

DEPLOYING LOW-COST AND LONG-RANGE INTERNET OF THINGS IN DEVELOPING COUNTRIES

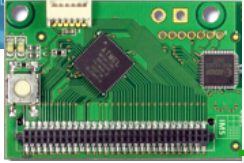
WORKSHOP IOT TUNISIA

SESAME UNIVERSITY, APRIL 26TH, 2018



PROF. CONGDUC PHAM
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)
UNIVERSITÉ DE PAU, FRANCE





MATURATION OF THE IOT MARKET...



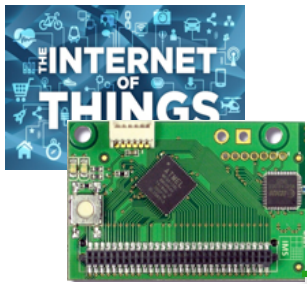
... but not adapted for rural developing countries context & environment

- Too expensive
- Too integrated
- Highly specialized
- Difficult to customize
- Difficult to upgrade

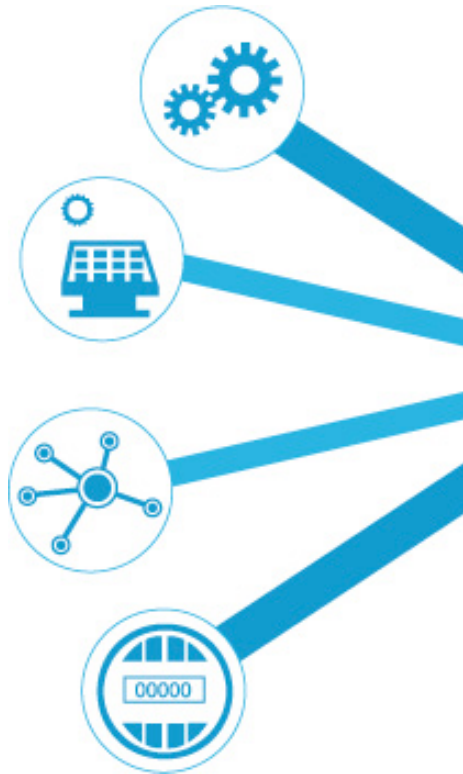


Ultrasonic fill level sensor
10+ years battery life
IP 66, [-40°, +85°]





INTERNET, CLOUD & BIG DATA ANALYTICS



Internet connectivity is weak and expensive!

Nearly impossible in remote/rural areas



Predictive Maintenance

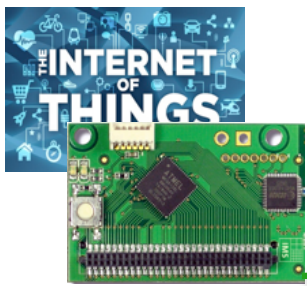
Outage Management

Fraud Detection

Demand/Supply Optimization

Customer Engagement

Graphics from <http://www.vitria.com/iot-analytics/>



IOT FOR DEVELOPMENT



Irrigation



Livestock farming



Fish farming & aquaculture



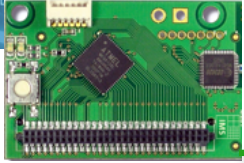
Storage & logistic



Agriculture

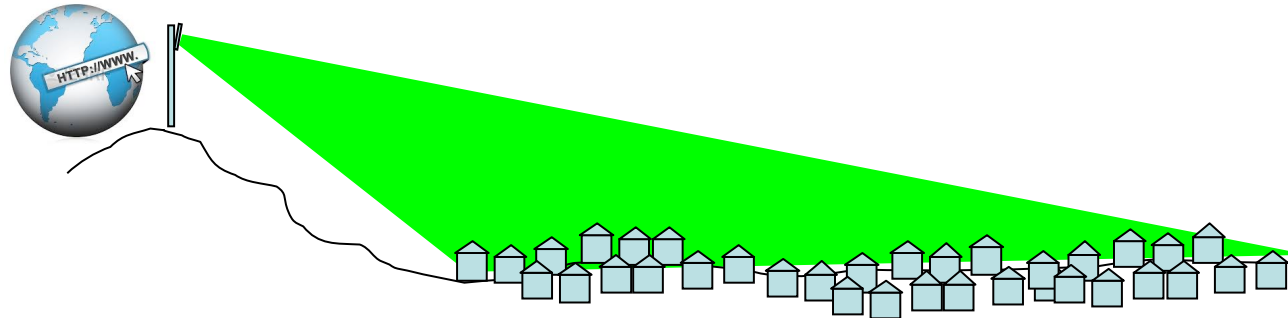
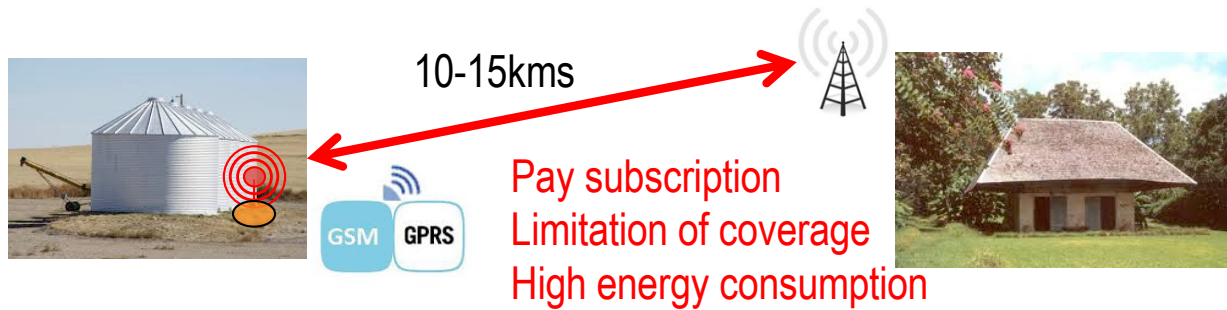


Fresh water

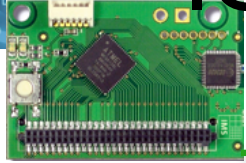


LONG-RANGE SENSING

Moisture/
Temperature of
storage areas

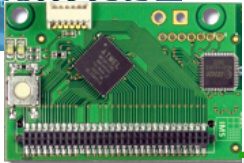


Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC



IoT IN DEVELOPING COUNTRIES AND RURAL AREAS

- ❑ Developing countries/rural areas are still far from being ready to enjoy the smallest benefit of IoT
 - ❑ lack of infrastructure
 - ❑ high cost of hardware
 - ❑ complexity in deployment
 - ❑ lack of technological eco-system and background
- ❑ **to deploy IoT in developing countries, it is necessary to target three major issues**
 - ❑ **reduce cost of infrastructures, hardware and services**
 - ❑ **limit dependancy to proprietary infrastructures and provide local interaction models**
 - ❑ **target technology appropriation, push for local business models**



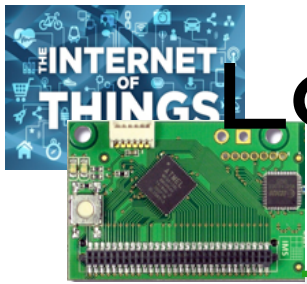
WAZIUP: LOW-COST IOT



[ABOUT »](#) [TECHNOLOGIES »](#) [COMMUNITY](#) [NEWS & EVENT »](#) [DOWNLOADS](#) [DEV KIT](#) [FAQ](#) [CONTACT](#)


European Commission
HORIZON 2020

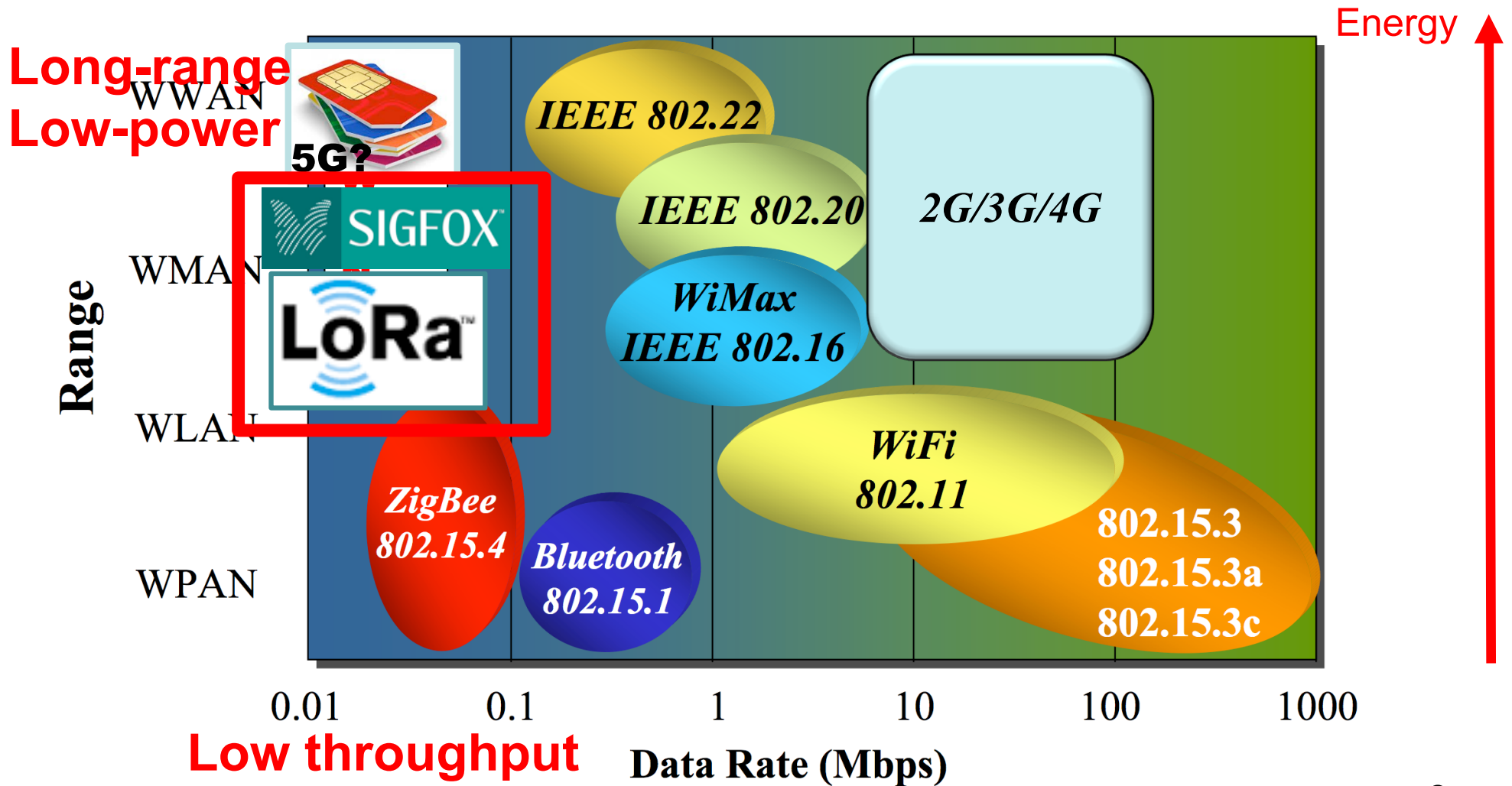
AFFORDABLE
TECHNOLOGIES
TO
EMPOWER
RURAL ECONOMIES

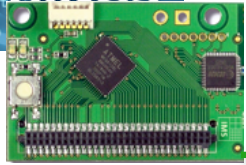


LOW-POWER & LONG-RANGE RADIO TECHNOLOGIES

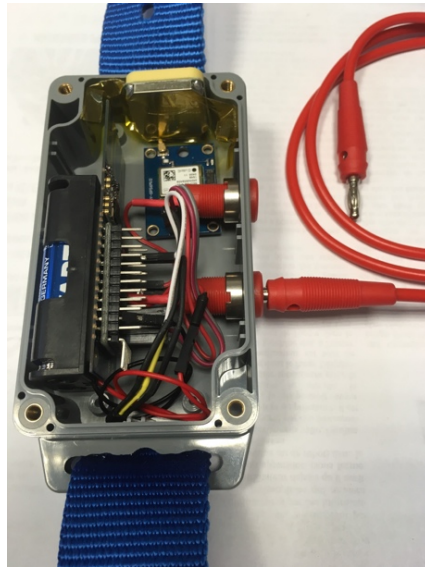


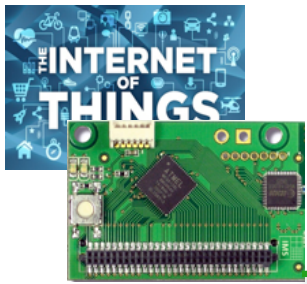
Energy-Range dilemma





LOW-COST IOT DEVICES





LOW-COST HARDWARE INITIATIVE



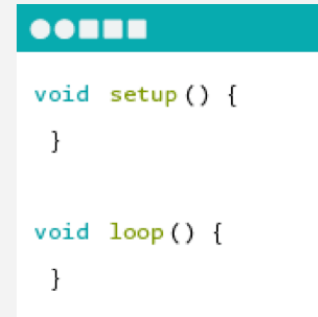
WHAT IS ARDUINO?

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects.



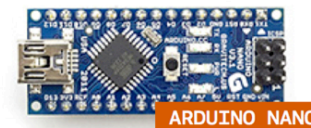
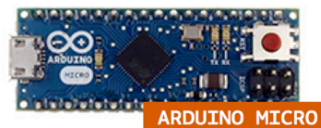
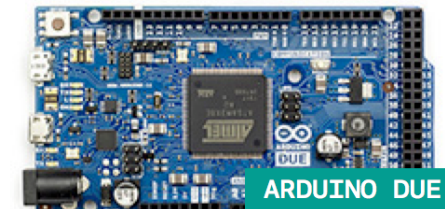
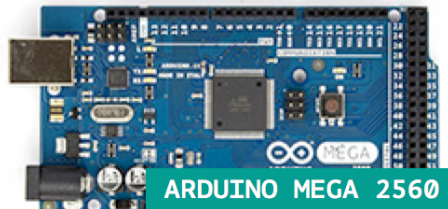
ARDUINO BOARD

Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators.



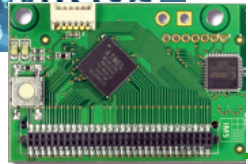
ARDUINO SOFTWARE

You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment.

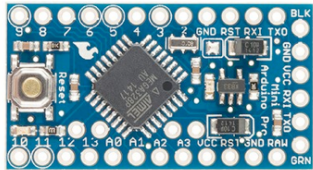




LARGE ECOSYSTEM, STILL GROWING...



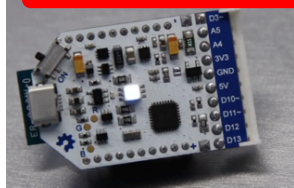
Arduino Pro Mini



LoPy

<http://blog.atmel.com/2015/12/16/rewind-50-of-the-best-boards-from-2015/>

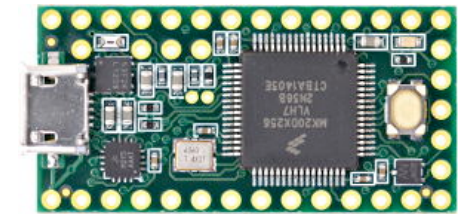
<http://blog.atmel.com/2015/04/09/25-dev-boards-to-help-you-get-started-on-your-next-iot-project/>



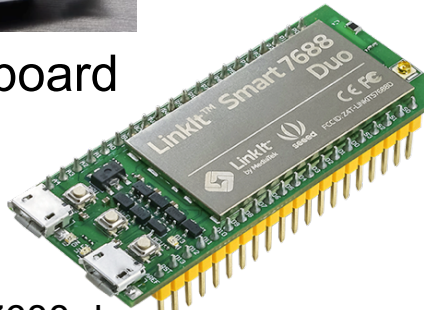
Theairboard



Expressif ESP32

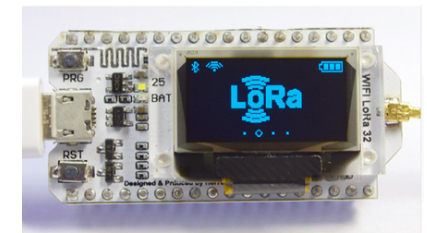
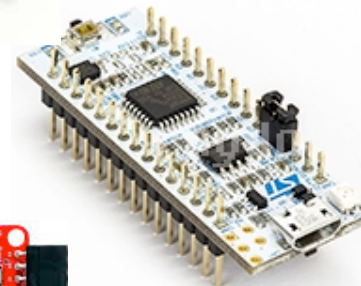


Teensy 3.2



LinkIt Smart7688 duo

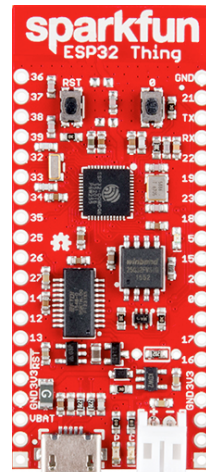
STM32 Nucleo-32



Heltec ESP32 + OLED



Adafruit Feather



Sparkfun ESP32 Thing

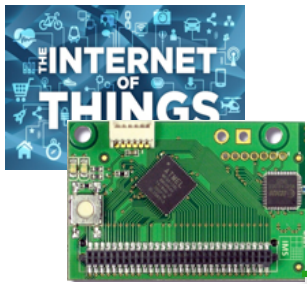


Tessel

SodaqOnev2



Tinyduino



... STIMULATING "DO-IT-YOURSELF" WORLDWIDE

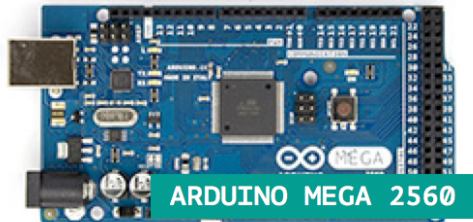


- DIY usually means
 - More open-source software from larger community
 - More flexibility

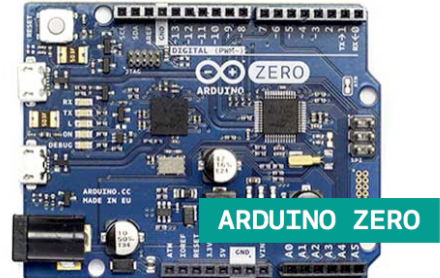
WAZIUP PROVIDES SW/HW BUILDING BLOCKS INTEGRATION



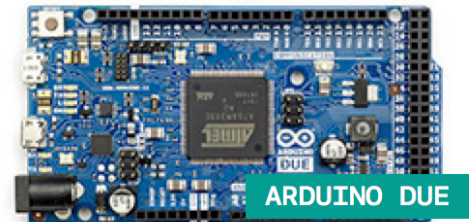
ARDUINO UNO



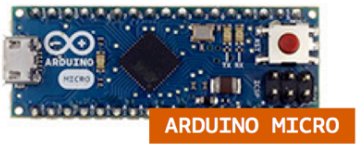
ARDUINO MEGA 2560



ARDUINO ZERO



ARDUINO DUE



ARDUINO MICRO



ARDUINO PRO MINI



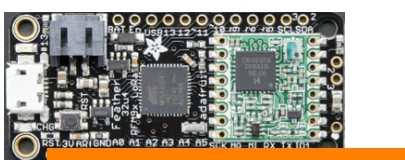
ARDUINO NANO



Ideetron Nexus



TeensyLC/3.1/3.2



Adafruit Feather 32u4/M0



Expressif ESP8266/ESP32

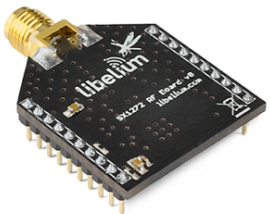
More to come...



LoRa radios that our library already supports



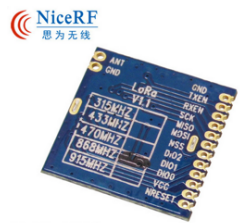
HopeRF RFM92W/95W



Libelium LoRa



Modtronix inAir9/9B



LoRa1276 NiceRF LoRa1276

Long-Range communication library



WAZIUP PROPOSES 100% OPEN-SOURCE SOFTWARE



```
Arduino_LoRa_temp | Arduino 1.6.6
Arduino_LoRa_temp
* temperature sensor on analog 8 to test the LoRa gateway
* Copyright (C) 2015 Congduc Pham, University of Pau, France
* This program is free software: you can redistribute it and/or modify
* it under the terms of the GNU General Public License as published by
* the Free Software Foundation, either version 3 of the License, or
* (at your option) any later version.
* This program is distributed in the hope that it will be useful,
* but WITHOUT ANY WARRANTY;
* MERCHANTABILITY or FITNESS
* GNU General Public License
* You should have received
* along with the program.
* .....
// Include the SX1272
#include "SX1272.h"
// IMPORTANT
// please uncomment only 1 ch
// it seems that both HopeRF
// boards we set the initial
//
// uncomment if your radio is
#define RADIO_RF92_95
// uncomment if your radio is
#define RADIO_INA1R98
// IMPORTANT
```

CongducPham / LowCostLoRaGw

Watch 50 Star 161 Fork 95

Code Issues 62 Pull requests 2 Projects 0 Pulse Graphs

Low-cost LoRa IoT & gateway with SX1272/76, Raspberry and Arduino

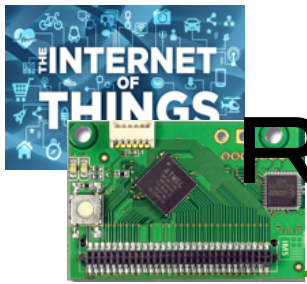
122 commits 1 branch 0 releases 2 contributors

Branch: master New pull request Find file Clone or download

Congduc Pham bug fix in lora_gateway.cpp Latest commit a0daa4a a day ago

Arduino	update SMS scripts	15 days ago
gw_full_latest	bug fix in lora_gateway.cpp	a day ago
tutorials	update SMS scripts	15 days ago
.gitignore	.DS_Store banished	10 months ago
README.md	update README	11 days ago

LowCostLoRaGw github has latest general distribution:
<https://github.com/CongducPham/LowCostLoRaGw>
WAZIUP-specific configuration can be found on
<https://github.com/Waziup/waziup-gateway>



READY-TO-USE TEMPLATES



Moisture/
Temperature of
storage areas



10-15kms



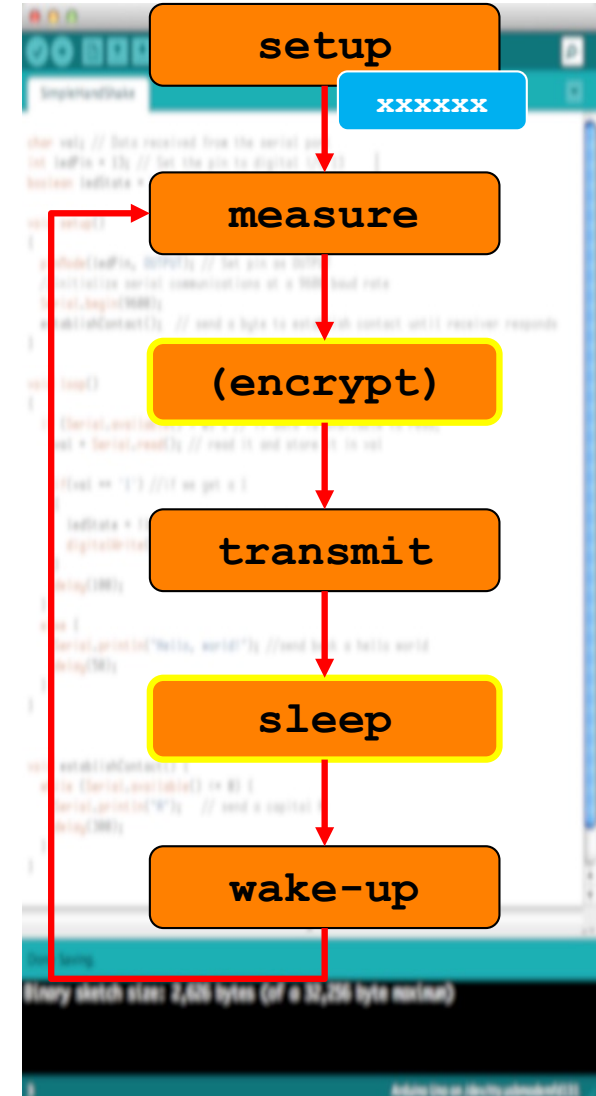
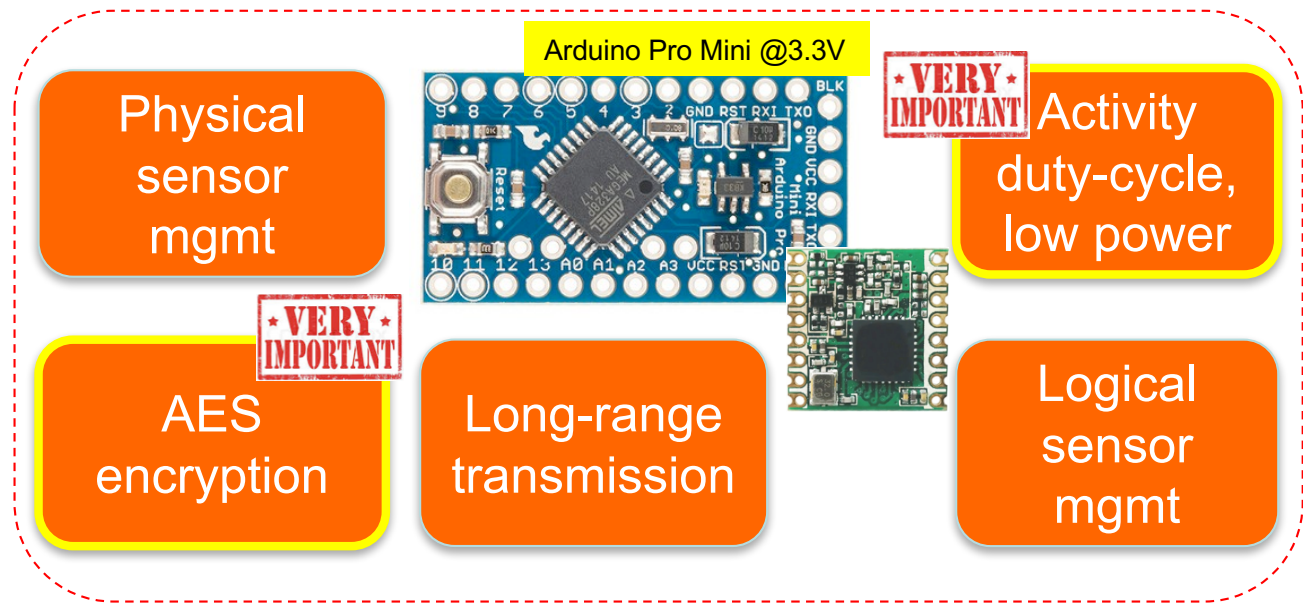
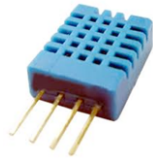
Physical
sensor

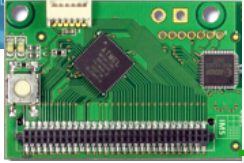


Physical
sensor

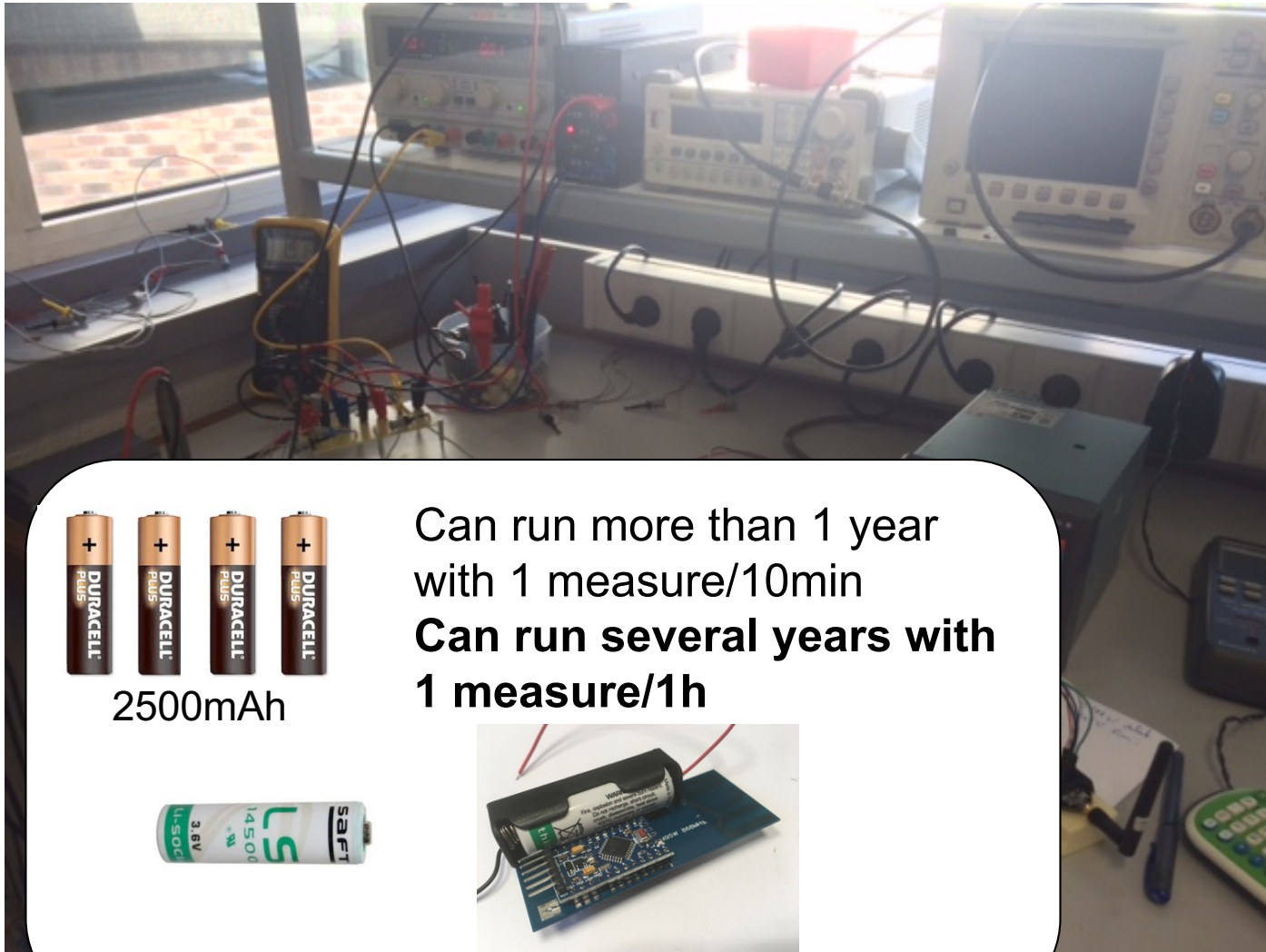


Physical
sensor



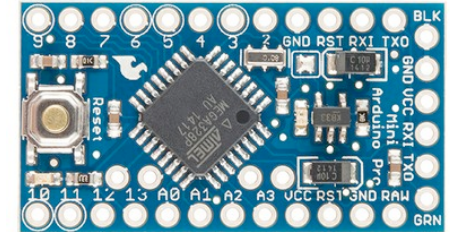


LOW-POWER FOR LONGER LIFETIME!

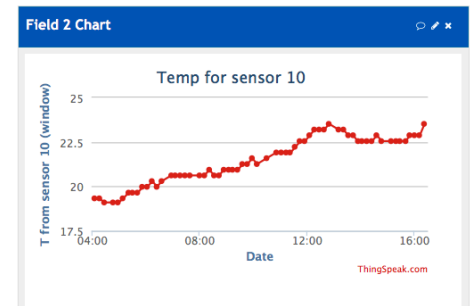


2500mAh

Can run more than 1 year with 1 measure/10min
Can run several years with 1 measure/1h



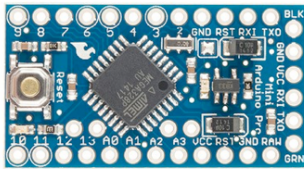
Wakes-up every 10min, take a measure (temp) and send to GW



5 μ A in deep sleep mode, about 40mA when active and sending!

A SIMPLE TEMPERATURE SENSOR EXAMPLE

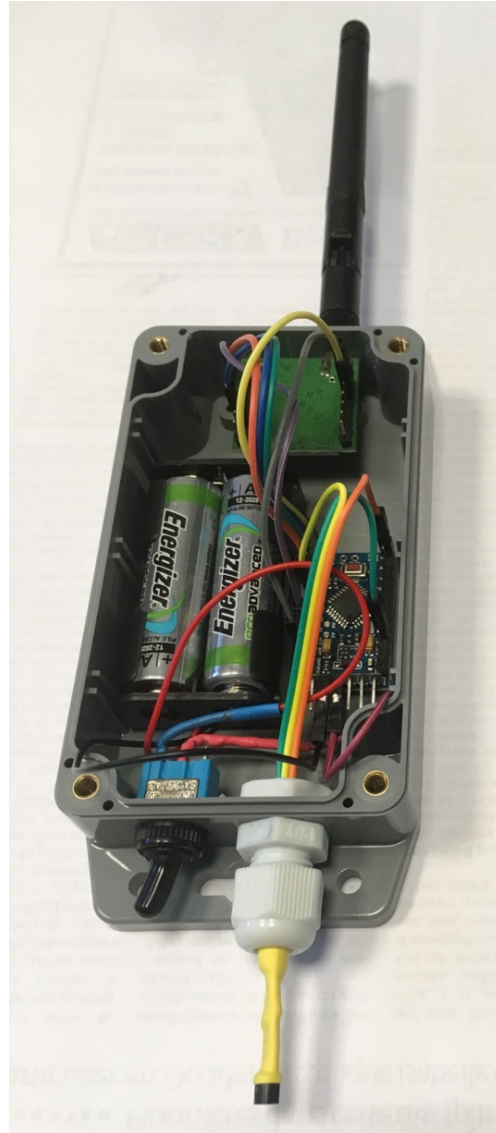
Arduino Pro Mini @3.3V



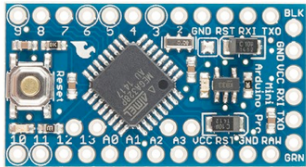
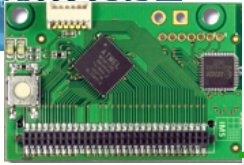
Modtronix inAir9



TMP36

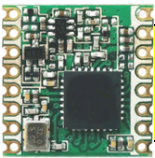


LOW-COST INTEGRATION

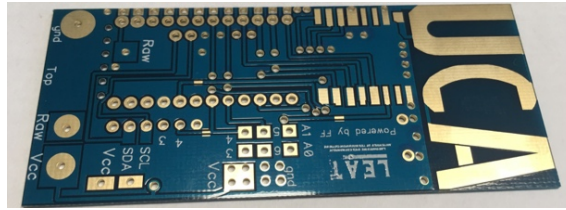


1.5€

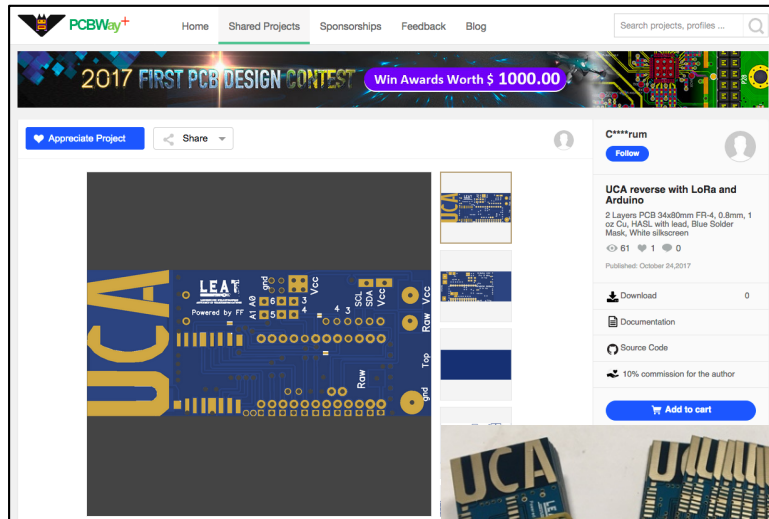
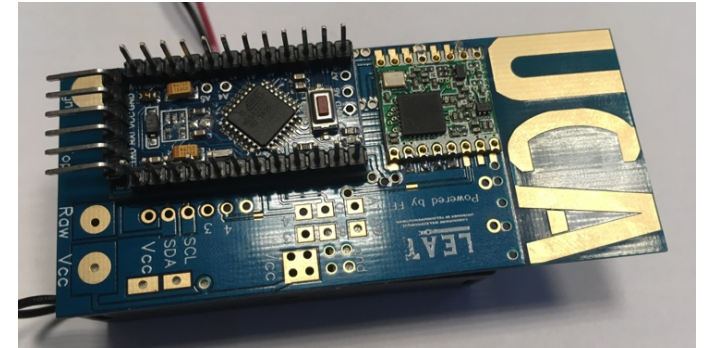
https://github.com/FabienFerrero/UCA_Board



5€

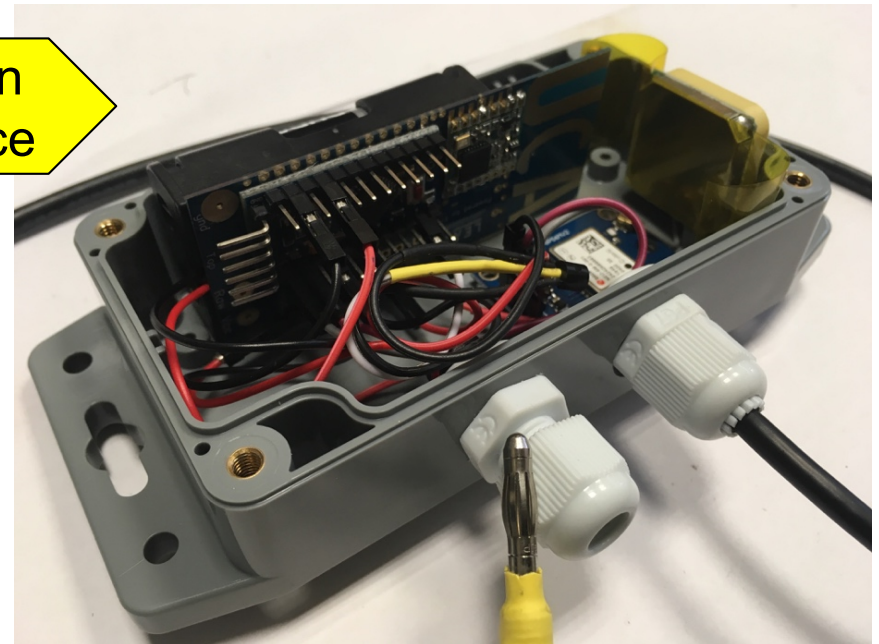
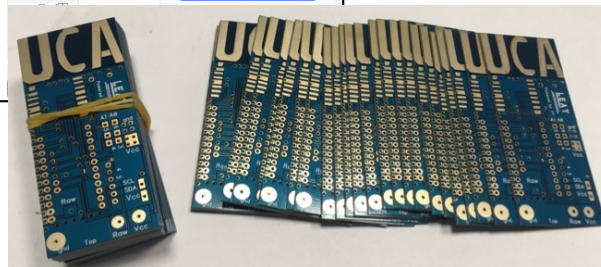


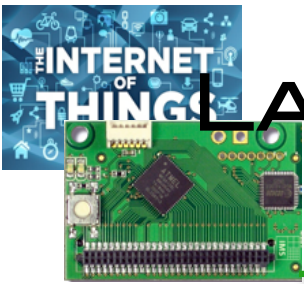
1€



Less than 10€/device

1-click order





LARGE VARIETY OF EXAMPLES TO LEARN AND ADAPT



CongducPham / LowCostLoRaGw

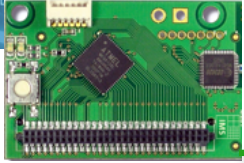
Unwatch 49 Unstar 216 Fork 120

Code Issues 96 Pull requests 2 Projects 0 Wiki Insights Settings

Branch: master LowCostLoRaGw / Arduino / Create new file Upload files Find file History

Congduc Pham update README files, fix MD5 digest computation of gw id, always use ... Latest commit aba3ed2 2 days ago

..		
Arduino_LoRa_GPS	update README	19 days ago
Arduino_LoRa_Gateway	update gateway related files and some sketch	4 months ago
Arduino_LoRa_Gateway_1_4	improve management of transmission power, add channels in 863-865	a year ago
Arduino_LoRa_Generic_Sensor	update Arduino examples	a month ago
Arduino_LoRa_InteractiveDevice	update Arduino examples	a month ago
Arduino_LoRa_Ping_Pong	update Arduino examples	a month ago
Arduino_LoRa_Simple_BeaconCol...	update Arduino example	23 days ago
Arduino_LoRa_Simple_SoilHum	update Arduino examples	a month ago
Arduino_LoRa_Simple_temp	update Arduino examples	a month ago
Arduino_LoRa_SoilHum	update Arduino examples	a month ago
Arduino_LoRa_temp	update Arduino examples	a month ago
Arduino_LoRa_ucamII	update image support	3 months ago
libraries	update README files, fix MD5 digest computation of gw id, always use ...	2 days ago
README.md	update README	19 days ago



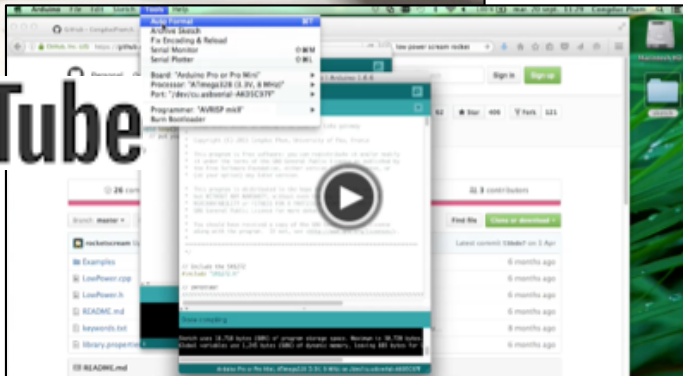
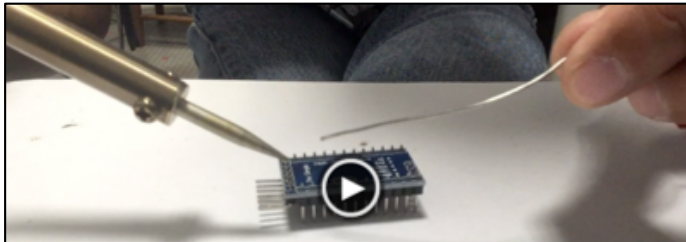
TUTORIALS AND VIDEOS



LOW-COST LORA IOT DEVICE: A STEP-BY-STEP TUTORIAL



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HTTP://WWW.UNIV-PAU.FR/~CPHAM
UNIVERSITÉ DE PAU, FRANCE



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

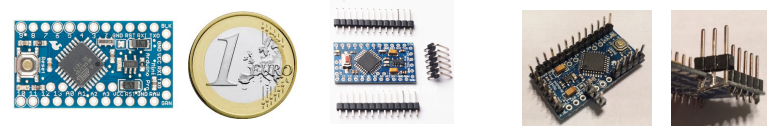


<http://www.waziup.eu>

The generic hardware platform

The Arduino Pro Mini

The Arduino Pro Mini is a compact form factor Arduino board based on the ATmega328P microcontroller. Use the **3.3v and 8MHz version** of the Arduino Pro Mini for lower power consumption.



You can get the original board designed by Sparkfun or get one of the various clones available mainly from Chinese manufacturer. The last solution is very cost-effective as the Pro Mini board can be purchased for a bit more than 1€ a piece.

Depending on how many sensors you want to connect, the number of ground (GND) pins may be limited. You can extend a GND pin with a header pin where all pins are soldered together.

The LoRa radio module

There are various LoRa radio modules that are all based on the Semtech SX1272/1276 chips family.



Fully tested LoRa radio modules



HopeRF RFM92W/95W



Libellium LoRa



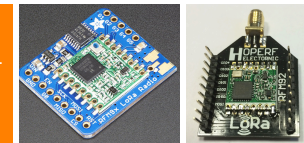
Modtronix inAir4/9/9B



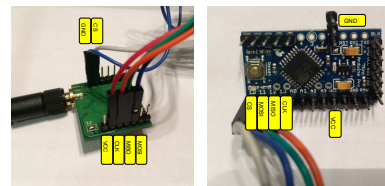
LoRa1276
NiceRF LoRa1276

Most of SPI-based LoRa radio modules are supported. We recommend the Modtronix inAir model if you don't have delicate soldering experience as this module can come with header pins ready to be connected with Dupont wires.

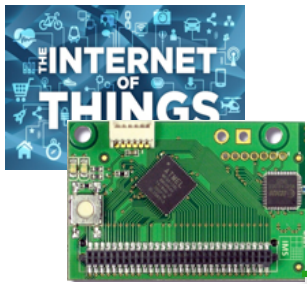
The RFM95W can be found assembled (Adafruit) or an adapter can be purchased (from Ideetron for instance).



Connect the LoRa radio module



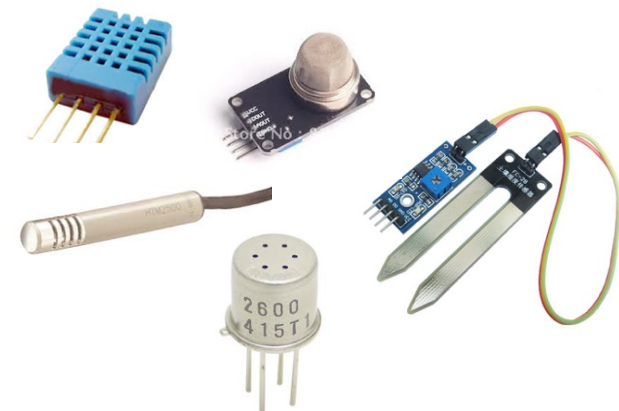
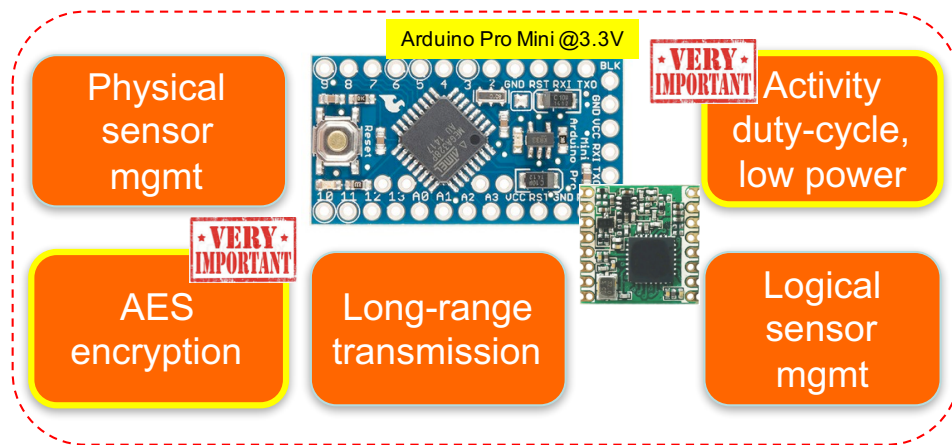
Connect the corresponding SPI pins of the radio module to the SPI pins on the Pro Mini board. MOSI (blue) is pin 11, MISO (green) is pin 12, CS (white) is pin 10 and CLK (orange) is pin 13 (right picture). Then connect also the VCC (red) and the GND (black) of the radio module to the VCC and the GND of the board (right picture). The VCC of the Pro Mini board gets 3.3v from the on-board voltage regulator.

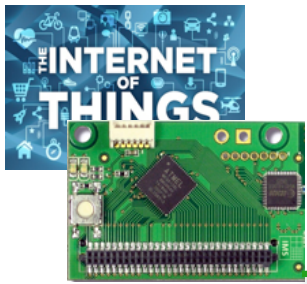


GENERIC SENSING IOT DEVICE VS HIGHLY SPECIALIZED



- ❑ Build low-cost, low-power, **long-range** enabled generic platform
- ❑ Methodology for low-cost platform design
- ❑ Technology transfers to user communities, economic actors, stakeholders,...



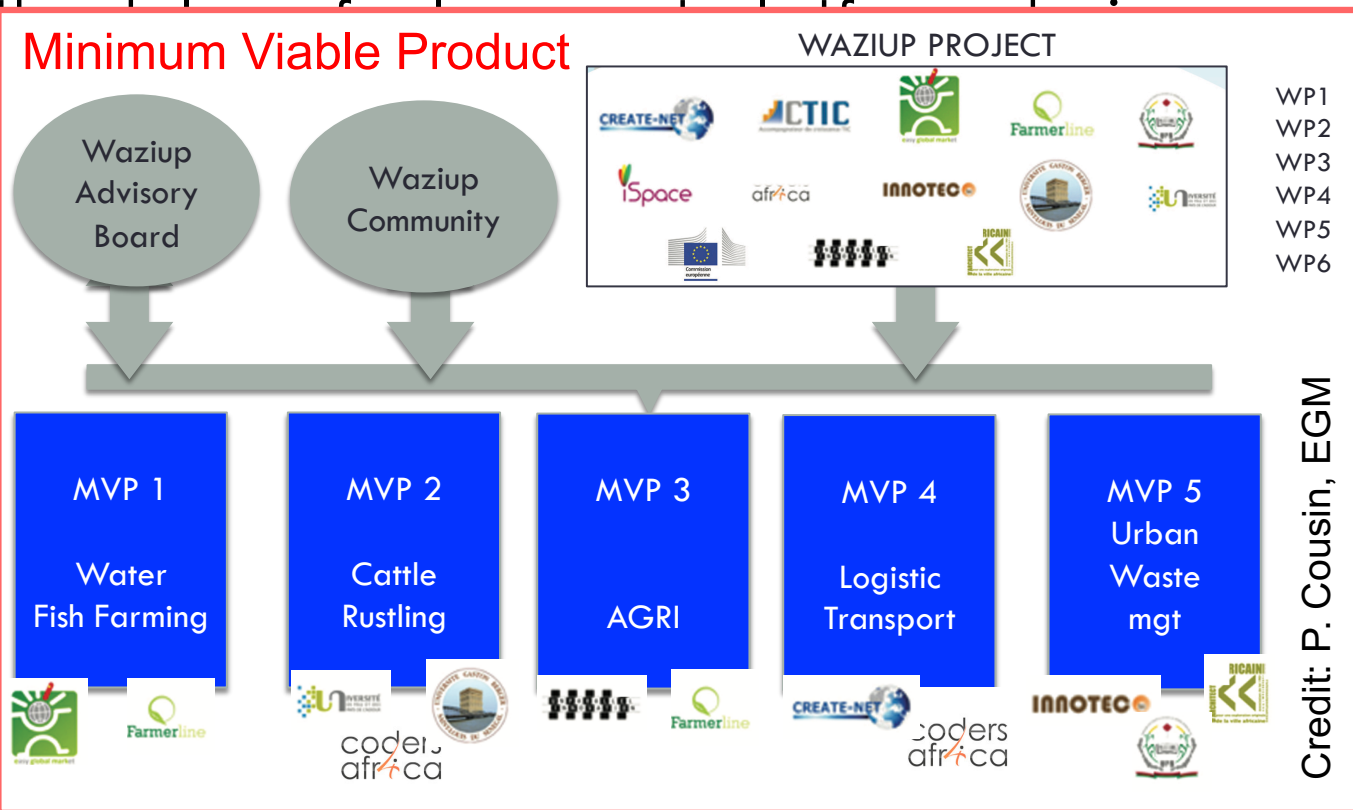


GENERIC SENSING IOT DEVICE VS HIGHLY SPECIALIZED



- ❑ Build low-cost, low-power, **long-range** enabled generic platform
- ❑ Meet the needs of the market
- ❑ Technical and economic

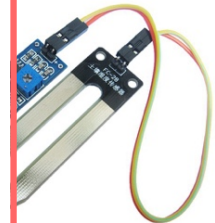
Minimum Viable Product



Physical sensor mgmt

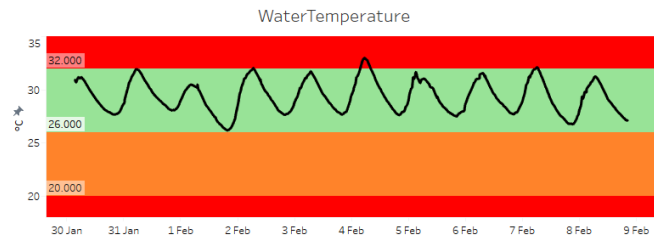
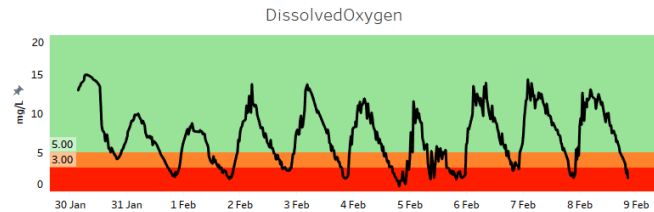
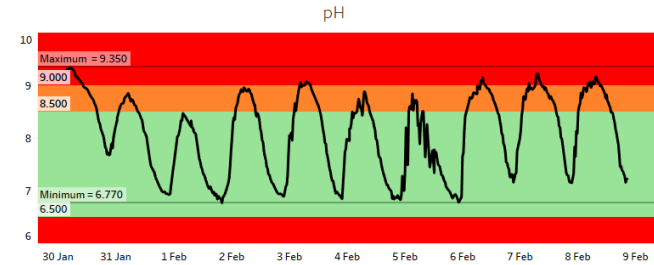
VERY IMPORTANT

AES encryption



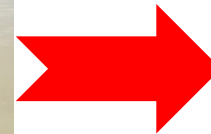


LOW-COST BUOY FOR FISH FARMING MVP

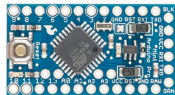


Physical sensor reading

Credit: EGM



Physical sensor management

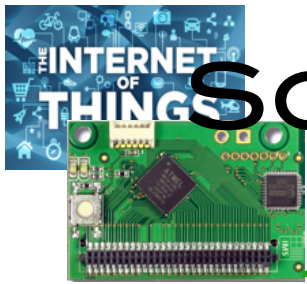


Activity duty-cycle, low power

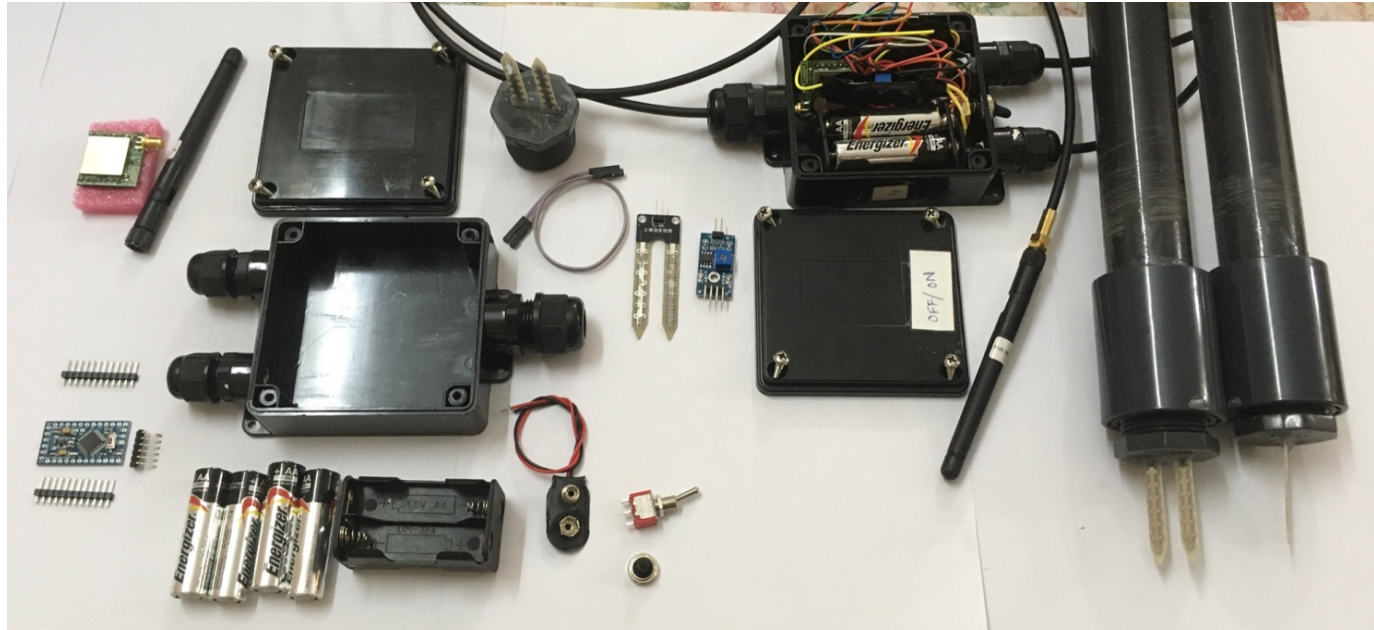
Security

Long-range transmission

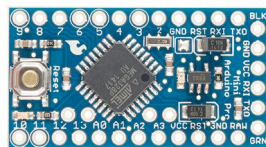
Logical sensor management



SOIL HUMIDITY SENSORS FOR AGRI MVP



Physical sensor management



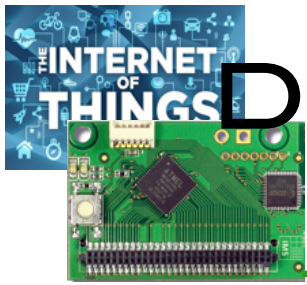
Activity duty-cycle, low power

Security

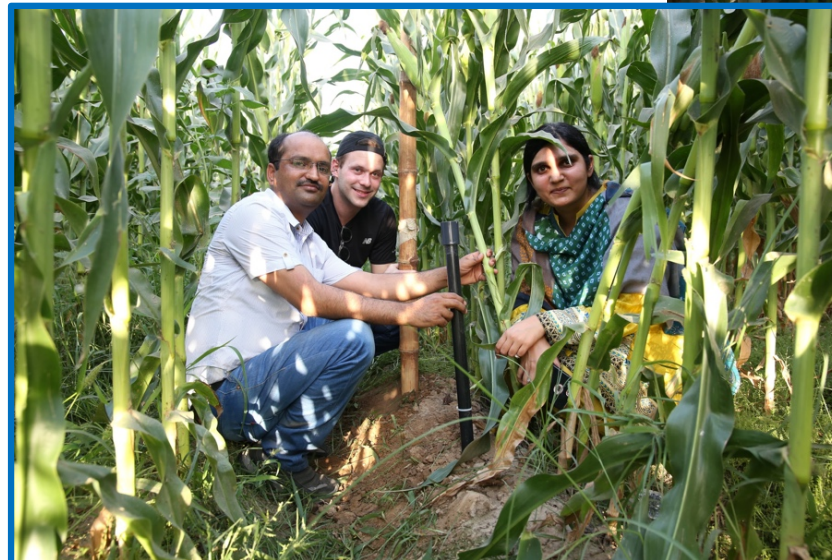
Long-range transmission

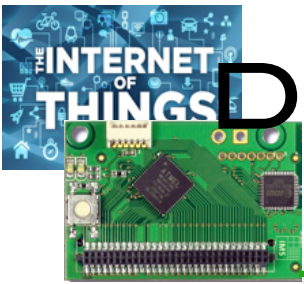
Logical sensor management



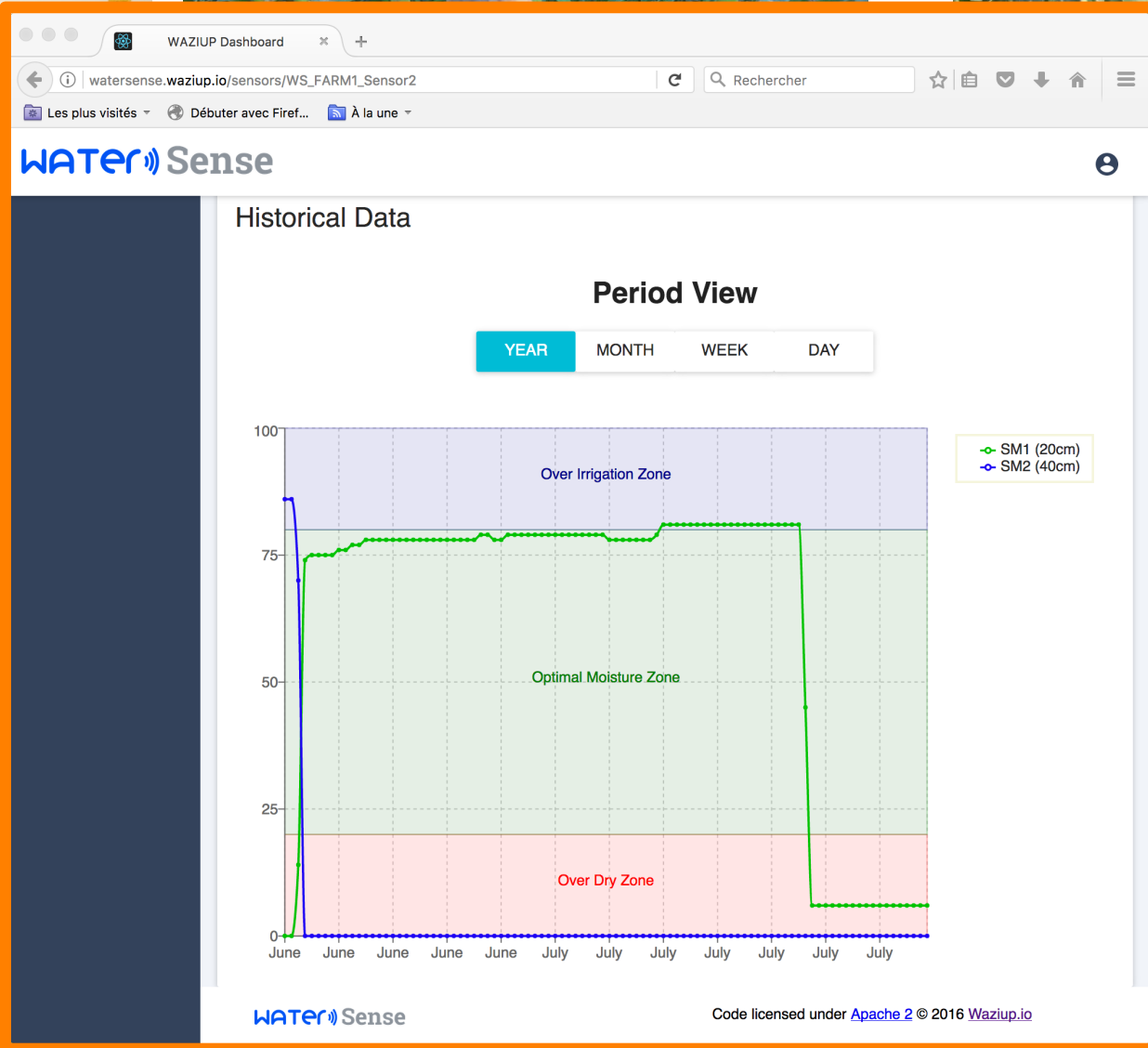


DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT



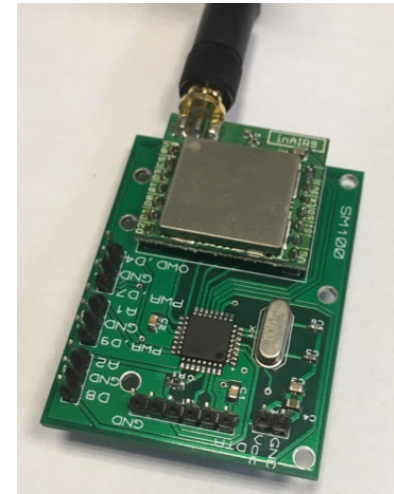
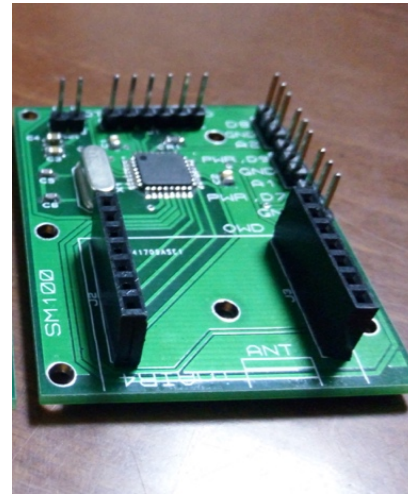
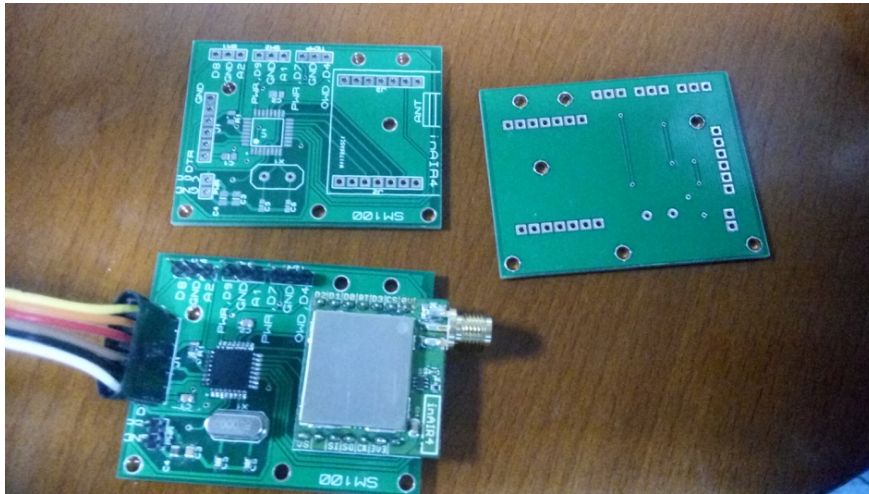


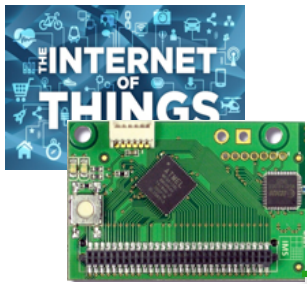
DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT



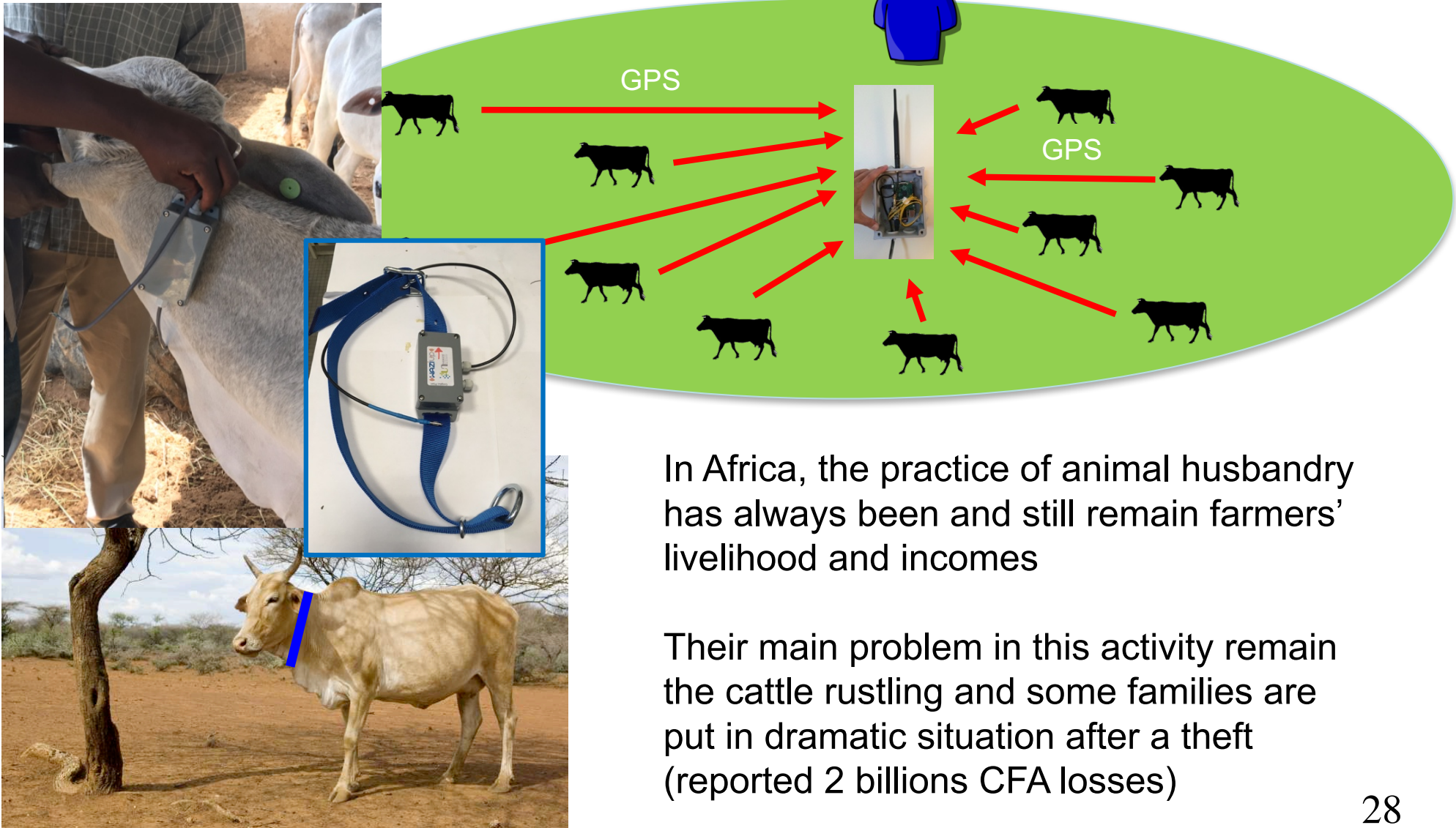


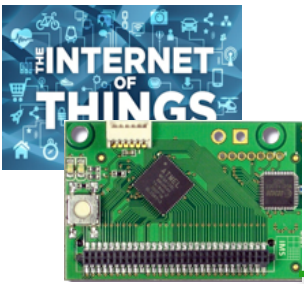
LOCAL INTEGRATION WITH TECHNOLOGY TRANSFER



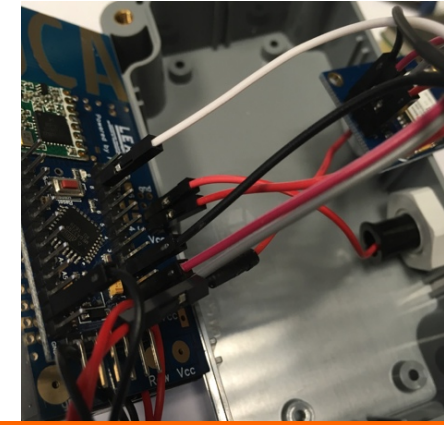
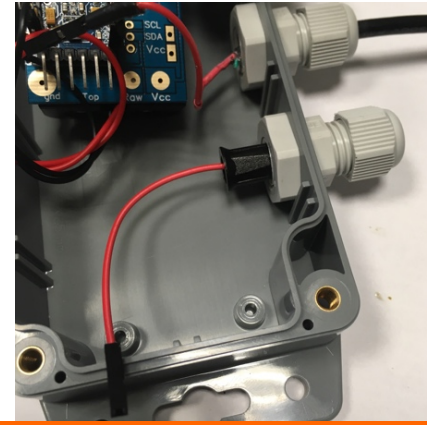
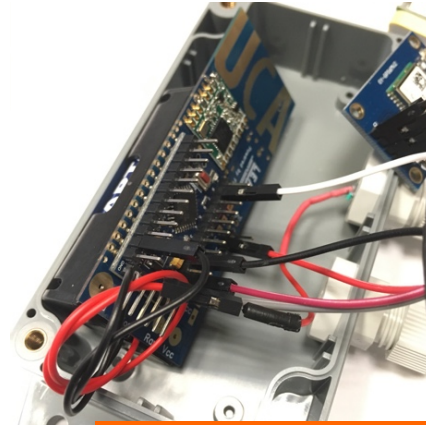
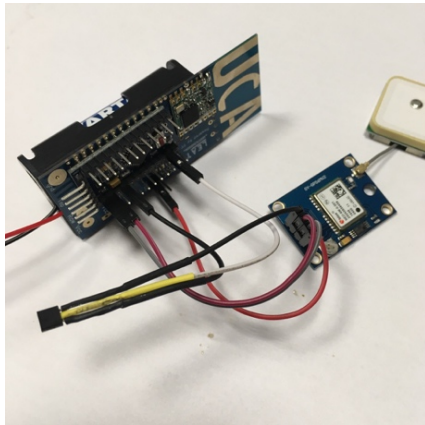


COLLAR FOR CATTLE RUSTLING MVP



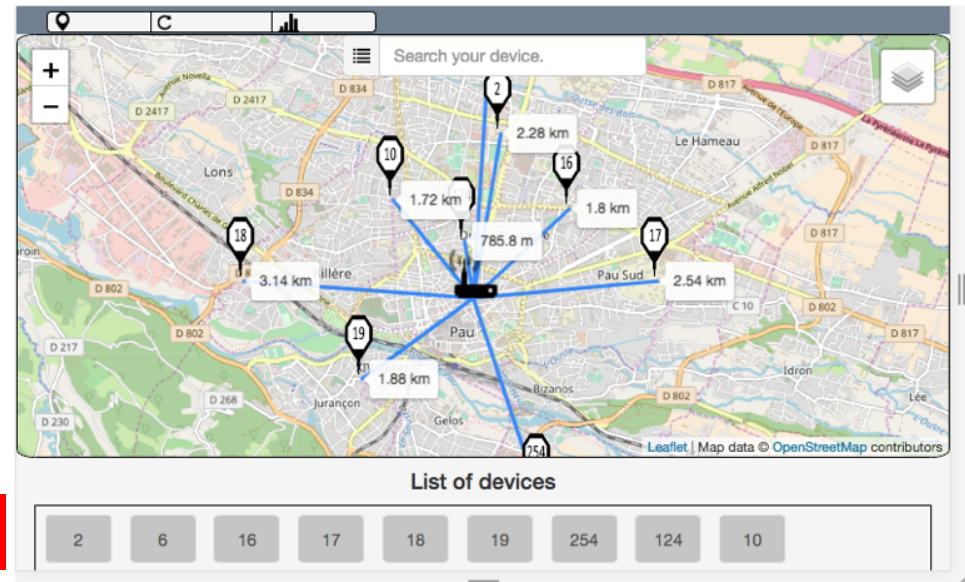
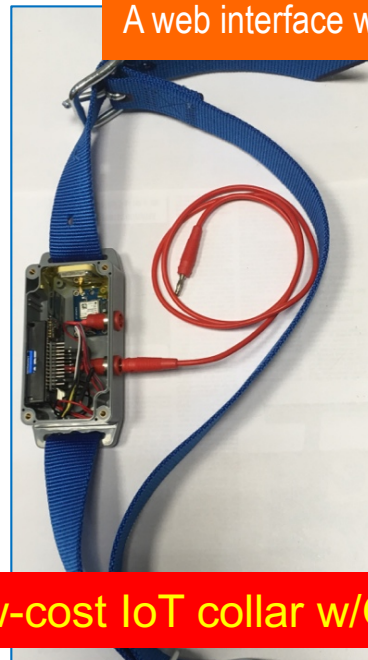
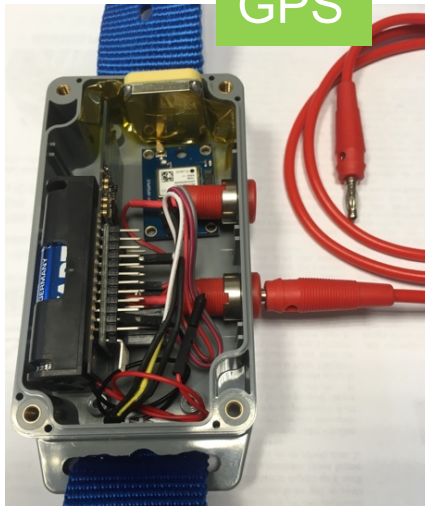


EASY INTEGRATION AND CUSTOMIZATION



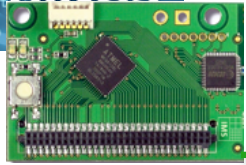
A web interface will display the position of the gateway and those of the remote GPS devices

GPS

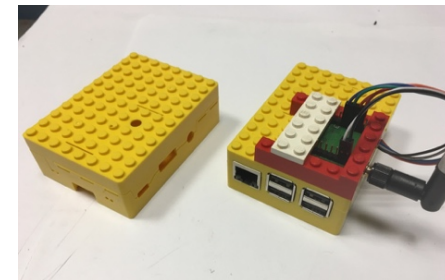
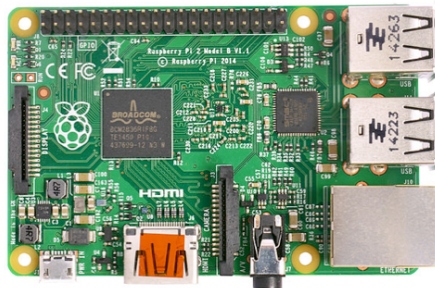


Dedicated tutorial on low-cost IoT collar w/GPS

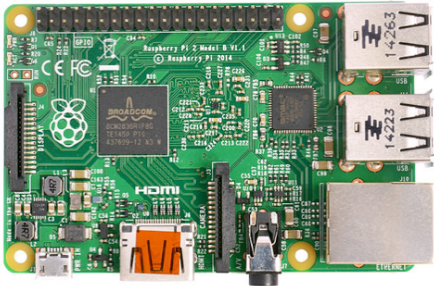
<https://github.com/CongducPham/tutorials/blob/master/Low-cost-LoRa-Collar.pdf>



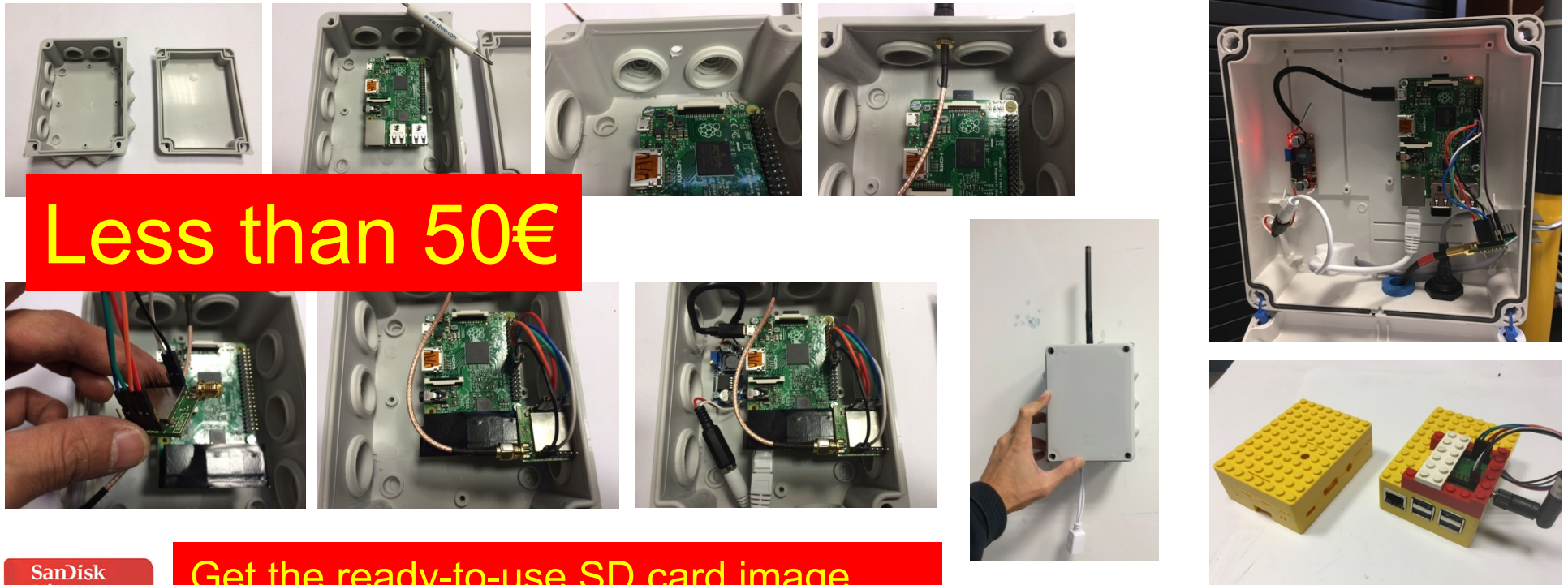
THE VERSATILE IOT GATEWAY



RASPBERRY-BASED LOW-COST LORA GATEWAY



We can use all model of Raspberry. The most important usefull feature is the Ethernet interface for easy Internet connection. Then WiFi and Bluetooth can be added with USB dongles. RPI3 provides built-in Ethernet, WiFi and Bluetooth!



Less than 50€

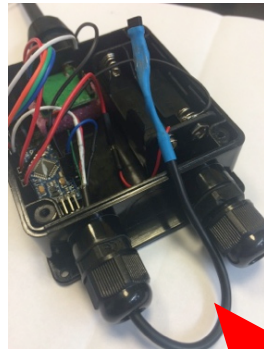
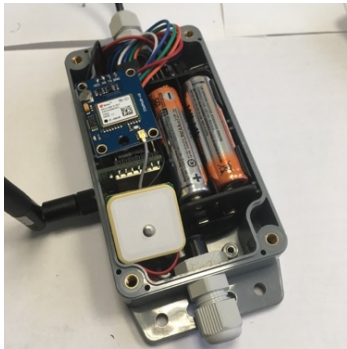


Get the ready-to-use SD card image

<http://cpham.perso.univ-pau.fr/LORA/WAZIUP/raspberrypi-jessie-WAZIUP-demo.dmg.zip>



100% DO-IT-YOURSELF !

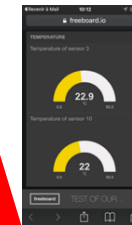


Step-by-step tutorial and source code available



Step-by-step tutorial and source code available

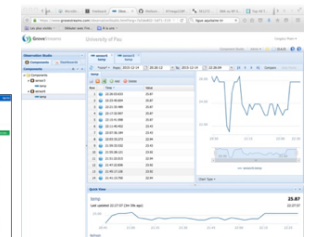
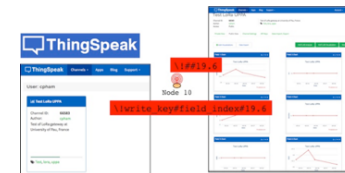
Python scripts available



freeboard



FIWARE

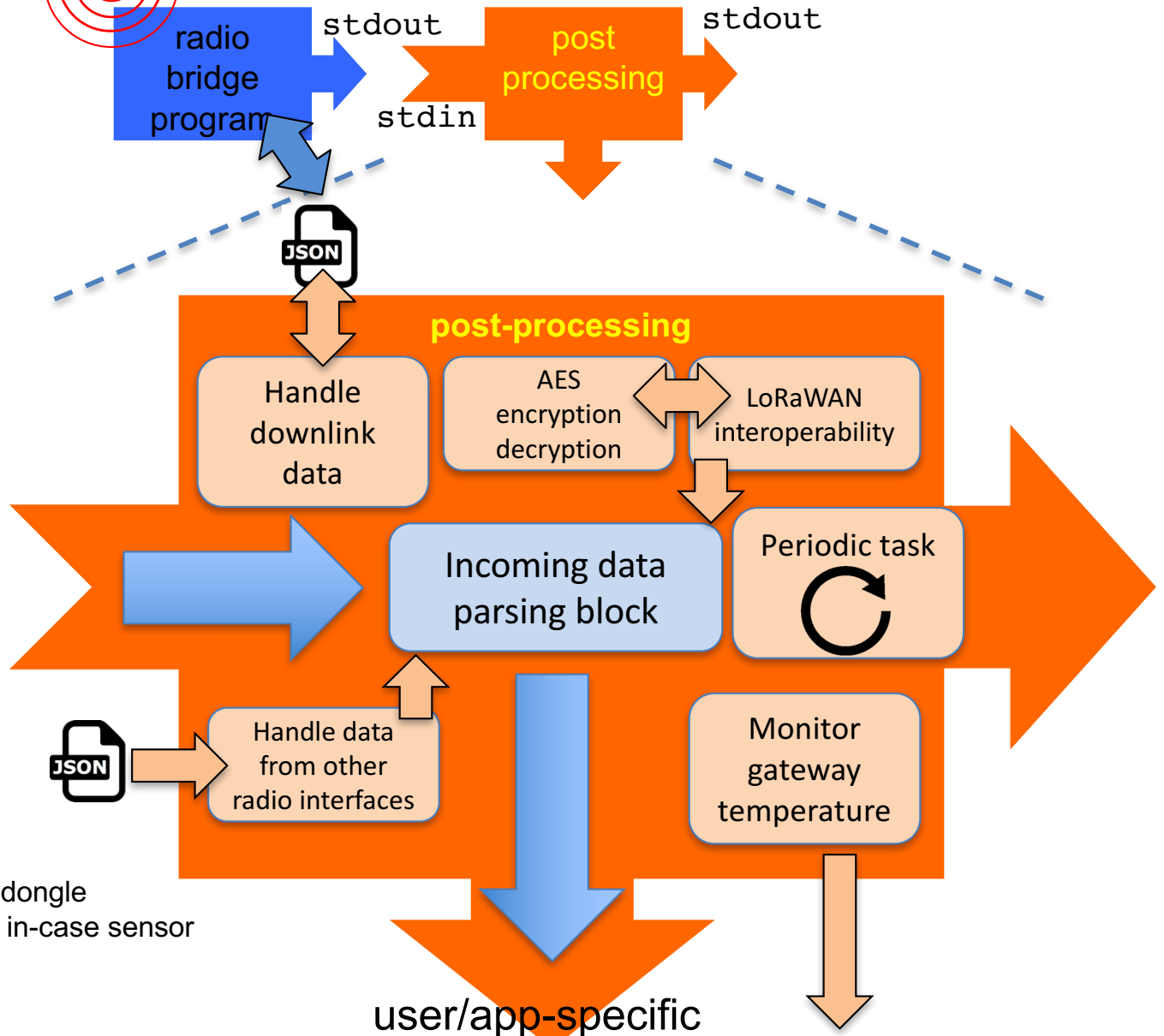
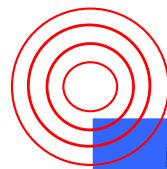
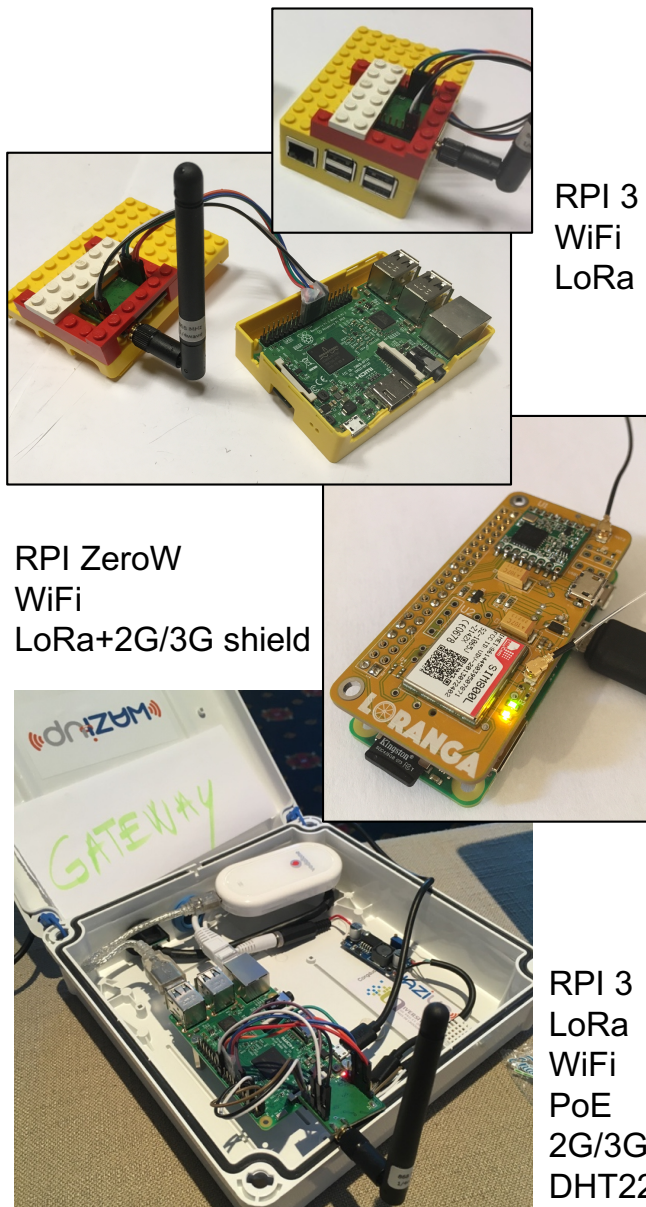


GroveStreams

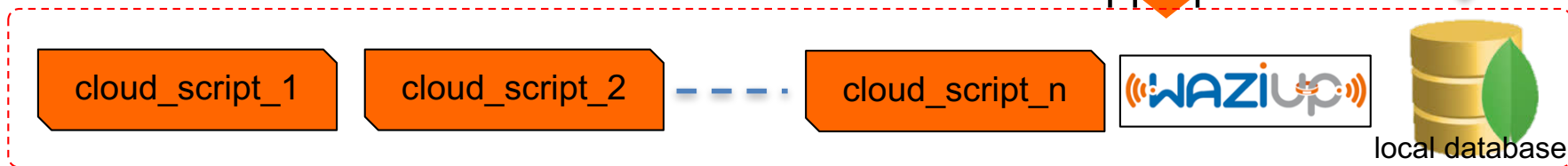
SensorCloud

<https://github.com/CongducPham/LowCostLoRaGw>

Data post-processing stage

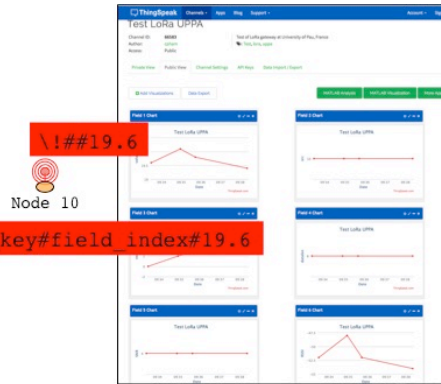
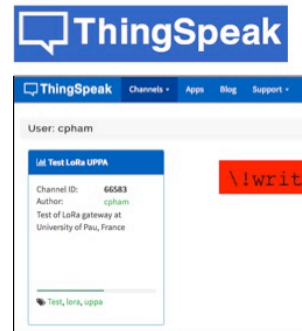
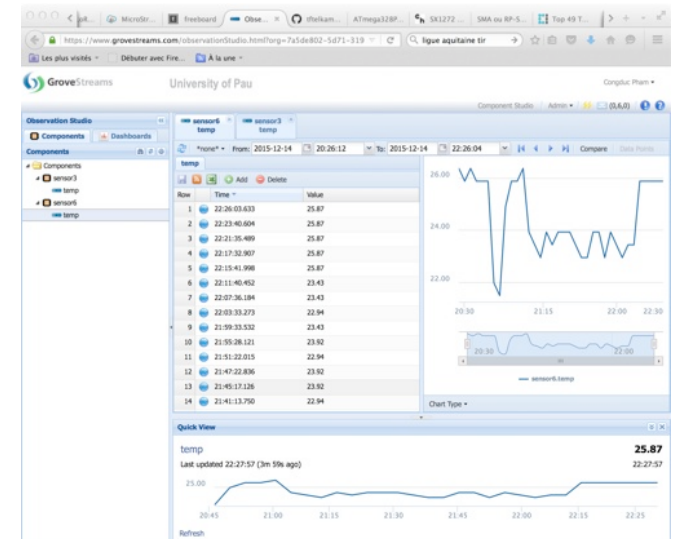
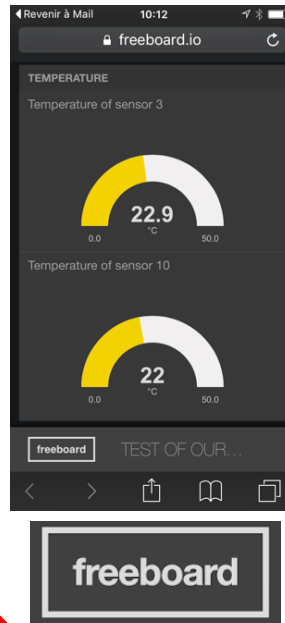
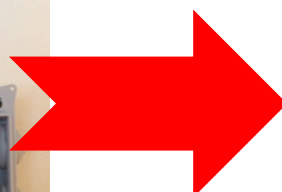
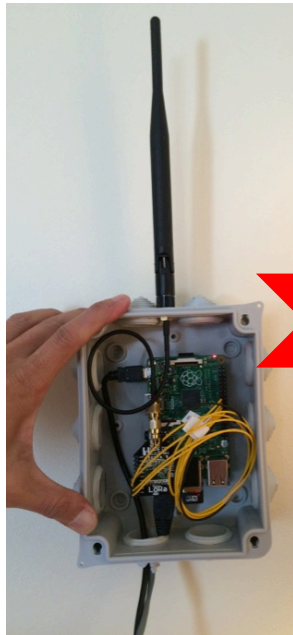


Cloud definition



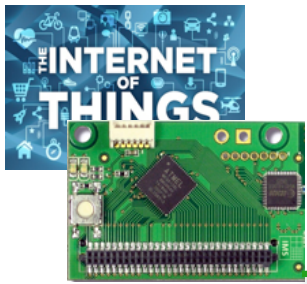


TEMPLATES FOR VARIOUS CLOUDS



And much more: HTTP, FTP, MQTT, Node-Red...





THE WAZIUP CLOUD PLATFORM

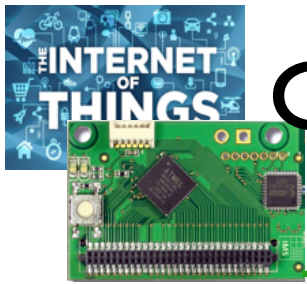


☐ dashboard.waziup.io

The screenshot displays the WAZIUP dashboard interface. The main content area is titled "Domain waziup-UPPA-TESTS2" and lists three sensor nodes:

- Node UPPA Sensor 6**: Shows a green card with a "Temperature" gauge reading 17.21 °C.
- Node (UPPA_Sensor3)**: Shows a green card with a "(TC)" gauge reading 21.43.
- Node (UPPA_Sensor10)**: Shows a red card with a "(TC)" gauge reading 23.97.

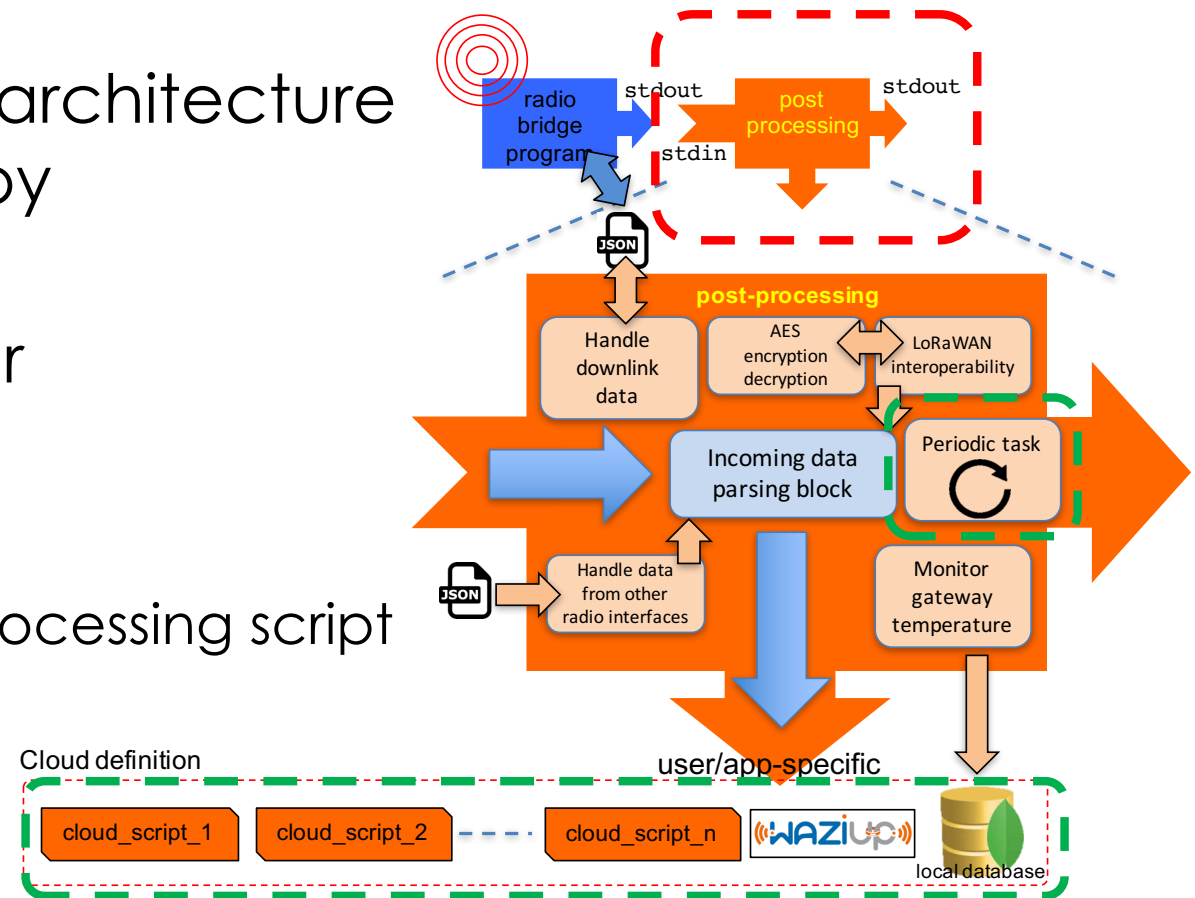
A detailed view of "UPPA Sensor 6" is shown on the right, featuring a "Temperature" gauge reading 17.21 °C, a small line graph, and a "Location" map of France with a "CHANGE..." button. The browser address bar shows "dev.waziup.io:3000/sensors".

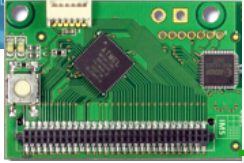


CUSTOMIZING/EXTENDING YOUR GATEWAY



- ❑ The flexible gateway architecture offers high versatility by customization
- ❑ There are 3 options for customization
- ❑ **The geek way**
 - ❑ Modify/extend post-processing script
- ❑ **The "smarter" way**
 - ❑ Add "cloud" scripts
 - On packet reception
 - ❑ Add periodic tasks
 - Independant from packet reception





WRITE YOUR OWN CLOUD SCRIPT



- ❑ Use our templates to write your own cloud script
- ❑ A cloud script is called with 5 arguments
 - ldata: the received data
 - e.g. #4#TC/21.5 as 1st argument (sys.argv[1] in python)
 - pdata: packet information
 - e.g. “1,16,3,0,10,8,-45” as 2nd argument (sys.argv[2] in python)
 - interpreted as dst,ptype,src,seq,len,SNR,RSSI for the last received packet
 - rdata: the LoRa radio information
 - e.g. “500,5,12” as 3rd argument (sys.argv[3] in python)
 - interpreted as bw,cr,sf for the last received packet
 - tdata: the timestamp information
 - e.g. “2016-10-04T02:03:28.783385” as 4th argument (sys.argv[4] in python)
 - gwid: the gateway id
 - e.g. 00000027EBBEDA21 as 5th argument (sys.argv[5] in python)

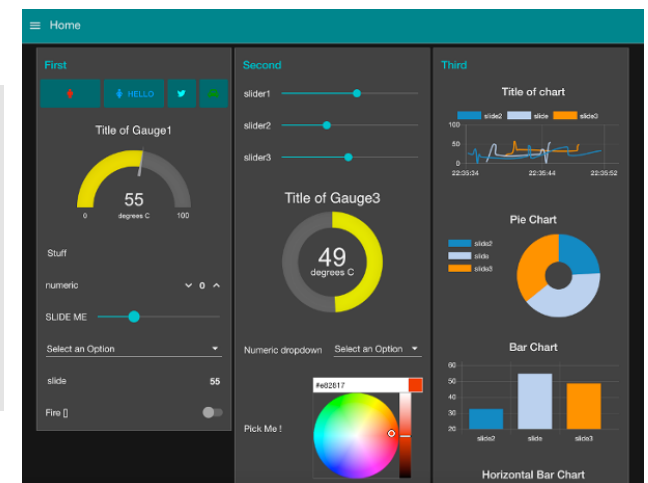
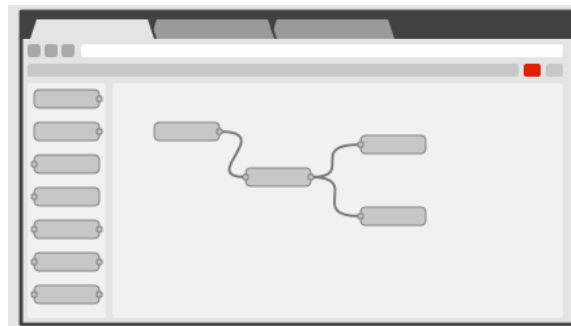
These parameters are passed to the script. It is up to the cloud script to use these parameters or not.



ADDING NODE-RED



- Node-RED is a programming tool for wiring together hardware devices, APIs and online services, e.g. clouds of various types
- provides a browser-based flow editor to wire together flows with a wide range of nodes

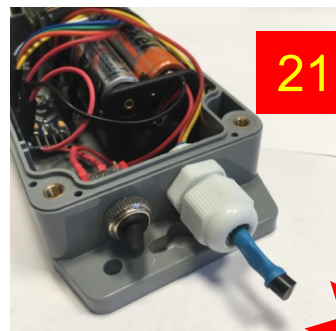




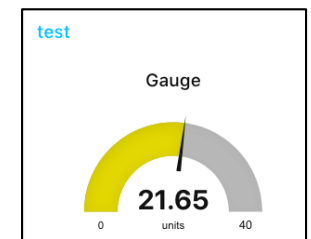
THE NODE-RED ENABLED GATEWAY



- Messages received on the gateway can be injected into a Node-Red flow, allowing complex data processing to be defined

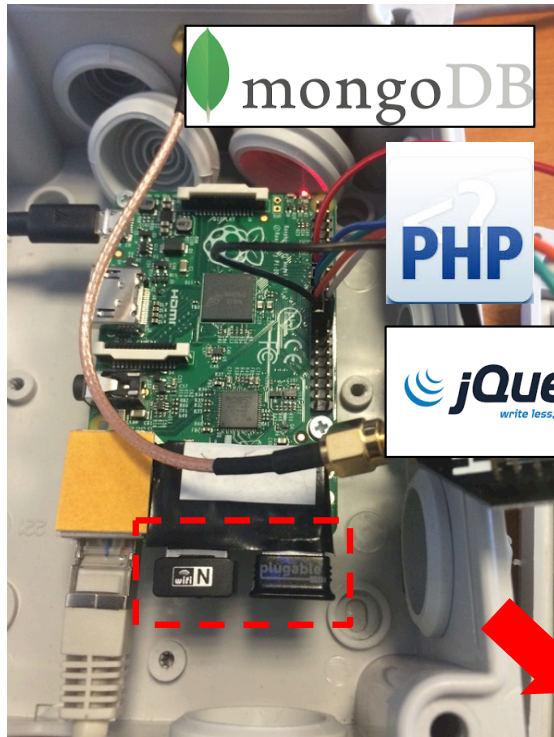


21.65





STANDALONE GATEWAY



mongoDB



PHP

jQuery
write less, do more.



Access to the data from MongoDB

export data to csv

Display the 10 last document(s)

Sort by date

Valid

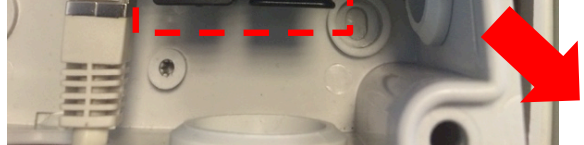
2016-12-15 15:47:58
2016-12-15 15:41:29
2016-12-15 15:36:24
2016-12-15 15:28:32
2016-12-15 15:24:50
2016-12-15 15:13:26
2016-12-15 15:03:38
2016-12-15 15:01:52
2016-12-15 14:56:37
2016-12-15 14:51:40

Display data: RSSI TC DEF

Display sources: node_3 node_6 node_10

Zoom to: Whole period Last month Current month Last seven days

Current day



Isolated areas



Orange F

Bluetooth_raspi

```

NODE: 1 DATE: 2016-05-09 08:04:59.807000 DATA: {"lw": 3.29, "th": 22.6, "hu": 50.7}
NODE: 1 DATE: 2016-05-09 08:28:52.993000 DATA: {"lw": 3.29, "th": 22.89, "hu": 50.29}
NODE: 1 DATE: 2016-05-09 08:53:04.317000 DATA: {"lw": 3.29, "th": 23.2, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 09:05:00.997000 DATA: {"lw": 3.29, "th": 23.29, "hu": 51.29}
NODE: 1 DATE: 2016-05-09 09:17:24.482000 DATA: {"lw": 3.29, "th": 23.39, "hu": 51.7}
NODE: 1 DATE: 2016-05-09 09:41:27.437000 DATA: {"lw": 3.29, "th": 23.6, "hu": 52.0}
NODE: 1 DATE: 2016-05-09 10:05:39.032000 DATA: {"lw": 3.29, "th": 23.79, "hu": 51.5}
NODE: 1 DATE: 2016-05-09 10:17:45.186000 DATA: {"lw": 3.29, "th": 23.79, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 10:29:24.285000 DATA: {"lw": 3.29, "th": 23.79, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 10:53:09.347000 DATA: {"lw": 3.29, "th": 23.79, "hu": 51.9}
NODE: 1 DATE: 2016-05-09 11:17:02.953000 DATA: {"lw": 3.29, "th": 23.5, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 11:52:53.334000 DATA: {"lw": 3.29, "th": 23.29, "hu": 50.7}
NODE: 1 DATE: 2016-05-09 12:04:32.437000 DATA: {"lw": 3.29, "th": 23.5, "hu": 50.29}
NODE: 1 DATE: 2016-05-09 12:16:56.116000 DATA: {"lw": 3.29, "th": 23.6, "hu": 50.29}

```

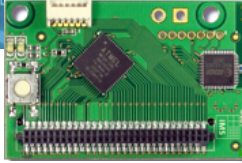
Display data

Retrieve data in a csv file

Search your device.

List of devices

2 6 16 17 18 19 254 124 10



TUTORIALS/RESOURCES



<https://github.com/CongducPham/tutorials>

WAZIUP
 101 823200 grant agreement number 887167

Low-cost LoRa IoT devices and gateway FAQ

1) **What is Internet-of-Thing (IoT)?**
 From IERC (European Research Cluster on the Internet of Things)
 The IERC definition states that IoT is "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network."
 From <http://www.gartner.com/it-glossary/internet-of-things/>
 "The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment."
 From <http://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT>
 "The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction."

2) **What is WAZIUP?**
 The EU H2020 WAZIUP project, namely the Open Innovation Platform for IoT-Big Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP operates by involving farmers and breeders in order to define the platform specifications in focused validation cases. Second, while tackling challenges which are specific to the rural ecosystem, it also engages the flourishing ICT ecosystem in those countries by fostering new tools and good practices, entrepreneurship and start-ups. Aimed at boosting the ICT sector, WAZIUP proposes solutions aiming at long term sustainability.
 WAZIUP will deliver a communication and big data application platform and generate locally the know-how by training by use cases and examples. The use of standards will help to create an interoperable platform, fully open source, oriented to radically new paradigms for innovative applications/services delivery. WAZIUP is driven by the following visions:
 1. Empower the African rural
 empower the African rural of rapid urbanization and support the necessary breeding on a new scale

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TUTORIAL ON HARDWARE & SOFTWARE FOR LOW-COST LONG-RANGE IOT

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LOW-COST LORA IOT DEVICE: SUPPORTED PHYSICAL SENSORS

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LOW-COST LORA GATEWAY: A STEP-BY-STEP TUTORIAL

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LOW-COST LORA IOT: USING THE WAZIUP DEMO KIT

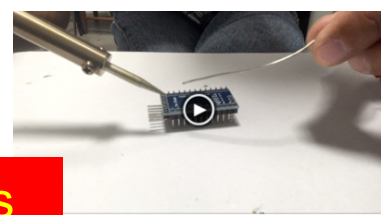
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Low-cost IoT device



+64000 views

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Low-cost IoT gateway



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Thanks.
Let's keep in touch



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