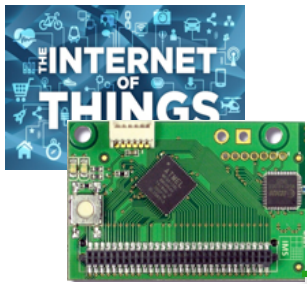


# DEPLOYING LOW-COST AND LONG-RANGE INTERNET OF THINGS IN DEVELOPING COUNTRIES



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





# IOT FOR DEVELOPMENT



Irrigation



Livestock farming



Fish farming & aquaculture



Storage & logistic

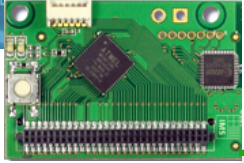


Agriculture



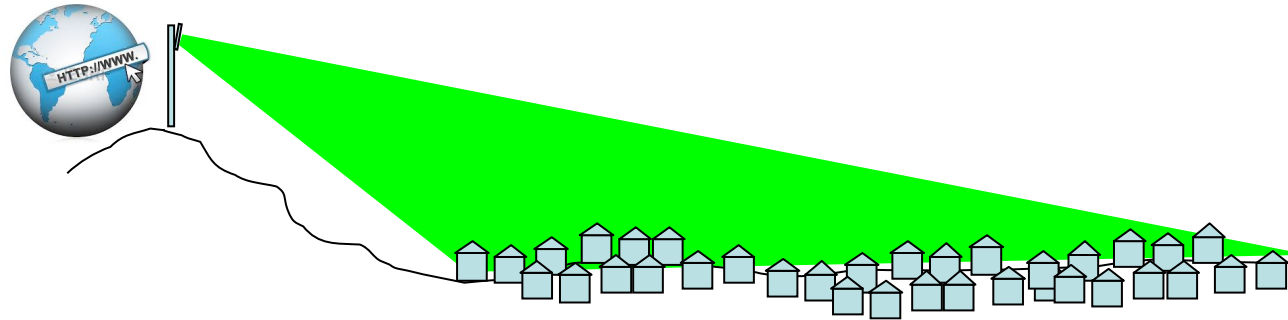
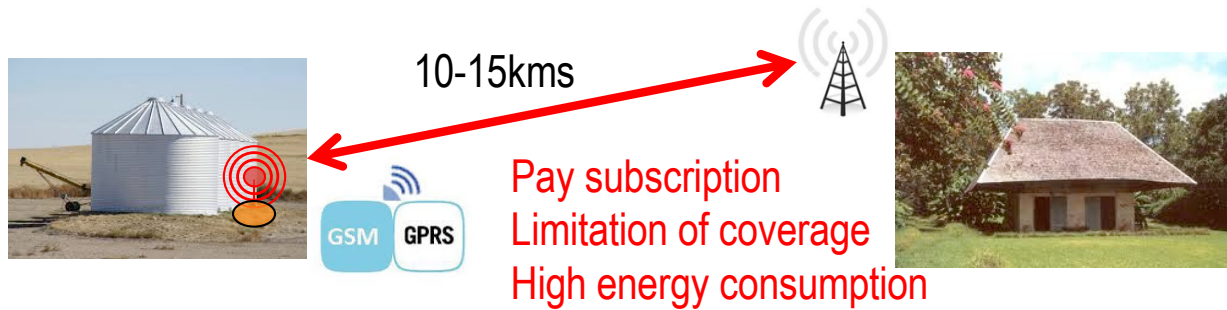
Fresh water



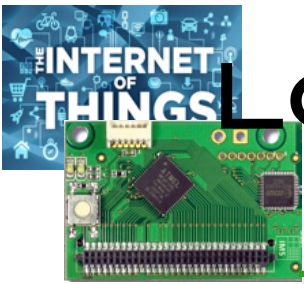


# LONG-RANGE SENSING

Moisture/  
Temperature of  
storage areas



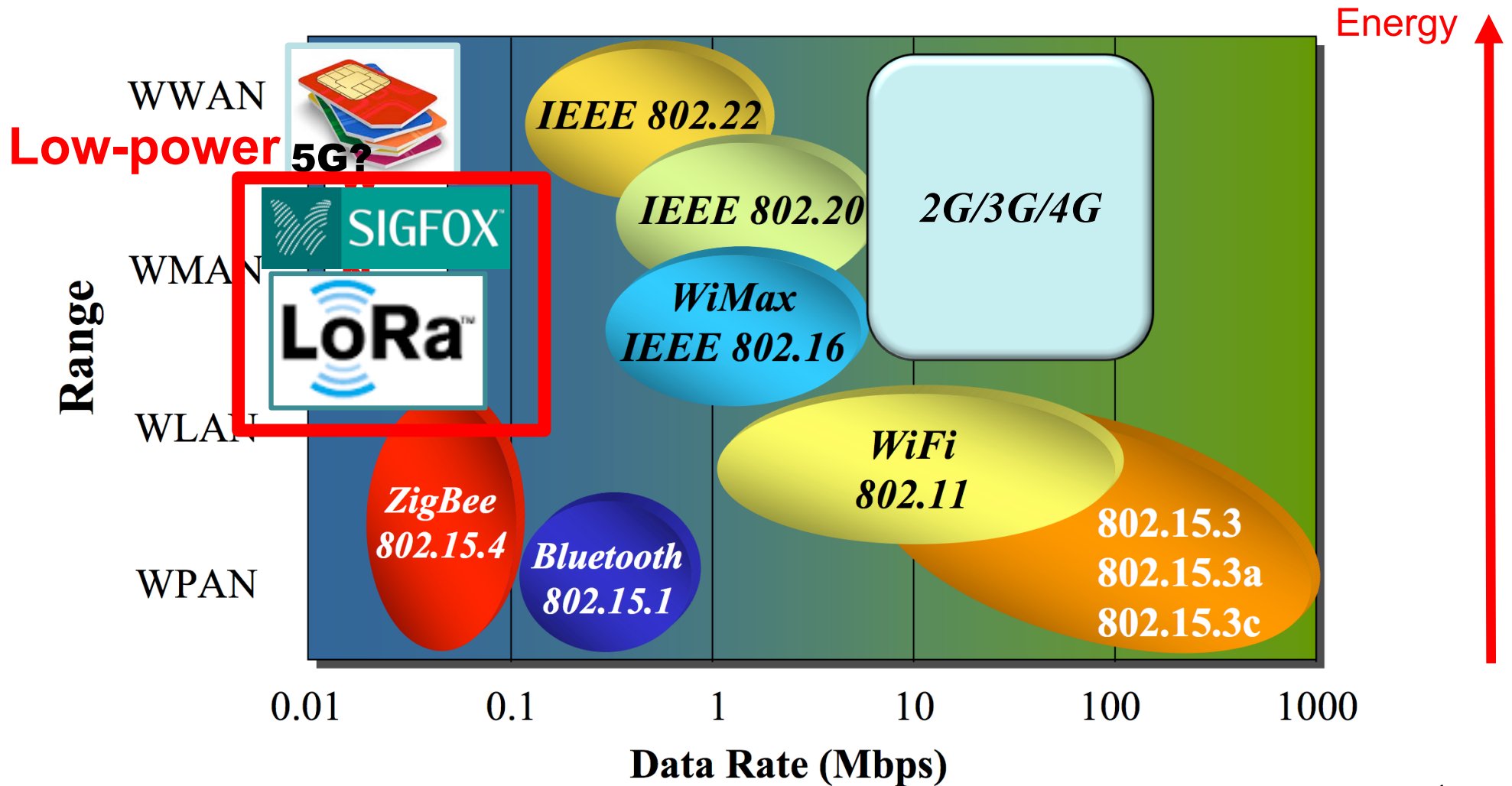
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC



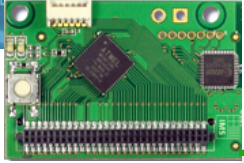
# LOW-POWER & LONG-RANGE RADIO TECHNOLOGIES



## Energy-Range dilemma

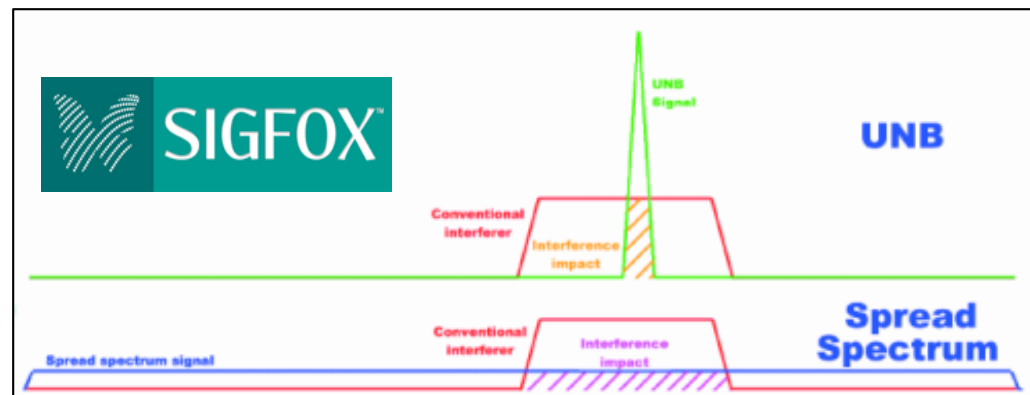
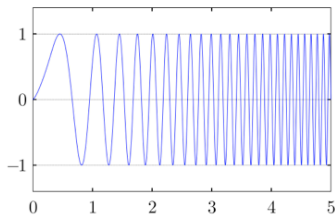


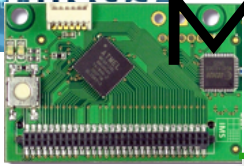




# INCREASING RANGE?

- ❑ Generally, robustness and sensitivity can be increased when **transmitting much slower**
- ❑ A Sigfox message is sent relatively slowly in an ultra narrow band of spectrum. **Max throughput= $\sim 100\text{bps}$**
- ❑ LoRa also increases time-on-air when maximum range is needed. But LoRa uses spread spectrum approach. **Throughput= $\sim 300\text{bps}-37500\text{bps}$**

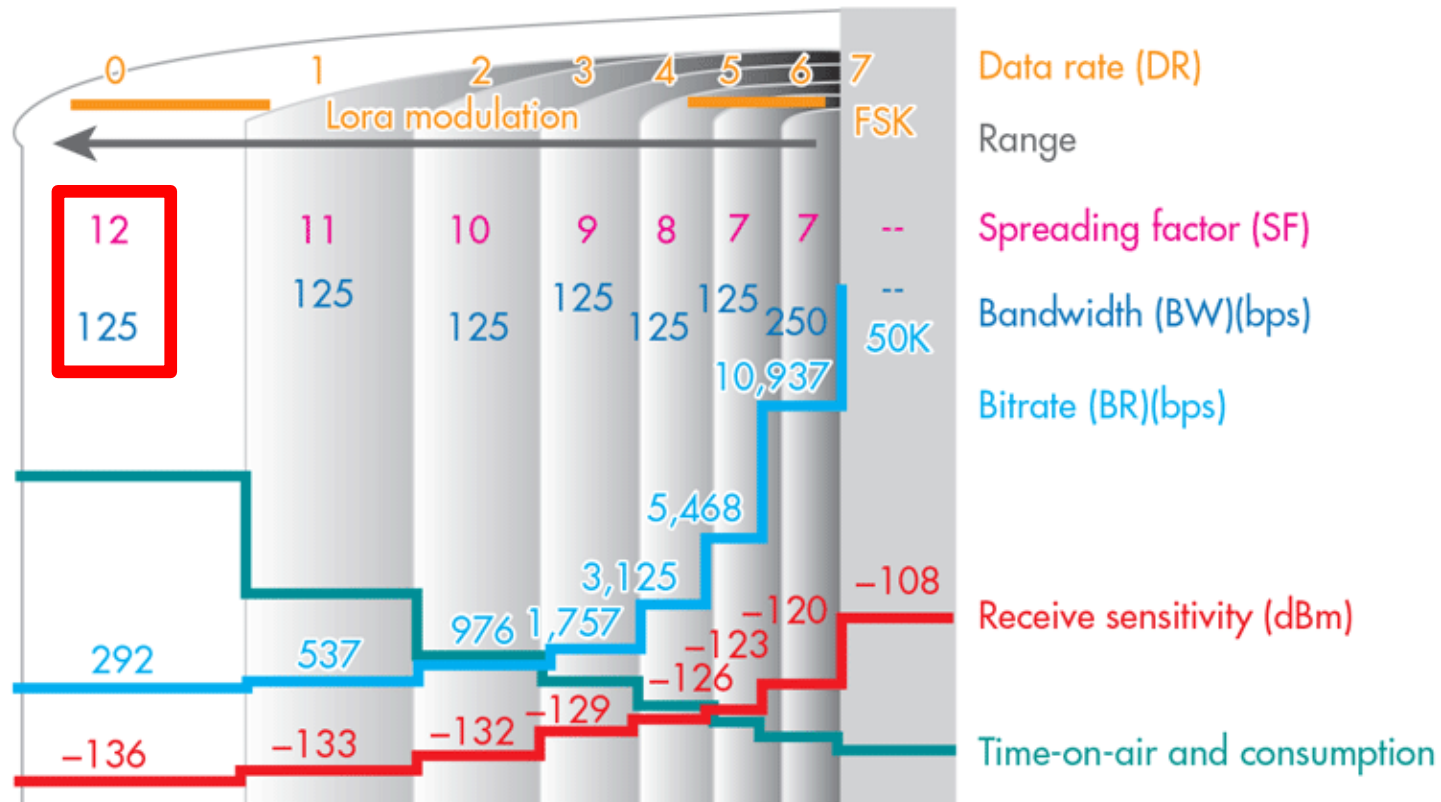




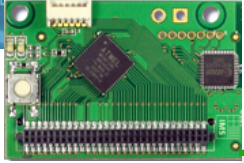
# MAIN LORA PARAMETERS

## □ Main parameters

- **Bandwidth:** 62.5kHz, 125kHz, 250kHz, 500kHz
- **Spreading factor:** 6 to 12







# LoRA DETAILS SPECS

$$R_b = SF * \frac{\text{Rate Code}}{\left[ \frac{2^{SF}}{BW} \right]} \text{ bits/sec}$$

## □ Main parameters

- **Bandwidth:** 62.5kHz, 125kHz, 250kHz, 500kHz
- **Spreading factor:** 6 to 12
- **Rate code:** 4/4+CR (CR=1, 2, 3, 4)

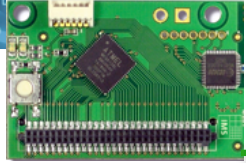
Sensitivity: lowest input power with acceptable link quality, typically 1% PER

SpreadingFactor (RegModemConfig2)	Spreading Factor (Chips / symbol)	LoRa Demodulator SNR
6	64	-5 dB
7	128	-7.5 dB
8	256	-10 dB
9	512	-12.5 dB
10	1024	-15 dB
11	2048	-17.5 dB
12	4096	-20 dB

Bandwidth (kHz)	Spreading Factor	Nominal Rb (bps)	Sensitivity (dBm)
125	6	9380	-122
125	12	293	-137
250	6	18750	-119
250	12	586	-134
500	6	37500	-116
500	12	1172	-131

**Rule of thumb**  
 6dB increase = twice the range in LOS  
 12dB needed for urban areas

Bandwidth (kHz)	Spreading Factor	Coding rate	Nominal Rb (bps)	Sensitivity (dBm)
125	12	4/5	293	-137
250	12	4/5	586	-134
500	12	4/5	1172	-131



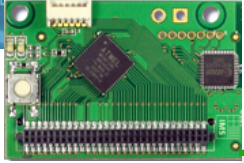
# LoRa TIME-ON-AIR



**Very low throughput**  
**Transmission time can be several seconds**

Range ↑ ↓ Throughput	time on air in second for payload size of										
	LoRa mode	BW	CR	SF	5 bytes	55 bytes	105 bytes	155 Bytes	205 Bytes	255 Bytes	max thr. for 255B in bps
	1	125	4/5	12	0.95846	2.59686	4.23526	5.87366	7.51206	9.15046	223
	2	250	4/5	12	0.47923	1.21651	1.87187	2.52723	3.26451	3.91987	520
	3	125	4/5	10	0.28058	0.69018	1.09978	1.50938	1.91898	2.32858	876
	4	500	4/5	12	0.23962	0.60826	0.93594	1.26362	1.63226	1.95994	1041
	5	250	4/5	10	0.14029	0.34509	0.54989	0.75469	0.95949	1.16429	1752
	6	500	4/5	11	0.11981	0.30413	0.50893	0.69325	0.87757	1.06189	1921
	7	250	4/5	9	0.07014	0.18278	0.29542	0.40806	0.5207	0.63334	3221
	8	500	4/5	9	0.03507	0.09139	0.14771	0.20403	0.26035	0.31667	6442
	9	500	4/5	8	0.01754	0.05082	0.08154	0.11482	0.14554	0.17882	11408
	10	500	4/5	7	0.00877	0.02797	0.04589	0.06381	0.08301	0.10093	20212





# ENERGY CONSUMPTION COMPARAISON

Tables from Semtech

Technology	2G	3G	LAN	ZigBee	Lo Power WAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m	O: 90m I: 30m	Same as 2G/3G
Tx current consumption	200-500mA	500-1000mA	100-300mA	18mA	20-40mA
Standby current	2.3mA	3.5mA	NC	0.003mA	0.001mA
Energy harvesting (solar, other)	No	No	No	Possible	Possible
Battery 2000mAh (LR6 battery)	4-8 hours(com) 36 days(idle)	2-4 hours(com) X hours(idle)	50 hours(com) X hours(idle)	60hours (com)	120 hours(com) 10 year(idle)
Module Revenue Annually	12 \$	20 \$	4 \$	\$3	3 \$

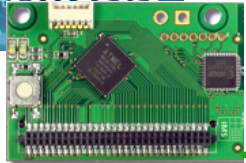
Autonomy GSM with 2000mAh -



Example for energy meter

Autonomy LP WAN with 2000mAh -

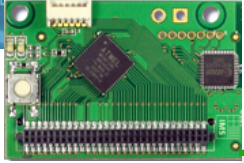




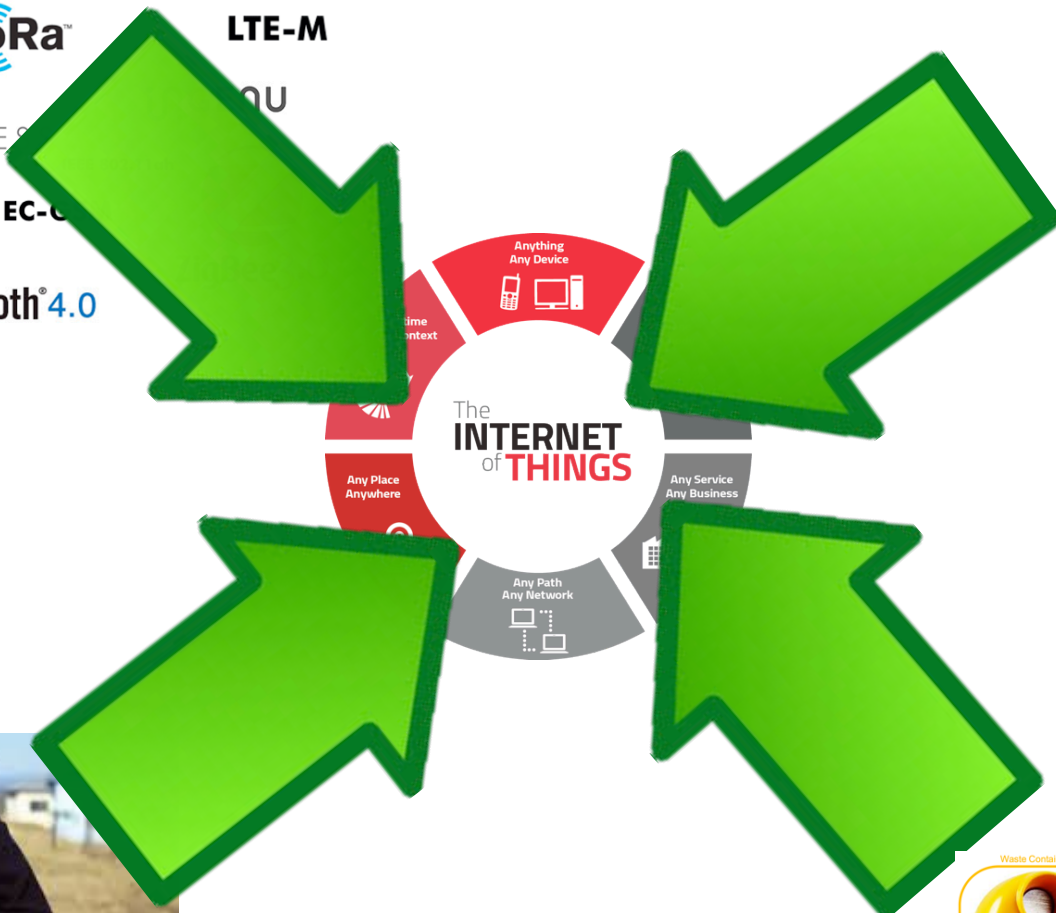
# MATURATION OF THE IOT MARKET...

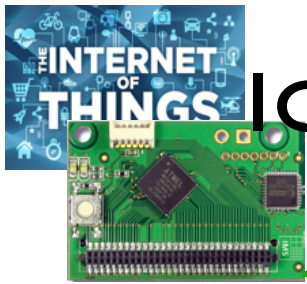






# IOT BECOMES REALITY!

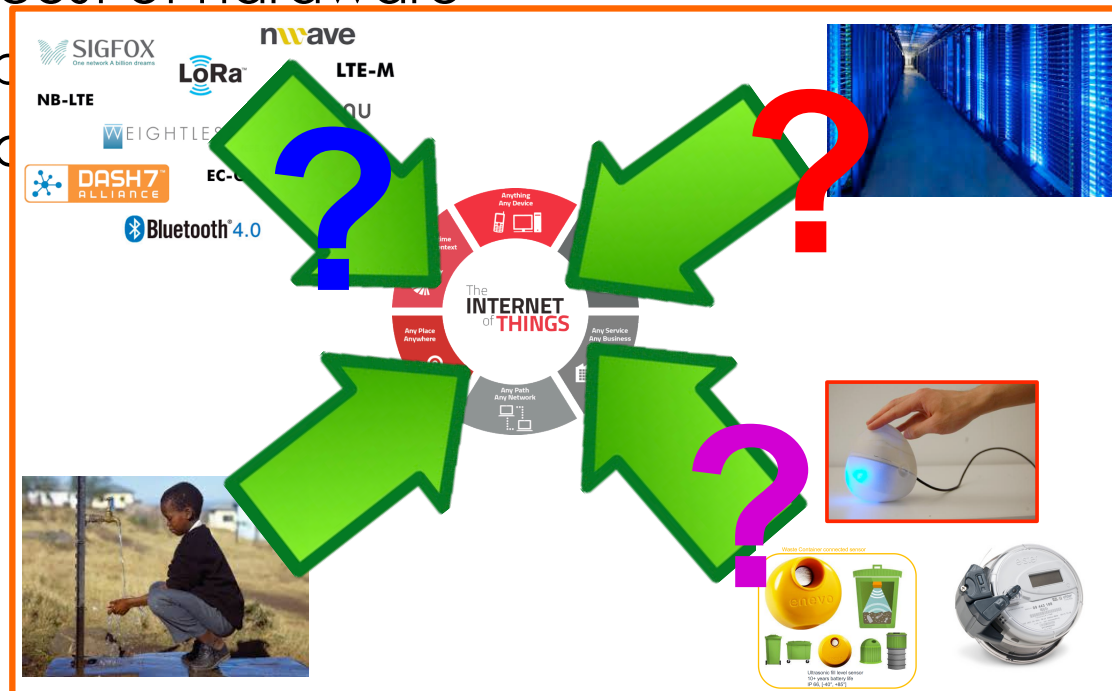


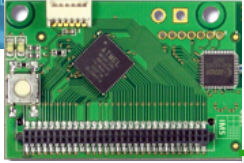


# IoT IN DEVELOPING COUNTRIES OR RURAL AREAS?

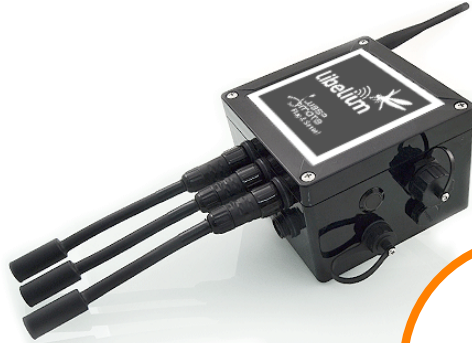


- ❑ Developing countries/rural areas are still far from being ready to enjoy the smallest benefit of IoT
  - ❑ lack of infrastructure
  - ❑ high cost of hardware
  - ❑ comp
  - ❑ lack of





# MATURATION OF THE IOT MARKET...



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

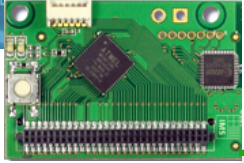
- Too expensive
- Too integrated
- Highly specialized
- Difficult to customize
- Difficult to upgrade



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

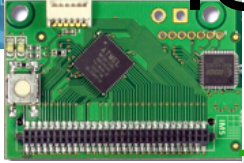
Fraud Detection

Demand/Supply Optimization

Customer Engagement

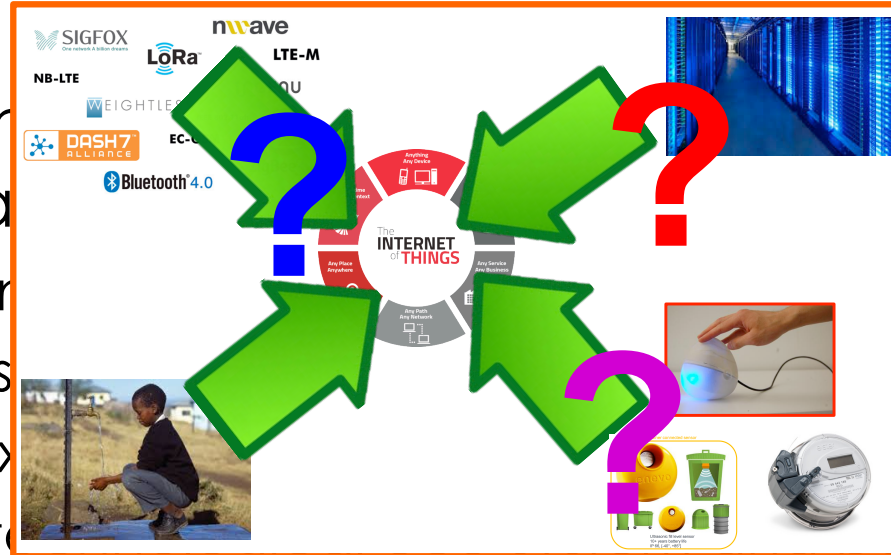
Graphics from <http://www.vitria.com/iot-analytics/>



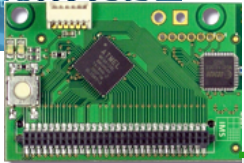


# IoT IN DEVELOPING COUNTRIES AND RURAL AREAS

- ❑ Developing IoT in rural areas is still far from being ready for the benefit of IoT
- ❑ lack of infrastructure
- ❑ high cost of services
- ❑ complex regulatory environment
- ❑ lack of technical 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

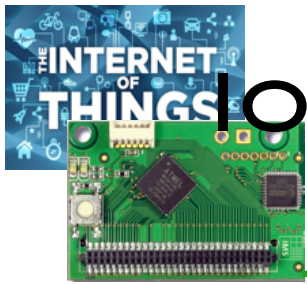


# WAZIUP: LOW-COST IOT



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

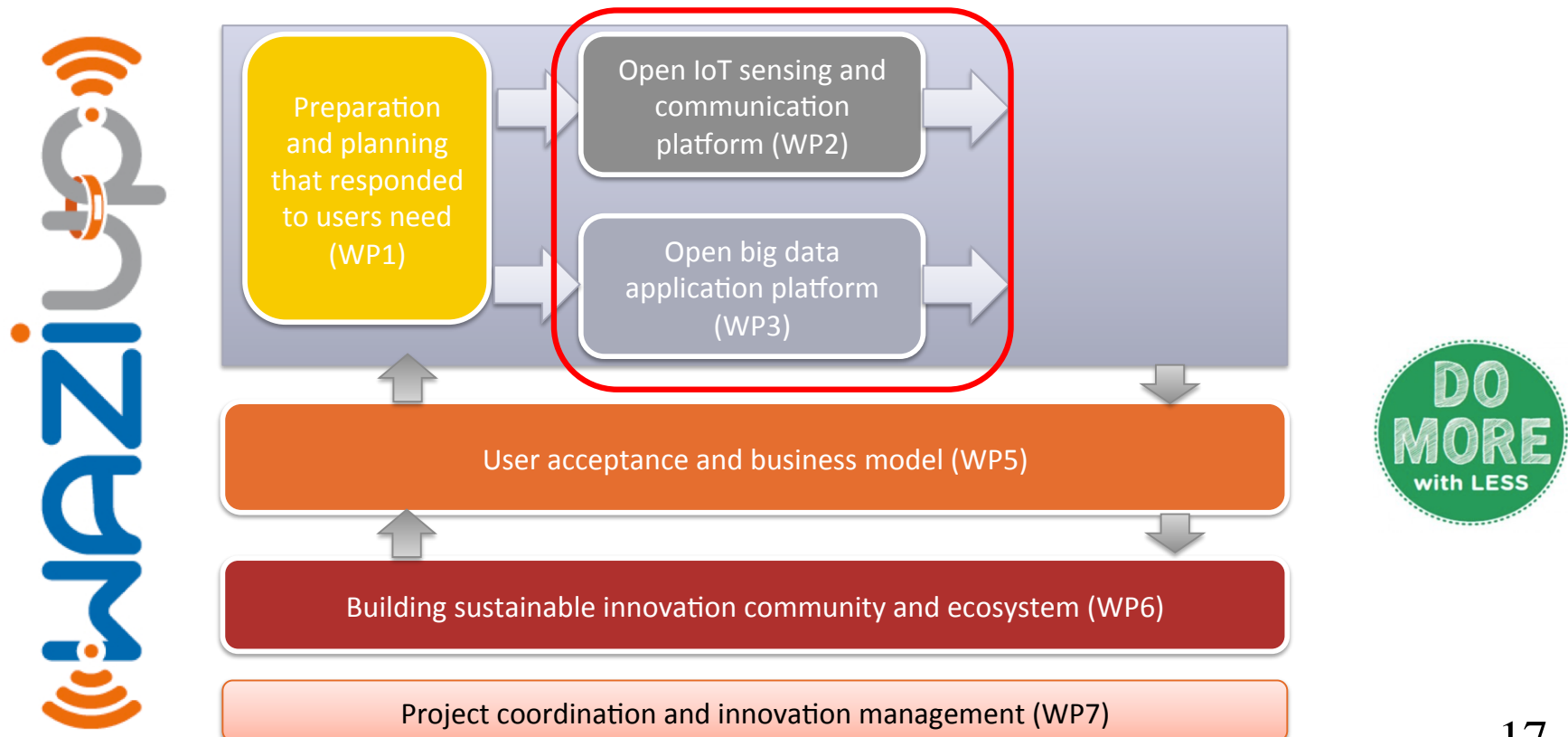
**AFFORDABLE  
TECHNOLOGIES  
TO  
EMPOWER  
RURAL ECONOMIES**



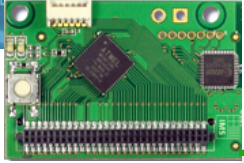
# IoT FOR RURAL APPLICATIONS IN DEVELOPPING COUNTRIES



- ❑ WAZIUP is an EU H2020 project (2016-2019)
- ❑ contributes to long-range networks for rural applications with WP2 and big data with WP3







# LOW-COST HARDWARE



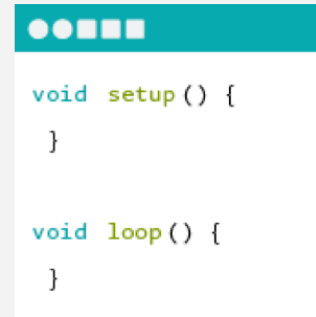
## WHAT IS ARDUINO?

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.

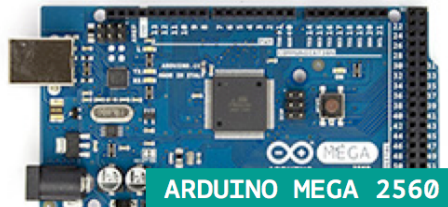


## ARDUINO SOFTWARE

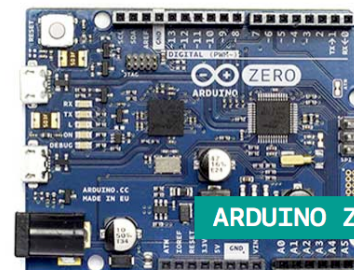
You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment.



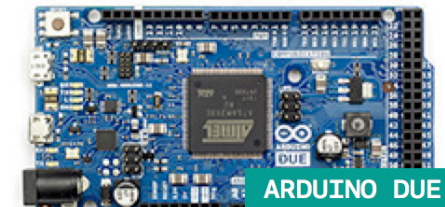
ARDUINO UNO



ARDUINO MEGA 2560



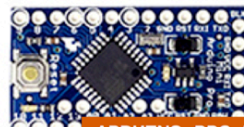
ARDUINO ZERO



ARDUINO DUE



ARDUINO MICRO

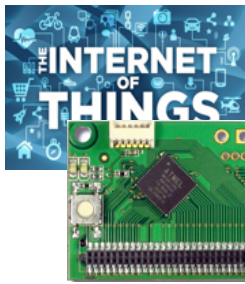


ARDUINO PRO MINI



ARDUINO NANO

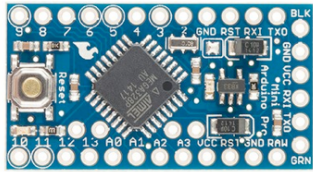




# LARGE ECOSYSTEM, STILL GROWING!



Arduino Pro Mini

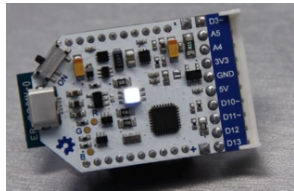


LoPy

<http://www.postscapes.com/internet-of-things-hardware/>

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

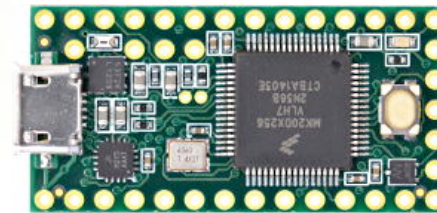
<http://blog.atmel.com/2015/04/09/25-dev-boards-to-help-you-get-started-on-your-next-iot-project/>



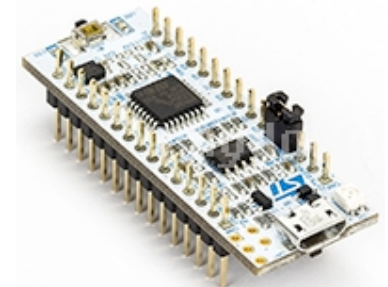
Theairboard



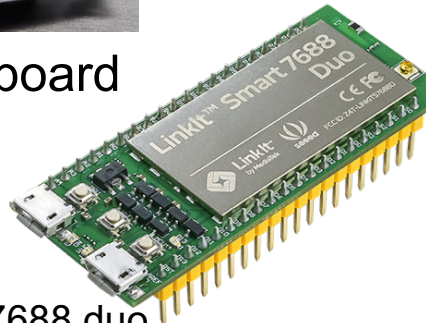
Expressif ESP32



Teensy 3.2



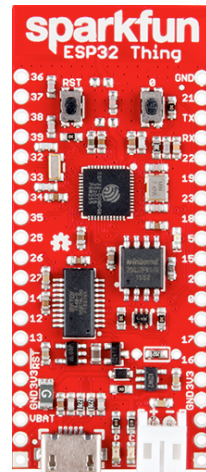
STM32 Nucleo-32



LinkIt Smart7688 duo



Adafruit Feather



Sparkfun ESP32 Thing



Tessel

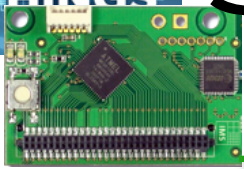
SodaqOnev2



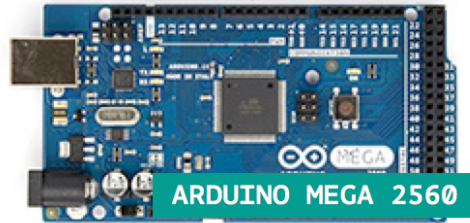
Tinyduino



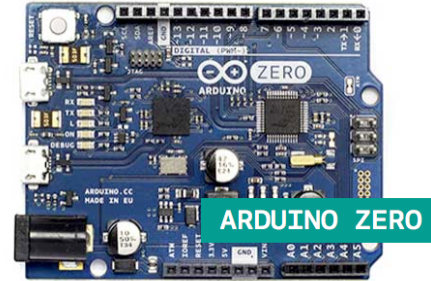
# SW/HW BUILDING BLOCKS INTEGRATION



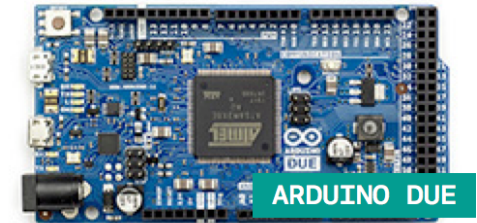
ARDUINO UNO



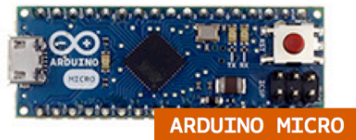
ARDUINO MEGA 2560



ARDUINO ZERO



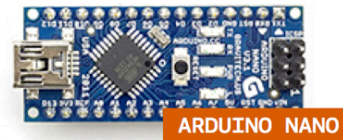
ARDUINO DUE



ARDUINO MICRO



ARDUINO PRO MINI



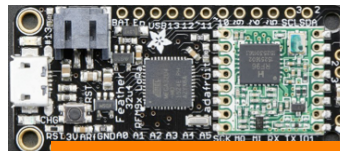
ARDUINO NANO



Ideeatron Nexus



Teensy3.1/3.2

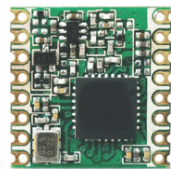


Adafruit Feather 32u4/M0

More to come...



LoRa radios that our library already supports



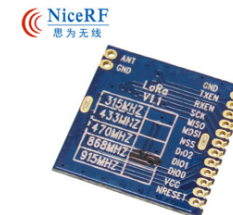
HopeRF RFM92W/95W



Libelium LoRa



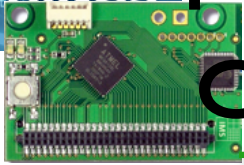
Modtronix inAir9/9B



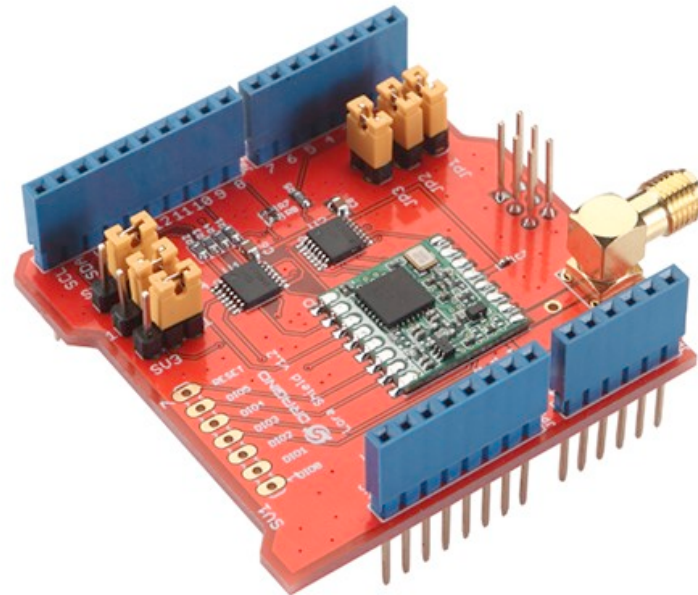
NiceRF LoRa1276

Long-Range communication library

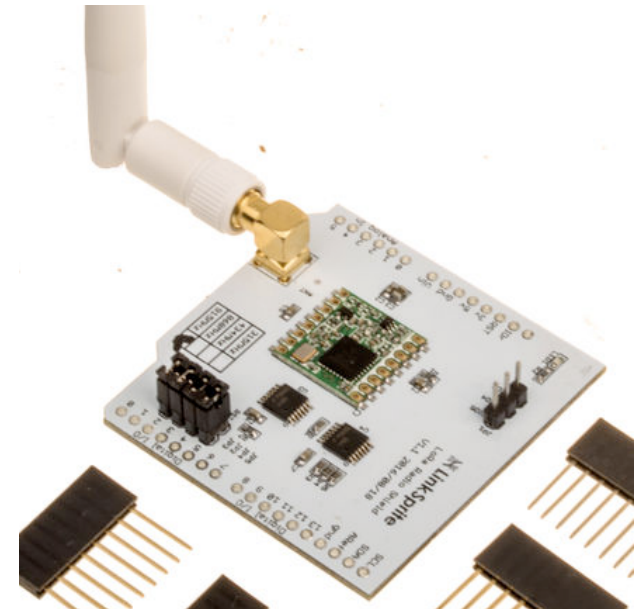
# MORE AND MORE EASY-TO-CONNECT LoRa MODULES!



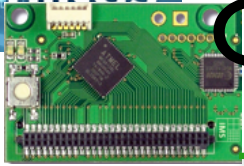
LORANGA LoRa + 2G/3G board, mainly for Raspberry Pi



Dragino LoRa shield for Arduino



LinkSprite LoRa shield for Arduino



# 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.
//
// .....
```

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

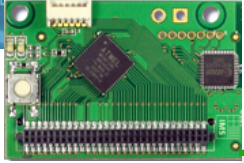
122 commits 1 branch 0 releases 2 contributors

Branch: master New pull request Find file Clone or download

File	Commit	Time 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>





# LARGE VARIETY OF EXAMPLES



CongducPham / LowCostLoRaGw

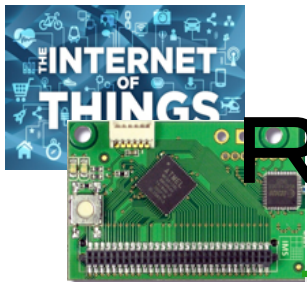
Unwatch 49 Unstar 216 Fork 120

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



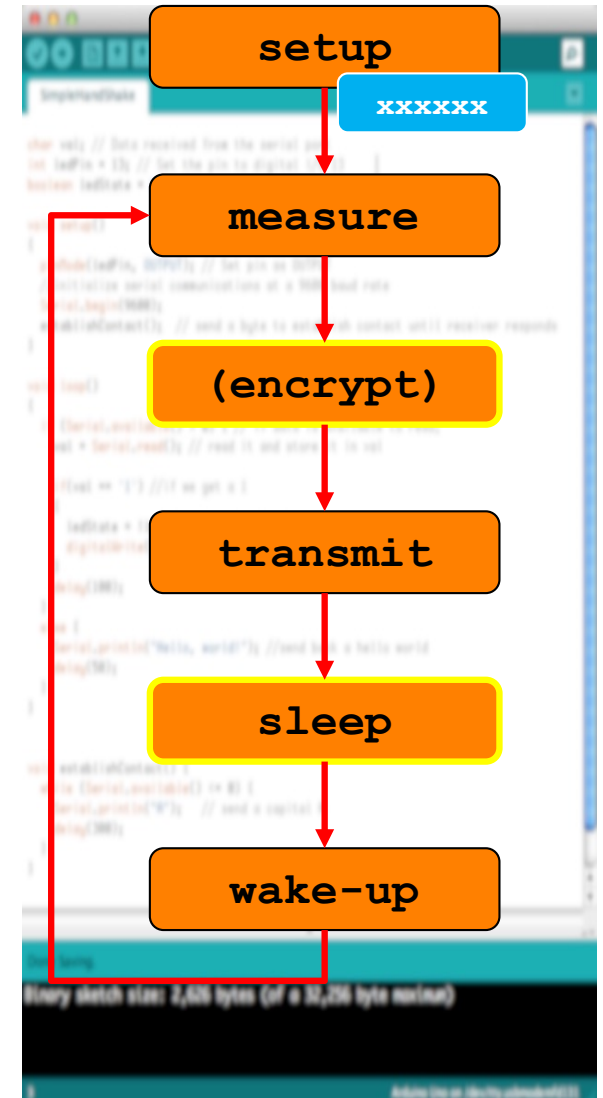
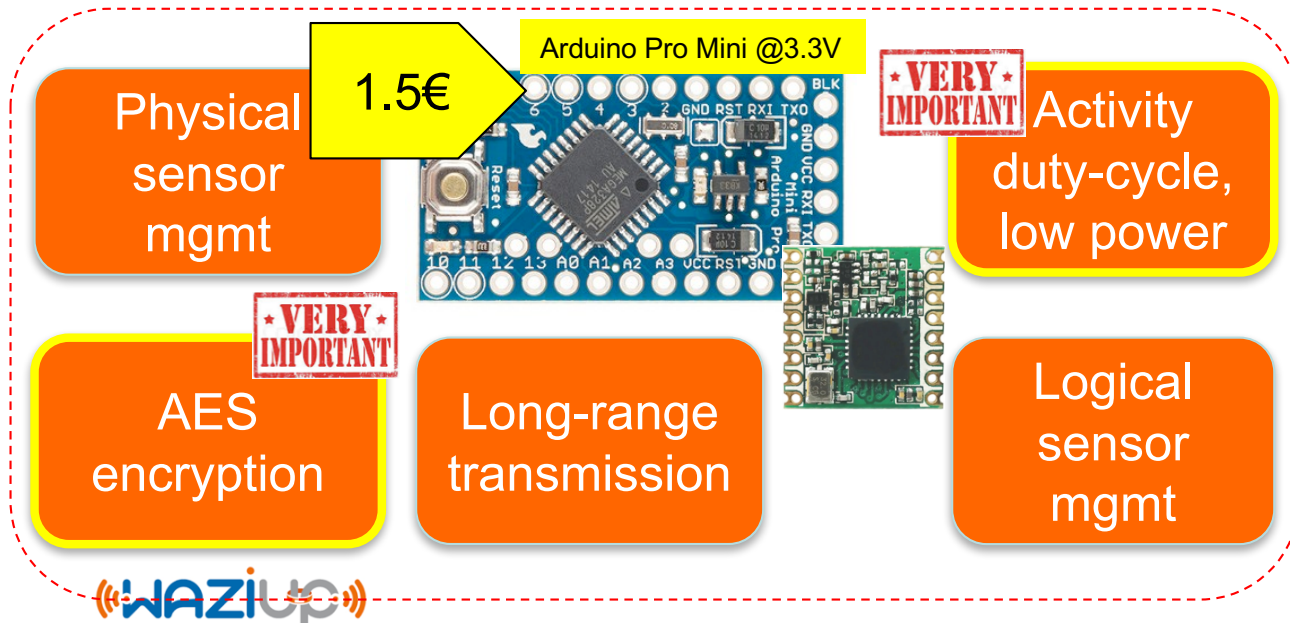
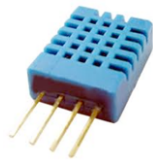
# READY-TO-USE TEMPLATES

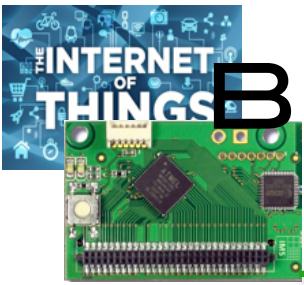


Physical sensor reading

Physical sensor reading

Physical sensor reading





# BUILD YOUR FIRST LORA IOT DEVICE

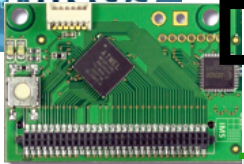


```
Arduino LoRa temp
/*
 * temperature sensor on analog 8 to t
 * Copyright (C) 2015 Congduc Pham, Un
 *
 * This program is free software: you
 * it under the terms of the GNU Gener
 * the Free Software Foundation, eithe
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with the program. If not, see <http://www.gnu.org/licenses/>.
 *
 *
 *
 *
 *
 */

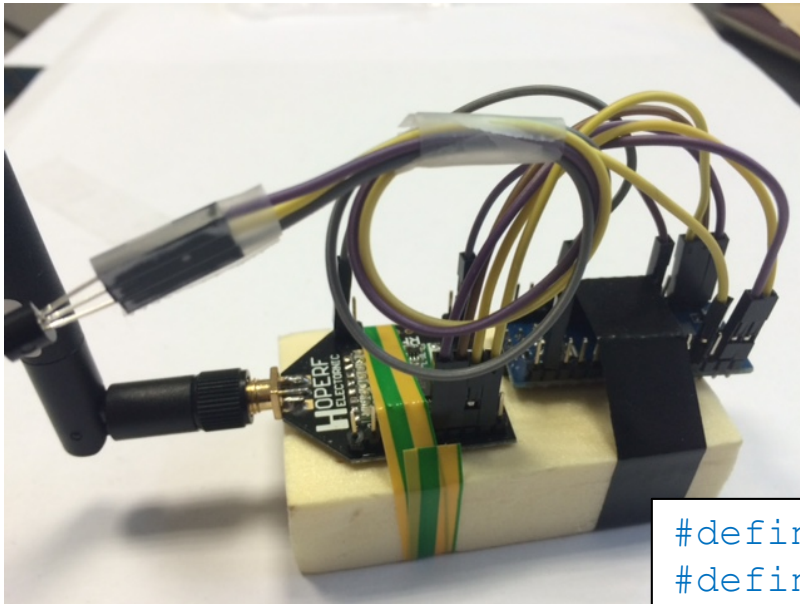
// Include the SX1272
#include "SX1272.h"

// IMPORTANT
///////////////////////////////////////
// please uncomment only 1 choice
//
```

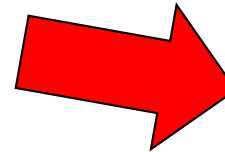
Connect the USB end to your computer and the USB port should be detected in the Arduino IDE. Select the serial port for your device. It may have another name than what is shown in the example. Then click on the « upload » button



# DEFAULT CONFIGURATION



\!TC/18.5



```
#define DEFAULT_DEST_ADDR 1
#define LORAMODE 1
#define node_addr 6
```



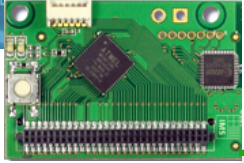
The default configuration in the Arduino\_LoRa\_Simple\_temp example is:

Send packets to the gateway (one or many if in range)

LoRa mode 1

Node short address is 6



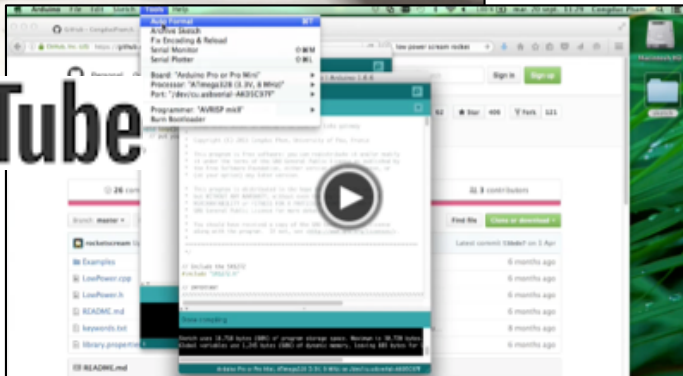
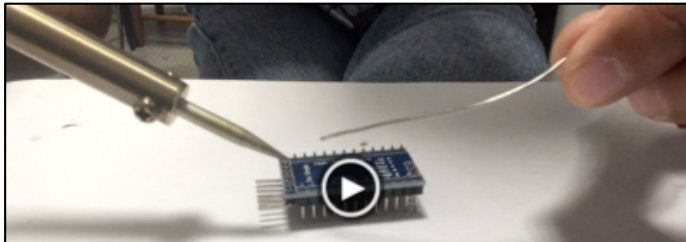


# TUTORIALS AND VIDEOS

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



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



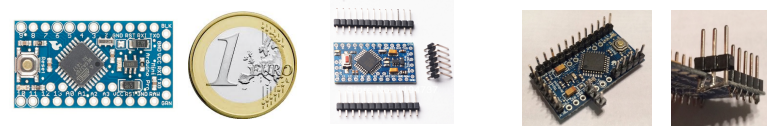
UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR  
Congduc Pham, <http://cpham.perso.univ-pau.fr>



## 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



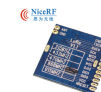
HopeRF RFM92W/95W



Libelium LoRa



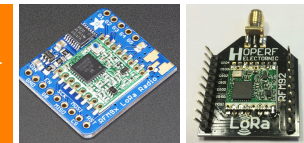
Modtronix inAir4/9/9B



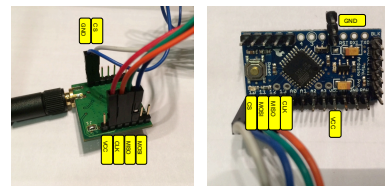
LoRa1276  
NiceRF LoRa1276

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.

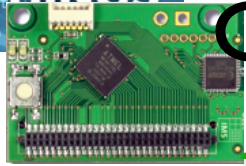
The RFM95W can be found assembled (Adafruit) or an adapter can be purchased (from Ideetron for instance).



## Connect the LoRa radio module

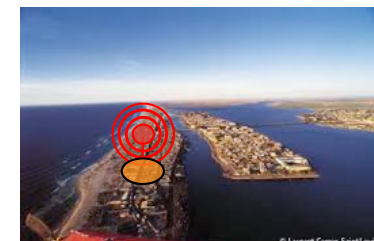
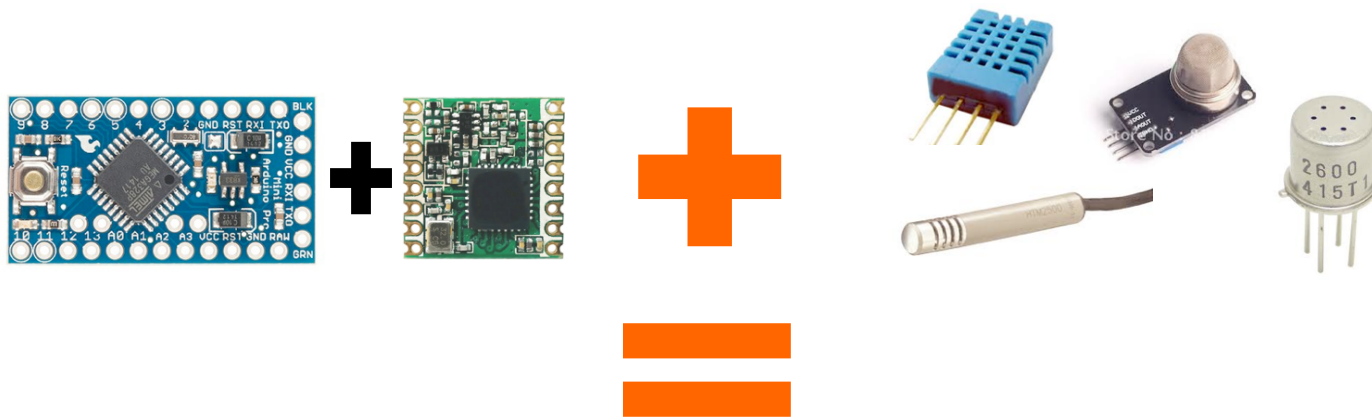


Connect the corresponding SPI pins of the radio module to the SPI pins on the Pro Mini board. MOSI (blue) is pin 11, MISO (green) is pin 12, CS (white) is pin 10 and CLK (orange) is pin 13 (right picture). Then connect also the VCC (red) and the GND (black) of the radio module to the VCC and the GND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

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

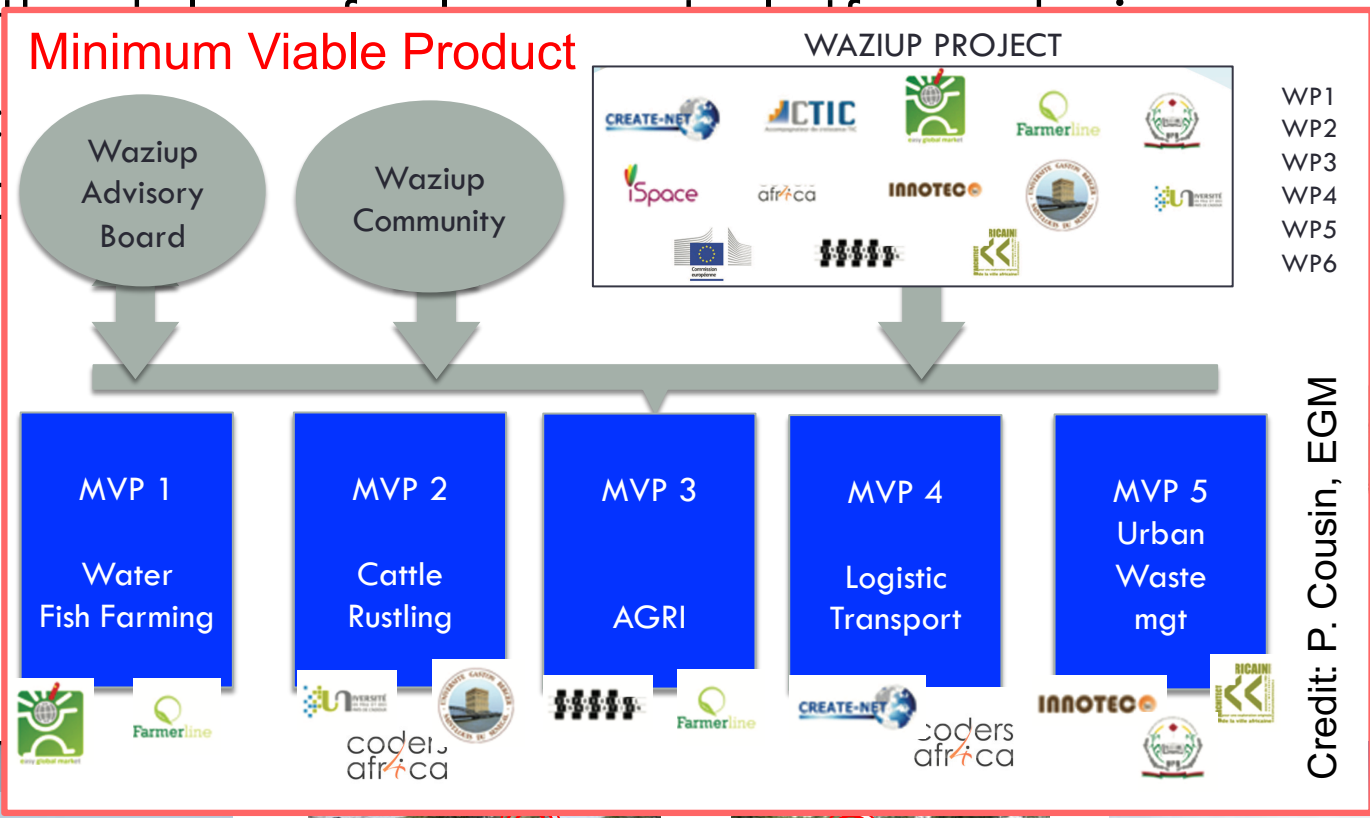




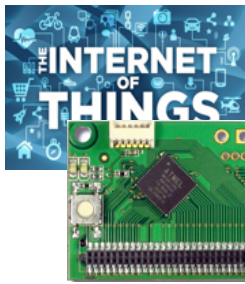
# GENERIC SENSING IOT DEVICE



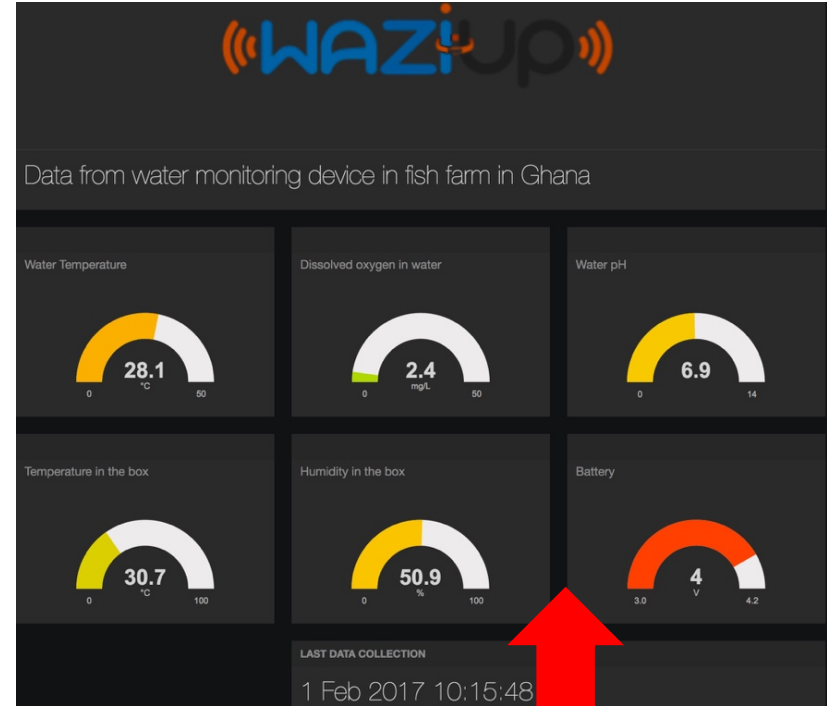
- ❑ Build low-cost, low-power, Long-range enabled generic platform
- ❑ Meet the needs of the African continent
- ❑ Technical and economic viability







# LOW-COST BUOY FOR FISH FARMING MVP



WAZIup  
Physical sensor reading

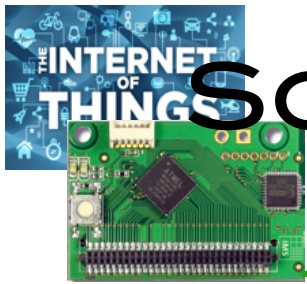
Credit: EGM



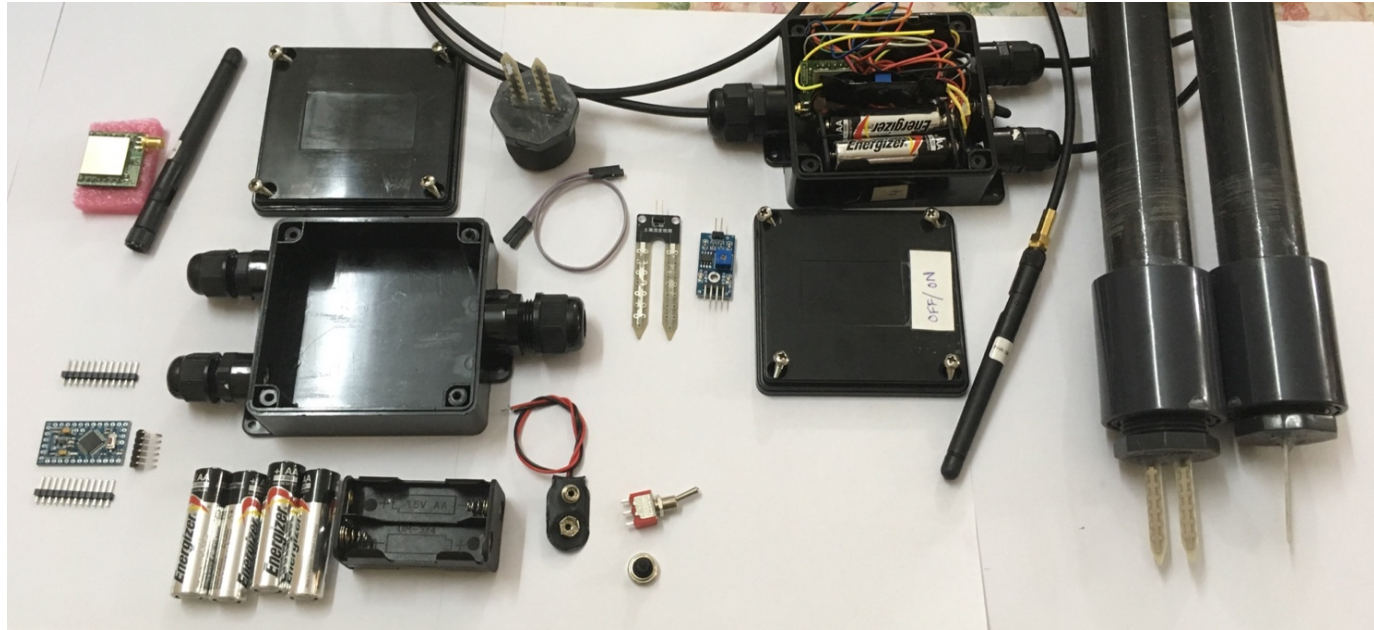
- Physical sensor management
- Activity duty-cycle, low power
- Security
- Long-range transmission
- Logical sensor management



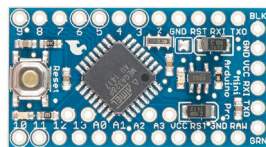




# SOIL HUMIDITY SENSORS FOR AGRI MVP



Physical sensor management



Activity duty-cycle, low power

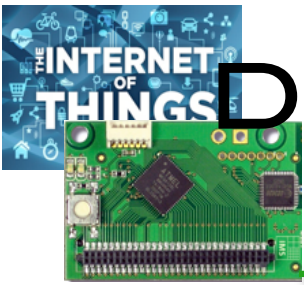
Security

Long-range transmission

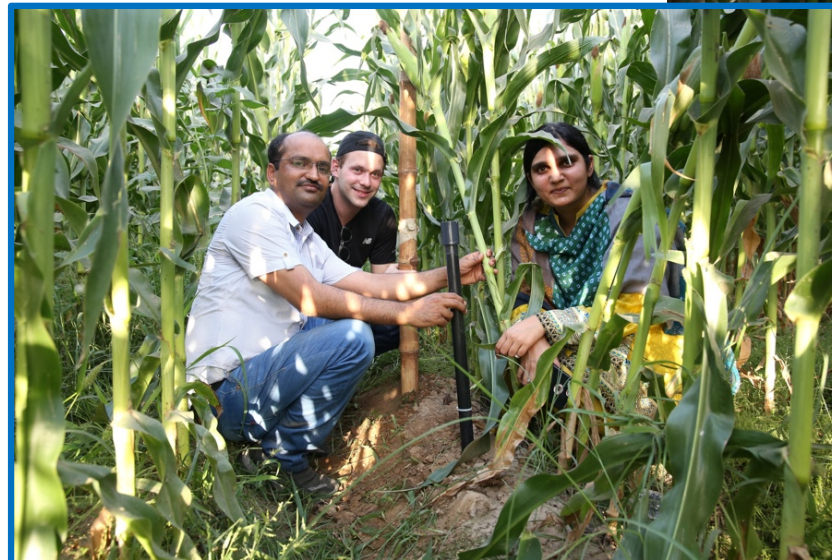
Logical sensor management



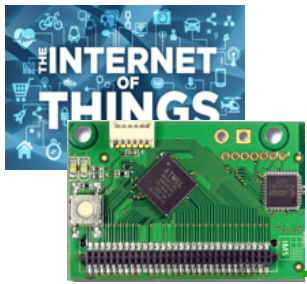




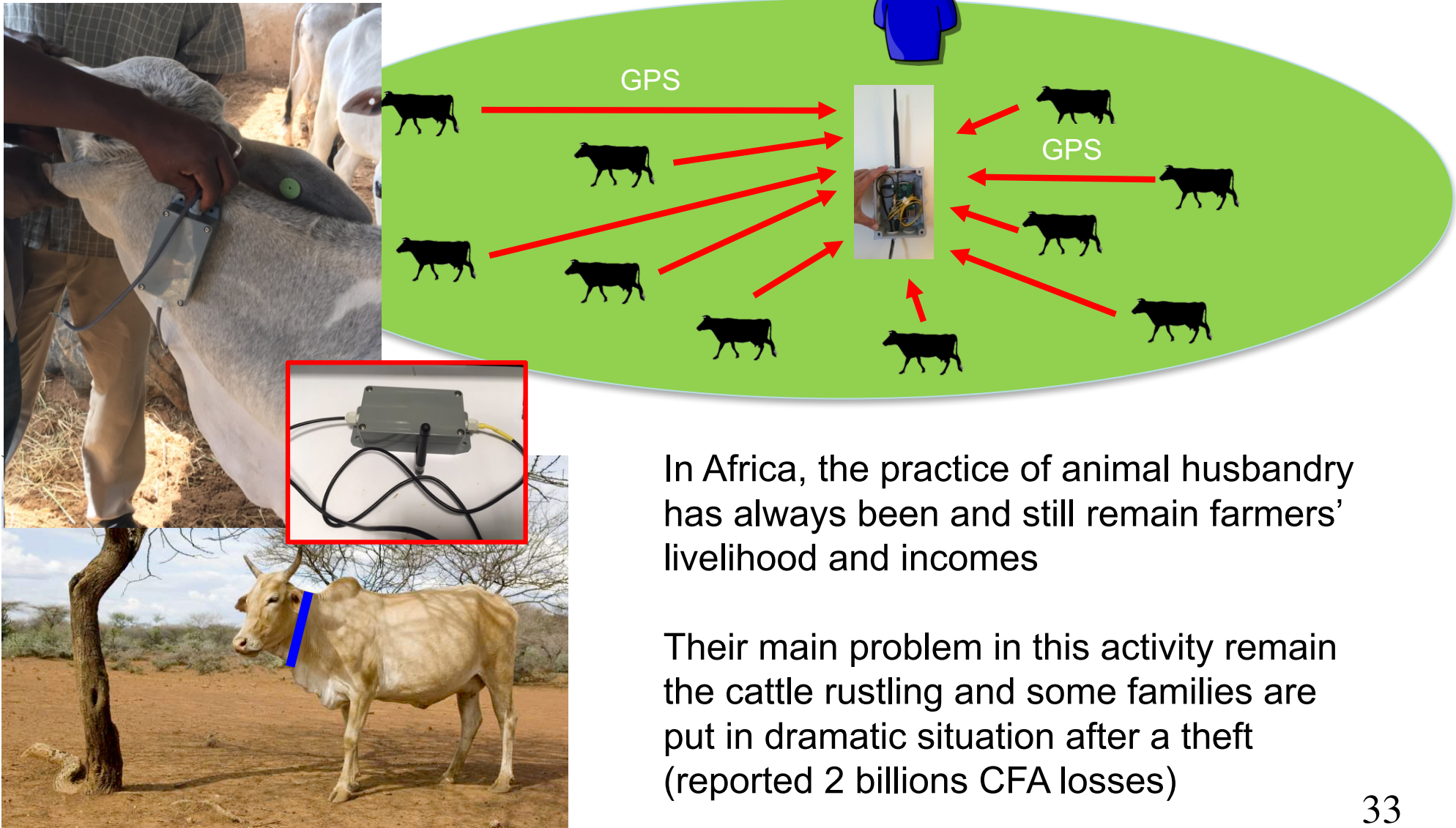
# DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT







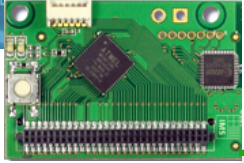
# COLLAR FOR CATTLE RUSTLING MVP



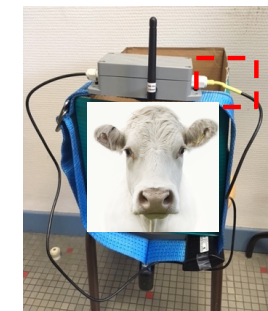
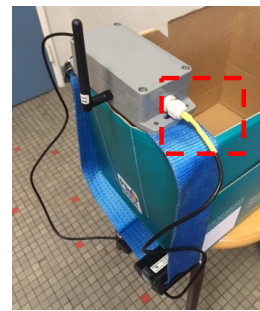
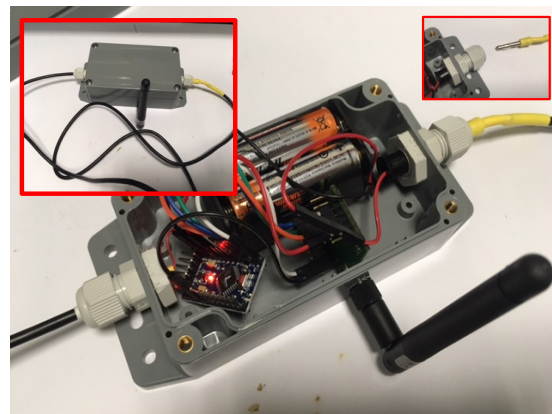
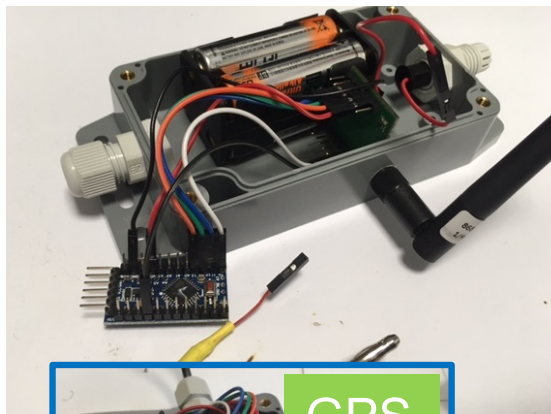
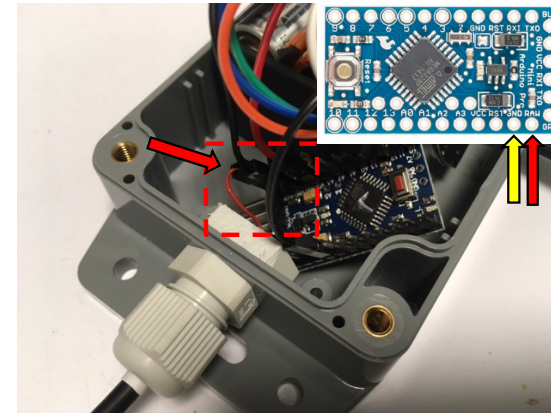
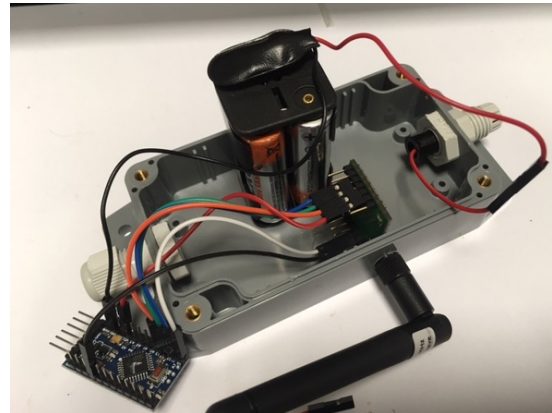
In Africa, the practice of animal husbandry has always been and still remain farmers' livelihood and incomes

Their main problem in this activity remain the cattle rustling and some families are put in dramatic situation after a theft (reported 2 billions CFA losses)

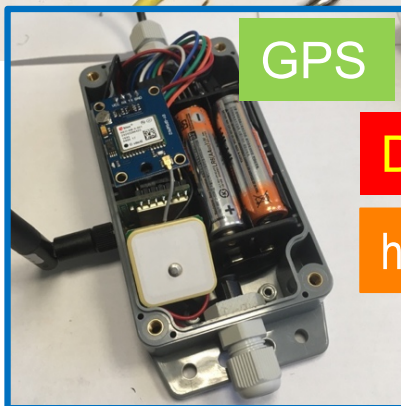




# EASY INTEGRATION AND CUSTOMIZATION

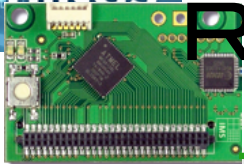


Afimilk collar courtesy of I. Andonovic from University of Strathclyde



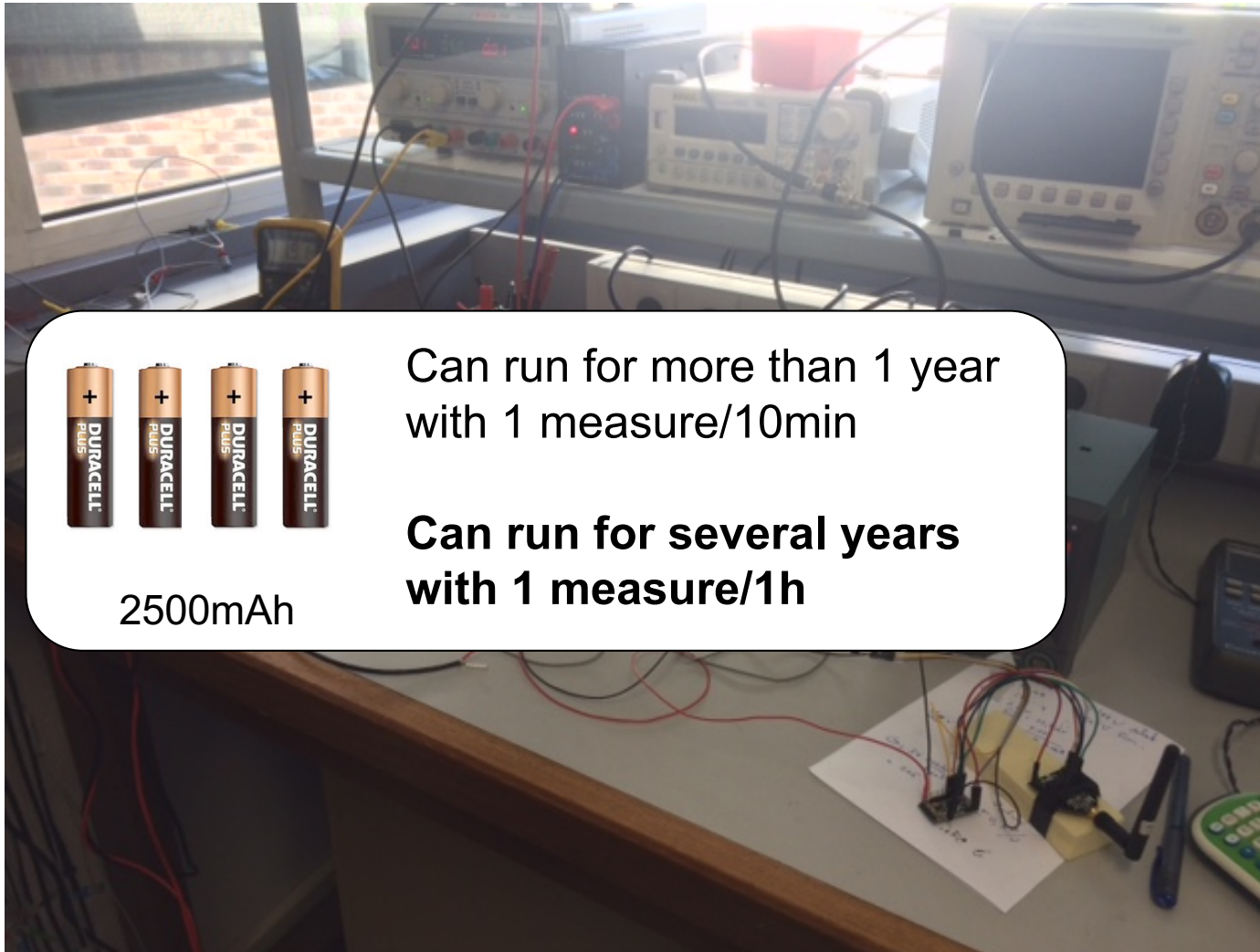
Dedicated tutorial on low-cost IoT collar w/GPS

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



# RUNNING FOR SEVERAL YEARS!

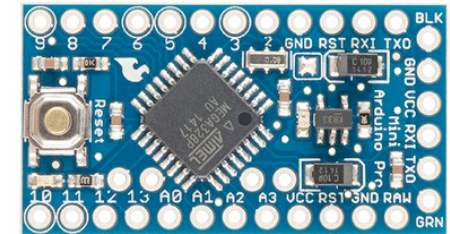
## Low-Power library from RocketScream



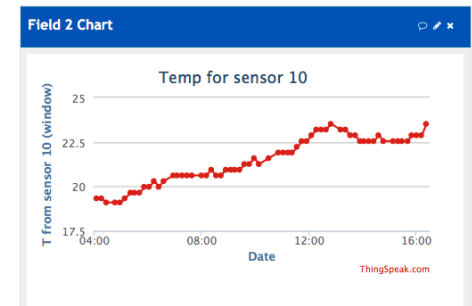
2500mAh

Can run for more than 1 year with 1 measure/10min

Can run for several years with 1 measure/1h



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



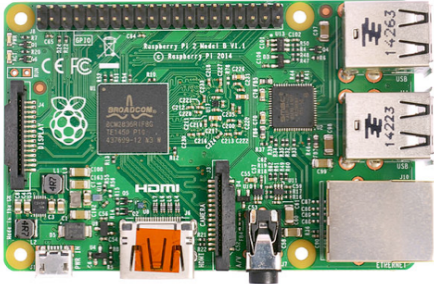
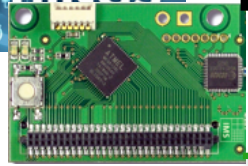
**5 $\mu$ A in deep sleep mode, about 40mA when active and sending!**

Thanks to T. Mesplou and P. Plouraboué for their help





# 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!



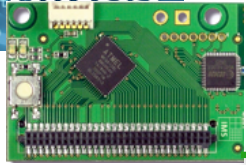
Less than 50€



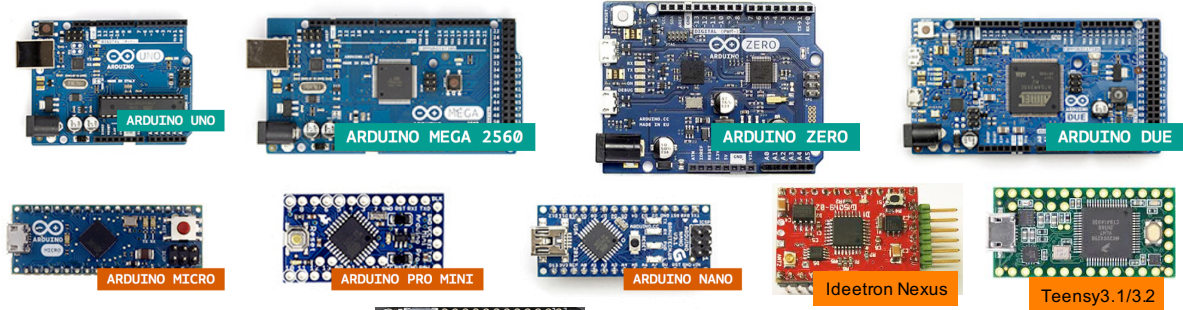
Get the ready-to-use SD card image

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





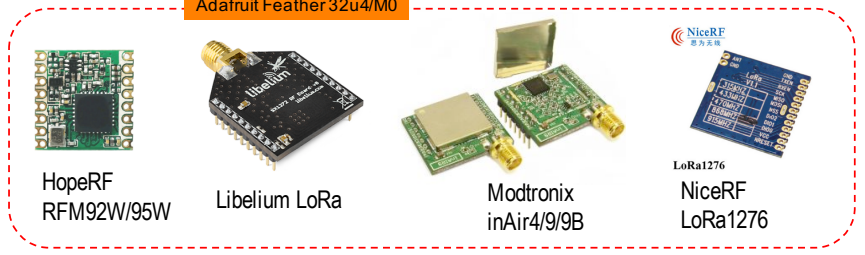
# SIMPLICITY!



More to come...



LoRa radios that our library already supports



Long-Range communication library

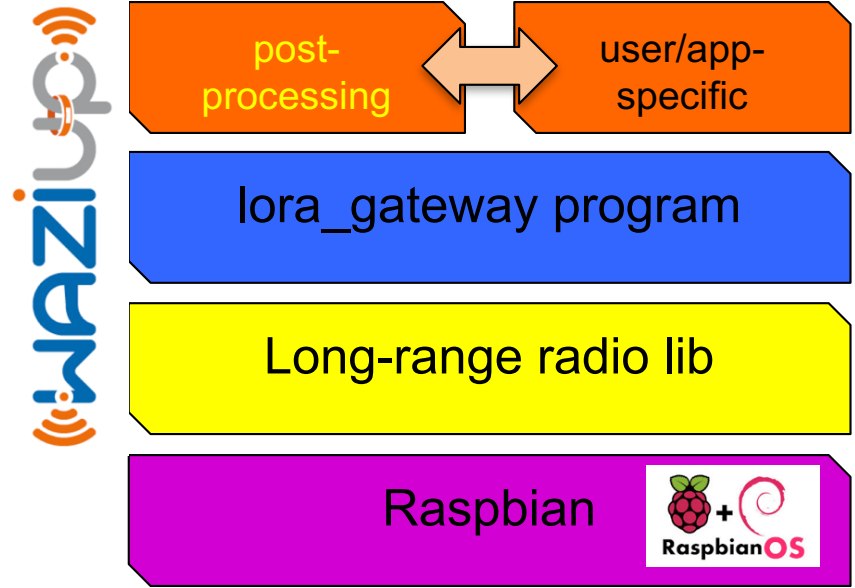
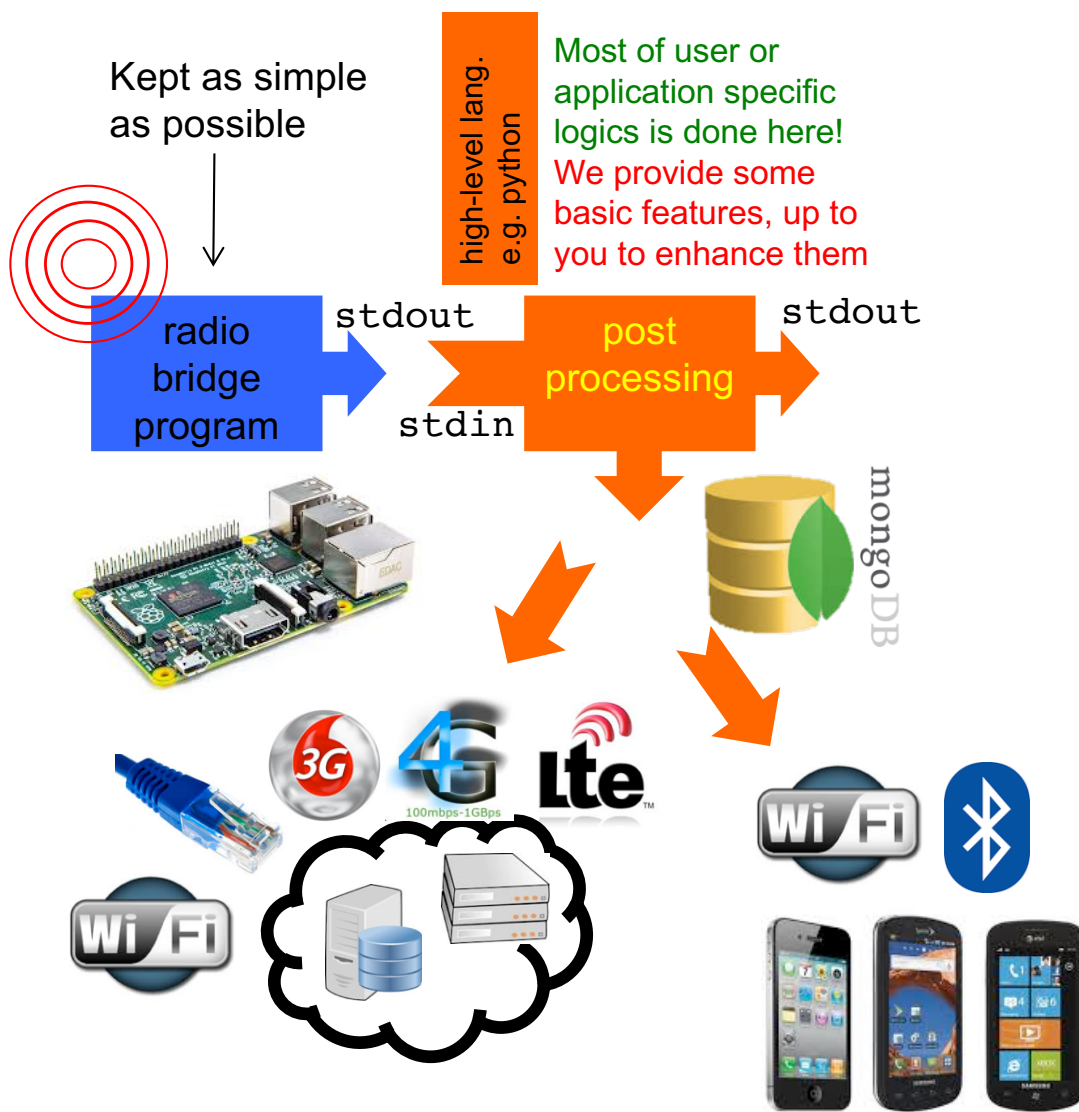


```
sendPacketTimeout("TC/18.5");
// sends to gateway
// TC : temperature celcius
// 18.5 : value
```

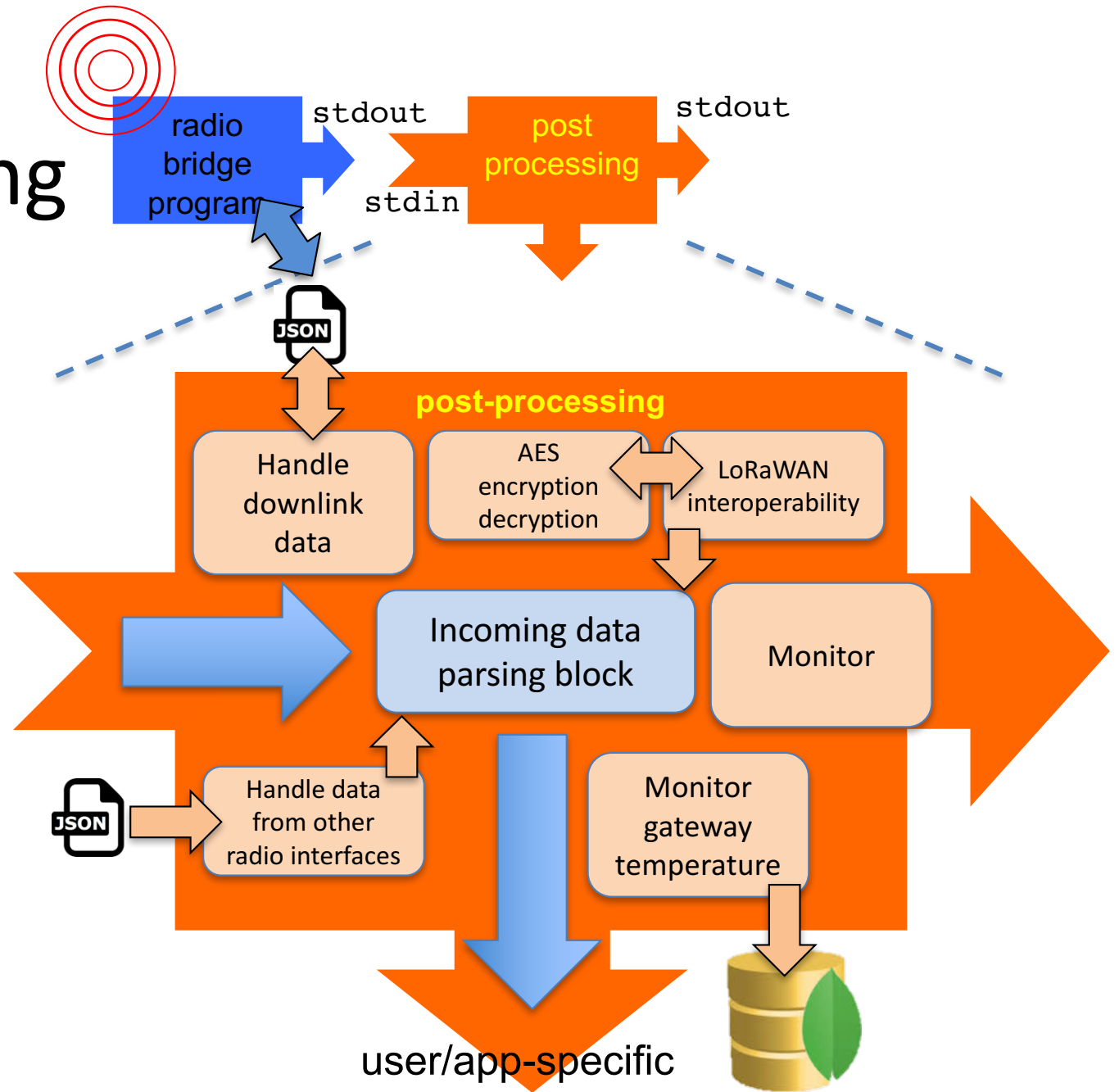
1 send function!



# OUR LOW-COST GATEWAY ARCHITECTURE

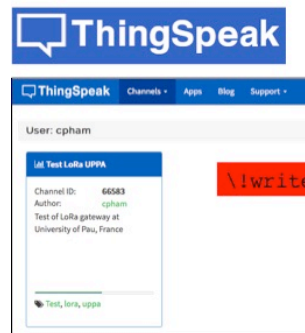
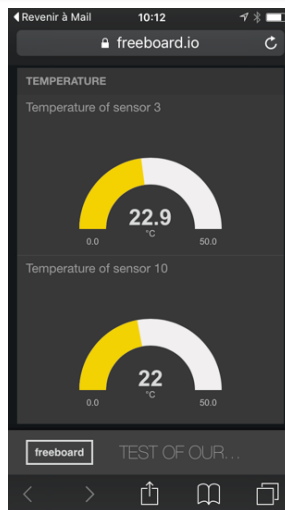
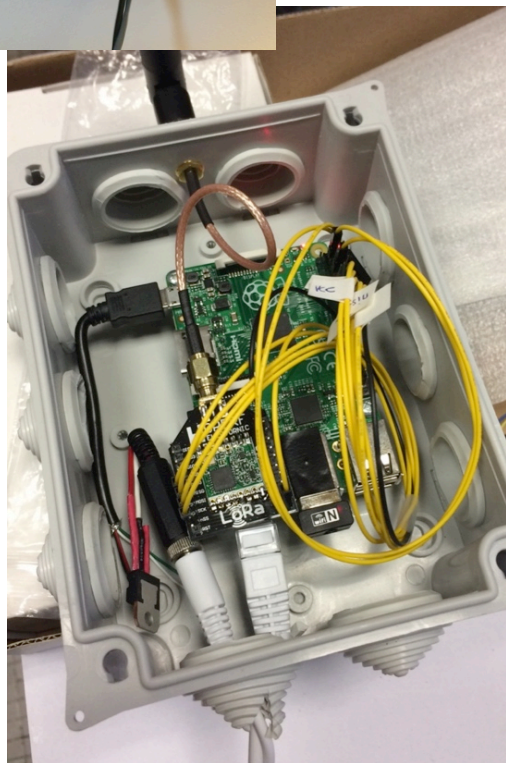


# Post-processing stage

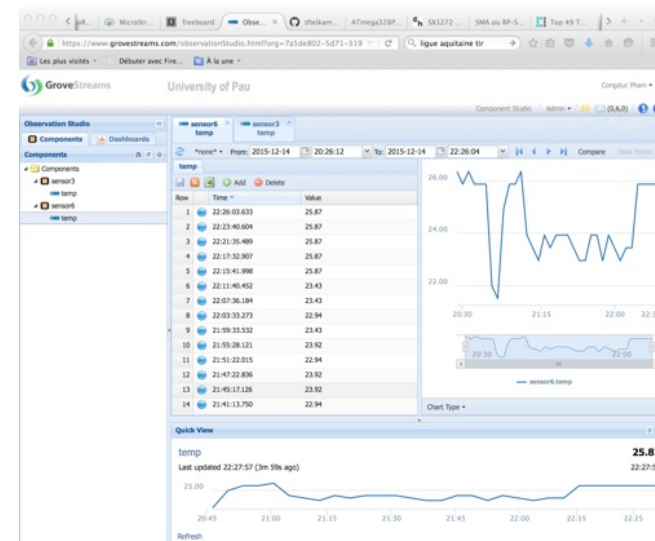


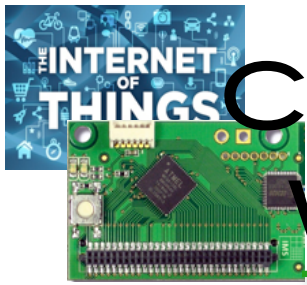


# TEMPLATES FOR VARIOUS CLOUDS



Node 10  
\\#19.6  
\\write\_key#field\_index#19.6





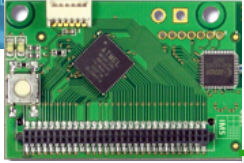
# CONFIGURE YOUR GATEWAY WITH THE WEB INTERFACE



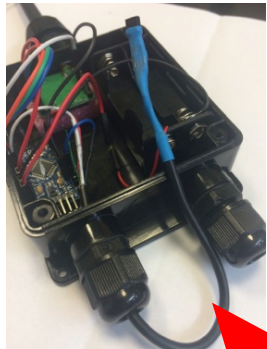
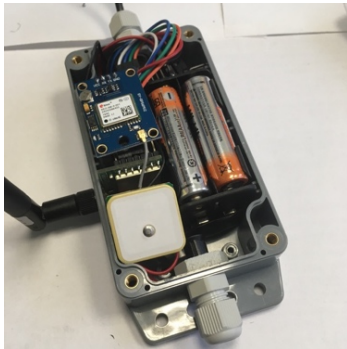
- <http://192.168.200.1/admin>
- Login: admin
- Password: loragateway

The screenshot shows a web browser window with the URL `192.168.200.1/admin/pages/gateway_config.php`. The page title is "Gateway Web Admin" and it features a navigation menu on the left with "Clouds", "Gateway Update", and "System". The main content area is titled "Gateway configuration" and has a sub-menu with "Radio", "Gateway", "Alert Mail", "Alert SMS", "Downlink Request", and "Get post-processing.log file". The "Radio" sub-menu is active, displaying a table with the following data:

Mode	4	
Frequency	-1	



# 100% DO-IT-YOURSELF !



Step-by-step tutorial and source code available

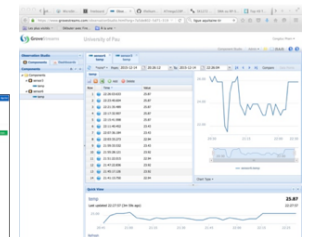


Step-by-step tutorial and source code available

Python scripts available

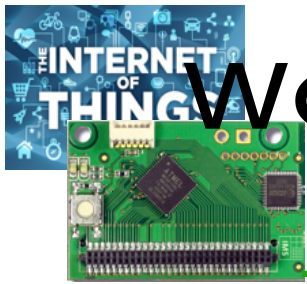


freeboard

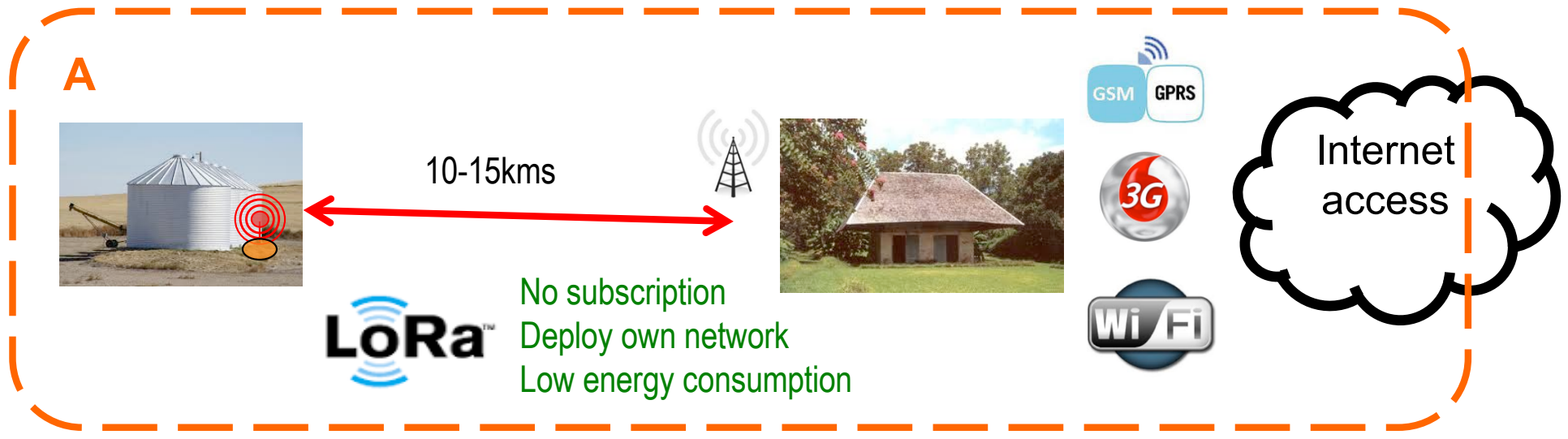


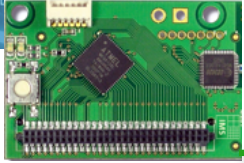
<https://github.com/CongducPham/LowCostLoRaGw>



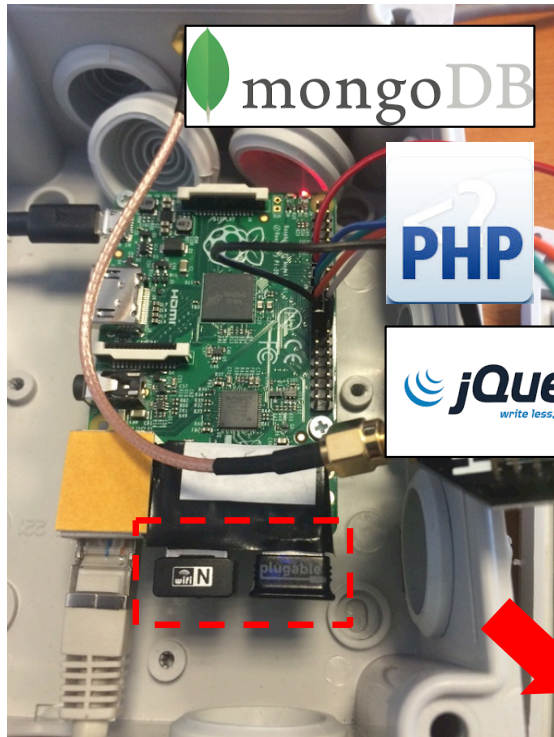


# WORKING WITHOUT INTERNET ACCESS





# 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 16:13:26
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

Orange F

Bluetooth\_raspi

**NODES PREFERENCES**

1 check to retrieve its data

8 check to retrieve its data

**DATES PREFERENCES**

Pick a begin date  
Retrieve data since 09-05-2016

Pick an end date  
Retrieve data until 17-05-2016

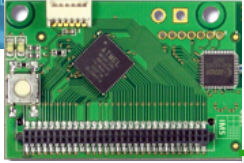
Display data    Retrieve data in a csv file

Orange F

Bluetooth\_raspi

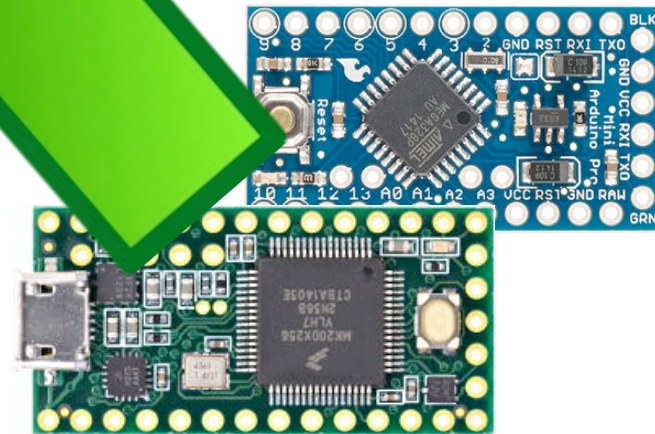
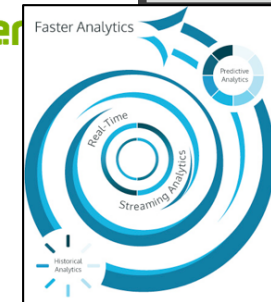
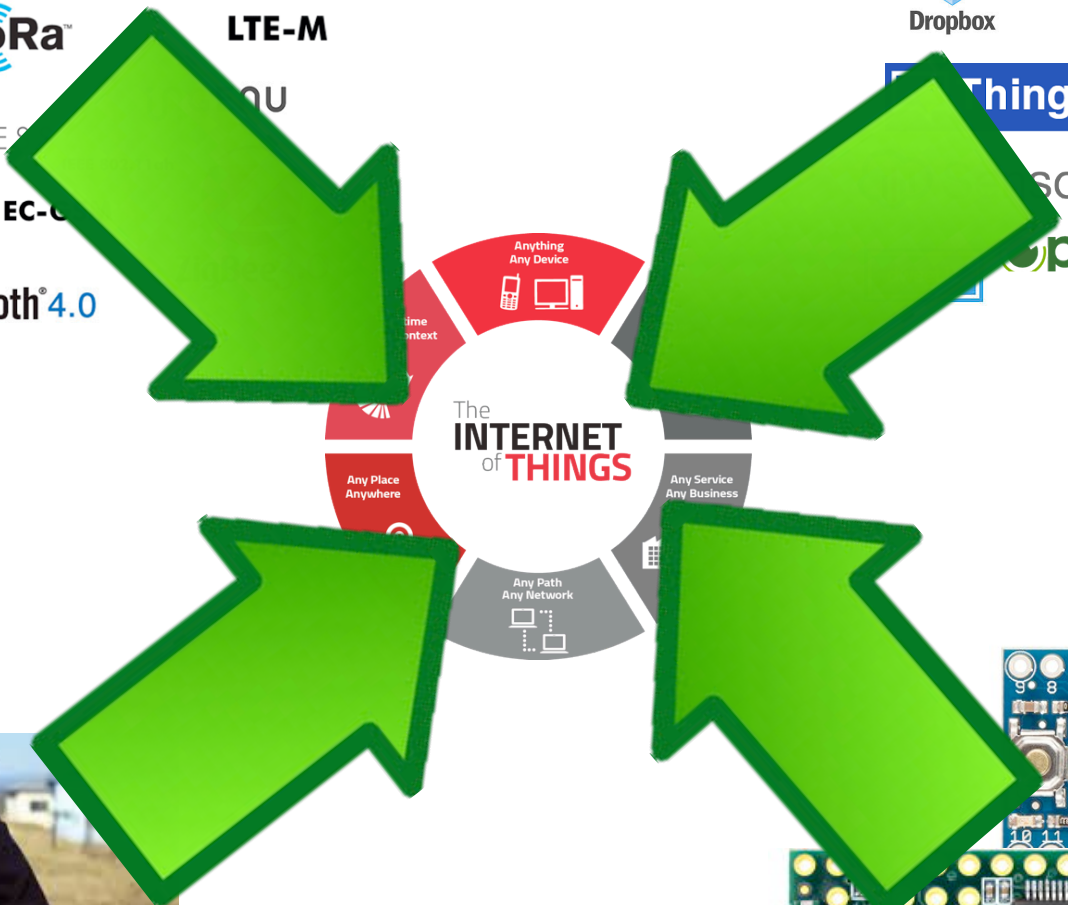
Creating csv file with the data received...  
File 17-05-2016\_10h39m36s.csv created and saved in the folder /storage/emulated/0/Raspberry\_local\_data

Display data    Retrieve data in a csv file

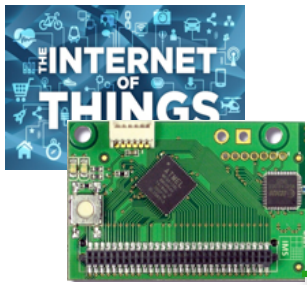


# NOW,

# IOT BECOMES REALITY!







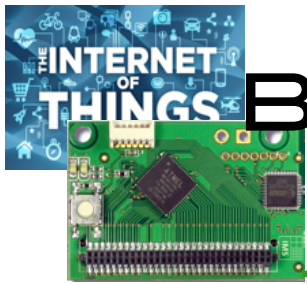
# INVOLVING INNOVATION HUBS/STAKEHOLDERS



- **Close to dev & entrepreneurs** communities
- Have their **own community and com channels** (community builders & catalysts)
- Used to organizing disruptive events
- **On the field** (know the targets personally & the market)
- **Used to empowering startups & businesses** (coaching, business dev, incubation, acceleration...)
- Affiliated to **international networks** that could be involved in dissemination or Business dev (Afrilabs)







# BUILDING WAZIUP COMMUNITY AND ECOSYSTEM



**International Events**  
+ 20 organized & attended

**Workshop at the European Conference on Networks & Communications (Greece, CNET)**



**Launch event (Ghana, iSpace)**



**IoTWeek2016 (Belgrade, EGM)**



**IoTBigData2016 (Italy, EGM)**

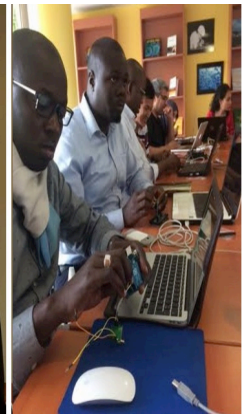
**Launch event (Senegal, CTIC Dakar)**



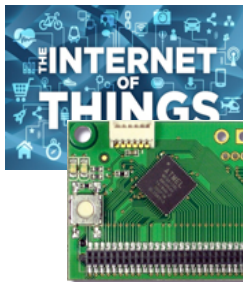
**WAZIUP Workshop on IoT (Togo, L'Africaine d'Architecture)**



**RESSACS 2016**



**IoT Care Conference (Budapest, CNET)**



# 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 role of rapid urbanization and support the necessary and breeding on a new scale

Author : Congduc Pham, University of Pau  
 Last update : 07.09.2016

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

**WAZIUP**

LIUPPA T2i team

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

UNIVERSITE DE PAU ET DES PAYS DE L'ADOUR

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

**WAZIUP**

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**BUILDING AN IOT DEVICE FOR OUTDOOR USAGE: A STEP-BY-STEP TUTORIAL**

**WAZIUP**

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**LOW-COST LORA IOT DEVICE: SUPPORTED PHYSICAL SENSORS**

**WAZIUP**

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

**WAZIUP**

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**LOW-COST LORA IOT: USING THE WAZIUP DEMO KIT**

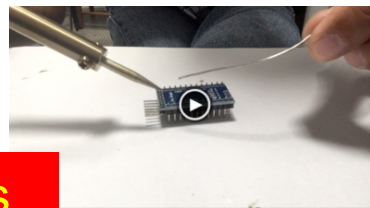
**WAZIUP**

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**Low-cost IoT device**



**+43000 views**

[https://www.youtube.com/watch?v=YsKbJeeav\\_M](https://www.youtube.com/watch?v=YsKbJeeav_M)

**Low-cost IoT gateway**



<https://www.youtube.com/watch?v=mj8ltKA14PY>





Thanks.  
**Let's keep in touch**



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github.com/waziup