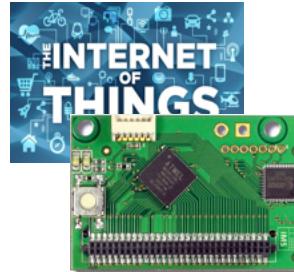


# DEPLOYING LOW-COST AND LONG-RANGE INTERNET OF THINGS IN DEVELOPING COUNTRIES



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





# IoT FOR DEVELOPMENT



Irrigation



Livestock farming



Fish farming & aquaculture



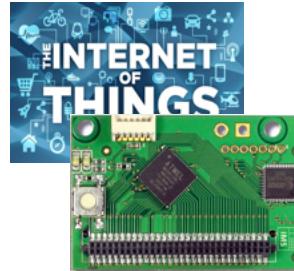
Storage & logistic



Agriculture



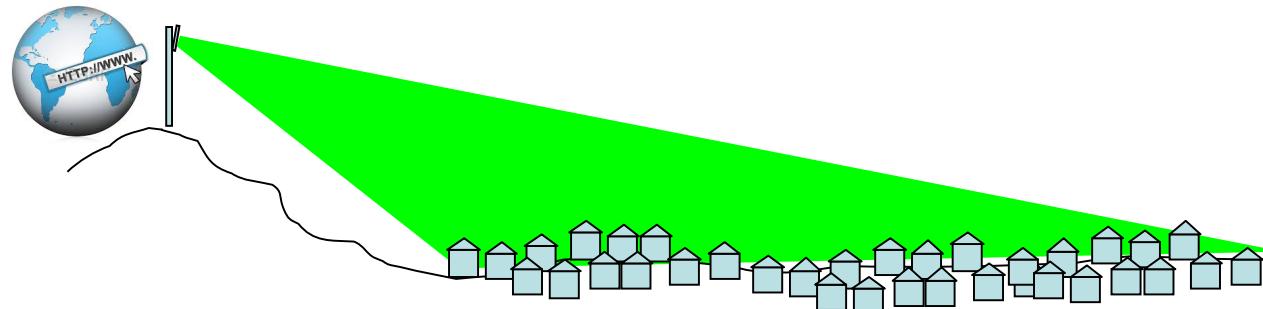
Fresh water



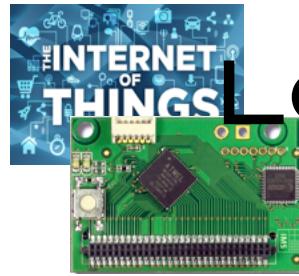
# LONG-RANGE SENSING



Moisture/  
Temperature of  
storage areas



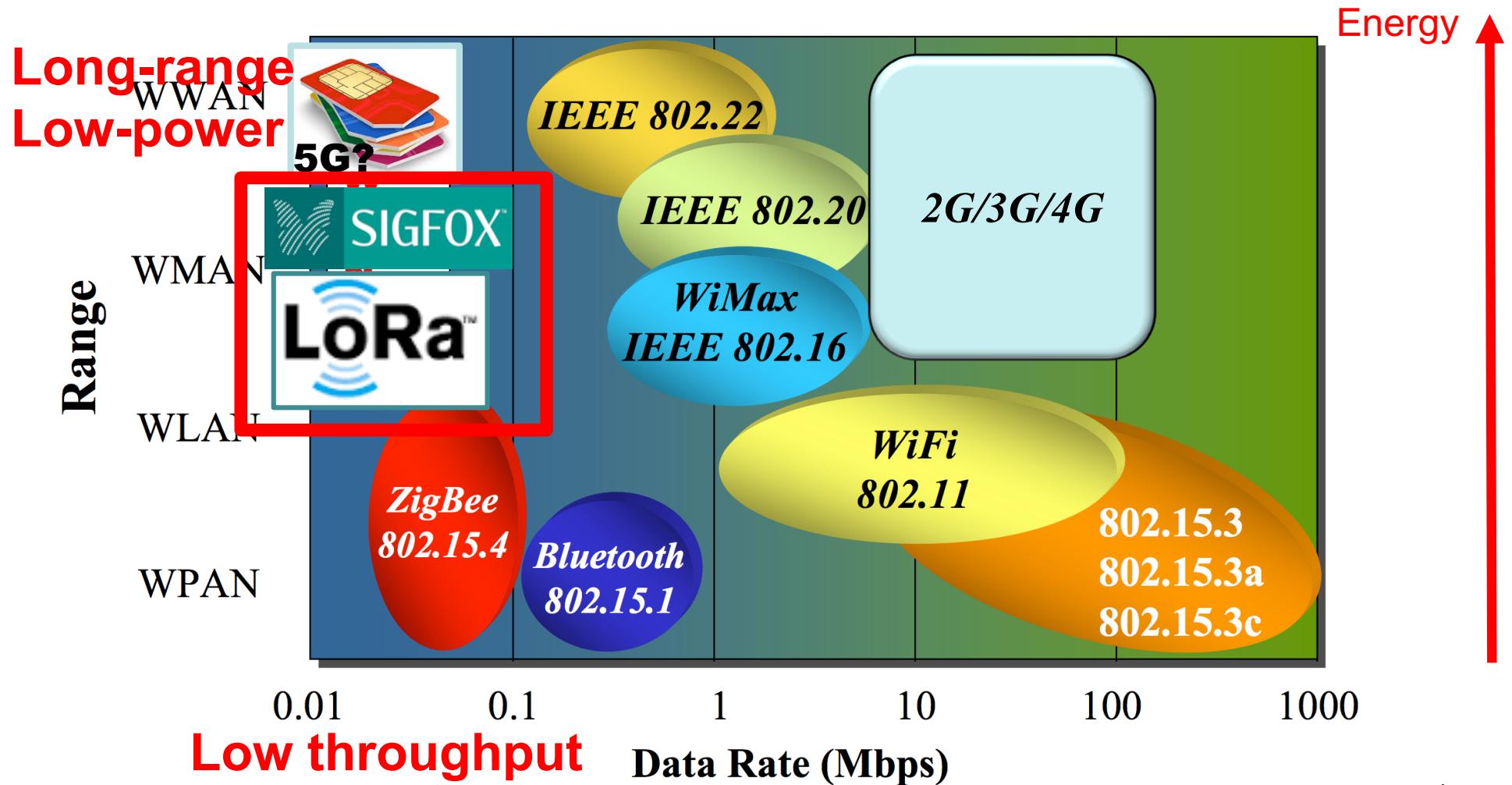
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC

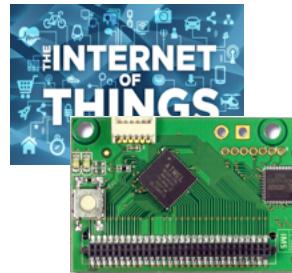


# LOW-POWER & LONG-RANGE RADIO TECHNOLOGIES



## Energy-Range dilemma

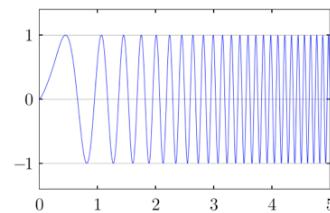




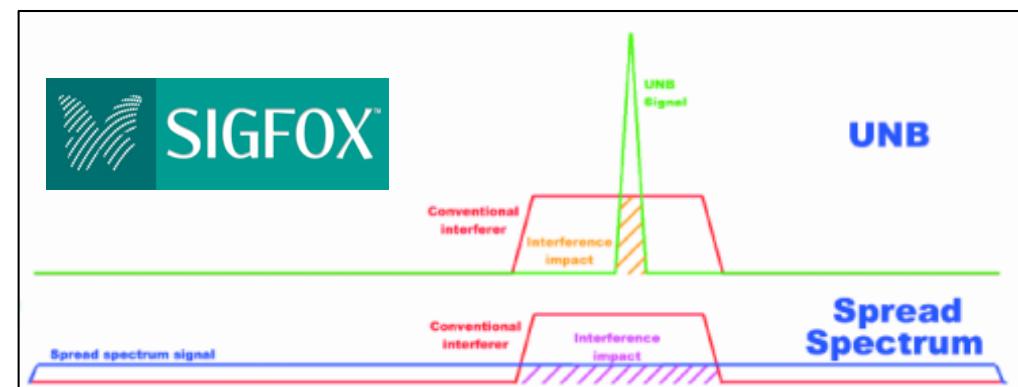
# INCREASING RANGE?

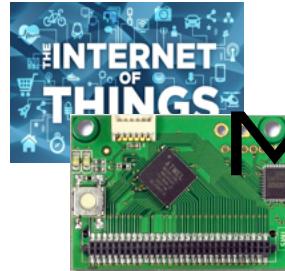


- Generally, robustness and sensitivity can be increased when **transmitting much slower**
- A Sigfox message is sent relatively slowly in an ultra narrow band of spectrum. **Max throughput=~100bps**
- LoRa also increases time-on-air when maximum range is needed. But LoRa uses spread spectrum approach.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



**LoRa™**



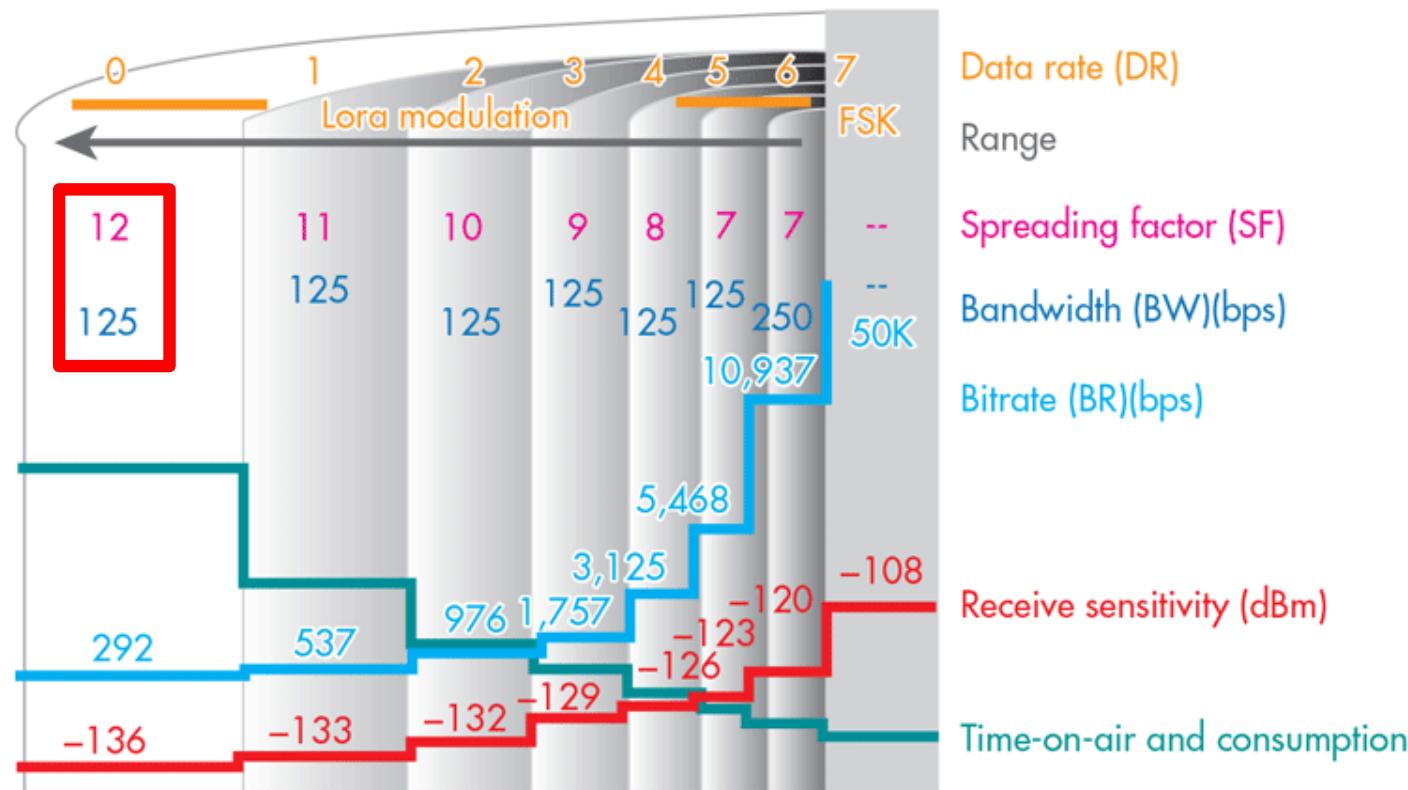


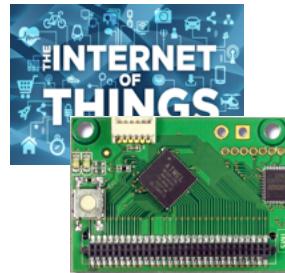
# MAIN LORA PARAMETERS



## □ Main parameters

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





# LORA DETAILS SPECS



## □ Main parameters

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

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

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

<i>SpreadingFactor (RegModemConfig2)</i>	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

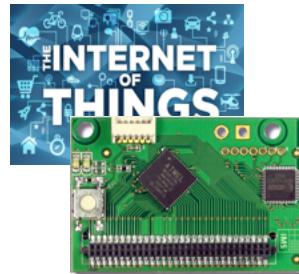
### Rule of thumb

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

Tables from Semtech

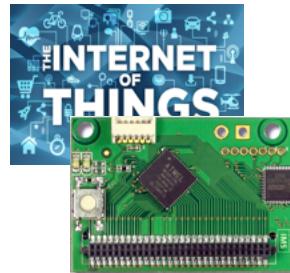


# LORA TIME-ON-AIR



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

LoRa mode	BW	CR	SF	time on air in second for payload size of						max thr. for 255B in bps
				5 bytes	55 bytes	105 bytes	155 Bytes	205 Bytes	255 Bytes	
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 -



Autonomy LP WAN with 2000mAh -

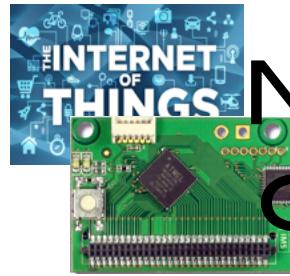


Example for energy meter

1 year

5 years

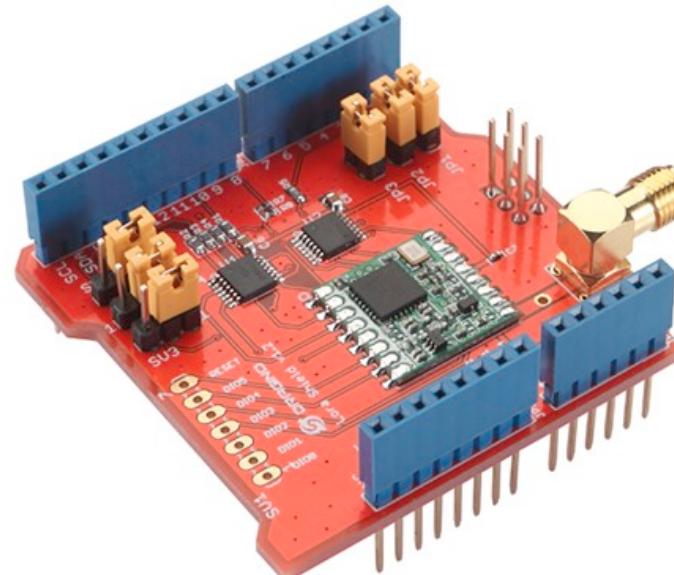
10 years



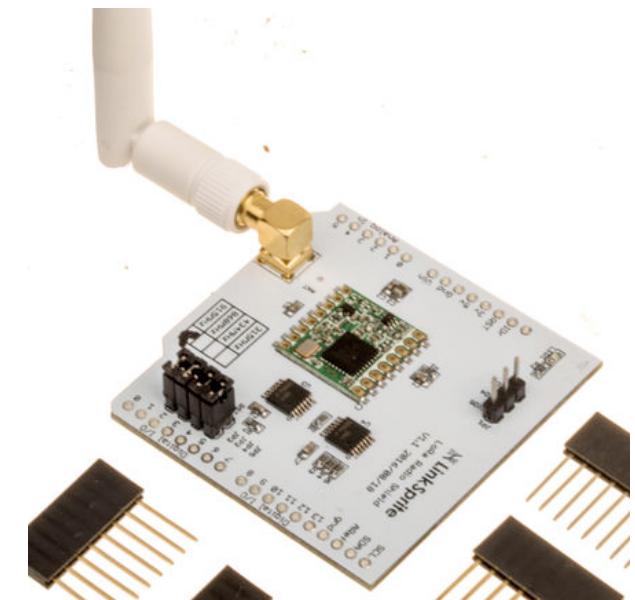
# MORE AND MORE EASY-TO-CONNECT LORA MODULES!



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



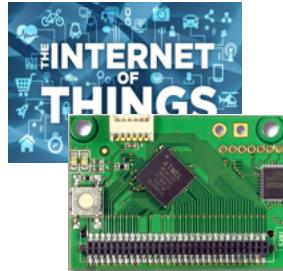
Dragino LoRa shield  
for Arduino



LinkSprite LoRa shield  
for Arduino

# MATURATION OF THE IOT MARKET...





# IOT BECOMES REALITY!



**SIGFOX**  
One network A billion dreams

**LoRa™**

**NB-LTE**

**WEIGHTLESS**

**DASH7™ ALLIANCE**

**Bluetooth® 4.0**

**nwave**

**LTE-M**

**EC-G**

**EC-U**

**EC-C**

**EC-S**

**EC-T**

**EC-R**

**EC-B**

**EC-A**

**EC-D**

**EC-E**

**EC-F**

**EC-G**

**EC-H**

**EC-I**

**EC-J**

**EC-K**

**EC-L**

**EC-M**

**EC-N**

**EC-O**

**EC-P**

**EC-Q**

**EC-R**

**EC-S**

**EC-T**

**EC-U**

**EC-V**

**EC-W**

**EC-X**

**EC-Y**

**EC-Z**

**EC-A**

**EC-B**

**EC-C**

**EC-D**

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**EC-X**

**EC-Y**

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**EC-A**

**EC-B**

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**EC-D**

**EC-E**

**EC-F**

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**EC-P**

**EC-Q**

**EC-R**

**EC-S**

**EC-T**

**EC-U**

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**EC-W**

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**EC-C**

**EC-D**

**EC-E**

**EC-F**

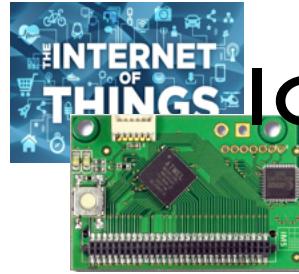
**EC-G**

**EC-H**

**EC-I**

**EC-J**

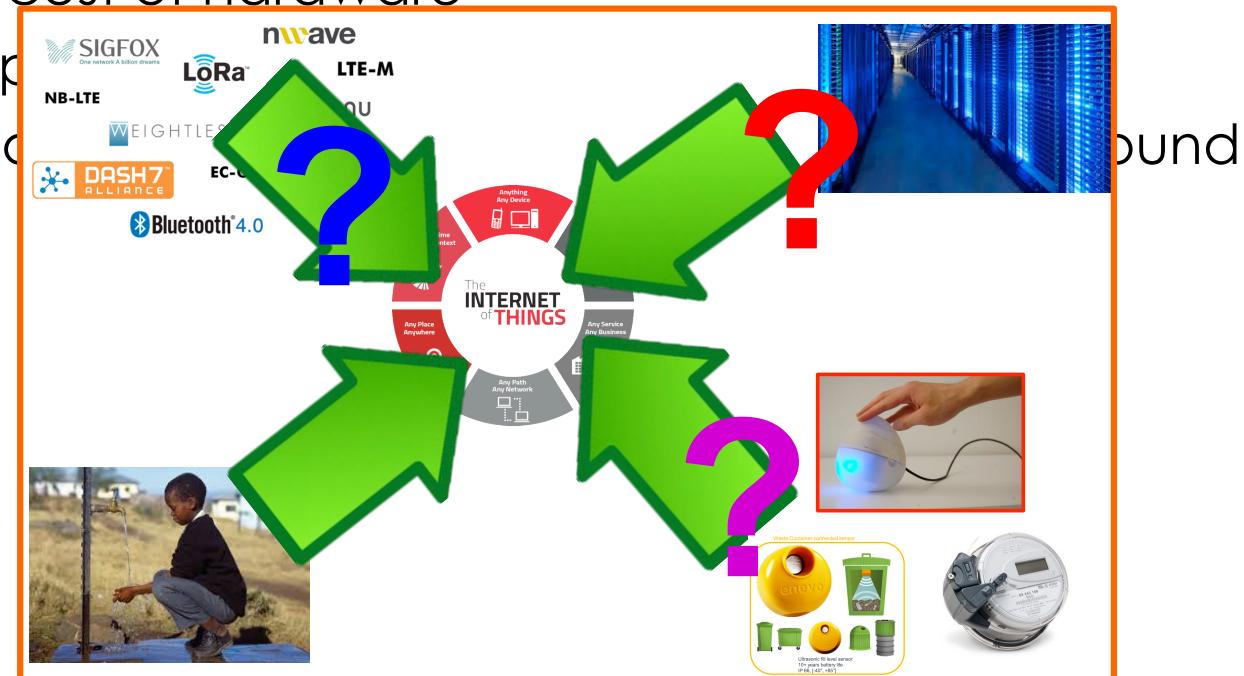
**EC-K**



# THE INTERNET OF THINGS 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
  - competition
  - lack of skilled labor

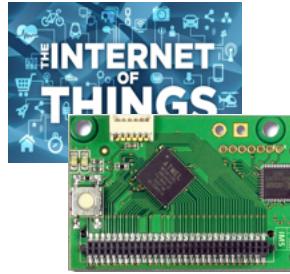


# MATURATION OF THE IOT MARKET...

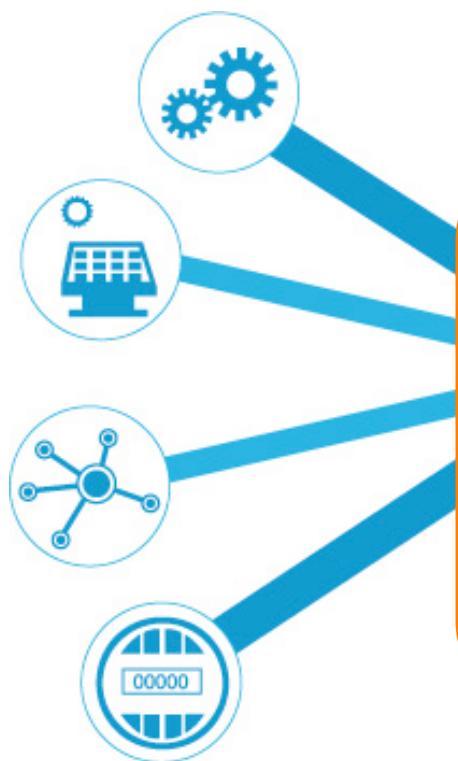


Too expensive  
Too integrated  
Highly specialized  
Difficult to customize  
Difficult to upgrade



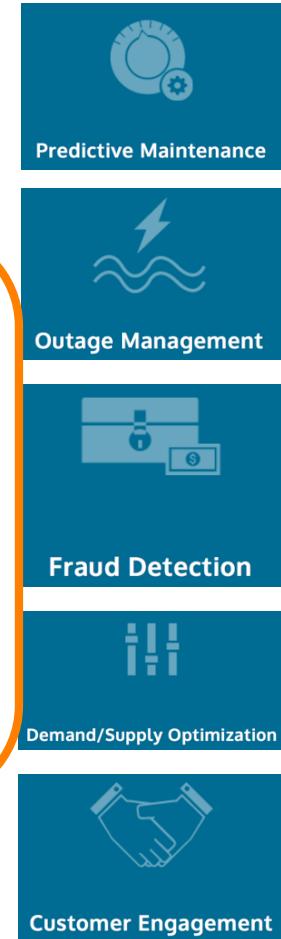


# INTERNET, CLOUD & BIG DATA ANALYTICS

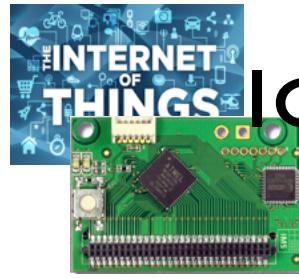


Internet connectivity is weak and expensive!

Nearly impossible in remote/rural areas



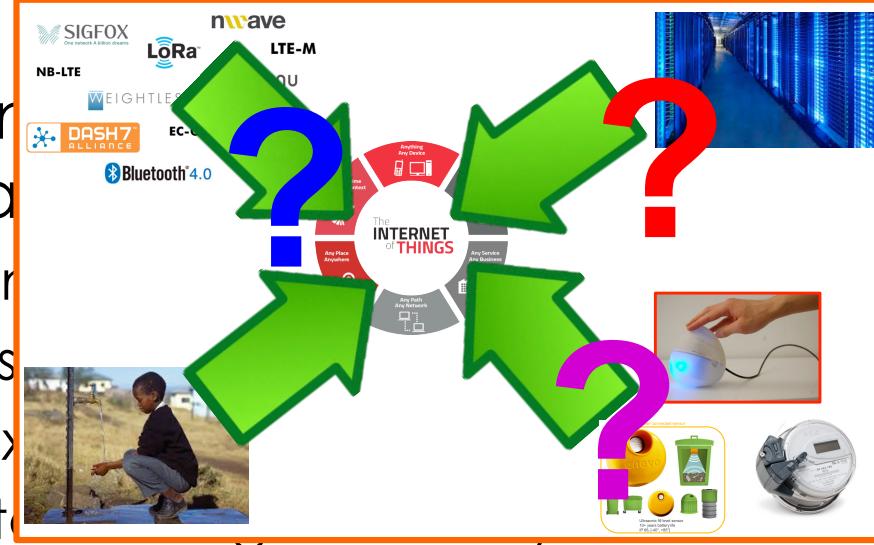
Graphics from <http://www.vitria.com/iot-analytics/>

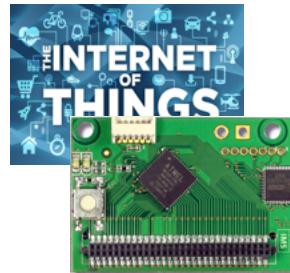


# IoT IN DEVELOPING COUNTRIES AND RURAL AREAS



- Developing countries being ready
  - lack of infrastructure
  - high costs
  - complex regulations
  - lack of technical background
- still far from benefit of IoT
- **to deploy IoT in developing countries, it is necessary to target three major issues**
  - reduce cost of infrastructures, hardware and services
  - limit dependency to proprietary infrastructures and provide local interaction models
  - target technology appropriation, push for local business models



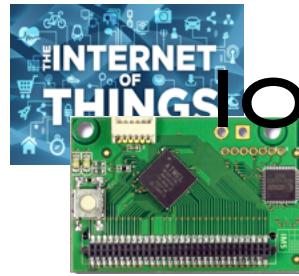


# WAZIUP: LOW-COST IoT



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

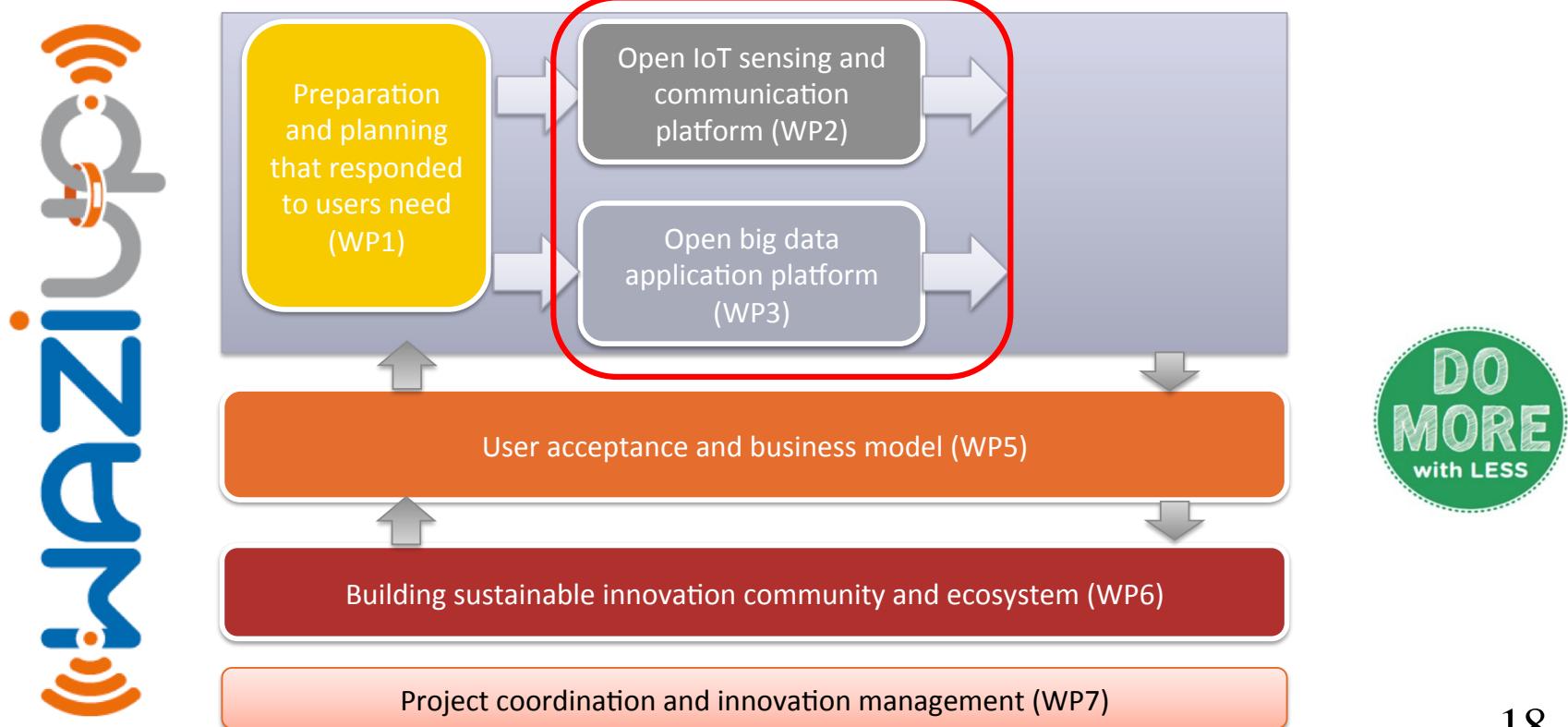




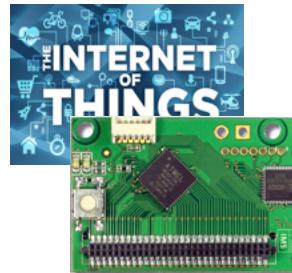
# IoT FOR RURAL APPLICATIONS IN DEVELOPPING COUNTRIES



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



DO  
MORE  
with LESS



# LOW-COST HARDWARE INITIATIVE



## WHAT IS ARDUINO?

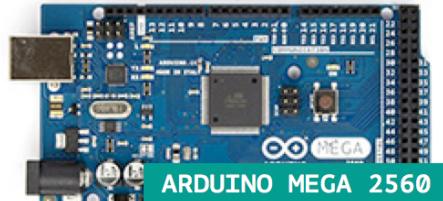
Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects.

## ARDUINO BOARD

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



ARDUINO UNO



ARDUINO MEGA 2560



ARDUINO ZERO



ARDUINO DUE



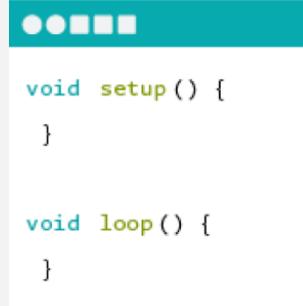
ARDUINO MICRO



ARDUINO PRO MINI



ARDUINO NANO

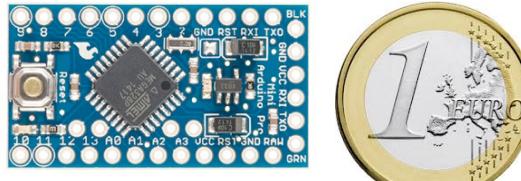


## ARDUINO SOFTWARE

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



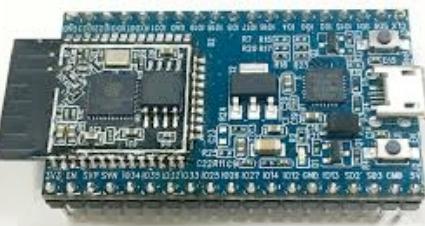
LoPy



Theairboard



LinkIt  
Smart7688 duo



Expressif ESP32

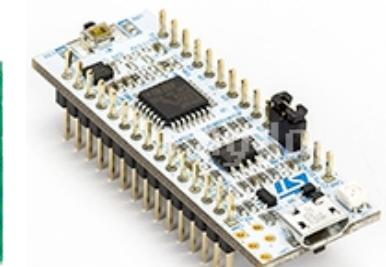
<http://www.postscapes.com/internet-of-things-hardware/>

<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/>



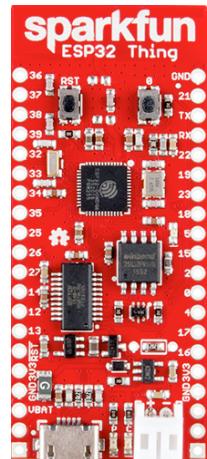
Teensy 3.2



STM32 Nucleo-32



Adafruit Feather



Sparkfun ESP32 Thing

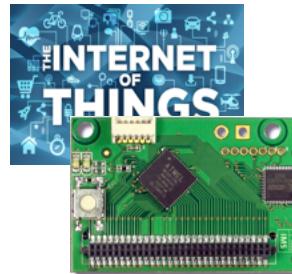


Tessel

SodaqOnev2



Tinyduino



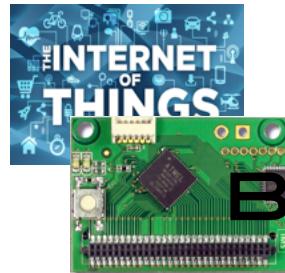
# ... STIMULATING "DO-IT-YOURSELF" WORLDWIDE



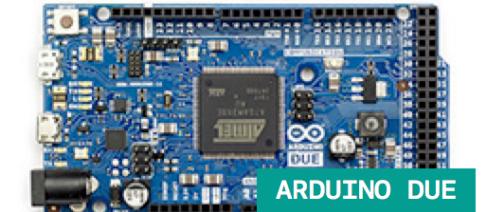
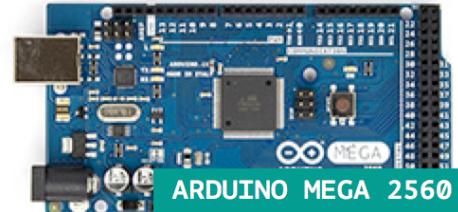
- DIY usually means
  - More open-source software from larger community
  - More flexibility

The screenshot shows the homepage of Projets DIY. At the top, there's a navigation bar with links like 'Domotique | IoT', 'Arduino | ESP8266 | ESP32', 'Raspberry Pi | Orange Pi', 'Impression 3D', 'Projets', 'Bons Plans', and 'Forums'. Below the navigation is a banner for 'GB 11.11 PRIME TIME THANKSGIVING' with offers for '\$1.11 COOL ADD-ONS' and '\$0.11 LUCKY BAGS'. A large headline reads '#Bons plans du Week End chez Gearbest (semaine 46) spécial Black Friday'. There are several product thumbnails, including a Christmas tree lamp, a Christmas pillow case, and Christmas LED lights. A search bar and a 'LIRE LA SUITE' button are also visible.

The screenshot shows a Pinterest board titled 'Arduino' under the category 'Bricolage et artisanat'. The board features a grid of pins related to Arduino projects. Some visible titles include '200+ ARDUINO PROJECTS', 'ARDUINO: INSTALLATION MODULE WIFI', 'CLICK HERE', 'ARDUINO PLANT WATERING SYSTEM', 'Solar Powered WiFi Weather Station', 'Réalisation de mon', 'KIT Boiler Ultra Plat Aluminium pour Raspberry Pi 3 / Pi 2 - Ce', and 'Simple Electronic'. Each pin includes a small image and some descriptive text or a link.



# WAZIUP PROVIDES SW/HW BUILDING BLOCKS INTEGRATION



More to come...



LoRa radios that  
our library already  
supports



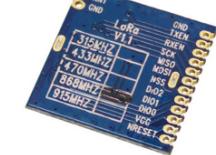
HopeRF  
RFM92W/95W



Libelium LoRa

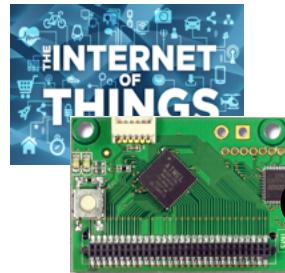


Modtronix  
inAir9/9B



NiceRF  
LoRa1276

Long-Range communication library



# WAZIUP PROPOSES 100% OPEN-SOURCE SOFTWARE



```
/*
 * 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; 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
 * 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
// comment if your radio is
#define RADIO_RFHM92_95
// uncomment if your radio is
//define RADIO_INAIRB8

// TMDEINSTANT
```

Arduino 1.6.6      Teensyduino 1.2.7

AN OPEN PROJECT WRITTEN, DEBUGGED,  
AND SUPPORTED BY ARDUINO.CC AND  
THE ARDUINO COMMUNITY WORLDWIDE

LEARN MORE ABOUT THE CONTRIBUTORS  
OF [ARDUINO.CC](#) ON [arduino.cc/credits](#)

CongducPham / LowCostLoRaGw

Code Issues 62 Pull requests 2 Projects 0 Pulse Graphs

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

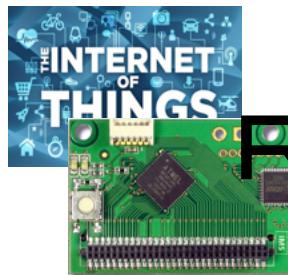
122 commits 1 branch 0 releases 2 contributors

Branch: master New pull request Find file Clone or download

Congduc Pham bug fix in lora\_gateway.cpp Latest commit a0daaa4 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



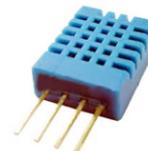
Physical  
sensor



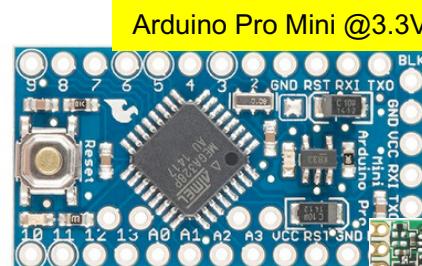
Physical  
sensor



Physical  
sensor



Physical  
sensor  
mgmt



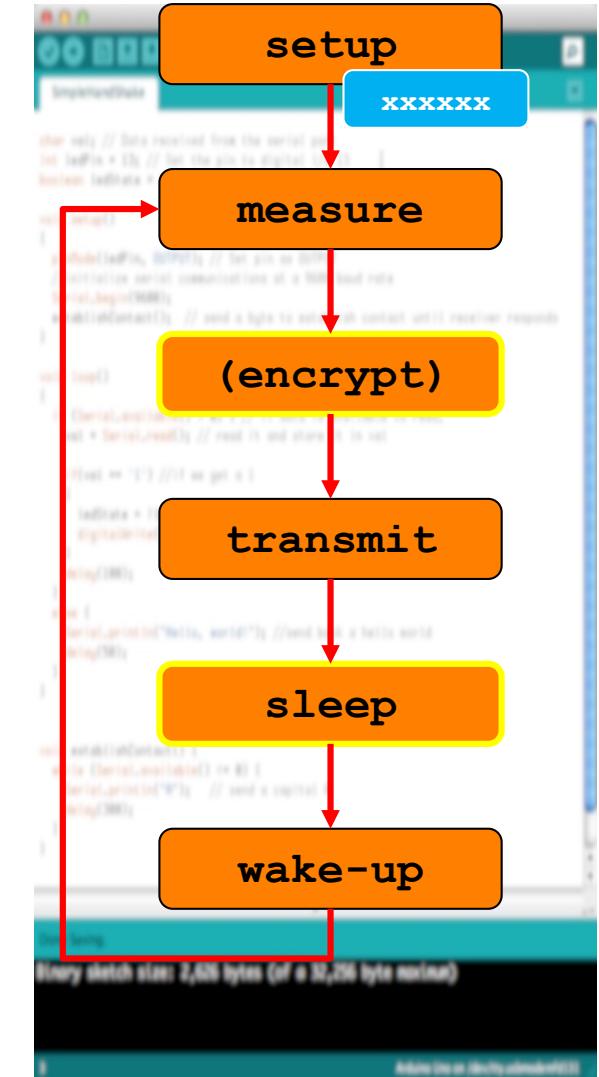
**\*VERY\*  
IMPORTANT**

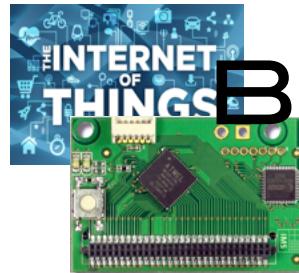
Activity  
duty-cycle,  
low power

**\*VERY\*  
IMPORTANT**  
AES  
encryption

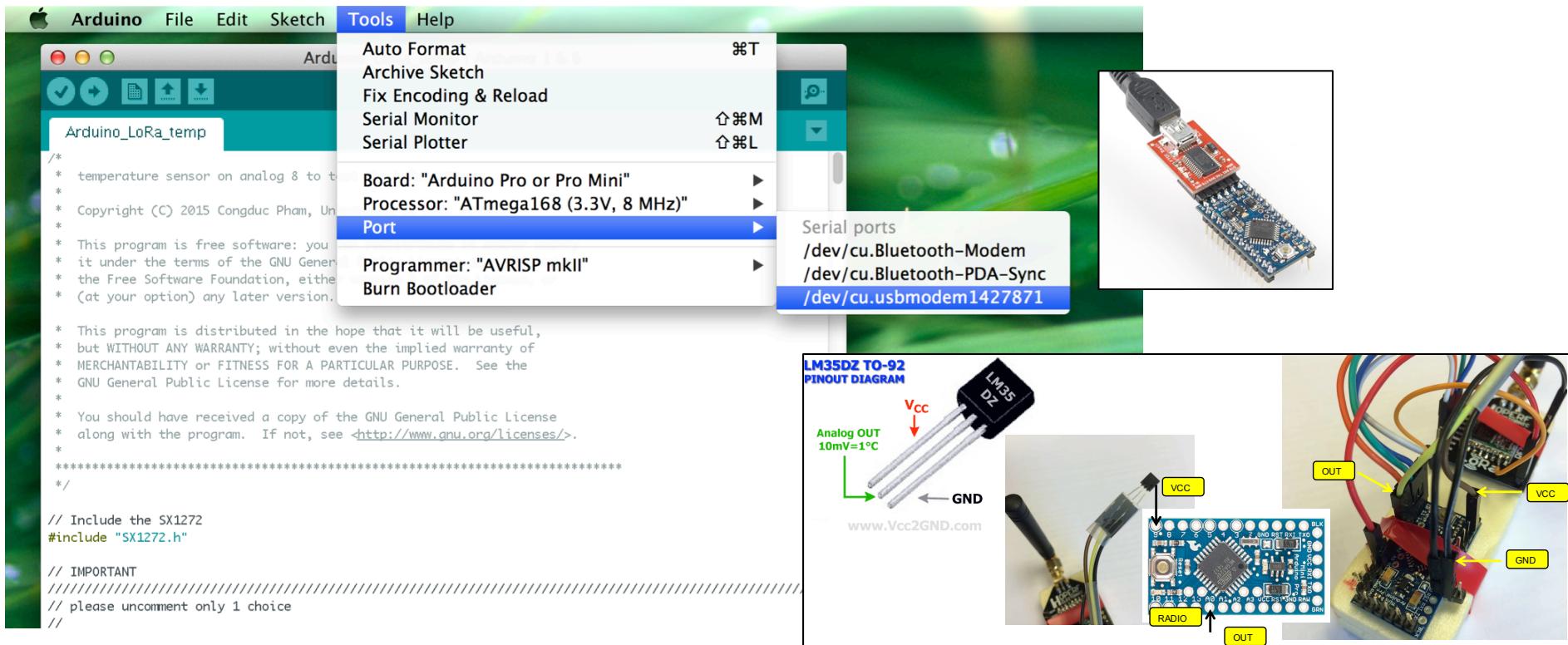
Long-range  
transmission

Logical  
sensor  
mgmt



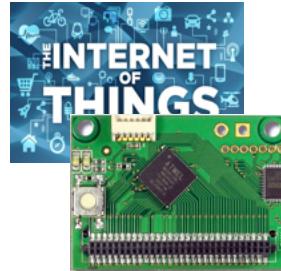


# BUILD YOUR FIRST LORA IOT DEVICE

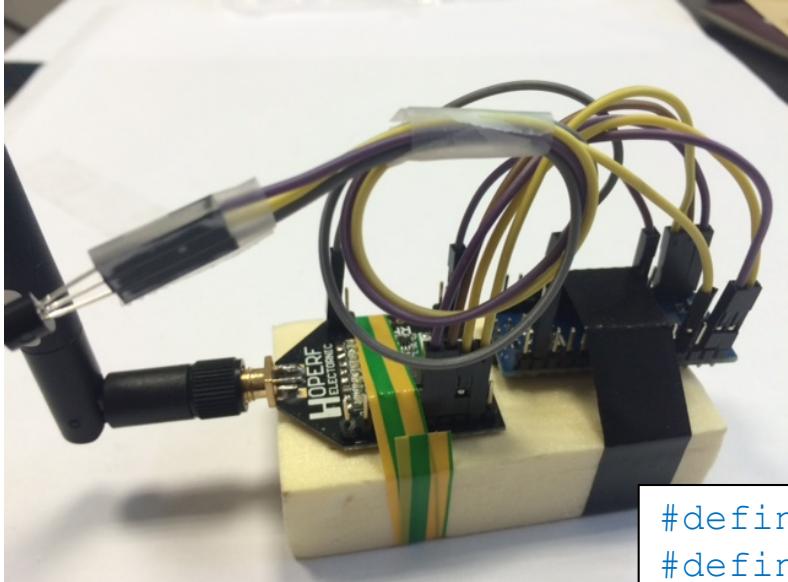


Connect the USB end to your computer and the USB port should be detected in the Arduino IDE. Select the serial port for your device. It may have another name than what is shown in the example. Then click on the « upload » button

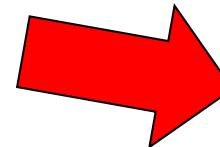




# DEFAULT CONFIGURATION



!\!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:

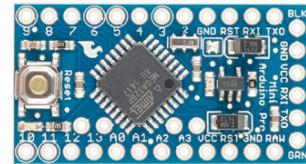
Send packets to the gateway (one or many if in range)

LoRa mode 1

Node short address is 6



# LOW-COST INTEGRATION

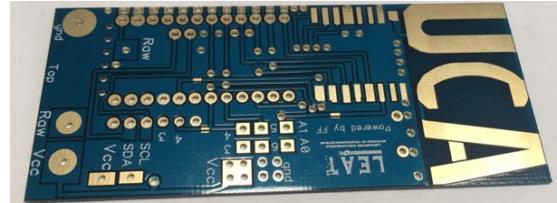


1.5€

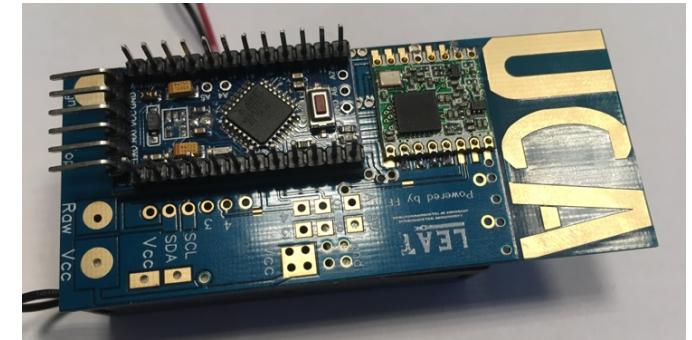
[https://github.com/FabienFerrero/UCA\\_Board](https://github.com/FabienFerrero/UCA_Board)



5€

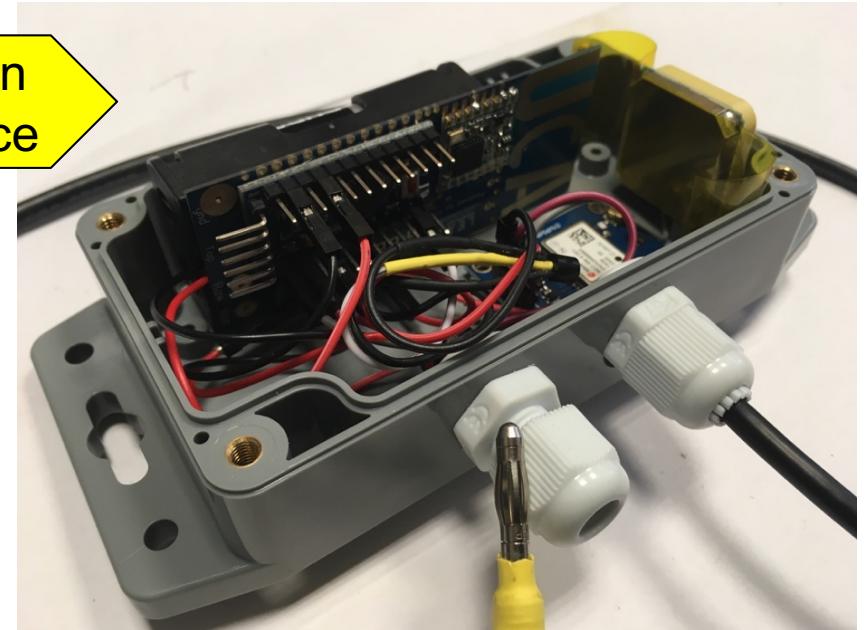


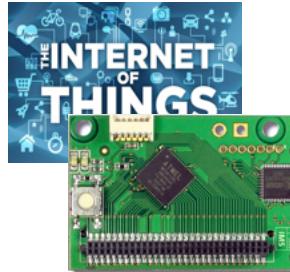
1€



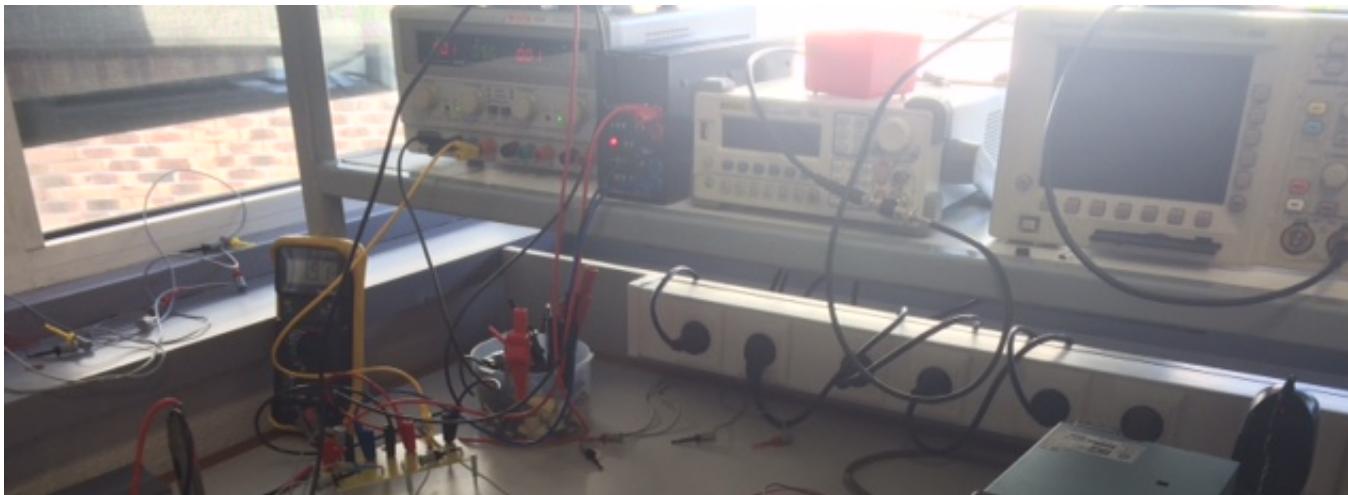
1-click order

Less than 10€/device

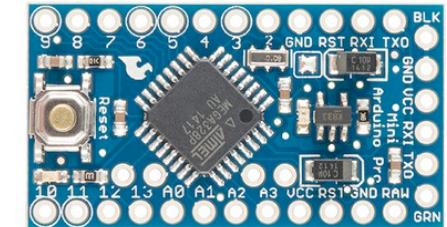




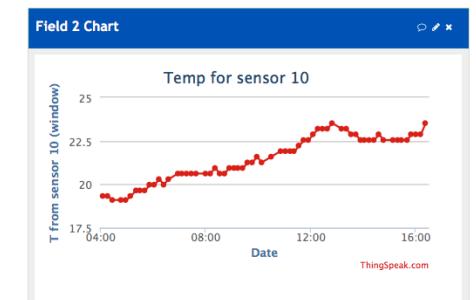
# LOW-POWER FOR LONGER LIFETIME!



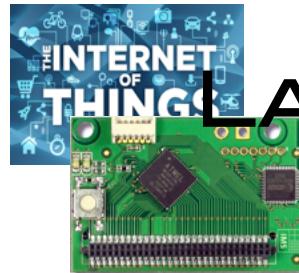
Can run more than 1 year  
with 1 measure/10min  
**Can run several years with  
1 measure/1h**



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



**5µA in deep sleep mode, about 40mA when active and sending!**



# 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

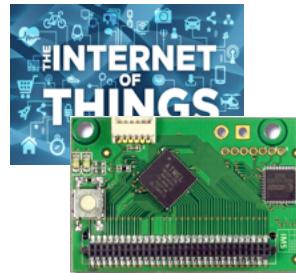
Branch: master LowCostLoRaGw / Arduino /

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_ucamll	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



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



# YouTube



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



<http://www.waziup.eu>

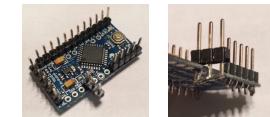
## The generic hardware platform

### 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.



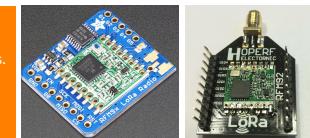
Depending on how many sensors you want to connect, the number of ground (GND) pins may be limited. You can extend a GND pin with a header pin where all pins are soldered together.

### The LoRa radio module

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

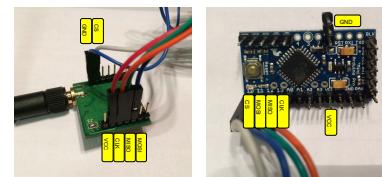


Most of SPI-based LoRa radio modules are supported. We recommend the Modtronix inAir model if you don't have delicate soldering experience as this module can come with header pins ready to be connected with Dupont wires.



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

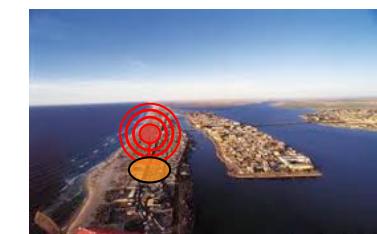
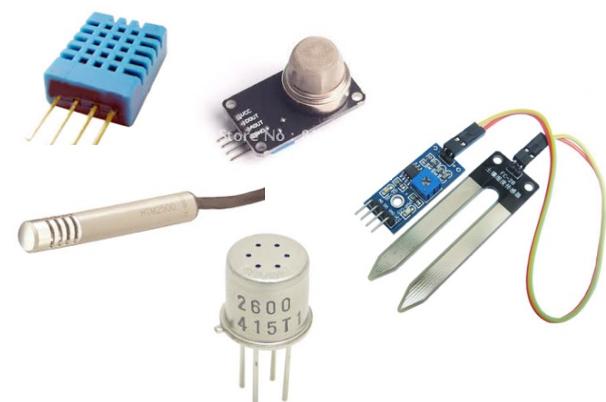
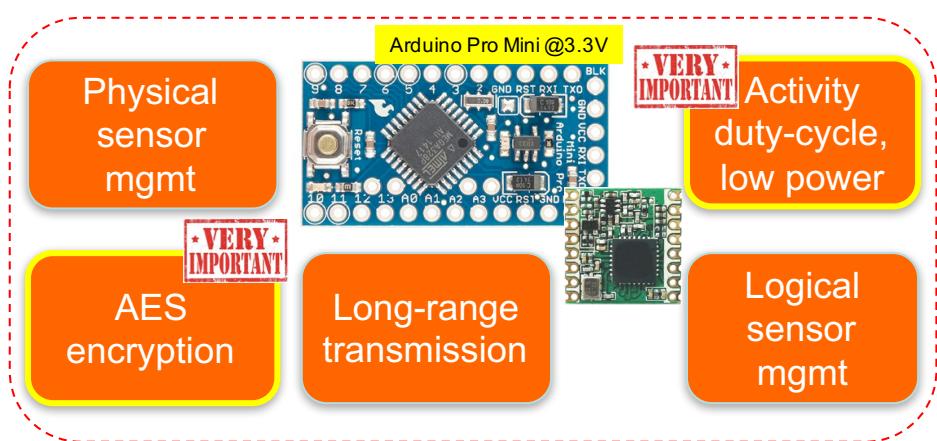
## Connect the LoRa radio module

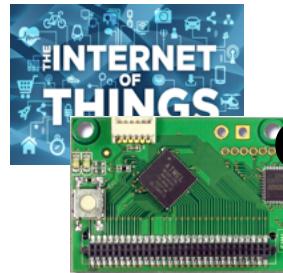


Connect the corresponding SPI pins of the radio module to the SPI pins on the Pro Mini board. MOSI (blue) is pin 11, MISO (green) is pin 12, CS (white) is pin 10 and CLK (orange) is pin 13 (right picture). Then connect also the VCC (red) and the GND (black) of the radio module to the VCC and the GND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

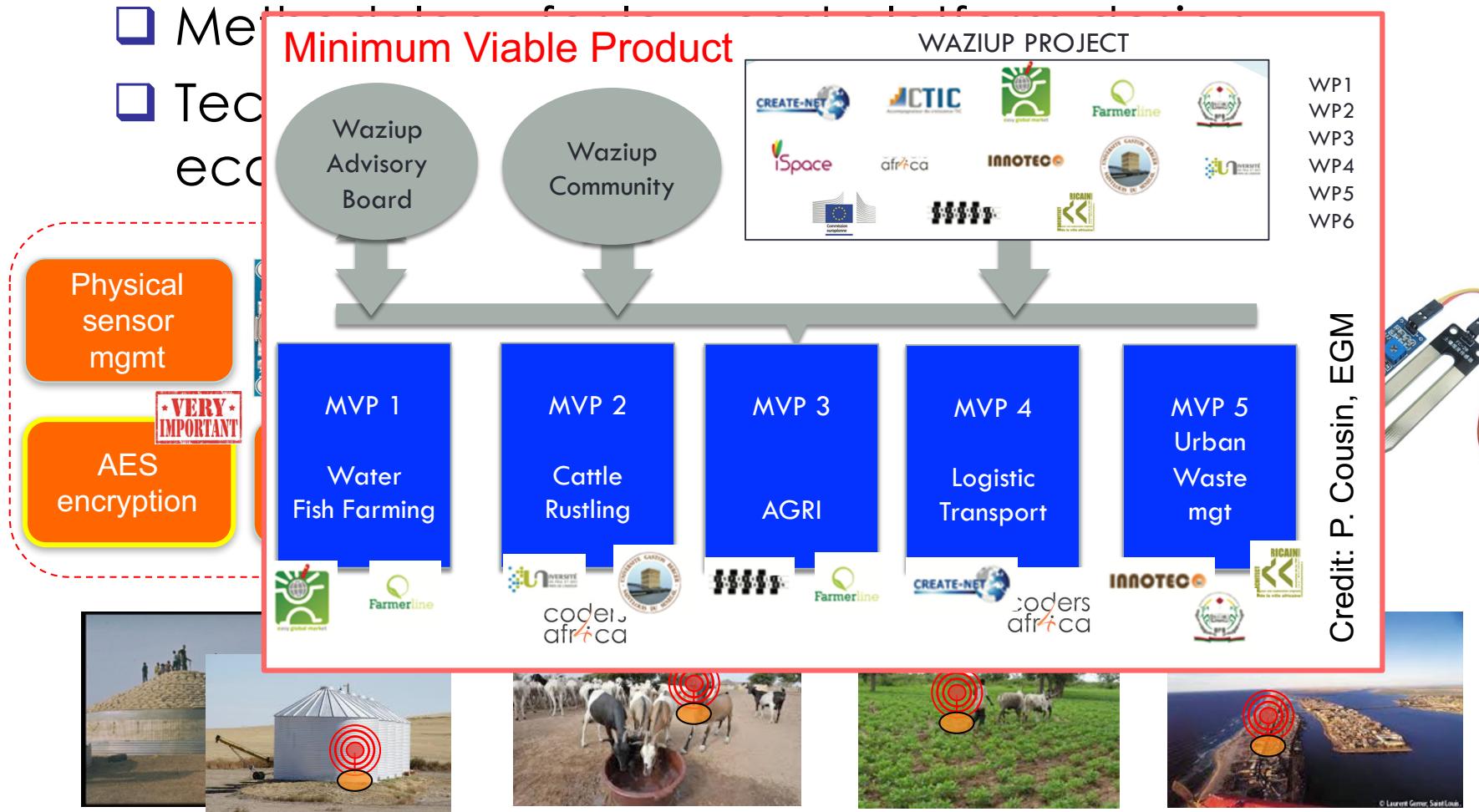


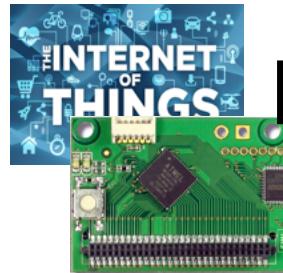
- ❑ Build low-cost, low-power, Long-range enabled generic platform
  - ❑ Meet the needs of the market
  - ❑ Technical validation
  - ❑ Economic validation

Minimum Viable Product

WAZIUP PROJECT

CREATE-NET	CTIC	euro global market	Farmerline	WAZIUP
iSpace	africa	INNOTECH	TECHNOLOGIES	UNIVERSITY
Waziup Advisory	Waziup Community			
WP1	WP2	WP3	WP4	



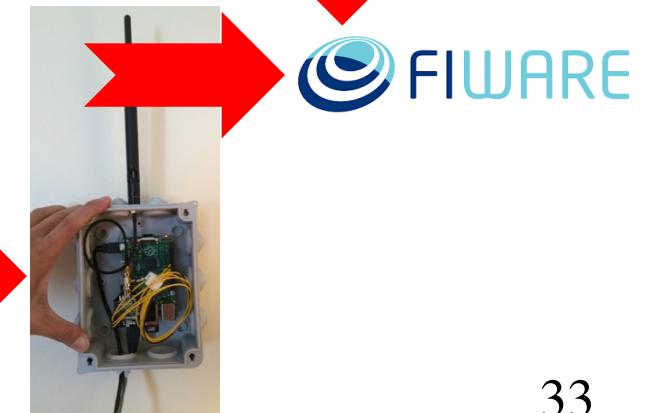
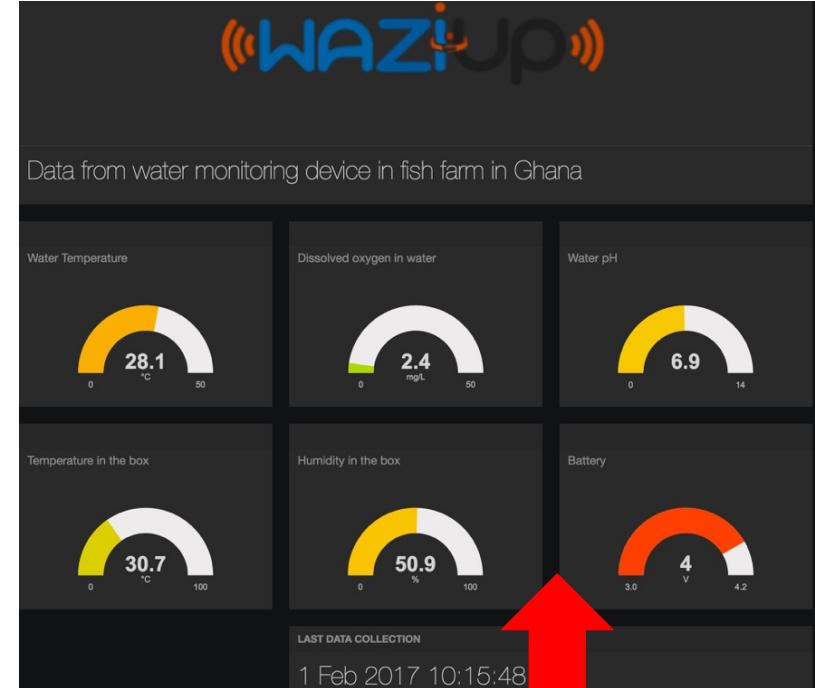
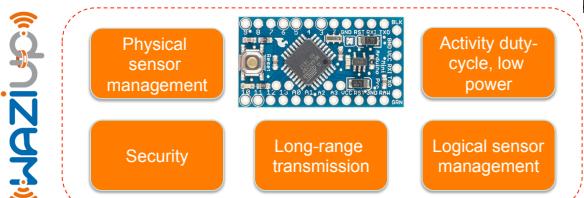


# LOW-COST BUOY FOR FISH FARMING MVP



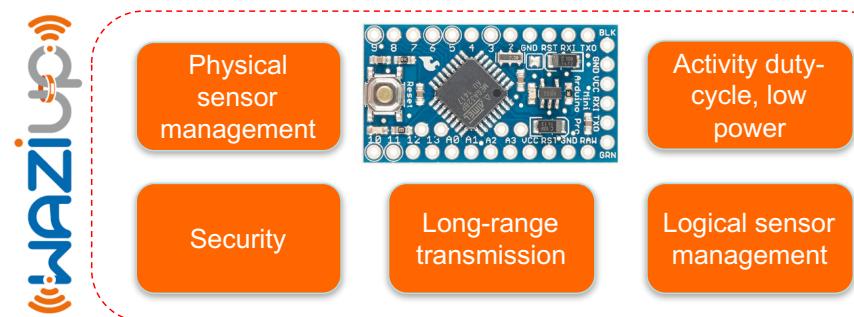
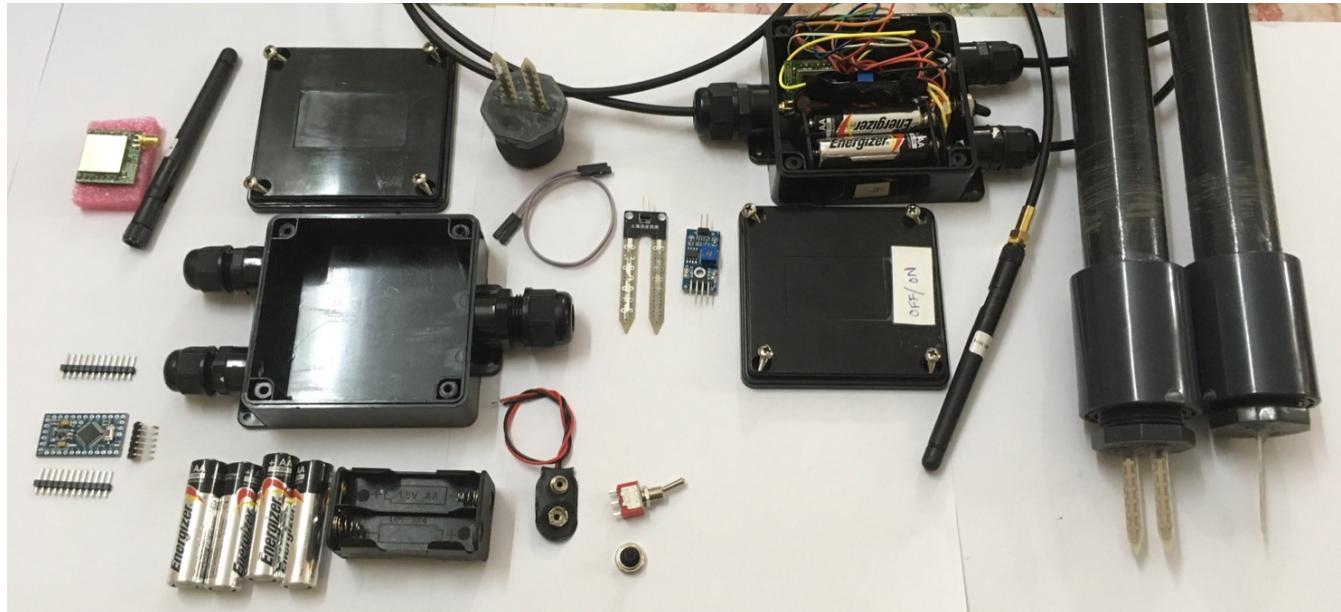
WAZIUP  
Physical sensor reading

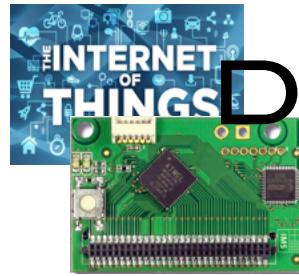
Credit: EGM





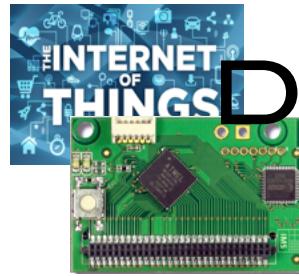
# SOIL HUMIDITY SENSORS FOR AGRI MVP



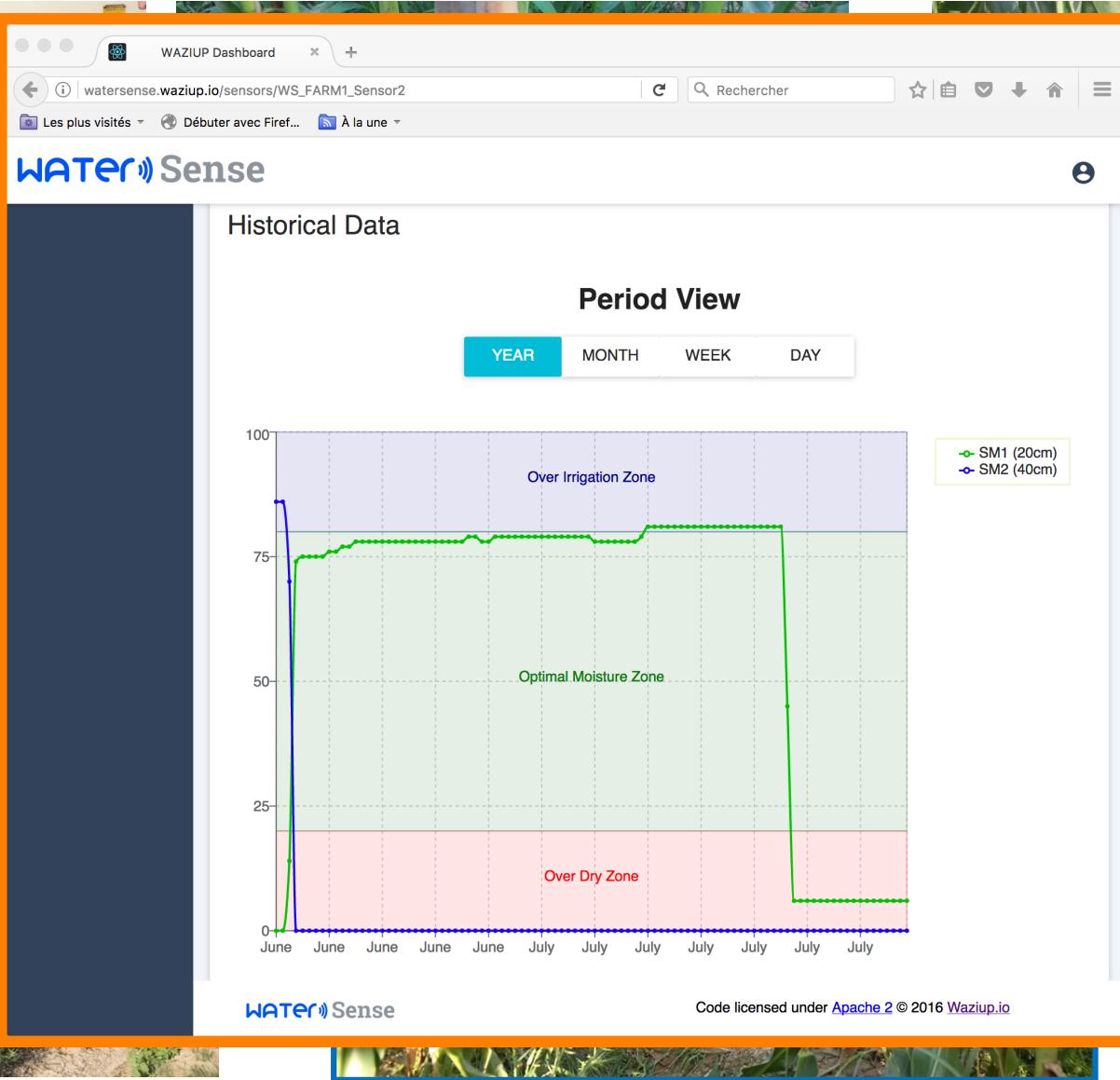


# DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT





# DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT

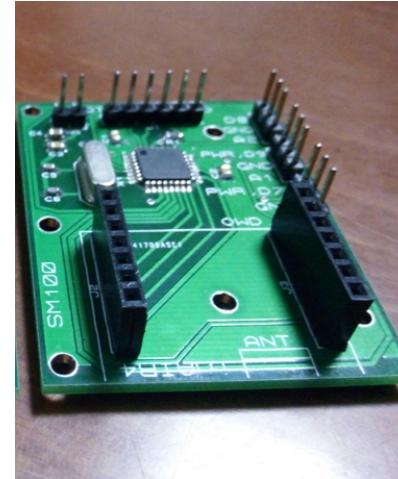


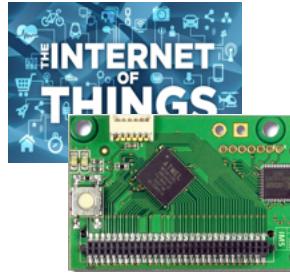


# LOCAL INTEGRATION WITH TECHNOLOGY TRANSFER

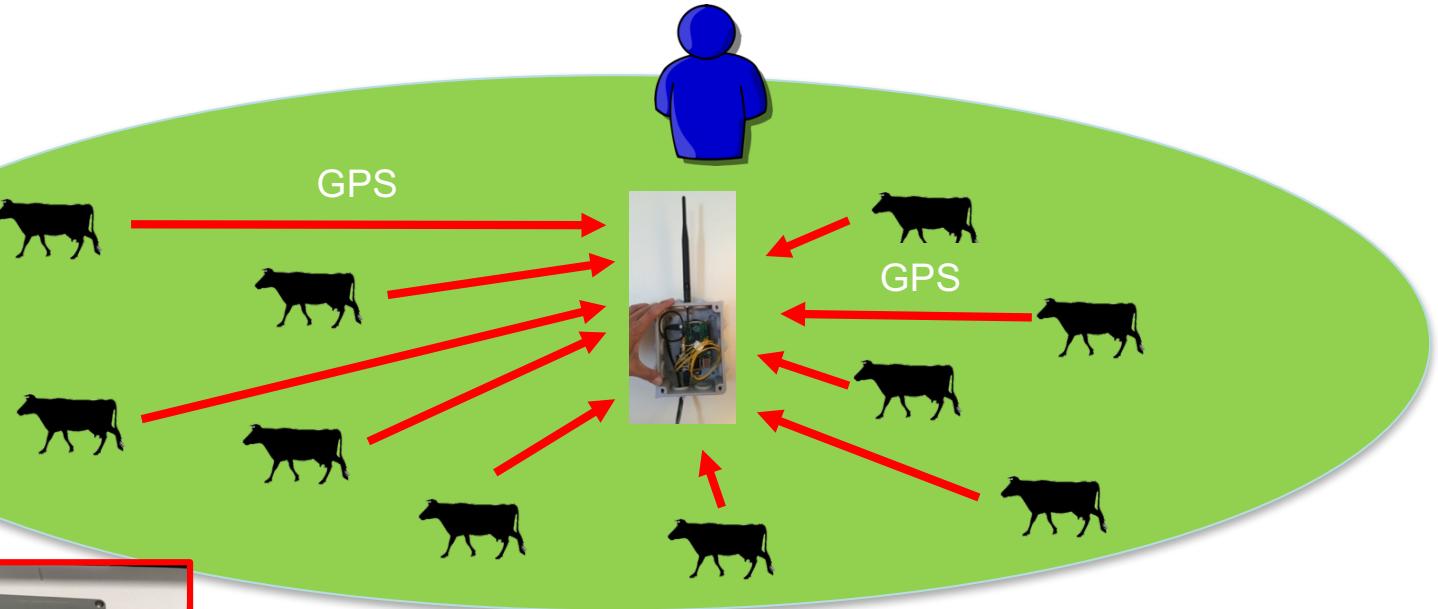
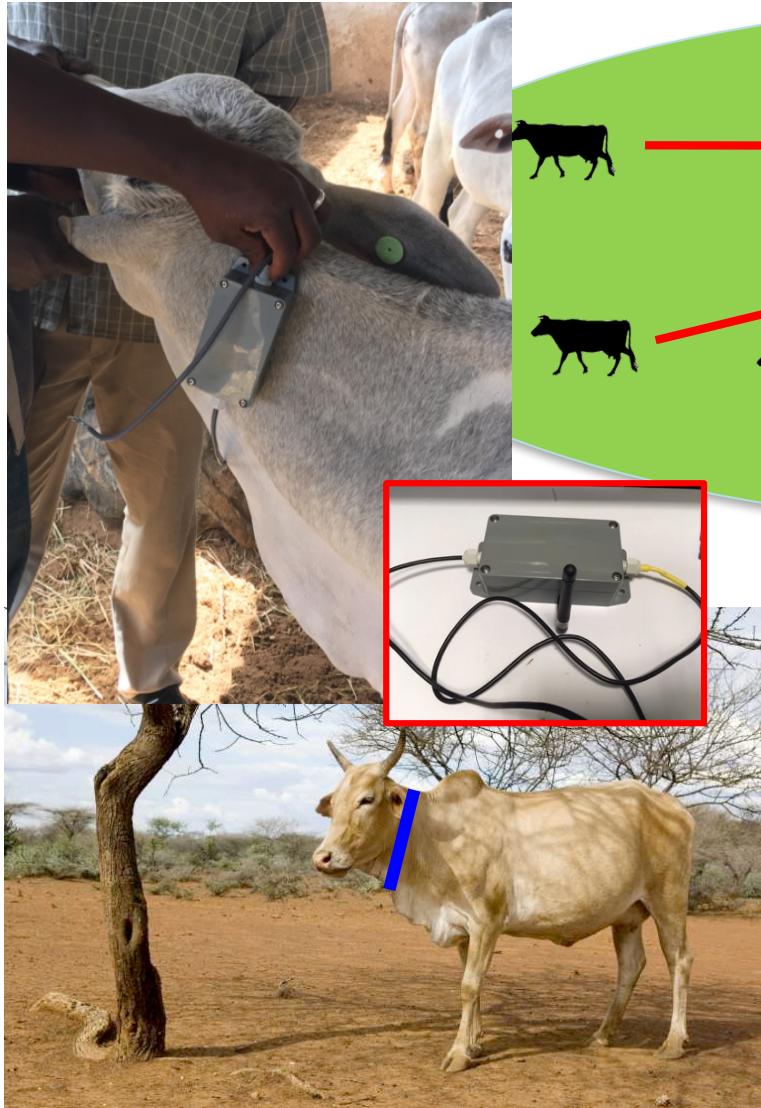


HORIZON 2020





# COLLAR FOR CATTLE RUSTLING MVP

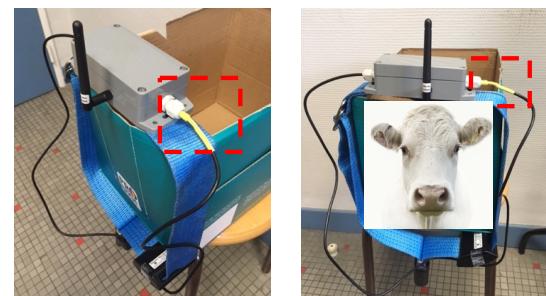
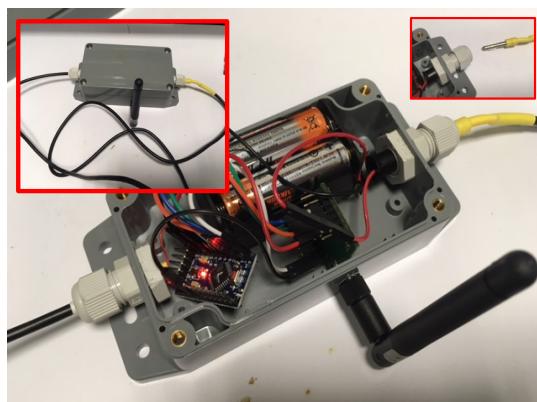
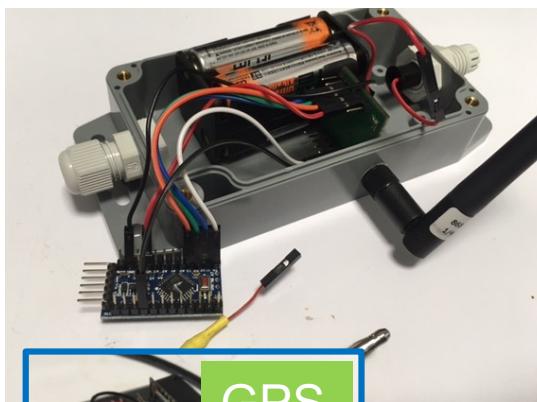
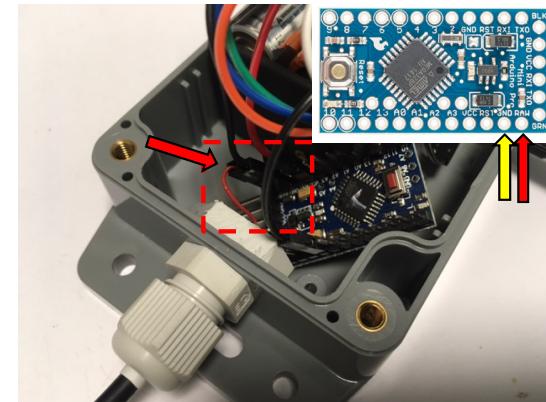
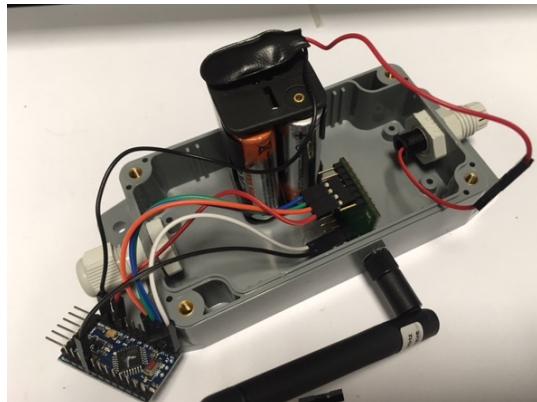


In Africa, the practice of animal husbandry has always been and still remain farmers' livelihood and incomes

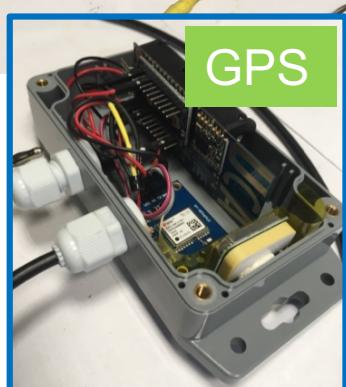
Their main problem in this activity remain the cattle rustling and some families are put in dramatic situation after a theft (reported 2 billions CFA losses)



# EASY INTEGRATION AND CUSTOMIZATION

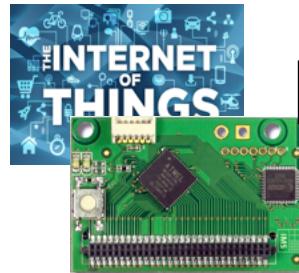


Afimilk collar courtesy of I. Andonovic  
from University of Strathclyde



Dedicated tutorial on low-cost IoT collar w/GPS

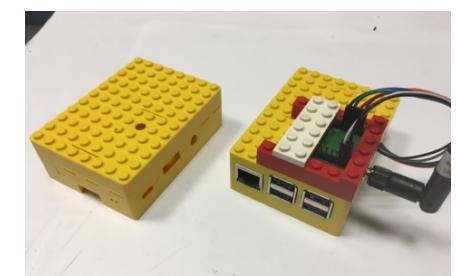
<https://github.com/CongducPham/tutorials/blob/master/Low-cost-LoRa-Collar.pdf>



# RASPBERRY-BASED LOW-COST LORA GATEWAY

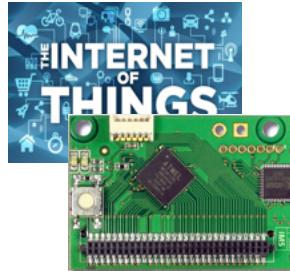


We can use all model of Raspberry. The most important usefull feature is the Ethernet interface for easy Internet connection. Then WiFi and Bluetooth can be added with USB dongles. RPI3 provides built-in Ethernet, WiFi and Bluetooth!

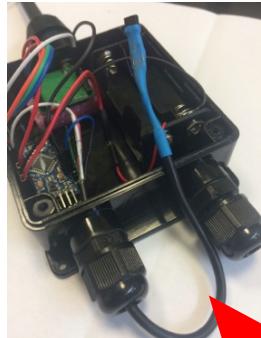
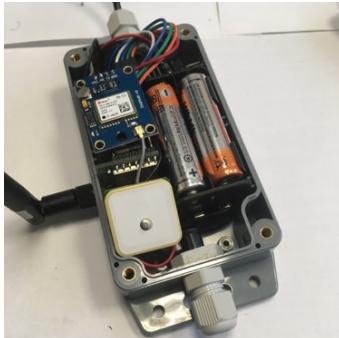


Get the ready-to-use SD card image

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



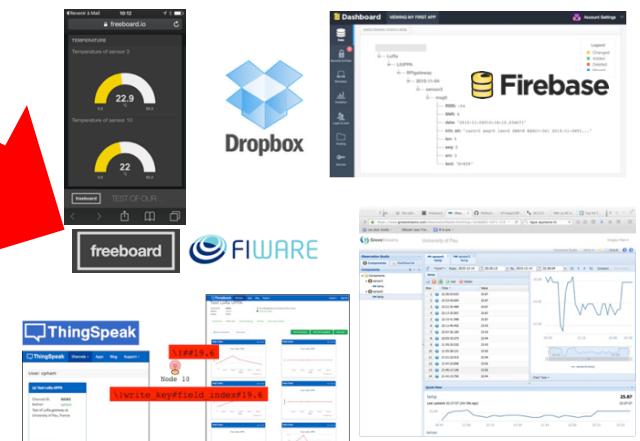
# 100% DO-IT-YOURSELF !



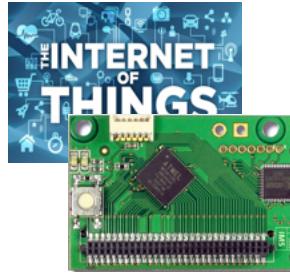
Step-by-step tutorial  
and source code  
available



Step-by-step tutorial  
and source code  
available



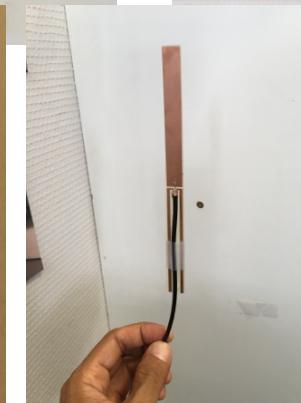
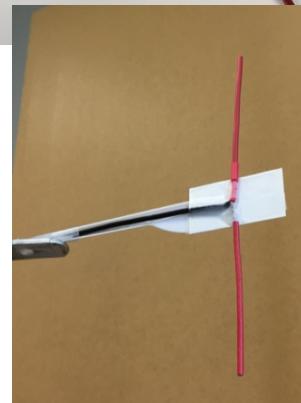
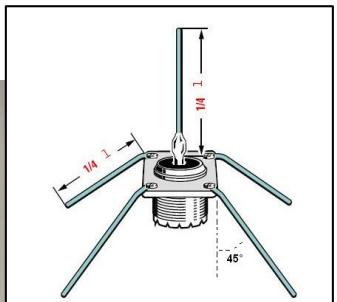
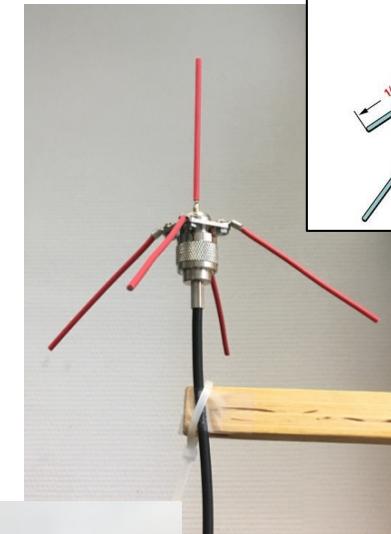
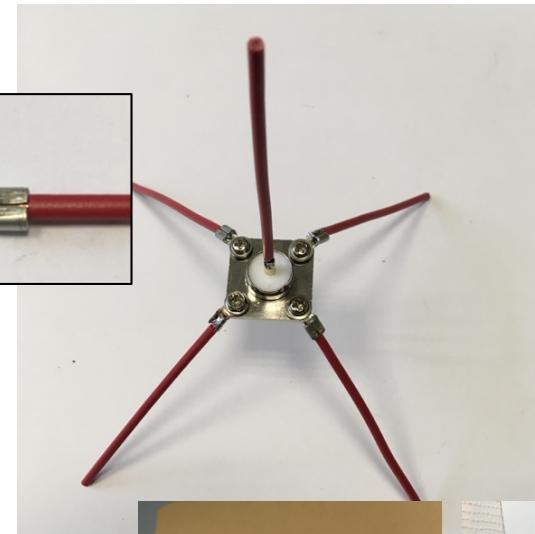
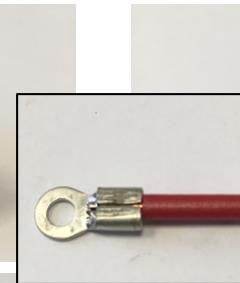
Python scripts  
available



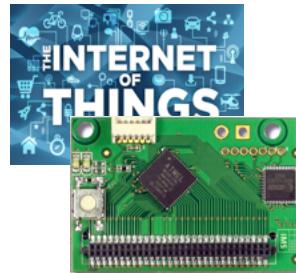
# DIY ANTENNA AS WELL



- The ground plane antenna can be made with 5 pieces of  $\frac{1}{4}$  wave wires.  $\frac{1}{4}$  wave in 868MHz is about 8.2cm.



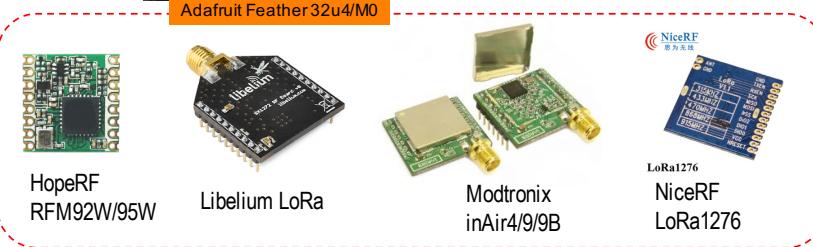
- Simple dipole antenna



# SIMPLICITY!



LoRa radios that our library already supports

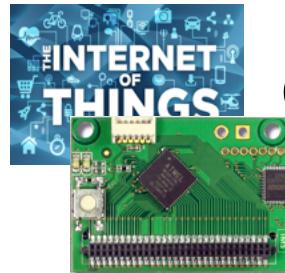


Long-Range communication library

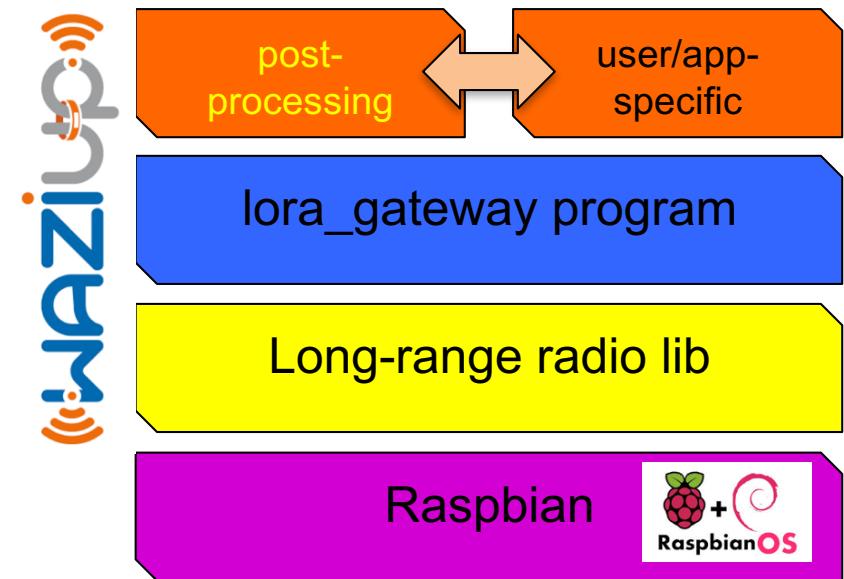
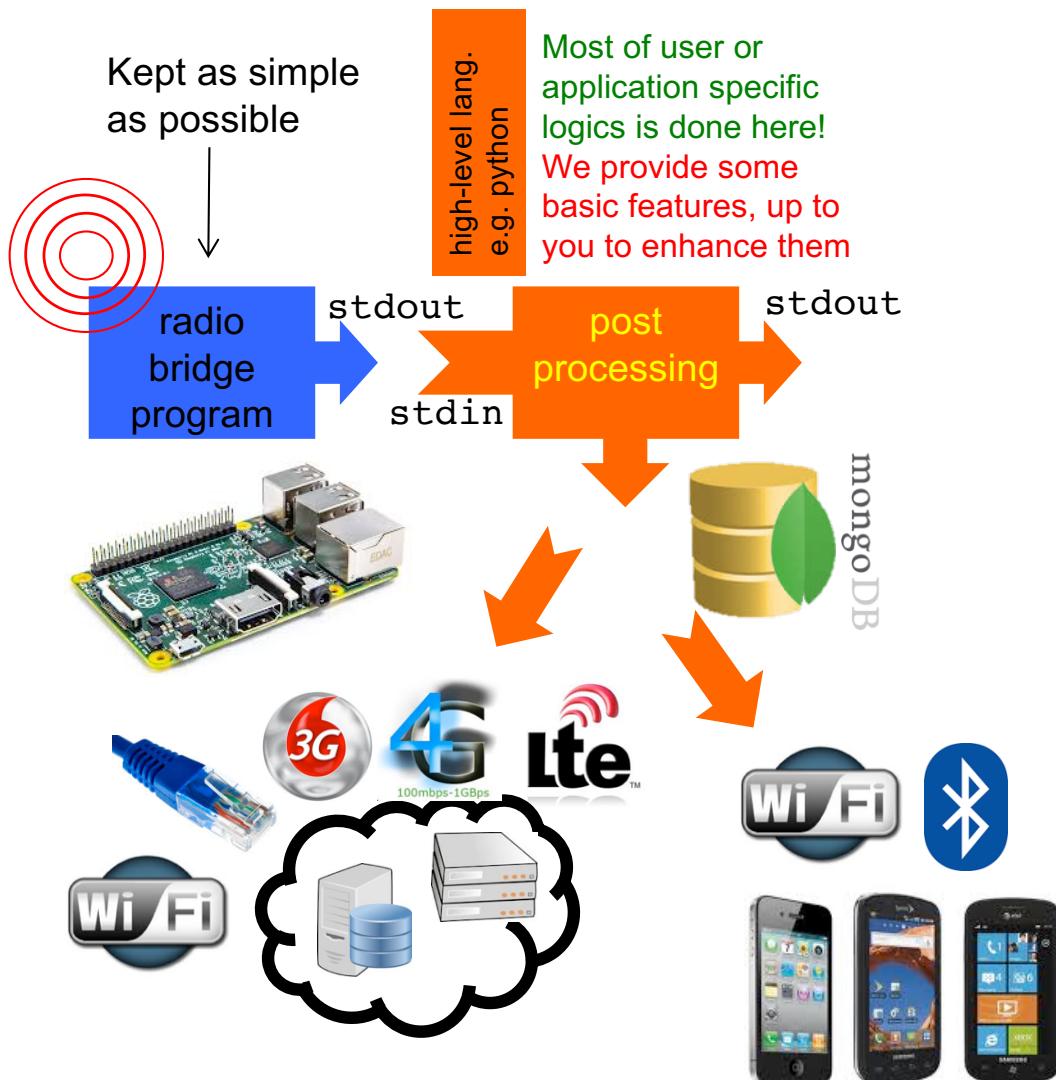
```
sendPacketTimeout("TC/18.5");
// sends to gateway
// TC : temperature celcius
// 18.5 : value
```

1 send function!

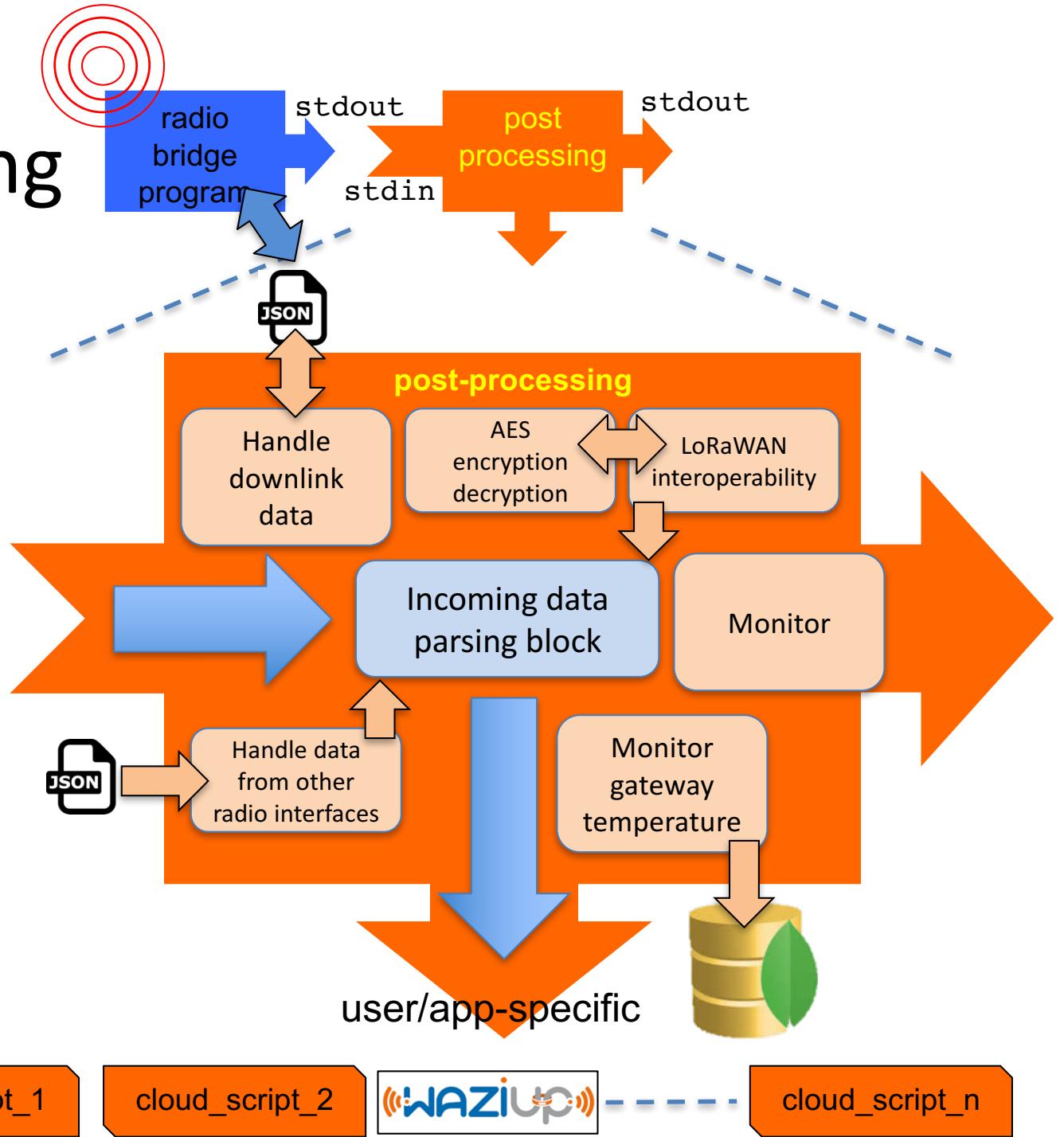




# OUR LOW-COST GATEWAY ARCHITECTURE



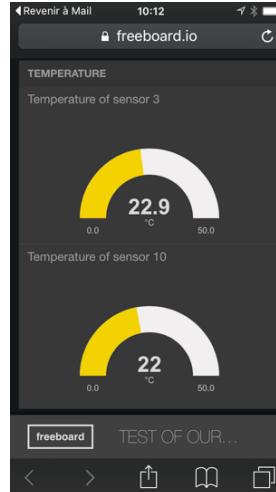
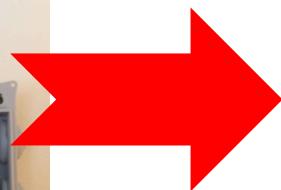
# Post-processing stage



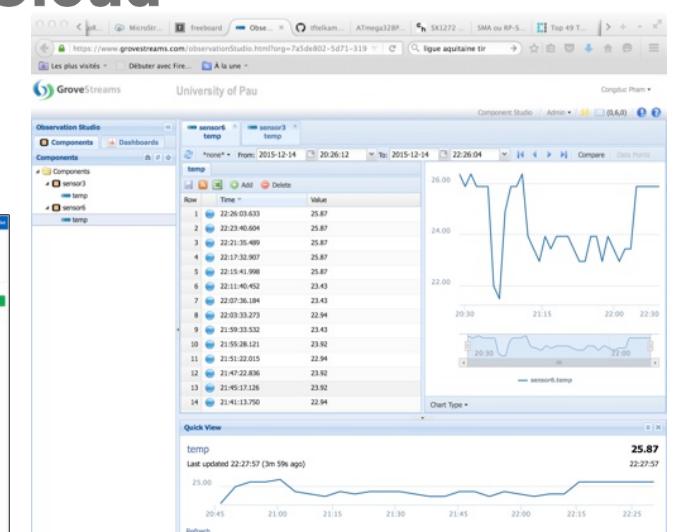
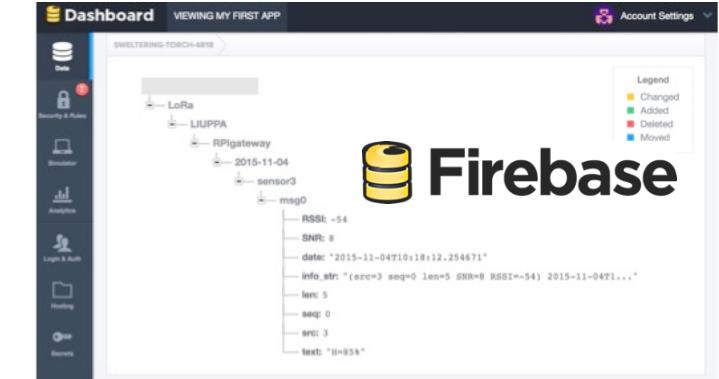


# TEMPLATES FOR VARIOUS CLOUDS

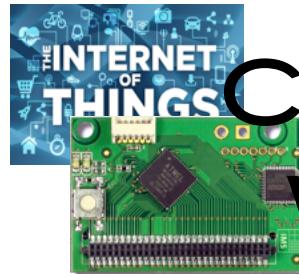
WAVESHARE



\!#\#19.6  
\!write\_key#field\_index#19.6



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



# CONFIGURE YOUR GATEWAY WITH THE WEB INTERFACE



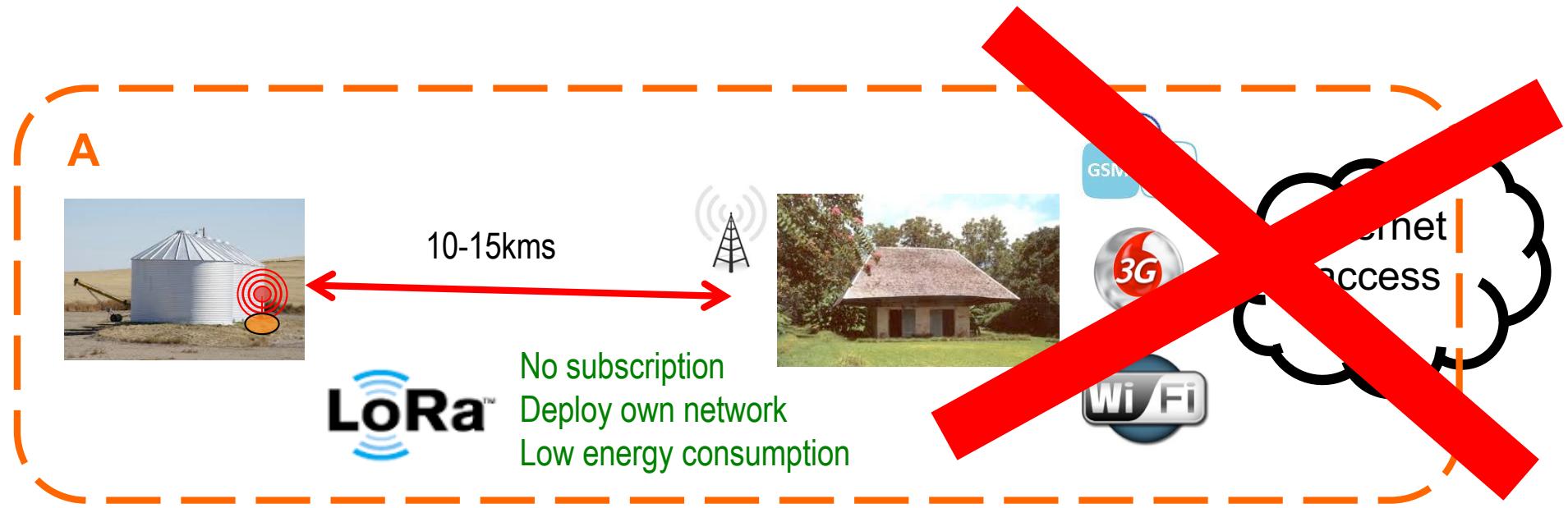
□ <http://192.168.200.1/admin>

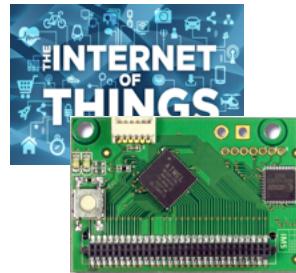
- Login: admin
- Password: loragateway

The screenshot shows a web browser window titled "Admin" with the URL "192.168.200.1/admin/pages/gateway\_config.php". The page is titled "Gateway configuration". On the left, there is a sidebar with "Clouds", "Gateway Update", and "System" options. The main content area has tabs for "Radio", "Gateway", "Alert Mail", "Alert SMS", "Downlink Request", and "Get post-processing.log file". Under the "Radio" tab, there is a table with two rows: "Mode" (value: 4) and "Frequency" (value: -1). Each row has an edit icon on the right.

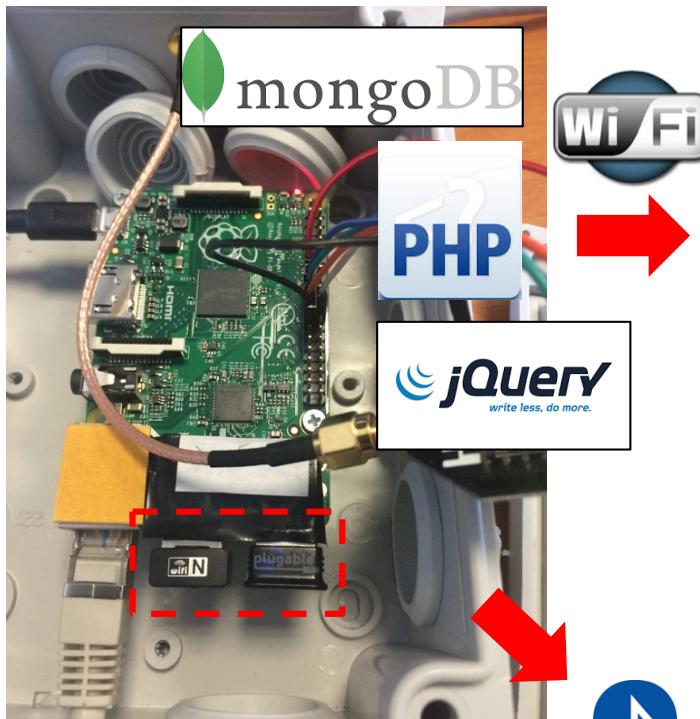


# WORKING WITHOUT INTERNET ACCESS

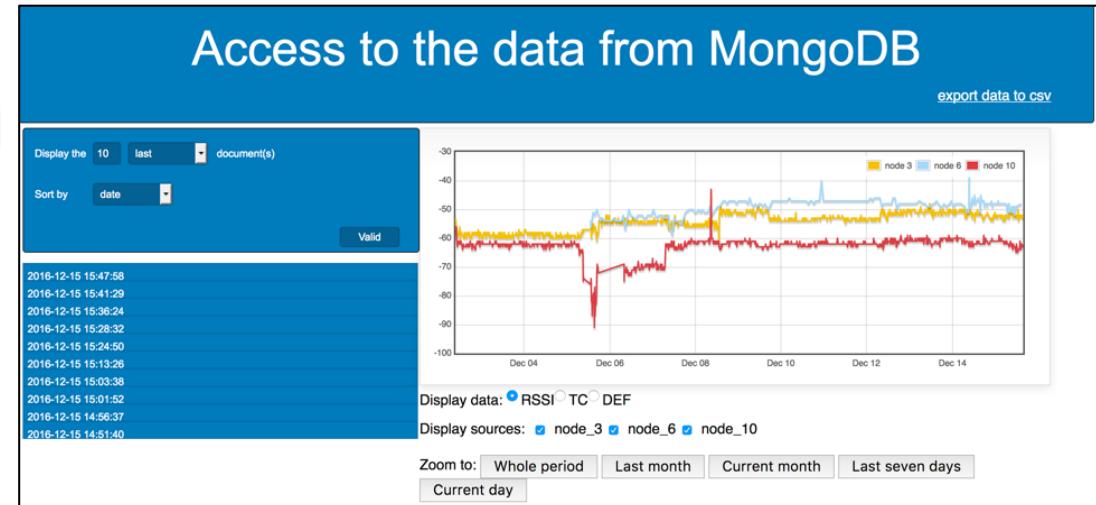




# STANDALONE GATEWAY



Isolated areas



Orange F 10:34

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 10:37

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

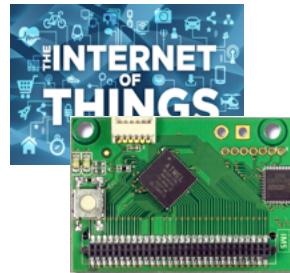
Retrieve data in a csv file

Orange F 10:39

Bluetooth\_raspi

Display data

Retrieve data in a csv file



NOW,

# IoT BECOMES REALITY!

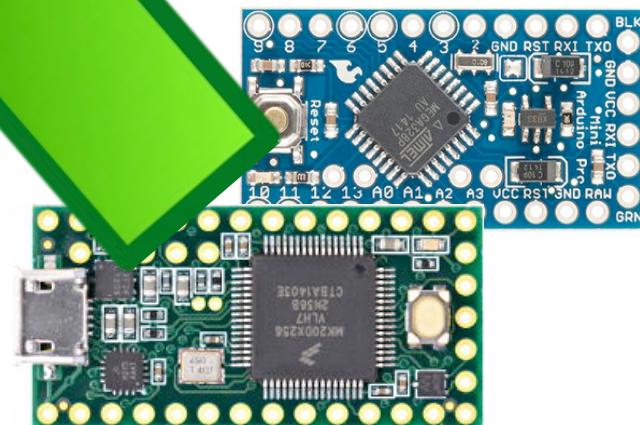


NB-LTE



Bluetooth® 4.0

nwave  
LoRa™  
NB-LTE  
WEIGHTLESS  
DASH7™  
Alliance  
LTE-M  
EC-GSM



Firebase

Dropbox

ThingSpeak

SensorCloud™

openRan

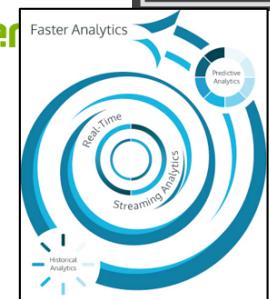
FIWARE

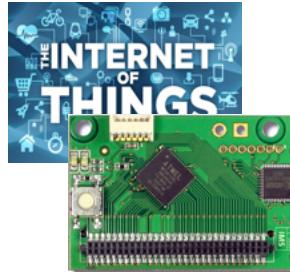
Axēda®

ioBridge®  
Connect things.

GroveStreams

freeboard





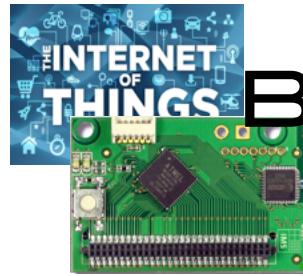
# INVOLVING INNOVATION HUBS/STAKEHOLDERS



- **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)



Credit: C. Vavasseur, CTIC Dakar



# BUILDING WAZIUP COMMUNITY AND ECOSYSTEM



International Events  
+ 20 organized & attended



Launch event (Senegal, CTIC Dakar)



Launch event (Ghana, iSpace)

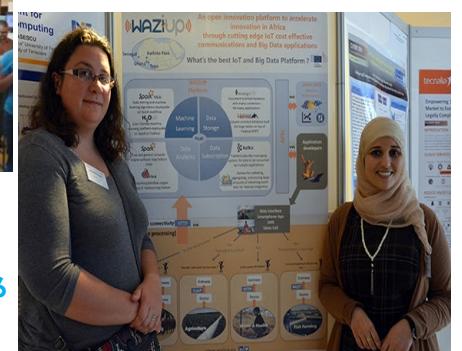
Workshop at the European Conference on Networks & Communications (Greece, CNET)



IoTWeek2016 (Belgrade, EGM)



IoTBIGDATA2016 (Italy, EGM)



IoTCareConference (Budapest, CNET)

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



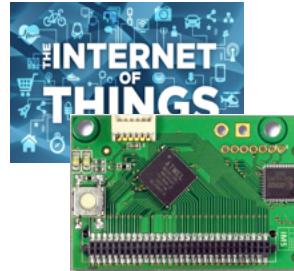
Credit: C. Vavasseur, CTIC Dakar



RESSACS 2016



Workshop at the RESSACS 2016 (France, UPPA) 52



# TUTORIALS/RESOURCES



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



EU H2020 grant agreement number 676707

Low-cost LoRa IoT devices and gateway FAQ

## 1) What is Internet-of-Thing (IoT)?

From IERC (European Research Cluster on the Internet of Thing)  
The IERC definition states that IoT is "A dynamic global network infrastructure with self-sensing capabilities based on standard communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the Internet".

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 via a network without requiring human-to-computer interaction."

## 2) What is WAZIUP?

The EU-H2020 WAZIUP project, namely the Open Innovation Platform for IoT-dig Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to support the development of local economies in Sub-Saharan Africa. First, WAZIUP creates by involving farmers and breeders in order to define the platform specifications in a focused validation cases. Second, WAZIUP proposes solutions aiming at long term sustainability. Also, it engages the flourishing ICT ecosystem in those countries by fostering new tools and guidelines for the development of interoperable platforms. Fully open source, oriented to radically new paradigms for innovative application/services delivery, WAZIUP is driven by the following vision:

1. Empower the rural population in Sub-Saharan Africa to empower the African rural population in Sub-Saharan Africa 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



PROF. CONGUDC PHAM  
[HTTP://WWW.UNIV-PAU.FR-/CPHAM](http://WWW.UNIV-PAU.FR-/CPHAM)  
UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

## LOW-COST LoRA IoT DEVICE: A STEP-BY-STEP TUTORIAL



PROF. CONGUDC PHAM  
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## BUILDING AN IoT DEVICE FOR OUTDOOR USAGE: A STEP-BY-STEP TUTORIAL



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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

+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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Communication & Event Manager

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[linkedin.com/groups/8156933](https://linkedin.com/groups/8156933)



[github.com/waziup](https://github.com/waziup)