



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

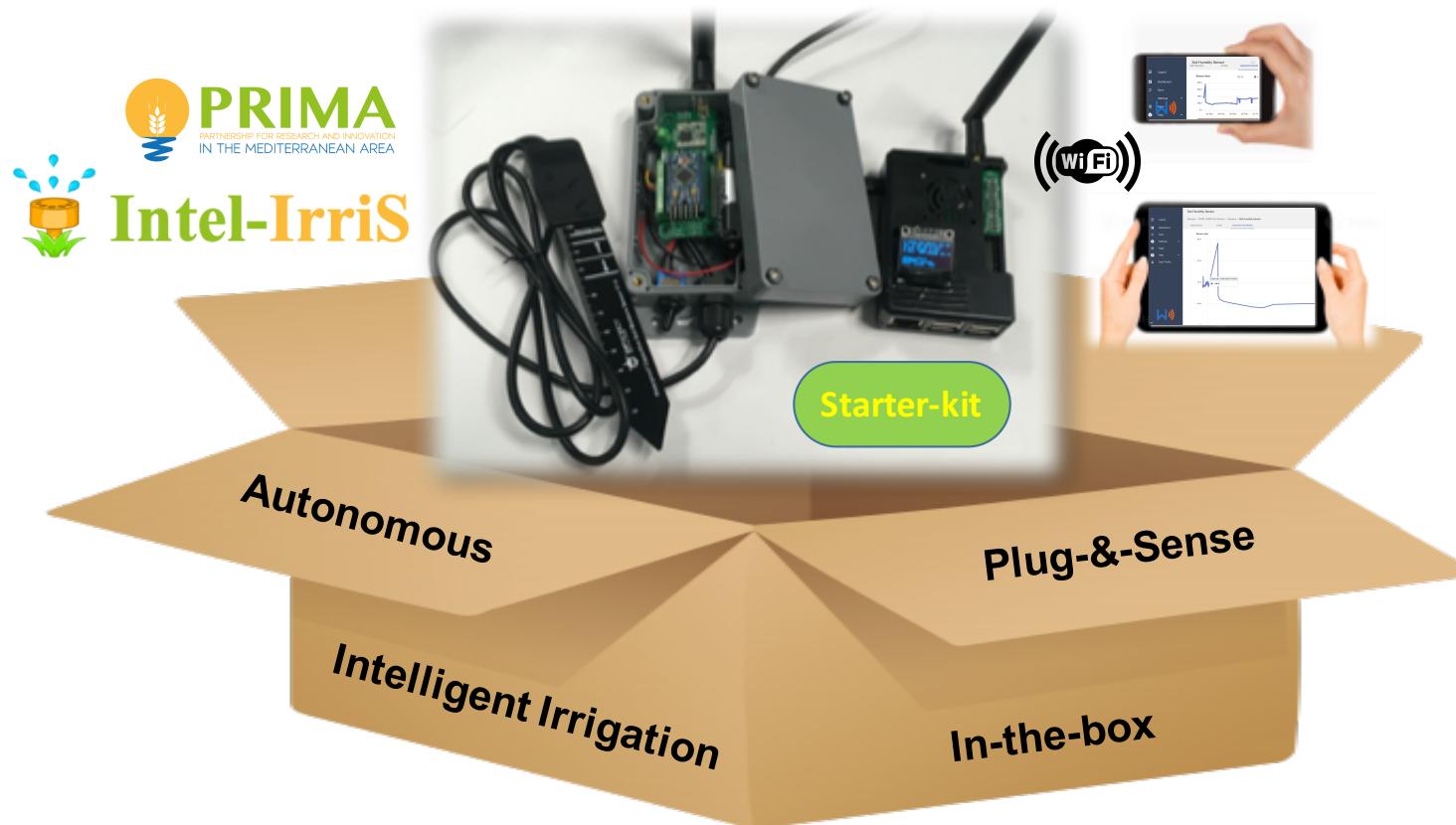


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<http://www.univ-pau.fr/~cpham>
Université de Pau, France



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 device

Fully assembled

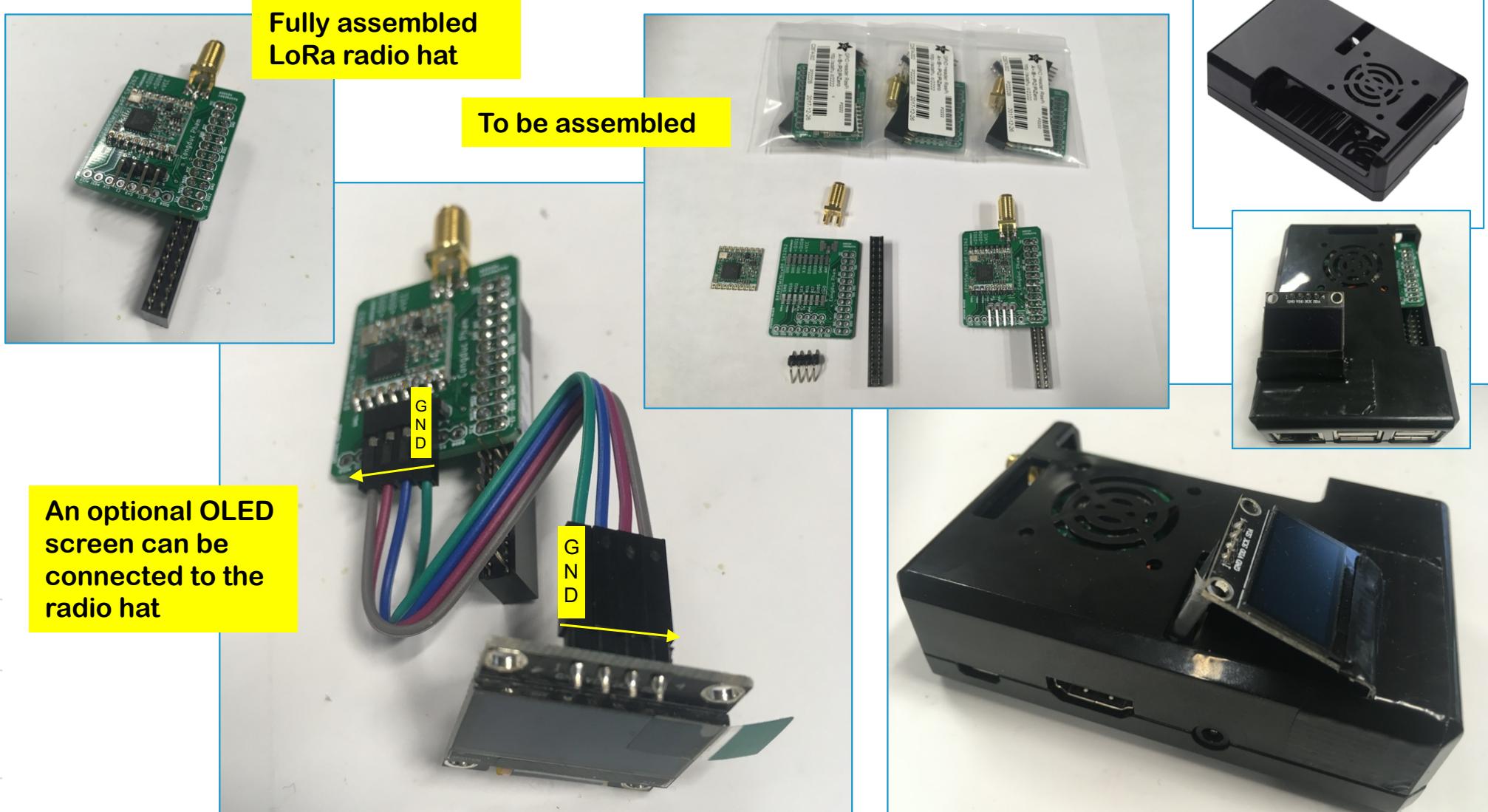


Packaging in enclosure



To be assembled

Gateway (WaziGate)



First round of starter-kits

- 1 fully assembled & configured soil sensor device
- 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**

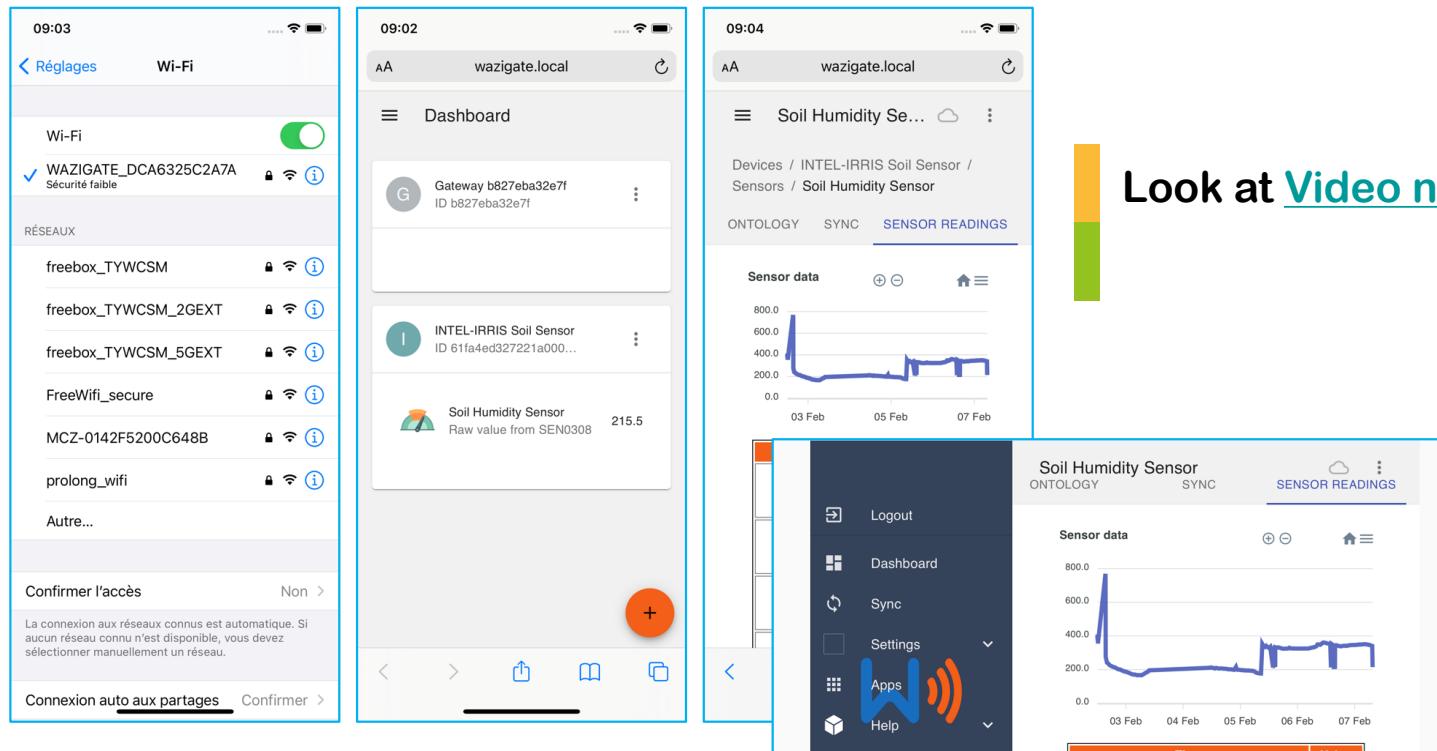
Assembling starter-kit

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](#)
 - Download SD card image and flashing SD card: [Video n°4 at t=124s](#)

Checking WaziGate

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



Testing transmission to WaziGate

- Test with the fully assembled soil sensor device
 - 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>



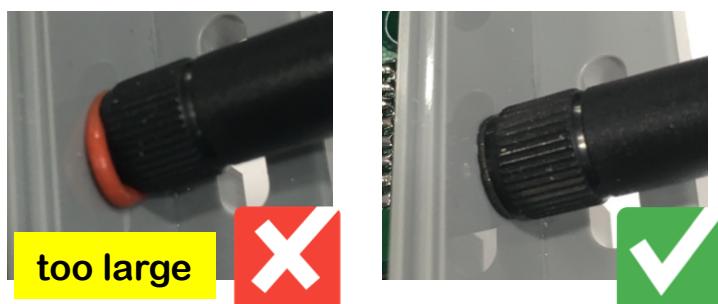
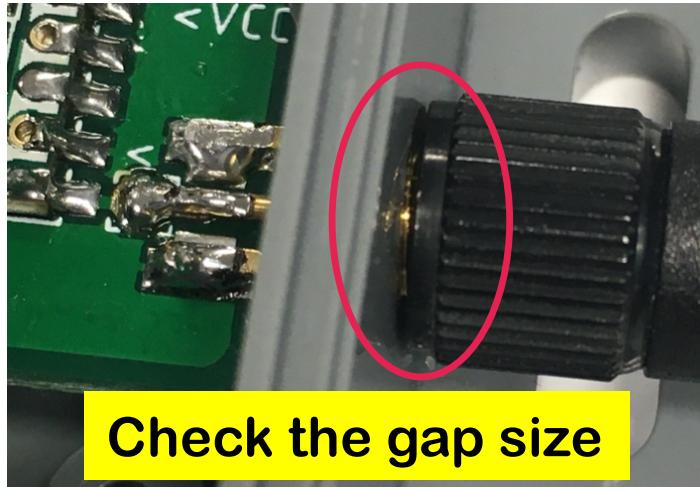
Soil sensor: connecting antenna



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

Waterproofing 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 you have a doubt, add silicon!

Configure soil device for WaziGate

Intelirris_Soil_Sensor | Arduino 1.8.13

```

 28
 29 ****
 30 -----
 31 / \ / \ -----
 32 | / \ | | | |
 33 | | / \ | | | |
 34 | \ / \ | | | |
 35 \ / \ | | | |
 36 | | | |
 37 | | |
 38 ****
 39
 40 // sends data to INTEL-IRRIS WaziGate edge-gateway
 41 #define TO_WAZIGATE
 42
 43
 44 // WAZISENSE and WAZIDEV v1.4 boards have
 45 // - an embedded SI7021 sensor
 46 // WAZISENSE has an integrated solar panel level monitoring circuit
 47 // - input voltage comming from solar panel is exposed on pin A2
 48 // WAZIDEV has a battery voltage level monitoring circuit
 49 // - exposed on pin A7, and D7 must then be at LOW level
 50
 51
 52 //choose either WAZISENSE or WAZIDEV14, or NONE of them for DIY ProMini
 53 // #define WAZISENSE
 54 // #define WAZIDEV14
 55
 56 //can be uncommented for both WAZISENSE and WAZIDEV14
 57 //#define SI7021_SENSOR
 58
 59 //uncomment to use XLPP format to send to WAZIGATE for instance
 60 //so uncomment XLPP only with !ORAWAN to WAZIGATE
 61

```

Done Saving.

42 Arduino Pro or Pro Mini, ATmega328P (3.3V, 8 MHz) on /dev/cu.usbserial-AK05C87P

Be sure that

#define TO_WAZIGATE

is uncommented

Configuring for EU433 band

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 //*****
58 // End from SX12XX example - Stuart Robinson
59 ****
60
61 // IMPORTANT SETTINGS
62 /////////////////
63 // please uncomment only 1 choice
64 //
65 #define ETSI_EUROPE_REGULATION
66 // #define FCC_US_REGULATION
67 // #define SENEGAL_REGULATION
68 /////////////////
69
70 /////////////////
71 // please uncomment only 1 choice
72 // #define BAND868
73 // #define BAND900
74 #define BAND433
75 /////////////////
76
77 // #define USE_20DBM
78 /////////////////
79
80
81 /////////////////
82 // DO NOT CHANGE
83
84 #ifdef ETSI_EUROPE_REGULATION
85 #define MAX_DBM 14
86 #elif defined SENEGAL_REGULATION
87 #define MAX_DBM 10
88 #elif defined FCC_US_REGULATION

```

74

Arduino Pro or Pro Mini, ATmega328P (3.3V, 8 MHz) on /dev/cu.usbserial-AK05C87P

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 <12>
```

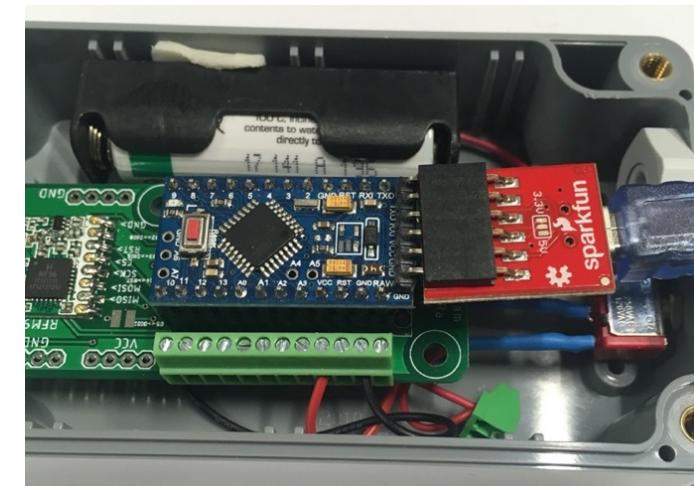
1/*
2 * INTEL_IRRIS soil humidity sensor platform
3 * extended version with AES and custom Carrier Sense features
4 *
5 * Copyright (C) 2016-2021 Congduc Pham, University of Pau, France
6 *
7 * This program is free software: you can redistribute it and/or modify
8 * it under the terms of the GNU General 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 | / \ _____
33 | | | _____
34 | | | | |

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.

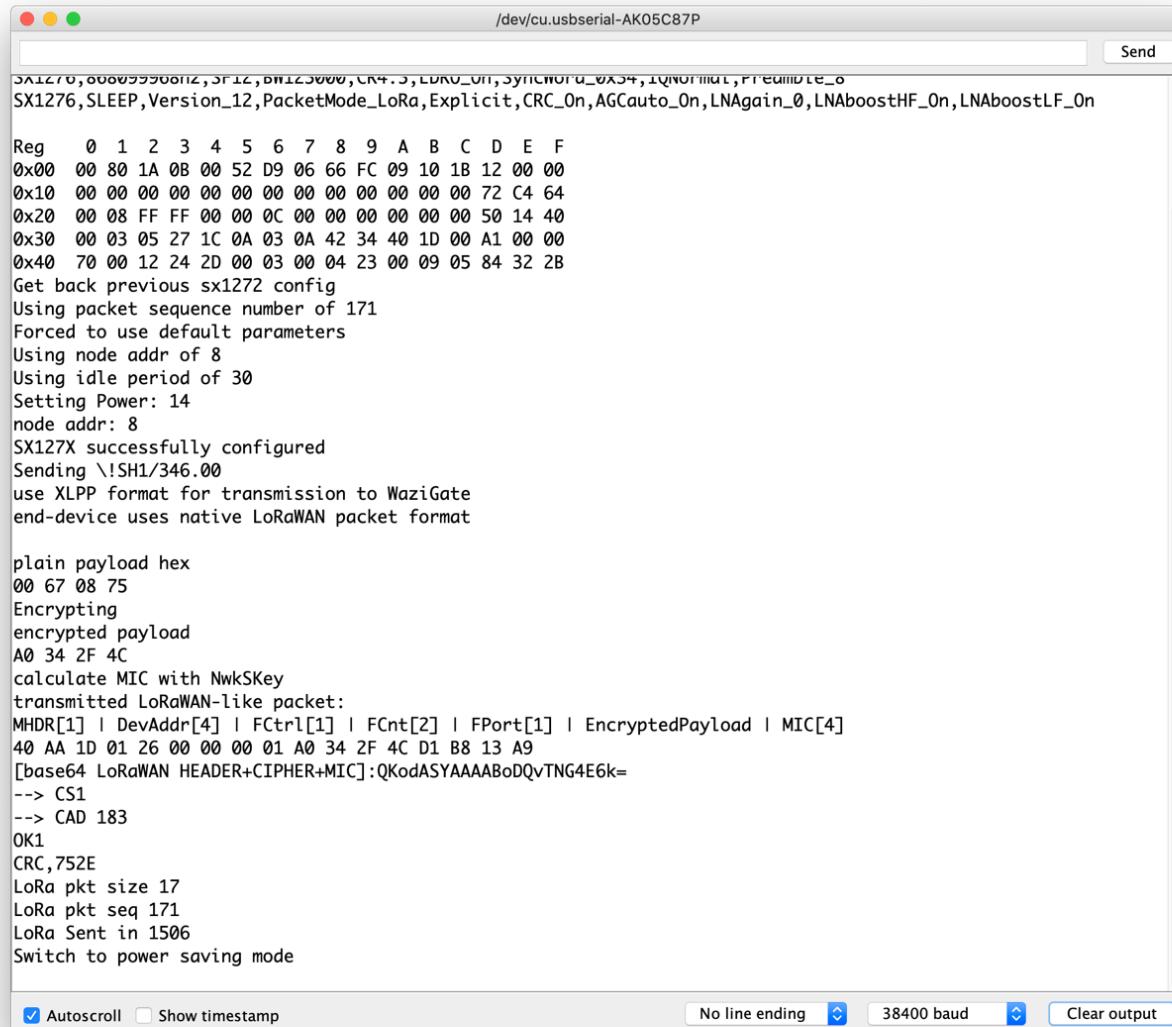
Click on the "upload" button



And wait until upload is completed



Checking that device is operational



```

/dev/cu.usbserial-AK05C87P
Send

SX1276,0000000000000000,3F12,B0123000,CR4.5,LDRU_0H,SYNCHRO_0X34,TQNormal,Preamble_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 38400 baud 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
- 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

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

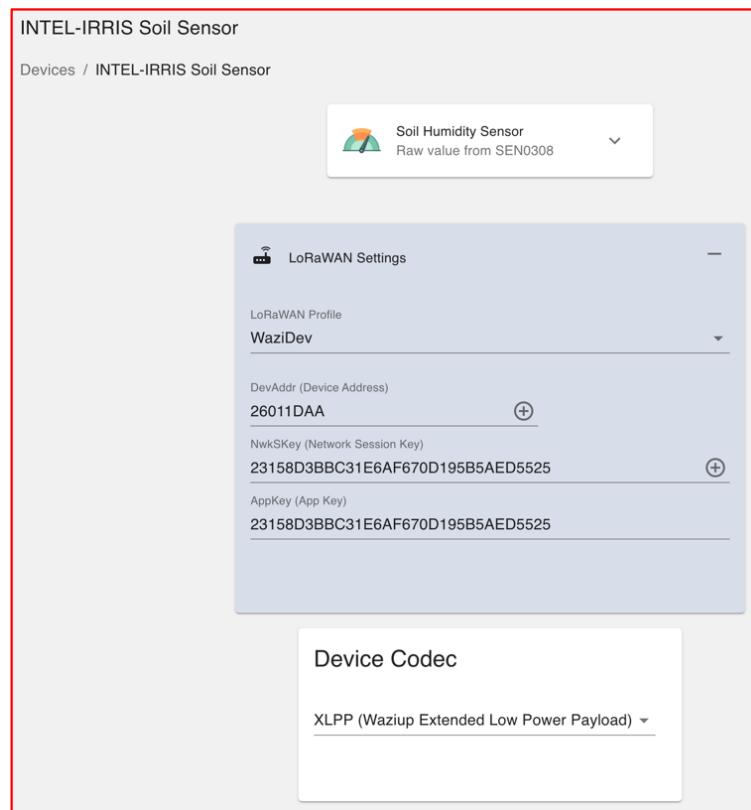
Advanced configuration

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

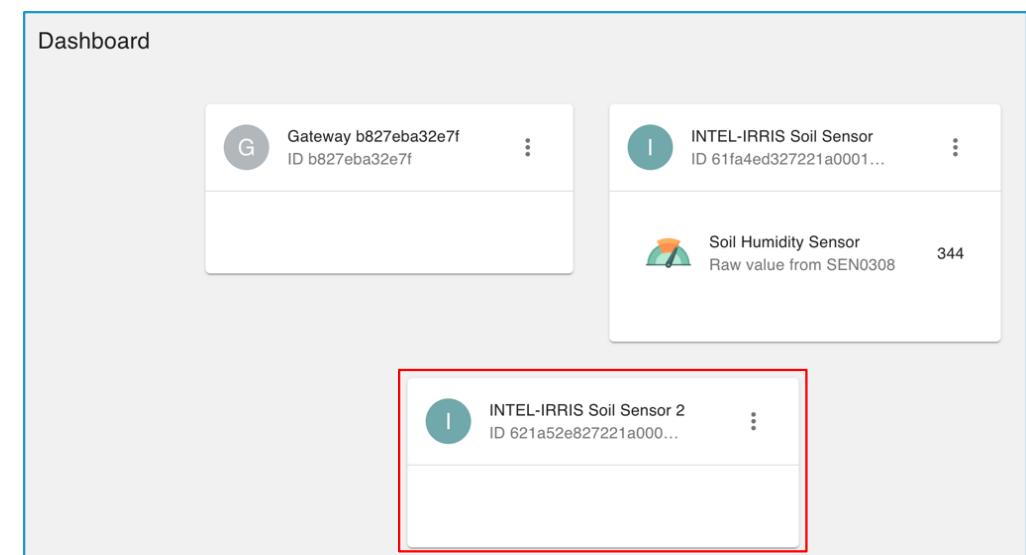
NwksKey (Network Session Key)
23158D3BBC31E6AF670D195B5AED5525

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...

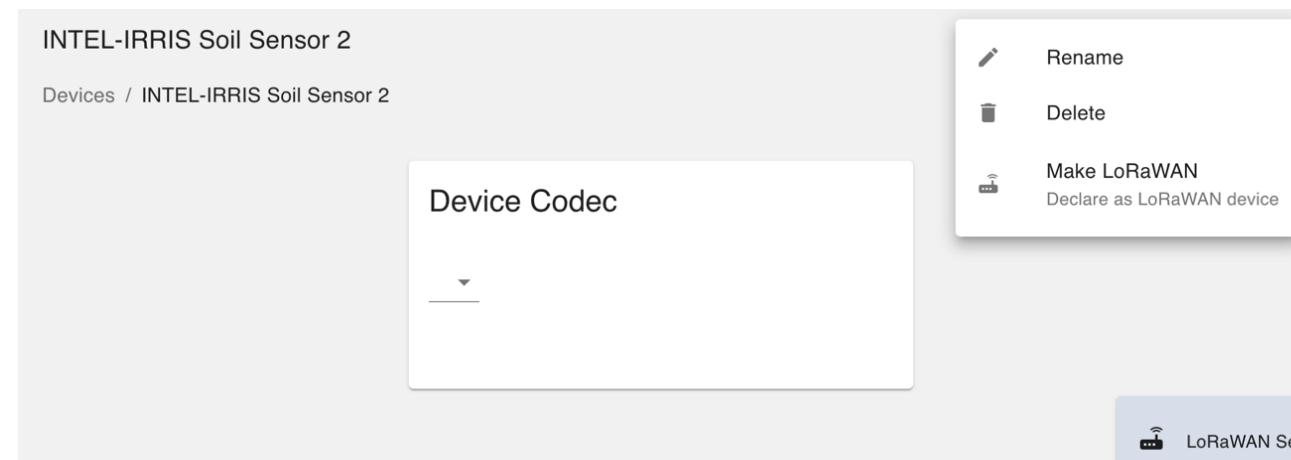
Soil Humidity Sensor
Raw value from SEN0308 344

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

Advanced configuration

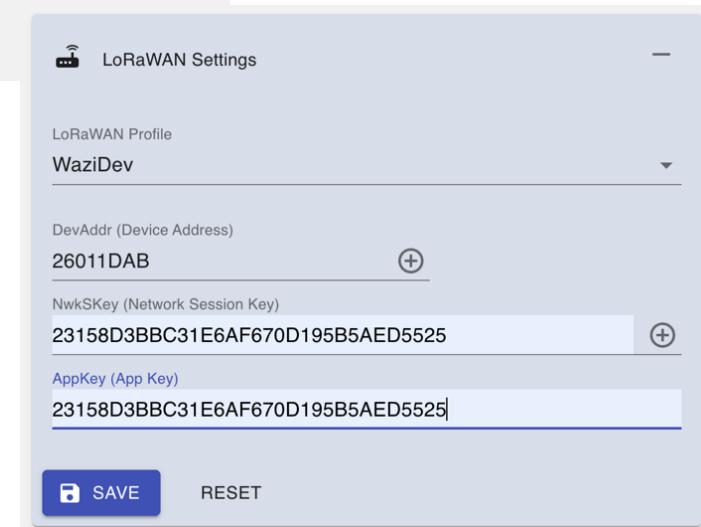
configure LoRaWAN parameters

- Select the new sensor and make it as LoRaWAN device



The screenshot shows a web-based interface for managing devices. At the top left, it says "INTEL-IRRIS Soil Sensor 2" and "Devices / INTEL-IRRIS Soil Sensor 2". Below this, there is a large white box labeled "Device Codec" with a dropdown arrow. To the right of this box is a context menu with three items: "Rename" (with a pencil icon), "Delete" (with a trash bin icon), and "Make LoRaWAN" (with a Wi-Fi icon). The "Make LoRaWAN" option is described as "Declare as LoRaWAN device".

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

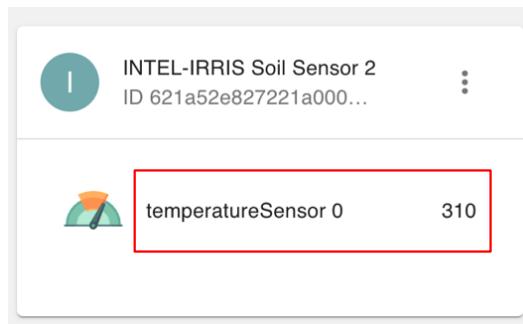


The screenshot shows the "LoRaWAN Settings" page. It includes fields for "LoRaWAN Profile" (set to "WaziDev"), "DevAddr (Device Address)" (set to "26011DAB"), "NwkSKey (Network Session Key)" (set to "23158D3BBC31E6AF670D195B5AED5525"), and "AppKey (App Key)" (set to "23158D3BBC31E6AF670D195B5AED5525"). At the bottom are "SAVE" and "RESET" buttons.

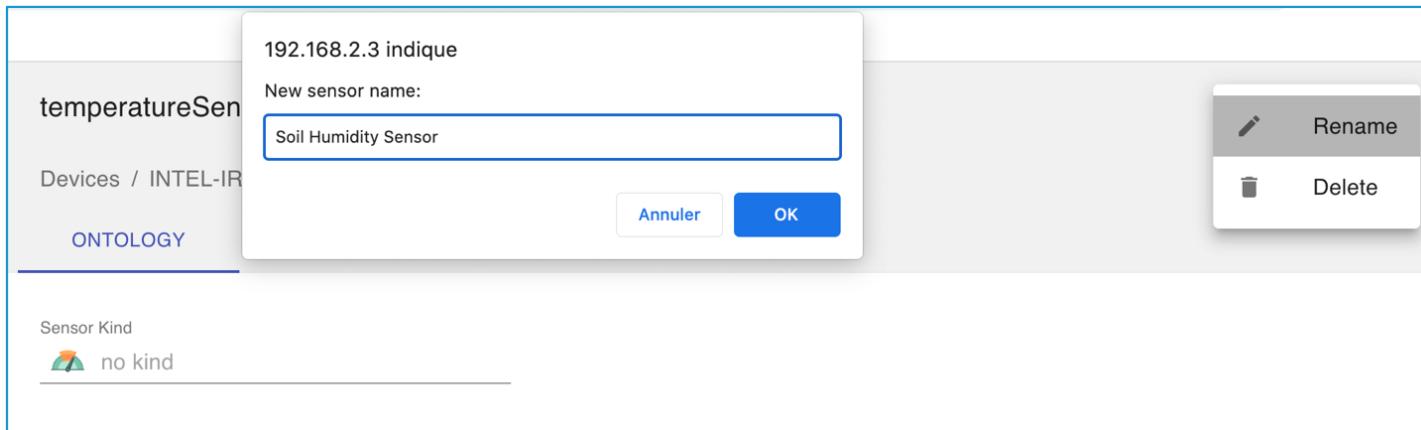
Advanced configuration

configure sensor name

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



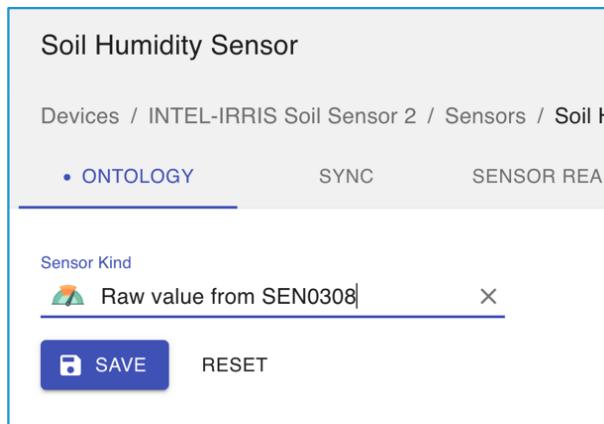
- Click on the "temperatureSensor 0" and then rename it



Advanced configuration

configure sensor kind

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



Soil Humidity Sensor

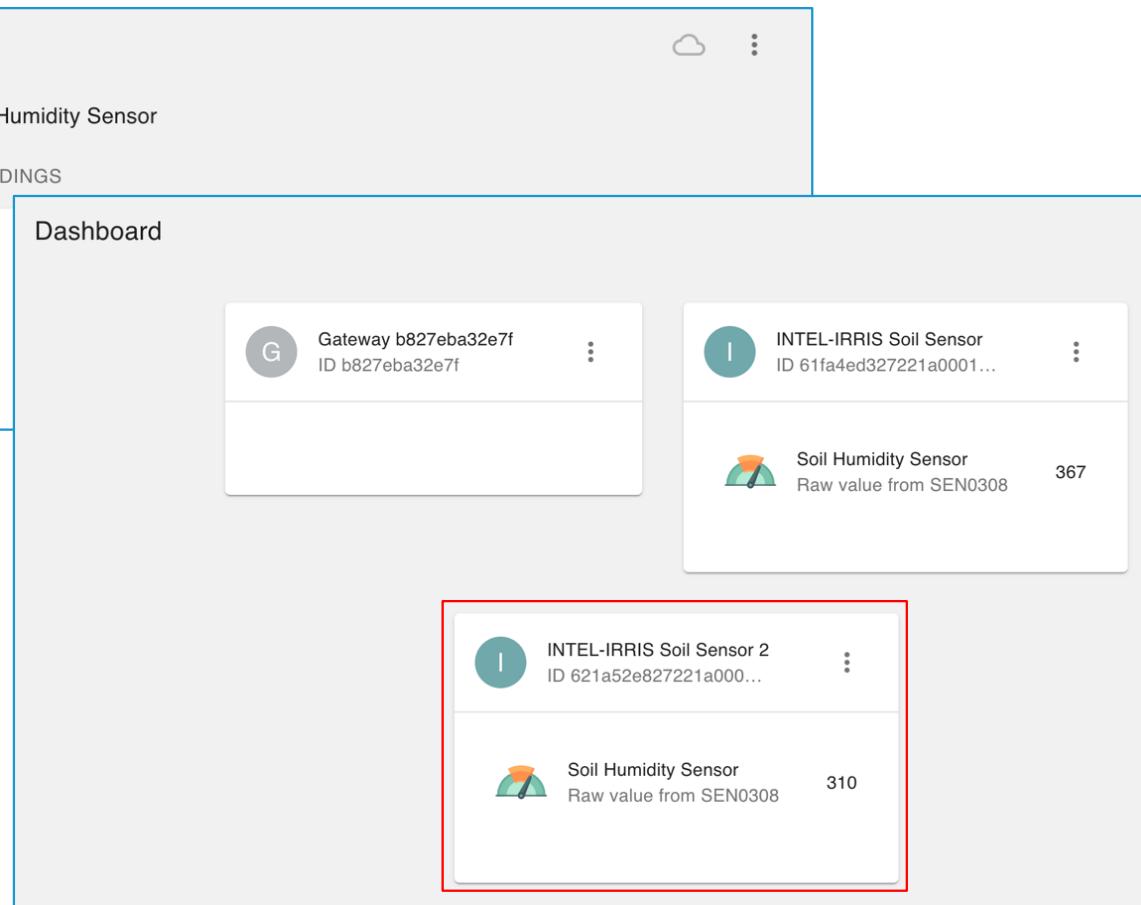
Devices / INTEL-IRRIS Soil Sensor 2 / Sensors / Soil Humidity Sensor

- ONTOLOGY SYNC SENSOR READINGS

Sensor Kind

 Raw value from SEN0308 X

SAVE RESET



Dashboard

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

- The dashboard now displays correctly the new sensor