)
- Flash SD card: [Video n°4 at t=124s](#), then insert SD card

Powering the WaziGate

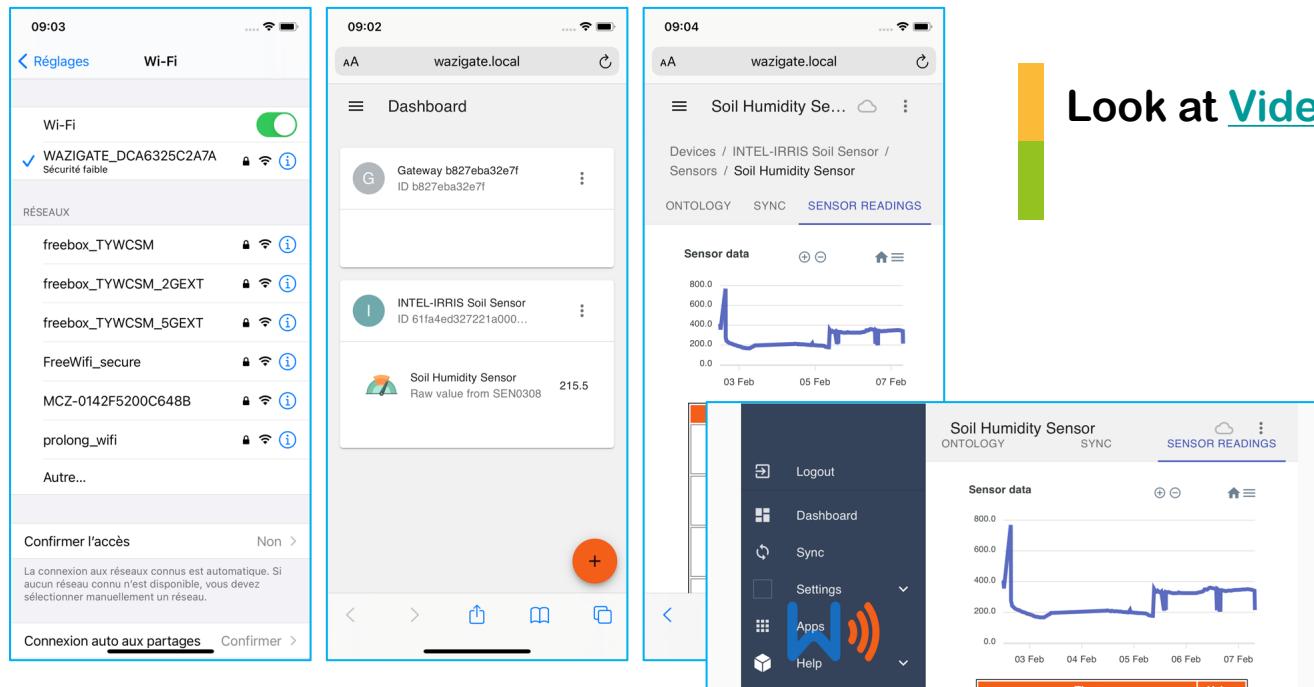


RPI3B consumes less than
300mA

A low-cost 1A micro USB charger
for smartphone is suitable

Checking WaziGate

- Power the WaziGate, no Internet is required
- Wait 3-4mins for the gateway to boot
- Connect to the WaziGate's WiFi with a smartphone
- Open <http://wazigate.local> or <http://10.42.0.1>

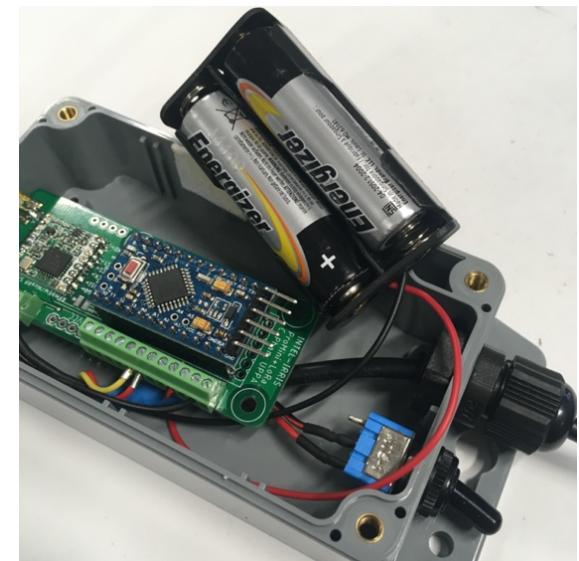
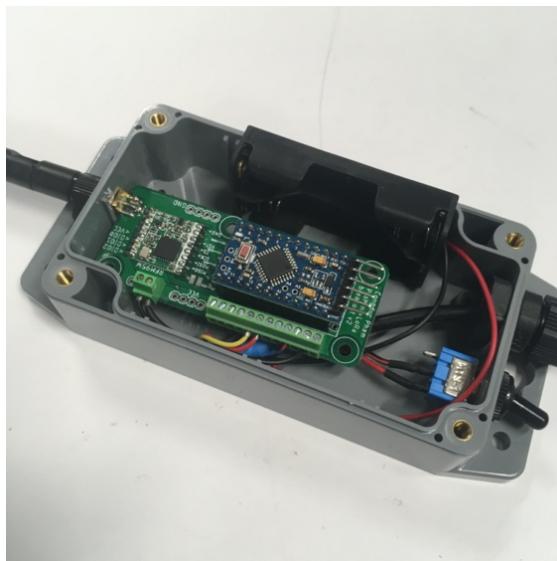


Look at [Video n°4 at t=239s](#)

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



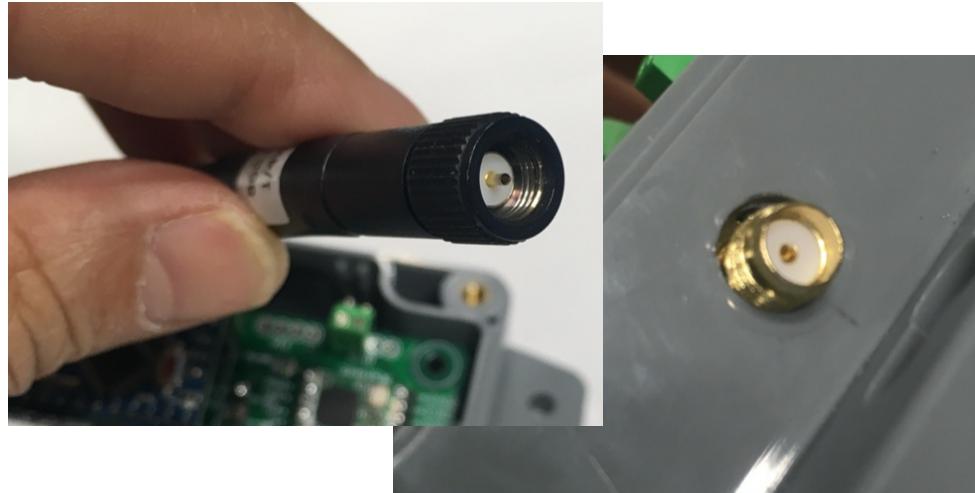
Take good AA batteries

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



Preparing soil sensor device

screw in the antenna

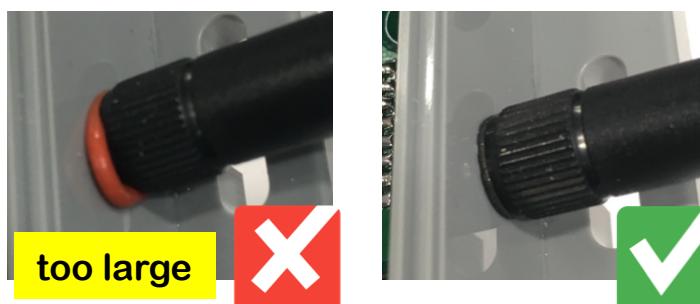
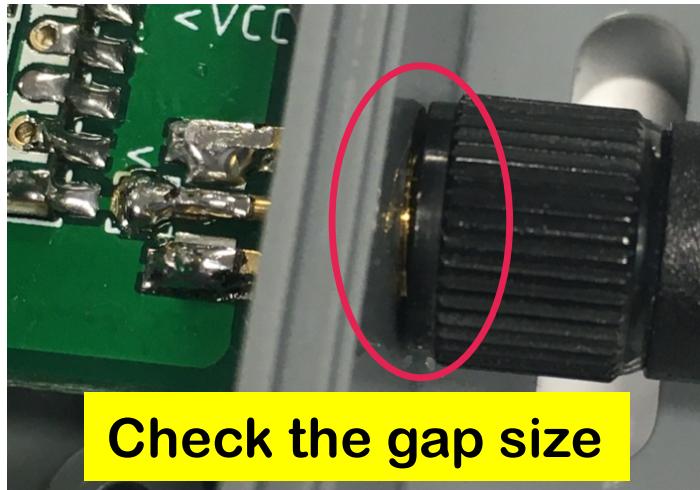


Be sure to connect the matching antenna
Here, SMA female with SMA male antenna
Need to screw the antenna in all the way

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

Do not have or can not use o-ring?

Maybe the gap is too big? Use silicon joint sealant



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, if is good to add silicon!



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 female header 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

Testing transmission to WaziGate

- Test with the fully assembled & configured soil sensor device
 - Check that antenna is connected
 - Toggle switch on the soil sensor device to get data transmission
 - Check reception of data on WaziGate's dashboard



Look at [Video n°4 at t=331s](#)

Transmission to WaziGate



Parameters for
WaziGate (default in red)



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>



Be sure that

```
#define TO_WAZIGATE
```

is uncommented

```
Intelirris_Soil_Sensor - SX127X_RadioSettings.h | Arduino 1.8.13

Intelirris_Soil_Sensor DS18B20.cpp DS18B20.h RadioSettings.h SX126X_RadioSettings.h SX127X_RadioSettings.h

56 const uint8_t IQ_Setting = LORA_IQ_NORMAL;
57 // **** End from SX12XX example - Stuart Robinson ****
58 // IMPORTANT SETTINGS
59 // please uncomment only 1 choice
60 //
61 // #define ETSI_EUROPE_REGULATION
62 // #define FCC_US_REGULATION
63 // #define SENEGAL_REGULATION
64 //
65 // #define BAND868
66 // #define BAND900
67 // #define BAND433
68 //
69 // DO NOT CHANGE
70 //
71 // please uncomment only 1 choice
72 // #define USE_20DBM
73 //
74 #ifdef ETSI_EUROPE_REGULATION
75 #define MAX_DBM 14
76 #elif defined SENEGAL_REGULATION
77 #define MAX_DBM 10
78 #elif defined FCC_US_REGULATION
```

If you use the EU433 band

Edit SX127X_RadioSettings.h

comment

```
//#define BAND868
```

and uncommented

```
#define BAND433
```

Intelirris_Soil_Sensor | Arduino 1.8.13

```
Intelirris_Soil_Sensor DS18B20.cpp DS18B20.h RadioSettings.h SX126X_RadioSettings.h SX127X_RadioSettings.h
```

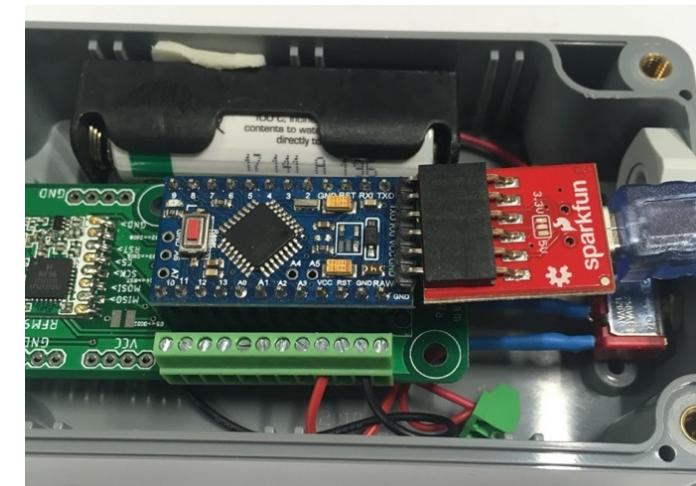
1/*
2 * INTEL_IRRIS soil humidity sensor platform
3 * extended version with AES and custom Carrier Sense features
4 *
5 * Copyright (C) 2016-2021 Congduc Pham, University of Pau, France
6 *
7 * This program is free software: you can redistribute it and/or modify
8 * it under the terms of the GNU General Public License as published by
9 * the Free Software Foundation, either version 3 of the License, or
10 * (at your option) any later version.
11 *
12 * This program is distributed in the hope that it will be useful,
13 * but WITHOUT ANY WARRANTY; without even the implied warranty of
14 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
15 * GNU General Public License for more details.
16 *
17 * You should have received a copy of the GNU General Public License
18 * along with the program. If not, see <<http://www.gnu.org/licenses/>>.
19 *
20 ****
21 * last update: February 2nd, 2022 by C. Pham
22 *
23 * NEW: LoRa communicain library moved from Libelium's lib to StuartProject's lib
24 * <https://github.com/StuartsProjects/SX12XX-LoRa>
25 * to support SX126X, SX127X and SX128X chips (SX128X is LoRa in 2.4GHz band)
26 *
27 */
28
29****
30-----
31 / \
32 | / \v
33 | | \ /
34 | \ / \v

Done uploading.
Using library LowPower at version 1.0 in folder: /Users/cpham/Dropbox/Arduino/sketch/libraries/
Using library OneWire at version 2.3.2 in folder: /Users/cpham/Dropbox/Arduino/sketch/libraries/
Using library Dallas-Temperature at version 3.7.7 in folder: /Users/cpham/Dropbox/Arduino/sketch/
Using library AES-128_V10 in folder: /Users/cpham/Dropbox/Arduino/sketch/libraries/AES-128_V10
Using library Base64 at version 1.0.0 in folder: /Users/cpham/Dropbox/Arduino/sketch/libraries/
/Users/cpham/Library/Arduino15/packages/arduino/tools/avr-gcc/7.3.0-atmel3.6.1-arduino7/bin/avr
Sketch uses 14208 bytes (46%) of program storage space. Maximum is 30720 bytes.
Global variables use 476 bytes (23%) of dynamic memory, leaving 1572 bytes for local variables

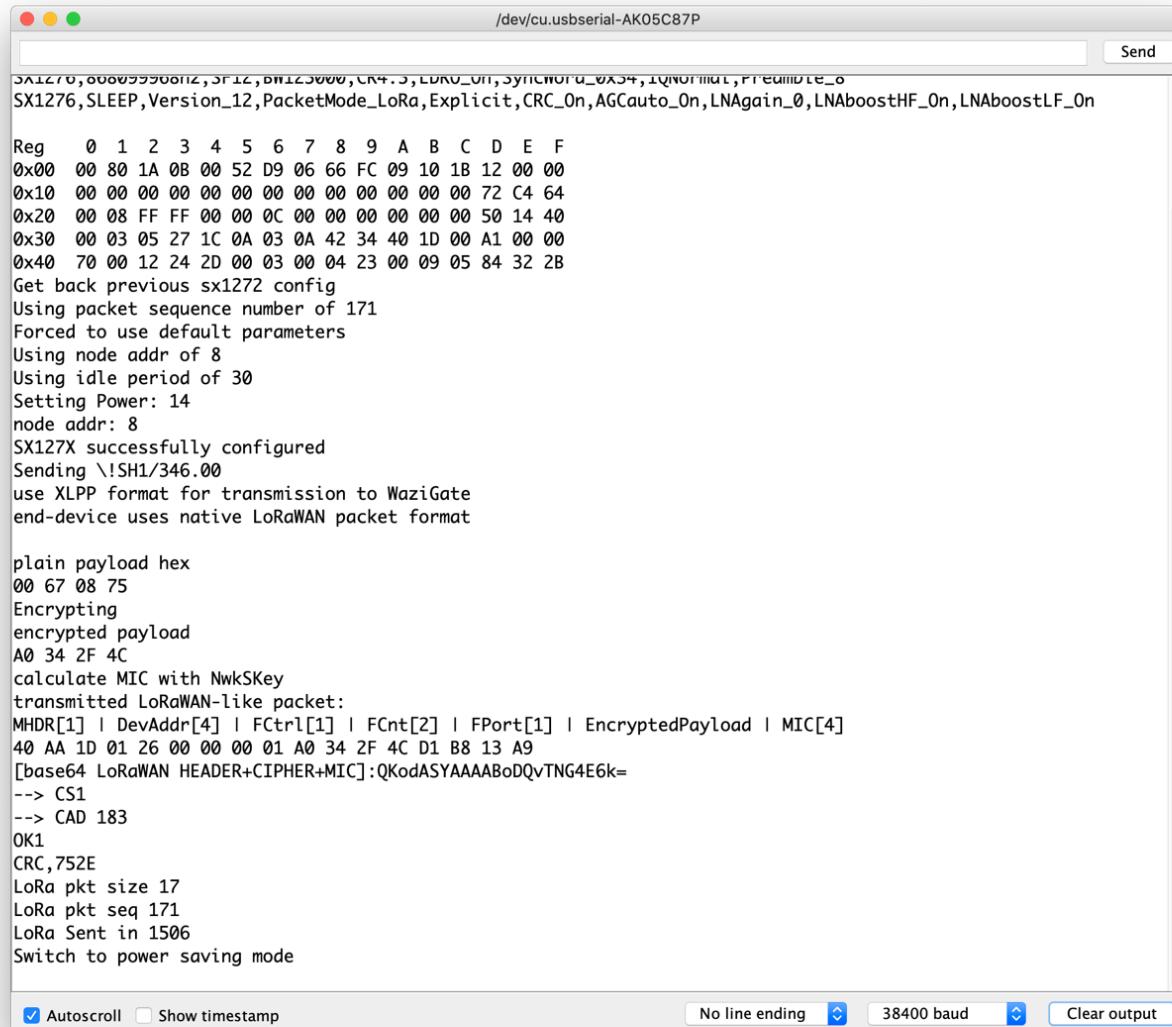
Click on the "upload" button



And wait until upload is completed



Checking that device is operational



```

/dev/cu.usbserial-AK05C87P
Send

SX1276,0000000000000000,3F12,B0123000,CRC4.5,LDRU_0H,SYNCHRO_0X34,TQ_NORM,PREDECODE_0
SX1276,SLEEP,Version_12,PacketMode_LoRa,Explicit,CRC_On,AGCAuto_On,LNAgain_0,LNAboostHF_On,LNAboostLF_On

Reg 0 1 2 3 4 5 6 7 8 9 A B C D E F
0x00 00 80 1A 0B 00 52 D9 06 66 FC 09 10 1B 12 00 00
0x10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 72 C4 64
0x20 00 08 FF FF 00 00 0C 00 00 00 00 00 00 00 50 14 40
0x30 00 03 05 27 1C 0A 03 0A 42 34 40 1D 00 A1 00 00
0x40 70 00 12 24 2D 00 03 00 04 23 00 09 05 84 32 2B
Get back previous sx1272 config
Using packet sequence number of 171
Forced to use default parameters
Using node addr of 8
Using idle period of 30
Setting Power: 14
node addr: 8
SX127X successfully configured
Sending \!SH1/346.00
use XLPP format for transmission to WaziGate
end-device uses native LoRaWAN packet format

plain payload hex
00 67 08 75
Encrypting
encrypted payload
A0 34 2F 4C
calculate MIC with NwkSKey
transmitted LoRaWAN-like packet:
MHDR[1] | DevAddr[4] | FCtrl[1] | FCnt[2] | FPort[1] | EncryptedPayload | MIC[4]
40 AA 1D 01 26 00 00 00 01 A0 34 2F 4C D1 B8 13 A9
[base64 LoRaWAN HEADER+CIPHER+MIC]:QKodASYAAABoDQvTNG4E6k=
--> CS1
--> CAD 183
OK1
CRC,752E
LoRa pkt size 17
LoRa pkt seq 171
LoRa Sent in 1506
Switch to power saving mode

 Autoscroll  Show timestamp
  No line ending  Clear output

```

Open serial monitor

Set baud rate to 38400

See output from board

Check that transmission is OK

Deploying the starter-kit

- Calibrate the soil sensor device
 - See dedicated slides/videos
- Install the soil sensor device in the field
 - See dedicated slides/videos
- 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 smartphone
- **NEVER TRANSMIT WITHOUT AN ANTENNA**
- Test correct data reception on WaziGate
 - Toggle switch on the soil sensor device to get data transmission
 - Check reception of data on WaziGate's dashboard

- Only if you need to have several soil sensors in a single farm:
change the device address in the soil sensor Arduino code

Intellirris_Soil_Sensor | Arduino 1.8.13

```
Intellirris_Soil_Sensor DS18B20.cpp DS18B20.h RadioSettings.h SX126X_RadioSettings.h SX127X_RadioSettings.h
166
167 // --- DS18B20 --- //
168 // --- DS18B20 --- //
169 // --- DS18B20 --- //
170 ****
171 //////////////////////////////////////////////////////////////////
172 // LORAWAN OR EXTENDED DEVICE ADDRESS FOR LORAWAN CLOUD
173 #if defined LORAWAN || defined EXTDEVADDR
174 //////////////////////////////////////////////////////////////////
175 //ENTER HERE your Device Address from the TTN device info (same order, i.e. msb). Example
176 //unsigned char DevAddr[4] = { 0x12, 0x34, 0x56, 0x78 };
177 //////////////////////////////////////////////////////////////////
178 //////////////////////////////////////////////////////////////////
179 //Pau
180 //unsigned char DevAddr[4] = { 0x26, 0x01, 0x17, 0x21 };
181 //////////////////////////////////////////////////////////////////
182 //WaziGate default
183 //26011DA
184 unsigned char DevAddr[4] = { 0x26, 0x01, 0x1D, 0xAA };
185 #else
186 //////////////////////////////////////////////////////////////////
187 // DO NOT CHANGE HERE
188 //unsigned char DevAddr[4] = { 0x00, 0x00, 0x00, node_addr };
189 //////////////////////////////////////////////////////////////////
190 #endif
191 //////////////////////////////////////////////////////////////////
192 //////////////////////////////////////////////////////////////////
193 //////////////////////////////////////////////////////////////////
194 //////////////////////////////////////////////////////////////////
195 ****
196 // --- DS18B20 --- //
197 // --- DS18B20 --- //
198 // --- DS18B20 --- //
```

Default address is

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

Just increase the last byte

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

Compile and upload the code to the soil sensor device

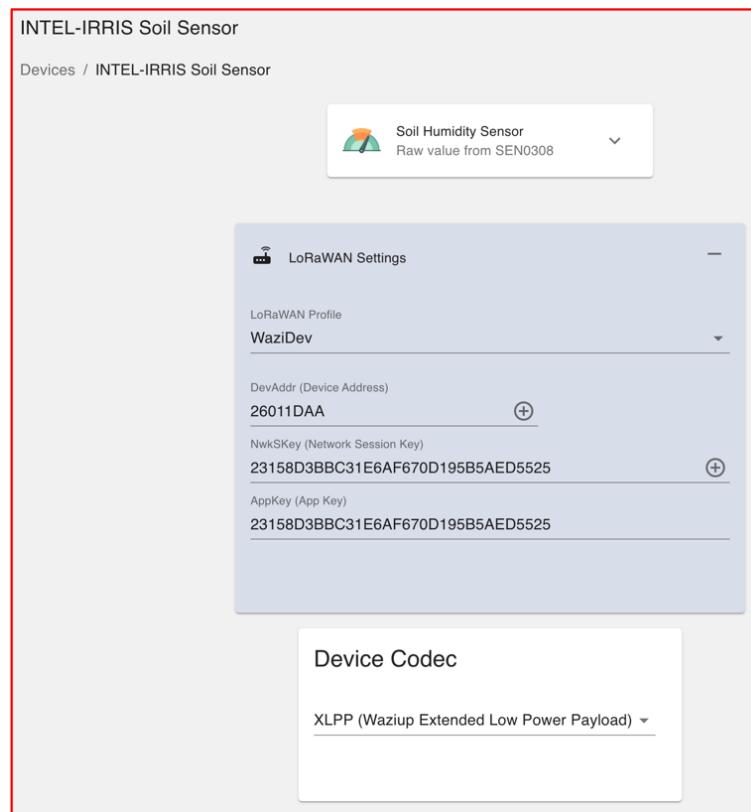
Advanced configuration

create a new sensor device on WaziGate

- Here is the configuration of the default soil sensor device
- Create a new sensor: INTEL-IRRIS Soil Sensor 2

INTEL-IRRIS Soil Sensor

Devices / INTEL-IRRIS Soil Sensor



Soil Humidity Sensor
Raw value from SEN0308

LoRaWAN Settings

LoRaWAN Profile
WaziDev

DevAddr (Device Address)
26011DAA

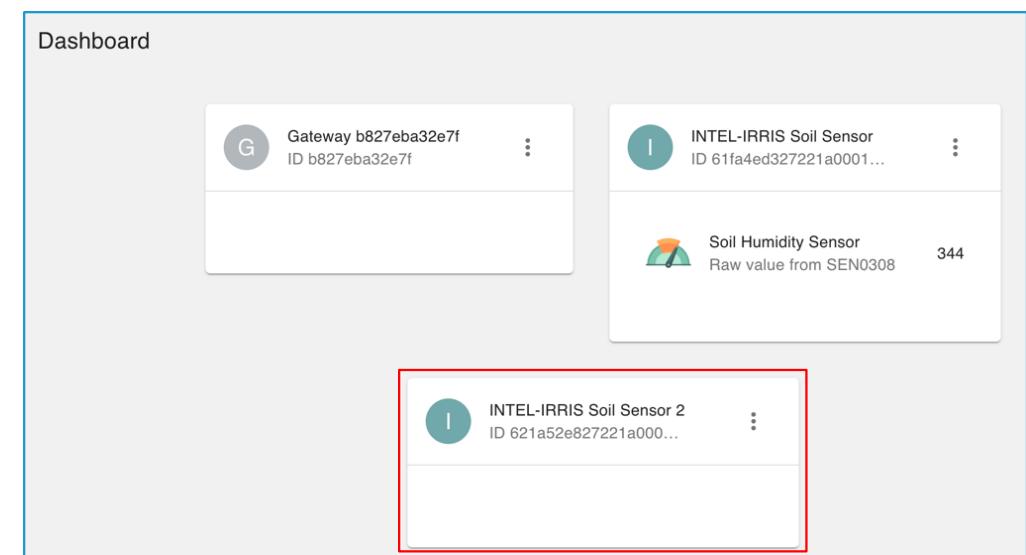
NwksKey (Network Session Key)
23158D3BBC31E6AF670D195B5AED5525

AppKey (App Key)
23158D3BBC31E6AF670D195B5AED5525

Device Codec

XLPP (Waziup Extended Low Power Payload)

Dashboard



G Gateway b827eba32e7f
ID b827eba32e7f

I INTEL-IRRIS Soil Sensor
ID 61fa4ed327221a0001...

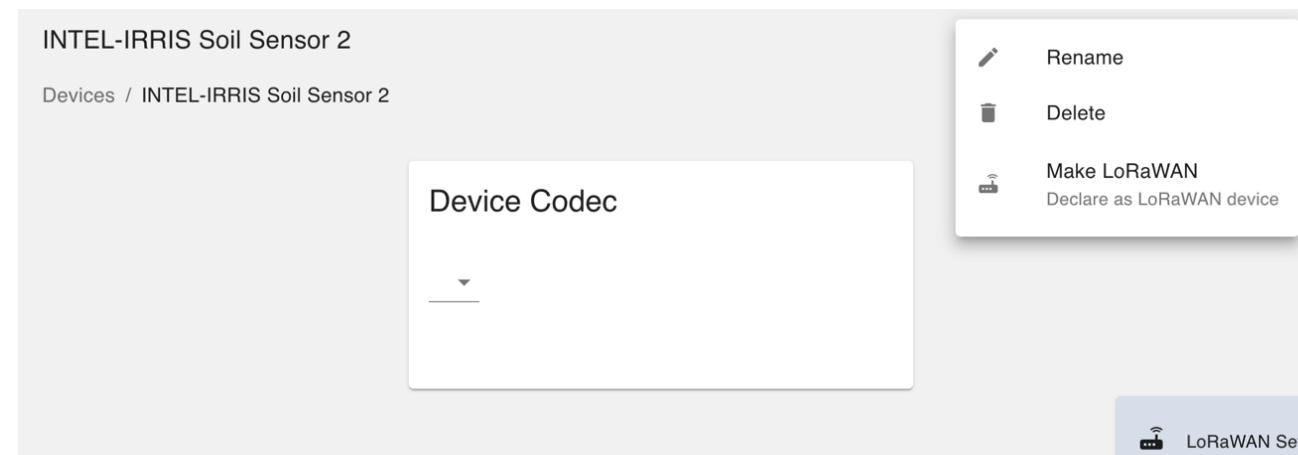
Soil Humidity Sensor
Raw value from SEN0308 344

I INTEL-IRRIS Soil Sensor 2
ID 621a52e827221a000...

Advanced configuration

configure LoRaWAN parameters

- Select the new sensor and make it as LoRaWAN device



INTEL-IRRIS Soil Sensor 2

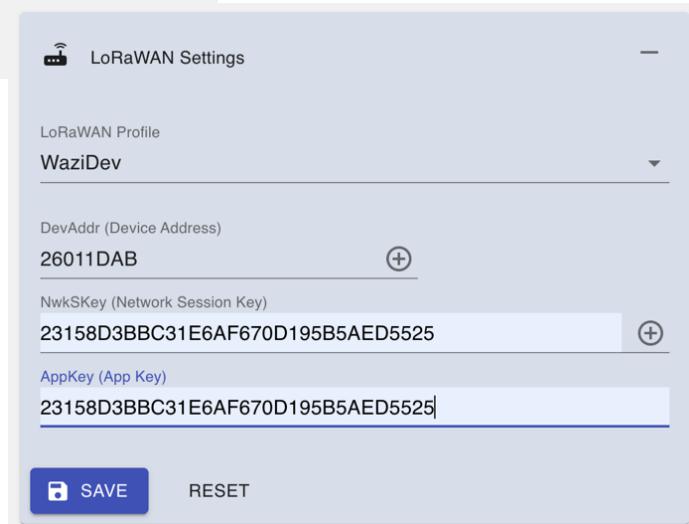
Devices / INTEL-IRRIS Soil Sensor 2

Device Codec

Rename

Delete

Make LoRaWAN
Declare as LoRaWAN device



LoRaWAN Settings

LoRaWAN Profile
WaziDev

DevAddr (Device Address)
26011DAB

NwkSKey (Network Session Key)
23158D3BBC31E6AF670D195B5AED5525

AppKey (App Key)
23158D3BBC31E6AF670D195B5AED5525

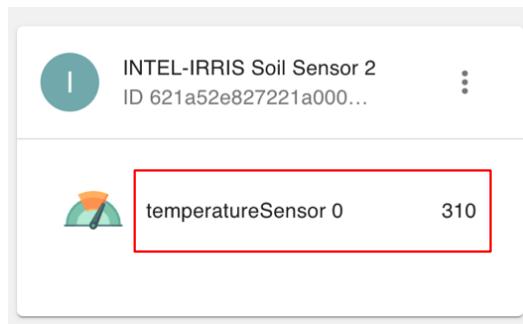
SAVE RESET

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

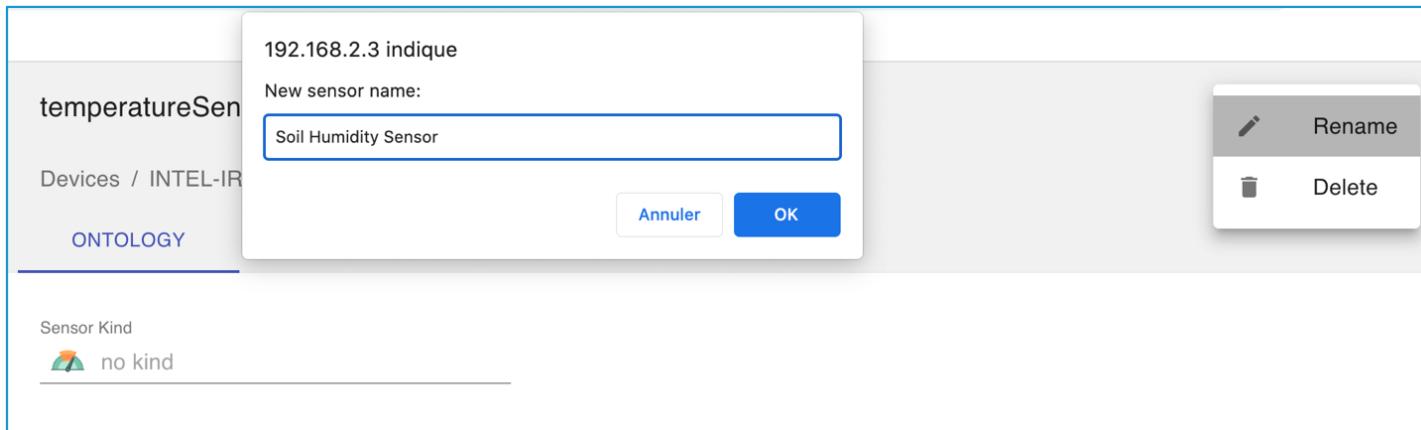
Advanced configuration

configure sensor name

- Power on the new soil sensor device to trigger data transmission
- Refresh the WaziGate dashboard, the new data should appear



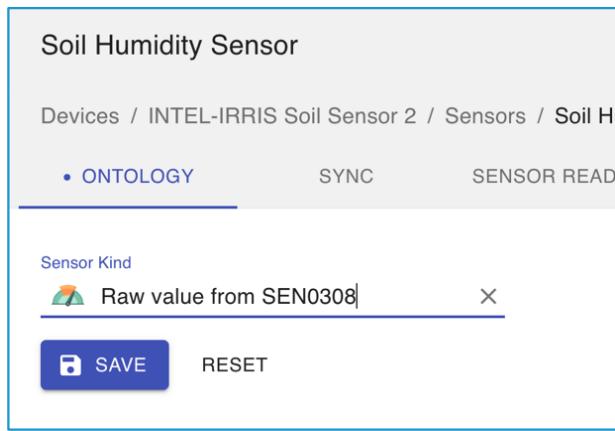
- Click on the "temperatureSensor 0" and then rename it



Advanced configuration

configure sensor kind

- Change de Sensor kind to "Raw value from SEN0308"



Soil Humidity Sensor

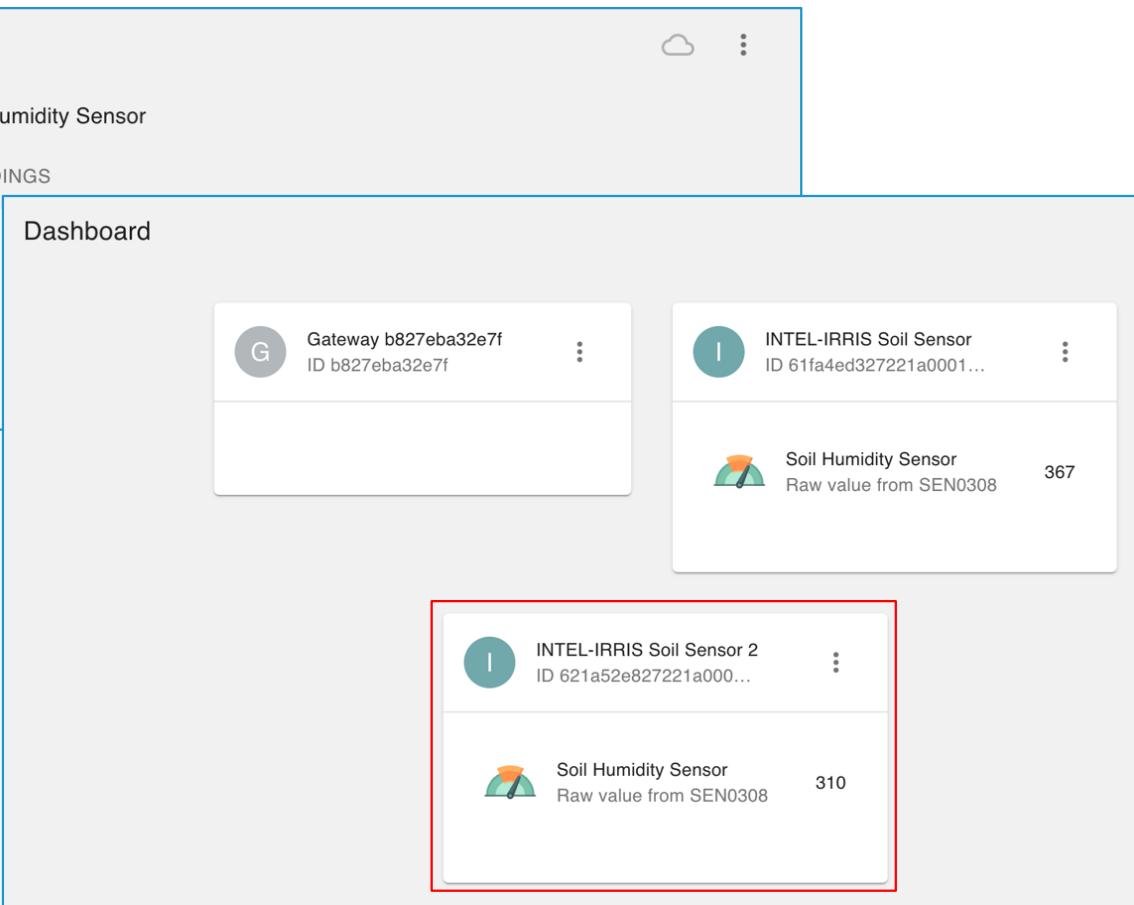
Devices / INTEL-IRRIS Soil Sensor 2 / Sensors / Soil Humidity Sensor

- ONTOLOGY
- SYNC
- SENSOR READINGS

Sensor Kind

Raw value from SEN0308

SAVE RESET



Dashboard

 Gateway b827eba32e7f ID b827eba32e7f	...
 INTEL-IRRIS Soil Sensor ID 61fa4ed327221a0001...	...
 Soil Humidity Sensor Raw value from SEN0308 367	
 INTEL-IRRIS Soil Sensor 2 ID 621a52e827221a000...	...
 Soil Humidity Sensor Raw value from SEN0308 310	

- The dashboard now displays correctly the new sensor