

# THE CHALLENGES OF DEPLOYING LOW-COST, LONG-RANGE IOT IN AFRICA



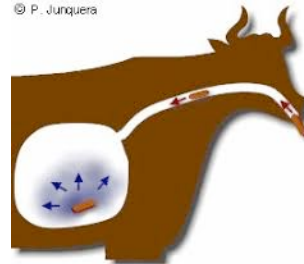
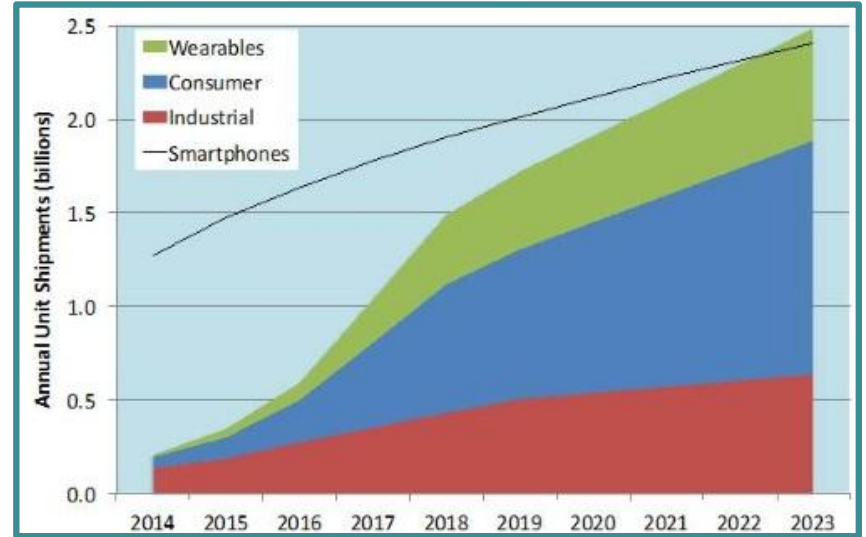
OCTOBER 11TH, AFRILAB, DAR-ES-SALAM, TANZANIA



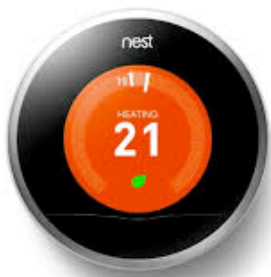
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# When talking about IoT...



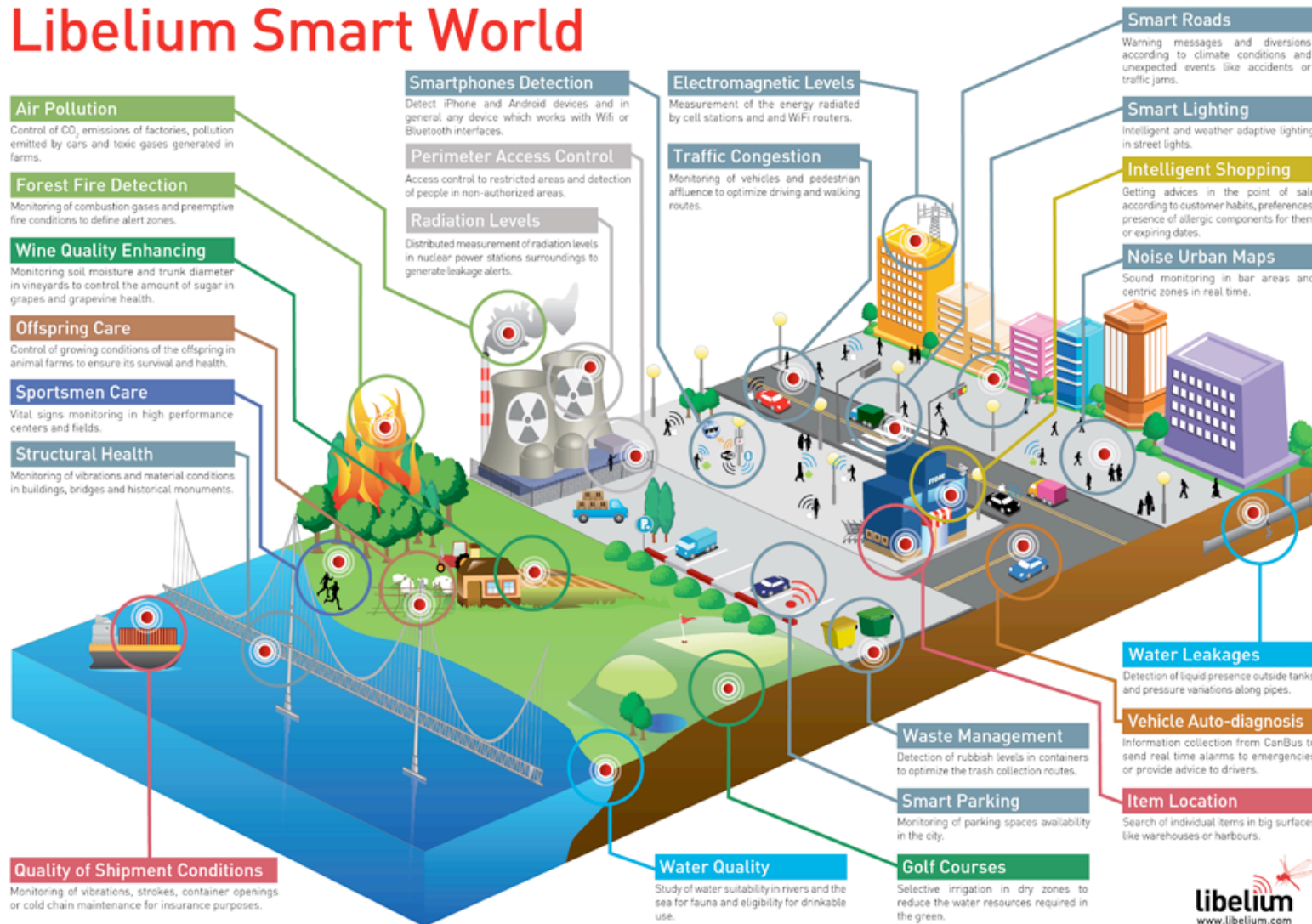
© P. Junquera



# Smart Cities



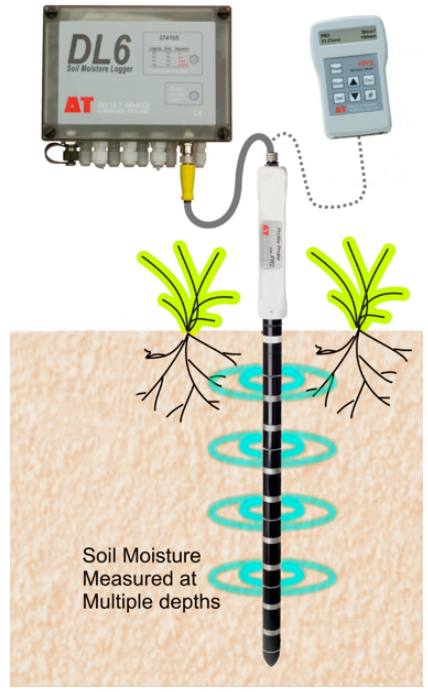
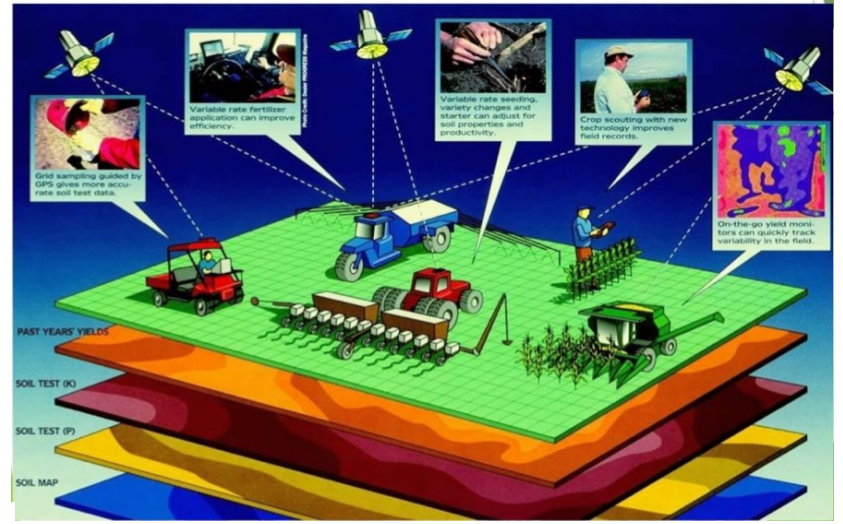
## Libelium Smart World



# Smart Farming & Smart Agriculture



## GPS in Agriculture





Needs, constraints, cost, design approach, control mechanism

Challenge: Bridging the digital divide



# IoT becomes reality!



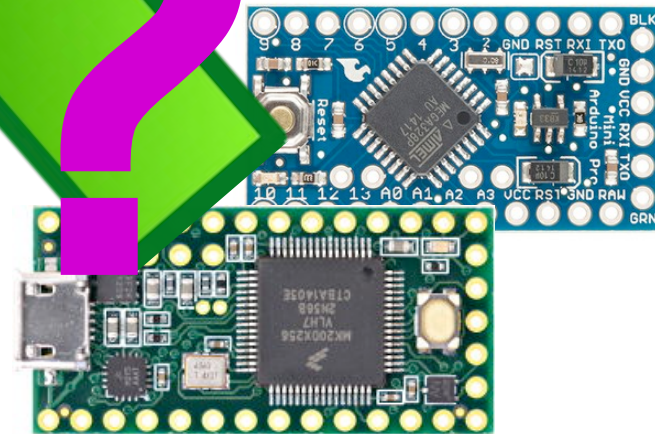
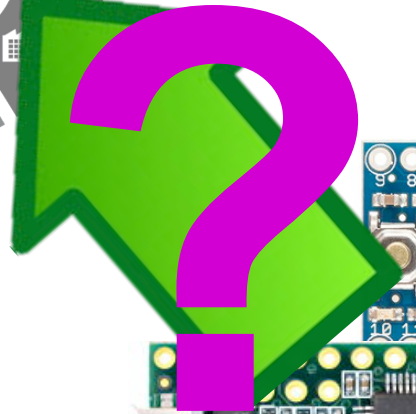
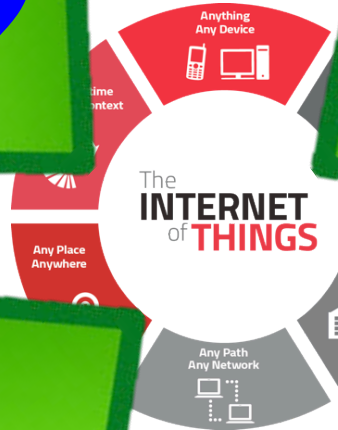
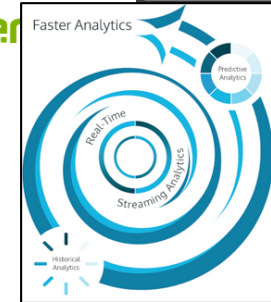
LTE-M



NB-LTE



EC-C

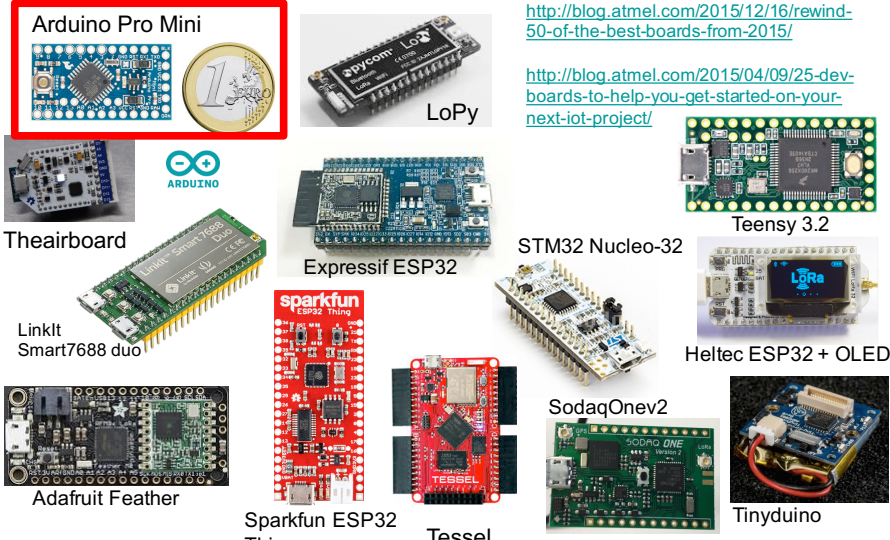


# Cost, efficiency & performance



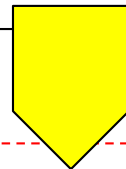
- ❑ Can we build low-cost, low-power, generic IoT platforms from off-the-shelves components?
- ❑ Can we create sustainable innovation with user communities, economic actors, entrepreneurs, stakeholder?

### LOW-COST 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/>



# Ready-to-use templates

Moisture/  
Temperature of  
storage areas



10-15kms



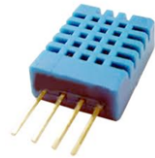
Physical  
sensor



Physical  
sensor

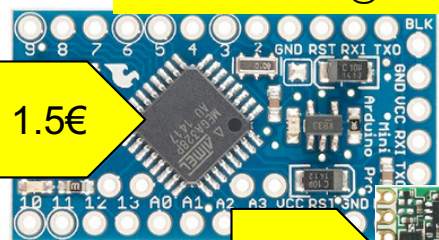


Physical  
sensor



Physical  
sensor  
mgmt

1.5€



Arduino Pro Mini @3.3V

**VERY IMPORTANT**

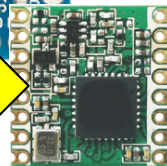
Activity  
duty-cycle,  
low power

AES  
encryption

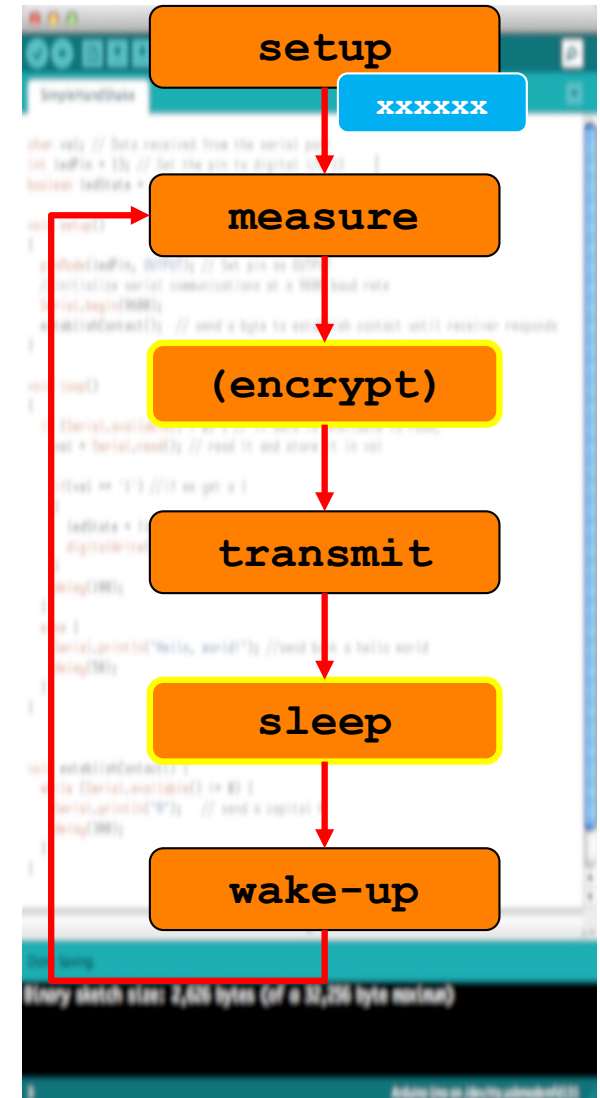
**VERY IMPORTANT**

Long-range  
transmission

4€

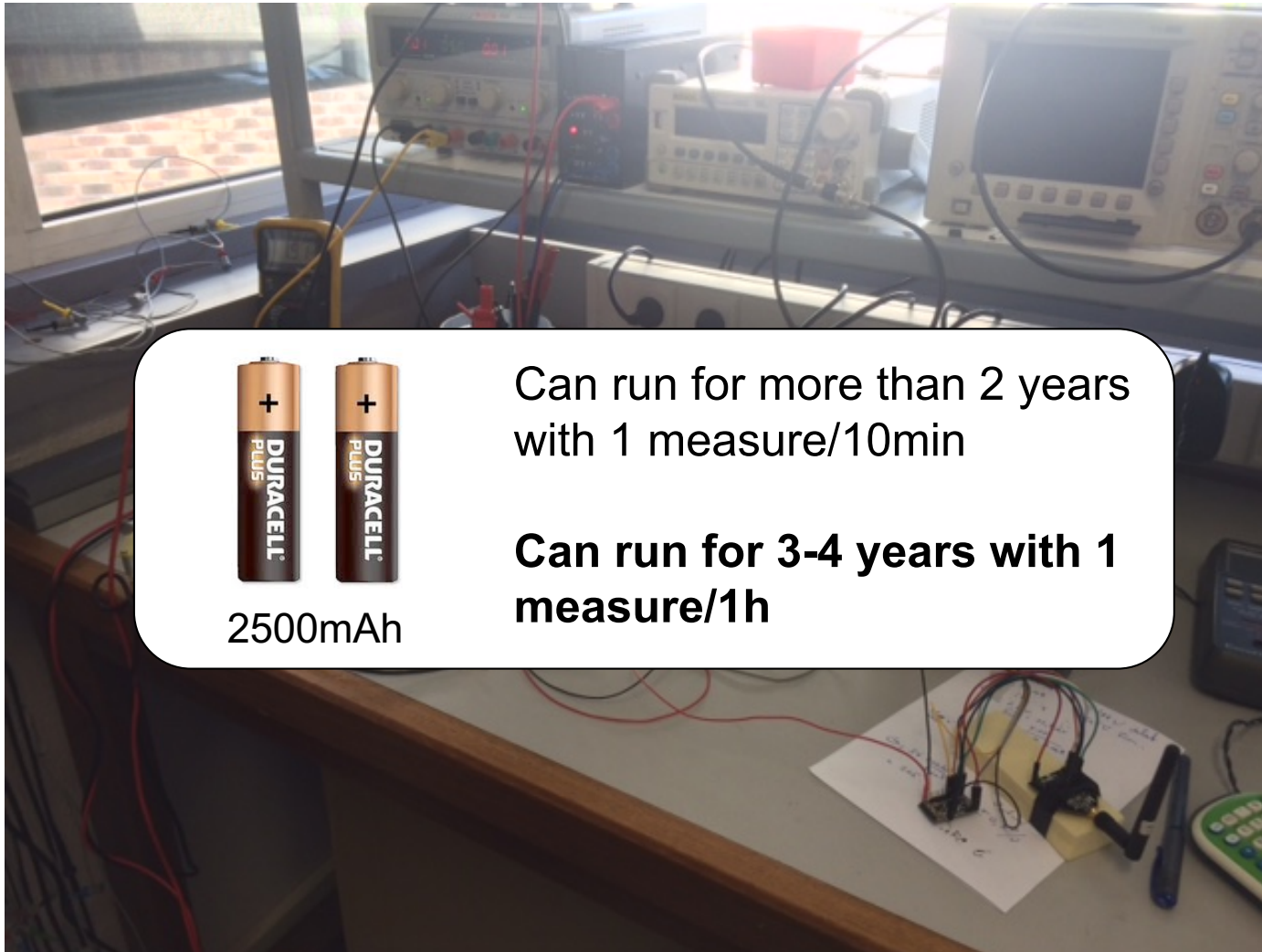



Logical  
sensor  
mgmt





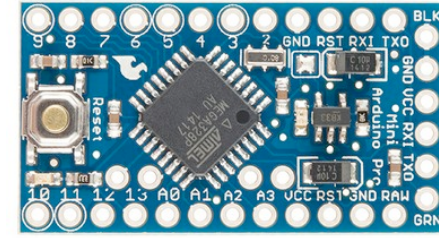
# Running for several years!



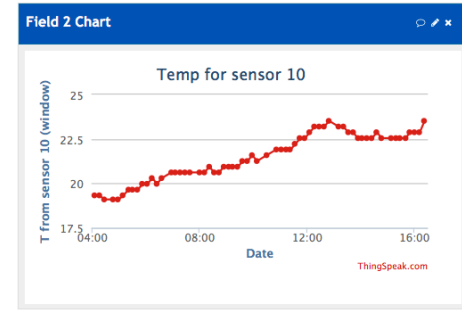
  
2500mAh

Can run for more than 2 years with 1 measure/10min

Can run for 3-4 years with 1 measure/1h

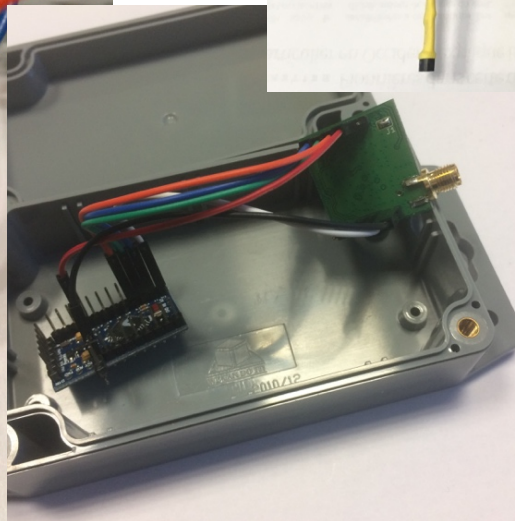
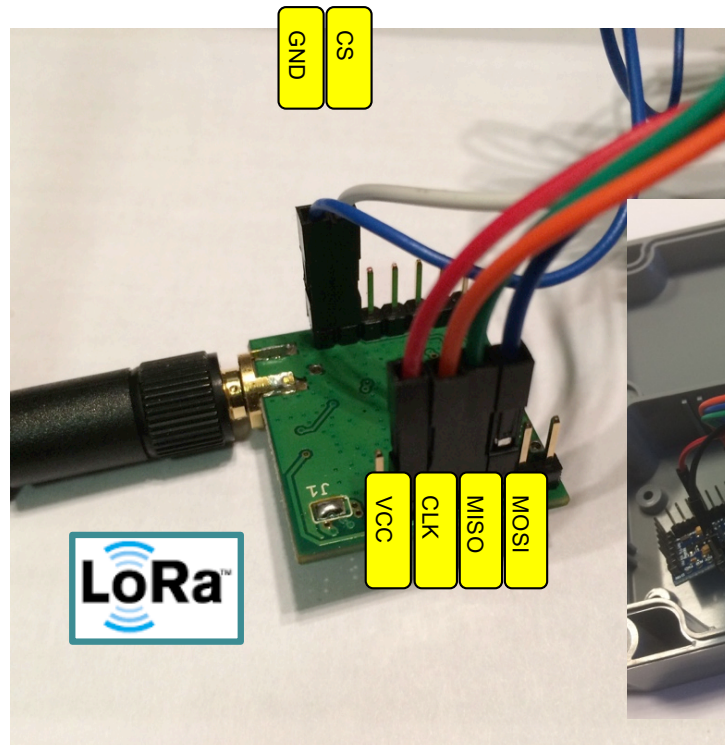
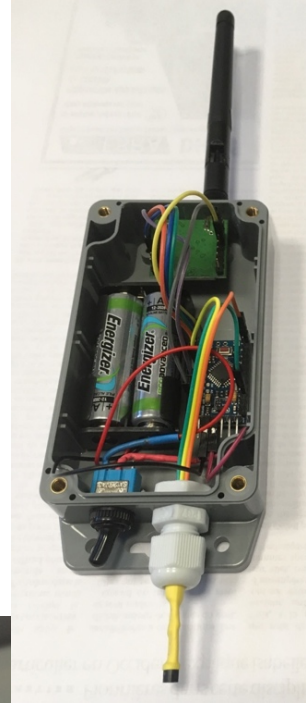
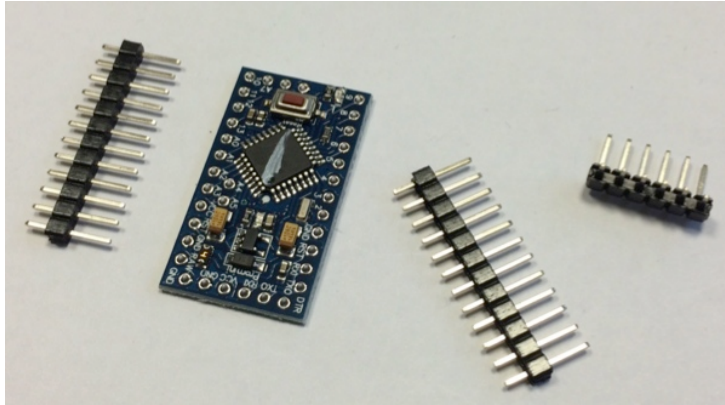


Wakes-up every 10min, take a measure (temp) and send to GW

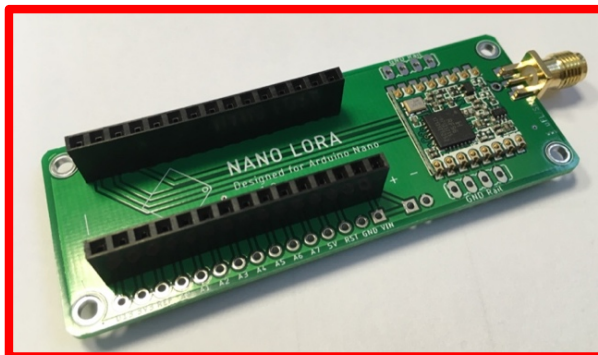
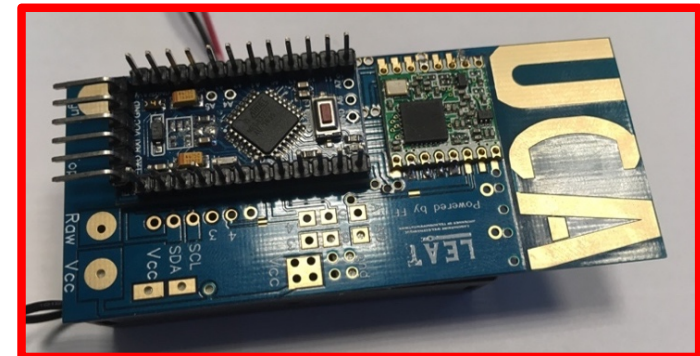
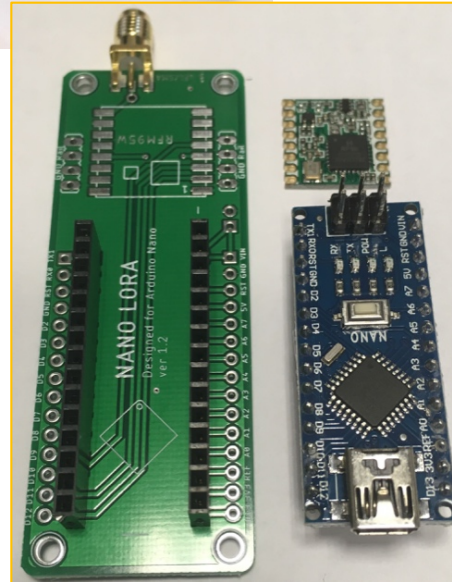
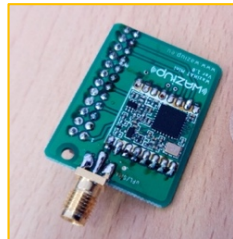
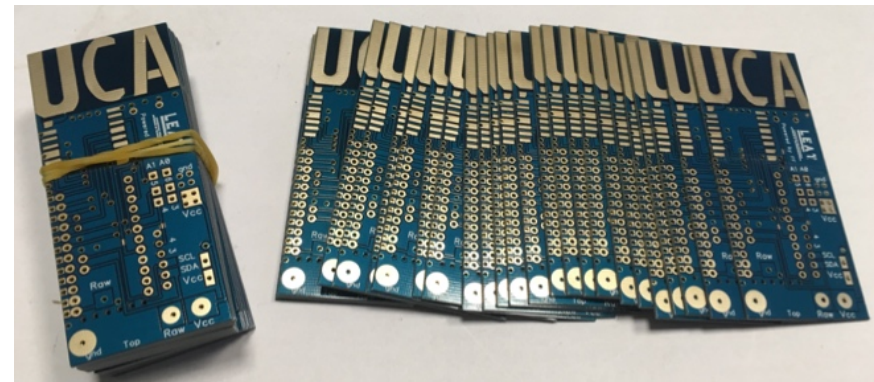
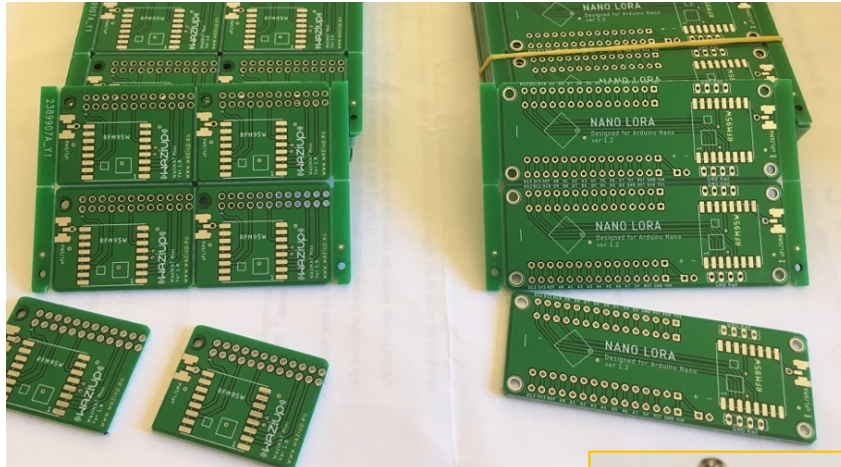


**5 $\mu$ A in deep sleep mode, about 40mA when active and sending!**

# Full Do-It-Yourself approach



# Still DIY but simple PCBs make it much easier for developers



# Many tutorials/resources



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

**WAZIUP**  
 H2020 grant agreement number 887167

**Low-cost LoRa IoT devices and gateway FAQ**

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

2) **What is WAZIUP?**  
 The EU H2020 WAZIUP project, namely the Open Innovation Platform for IoT-Big Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP operates by involving farmers and breeders in order to define the platform specifications in focused validation cases. Second, while tackling challenges which are specific to the rural ecosystem, it also engages the flourishing ICT ec and good practices, emergent sector. WAZIUP proposes solu  
 WAZIUP will deliver a commu generate locally the know how standards will help to create ar to radically new paradigms for driven by the following visions:  
 1. Empower the African R empower the African vol of rapid urbanization an support the necessary ar breeding on a new scale

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

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

**WAZIUP**

LIUPPA T2i team

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

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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**

**WAZIUP**

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**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 5MHz 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 best solution is very cost-effective as the Pro Mini board can be purchased for a bit more than 1€ a piece.

Depending to connect pins may not soldered.

**The LoRa radio module**  
 There are various LoRa radio modules that are all based on the Semtech SX1272/1272.

**LoRa**  
 Fully tested LoRa radio module: HqRF RFM120/5W, Liblum LoRa, Modtronics HA499B.

Most of SPI based LoRa radio modules are supported. We recommend the Modtronics (aka modu) if you don't have discrete soldering experience as this module can come with header pins ready to be connected with Dupont wires.

The RFM120W can be found assembled (Adafruit) or an adapter can be purchased (from Ideetron for instance).

**Connect the LoRa radio module**  
 Connect the correspond module to the SPI pins (based on pin 11, MISO) pin 10 and CLK (orange). Then connect also the of the radio module to board (right picture). The VCC of the Pro Mini board gets 3.3v from the on-board voltage regulator.

**LOW-COST LORA GATEWAY: WEB ADMIN INTERFACE**

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**LOW-COST LORA IOT ANTENNA TUTORIAL FOR GATEWAY**

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**IOT DEPLOYMENT WITH WAZIUP \*\*\***

**GUIDELINES, BEST PRACTICES, TROUBLESHOOTING AND FAQ**

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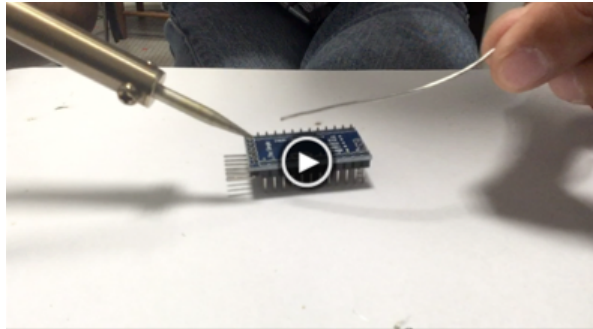
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# Youtube videos



Low-cost  
LoRa IoT  
device



+74000 views

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

Low-cost  
LoRa IoT  
gateway



+11000 views

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

Extreme low-  
power LoRa  
IoT



[https://www.youtube.com/watch?v=2\\_VQpcCwdd8](https://www.youtube.com/watch?v=2_VQpcCwdd8)

Setting up a  
gateway in  
5mins



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

# From generic to specific applications



GPS collar

Image sensors

Soil Moisture

Weather Station

Buoy for water quality

Waste Mngt

Bin presented at Woelab

Photo from EGM

Photo from Unparallel

## 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



**WATER MONITORING LOW-COST BUOY**

- Pipe fixed at the bottom of the pond
- Solar Panel
- Water-proof box with 2 sensors inside (temperature, humidity)
- Buoy
- 3 Water Sensors (pH, Dissolved Oxygen, Temperature) 30 cm below surface
- Mesh tube to protect the sensors

WAZIUP

In Sub-Saharan 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

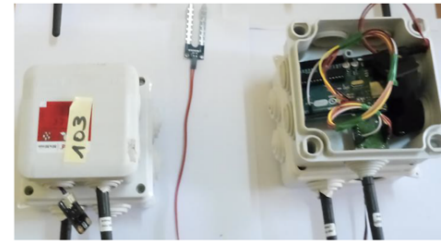
- ❑ Farm located at less than 2 km from UGB.
- ❑ One pond is dedicated for the Waziup application : 50x25m, average depth of 0.5 meters, populated by 4000 individuals of saltwater tilapia.
- ❑ The basin is irrigated via a water supply system fed by a river in proximity.
- ❑ The water in the pond is changed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

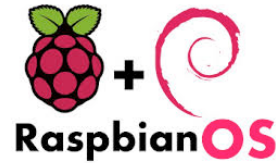
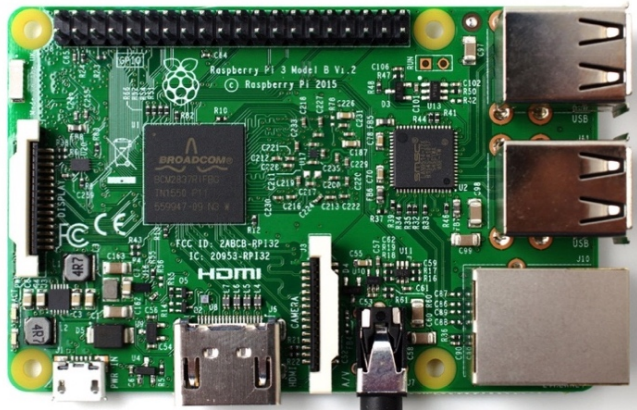


## URBANNATIC GARDENS, TOGO

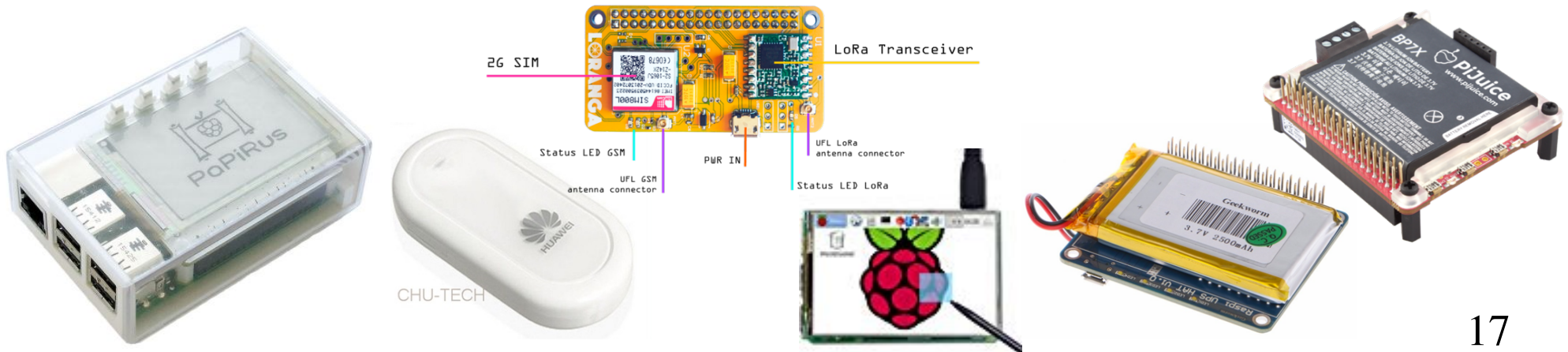




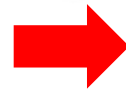
# Open gateway



Raspberry Pi: lots of libraries, lots of software, lots of hardware, lots of shields,...



# Open, versatile gateway



## Access to the data from MongoDB

export data to csv

Display the 10 last document(s)

Sort by date

Valid

```

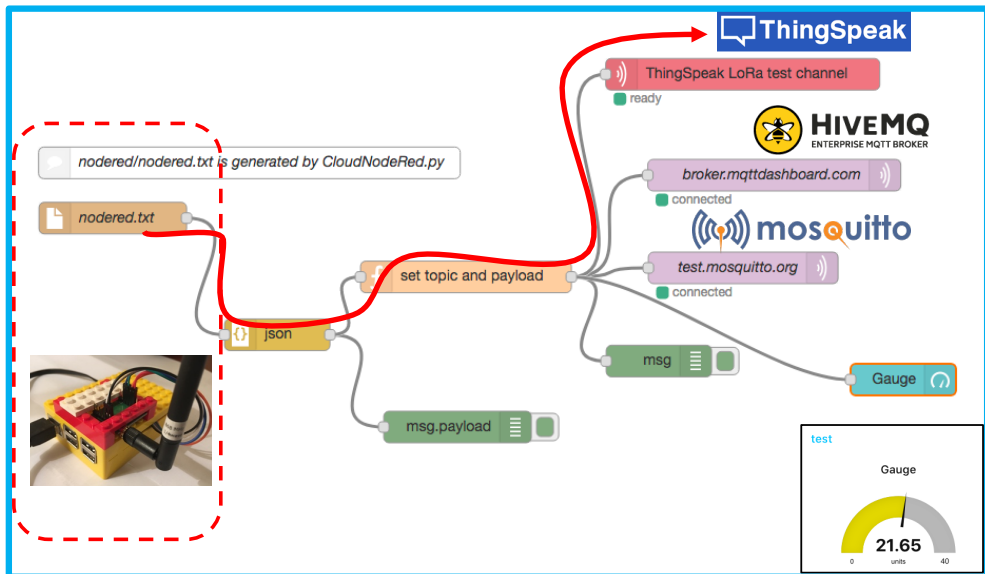
2016-12-15 16:47:58
2016-12-15 16:41:29
2016-12-15 16:36:24
2016-12-15 16:28:32
2016-12-15 16:24:50
2016-12-15 16:13:26
2016-12-15 16:03:38
2016-12-15 16:01:52
2016-12-15 14:56:37
2016-12-15 14:51:40
    
```

Display data: RSSI TC DEF

Display sources: node\_3 node\_6 node\_10

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

Current day



### Gateway configuration

Mode: 1

Frequency: -1

Gateway Web Admin

Internet Low-level status ON Reboot Shutdown

### Cloud

Cloud WAZIUP	ThingSpeak	Cloud No Internet	Cloud Gps File	Cloud MQTT	Cloud Node-RED
Enabled	false				
project name	waziup				
organization name	ORG				
service tree					
auth token	this_is_my_authorization_token				
source list	Empty				

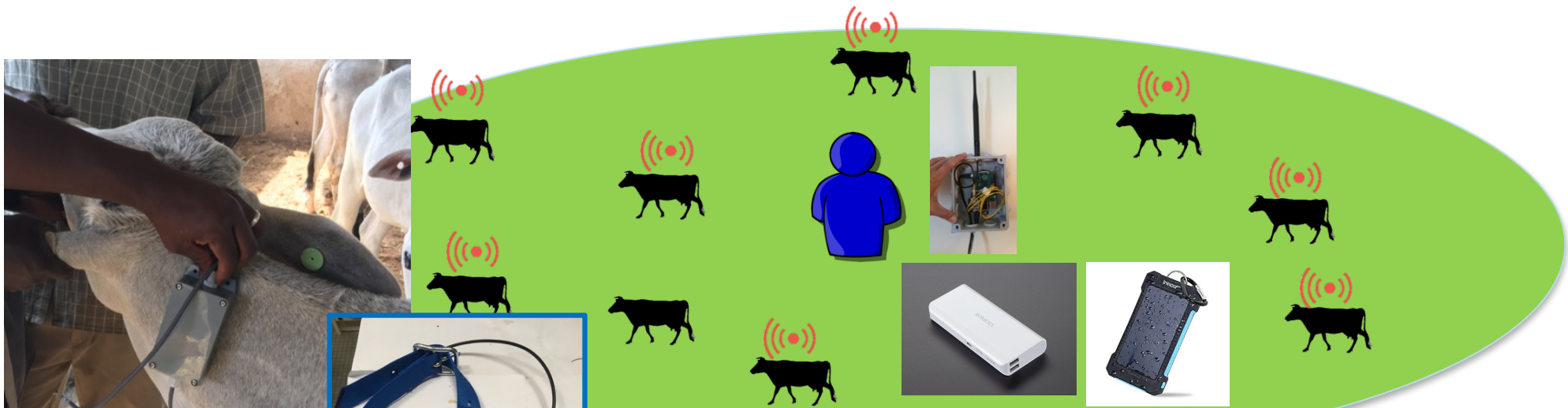
# IoT in Africa usually means...



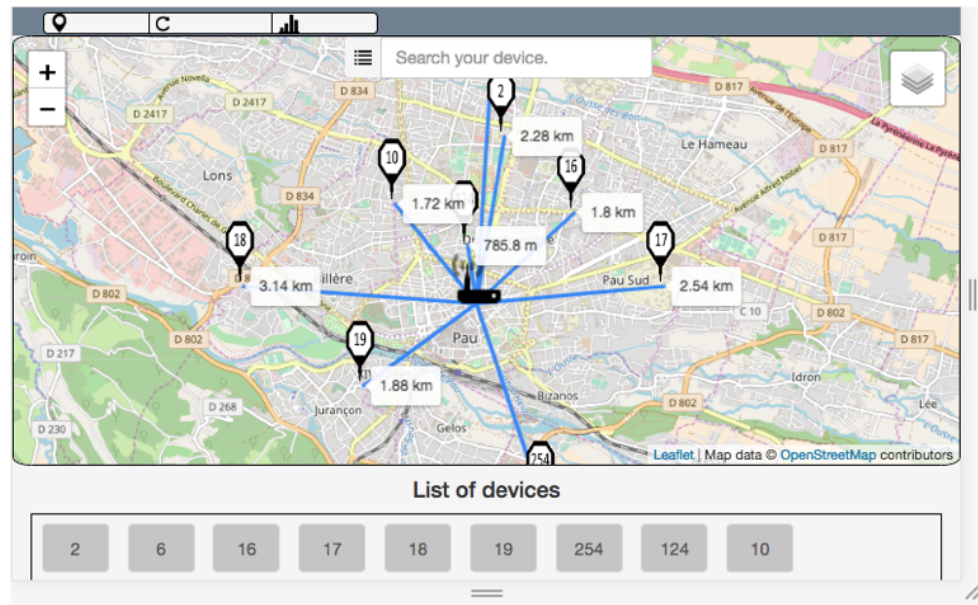
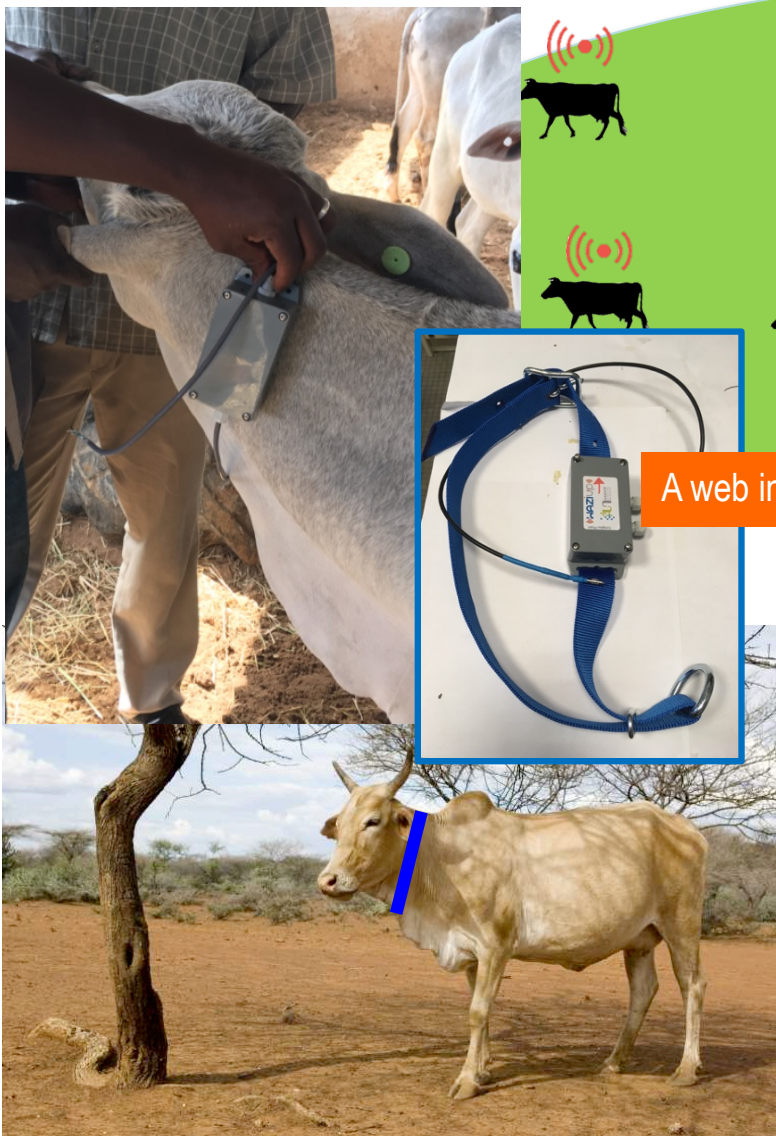
- ❑ ... deploying IoT in very isolated areas...
- ❑ ... where internet and electricity are not stable!



# GW embedded applications: GPS for cattle localization – on-the-go



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



# Cellular Internet and SMS



- ❑ Internet connection can be obtained from cellular networks
- ❑ Instead of uploading to clouds, the gateway can also send SMS to the end-user



# Making IoT happening!

