Low-cost Antenna Technology for LPWAN IoT in Rural Applications

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Friday, June 16th, 2017
Vieste, Italy

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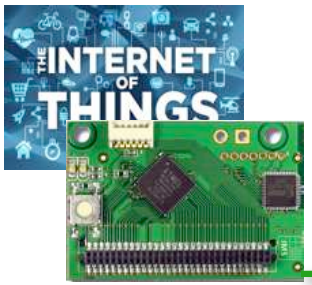
Université de Pau, France

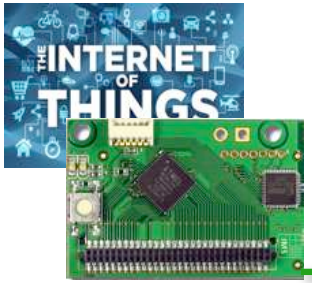


BigData & low-cost IoT

WAZIUP ABOUT » TECHNOLOGIES » COMMUNITY NEWS & EVENT » DOWNLOADS DEV KIT FAQ CONTACT

HORIZON 2020

AFFORDABLE TECHNOLOGIES TO EMPOWER RURAL ECONOMIES



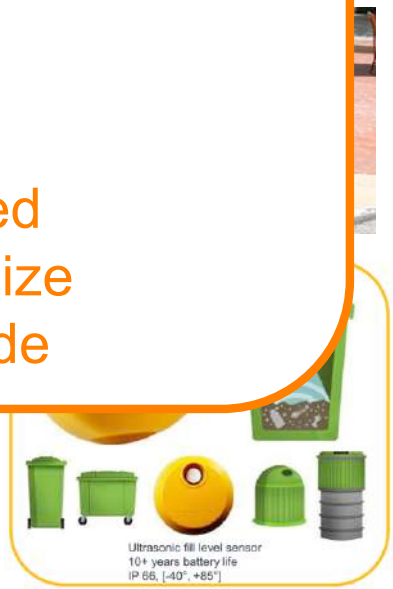
Objectives

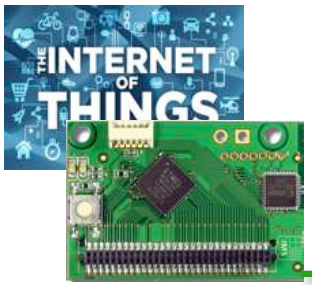
- To propose **low-cost and energy-efficient hardware** platforms that fit to African context
- To design and develop **IoT long-range communication** framework **(device+gateway)**
- To develop and validate the **open IoT and Big data** and advanced analytic application platform
- To offer **open sources WAZIUP** (hardware and software) platform for developer and SMEs communities
- To **engage local communities/entrepreneurs** for sustainable innovation

MATURATION OF THE IoT MARKET…

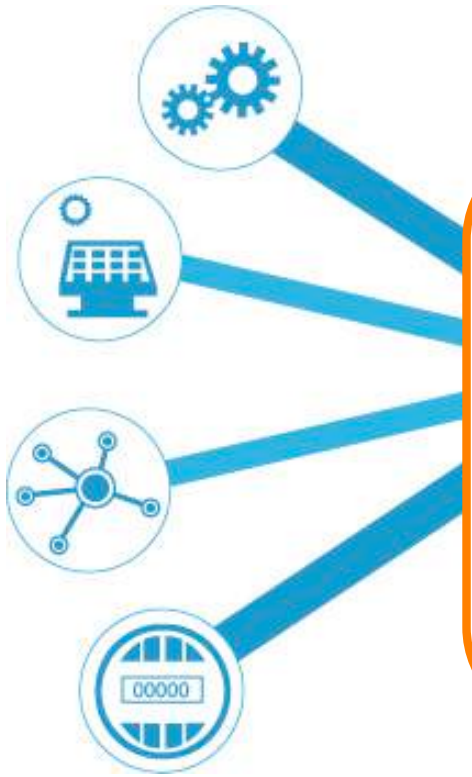
… but not adapted for rural developing countries context & environment

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



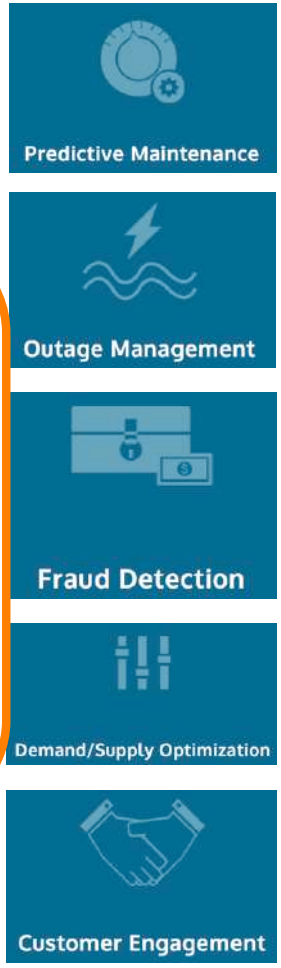


Internet, Cloud & big data analytics

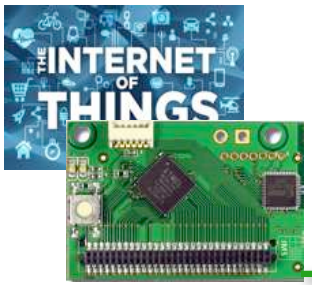


Internet connectivity is weak and expensive!

Nearly impossible in remote/rural areas



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



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.

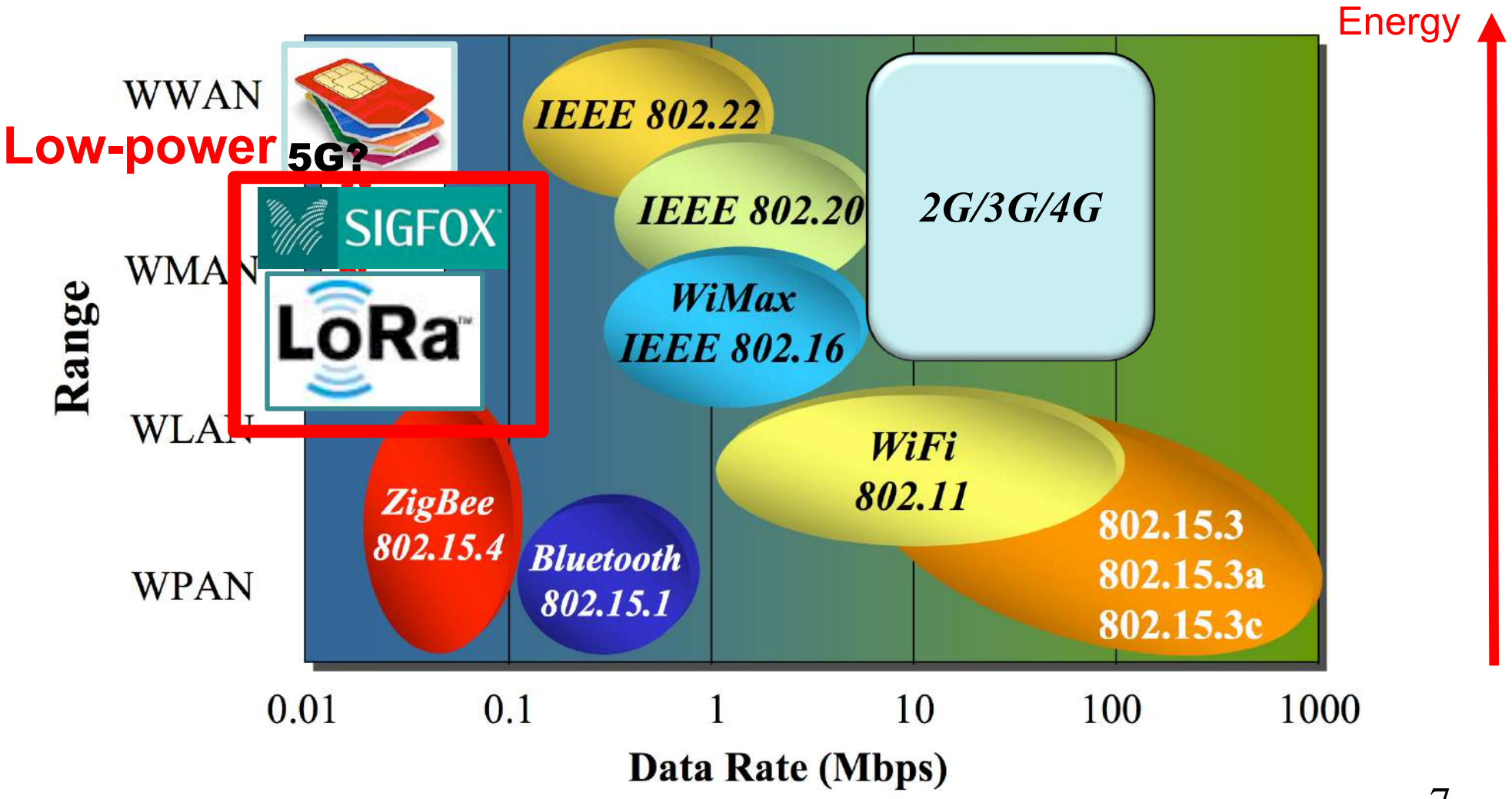
```
void setup() {
 }

void loop() {
 }
```

ARDUINO SOFTWARE

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

LOW-POWER & LONG-RANGE RADIO TECHNOLOGIES

Energy-Range dilemma



LPWAN ARCHITECTURE

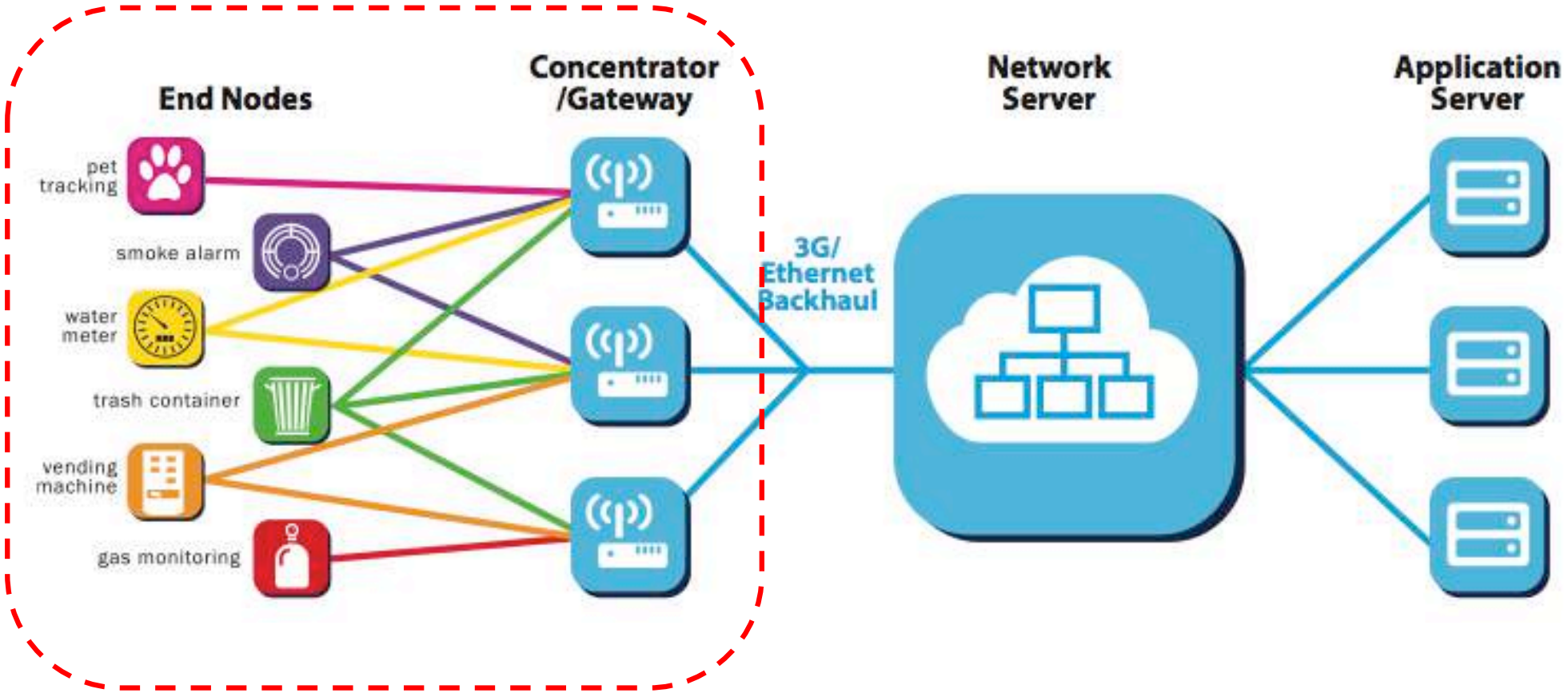


Figure from Semtech

SW/HW BUILDING BLOCKS INTEGRATION

More to come…

LoRa radios that our library already supports

HopeRF RFM92W/95W

Libelium LoRa

Modtronix inAir4/9/9B

NiceRF LoRa1276

Long-Range communication library

Ready-to-use templates

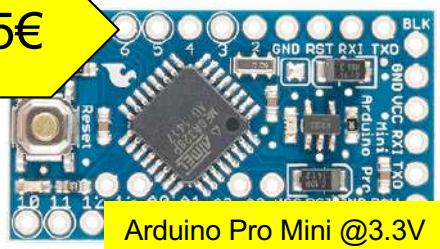
Physical sensor reading

Physical sensor reading

Physical sensor reading

Physical sensor management

1.5€



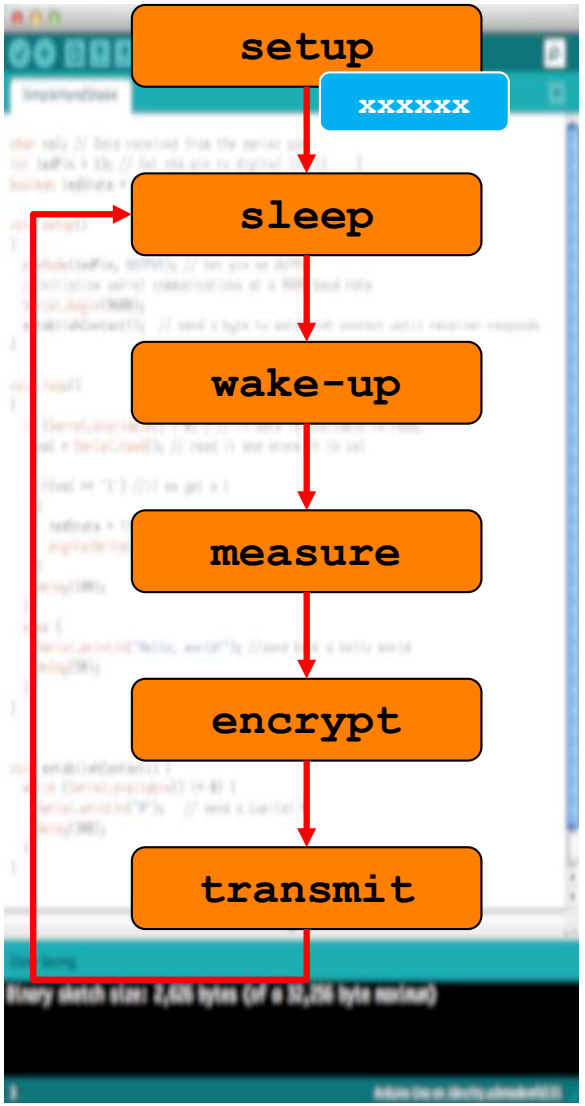
Arduino Pro Mini @3.3V

Activity duty-cycle, low power

AES encryption

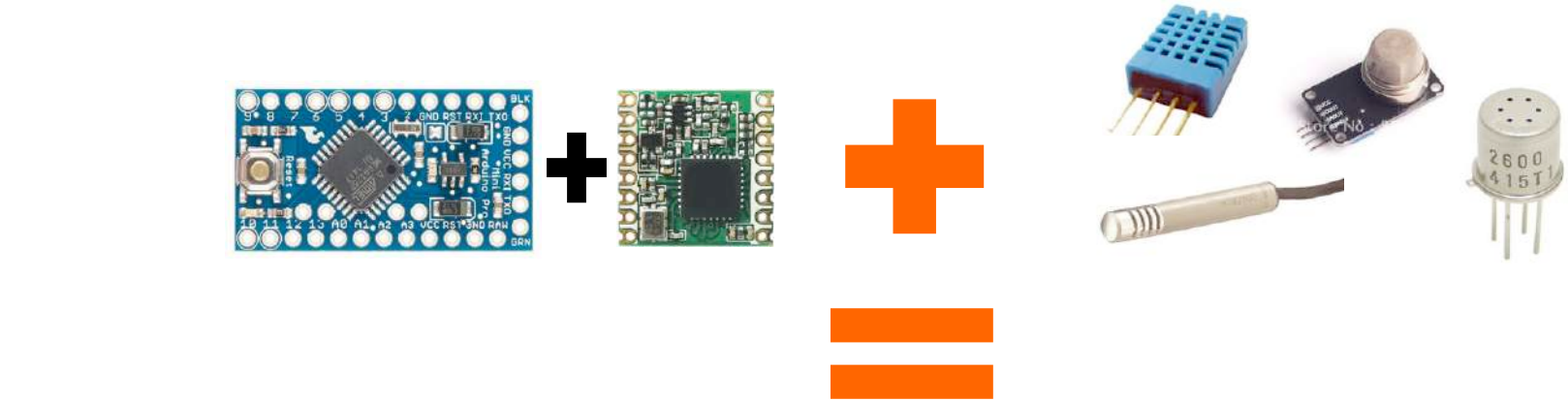
Long-range transmission

Logical sensor management



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
- Me
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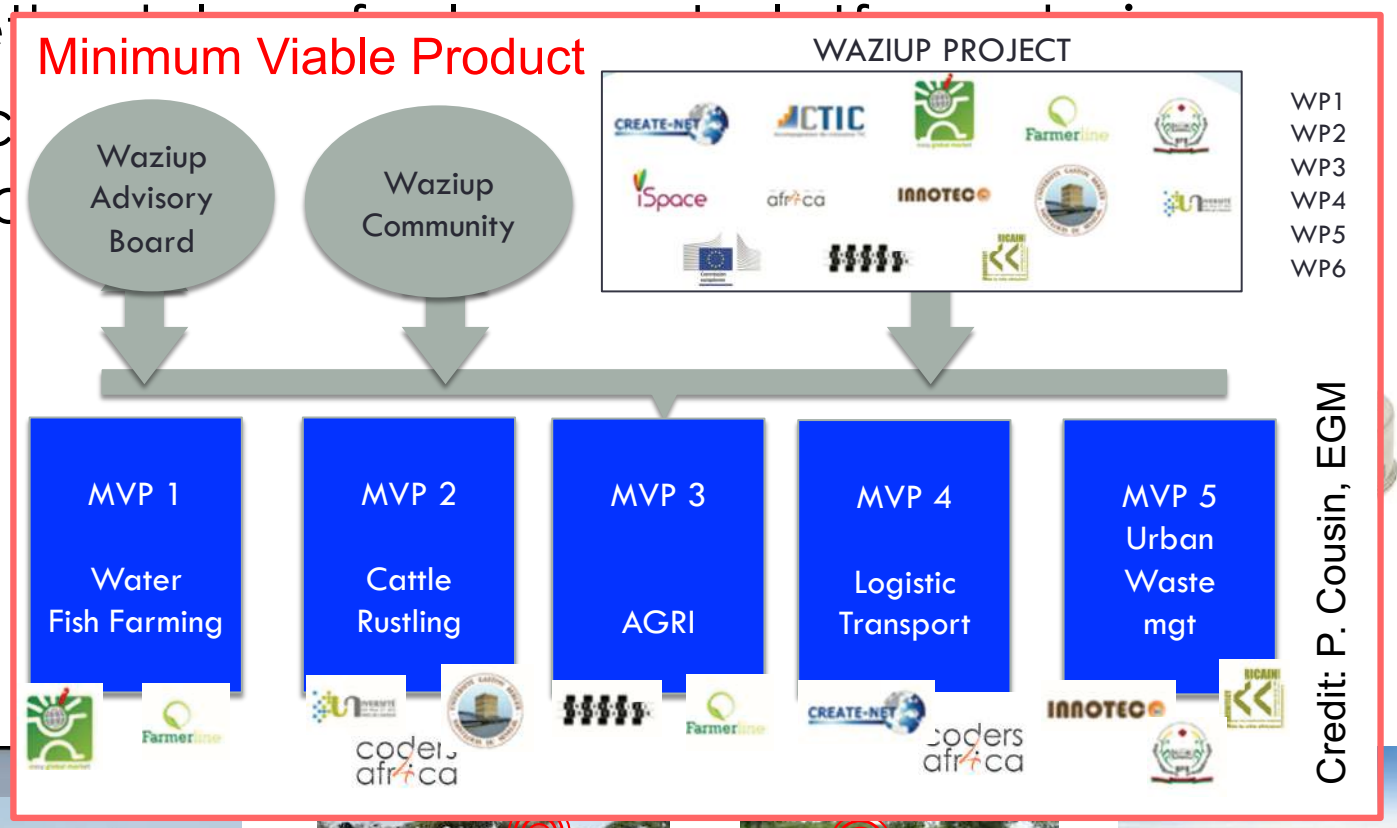
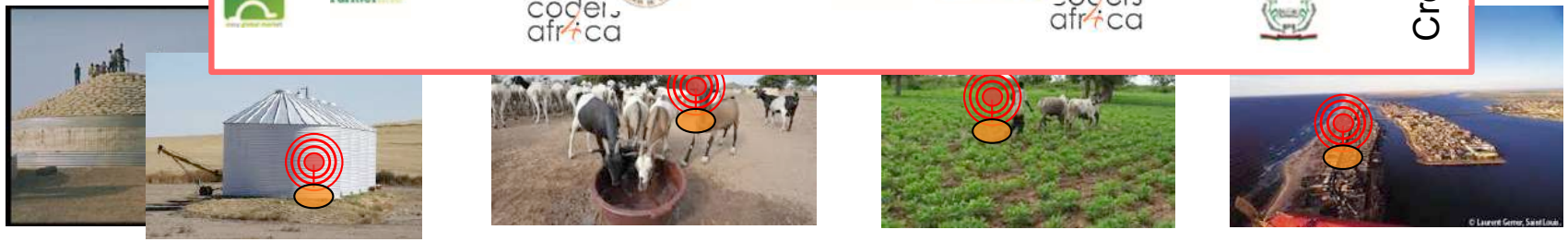
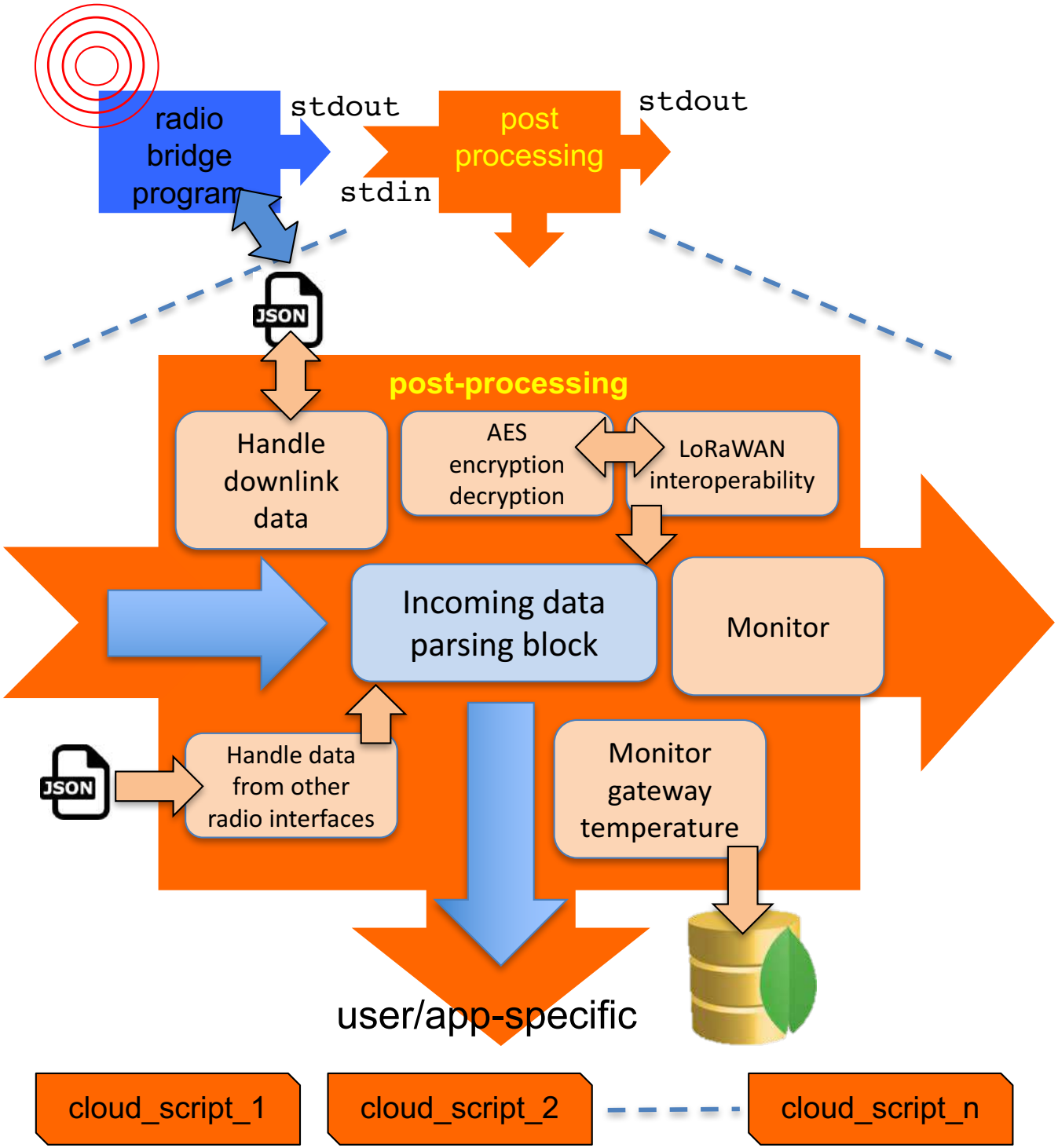
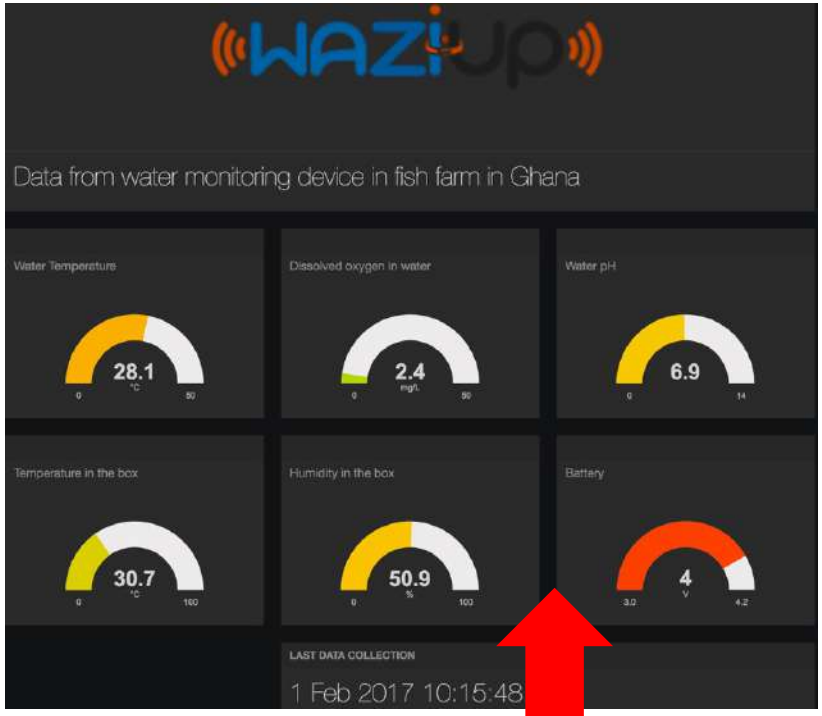





GATEWAY

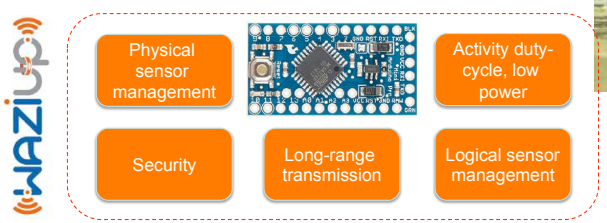

radio bridge program
stdout
stdin
post processing
stdout
JSON
post-processing
Handle downlink data
AES encryption decryption
LoRaWAN interoperability
Incoming data parsing block
Monitor
JSON
Handle data from other radio interfaces
Monitor gateway temperature
user/app-specific
cloud_script_1
cloud_script_2
cloud_script_n

Low-cost buoy for fish farming MVP



WAZIUP

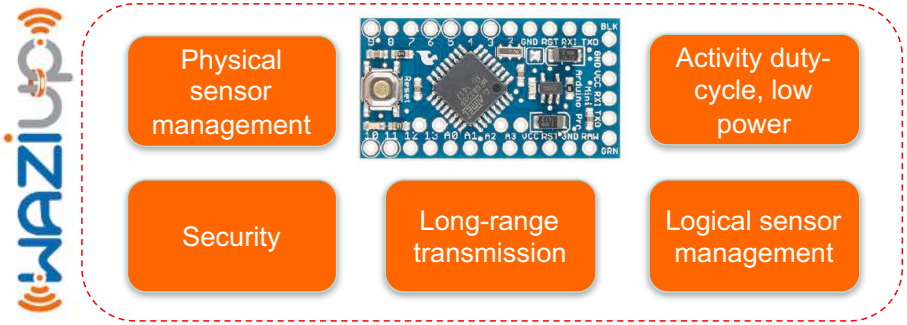
Physical sensor reading



Credit: EGM

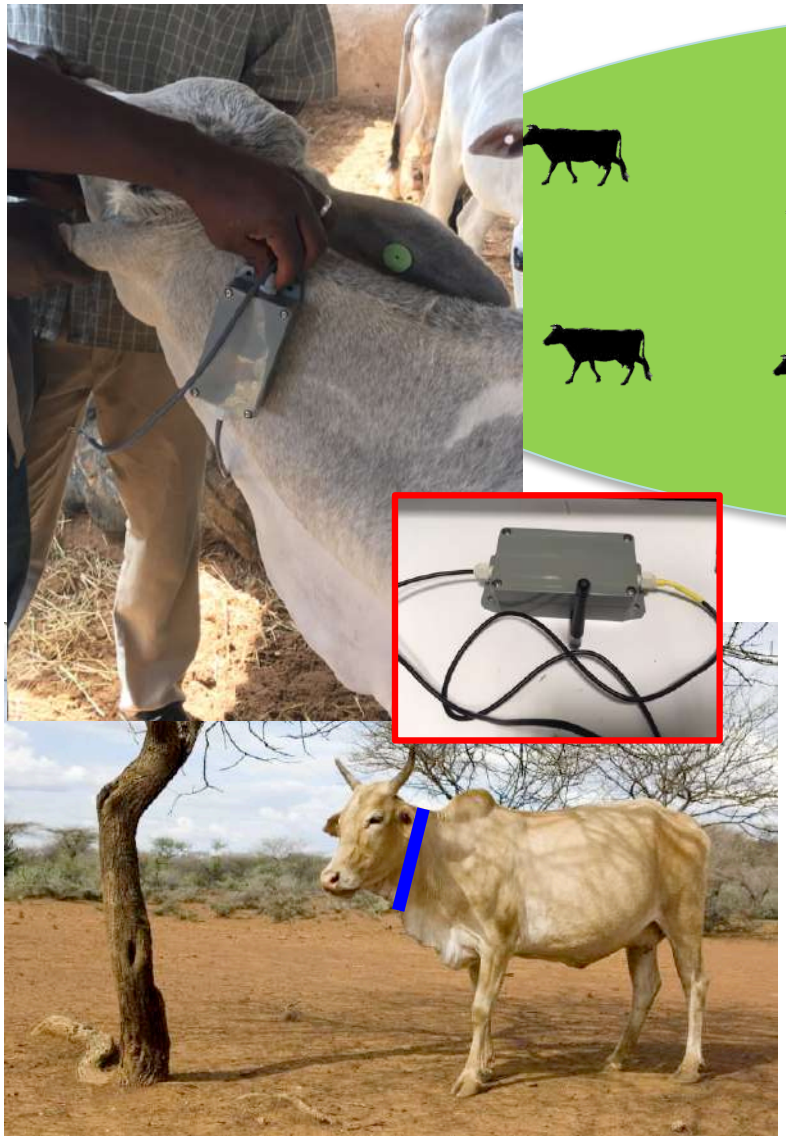
FIWARE

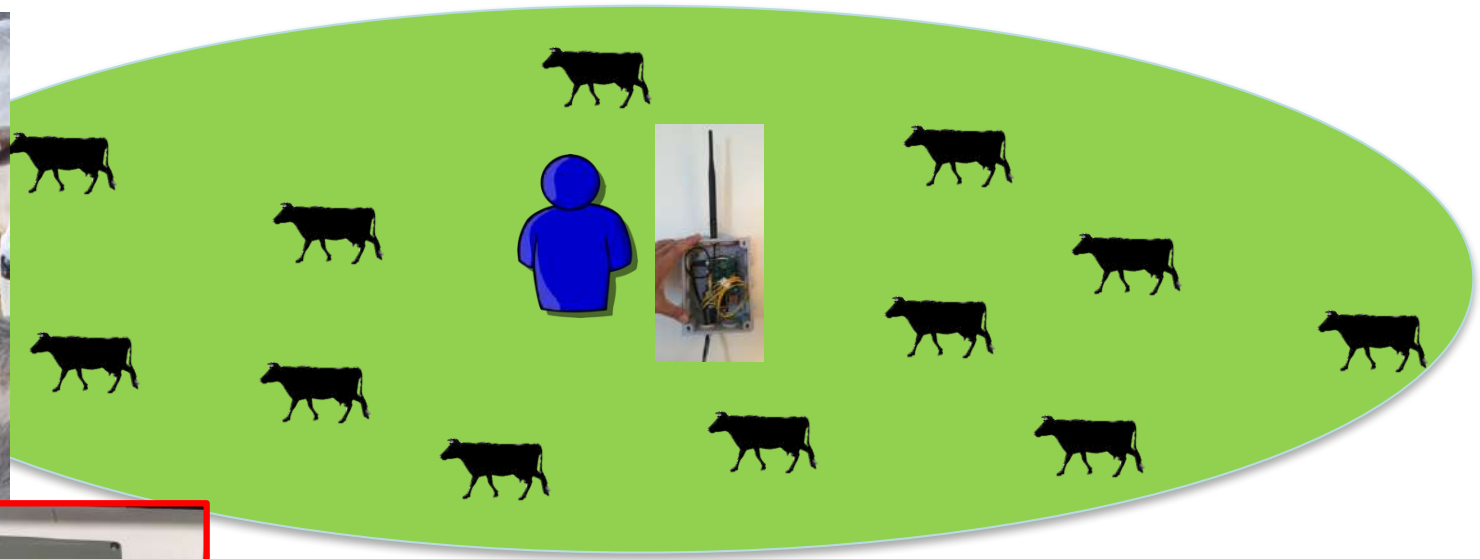
SOIL HUMIDITY SENSORS FOR AGRI MVP



Deployment for Nestlé's WaterSense project

Collar for Cattle Rustling MVP

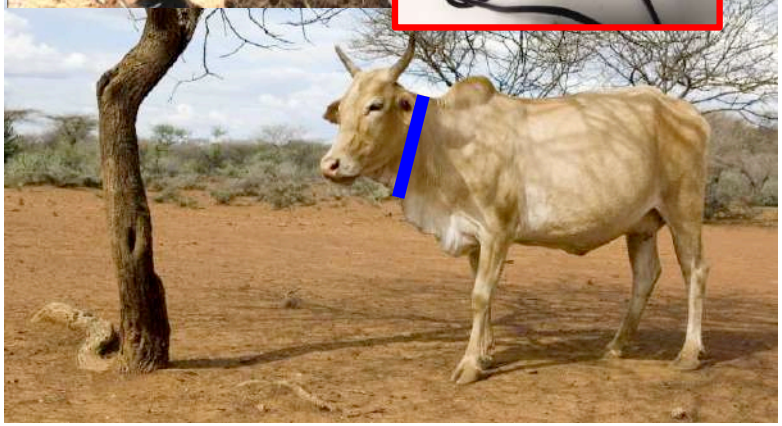


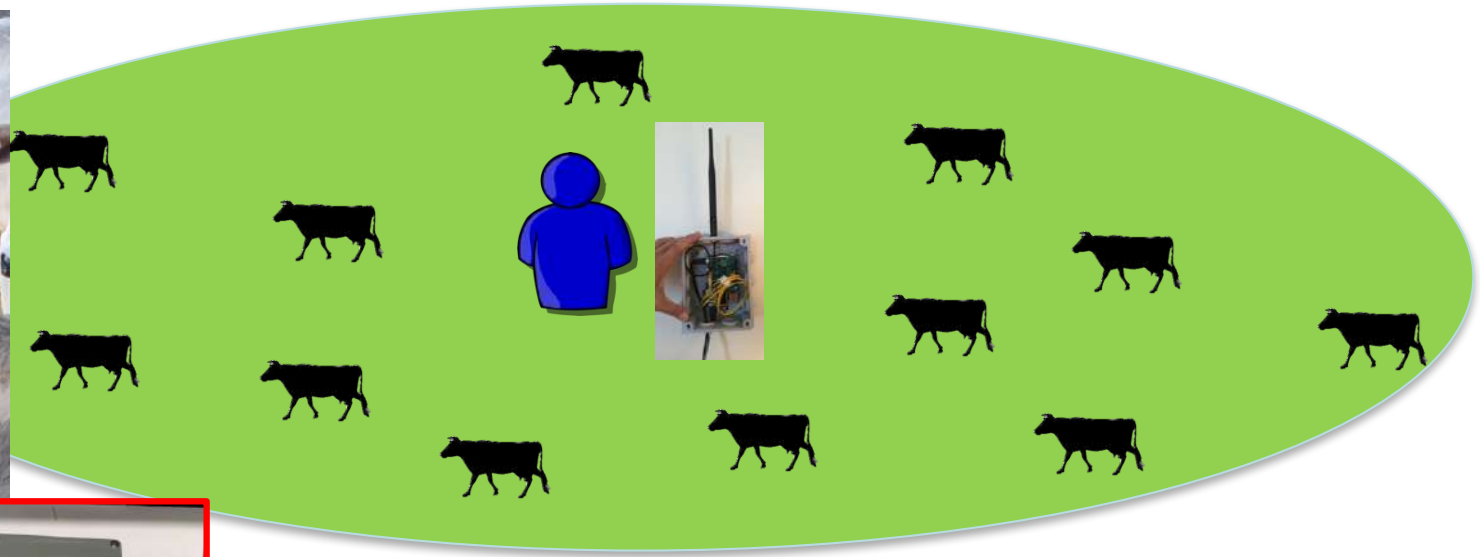


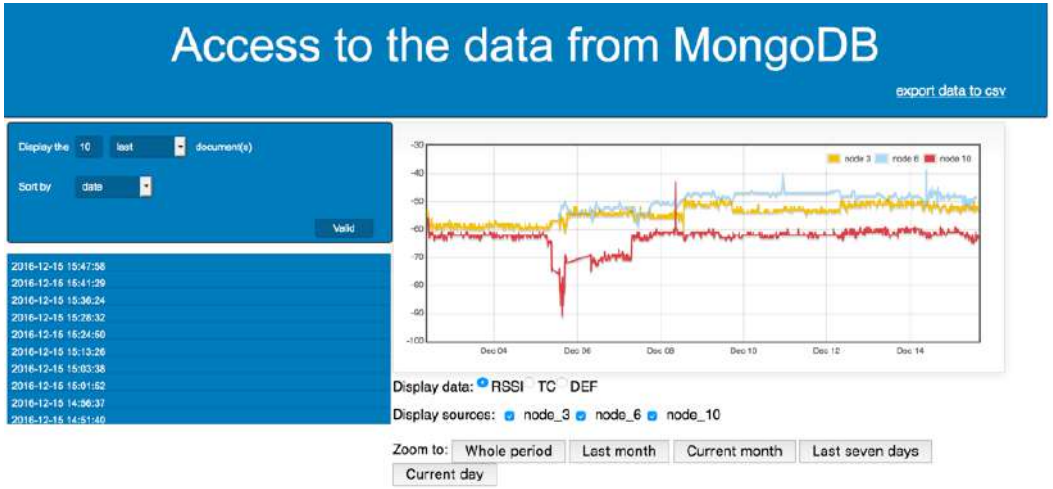
In Africa, the practice of animal husbandry has always been and still remain farmers' livelihood and incomes

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

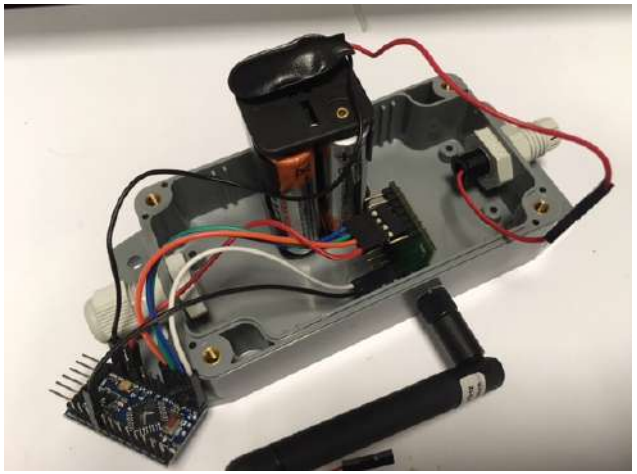
Collar for Cattle Rustling MVP

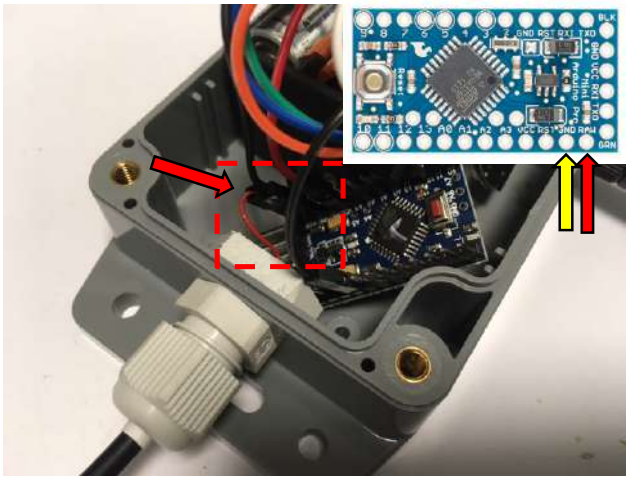


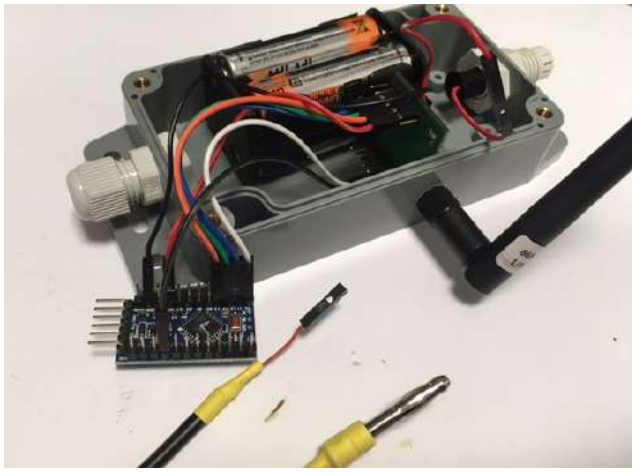


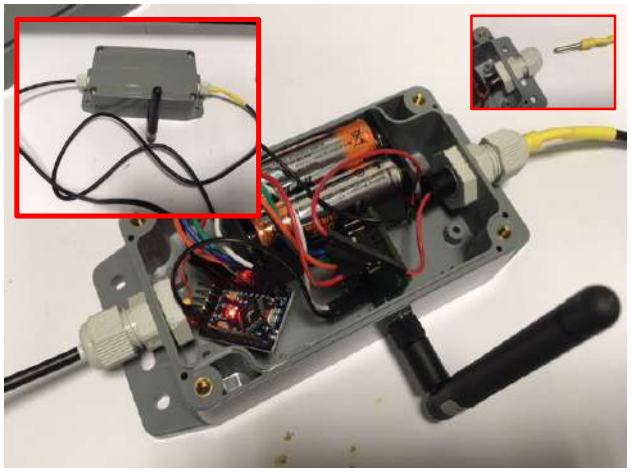


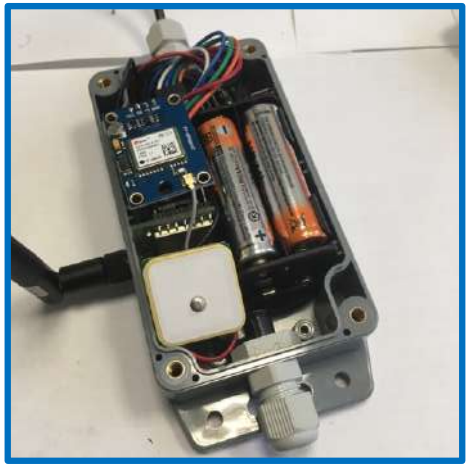
Easy integration and customization

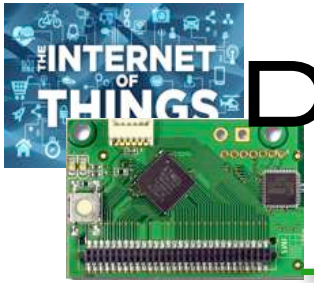










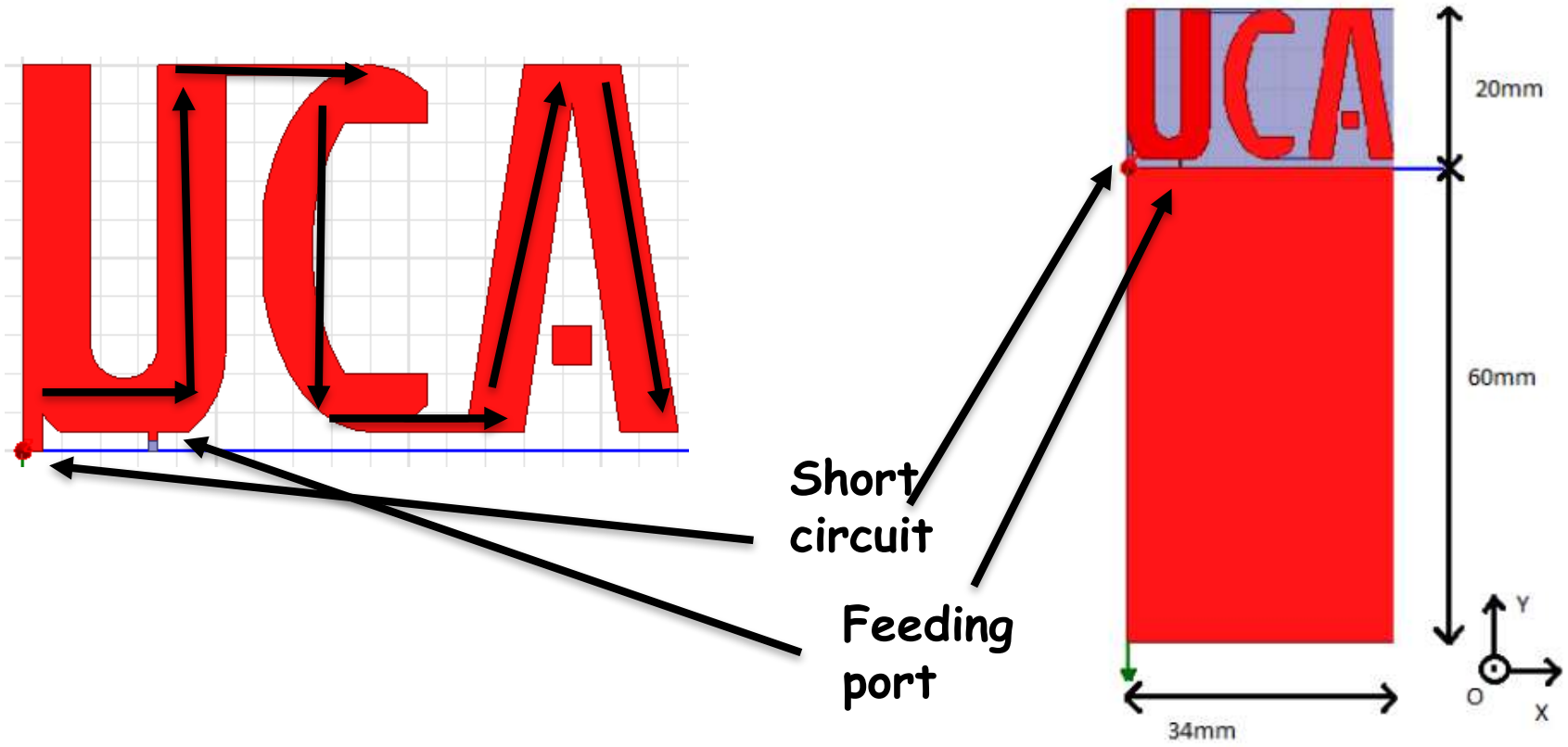


Design of cost efficient antenna @868MHz

- Cost reduction
  - Avoids RF connectors, use less expensive LoRa module
  - Avoid external antenna
  - A PCB is needed for component integration
  - The cost for an extension of the PCB is negligible, so PCB integrated antenna is very cost efficient
- Radiation performance
  - Two parameters need to be optimized : impedance matching and radiation efficiency
  - Impedance matching can be easily optimized with antenna geometry
  - Radiation efficiency mainly depend on the antenna size

Antenna design

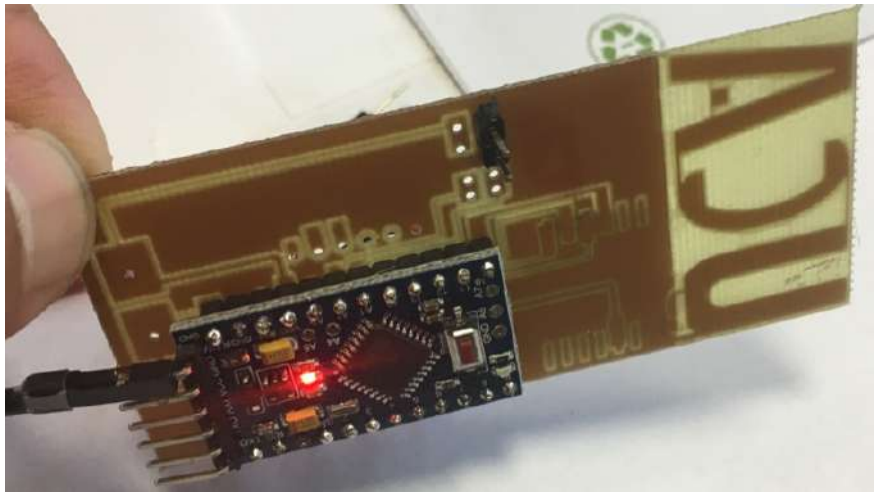
- Open-source layout
  - Inverted F antenna (IFA) topology
  - Antenna meandered for miniaturization
  - Logo of Université Côte d'Azur used for the design

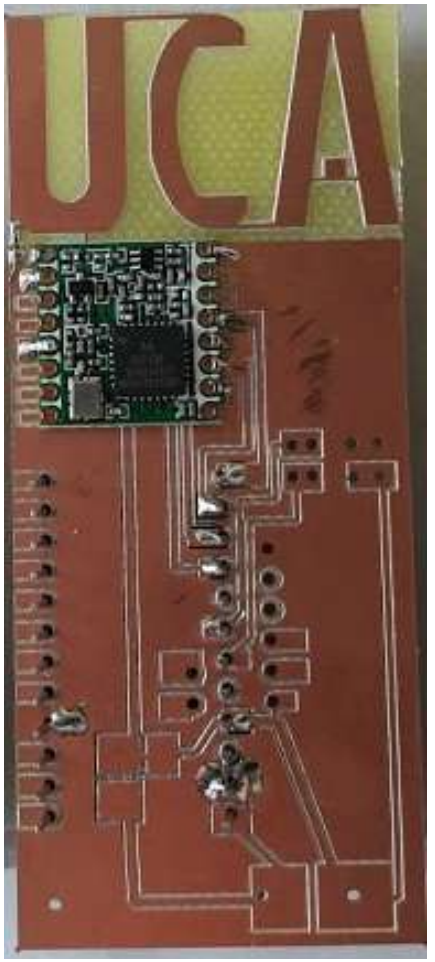


Low-cost integration

5€

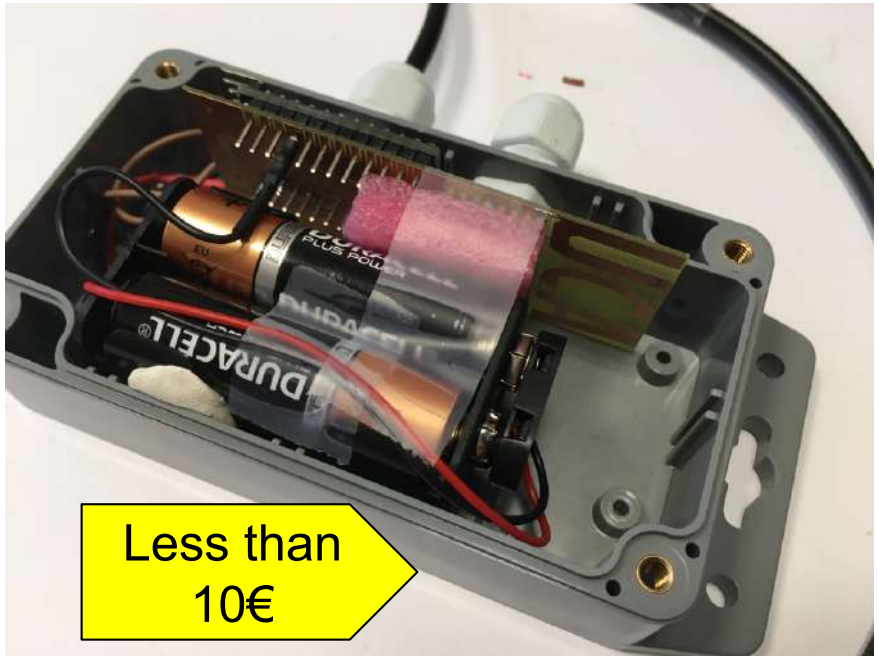
HopeRF
RFM92W/95W





10€

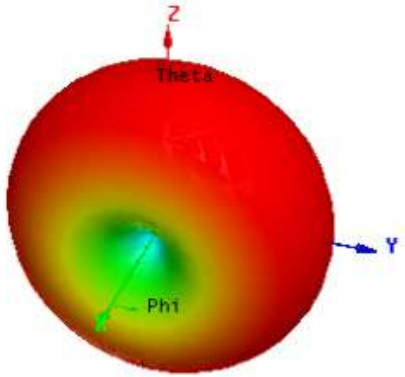
Modtronix
inAir4/9/9B

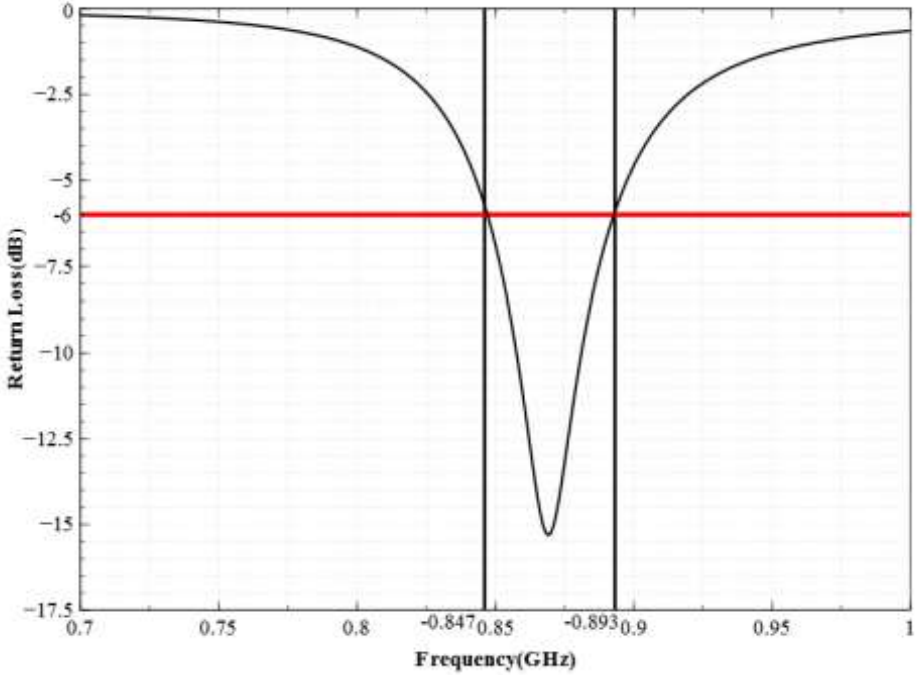


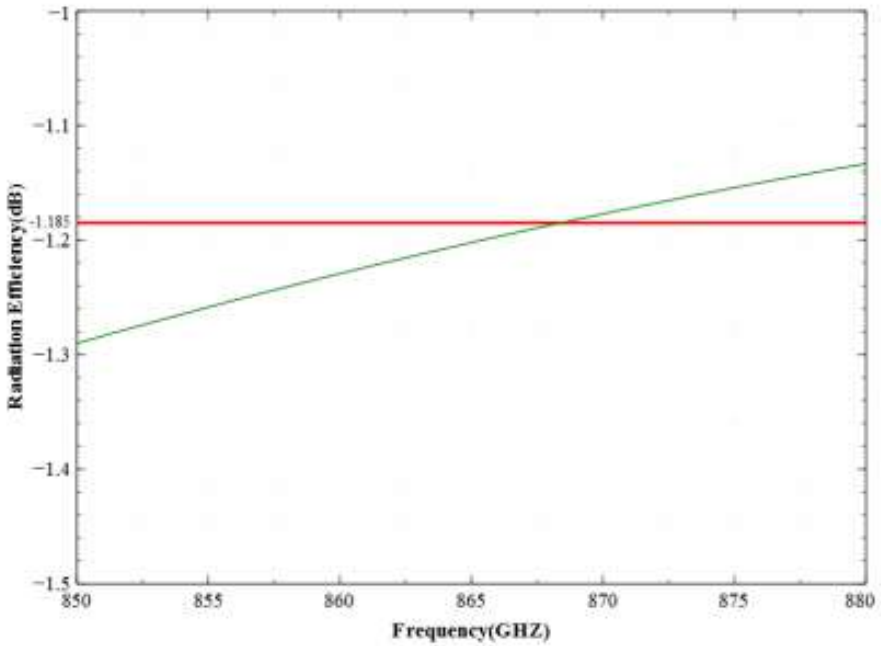
3€

ANTENNA CHARACTERISTICS

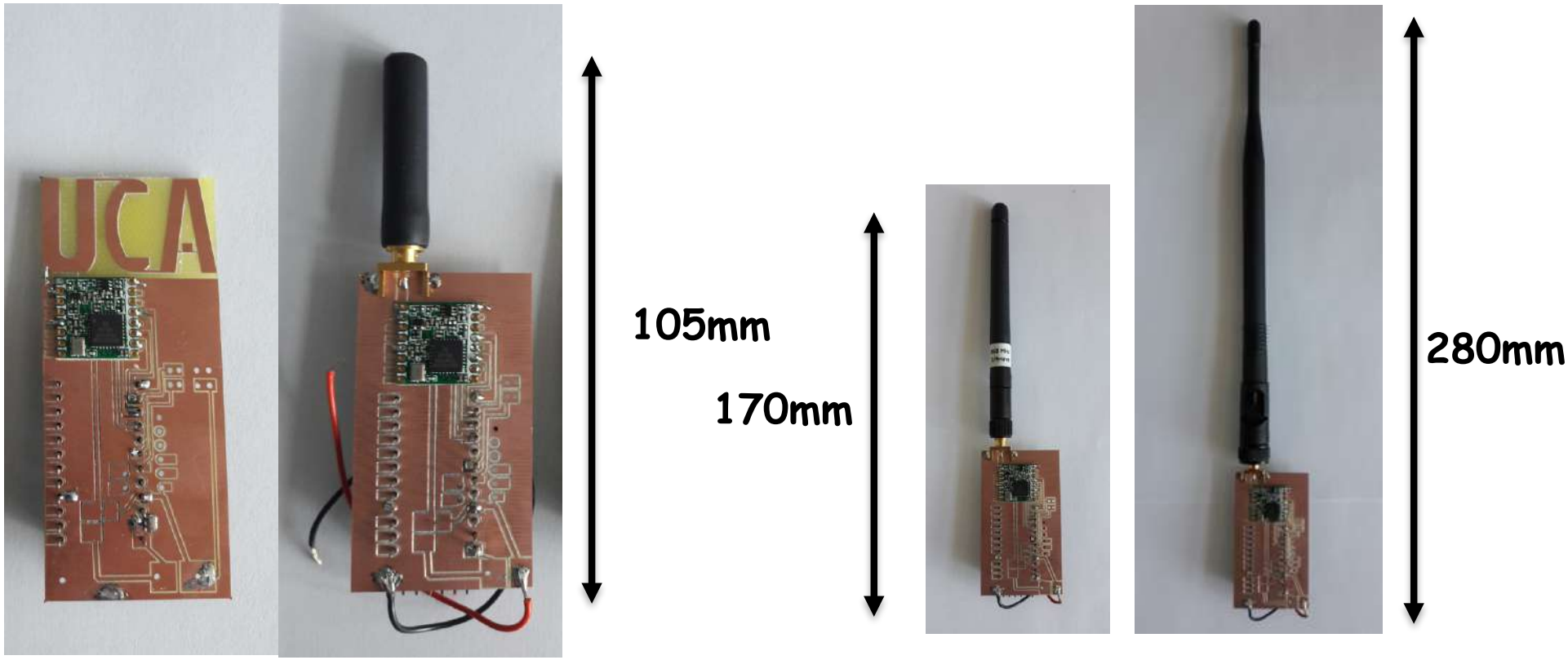
- Antenna simulation
  - -6dB reflection coefficient 850- 893MHz band
  - -1.2 dB radiation efficiency (75%)
  - Dipole radiation pattern







COMPARISON WITH EXTERNAL ANTENNAS



UCA antenna

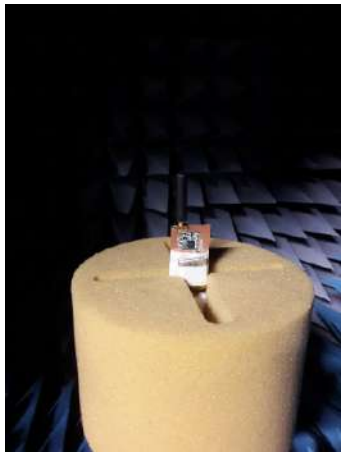
Short monopole

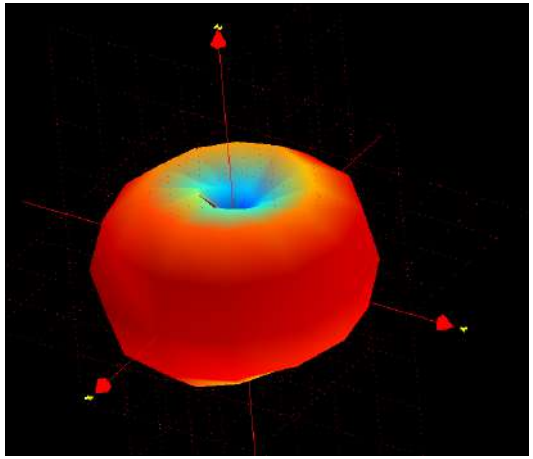
Quarter-wave monopole

half-wave dipole

Radiation measurements : Synthesis

- Measurement on Satimo Starlab station
  - Continuous wave with 14 dBm power
  - Efficiency calculated from the 3D antenna measurement

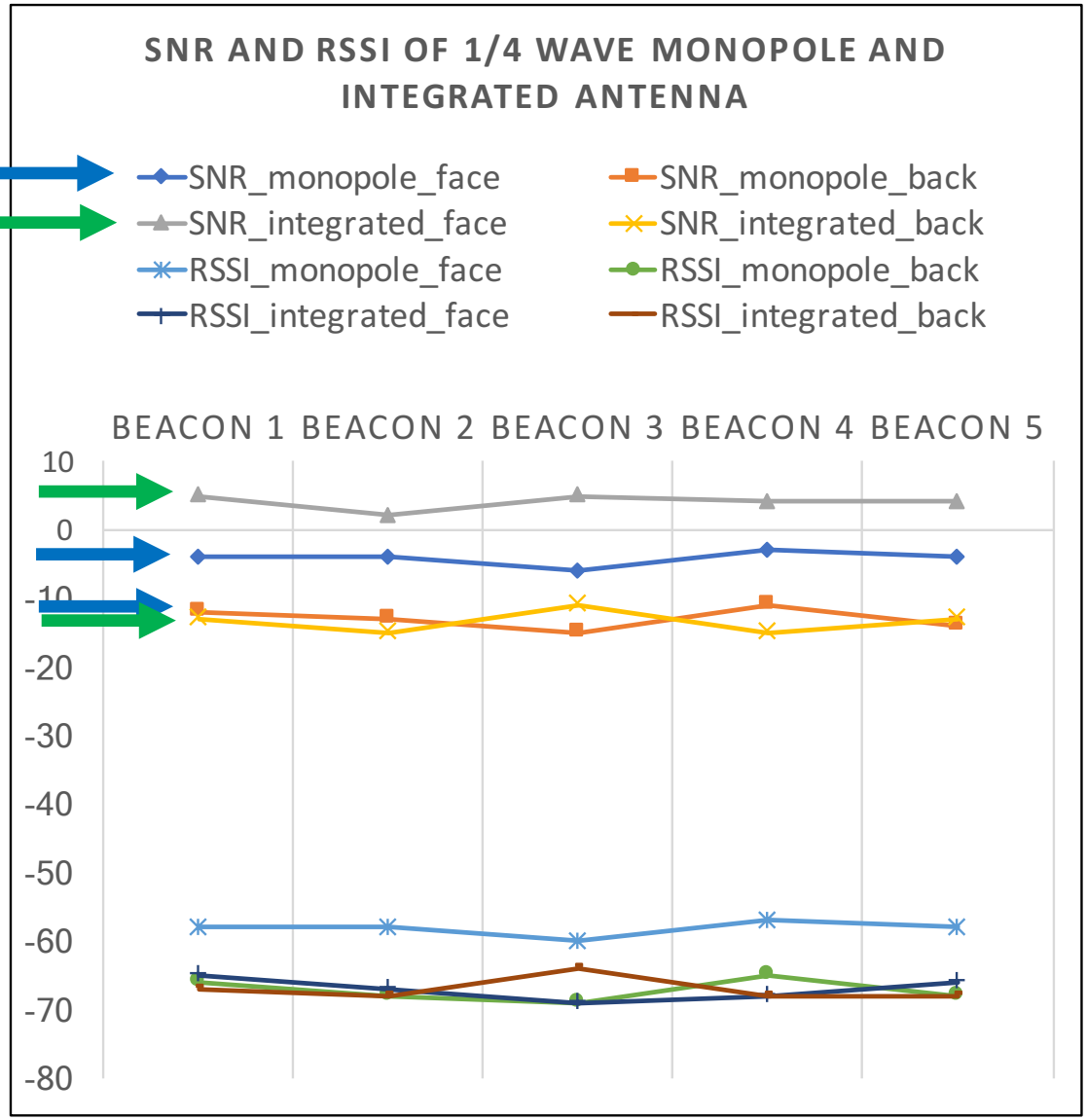


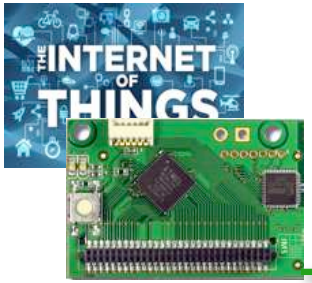


Antenna structure	TRP (dBm)	Total efficiency	Max Dimension
Small monopole	14.7	74%	105 mm
Quarter-wave monop.	15.7	94%	170 mm
Half-wave monop.	13.9	61%	280 mm
UCA without casing	13.8	60%	80mm
UCA with casing	14.8	76%	80mm

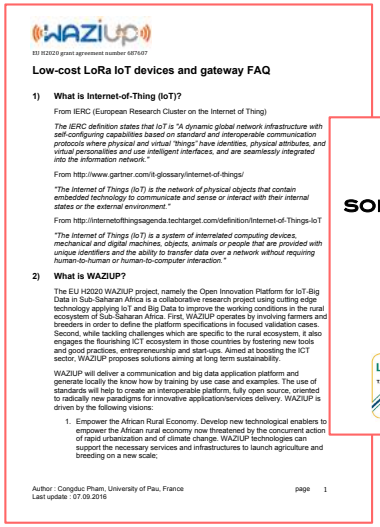
Field tests

800m with vegetation





Tutorials/resources



WAZIUP

EU H2020 grant agreement number 687607

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-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network."

From http://www.gartner.com/it-glossary/internet-of-things/

"The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment."

From http://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

"The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction."

2) What is WAZIUP?

The EU H2020 WAZIUP project, namely the Open Innovation Platform for IoT-Big Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP operates by involving farmers and breeders in order to define the platform specifications in focused validation cases. Second, while tackling challenges which are specific to the rural ecosystem, it also engages the flourishing ICT ecosystem in those countries by fostering new tools and good practices, entrepreneurship and start-ups. Aimed at boosting the ICT sector, WAZIUP proposes solutions aiming at long term sustainability.

WAZIUP will deliver a communication and big data application platform and generate locally the know how by training by use case and examples. The use of standards will help to create an interoperable platform, fully open source, oriented to radically new paradigms for innovative application/services delivery. WAZIUP is driven by the following visions:

1. Empower the African Rural Economy. Develop new technological enablers to empower the African rural economy now threatened by the concurrent action of rapid urbanization and of climate change. WAZIUP technologies can support the necessary services and infrastructures to launch agriculture and breeding on a new scale;

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

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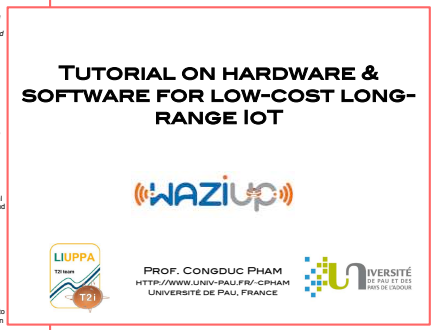
Tutorial on hardware & software for low-cost long-range IoT



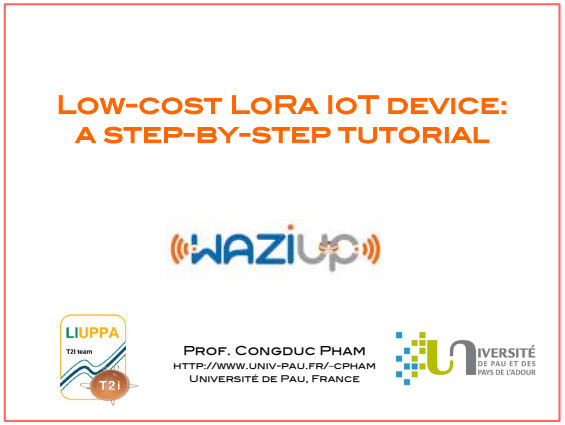
WAZIUP

LIUPPA T2i team T2i

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Low-cost LoRa IoT device: a step-by-step tutorial



WAZIUP

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UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Building an IoT device for outdoor usage: a step-by-step tutorial

WAZIUP

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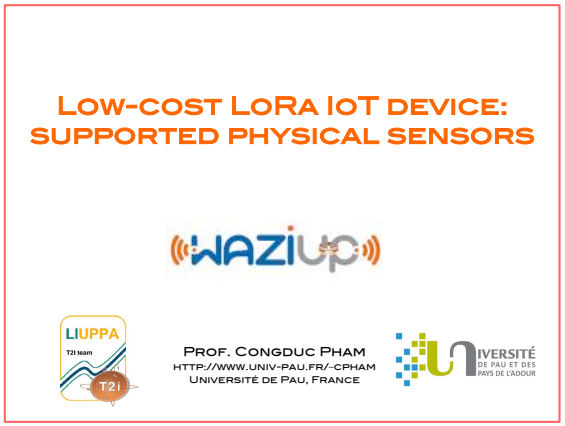
Low-cost LoRa IoT device: supported physical sensors



WAZIUP

LIUPPA T2i team T2i

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

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Low-cost LoRa gateway: a step-by-step tutorial

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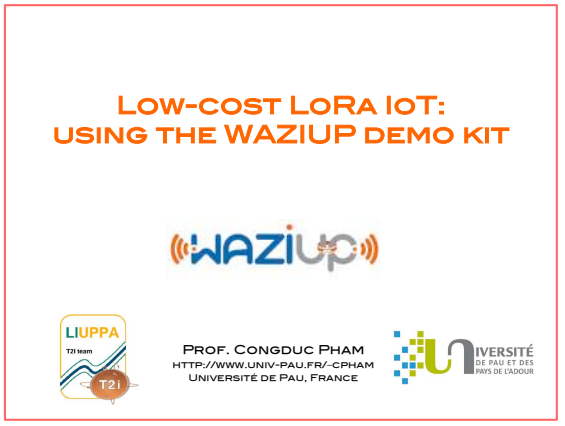
Low-cost LoRa IoT: using the WAZIUP demo kit



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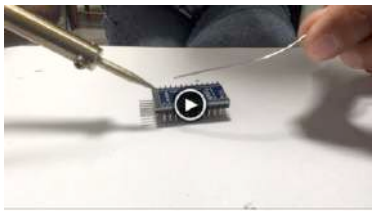

Thanks.

Let's keep in touch

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