Concevoir et déployer des objets connectés à faible coût

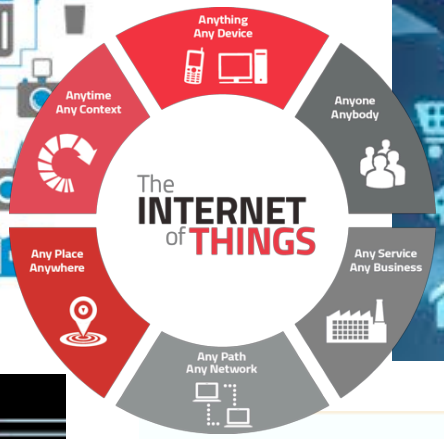
* * *

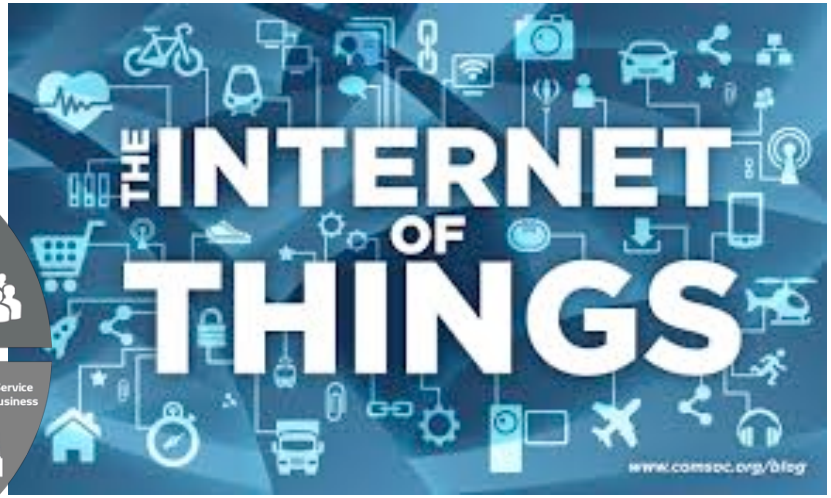
une opportunité pour développer l'agriculture numérique

ENSA Safi
March 13th, 2019

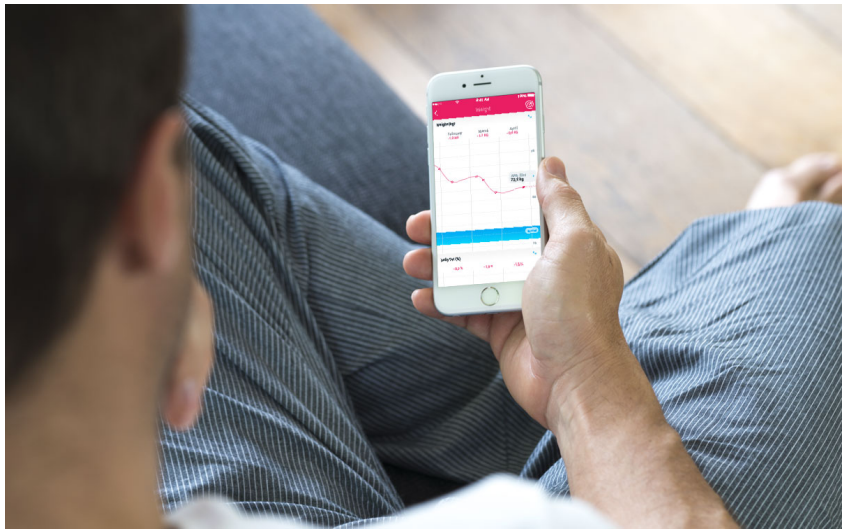
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham
Université de Pau, France

Communicating Objects



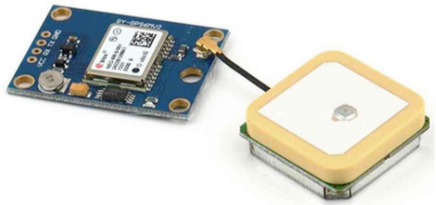


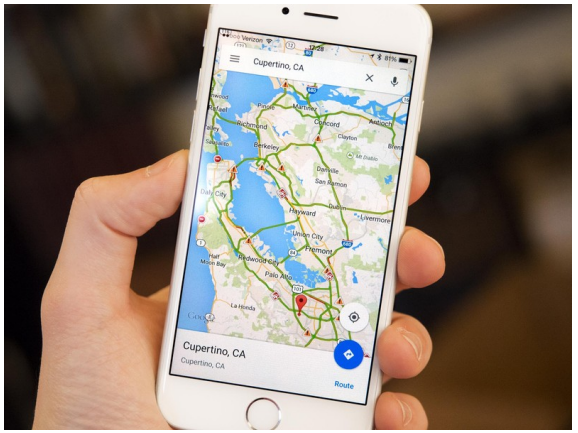
Home/consumer IoT products



Pictures from WiThing, https://www.withings.com/eu/fr/products/body

Monitoring the physical world





Monitor, Optimize & Control !

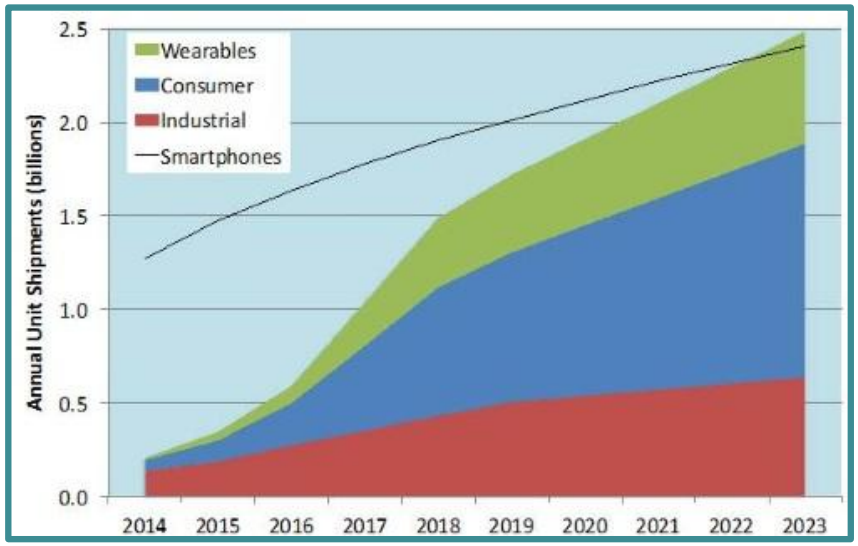
DATA ANALYSIS, OPTIMIZATION & CONTROL

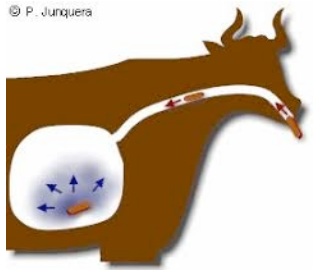
MONITORING

SENSING

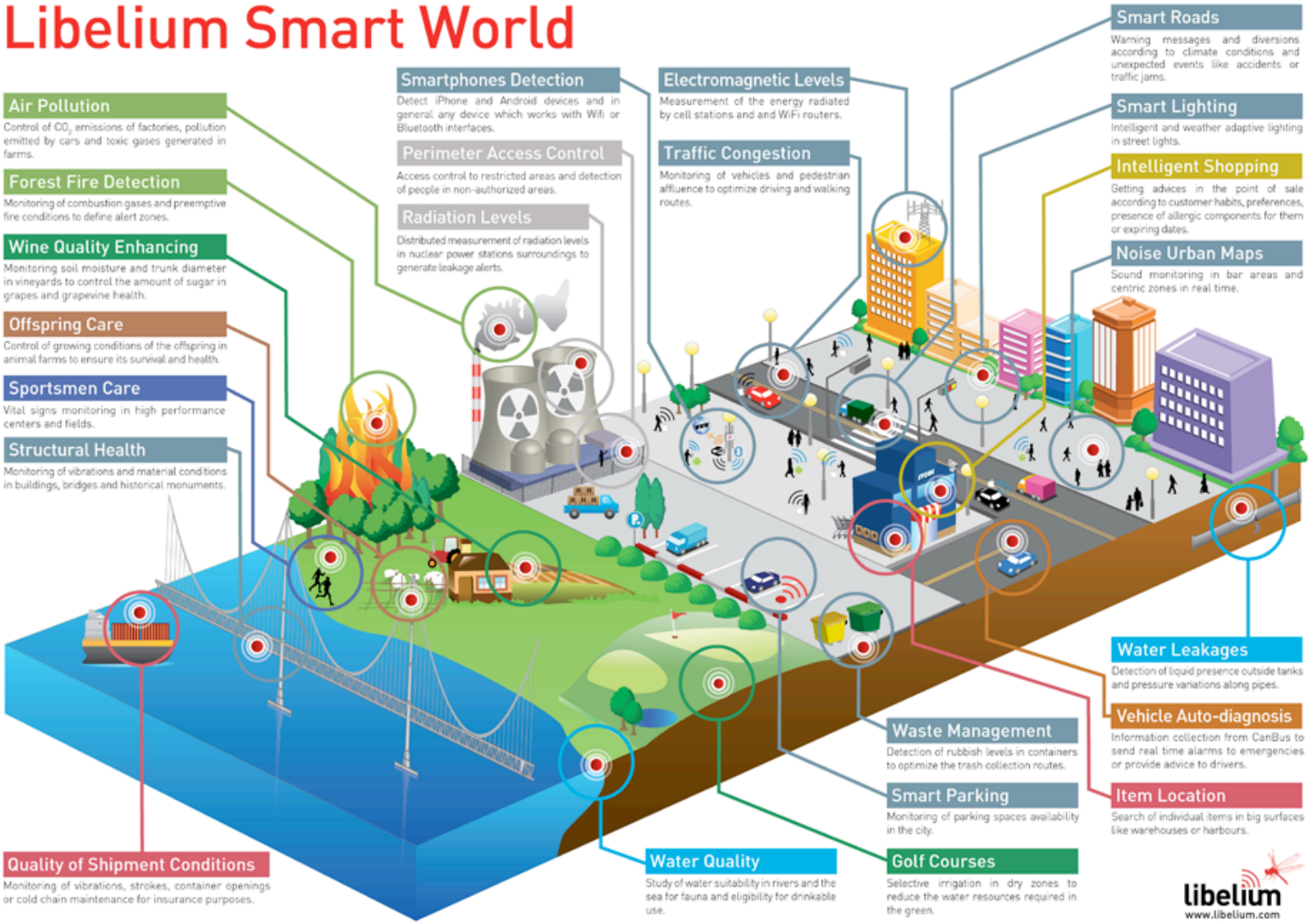
APPLICATION DOMAINS

One of the most promising market is IoT!



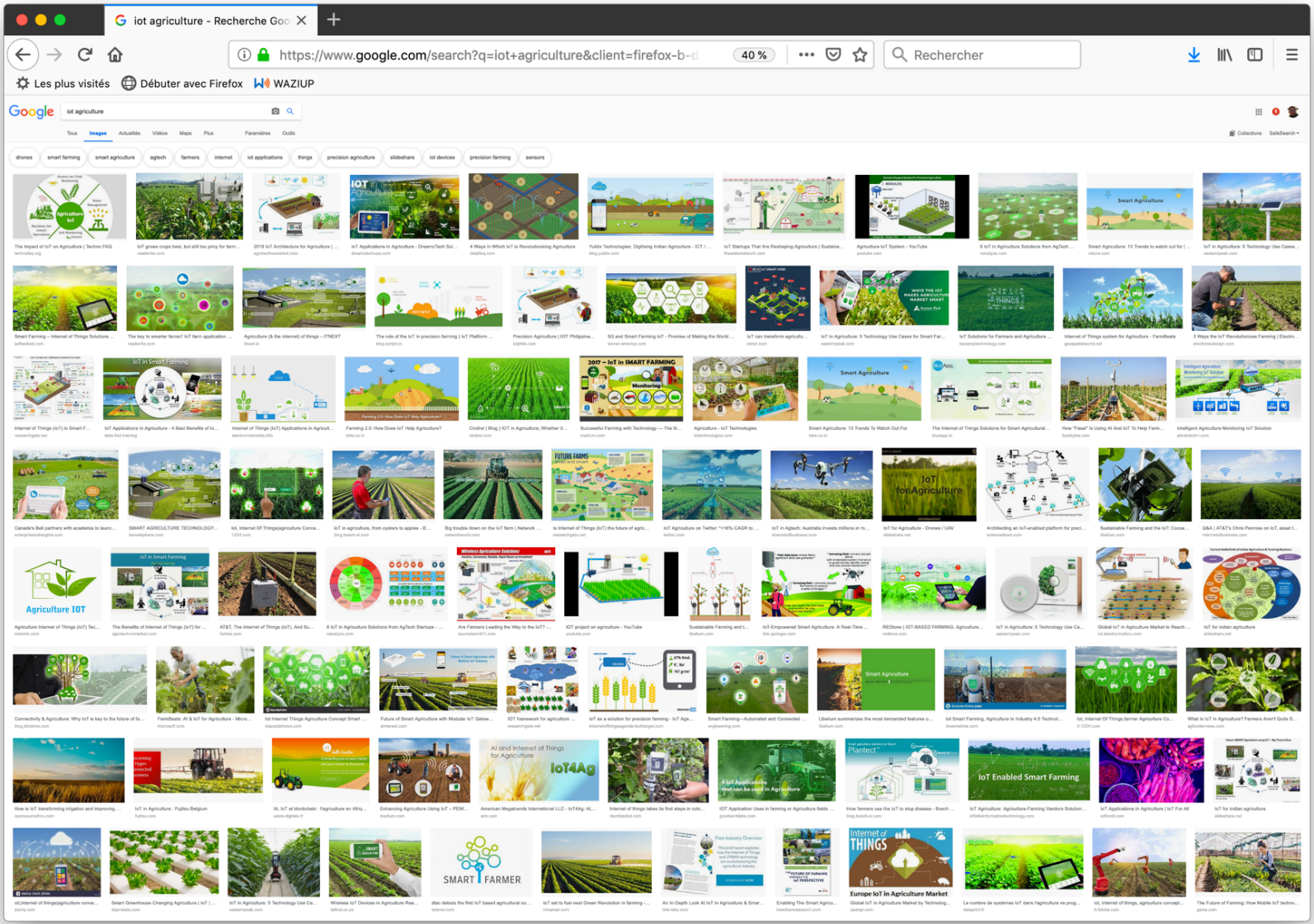


Example 1: Cities



HTTP://WWW.LIBELIUM.COM/TOP_50_IOT_SENSOR_APPLICATIONS_RANKING/#SHOW_INFOGRAPHIC

Example 2: Farming & Agriculture



IoT in agriculture= smart agriculture

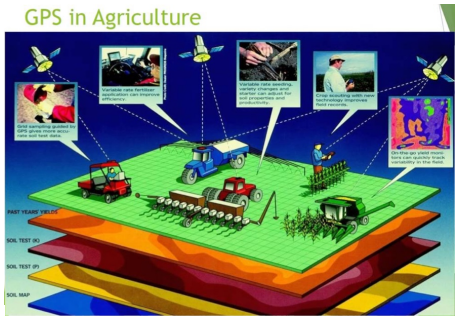
IoT in Agriculture: 5 Technology Use Cases for Smart Farming (and 4 Challenges to Consider)

- **Data, tons of data, collected by smart agriculture sensors,** e.g. weather conditions, soil quality, crop's growth progress or cattle's health. This data can be used to track the state of your business in general as well as staff performance, equipment efficiency, etc.
- **Better control over the internal processes and, as a result, lower production risks**. The ability to foresee the output of your production allows you to plan for better product distribution. If you know exactly how much crops you are going to harvest, you can make sure your product won't lie around unsold.
- **Cost management and waste reduction thanks to the increased control over the production**. Being able to see any anomalies in the crop growth or livestock health, you will be able to mitigate the risks of losing your yield.
- **Increased business efficiency through process automation**. By using smart devices, you can automate multiple processes across your production cycle, e.g. irrigation, fertilizing, or pest control.
- **Enhanced product quality and volumes**. Achieve better control over the production process and maintain higher standards of crop quality and growth capacity through automation.

The adoption of IoT solutions for agriculture is constantly growing. Namely, BI Intelligence predicts that the number of agriculture IoT device installations will hit 75 million by 2020, growing 20% annually.
At the same time, the global smart agriculture market size is expected to triple by 2025, reaching $15.3 billion (compared to being slightly over $5 billion back in 2016).

- Climate conditions
- Greenhouse automation
- Plant & soil monitoring
- Fertilizer optimization
- Crop management
- Livestock monitoring
- End-to-end farm mngt
- …

Most of existing system are not adapted for small holders



SMALLHOLDERS AND FAMILY FARMERS

DID YOU KNOW?

ENVIRONMENT

Eighty percent of the farmland in sub-Saharan Africa and Asia is managed by smallholders (working on up to 10 hectares). While 75 percent of the world's food is generated from only 12 plants and 5 animal species, making the global food system highly vulnerable to shocks, biodiversity is key to smallholder systems who keep many rustic and climate-resilient varieties and breeds alive.

ECONOMY

Out of the 2.5 billion people in poor countries living directly from the food and agriculture sector, 1.5 billion people live in smallholder households. Many of those households are extremely poor: overall, the highest incidence of workers living with their families below the poverty line is associated with employment in agriculture.

SOCIAL

Women comprise an average of 43 percent of the agricultural labour force of developing countries up to almost 50 percent in Eastern and Southeastern Asia and sub-Saharan Africa. Should women farmers have the same access to productive resources as men, they could increase yields on their farms by 20-30 percent, lifting 100-150 million people out of hunger. Women are the quiet drivers of change towards more sustainable production systems and a more varied and healthier diet.

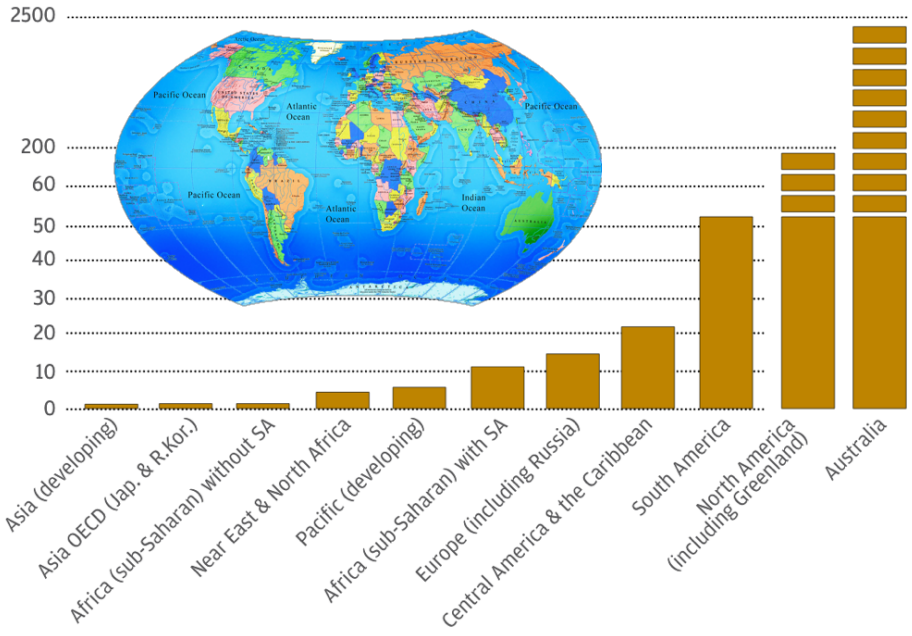
GOVERNANCE

Smallholders provide up to 80 percent of the food supply in Asian and sub-Saharan Africa. Their economic viability and contributions to diversified landscape and culture is threatened by competitive pressure from globalization and integration into common economic areas; their fate is either to disappear and become purely self-subsistence producers, or to grow into larger units that can compete with large industrialized farms.

Food and Agriculture Organization of the United Nations

Smallholders are small-scale farmers, pastoralists, forest keepers, fishers who manage areas varying from less than one hectare to 10 hectares. Smallholders are characterized by family-focused motives such as favouring the stability of the farm household system, using mainly family labour for production and using part of the produce for family consumption.

AVERAGE SIZE OF AGRICULTURAL HOLDINGS (ha)

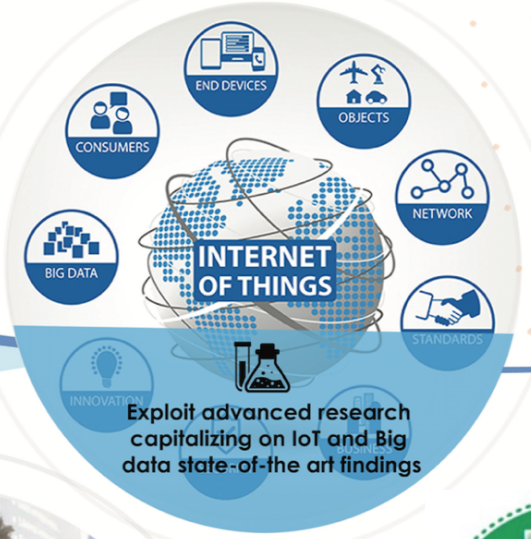


WAZIUP Open IoT and Big data platform for Africans, by Africans

Feb2016-Jan2019

HORIZON 2020

Affordable technologies to empower rural economics



Exploit advanced research capitalizing on IoT and Big data state-of-the art findings

Develop IoT solutions and applications meeting African needs

DO MORE with LESS

www.waziup.eu

Waziup IoT

Waziup IoT

Waziup

Waziup

waziup.community@create-net.org

IoT in developing countries and rural areas

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

Making IoT happening!

Innovative IoT technologies

"IoT for All" paradigm

IoT infrastructures and use cases

Knowledge dissemination & training

Users/Developers engagement

Innovative solutions adapted to local needs

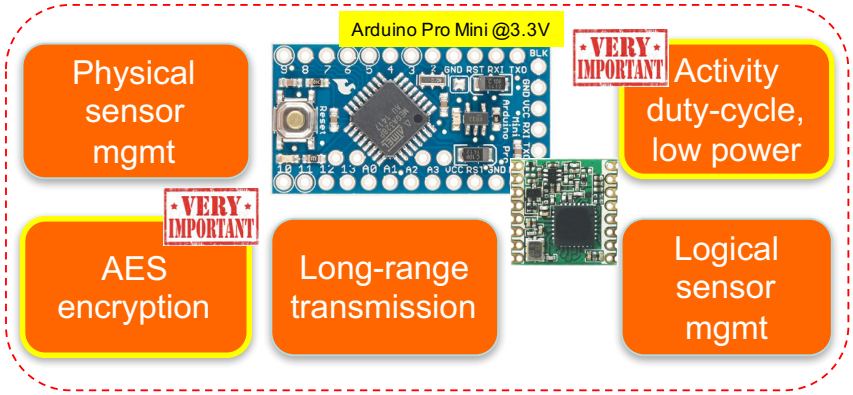
Exploitation plan and innovation hubs

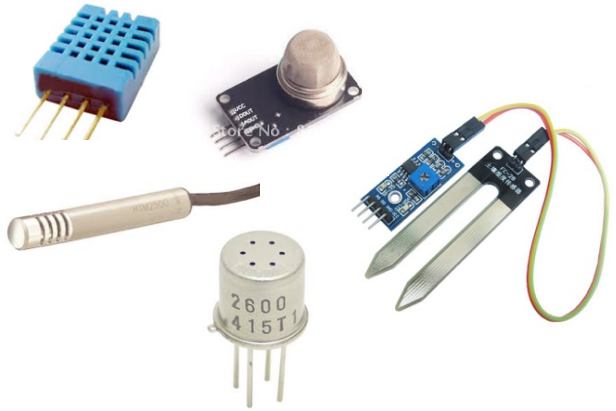
Communication & community building

Sustainable & long-term innovation

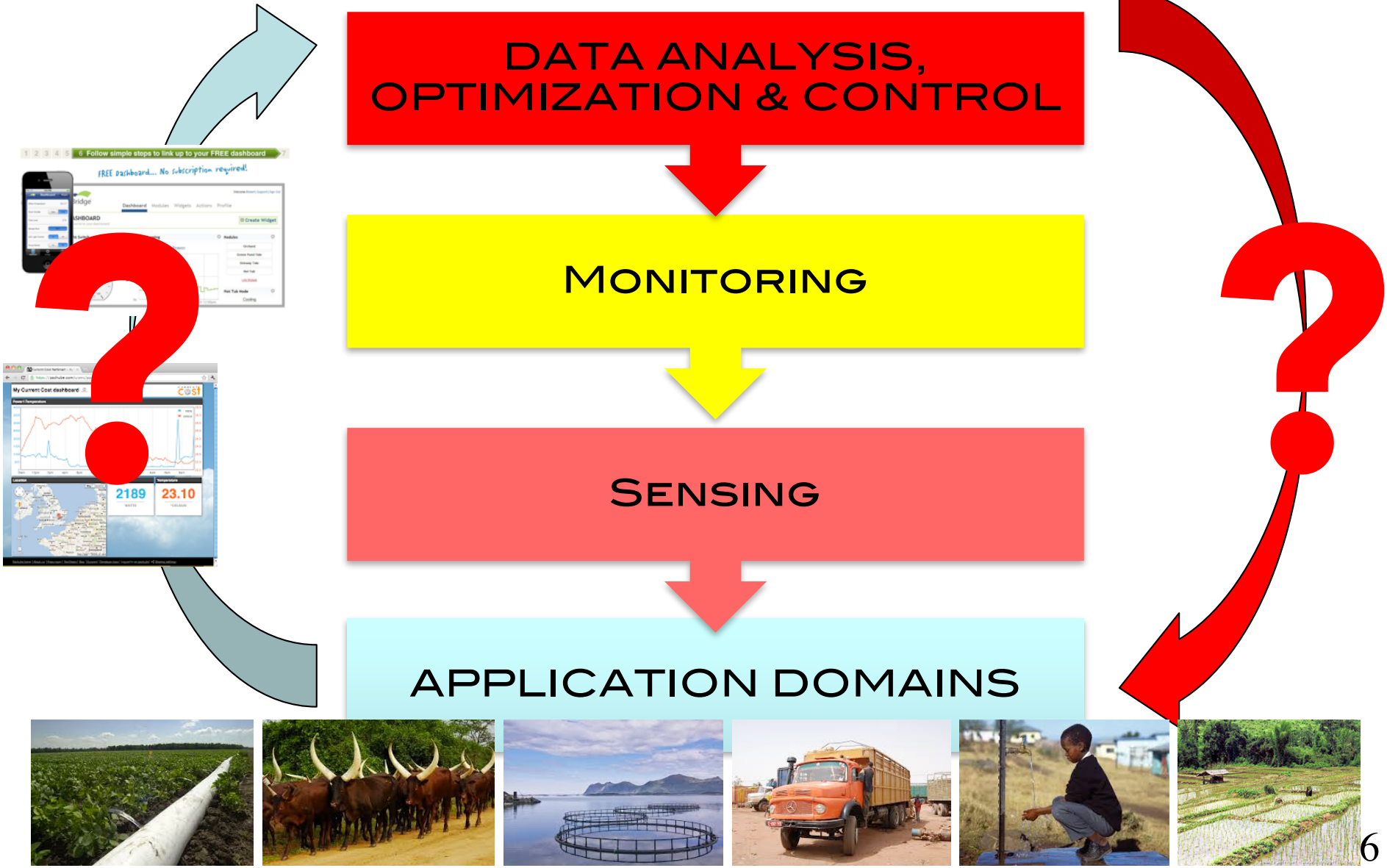
Generic IoT v.s. highly specialized

- Build low-cost, low-power, generic IoT platform
- Methodology for low-cost platform design
- Technology transfers to user communities, economic actors, stakeholders,…





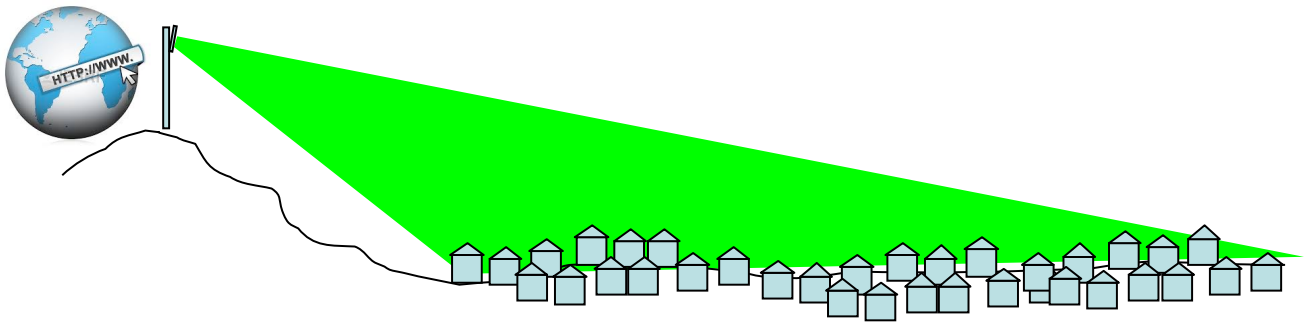
1st issue: collect data?

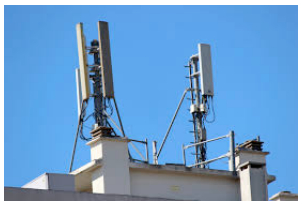


Telemetry and Transmission cost

Soil moisture monitoring

10-15kms

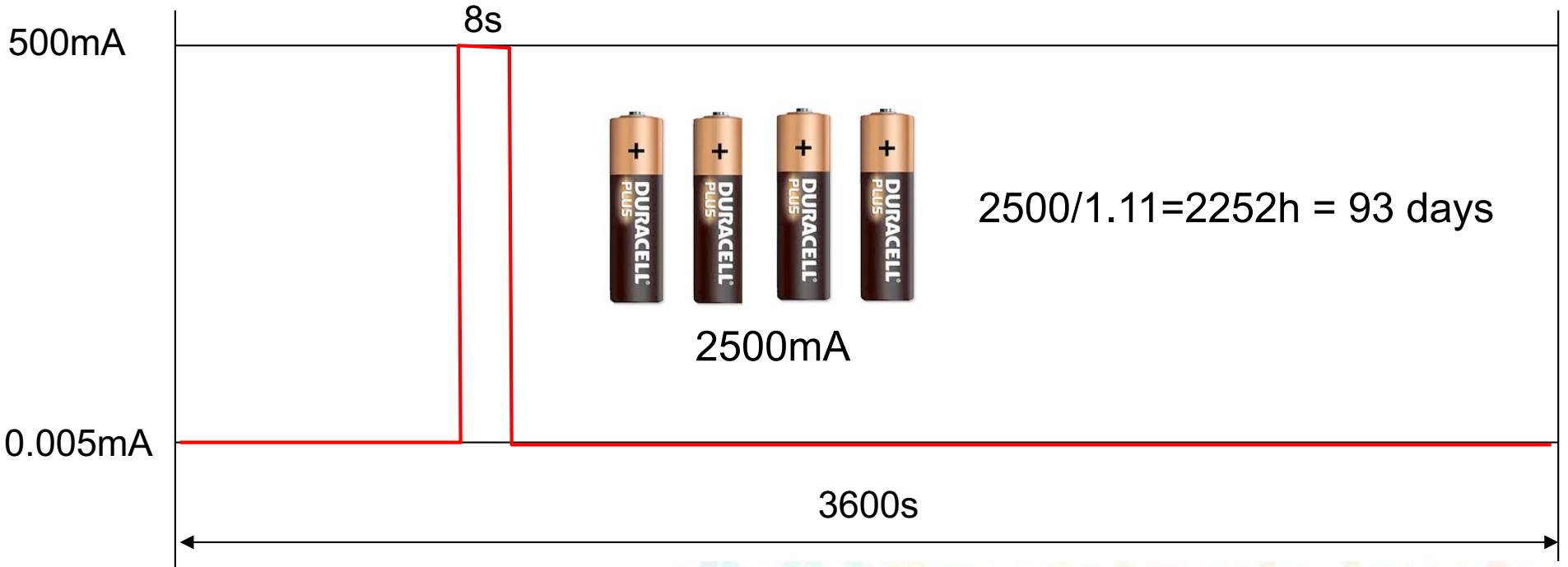


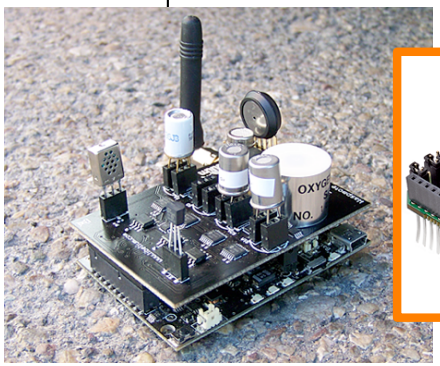


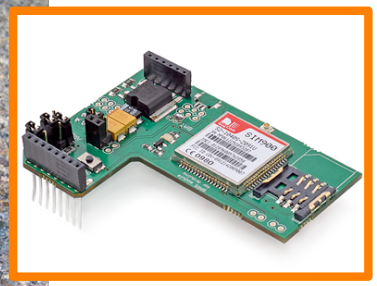
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC

Energy consideration

TX power: 500mA. Mean consumption: (8sx500+3592sx0.005)/3600=1.11mA







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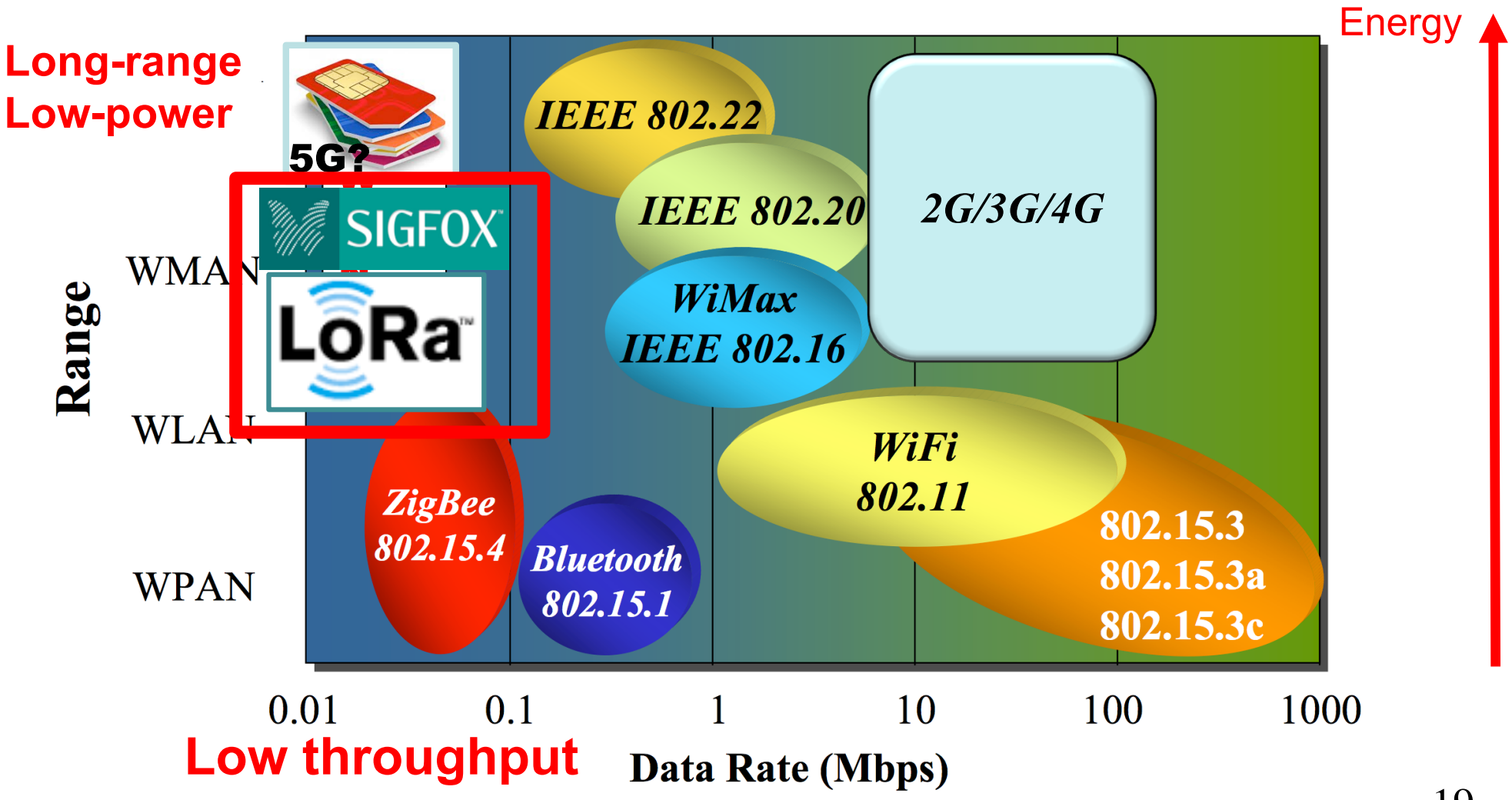
Low-power & long-range radio technologies

Energy-Range dilemma



Energy consumption comparaison

Tables from Semtech

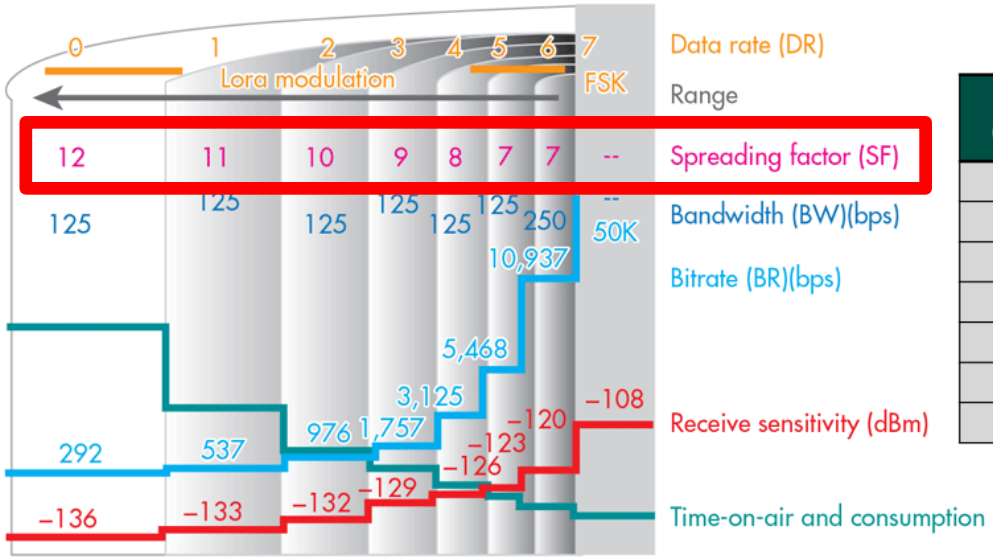
Technology	2G	3G	LAN	ZigBee	Lo Power WAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m	O: 90m I: 30m	Same as 2G/3G
Tx current consumption	200-500mA	500-1000mA	100-300mA	18mA	18mA-40mA
Standby current	2.3mA	3.5mA	NC	0.003mA	0.001mA
Energy harvesting (solar, other)	No	No	No	Possible	Possible
Battery 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)

TX power: 40mA. Mean consumption: (2sx40+3598sx0.005)/3600=0.027mA

2500/0.027=92592h = 3858 days = 10 years

Increasing range?

- Increase TX power and improve RX sensitivity
- Generally, robustness and RX sensitivity can be increased when transmitting (much) slower
- LoRa increases transmission time (spreading factor) as longer range is needed. 200bps-37.5kbps



SpreadingFactor (RegModulationCfg)	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

The price to pay!

Very low throughput: 200bps is 0.0002Mbps! WiFi is 54Mbps
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

Transmitting: `TC/22.5/HUM/67.7` ; about 20 bytes with packet header
Time on air is 1.44s

2nd issue: 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.

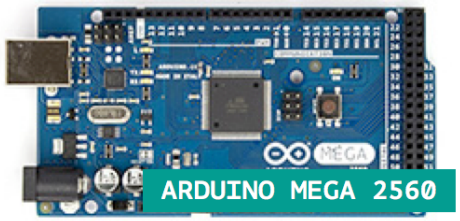
ARDUINO BOARD

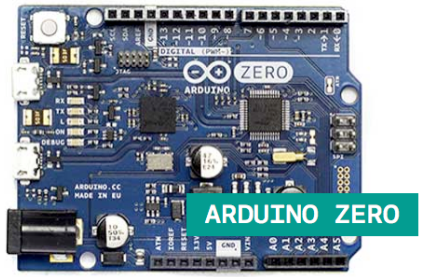
Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators.

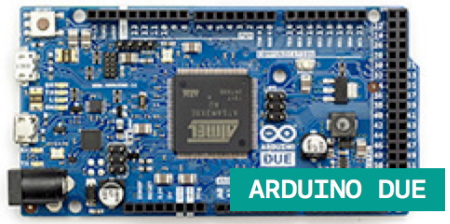
ARDUINO SOFTWARE

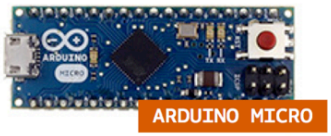
```
void setup() {
 }

void loop() {
 }
```

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



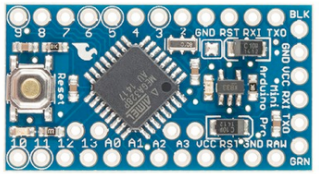






Large ecosystem, still growing…

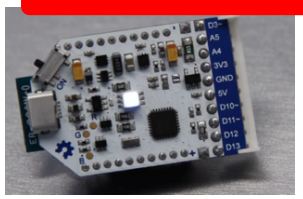
Arduino Pro Mini



LoPy

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

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

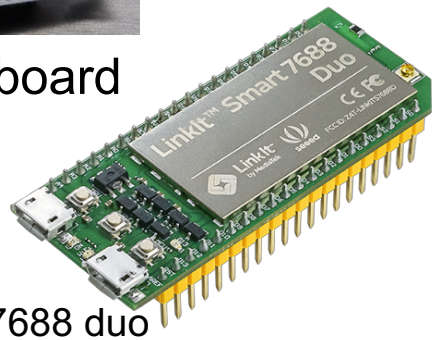


Theairboard

ARDUINO

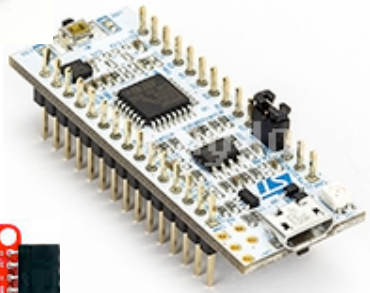
Expressif ESP32

Teensy 3.2



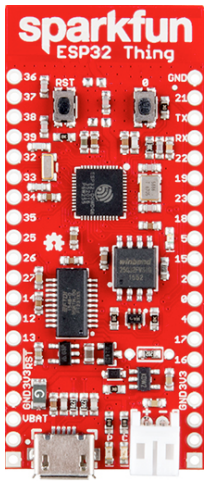
LinkIt Smart7688 duo

STM32 Nucleo-32



Heltec ESP32 + OLED

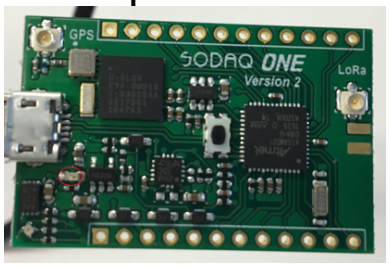
Adafruit Feather



Sparkfun ESP32 Thing

Tessel

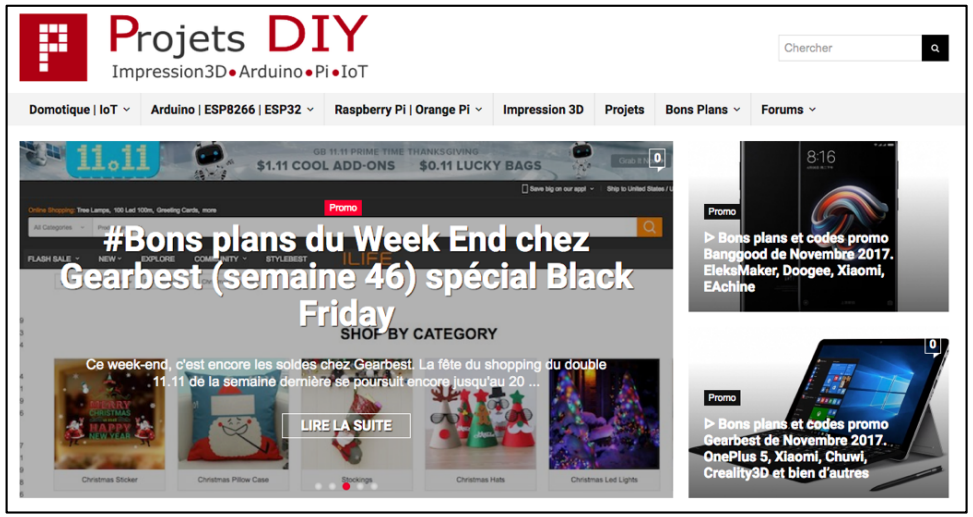
SodaqOnev2

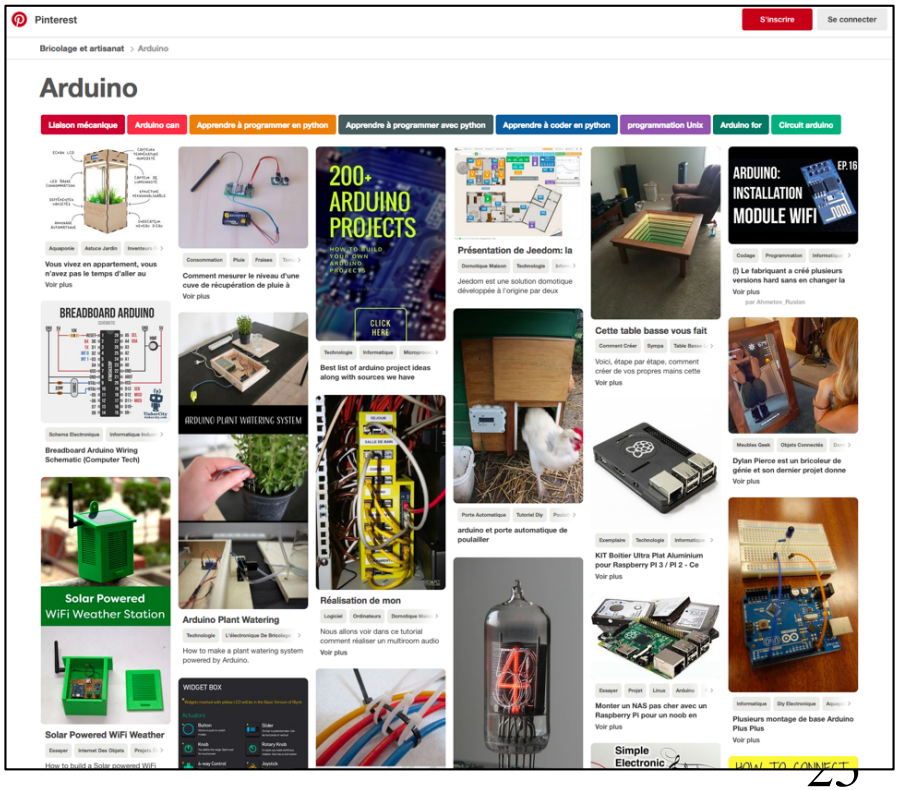


Tinyduino

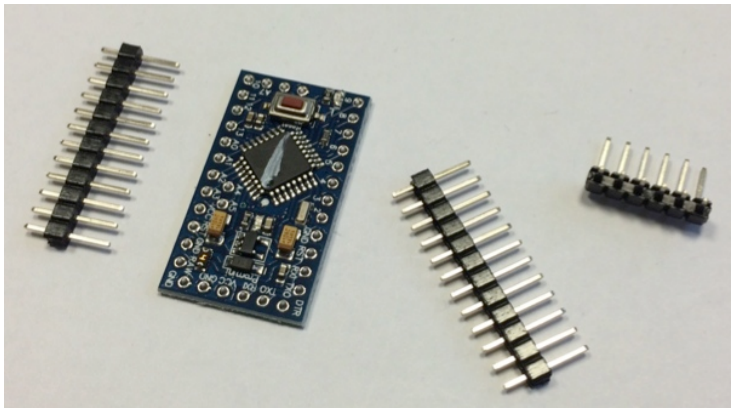
… stimulating worldwide "Do-it-Yourself" projects

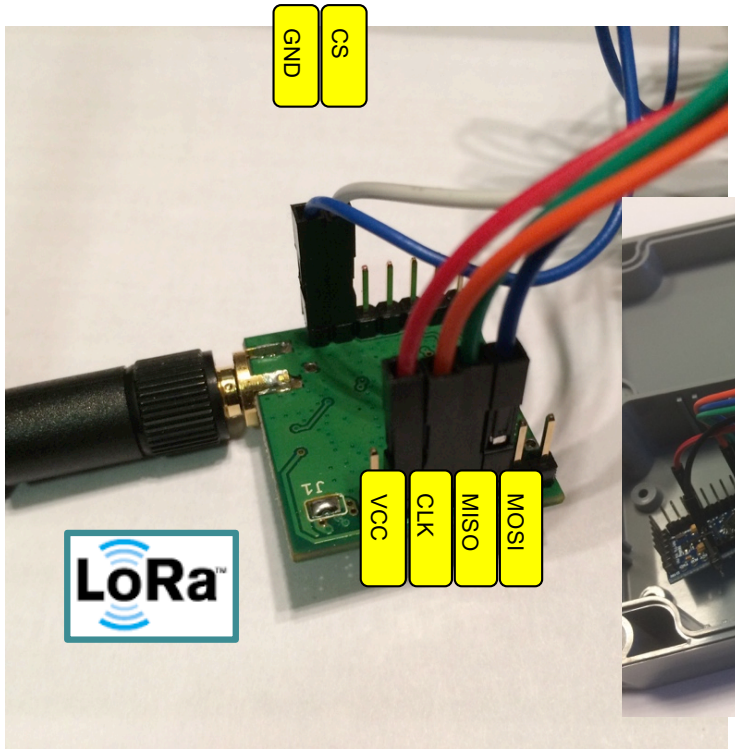
- DIY usually means
  - More open-source software from larger community
  - More flexibility

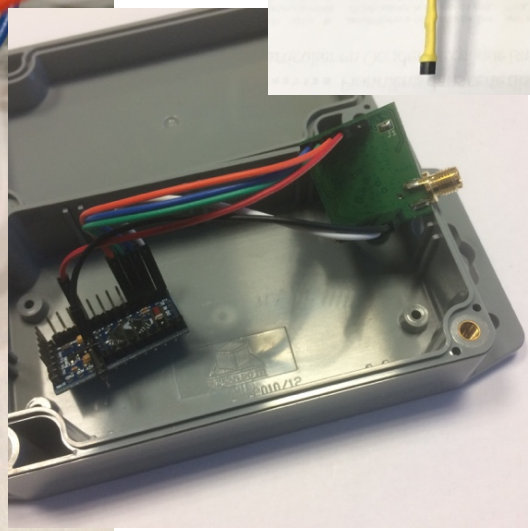




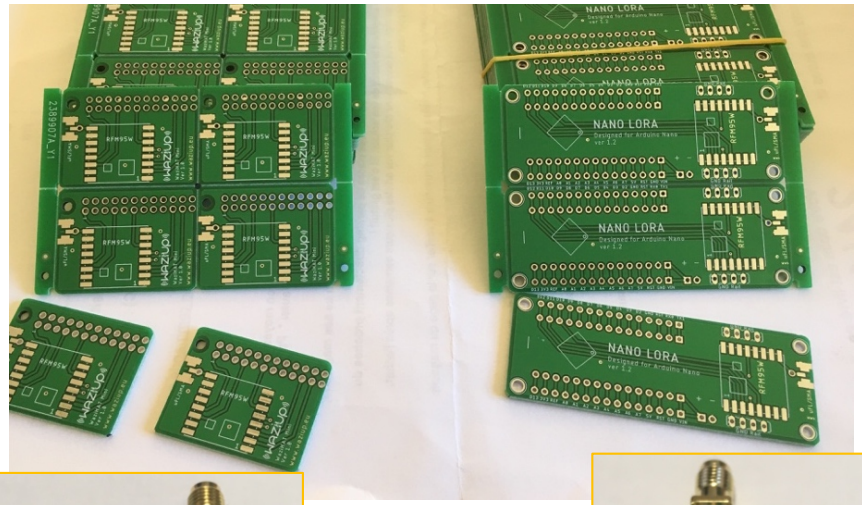
Full Do-It-Yourself approach

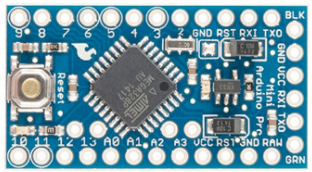






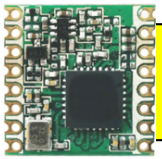
Still DIY but simple PCBs make it much easier for developers



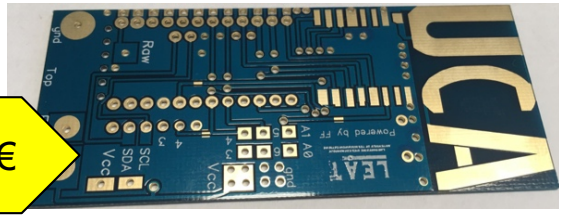


1.5€

https://github.com/FabienFerrero/UCA_Board



5€



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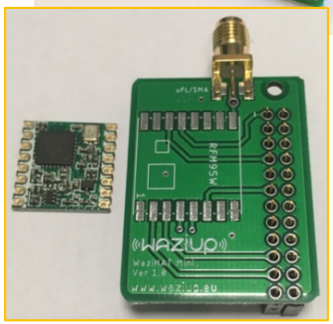
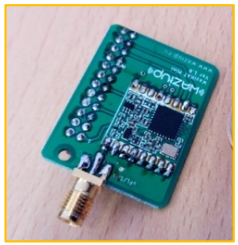
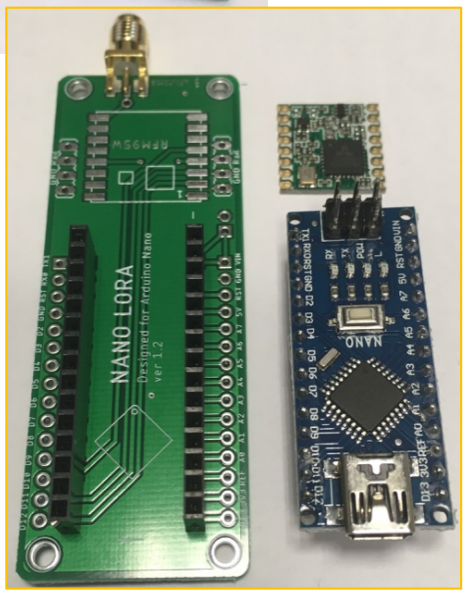
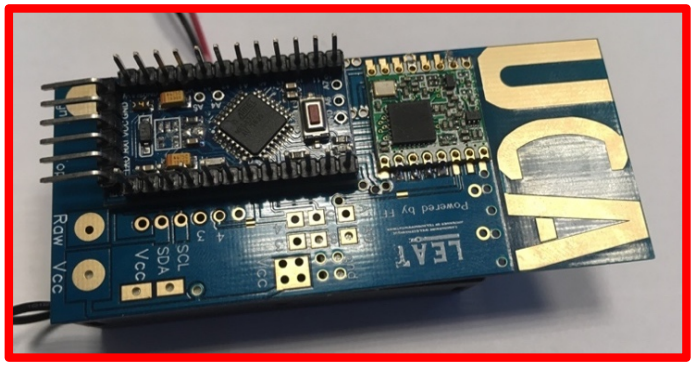
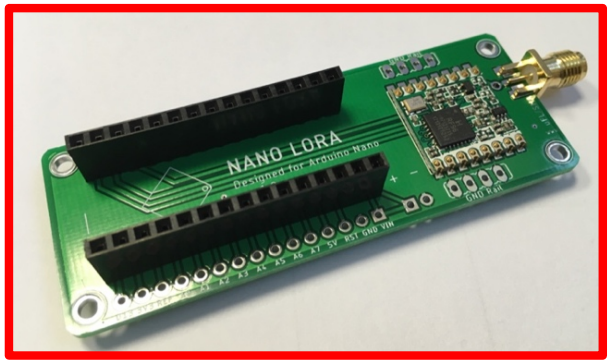
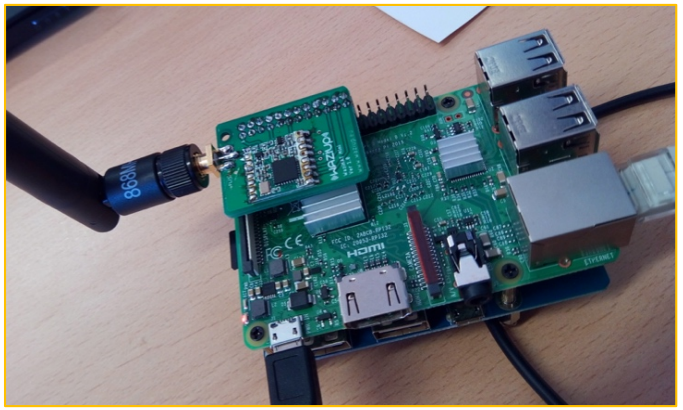






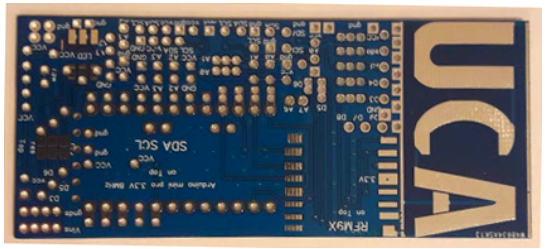


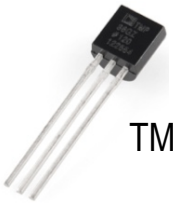




Ready-to-use IoT kits

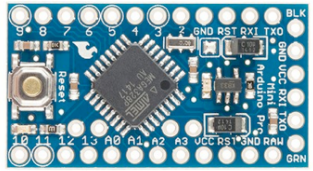
- 1 Arduino Pro Mini + FTDI breakout + 1 Arduino Nano
- RFM95 w/breakout + ¼ wave antenna
- 1 PCB w/integrated antenna (tunable)
- 0.96" OLED screen
- Jumpers+battery pack+case+breadboard
- Some sensors (LM35DZ, TMP36, DHT22, …)



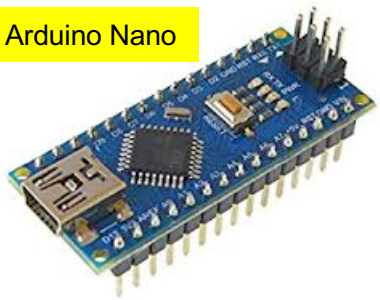


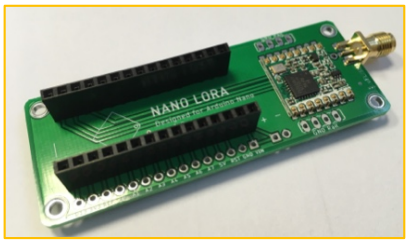
TMP36

Arduino Pro Mini @3.3V



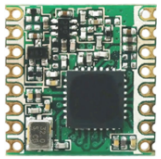
Arduino Nano

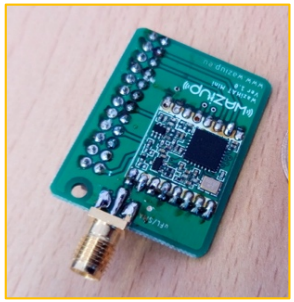


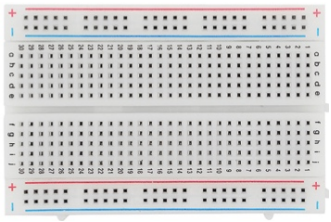


DHT22

RFM95

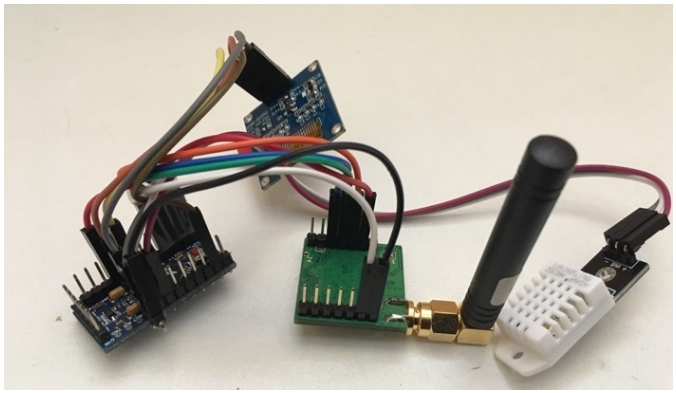


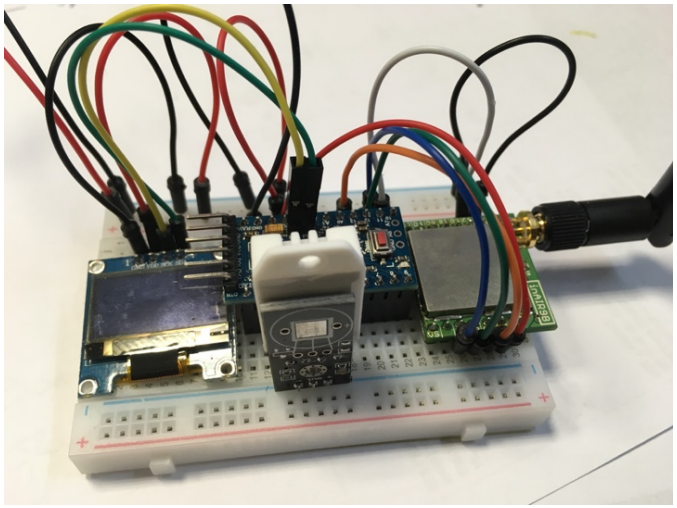


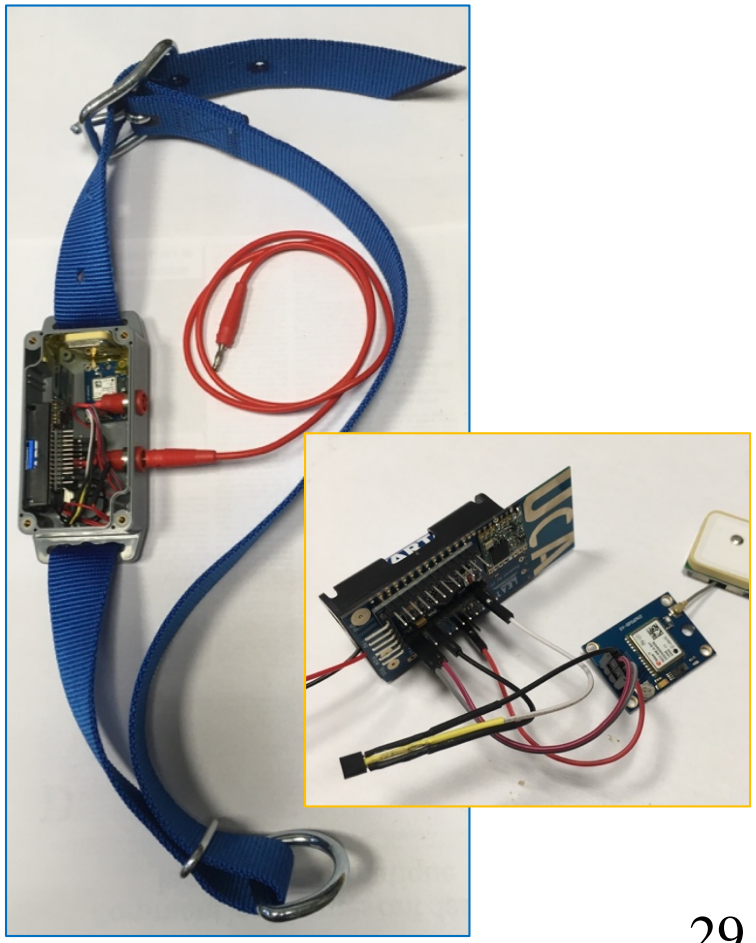


Using the IoT kit

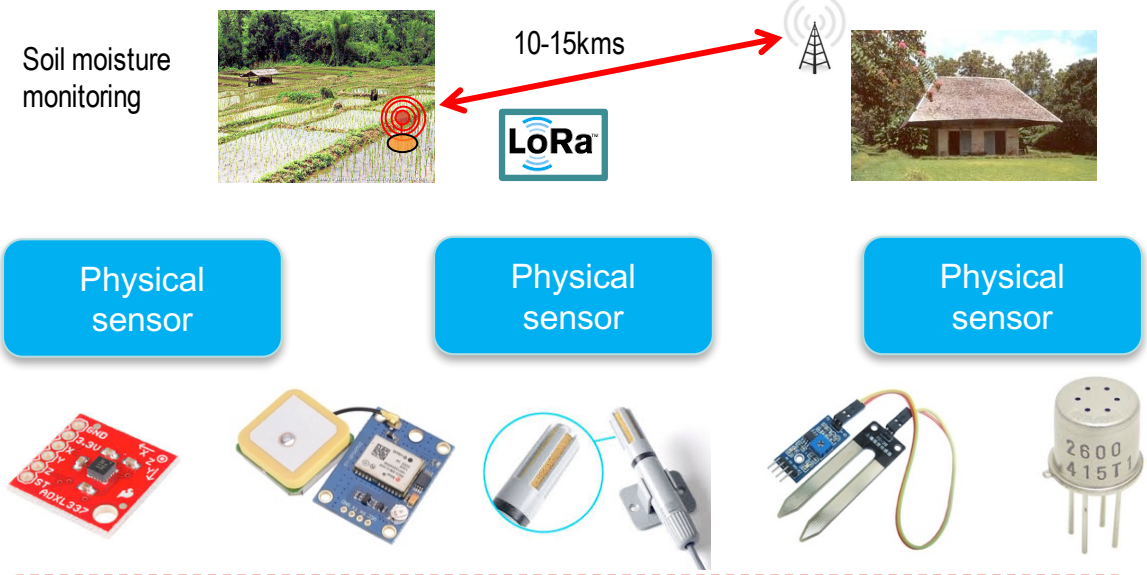
- For both training (knowledge dissemination) and device integration (startup, entrepreneurs)

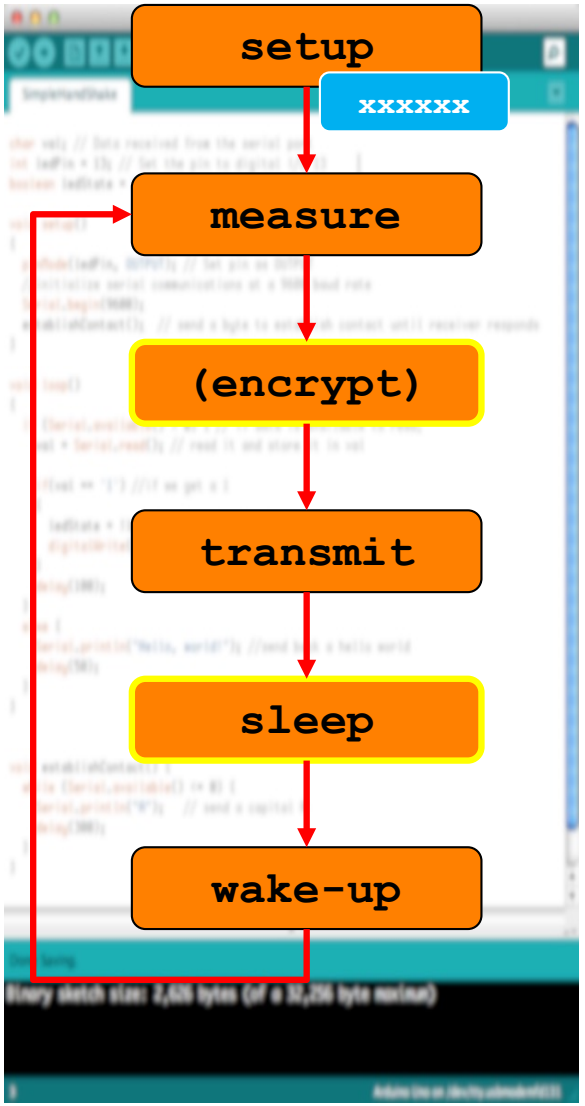




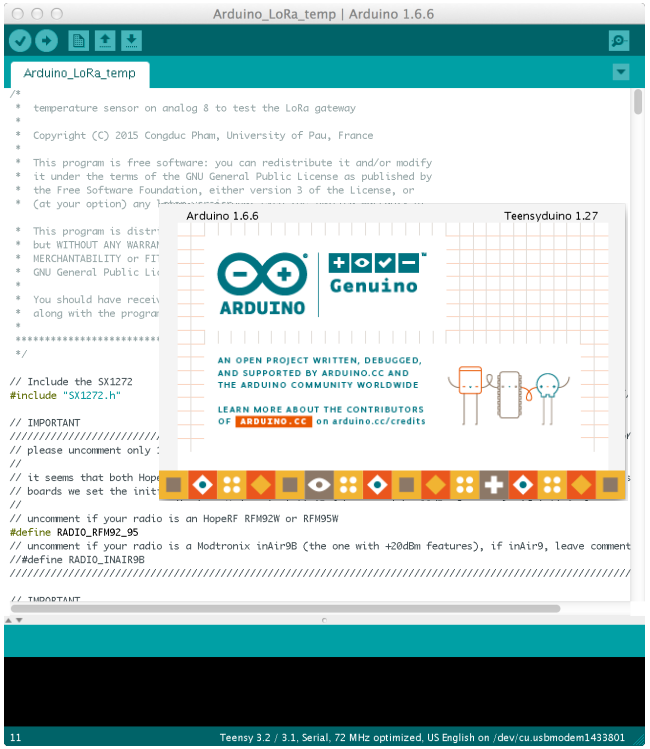


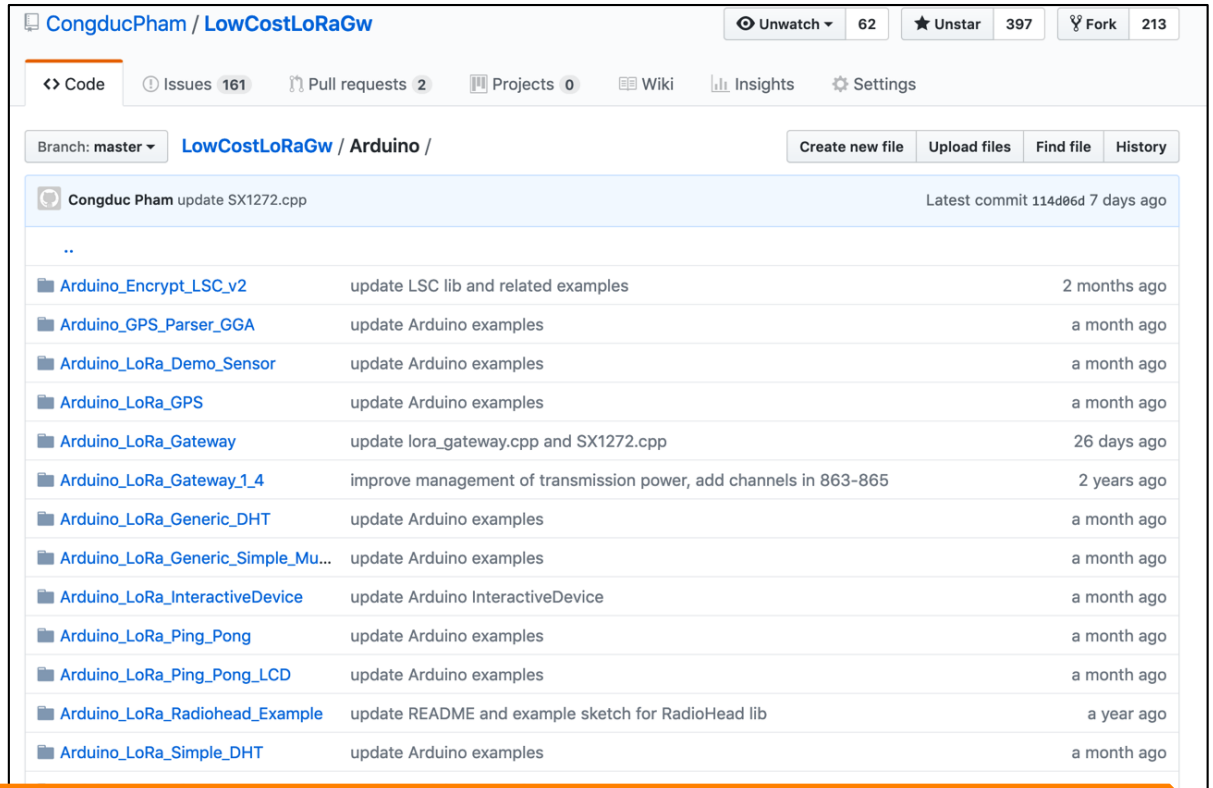
3rd issue: simple development cycle





100% open-source code templates





LowCostLoRaGw github has latest general distribution:
https://github.com/CongducPham/LowCostLoRaGw
Many examples using various temp/hum sensors
https://github.com/CongducPham/LowCostLoRaGw/tree/master/Arduino

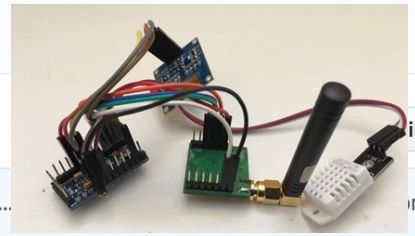
Large variety of examples to learn and adapt

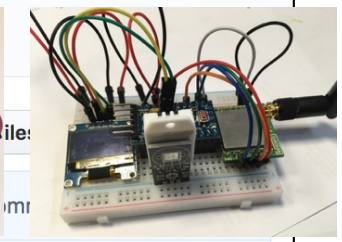
CongducPham / LowCostLoRaGw

Unwatch 49 | Unstar 216 | Fork 120

Code | Issues 96 | Pull requests 2 | Projects 0 | Wiki

Branch: master ▾ LowCostLoRaGw / Arduino /





Congduc Pham update README files, fix MD5 digest computation of gw id, always use ...

..	
Arduino_LoRa_GPS	update README
Arduino_LoRa_Gateway	update gateway r
Arduino_LoRa_Gateway_1_4	improve managen
Arduino_LoRa_Generic_Sensor	update Arduino ex
Arduino_LoRa_InteractiveDevice	update Arduino ex
Arduino_LoRa_Ping_Pong	update Arduino ex
Arduino_LoRa_Simple_BeaconCol...	update Arduino ex
Arduino_LoRa_Simple_SoilHum	update Arduino ex
Arduino_LoRa_Simple_temp	update Arduino ex
Arduino_LoRa_SoilHum	update Arduino ex
Arduino_LoRa_temp	update Arduino ex
Arduino_LoRa_ucamII	update image sup
libraries	update README f
README.md	update README 19 days ago

`Arduino_LoRa_Demo_Sensor` is a very simple demo sketch for training purpose. The main program, i.e. `Arduino_LoRa_Demo_Sensor` can be left unchanged by the students. They just have to add/modify code in `my_demo_sensor_code.h` and `my_demo_sensor_code.cpp` to adapt the code for a given physical sensor. The provided example reads from either an LM35DZ or a TMP36 analog temperature sensor. The sensor is connected on pin A0 and is powered with digital pin 9.

`Arduino_LoRa_Simple_temp` uses the same simple structure than `Arduino_LoRa_Demo_Sensor` where `my_temp_sensor_code.cpp` contains the code to read values from the physical sensor (which is still either an LM35DZ or a TMP36 analog temperature sensor). Additionally, this example illustrates how to implement periodic sensing with low-power mode to run on battery for years. The sensor is connected on pin A0 and is powered with digital pin 9.

`Arduino_LoRa_Simple_DHT` shows how a more elaborated digital sensor such as the DHT22 (also known as AM2302) can be used. Code for DHT sensor is provided by the DHT library by Adafruit. This example therefore shows how you can use libraries provided by third-parties which is most likely the approach that you will use if you need to support a new physical sensor. Note that the DHT code can also be used for the AM2305 sensor. One advantage of the AM2305 is that it usually comes in an outdoor casing which make it suitable for outdoor and real-world deployment scenarios. Note that as it is a very simple example, only one physical measure is provided. In the example, it is the temperature even if the DHT22 sensor can provide both temperature and humidity. The sensor is connected on pin A0 and is powered with digital pin 9.

`Arduino_LoRa_temp` ends the simple temperature example serie. It illustrates a more complex example with AES encryption and the possibility to send LoRaWAN packet. It can also open a receive window after every transmission to wait for downlink message coming from the gateway (to do so, uncomment `#define WTH_RCVW`). The template shows for instance how an '/@Ax#' command from the gateway can be parsed to set the node's address to 'x'. It can serve as a template for a more complex LoRa IoT device with actuation capability on downlink packets from the gateway. The sensor is connected on pin A0 and is powered with digital pin 9.

Tutorials/docs 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

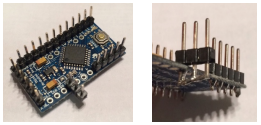
Congduc Pham, http://cpham.perso.univ-pau.fr

http://www.waziup.eu

The generic hardware platform

The Arduino Pro Mini

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



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

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

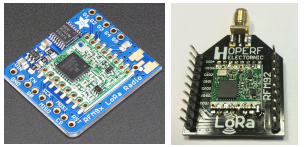
The LoRa radio module

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

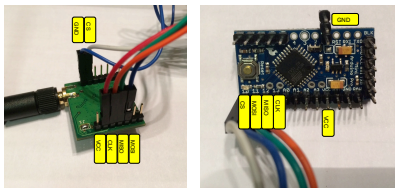
Fully tested LoRa radio modules | HopeRF RFM92W/95W | Libelium LoRa | Modtronix inAir4/9/9B | NiceRF LoRa1276

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.

From generic to specific agri-domain…

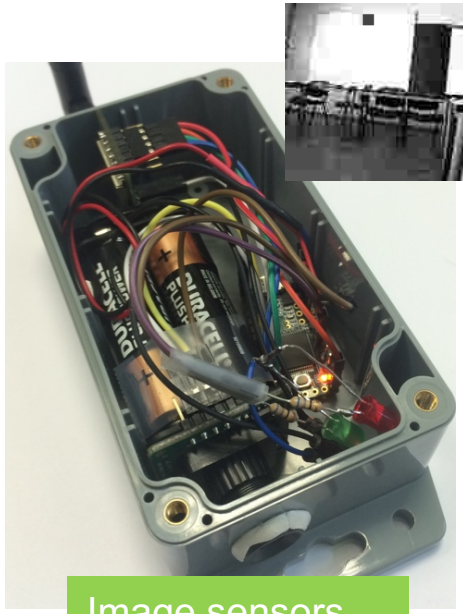
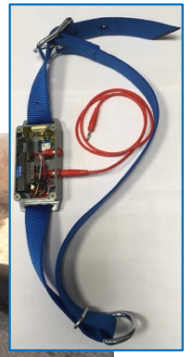
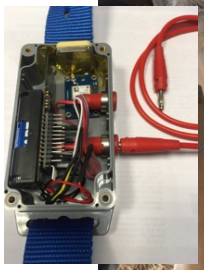
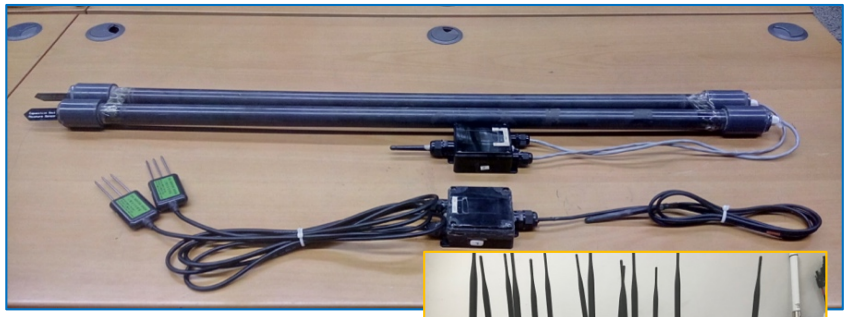


Image sensors

GPS collar







Soil Moisture

Photo from Unparallel

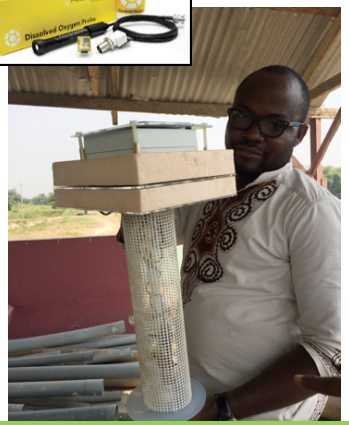


Photo from EGM

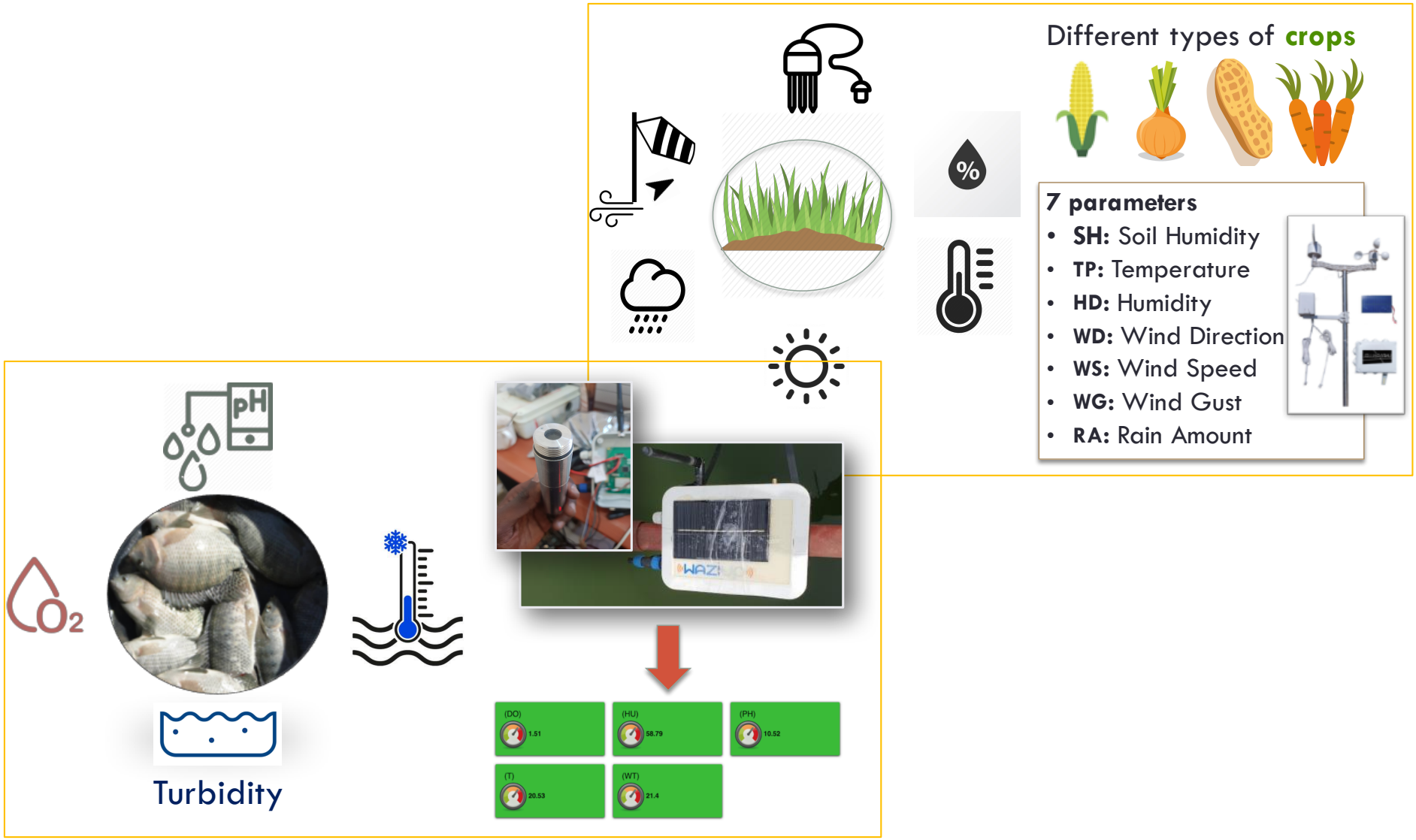
Buoy for water quality

Weather Station

Bin presented at Woelab

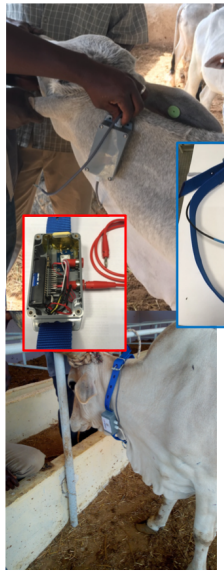
Waste Mngt

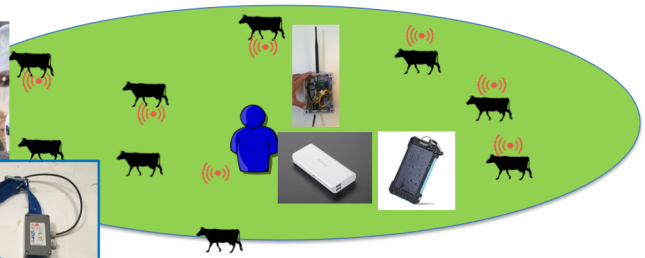
…to capture specific parametrs



From WAZIUP project

Low-cost collar for cattle rutling: CIMEL farm, Senegal





A web interface displays the position of the gateway those of the remote GPS devices

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)

Low-cost buoy for fish farming

In Sub-Saharian Africa, the volume of natural captured fish doesn't meet half of the population demand

Increasing production of aquaculture will help reduce the quantity of imported fishes in Africa

The aim is to monitor in real-time different parameters to control water quality and prevent some diseases that could affect fish in order to improve the quality and quantity of the production

Kumah farm, Ghana

- The Kwame Nkrumah University of Science and Technology (KNUST)
- Located on the campus of the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana.
- The farm comprises 30 constructed fish ponds, a farm house, a recirculating aquaculture system (RAS) laboratory and store houses.

Sanar farm, Senegal

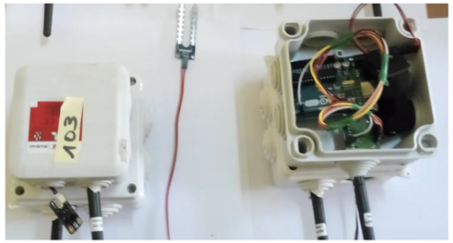
- Farm located at less than 2 km from UGB.
- One pond is dedicated for the Waziup application : 50x25m, average depth of 0.5 meters, populated by 4000 individuals of saltwater tilapia.
- The basin is irrigated via a water supply system fed by a river in proximity.
- The water in the pond is changed every 10 days

UBG farm, Senegal





Soil humidity sensor for agriculture



Monitoring soil moisture and other parameters to provide insightful recommendations and notifications to farmers, and advisors


Nasso site, Burkina Faso


Bananas field


Papayas solos field

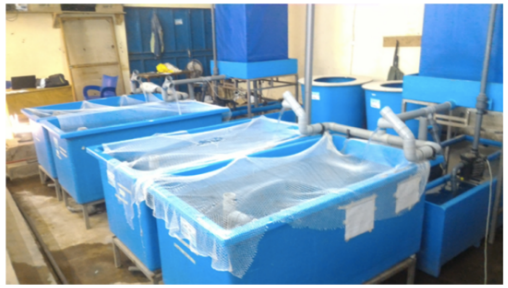

Banana plant

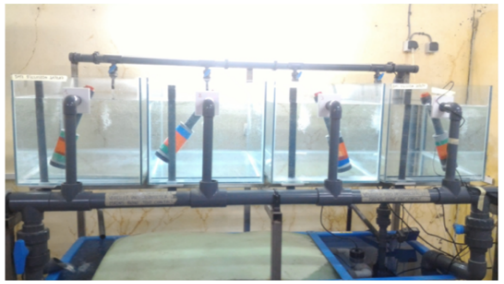

Papaya tree

Urbannatic gardens, Togo


Hatchery experiment, Burkina Faso

- Laboratory named Laboratoire d'Études des Ressources Naturelles et des Sciences de l'Environnement (LERNSE)
- NAZI BONI University in a small village of Bobo-Dioulasso city
- Sensors are placed in a hatchery and the box is placed outside of the building





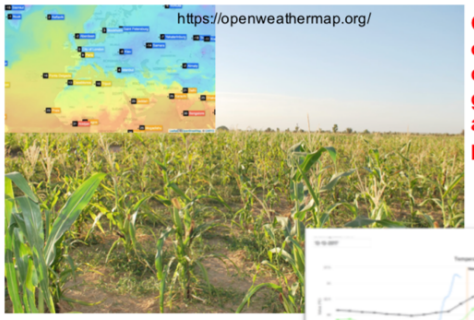
Local weather station for agriculture

In agriculture, different factors can be monitored. Having the ability to control those factors is the key to increase the productivity.

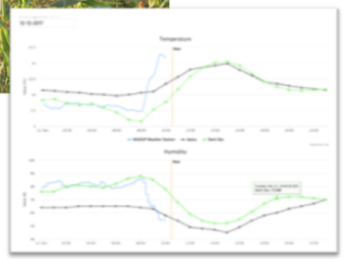
Agriculture MVP requirements:

Obtain and produce weather related information which will be used to advise the farmers!

Get local weather measurements

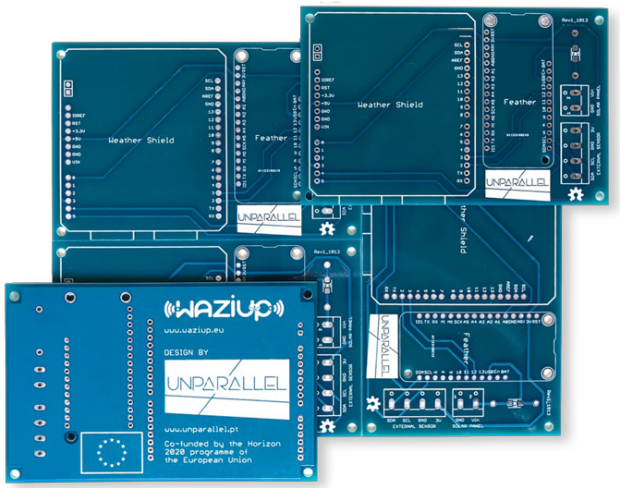


Combine with open weather data to get more accurate predictions



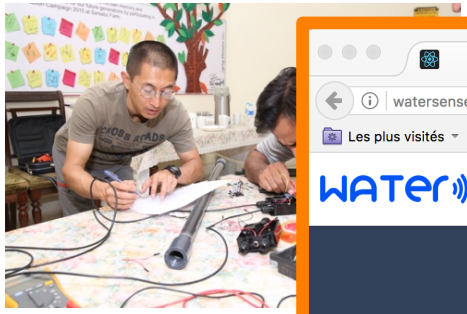
Weather Web App

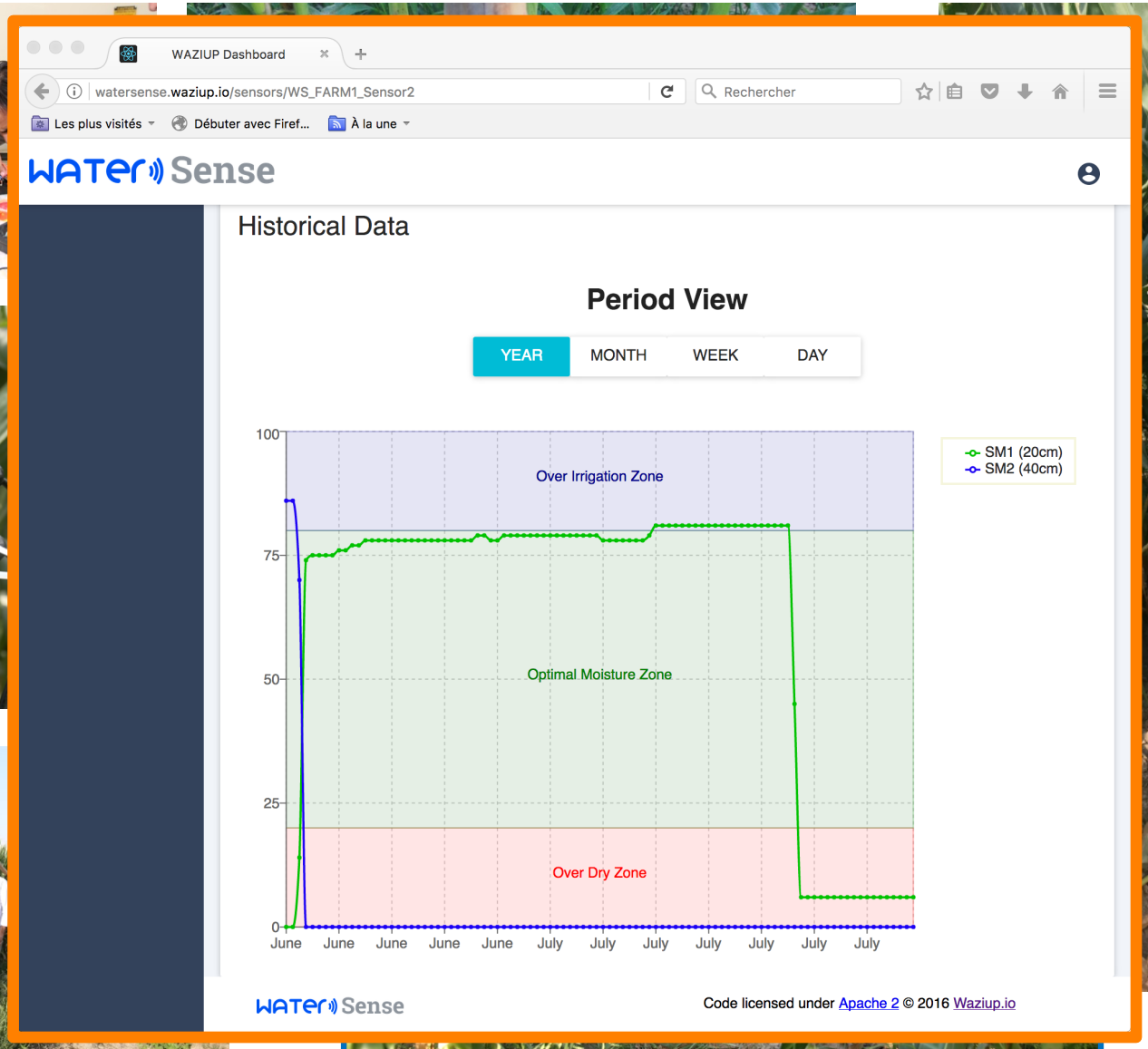
Pilot sites: Senegal, Togo, Ghana, Burkina Faso



From Unparallel for WAZIUP

Deployment for Nestlé's WaterSense project





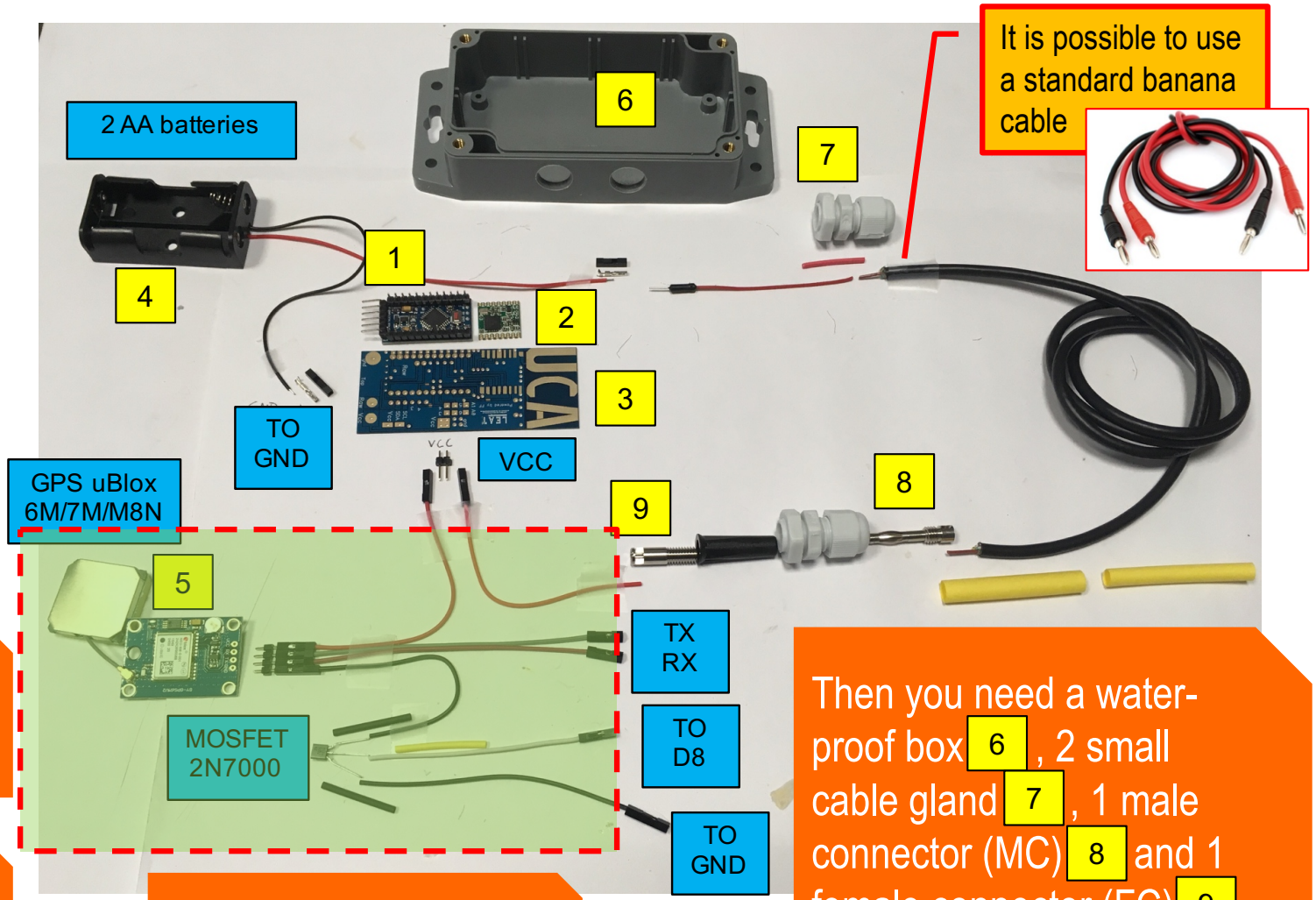
DIY GPS collar for Cattle Rustling

2 AA batteries 4 will power the board with an autonomy of several months

A GPS module can be added 5

Use an Arduino Pro Mini 3.3v at 8MHz 1

Radio module is an RFM95W 2

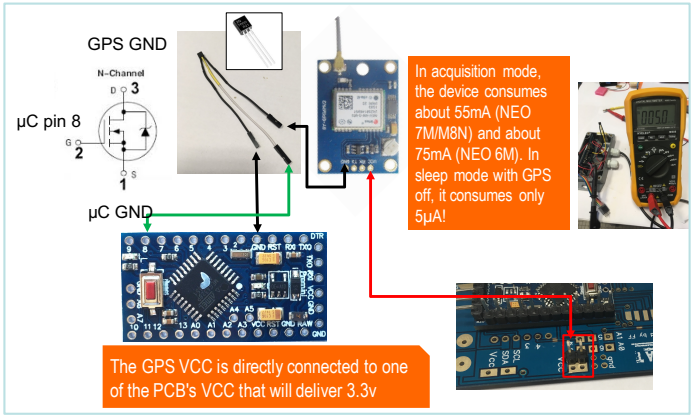


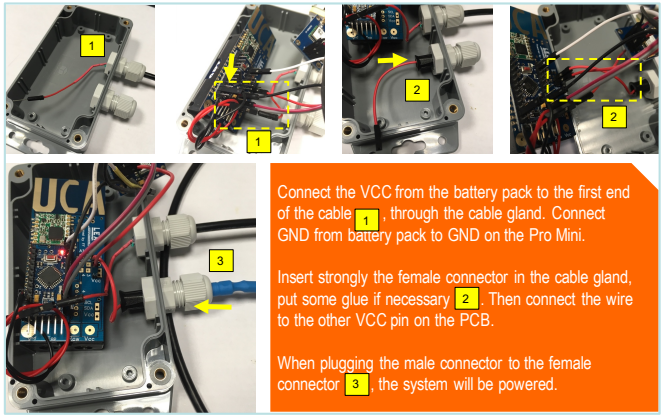
A PCB with integrated antenna will be used 3

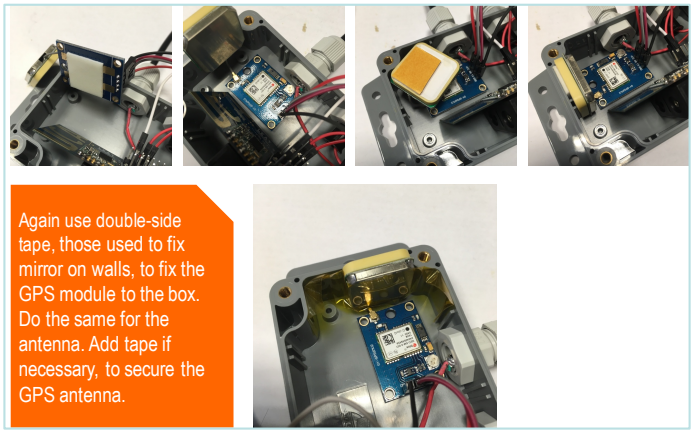
Then you need a water-proof box 6, 2 small cable gland 7, 1 male connector (MC) 8 and 1 female connector (FC) 9

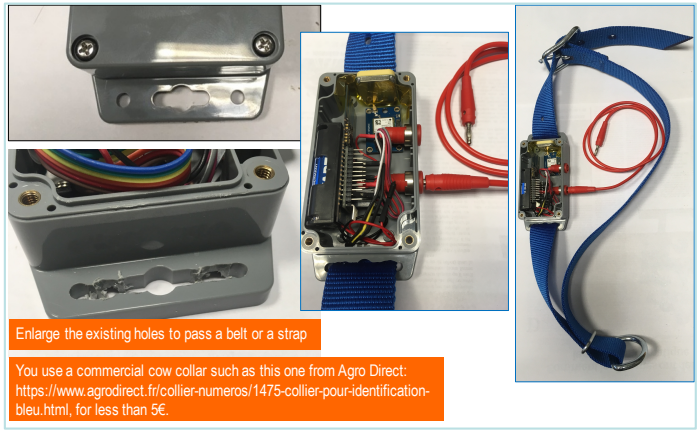
Building the GPS collar

- A dedicated tutorial addresses the open, DIY GPS collar design



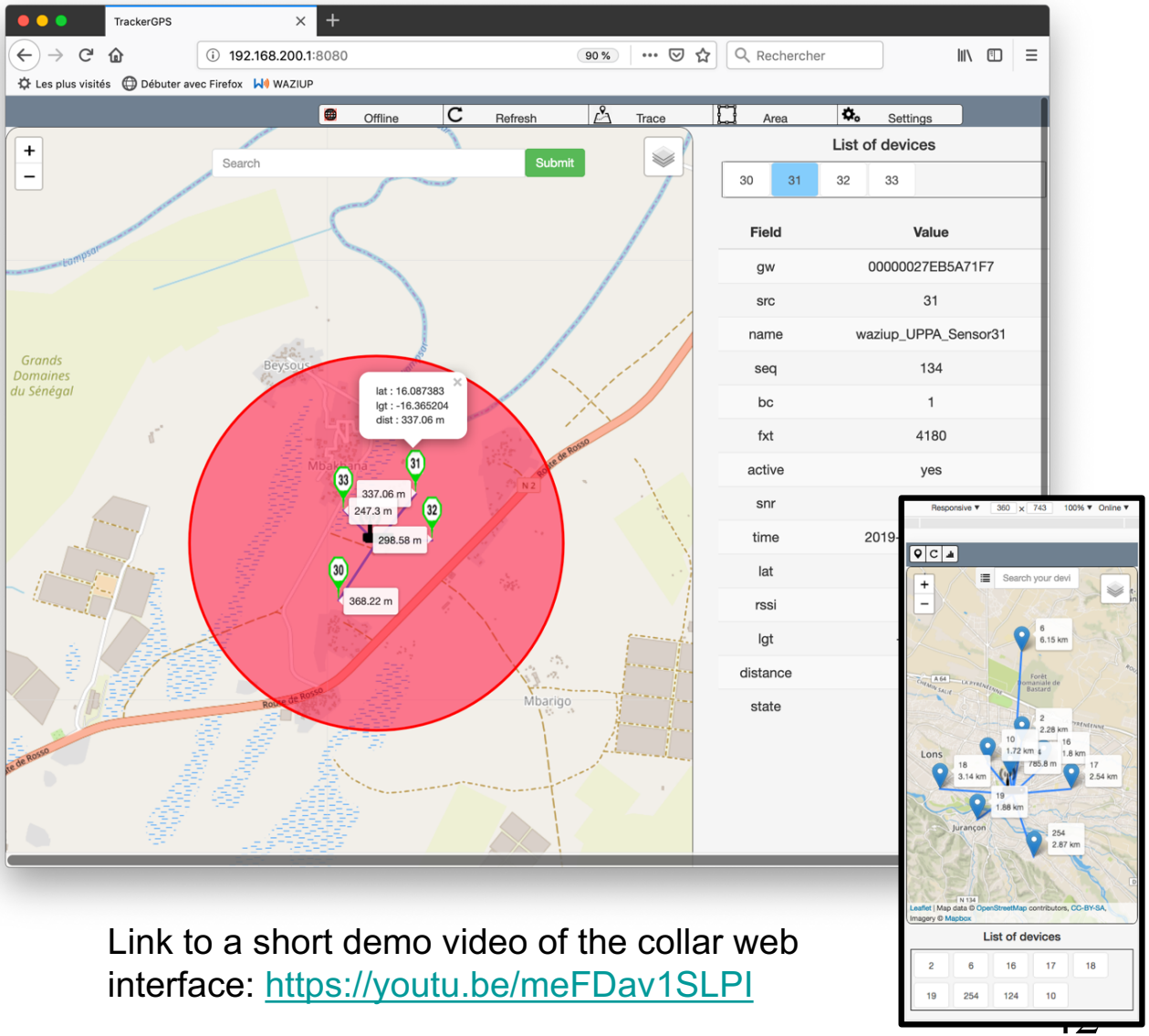






Web interface for viewing GPS collar devices

- a web interface is embedded on the gateway and can be displayed from a smartphone or tablet
- fast visualization of each collar device's distance to the gateway
- direct access to each collar device GPS and last received transmission data
- definition of a safe zone where collar devices will be displayed in green
- definition of a maximum time window for the last GPS reception from a collar device: those collars that exceed the time window will be displayed in black
- can work offline with no Internet connection in which case the background map is not displayed (unless a map is downloaded on the gateway beforehand)
- the distance indication, as well as safe area indication, are always available



Link to a short demo video of the collar web interface: https://youtu.be/meFDav1SLPI

Impact analysis

Agriculture: waziup benefit to users

What do you think about technology to help you?
We were very happy to have the soil moisture sensors in our farm".
How do you feel the benefit that WAZIUP technology can bring to you?
"Water is a very essential component of our operations. And with the soil moisture sensors, we will be able to know how much water we should use to irrigate the vegetable beds. This will help us save water as we will not be over irrigating the farm"
Do you see already indirect or direct benefit?
"There is already a direct benefit because by knowing the moisture in the soil, we are able to use energy efficiently since we use manual means to do everything on the farm. Also, we will be conserving water which means we can have water all year round."

Mr. Douglas Ansah – Chief Farmer – Peace and Love Farms, Ghana

It's all about saving water, fertiliser &labour costs

Aquaculture: waziup benefit to users

- **What do you think about technology to help you?**

"In the past, we have researchers who bring their sensors when they are conducting research and then the sensors are taken away. Having an automatic sensor to measure the water quality of our ponds is welcome technology. And we are able to know what the water quality is and what measures we can take to resolve issues."

- **How do you feel the benefit that WAZIUP technology can bring to you?**

"With these sensors in our pond, we know the DO mostly goes very low between dawn and morning which made us reduce the quantity of fish in the pond in order to reduce the stress level. We are also working on getting a very low-cost aerator to install to help us increase the DO in the early mornings."

- **Do you see already indirect or direct benefit?**

"There is already a direct benefit because by knowing the challenge of the fish getting stress in the morning, we have taken measures to reduce the mortality rate which will increase our harvest."

- **What global statement can you make?**

"I believe the sensor is of immense benefit to we the fish farmers and I will always recommend it to my other farmers to get some. The project is good and it was interesting to see improvement in the sensors during the project phase."

Nana Siaw, Managing Director, Kumah Farms

It's all about to improve production thus revenue

Cattle rustling: benefit to users

- this is not a direct production benefit but an insurance to economic and physical risks (ie with violence)

Mor Sène, 20 years old

Interested by collar: Yes
Is 50 euros an acceptable price? No
Acceptable price : 30 to 40 euros
Cow cost : local cow 450 euros for a female and 750 to 900 euros for a male

It's all about securing investment (the cattle)

Aquaculture : waziup impact

- Emilie Vital Coly, Manager of Agriculture organisation of Ndiawdoune, Senegal : « *Per season, I have a turnover of 2,5 to 3 Millions CFA. The benefice is about 1 million CFA. I could be ready to give 1/5 (= 200 000 CFA, approx.* ***300 euros****) for renting on 6 months (duration of the season)"*
- *Ibrahima Khalil & Seydina Kane, Management of fish farm, St Louis, Senegal « On each season we observed a loss of 50000 CFA (about 80 euros) due to mortality. I am ready to invest 300 000 CFA (approx.* ***457 euros****) for a device if data would be reliable »*

From WAZIUP project

4th issue: dealing with

HORIZON 2020

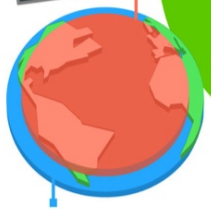
WAZIUP

Volume
SCALE OF DATA

40 ZETTABYTES
[43 TRILLION GIGABYTES]
of data will be created by 2020, an increase of 300 times from 2005

It's estimated that
2.5 QUINTILLION BYTES
[2.3 TRILLION GIGABYTES]
of data are created each day

6 BILLION PEOPLE
have cell phones



WORLD POPULATION: 7 BILLION

Most companies in the U.S. have at least
100 TERABYTES
[100,000 GIGABYTES]
of data stored

The FOUR V's of Big Data

From traffic patterns and music downloads to web history and medical records, data is recorded, stored, and analyzed to enable the technology and services that the world relies on every day. But what exactly is big data, and how can these massive amounts of data be used?

As a leader in the sector, IBM data scientists break big data into four dimensions: **Volume, Velocity, Variety and Veracity**

Depending on the industry and organization, big data encompasses information from multiple internal and external sources such as transactions, social media, enterprise content, sensors and mobile devices. Companies can leverage data to adapt their products and services to better meet customer needs, optimize operations and infrastructure, and find new sources of revenue.

By 2015
4.4 MILLION IT JOBS
will be created globally to support big data, with 1.9 million in the United States

Variety
DIFFERENT FORMS OF DATA

As of 2011, the global size of data in healthcare was estimated to be
150 EXABYTES
[161 BILLION GIGABYTES]

By 2014, it's anticipated there will be
420 MILLION WEARABLE, WIRELESS HEALTH MONITORS

4 BILLION+ HOURS OF VIDEO
are watched on YouTube each month

30 BILLION PIECES OF CONTENT
are shared on Facebook every month

400 MILLION TWEETS
are sent per day by about 200 million monthly active users

Velocity
ANALYSIS OF STREAMING DATA

The New York Stock Exchange captures
1 TB OF TRADE INFORMATION
during each trading session

Modern cars have close to
100 SENSORS
that monitor items such as fuel level and tire pressure

By 2016, it is projected there will be
18.9 BILLION NETWORK CONNECTIONS
– almost 2.5 connections per person on earth

Veracity
UNCERTAINTY OF DATA

1 IN 3 BUSINESS LEADERS
don't trust the information they use to make decisions

in one survey were unsure of how much of their data was inaccurate

Poor data quality costs the US economy around
$3.1 TRILLION A YEAR

Sources: McKinsey Global Institute, Twitter, Cisco, Gartner, EMC, SAS, IBM, MEPTEC, QAS

IBM

Analyse the data

- What is the meaning of the collected data?
- Example with farming
  - What is interesting for farmers?
    - Fertility detection
    - Eating/Ruminating time for welfare
  - What data can be easily obtained?
    - accelerometer data with neck-mounted collar
  - How to detect relevant event from these data?

Advanced data analysis

Need of experts from the domain!

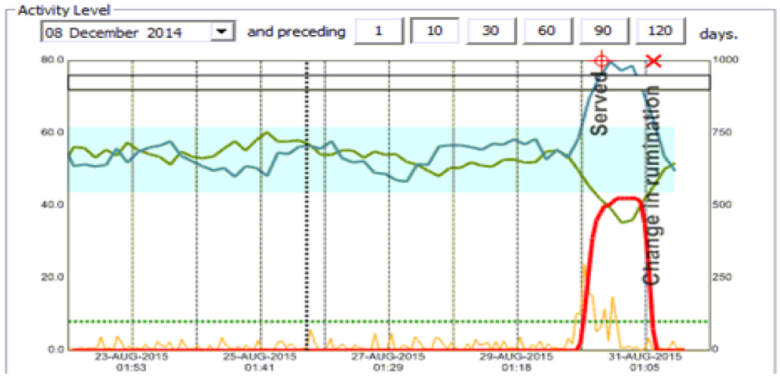
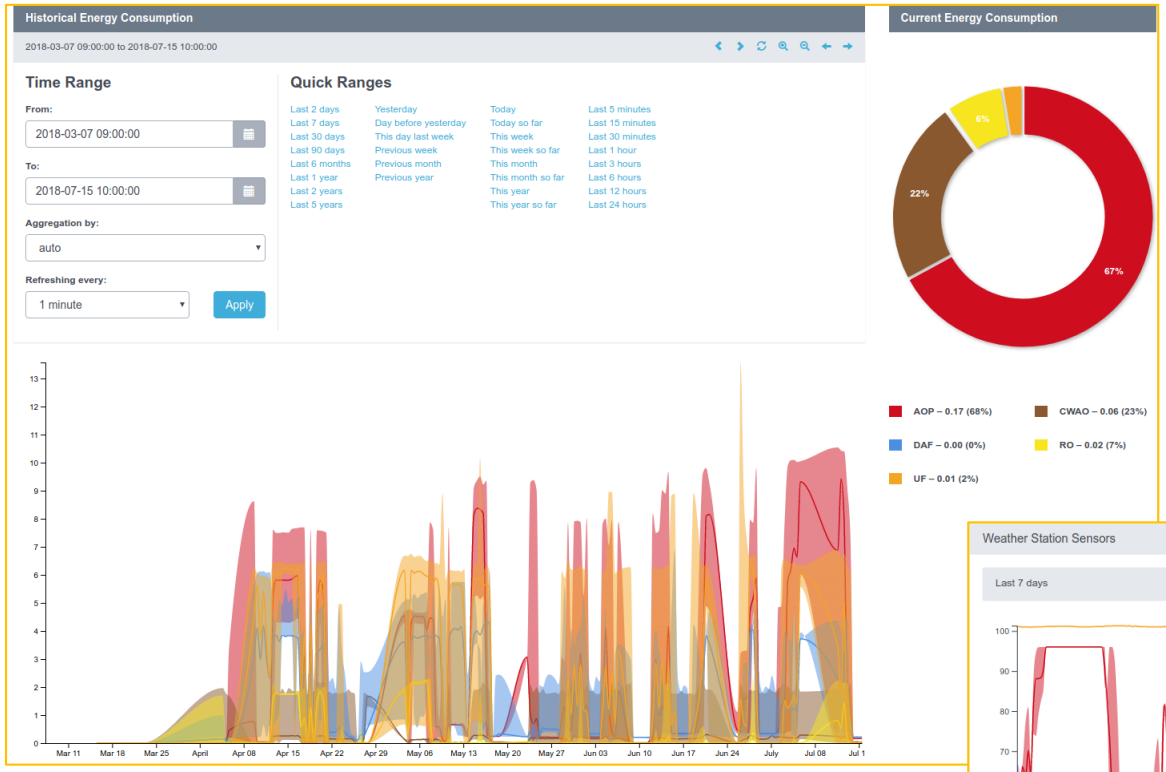
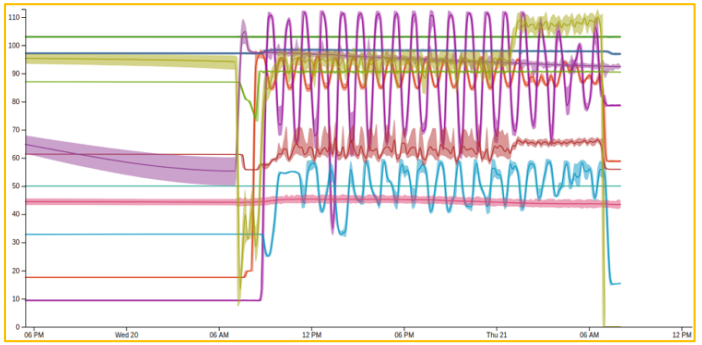


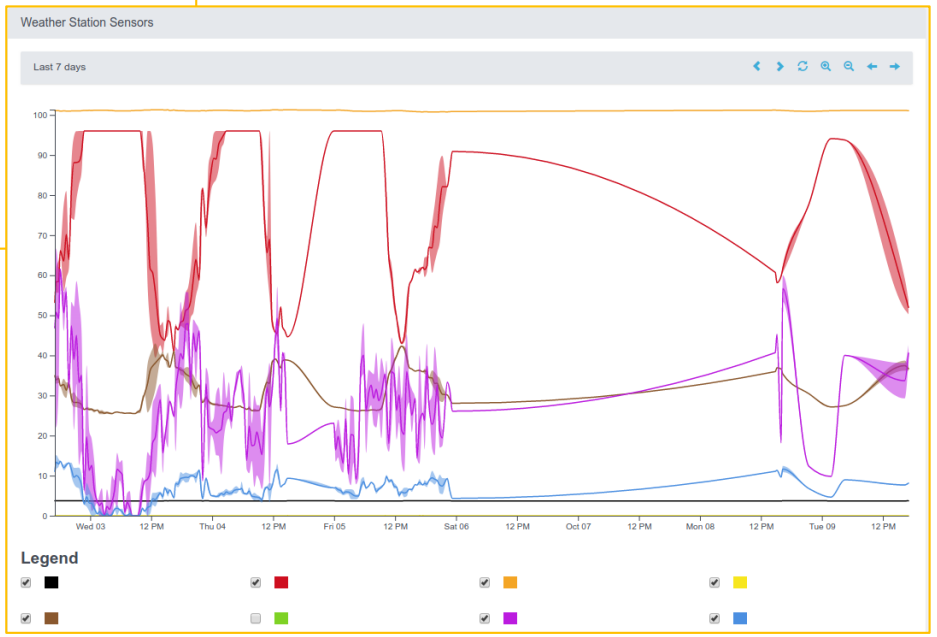
Fig. 3. Illustration of a rise in activity accompanied by a fall in rumination at the point of oestrus

The Big Data landscape

Visualize and managing the data







Name	Pending Actions	Current Weather	More details
Dehbala	✔	32°C 7	
Farm Sonatel	✔	28°C 74	
Gusbajay	✔	29°C 70	
Khalil	✉ 1	39.5°C 28	
Mitchells	✔	39.5°C 28	
Mustapha	✔	37°C 34	

IoT cloud and visualization tools

Firebase

FIWARE

Axēda

ioBridge
Connect things.

ThingSpeak

GroveStreams

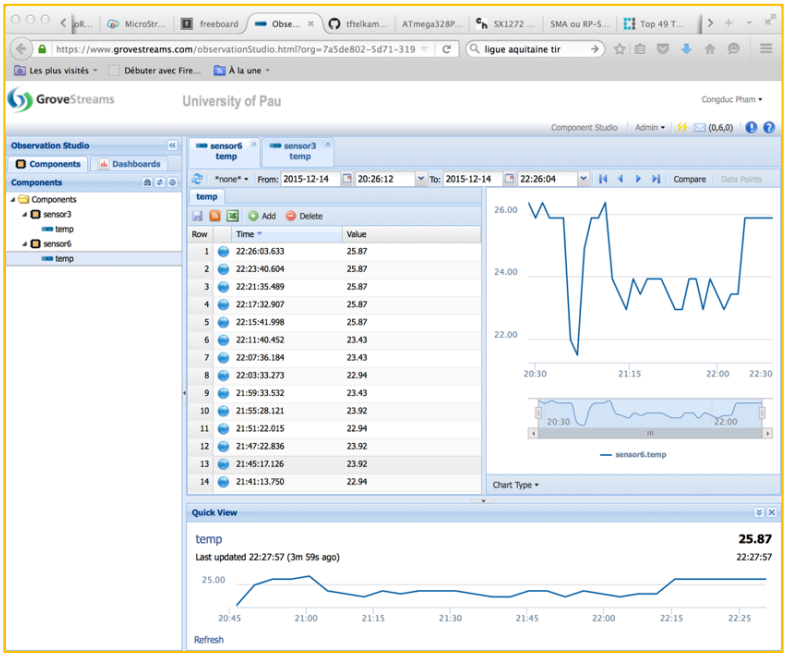
SensorCloud™

freeboard

dweet.io

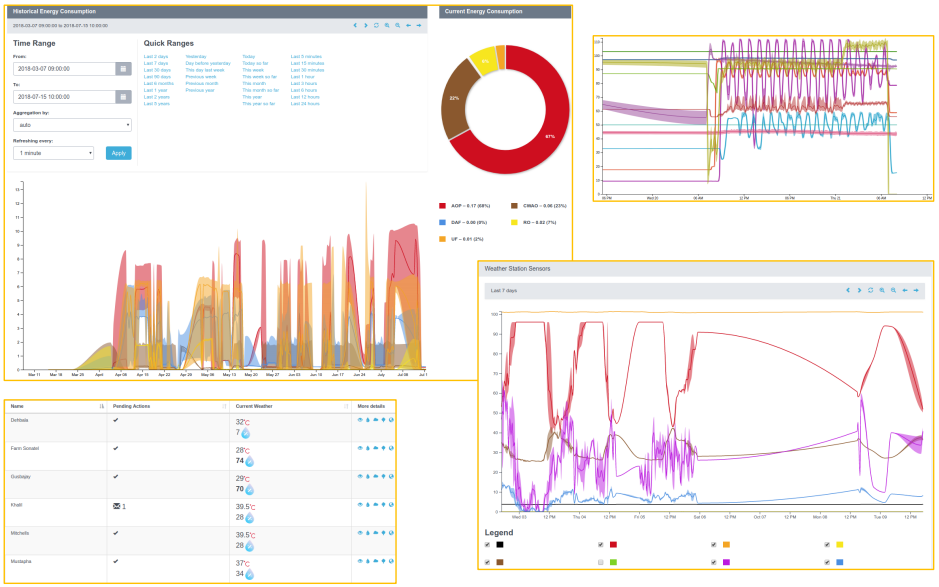
OpenRemote

TempoIQ

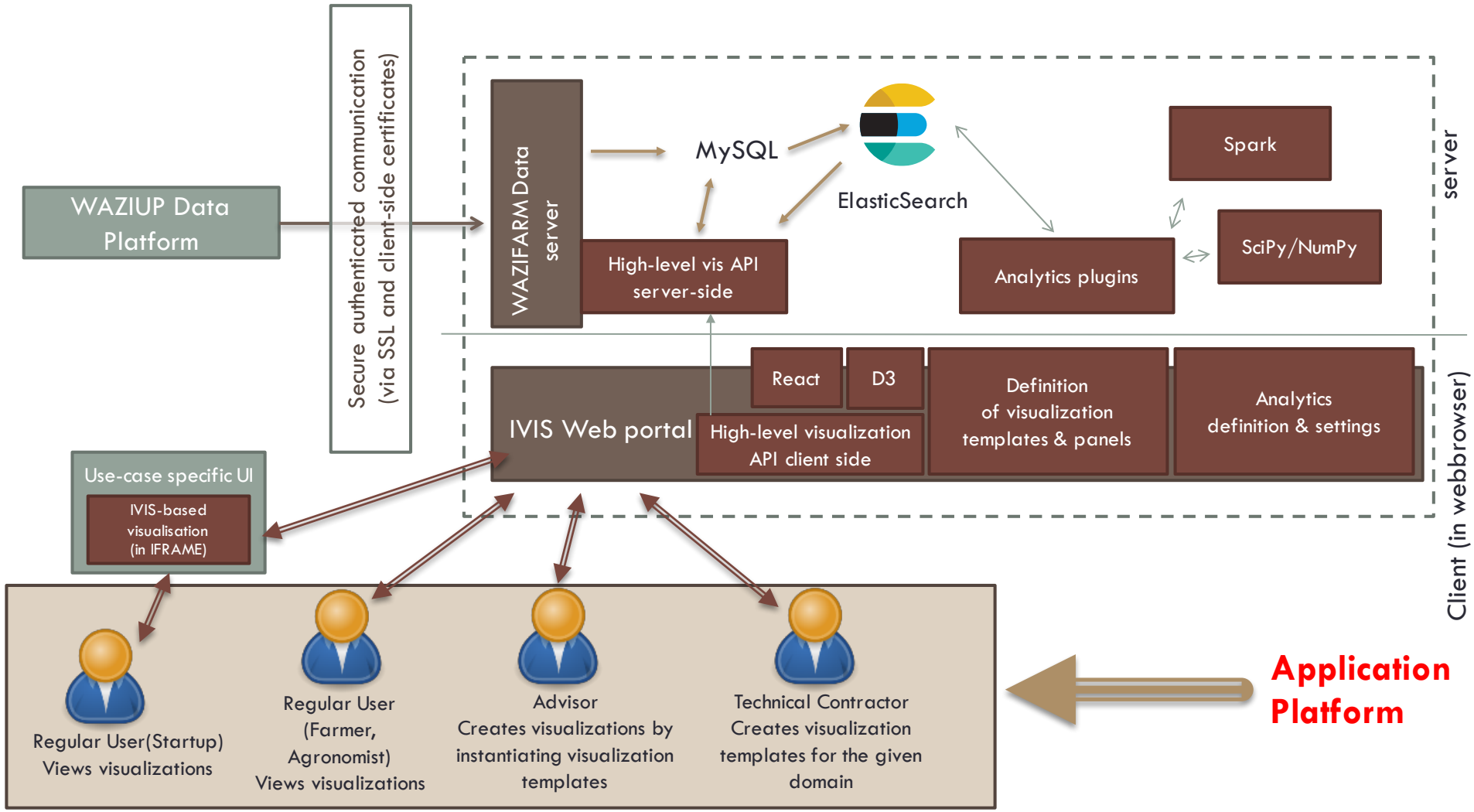


Create customized IoT dashboard for agriculture domain

- WAZIFARM
  - https://www.wazifarm.com
  - platform & framework for realization of advanced visualization, data analytics applications for various agriculture use cases, targeting a small-holder's profile
- Web-based framework for creating your own agriculture application
  - Easy to use framework based on the concept of visualization templates, workspaces, and panels.
  - Allows much higher customizations than what is possible in existing products (Kibana, Grafana, Freeboard)

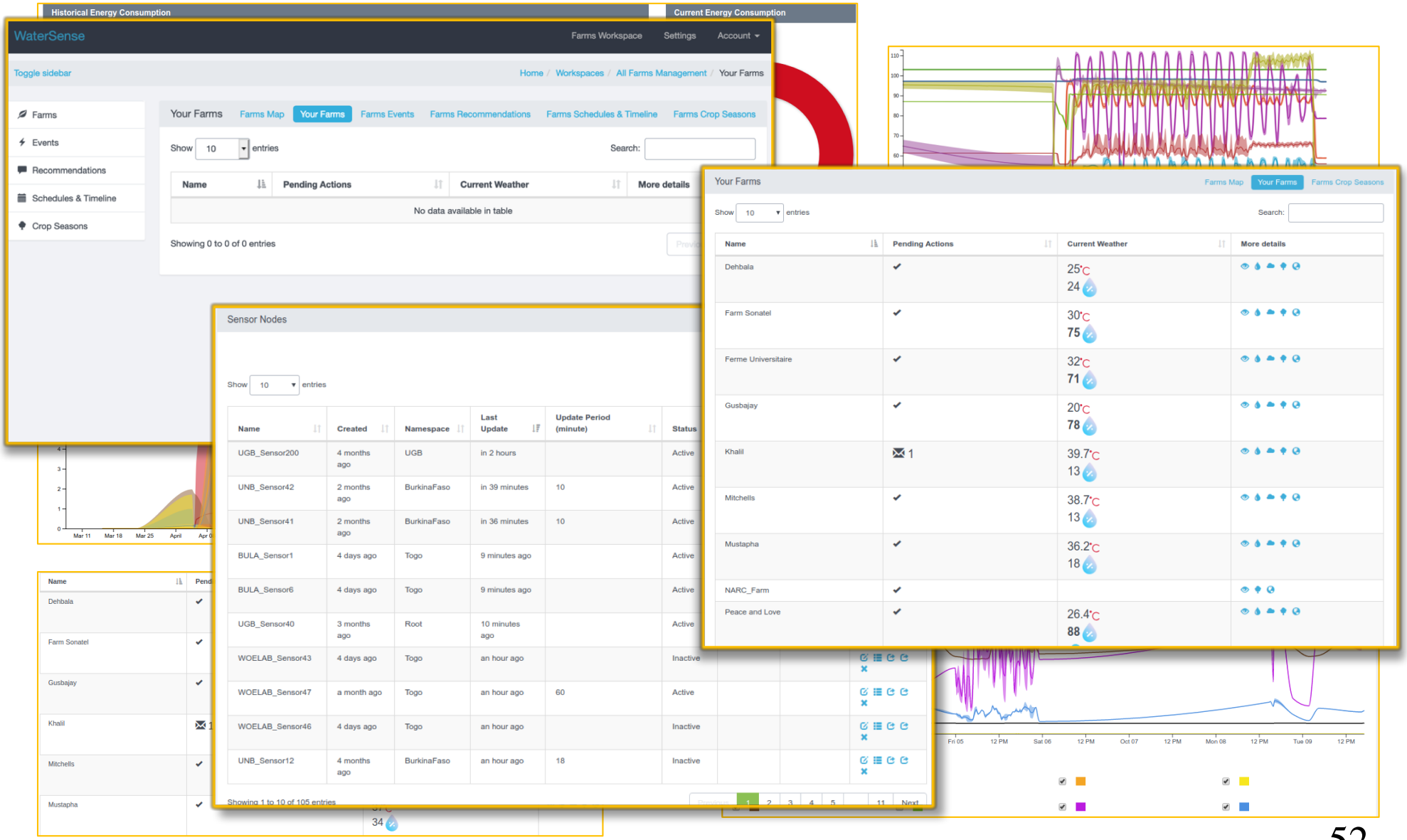


WAZIFarm architecture

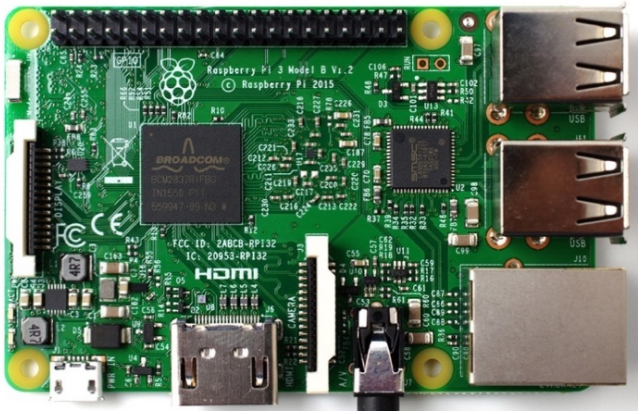


From WAZIUP project

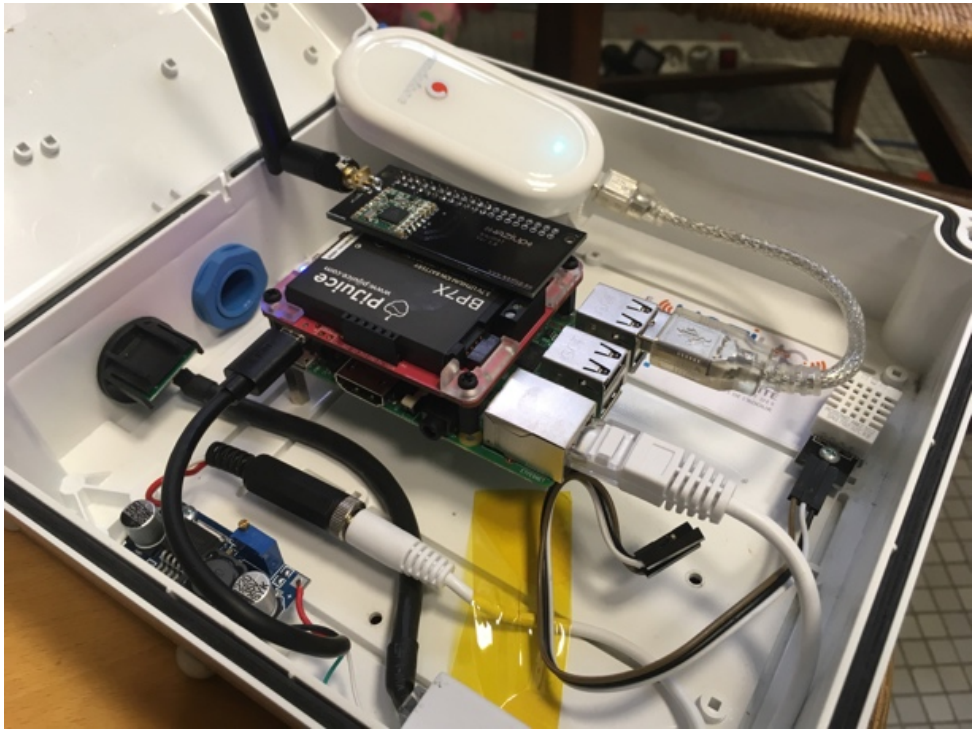
Beyond visualization: management



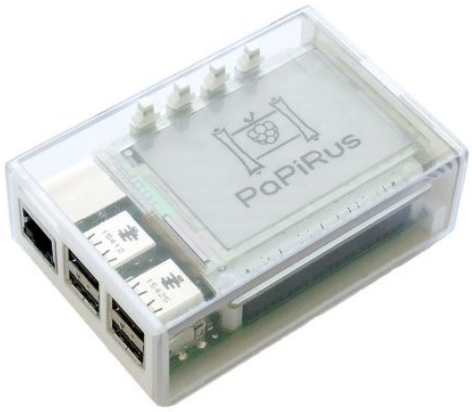
Open IoT gateway

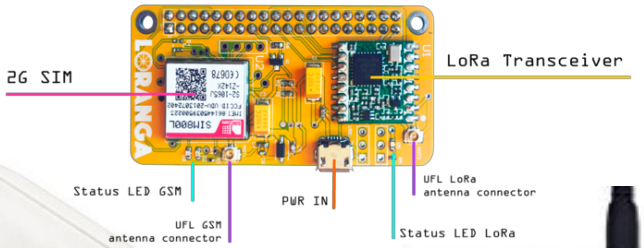


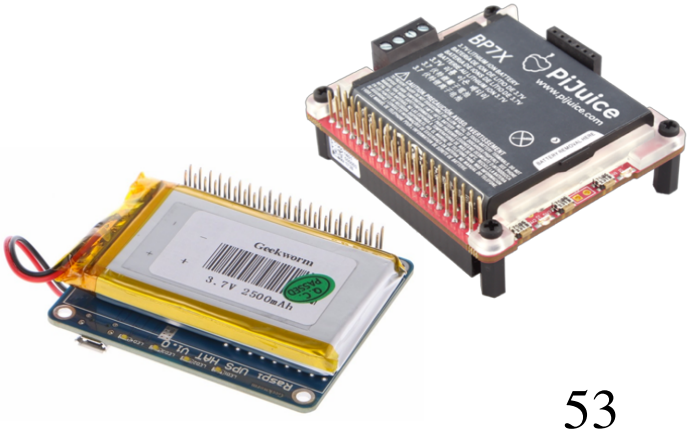
RaspbianOS



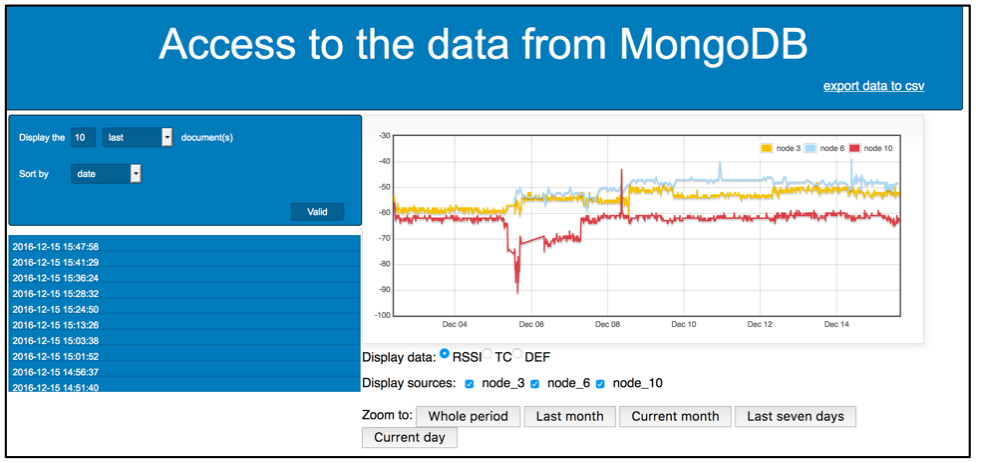
Raspberry PI: lots of libraries, lots of software, lots of hardware, lots of shields,…

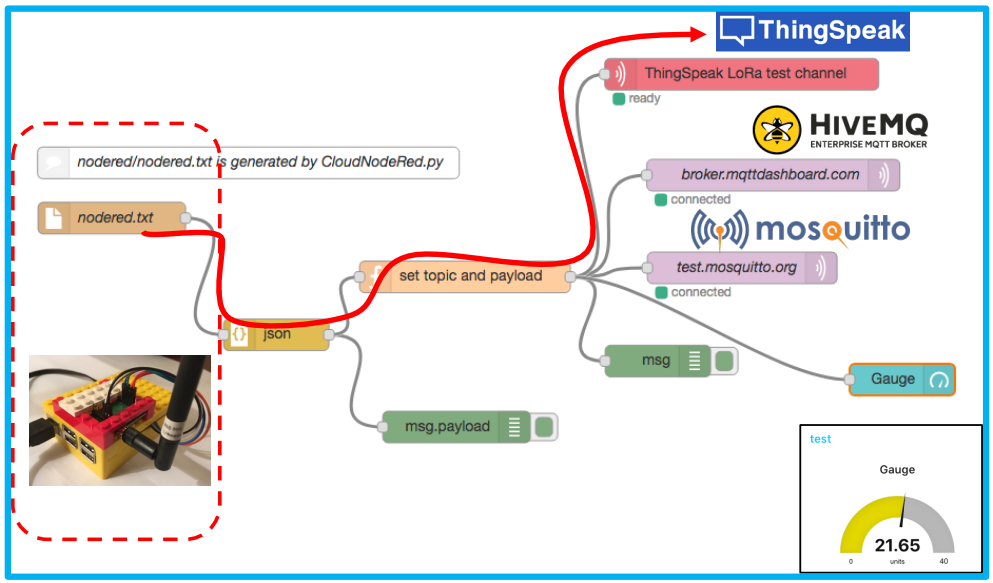


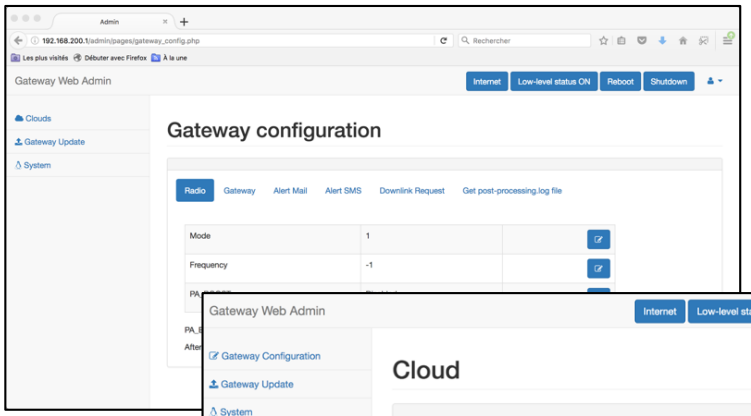


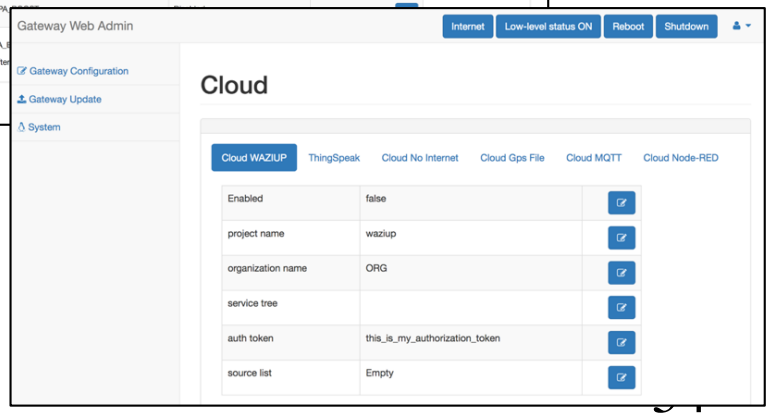


Versatile gateway



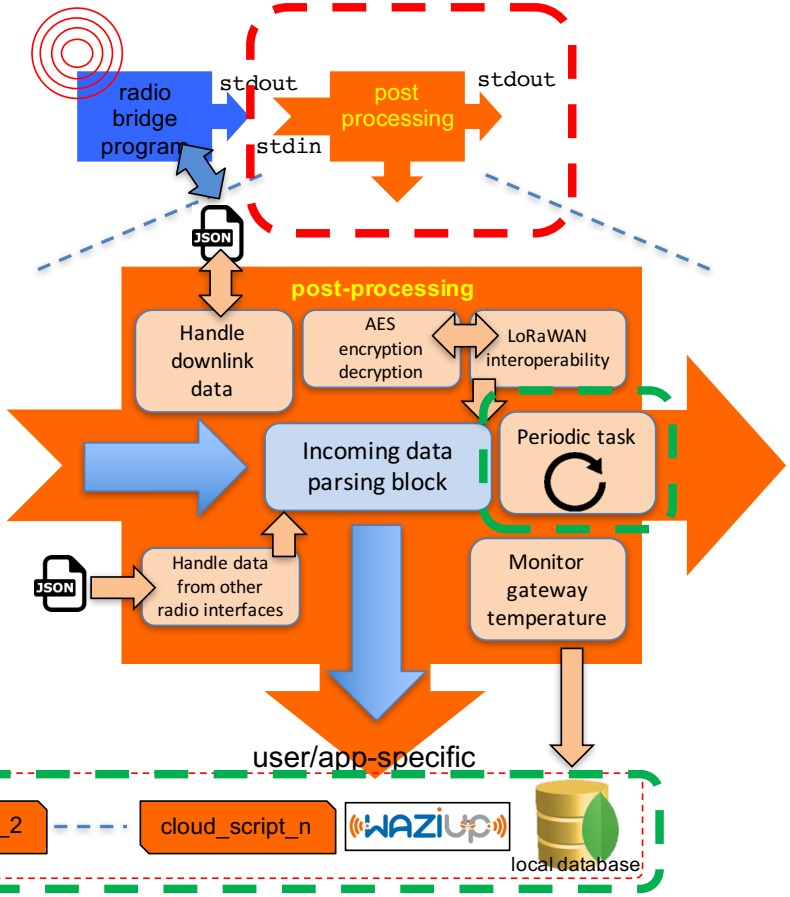






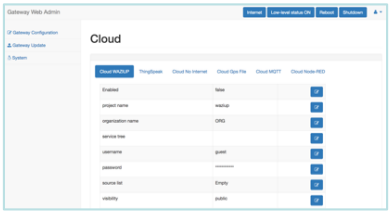
Large customization possibilities

- The flexible gateway architecture offers high versatility by customization
- There are 4 alternatives for customization
- The geek way
  - Modify/extend post-processing block
- The "smarter" way
  - Add "cloud" scripts
    - On packet reception
  - Add low rate periodic tasks
    - Independant from packet reception
  - Add fast rate statistic-oriented tasks



"Branding" your IoT gateway

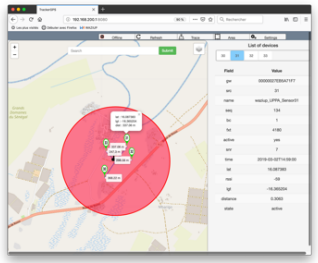
- Develop/Add project/company specific features on top of the general distribution

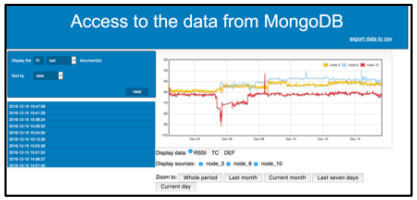


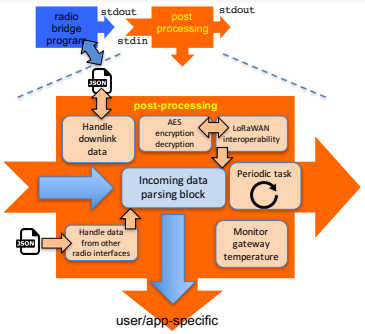
ADDITIONAL FEATURES SET 2

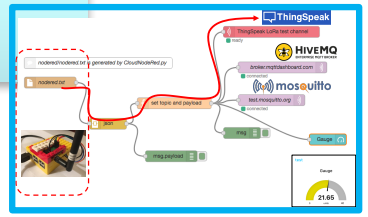
ADDITIONAL FEATURES SET 1

GENERAL DISTRIBUTION







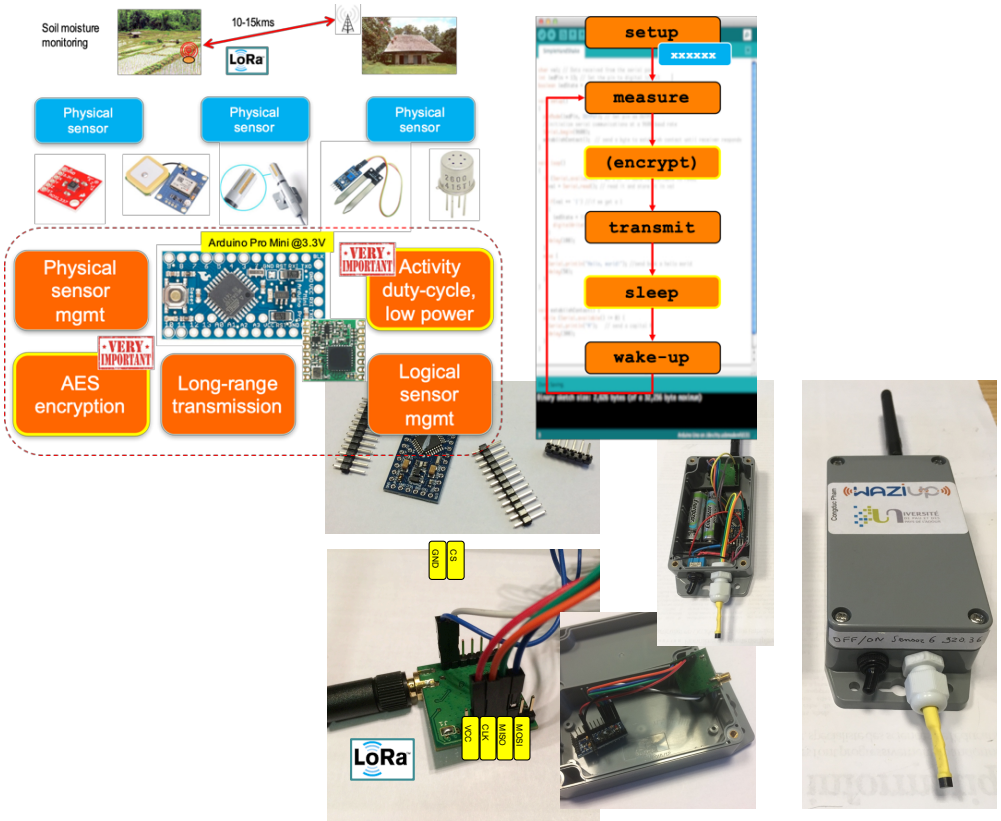


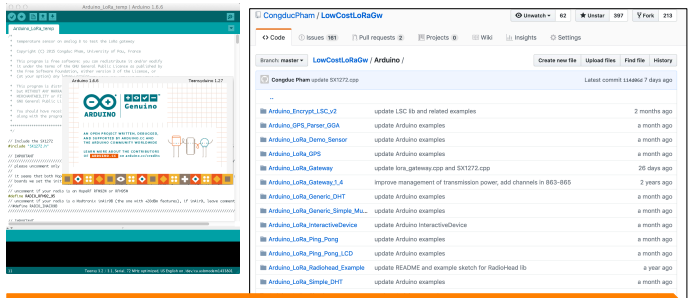
Some research we are doing

- Activity sharing to leverage radio time limitations under duty-cycle regulations
- Efficient channel access control to limit packet collisions
- Performance & reliability study of LoRa channel activity detection mechanism
- Smart and transparent 2-hop LoRa mechanism
- 2-hop LoRa extension with inter-device similarity detection
- RSSI-distance dynamic mapping for real time localization using minimum number of GPS nodes
- Low-power data encryption algorithms (vs AES)

R&D with WAZIUP

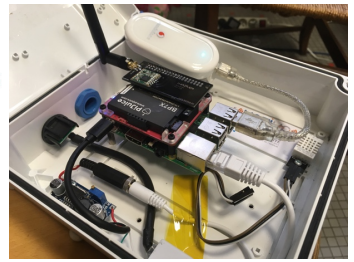
- The WAZIUP framework is good test-bed framework for fast implementation, performance evaluation and validation of research propositions





LowCostLoRaGw github has latest general distribution:
https://github.com/CongducPham/LowCostLoRaGw
Many examples using various temp/hum sensors
https://github.com/CongducPham/LowCostLoRaGw/tree/master/Arduino

RaspbianOS



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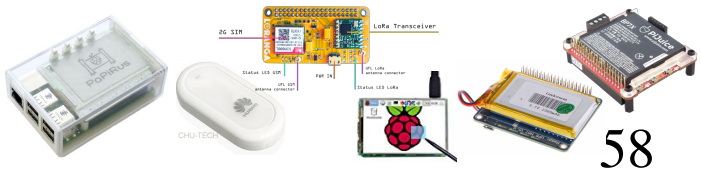
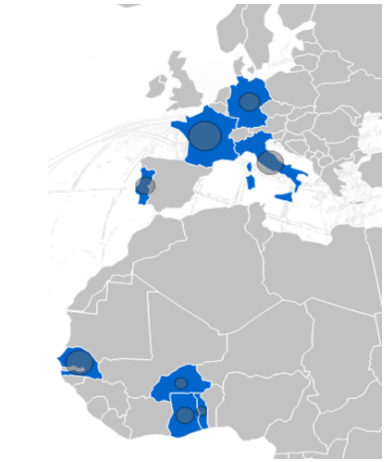


Conclusions

- ICT/IoT awareness is high
  - But lack of technological background makes IoT-based innovation low
- ICT/IoT for agriculture is not new concept
  - But taking into account smallholders profiles, needs and constraints is not always considered
- Low-cost, "do-it-yourself" IoT has ability to
  - Propose adapted solutions to smallholders in terms of costs and complexity
  - Increase technology competencies and capacity building of local actors
  - Engage user community with stakeholders
  - Acceralerate innovation and local entrepreneurship

Scaling up!

Feb 2016 - 2019



May 2018 - 2021