

THE IOT ECOSYSTEM AND MAKE IT HAPPENING!

IRD/UMMISCO-YAOUNDÉ,
UNIVERSITY YAOUNDÉ, CAMEROON

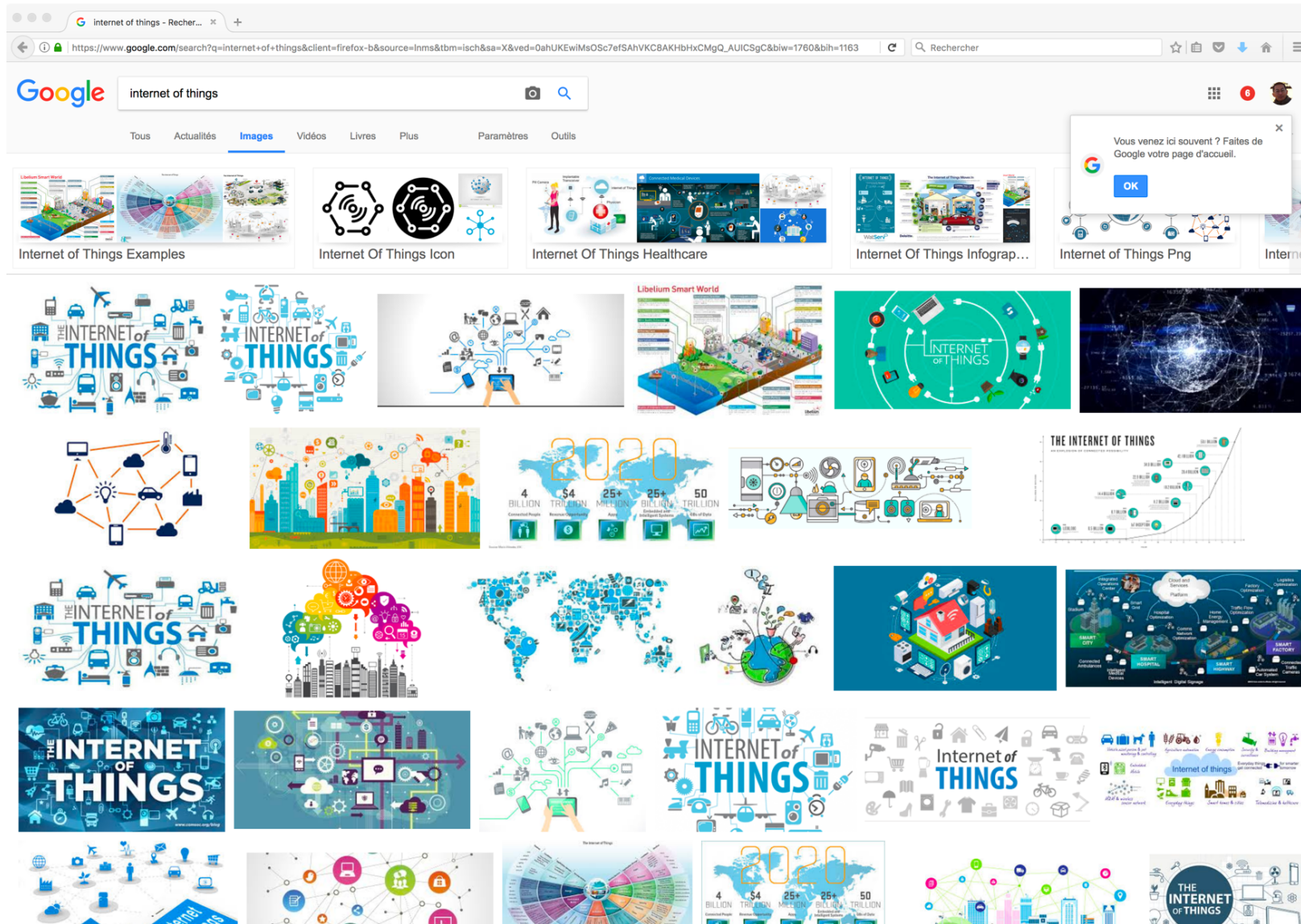
MARCH 19 TH, 2018

DISRUPTIVE
INTERNET
OF THINGS
APPLICATIONS
IN AFRICA

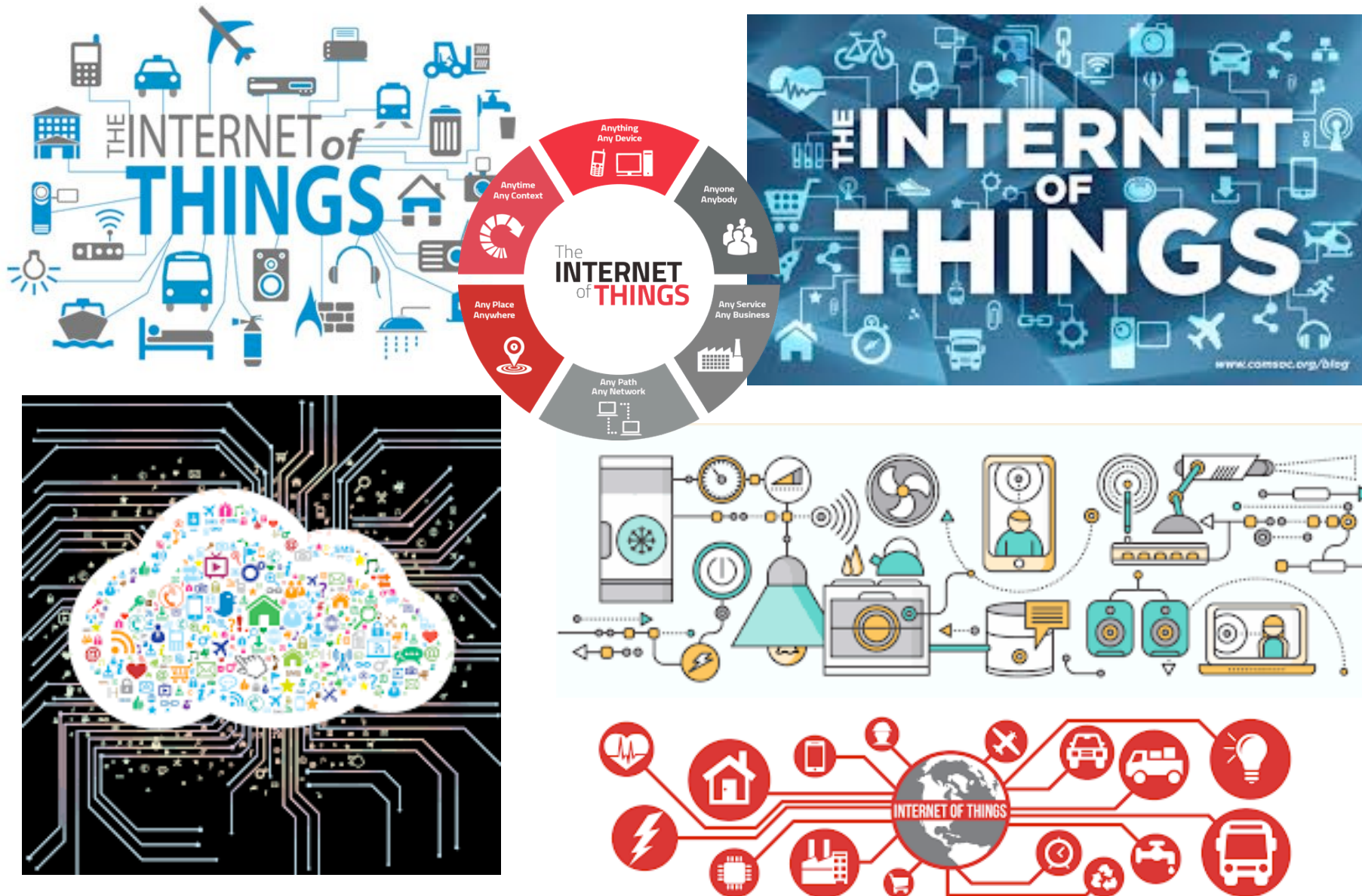


PROF. CONGDUC PHAM
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)
UNIVERSITÉ DE PAU, FRANCE

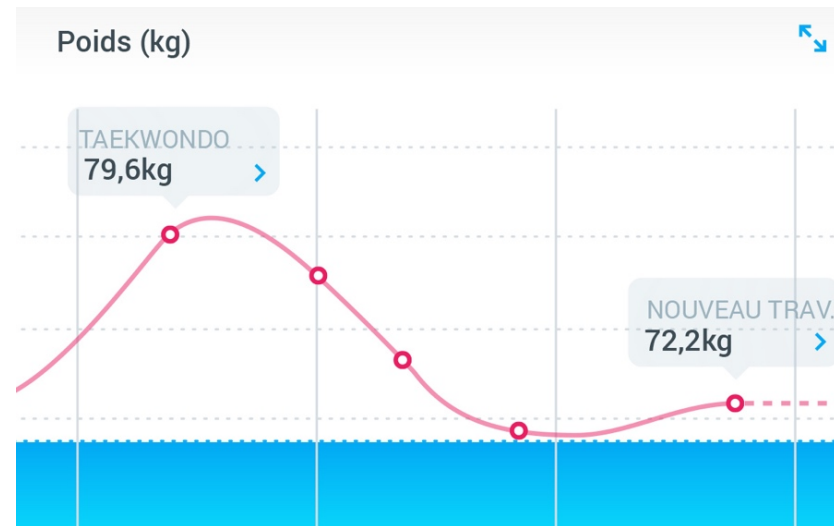
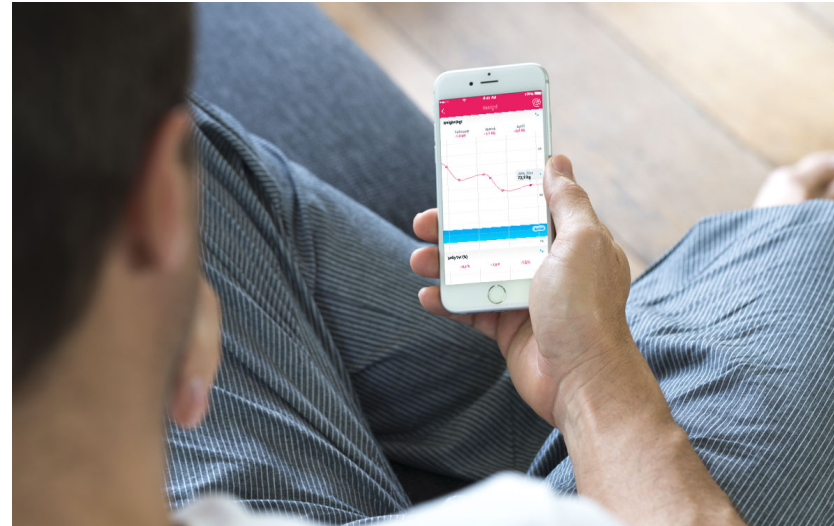
GOOGLING FOR « INTERNET OF THINGS »...



... TYPICALLY SHOWS COMMUNICATING OBJECTS



HOME/CONSUMER IOT PRODUCTS

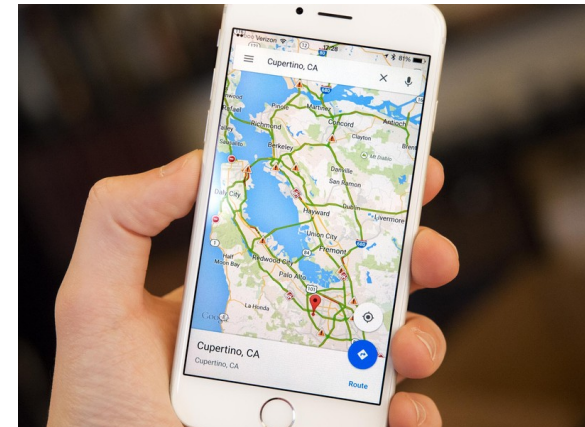
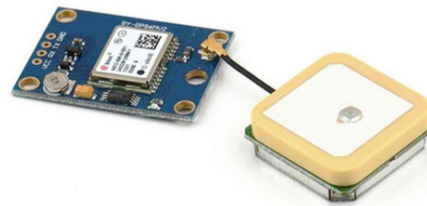


Pictures from WiThing, <https://www.withings.com/eu/fr/products/body>

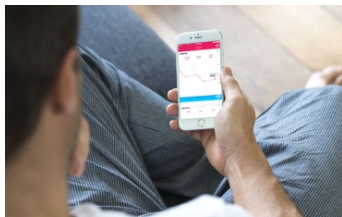
IoT & PHYSICAL WORLD



Waste Container connected sensor



LOCAL INTERACTION IS POSSIBLE

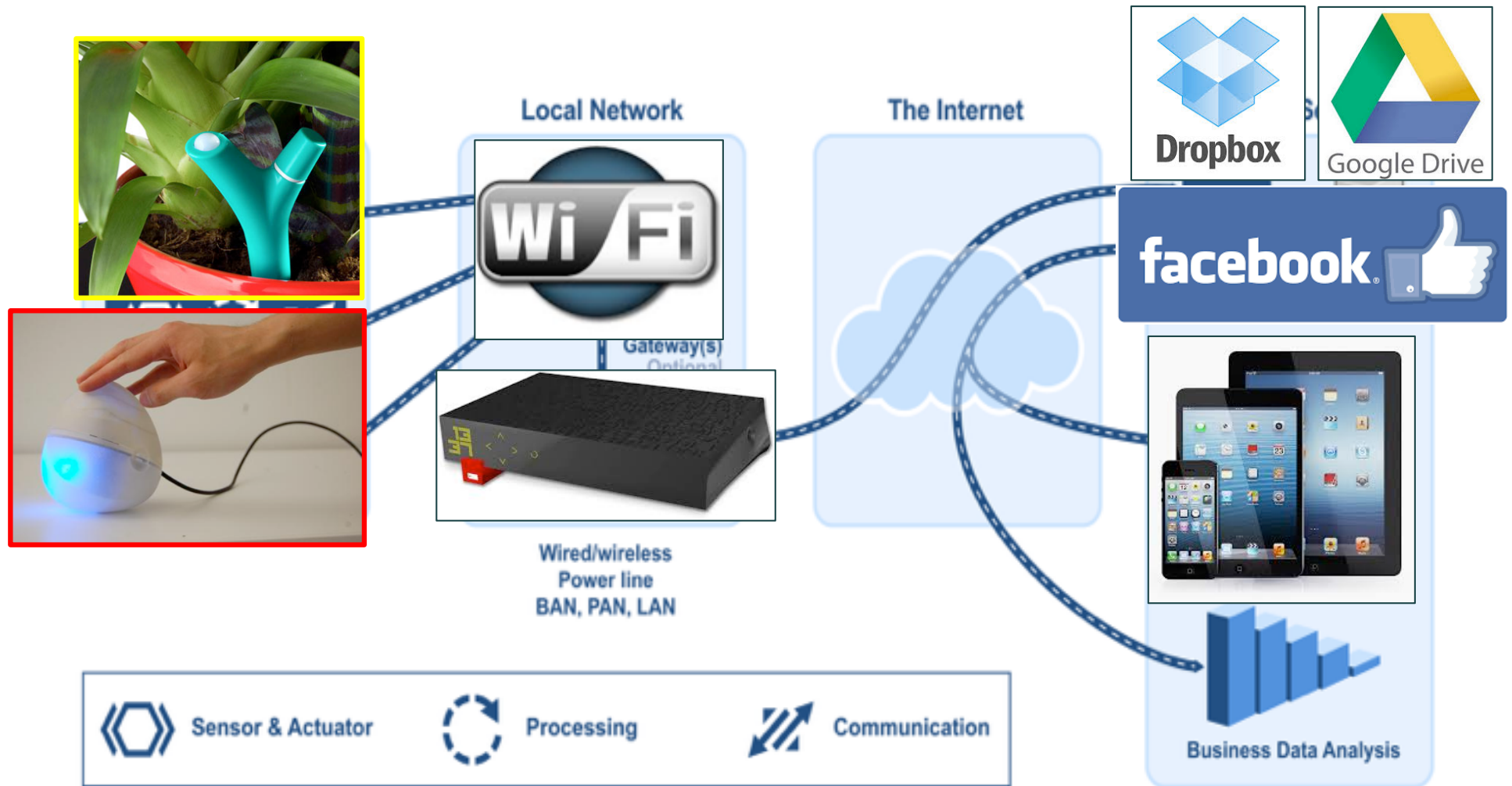


BUT IOT USUALLY MEANS CLOUD DATA

Lot's of data !



GENERAL PUBLIC IOT ARCHITECTURE



Pictures from ArchitectCorner

DEDICATED IOT CLOUD



USING ThingSpeak



ThingSpeak Channels Apps Blog Support

User: cpham

Test LoRa UPPA

Channel ID: **66583**
Author: **cpham**
Test of LoRa gateway at University of Pau, France

Test, lora, uppa

19.6



ThingSpeak Channels Apps Blog Support Account Sign Out

Test LoRa UPPA

Channel ID: **66583** Test of LoRa gateway at University of Pau, France
Author: **cpham**
Access: **Public** Test, lora, uppa

Private View Public View Channel Settings API Keys Data Import / Export

Add Visualizations Data Export MATLAB Analysis MATLAB Visualization More Apps

Field 1 Chart

Test LoRa UPPA

Date	value
09:34	19.5
09:35	20.5
09:36	19.8
09:37	19.6
09:38	19.5

Field 2 Chart

Test LoRa UPPA

Date	src
09:34	10
09:35	10
09:36	10
09:37	10
09:38	10

Field 3 Chart

Test LoRa UPPA

Date	seq
09:34	0
09:35	2
09:36	3
09:37	3.5
09:38	4

Field 4 Chart

Test LoRa UPPA

Date	duration
09:34	6
09:35	6
09:36	6
09:37	6
09:38	6

Field 5 Chart

Test LoRa UPPA

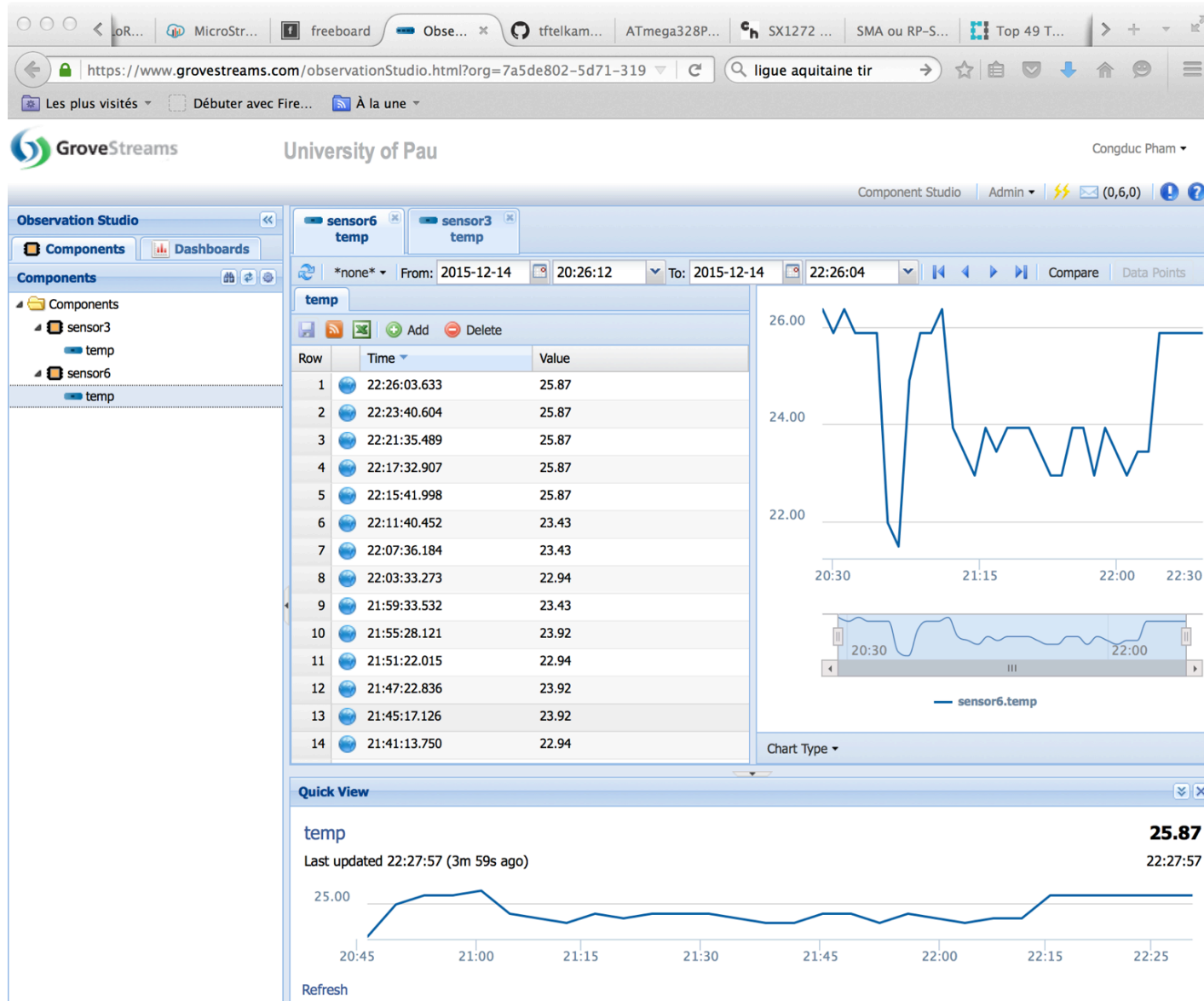
Date	SNR
09:34	4
09:35	4
09:36	4
09:37	4
09:38	4

Field 6 Chart

Test LoRa UPPA

Date	RSSI
09:34	-52.5
09:35	-47.5
09:36	-52.5
09:37	-53.5
09:38	-55

USING GroveStreams



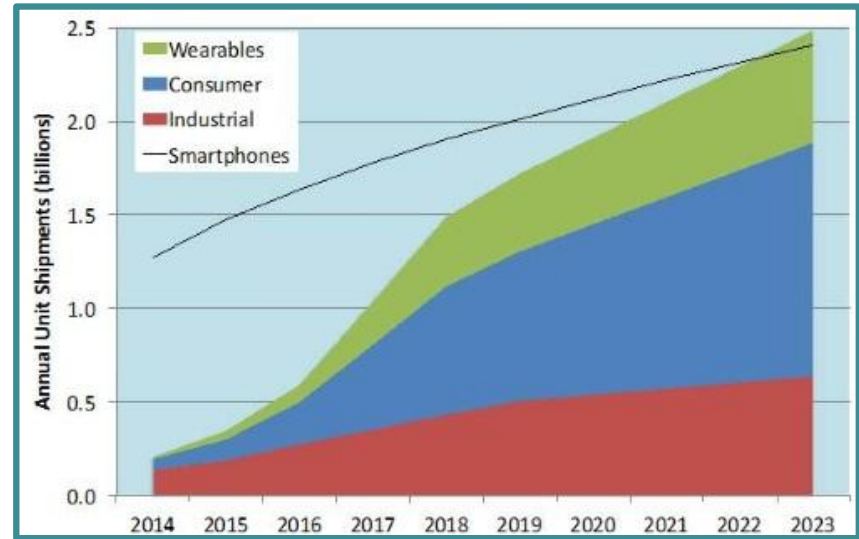
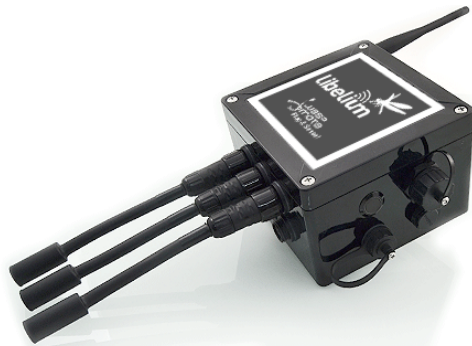
The screenshot displays the GroveStreams Observation Studio interface. The browser address bar shows the URL: <https://www.grovestreams.com/observationStudio.html?org=7a5de802-5d71-319>. The page header includes the GroveStreams logo, "University of Pau", and the user name "Congduc Pham".

The main interface is titled "Observation Studio" and shows two active sensors: "sensor6 temp" and "sensor3 temp". The "sensor6 temp" data is displayed in a table and a line chart. The table shows the following data points:

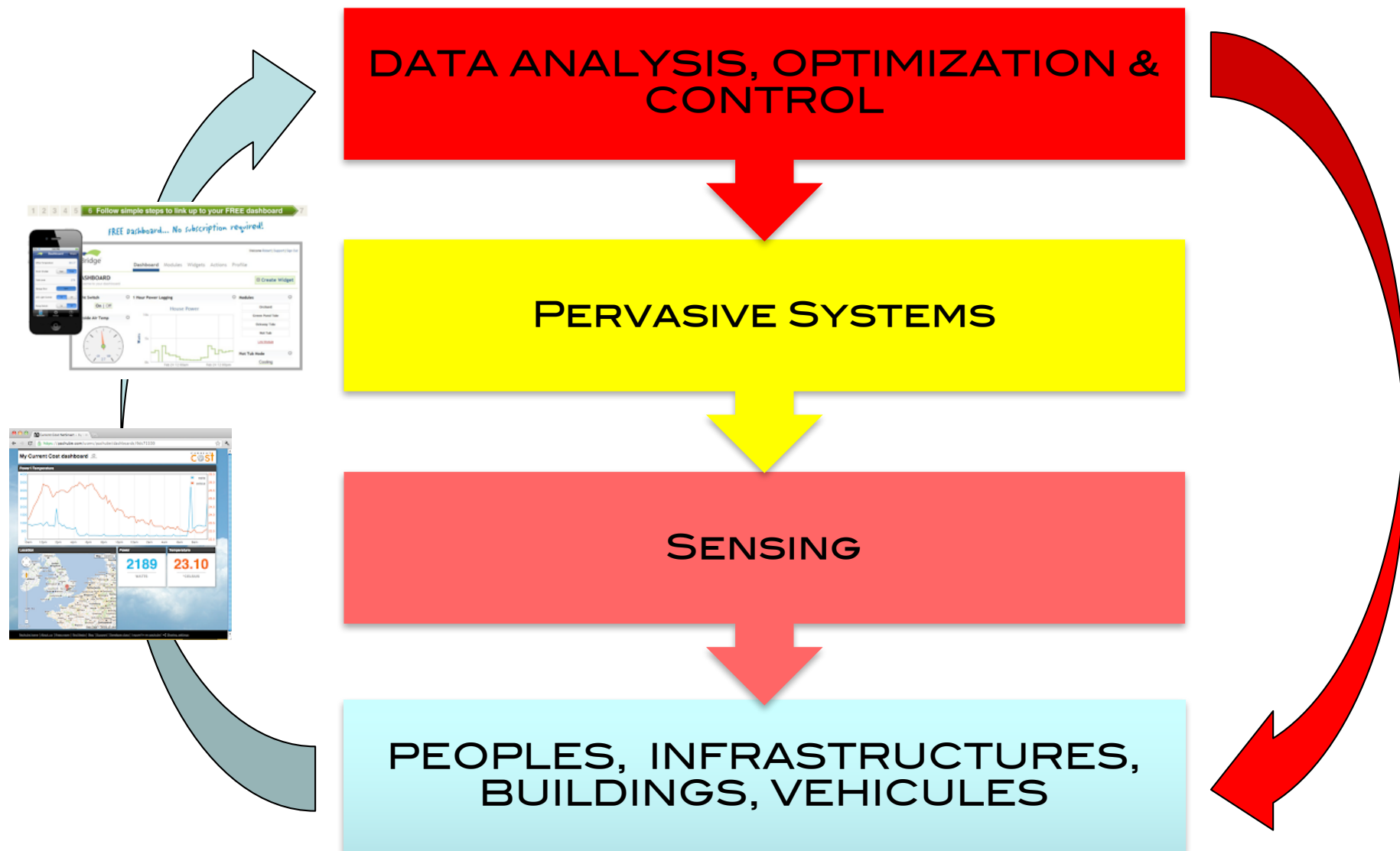
Row	Time	Value
1	22:26:03.633	25.87
2	22:23:40.604	25.87
3	22:21:35.489	25.87
4	22:17:32.907	25.87
5	22:15:41.998	25.87
6	22:11:40.452	23.43
7	22:07:36.184	23.43
8	22:03:33.273	22.94
9	21:59:33.532	23.43
10	21:55:28.121	23.92
11	21:51:22.015	22.94
12	21:47:22.836	23.92
13	21:45:17.126	23.92
14	21:41:13.750	22.94

The line chart on the right shows the temperature trend over time, with a zoomed-in view of the 20:30 to 22:30 period. The "Quick View" section at the bottom shows the current temperature for "temp" as **25.87**, last updated at 22:27:57 (3m 59s ago).

ONE OF THE MOST PROMISING MARKET IS IOT!

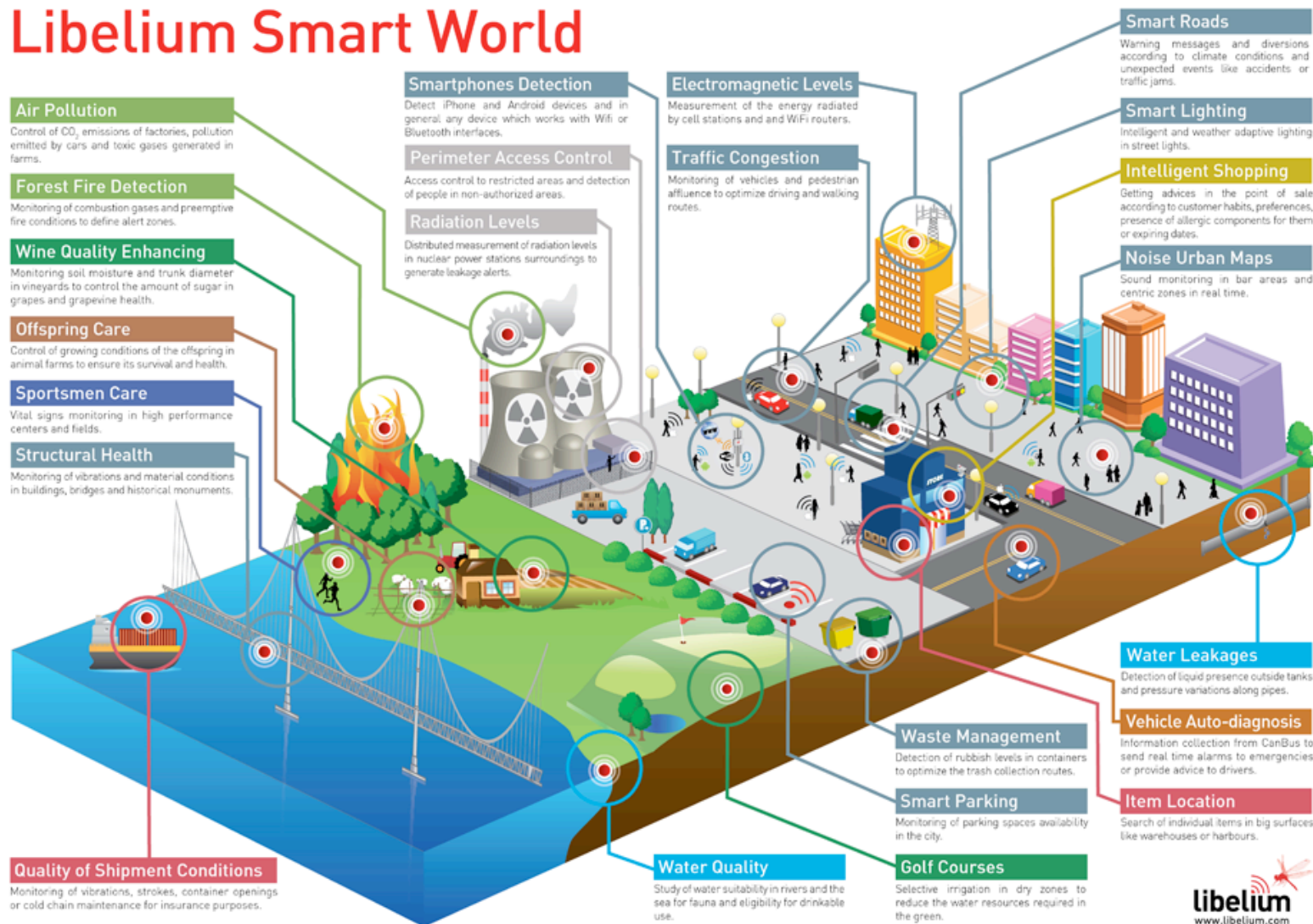


CONTROL, OPTIMIZE & INSTRUMENT !



EXAMPLE 1: SMART CITIES

Libelium Smart World



SMARTSANTANDER

WWW.SMARTSANTANDER.EU

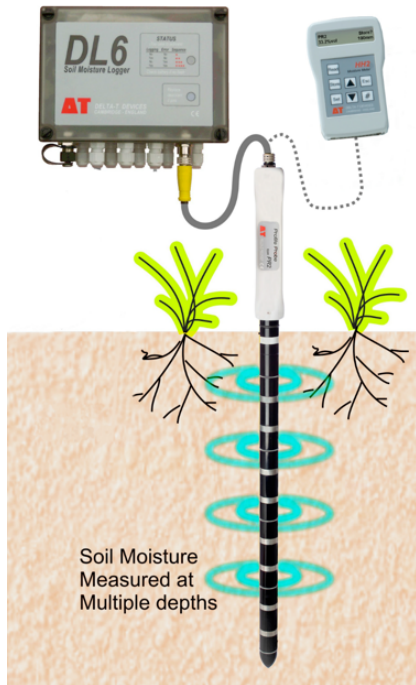
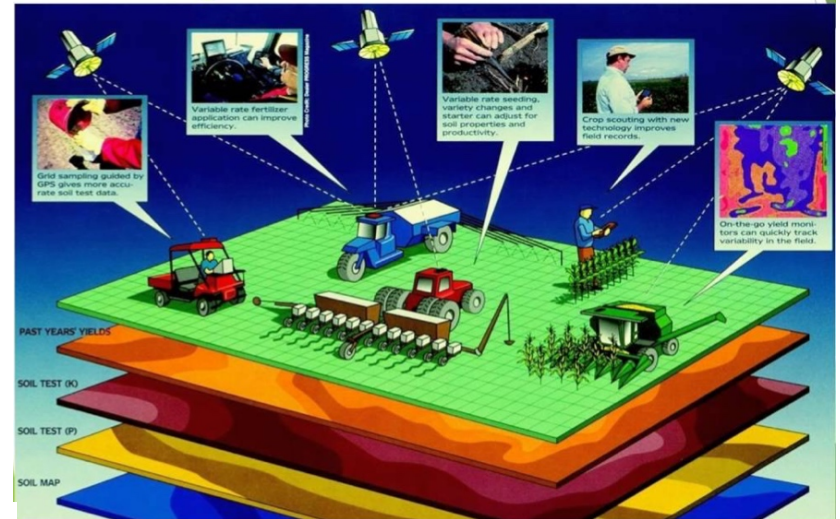


PICTURES ARE TAKEN IN THE CONTEXT OF THE EAR-IT PROJECT

EXAMPLE 2: FARMING & AGRICULTURE



GPS in Agriculture



- soil moisture
- precision farming
- moisture sensor
- farm
- precision agriculture
- irrigation
- smart
- sensor concept
- monitoring
- phosphorus potassium
- nitrogen phosphorus
- wireless



CHALLENGE 1: ANALYSE 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!

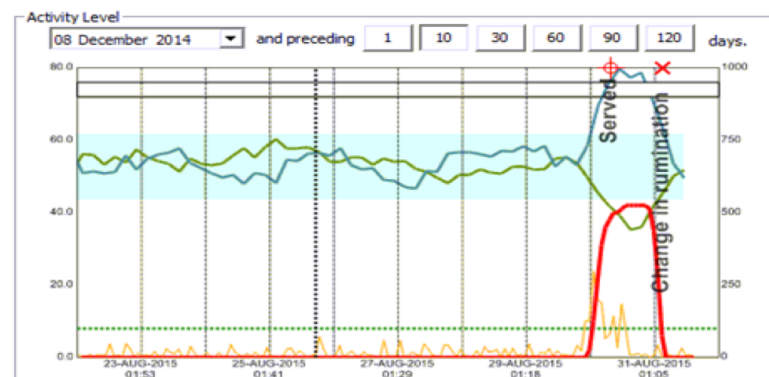
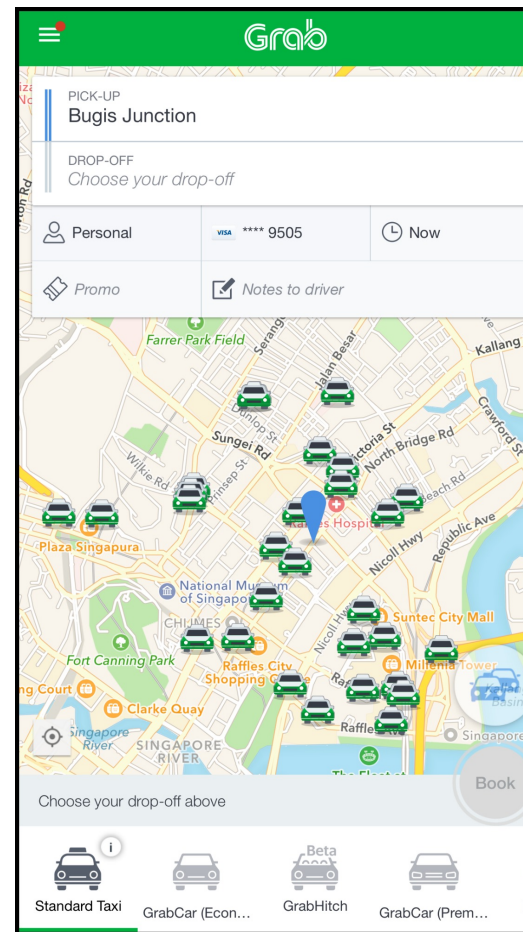


Fig. 3. Illustration of a rise in activity accompanied by a fall in rumination at the point of oestrus

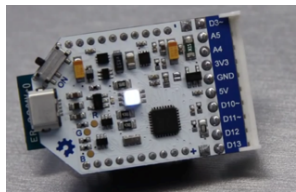
CHALLENGE 2: PROVIDE THE RIGHT SYSTEM!

- How would you implement a real-time positioning system of city buses?



1ST ISSUE: IOT ARE SMALL DEVICES

□ ANSWER: Smaller and more powerfull boards are now available!



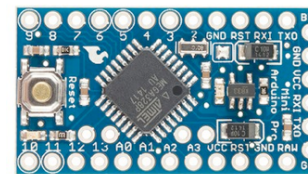
Theairboard



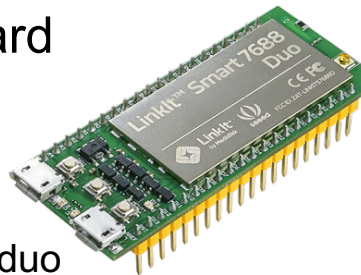
LoPy



Expressif ESP32



Arduino Pro Mini



LinkIt Smart7688 duo



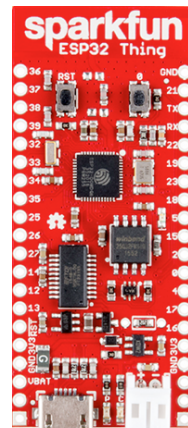
Teensy 3.2



STM32 Nucleo-32



Adafruit Feather



Sparkfun ESP32 Thing



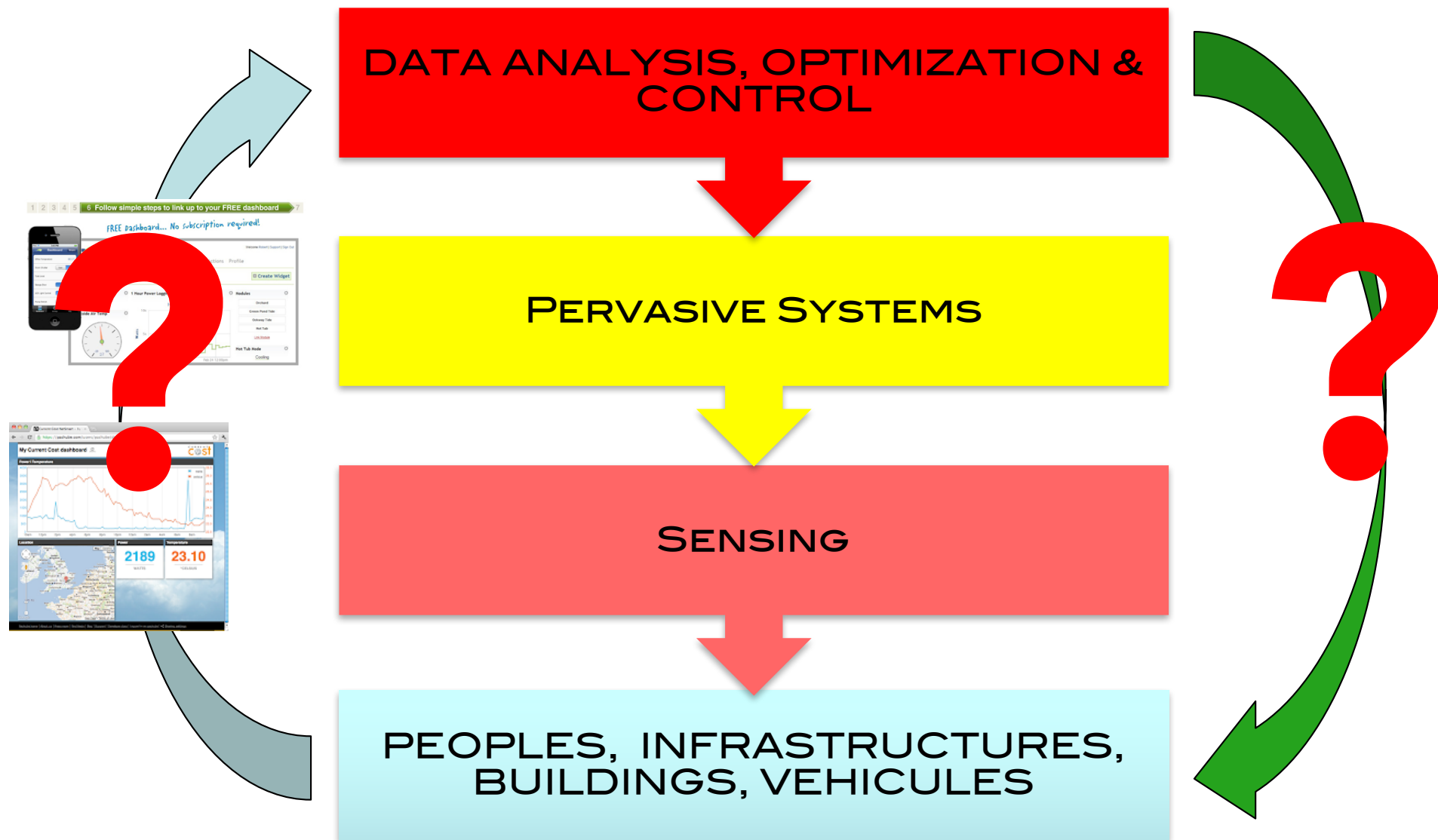
Tessel

SodaqOnev2

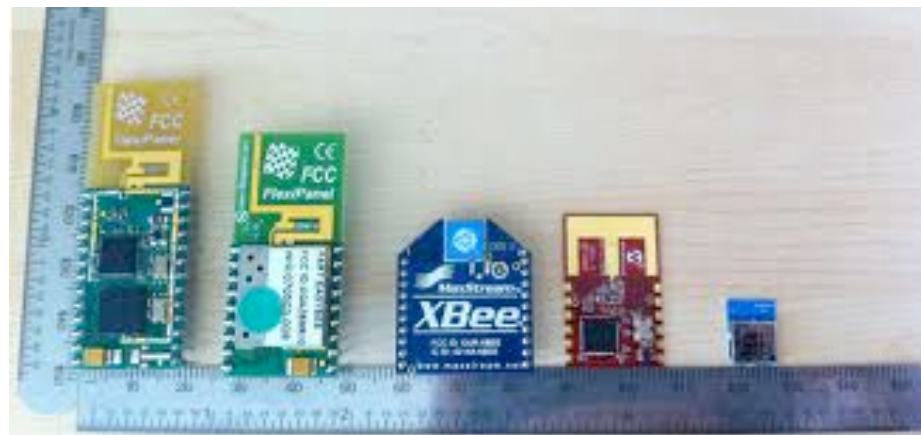


Tinyduino

2ND ISSUE: COLLECT DATA



WIRELESS COMMUNICATION MADE EASY

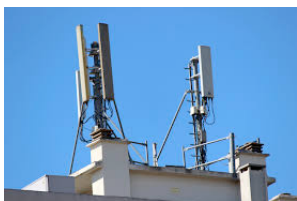
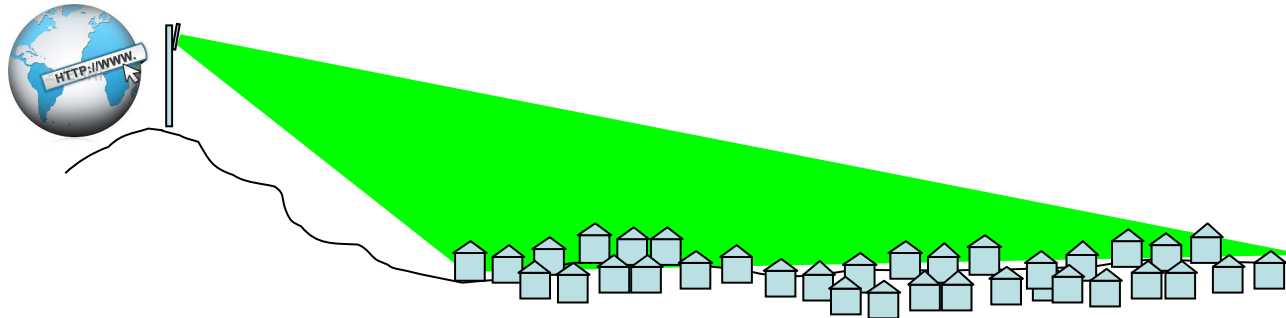


IoT=WIRELESS+BATTERY



TELEMETRY AND TRANSMISSION COST

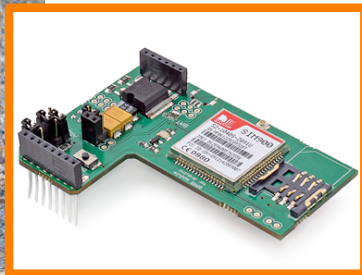
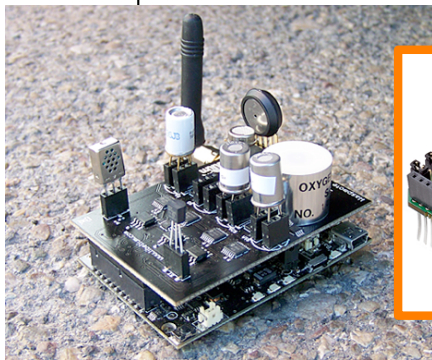
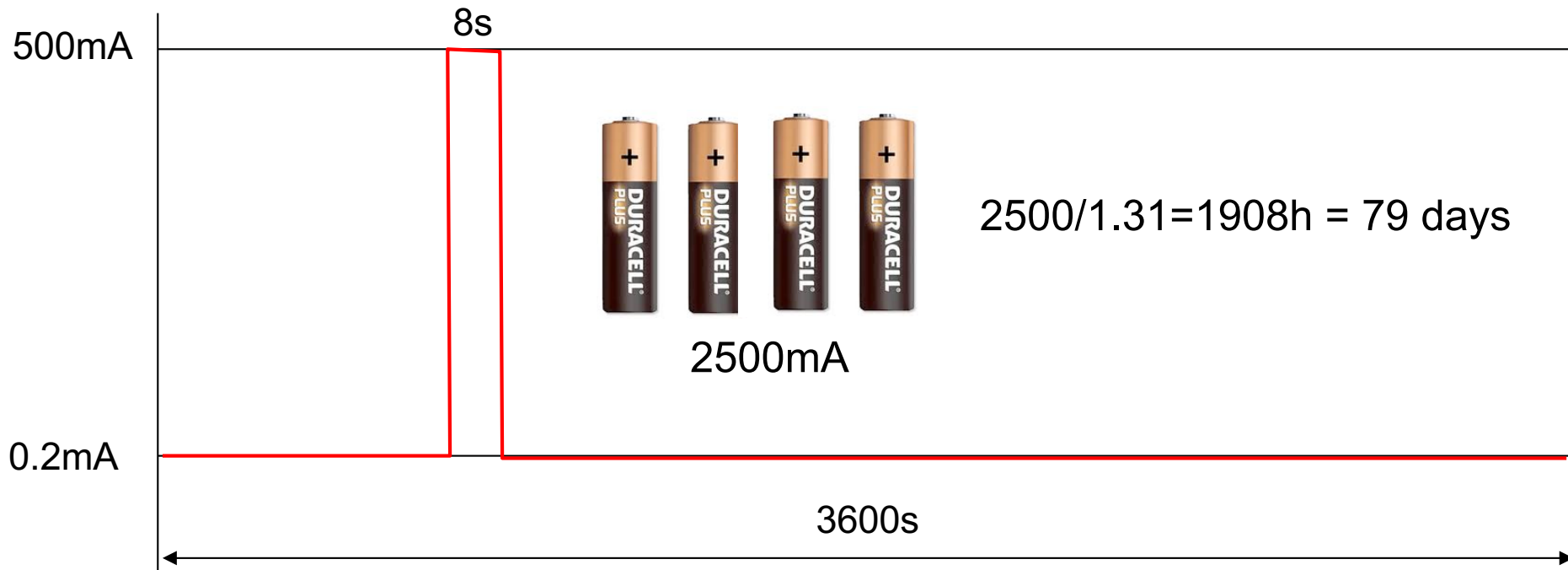
Moisture/
Temperature of
storage areas



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

ENERGY CONSIDERATION

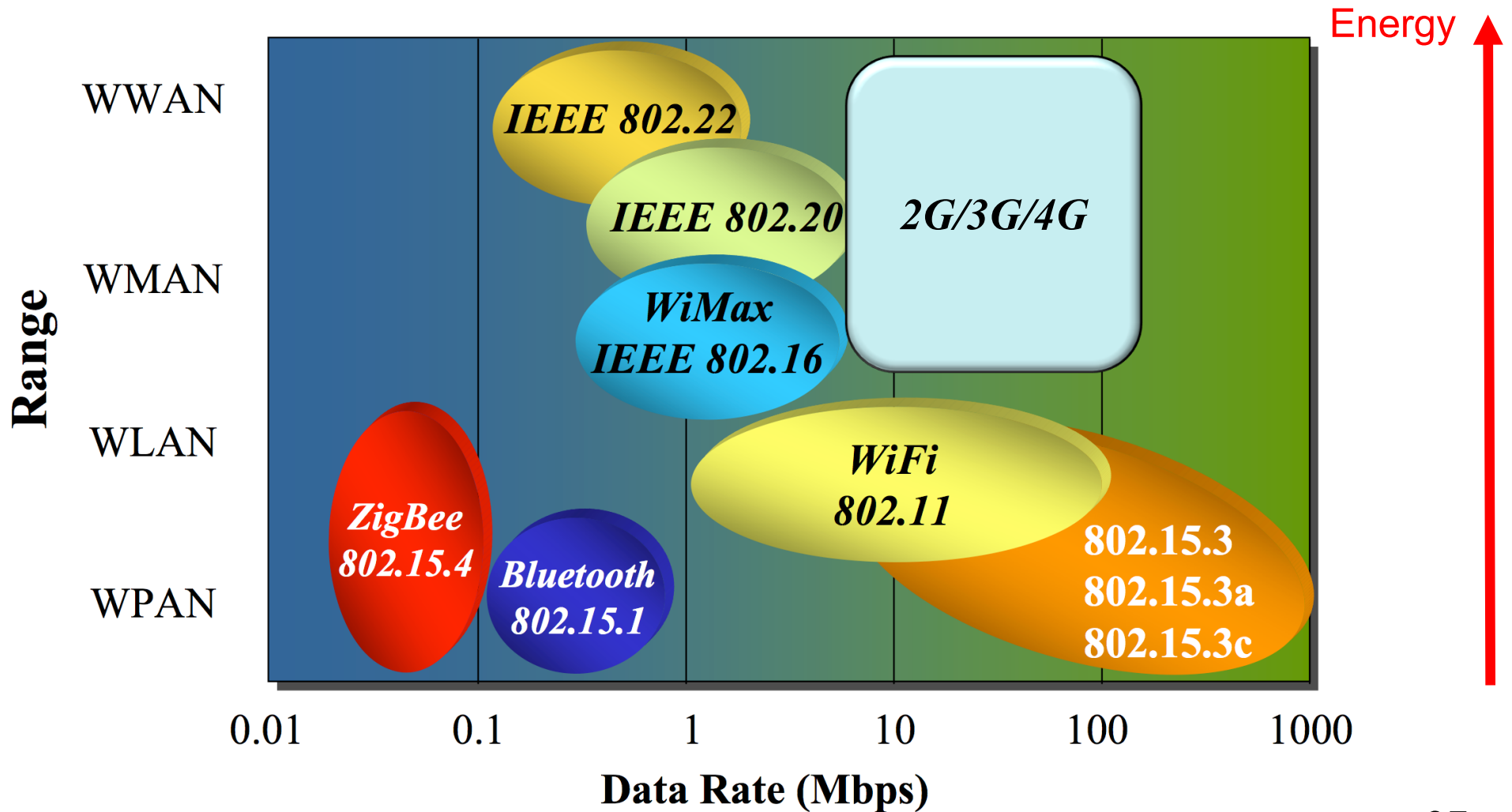
TX power: 500mA. Mean consumption: $(8 \times 500 + 3592 \times 0.2) / 3600 = 1.31 \text{mA}$



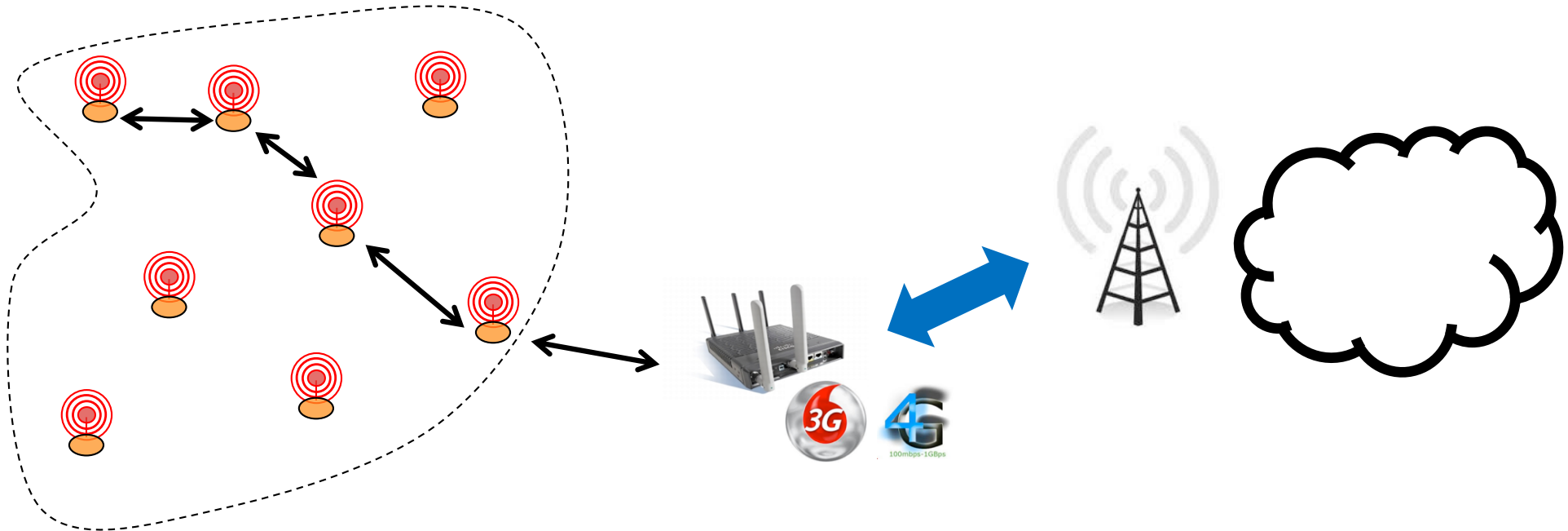
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC

THE WIRELESS SPACE

Energy-Range dilemma



LOWER ENERGY MEANS SHORTER RANGE!

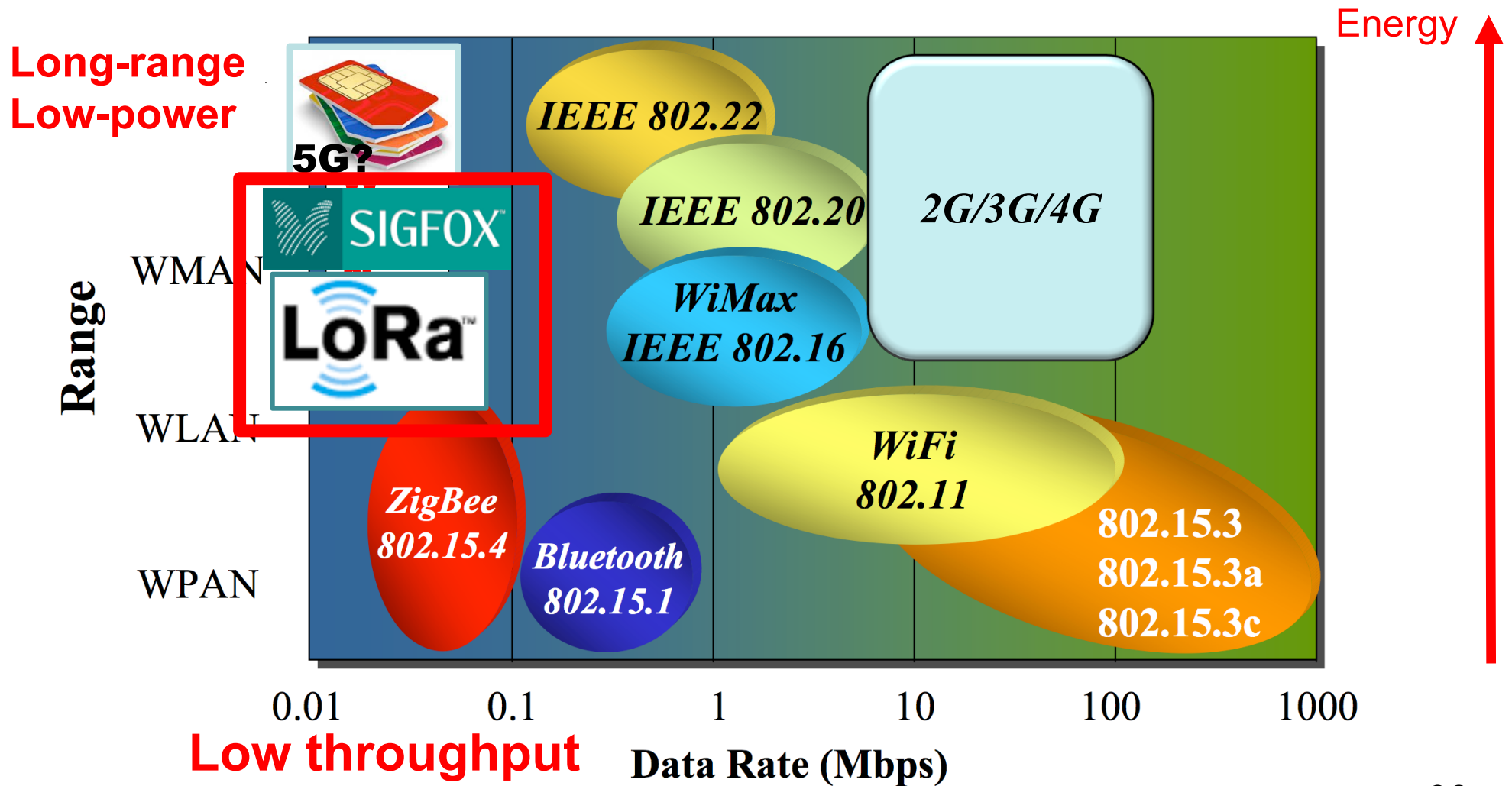


How bad is multi-hop routing?

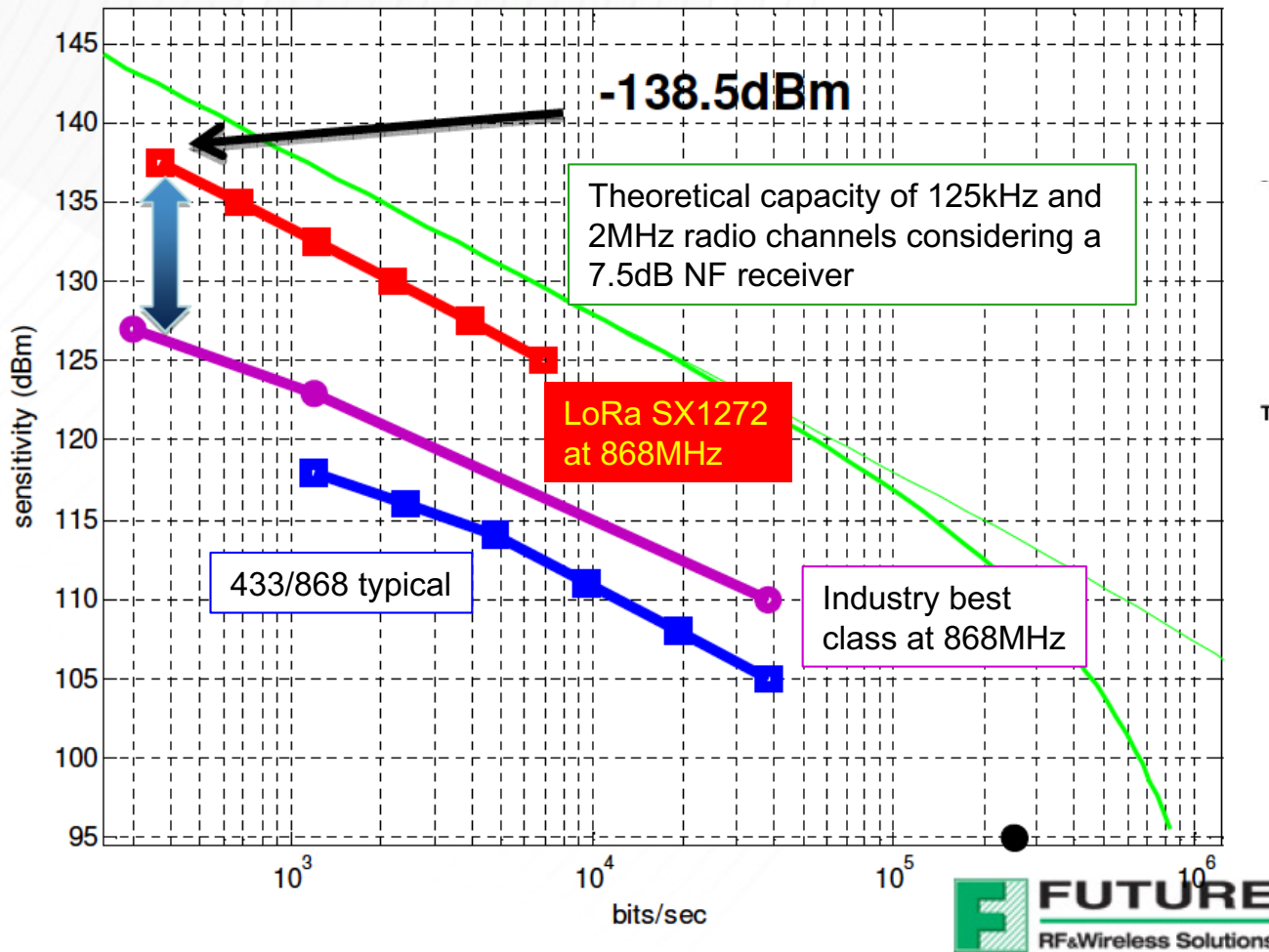
- Increases packet loss rate
- Increases end-to-end delivery time
- Consumes more energy as intermediate nodes must relay packets
- Limits energy saving mechanism benefits as both sender and intermediate node must be somehow synchronized
- Is impacted by intermediate node failure

LOW-POWER & LONG-RANGE RADIO TECHNOLOGIES

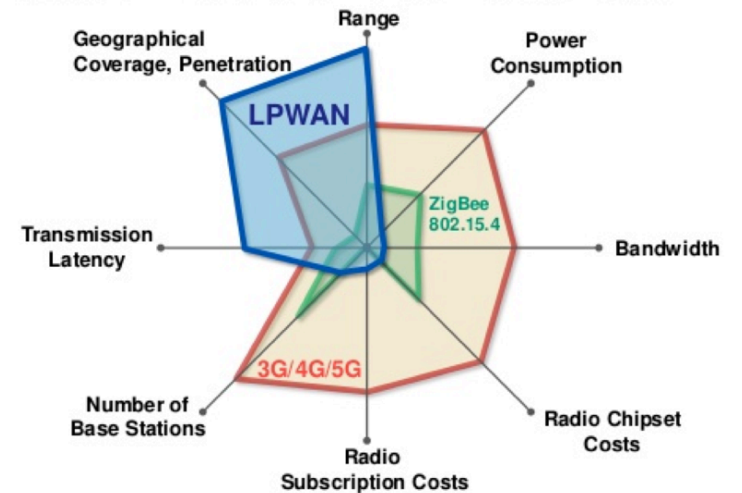
Energy-Range dilemma



THE LONG-RANGE REVOLUTION



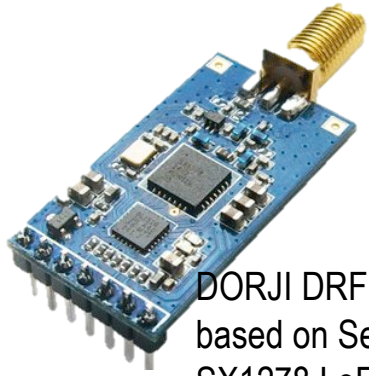
Sensitivity: lowest input power with acceptable link quality, typically 1% PER



From Peter R. Egli, INDIGOO.COM

The lower the receiver sensitivity, the longer is the range!

LoRa Modules from Semtech's SX127x Chips



DORJI DRF1278DM is based on Semtech SX1278 LoRa 433MHz



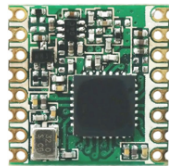
Libelium LoRa is based on Semtech SX1272 LoRa 863-870 MHz for Europe



inAir9 based on SX1276



Froggy Factory LoRa module (Arduino)



HopeRF RFM series



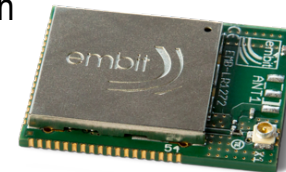
HopeRF HM-TRLR-D



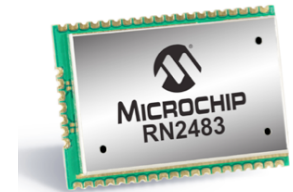
LinkLabs Symphony module



IMST IM880A-L is based on Semtech SX1272 LoRa 863-870 MHz for Europe



Embit LoRa



LoRa™ Long-Range Sub-GHz Module (Part # RN2483)

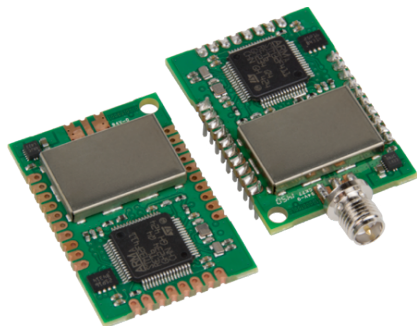
Microship RN2483



habSupplies



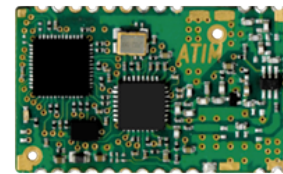
Adeunis ARF8030AA- Lo868



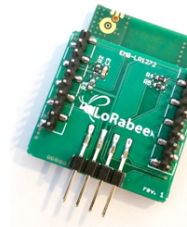
Multi-Tech MultiConnect mDot



AMIHO AM093



ARM-Nano N8 LoRa module from ATIM



SODAQ LoRaBee Embit



SODAQ LoRaBee RN2483

ENERGY CONSUMPTION COMPARAISON

Tables from Semtech

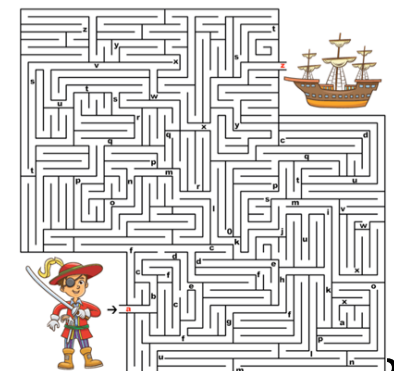
Technology	2G	3G	LAN	ZigBee	Lo Power WAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m	O: 90m I: 30m	Same as 2G/3G
Tx current consumption	200-500mA	500-1000mA	100-300mA	18mA	18mA-40mA
Standby current	2.3mA	3.5mA	NC	0.003mA	0.001mA
Energy harvesting (solar, other)	No	No	No	Possible	Possible
Battery 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: 30mA. Mean consumption: $(8 \times 30 + 3592 \times 0.2) / 3600 = 0.266 \text{mA}$

$2500 / 0.266 = 9398 \text{h} = 391 \text{ days} = 13 \text{ months}$

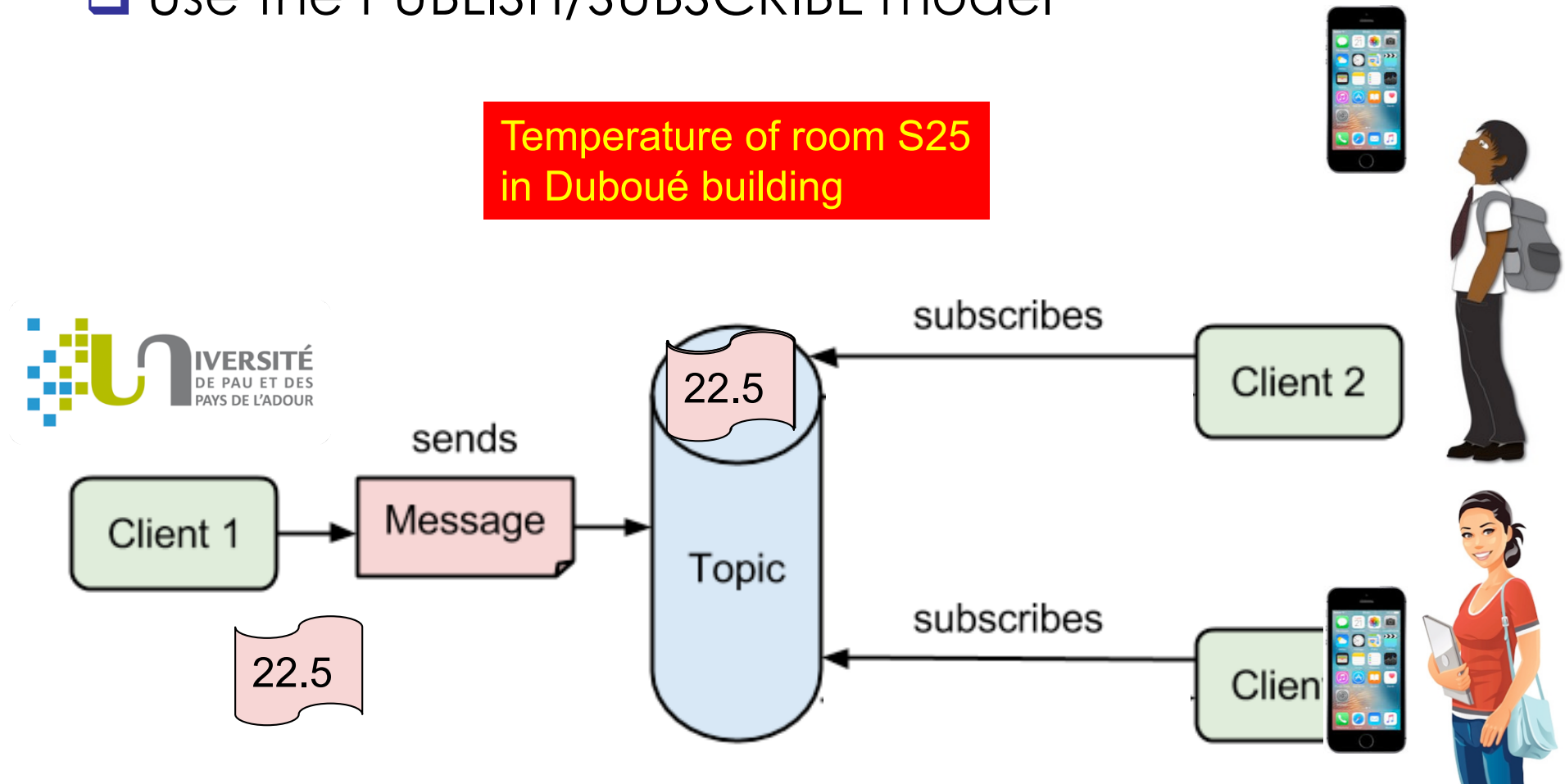
3RD ISSUE: FINDING THE INFORMATION YOU NEED

- ❑ Searching for information is a tough issue
 - ❑ Web search engine: Google,...
- ❑ Many IoT clouds uses HTTP request (GET, POST, PUT, ...) to push/store data to web platforms/servers
- ❑ If you need an information, for instance **the temperature in room S25 of Duboué building in UPPA**, then you have to go to the right web page
- ❑ When there can be millions of IoT nodes providing large variety of data, it is difficult to find your way!



FROM "SEARCH FOR INFO" TO "GET THE INFO"

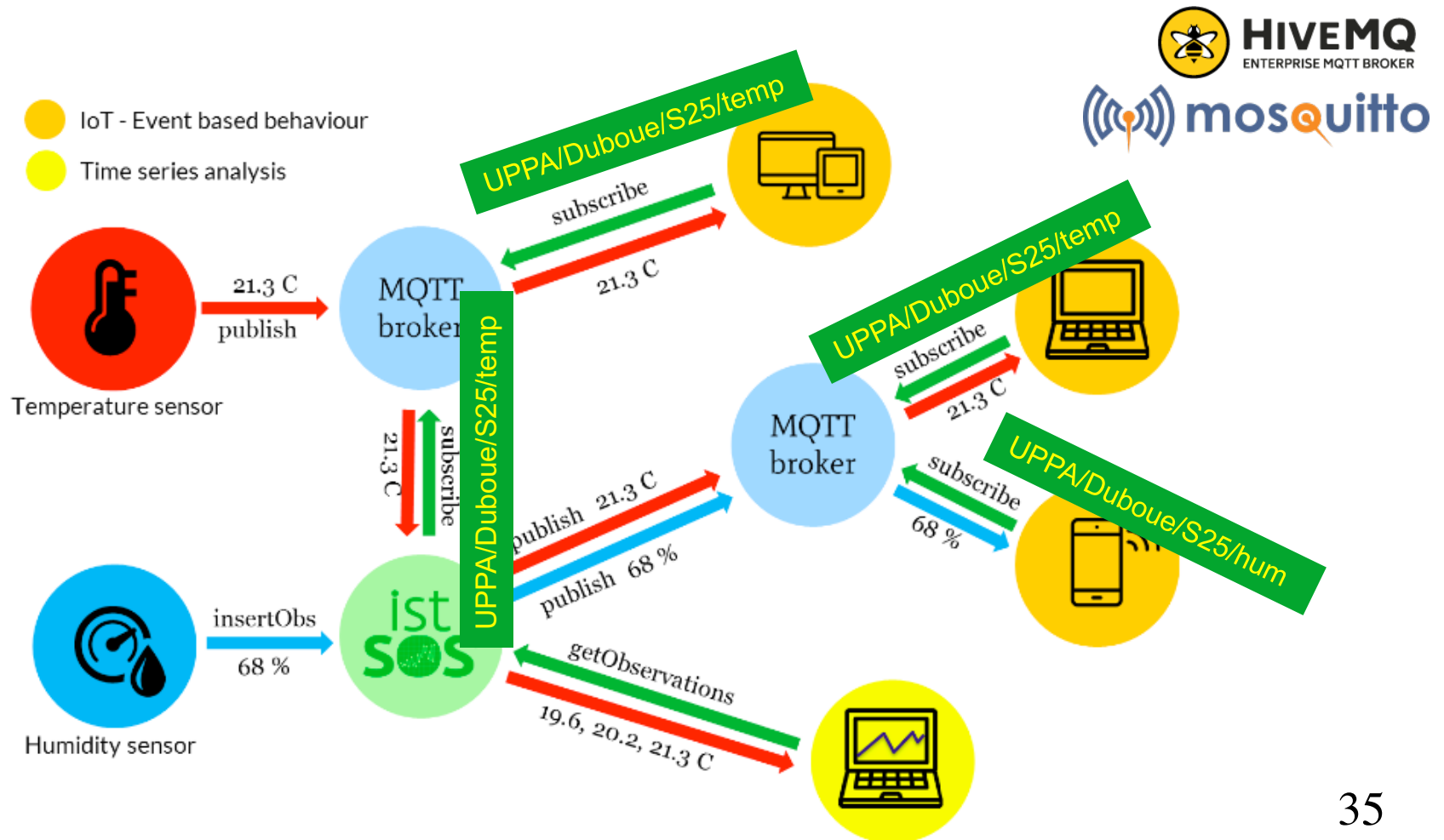
- Use the PUBLISH/SUBSCRIBE model



MQTT

MESSAGE QUEUE TELEMETRY TRANSPORT

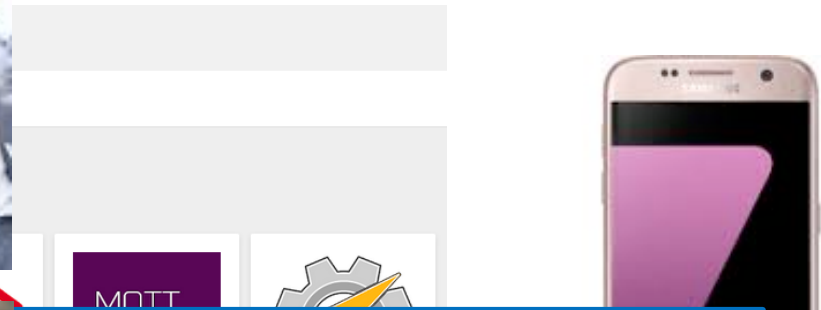
- Use broker nodes to manage topics
 - UPPA/Duboue/S25/temp, UPPA/Duboue/S25/hum



TOWARDS OPEN DATA?

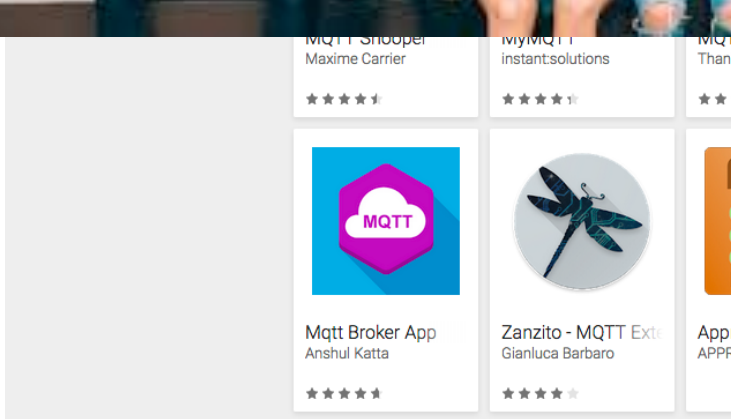
- ❑ CMR/YAOUNDE/UMMISCO/PROJECT1/#
- ❑ CMR/YAOUNDE/CITY/WEATHER/#
- ❑ CMR/DOUALA/WHARF12/AREA23/CONT/TC
- ❑ ...

MQTT+SMARTPHONE=



MQTT Dash (IoT, Smart Home)
Routix software Communication ★★★★★ 1,584
PEGI 3
This app is compatible with all of your devices.

Installed



Webcam
1 second ago

Outside temp
-3°C
1 second ago

Parking lot light
1 second ago

Inside temp
1 second ago

Outside humidity
11%
50 seconds ago

Garage door
3 seconds ago

Water level
10 seconds ago

MQTT Dash

- Home
- My MQTT broker
- Mom's house
- Servers' health
- My lab

MQTT Dash

This metric is intended for state displaying and switching (e.g. light on/off). Payload expected to be string.

Name

The door

Topic (sub)
door/lock

Topic (pub) - keep empty if the same as sub

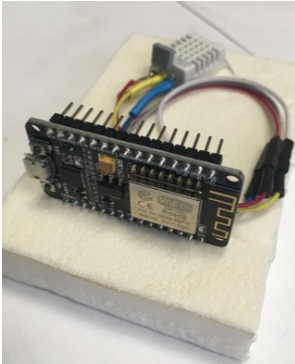
Payload and icons

On 1 OR 0

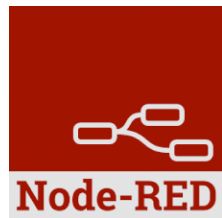
Other settings
 QoS(0) QoS(1) QoS(2)

Retained

4TH ISSUE: MAKE IT SIMPLER?

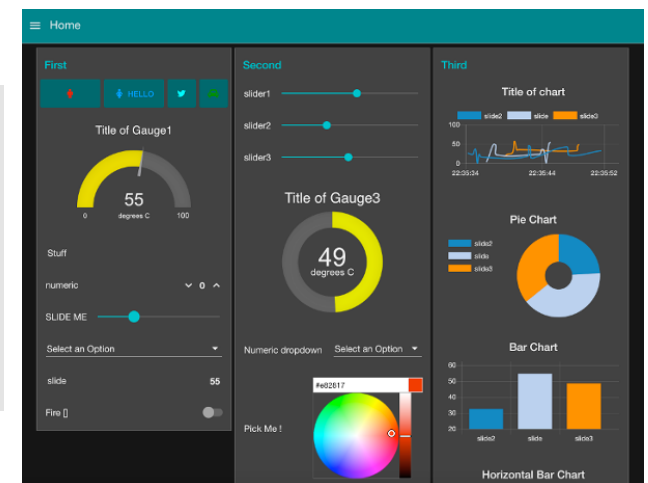
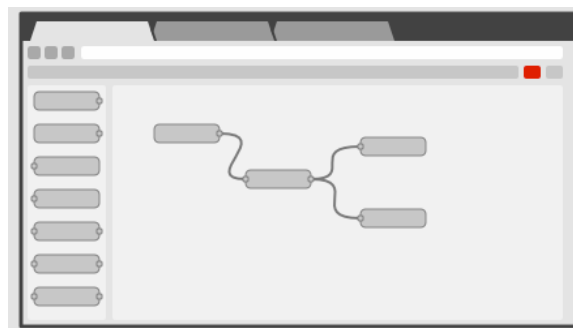


- ❑ End-users are not necessarily computer science experts nor high-skilled programmers
- ❑ Use graphical tools to build data processing flows, allowing intuitive connection from data producers to data consumers

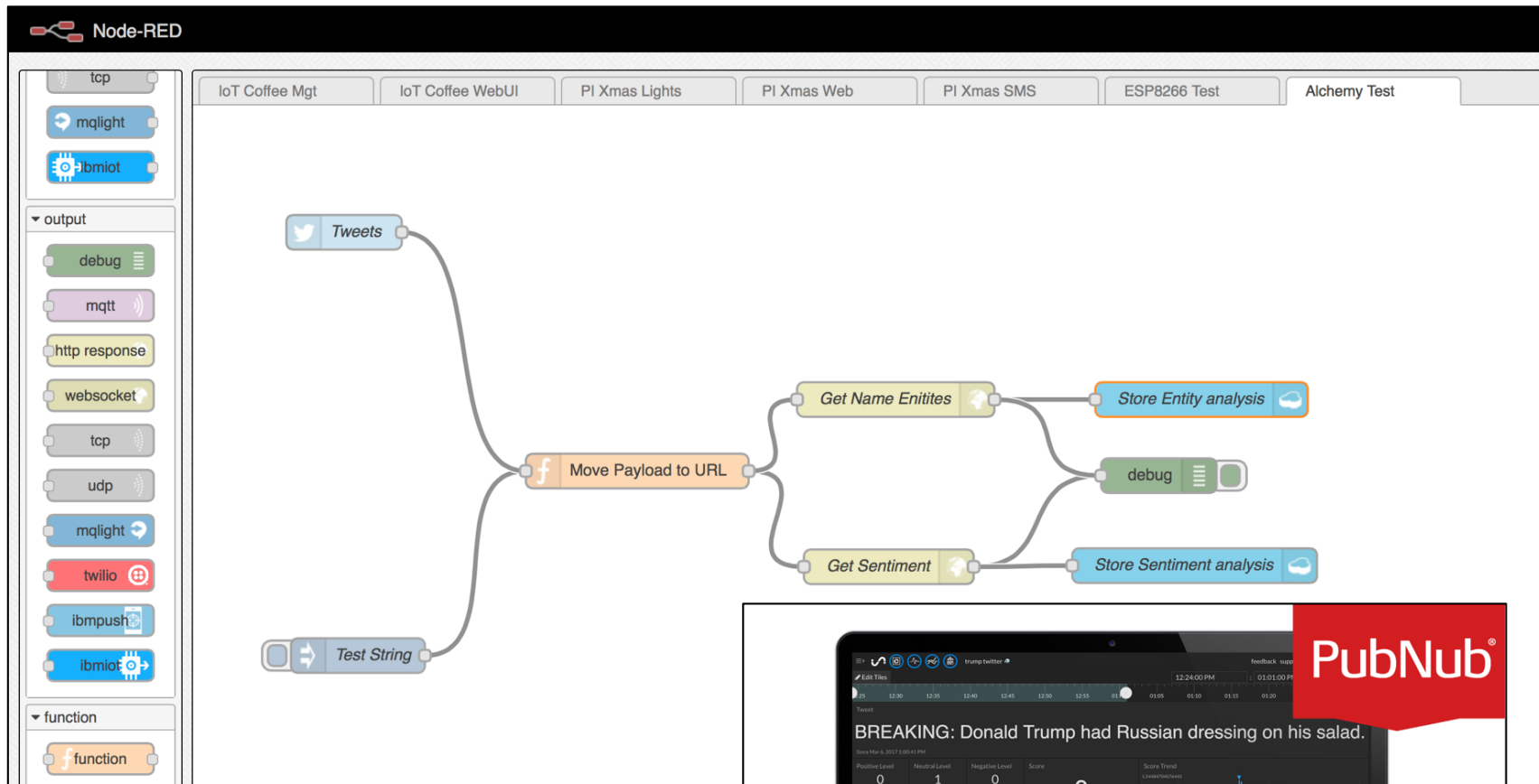


NODE-RED

- Node-RED is a programming tool for wiring together hardware devices, APIs and online services, e.g. clouds of various types
- provides a browser-based flow editor to wire together flows with a wide range of nodes



EXAMPLE



From AlchemyAPI and NoderED on Bluemix



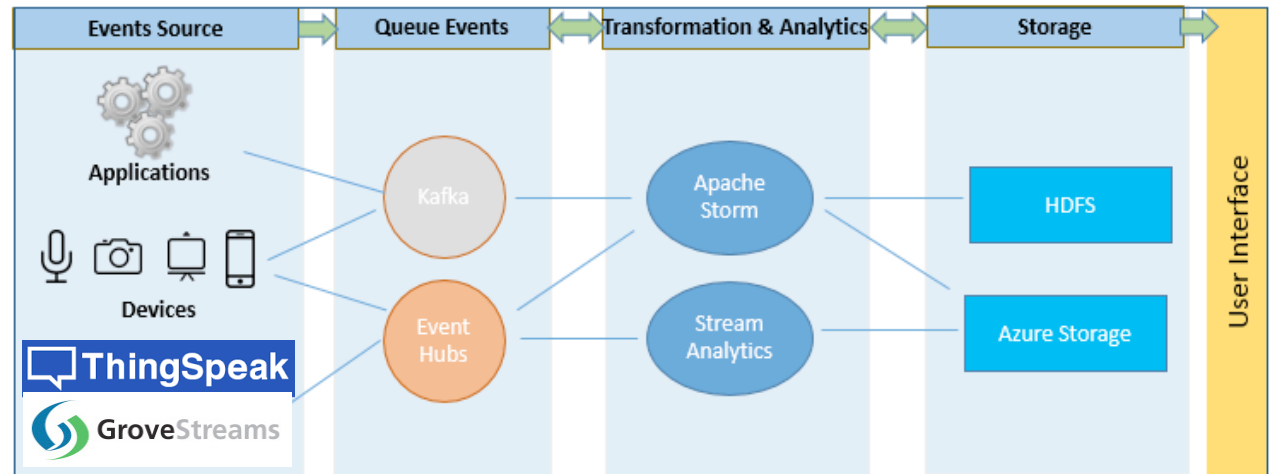
From PubNub Live Twitter Dashboard (feat. President Trump)

CONNECTING TO ADVANCED DATA MNGT/ANALYTIC PLATFORMS

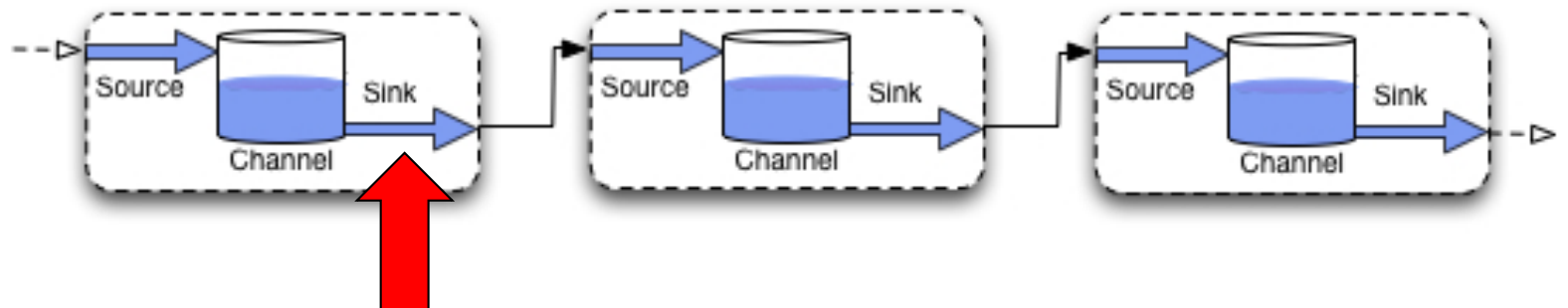


mahout Machine Learning	APACHE DRILL scalable, interactive query system	GRAPH Graph Processing
PIG Scripting	HIVE SQL - Like Queries	
HCatalog Table Management	Meta data Management	
hadoop MapReduce Data Processing		
HDFS Hadoop Distributed File System Data store		
oozie Import and Export of Relational Data	Flume Import and Export of data flows	

ZooKeeper Cluster Coordination
Whir
Apache Ambari Cluster Monitoring
oozie Work flow Automation
Ganglia Set of Libraries for running Cloud Services
 © J2eeDev.org

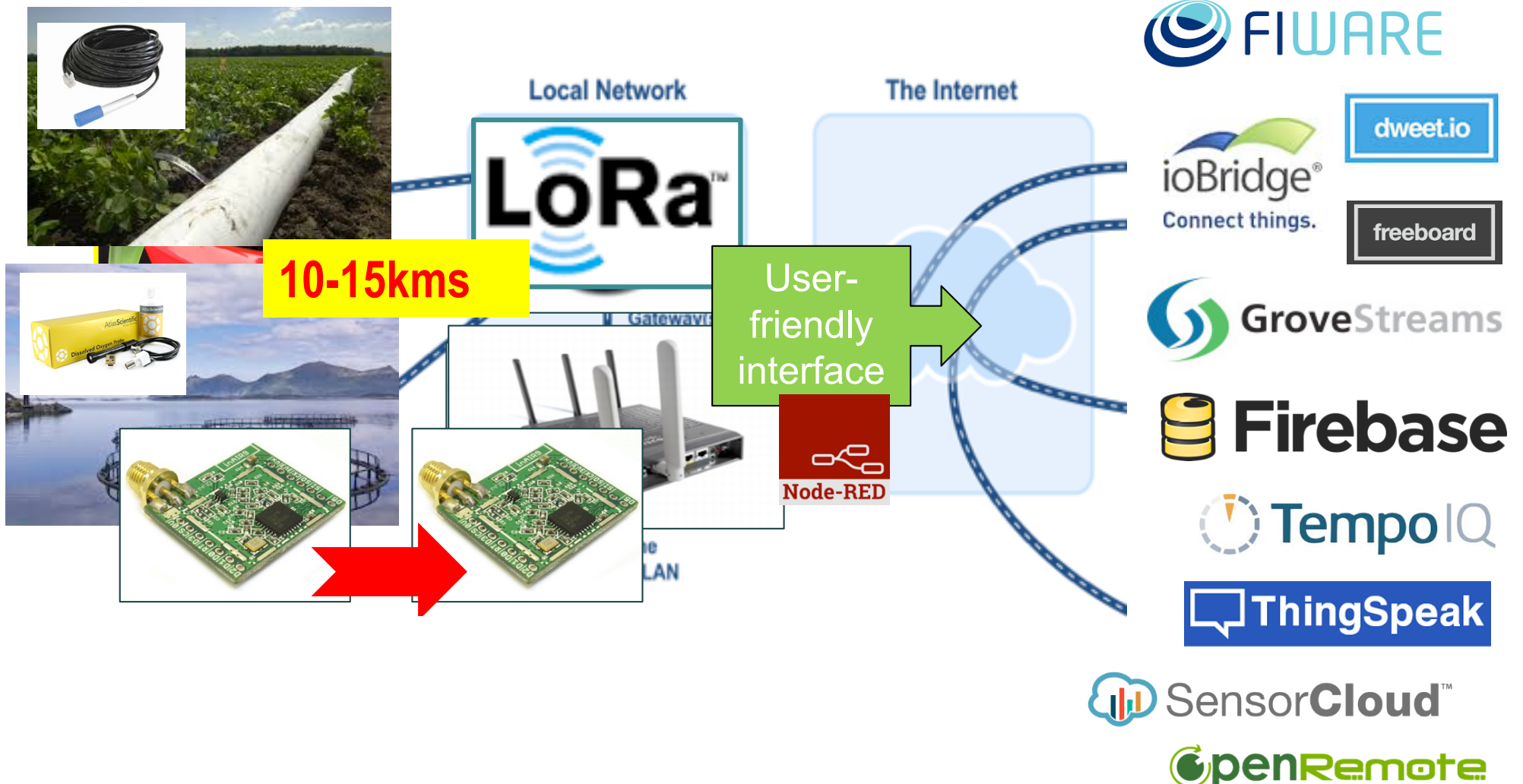


ThingSpeak



Advanced & customized data management

GLOBAL PICTURE OF LONG-RANGE IOT ECOSYSTEM



IOT BECOMES REALITY!

The INTERNET of THINGS

- Anything Any Device
- Any Service Any Business
- Any Path Any Network
- Any Place Anywhere

Logos: SIGFOX, LoRa, nwave, LTE-M, NB-LTE, WEIGHTLESS, DASH7 ALLIANCE, Bluetooth 4.0, Dropbox, Firebase, FIWARE, Axeda, ioBridge, ThingSpeak, GroveStreams, SensorCloud, OpenReel, freeboard.

Images:
1. A young boy crouching at a public water tap in a rural area.
2. A public waste container equipped with a solar-powered sensor.
3. A blue Y-shaped sensor installed in a potted plant.
4. A smart meter with a sensor attached, and a separate image of a yellow 'enovo' waste container sensor.

A REALITY FOR EVERYBODY?





Needs, constraints, cost, design approach, control mechanism

Challenge 2: Bridging the digital divide



IoT4D DEVELOPMENT FOR RURAL AREAS



Irrigation



Livestock farming



Fish farming & aquaculture



Storage & logistic

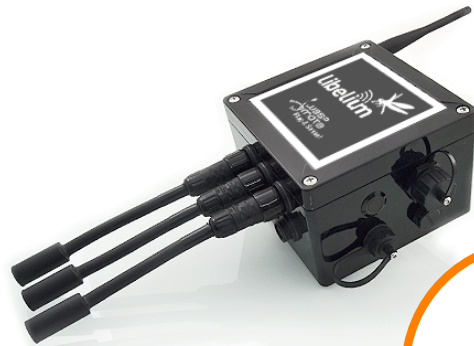


Agriculture



Environment

MATURATION OF THE IOT MARKET...



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

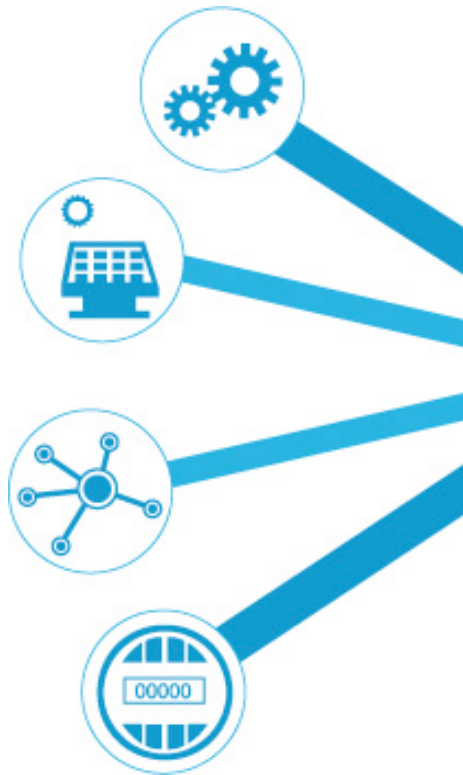
Too expensive
Too integrated
Highly specialized
Difficult to customize
Difficult to upgrade



Ultrasonic fill level sensor
10+ years battery life
IP 66, [-40°, +85°]








INTERNET, CLOUD & BIG DATA ANALYTICS



Internet connectivity is weak and expensive!

Nearly impossible in remote/rural areas



-  Predictive Maintenance
-  Outage Management
-  Fraud Detection
-  Demand/Supply Optimization
-  Customer Engagement

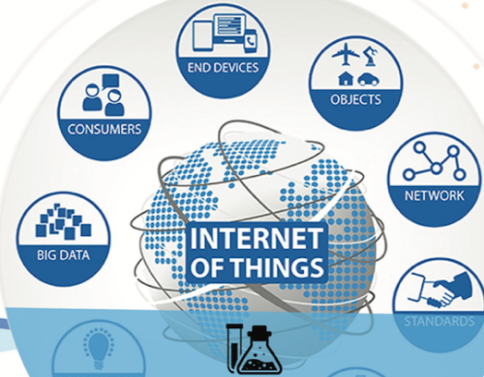
Graphics from <http://www.vitria.com/iot-analytics/>



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



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

INVOLVING INNOVATION HUBS/STAKEHOLDERS

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



COMMUNITY BUILDING FOR SUSTAINABLE INNOVATION

International Events
+ 20 organized & attended

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



Launch event (Ghana, iSpace)



IoTWeek 2016 (Belgrade, EGM)



Launch event (Senegal, CTIC Dakar)



IoTBigData 2016 (Italy, EGM)

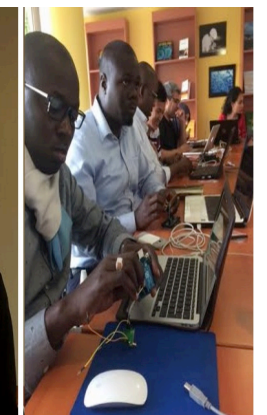


IoT Care Conference (Budapest, CNET)

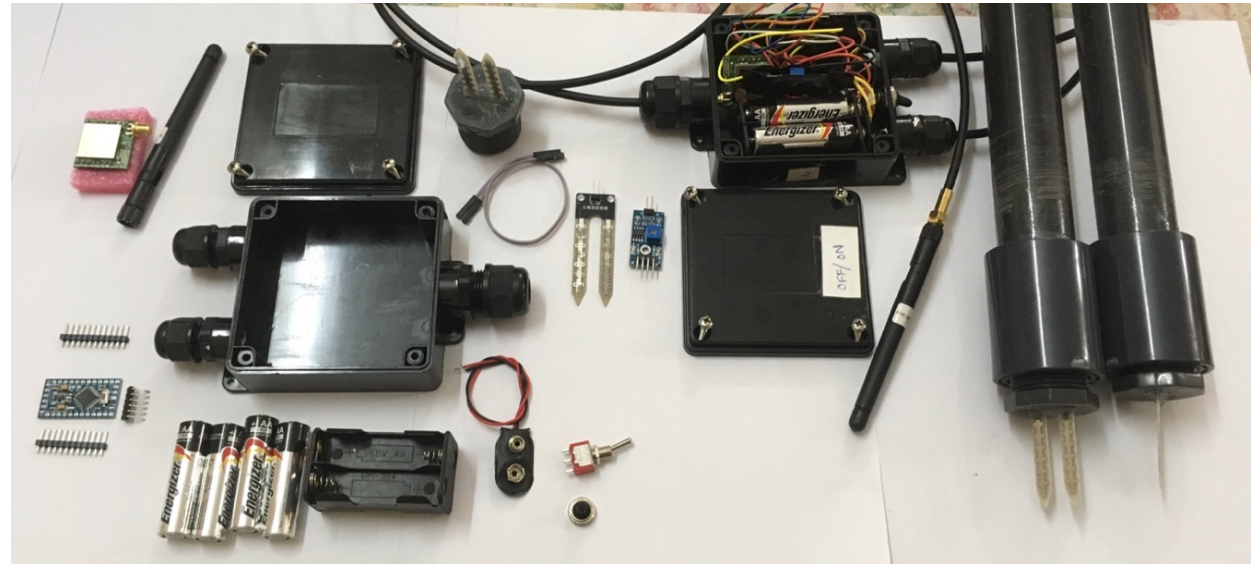
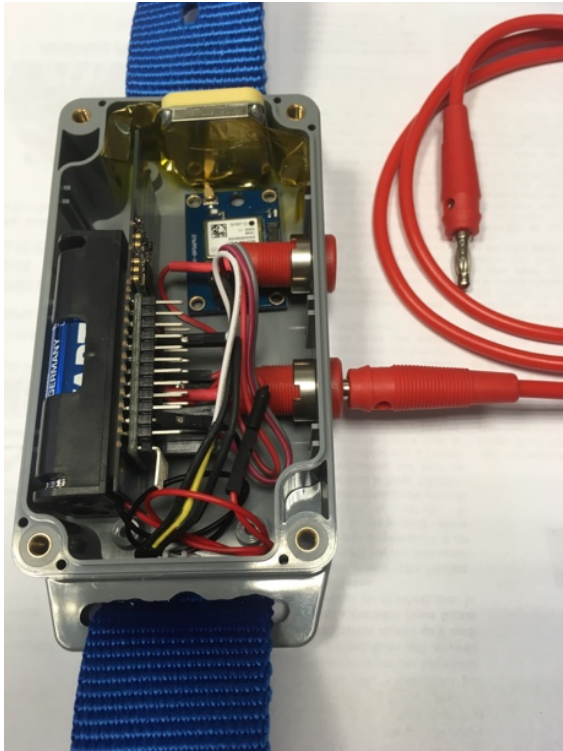
WAZIUP Workshop on IoT (Togo, L'Africaine d'Architecture)



RESSACS 2016



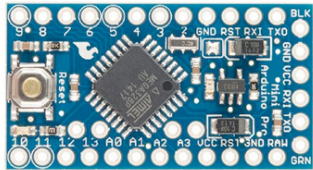
LOW-COST IOT DEVICES



LOW-COST HARDWARE



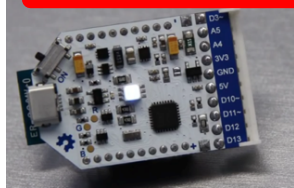
Arduino Pro Mini



LoPy

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

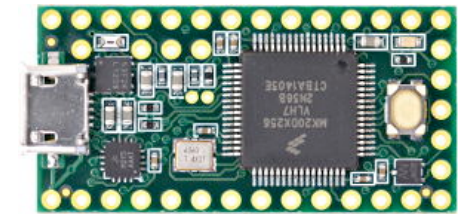
<http://blog.atmel.com/2015/04/09/25-dev-boards-to-help-you-get-started-on-your-next-iot-project/>



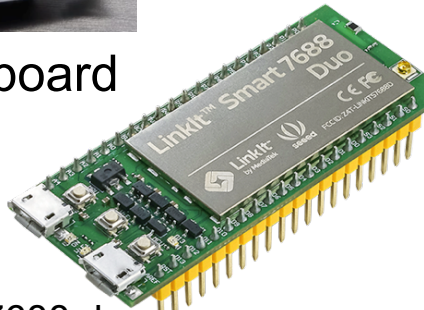
Theairboard



Expressif ESP32

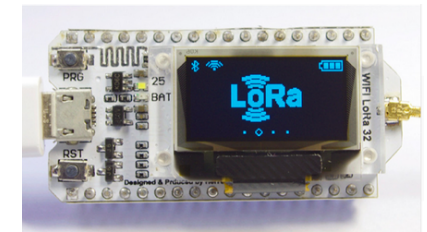
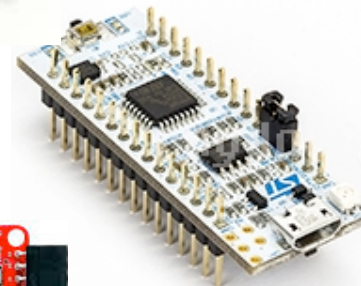


Teensy 3.2



LinkIt Smart7688 duo

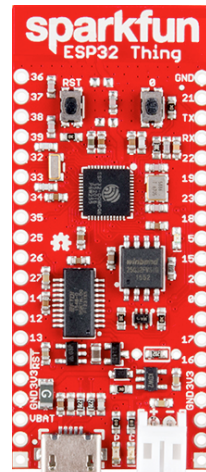
STM32 Nucleo-32



Heltec ESP32 + OLED



Adafruit Feather



Sparkfun ESP32 Thing



Tessel

SodaqOnev2



Tinyduino

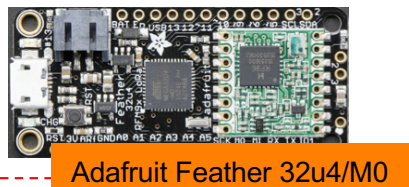
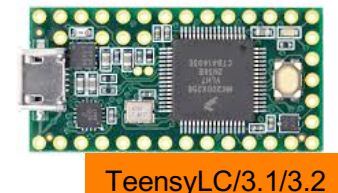
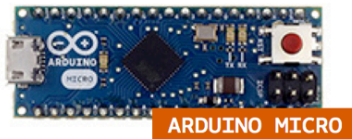
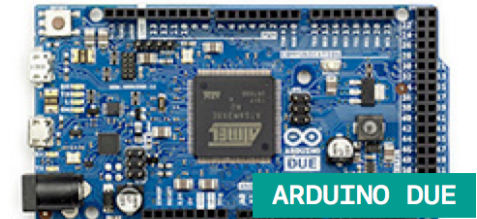
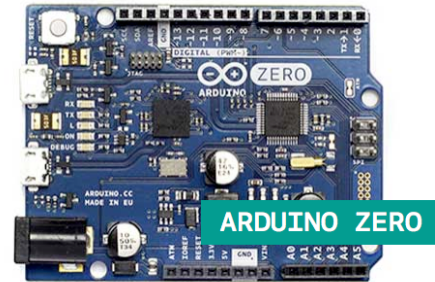
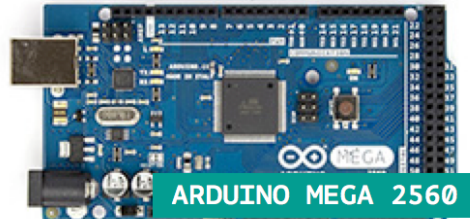
... STIMULATING "DO-IT-YOURSELF" WORLDWIDE

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

The screenshot shows the homepage of 'Projets DIY', a website dedicated to DIY projects. The header includes the site name and navigation links for various technologies like Arduino, Raspberry Pi, and IoT. A large banner for Black Friday is prominent, featuring the text '#Bons plans du Week End chez Gearbest (semaine 46) spécial Black Friday' and 'SHOF BY CATEGORY'. Below the banner, there are several promotional cards for different categories like Christmas Sticker, Christmas Pillow Case, and Christmas Hats. The page also features a search bar and a navigation menu.

The screenshot shows a Pinterest board titled 'Arduino'. The board is filled with various project ideas and tutorials, including '200+ ARDUINO PROJECTS', 'Arduino Plant Watering System', 'Solar Powered WiFi Weather Station', and 'Arduino Plant Watering'. The board is organized into a grid of pins, each with a title, a small image, and a brief description. The top of the board features a navigation bar with categories like 'Liaison mécanique', 'Arduino cash', and 'Apprendre à programmer en python'. The bottom of the board has a search bar and a 'S'nscrire' button.

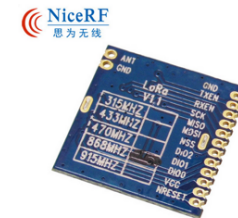
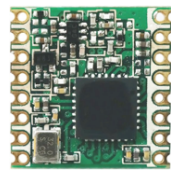
WAZIUP PROVIDES SW/HW BUILDING BLOCKS INTEGRATION



More to come...

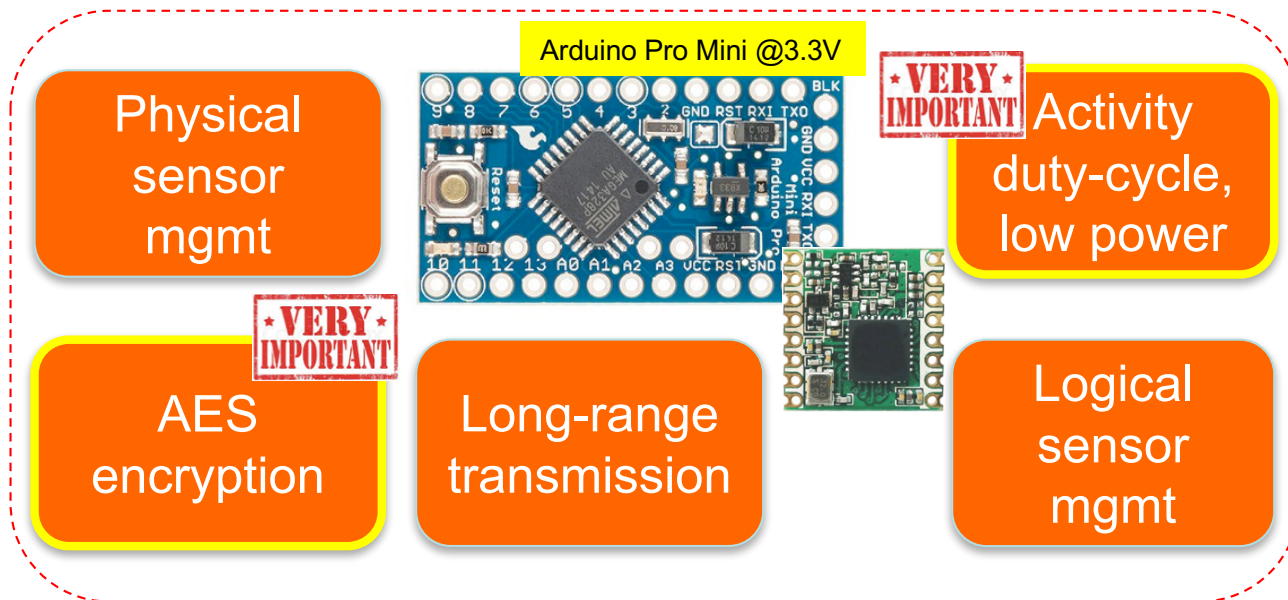
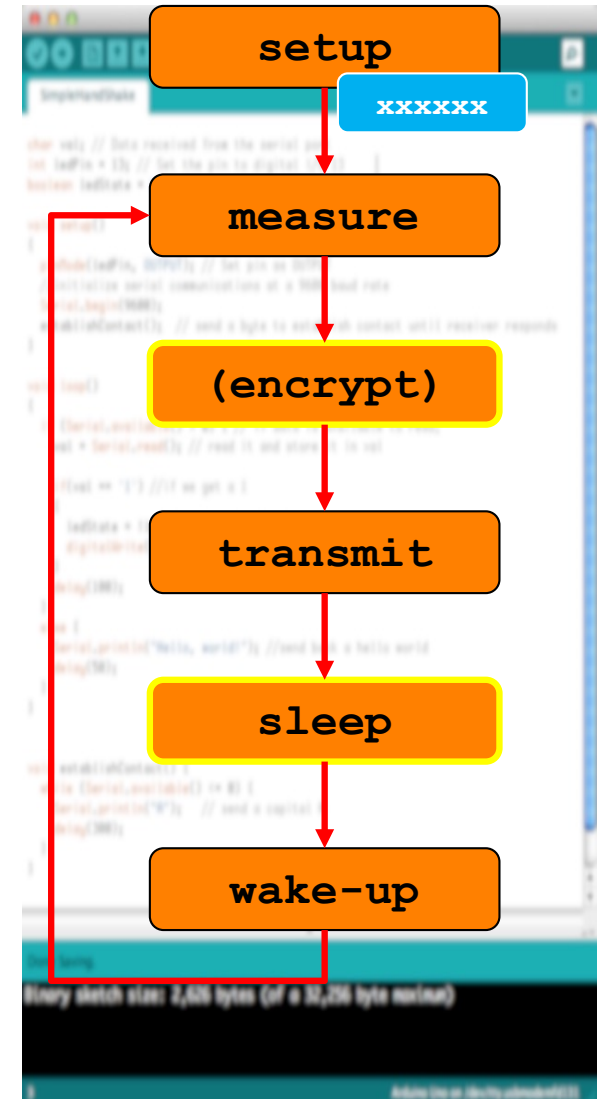
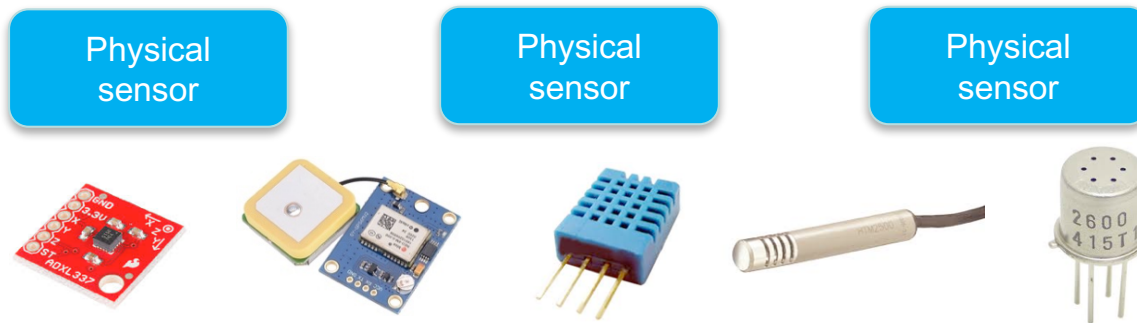
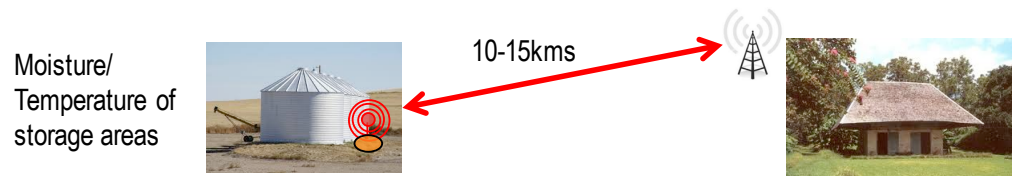


LoRa radios that our library already supports



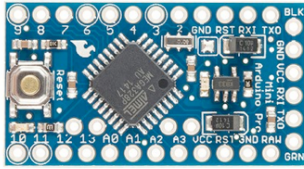
Long-Range communication library

READY-TO-USE TEMPLATES

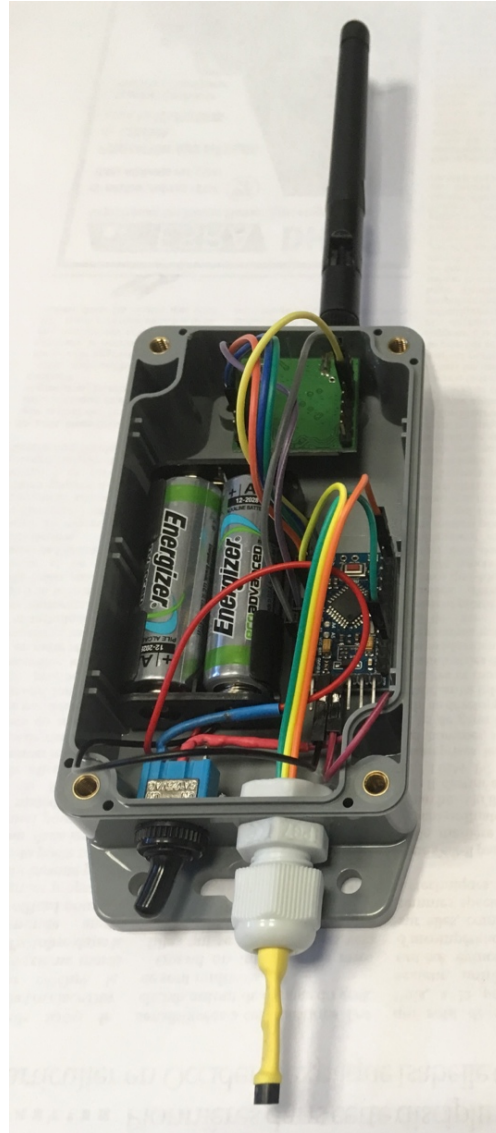


A SIMPLE TEMPERATURE SENSOR EXAMPLE

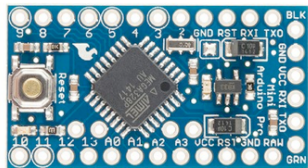
Arduino Pro Mini @3.3V



Modtronix inAir9

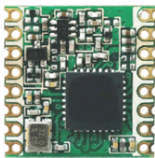


LOW-COST INTEGRATION

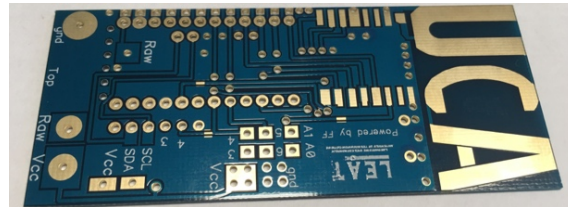


1.5€

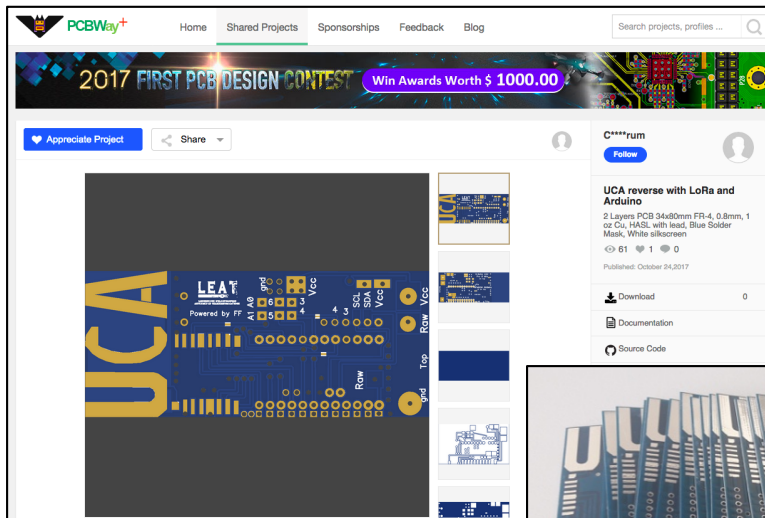
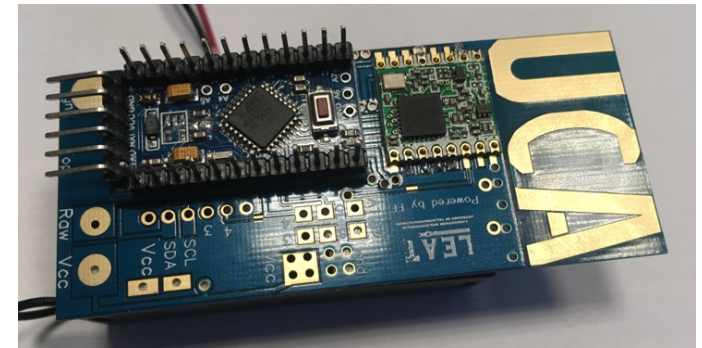
https://github.com/FabienFerrero/UCA_Board



5€

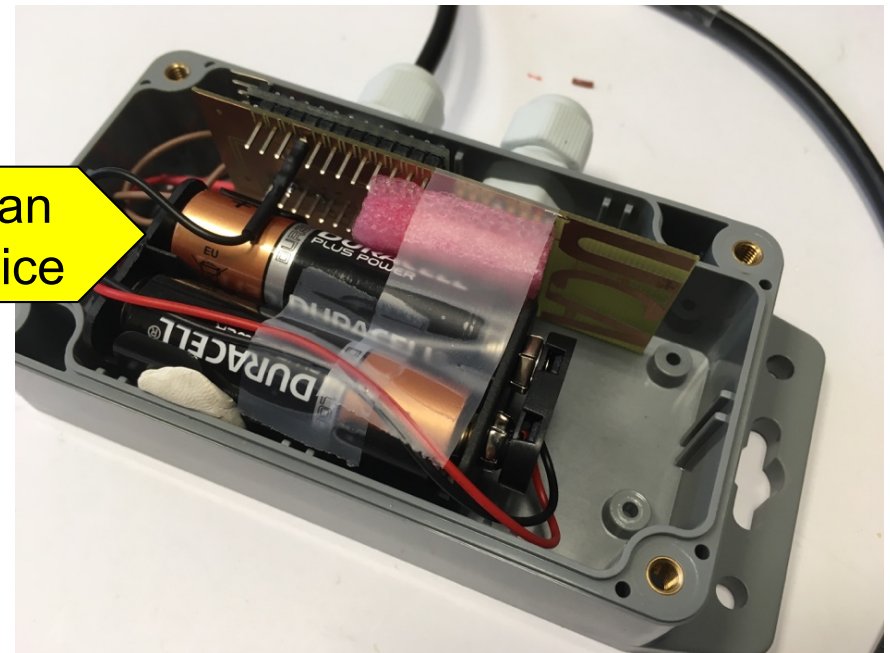


1€



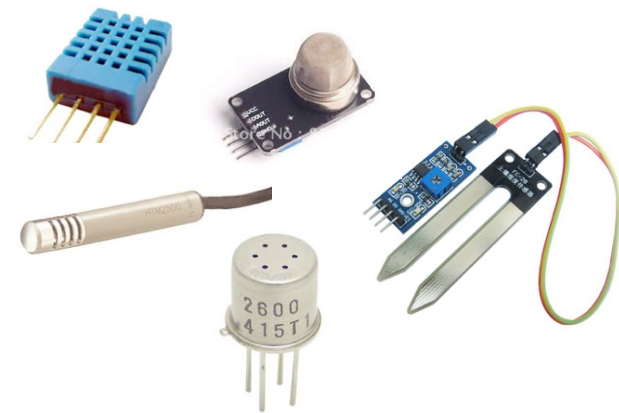
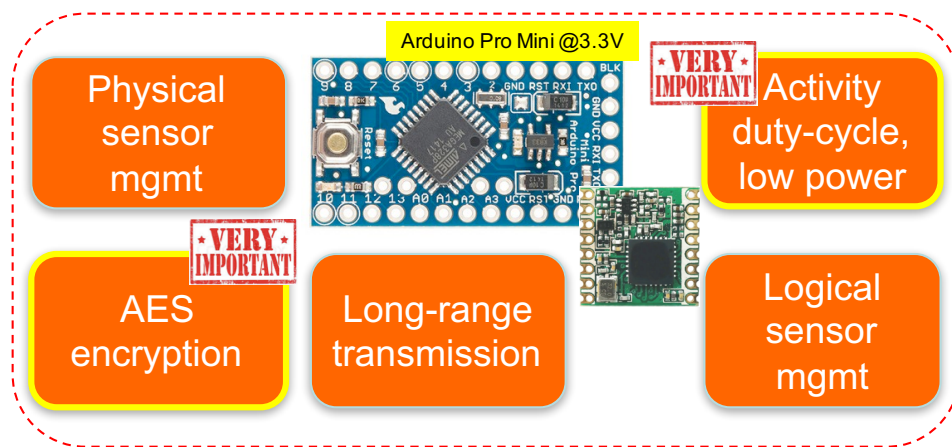
1-click order

Less than 10€/device



GENERIC SENSING IOT DEVICE VS HIGHLY SPECIALIZED

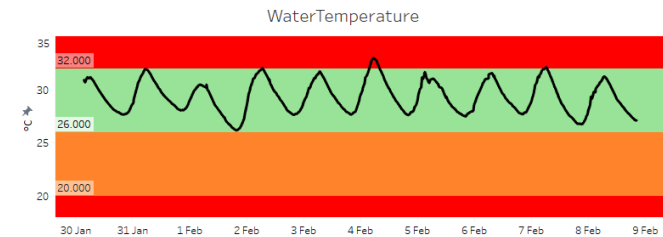
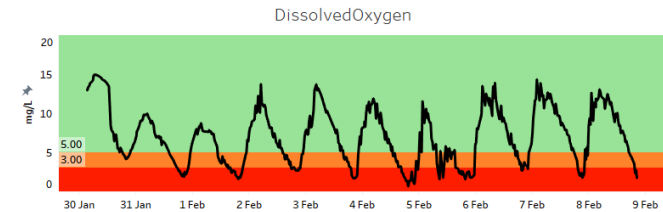
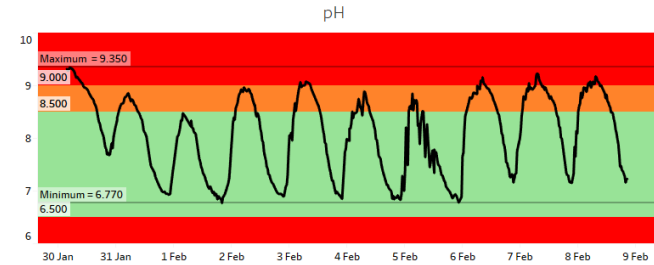
- ❑ Build low-cost, low-power, **long-range** enabled generic platform
- ❑ Methodology for low-cost platform design
- ❑ Technology transfers to user communities, economic actors, stakeholders,...



FISH FARMING IN KUMASI, GHANA

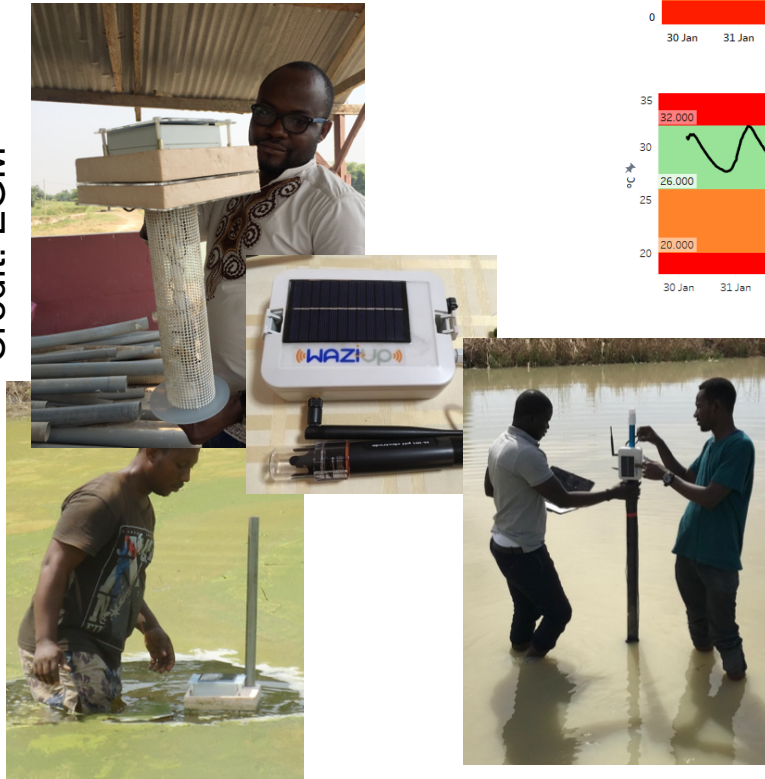


LOW-COST BUOY FOR FISH FARMING MVP

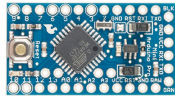


Physical sensor reading

Credit: EGM



Physical sensor management

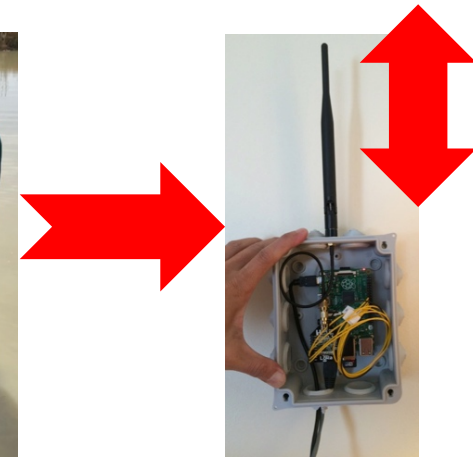


Activity duty-cycle, low power

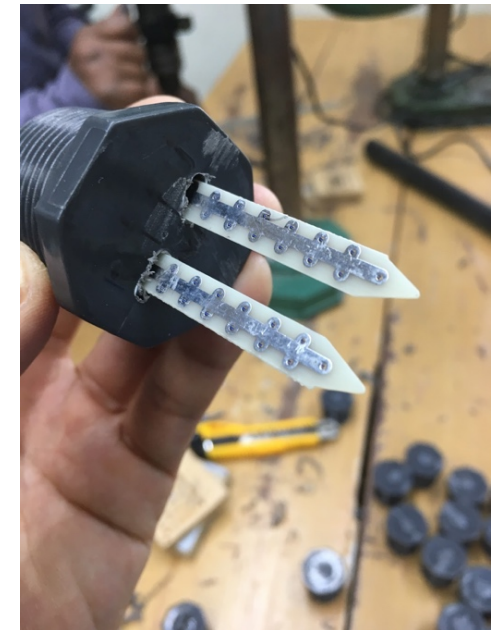
Security

Long-range transmission

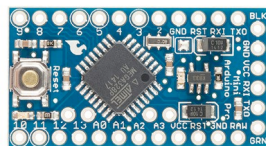
Logical sensor management



SOIL HUMIDITY SENSORS FOR AGRI MVP



Physical sensor management



Activity duty-cycle, low power

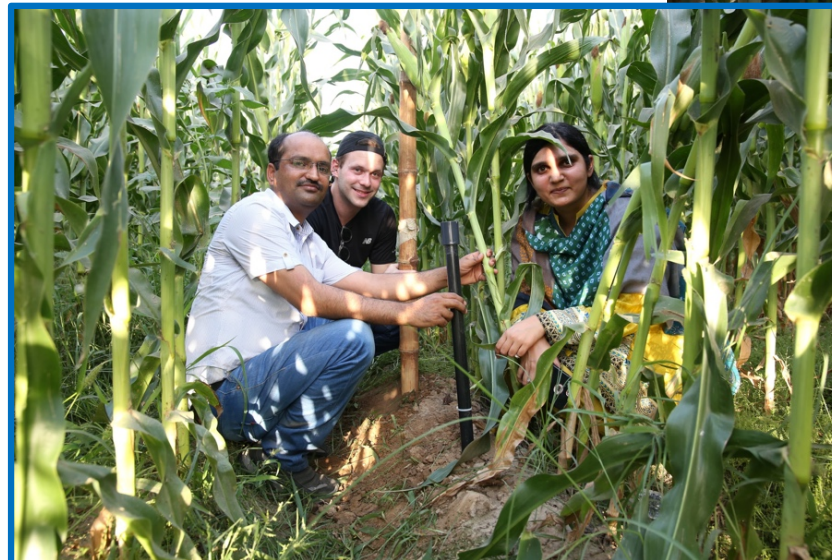
Security

Long-range transmission

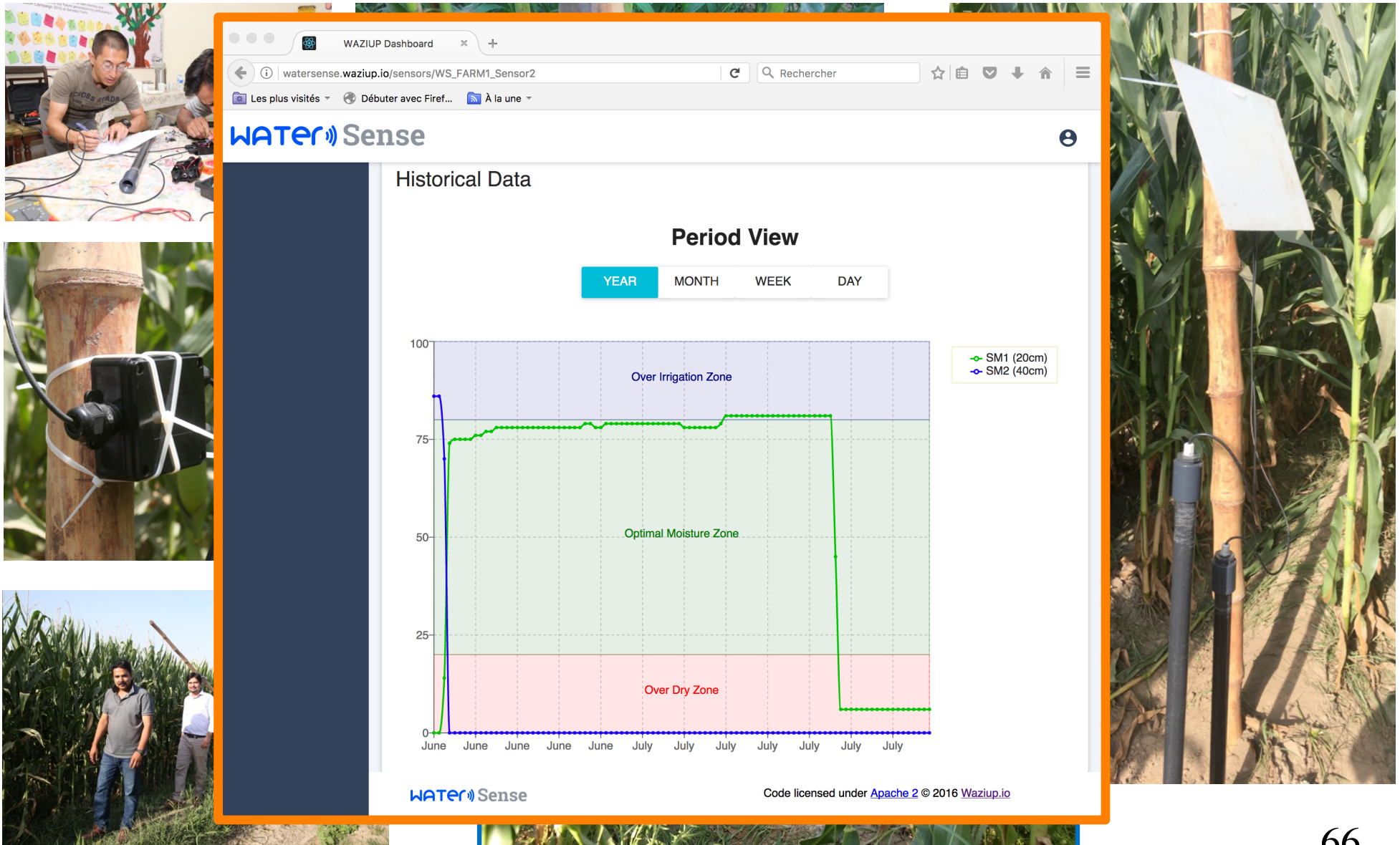
Logical sensor management



DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT



DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT

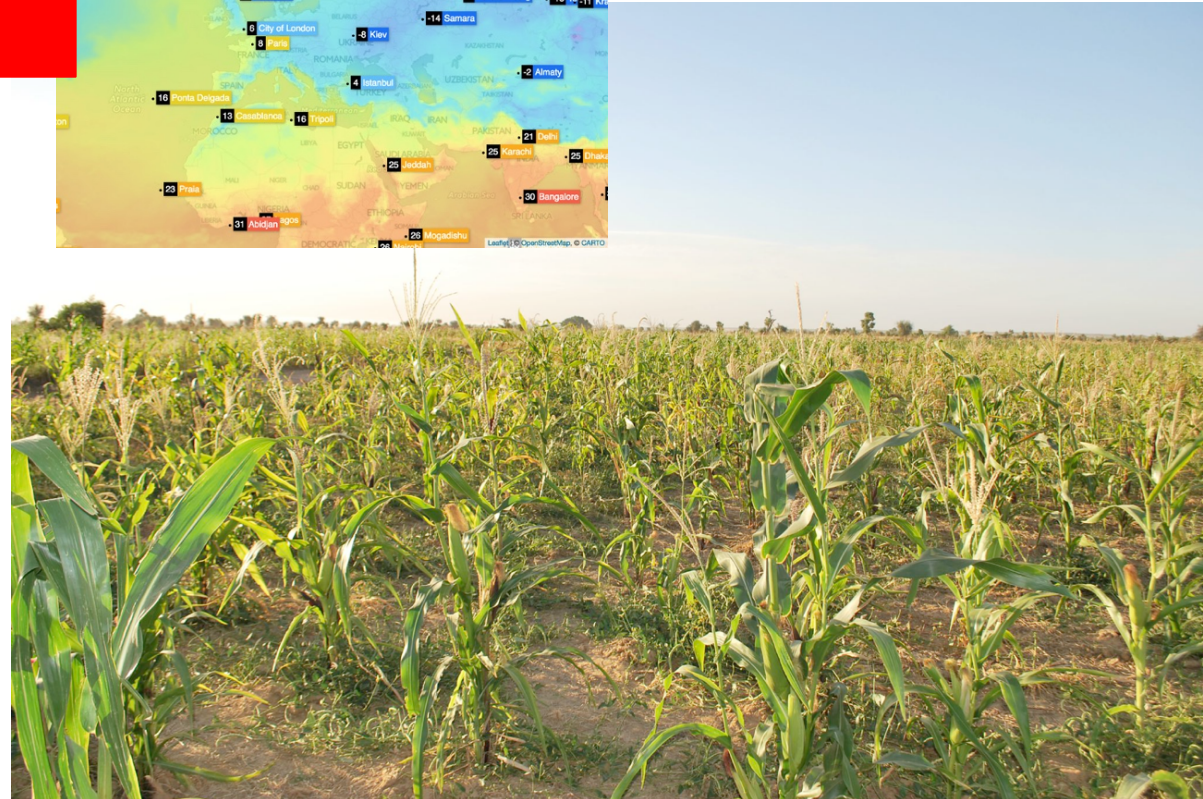


LOCAL WEATHER STATION FOR AGRI MVP

<https://openweathermap.org/>



Photo from Unparallel



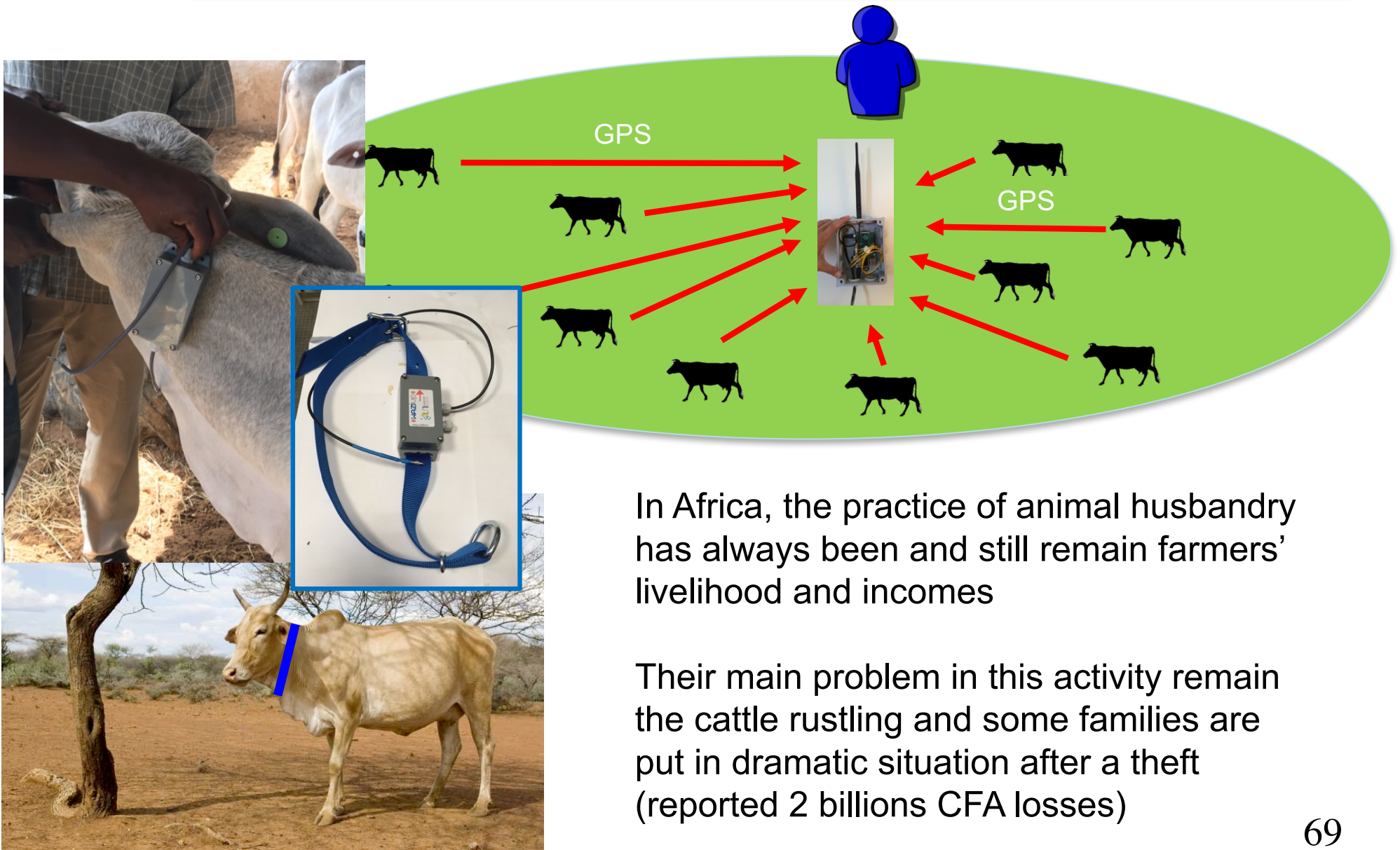
**Get local weather
measurements**

**Combine with open weather data to
get more accurate predictions**

CATTLE RUSTLING IN SAINT-LOUIS, SENEGAL



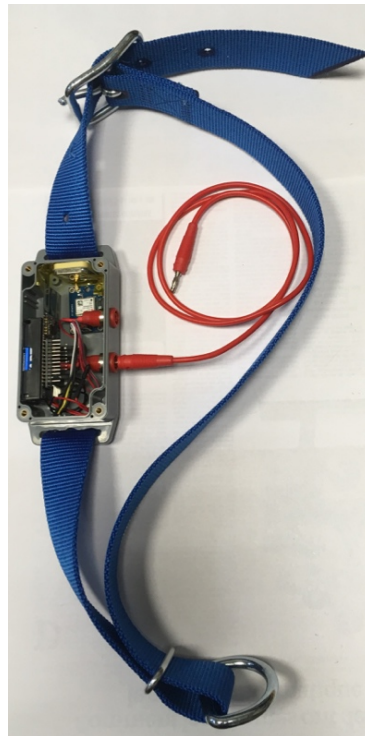
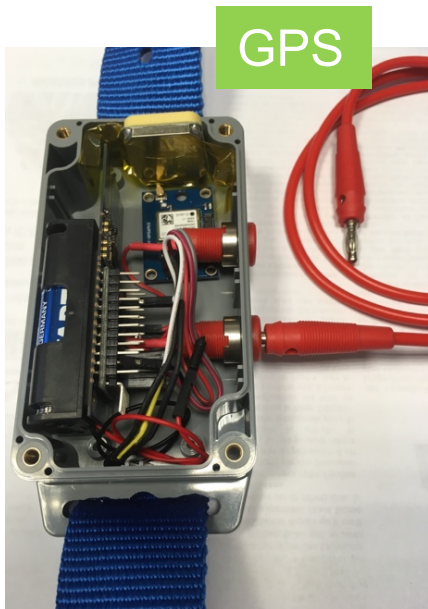
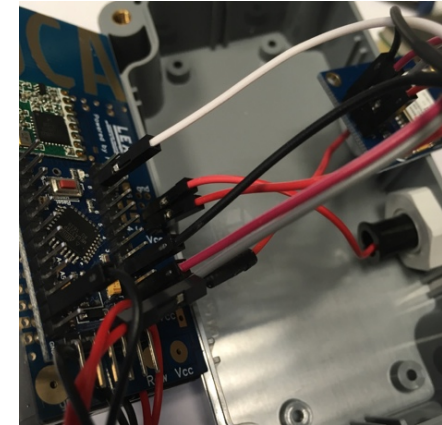
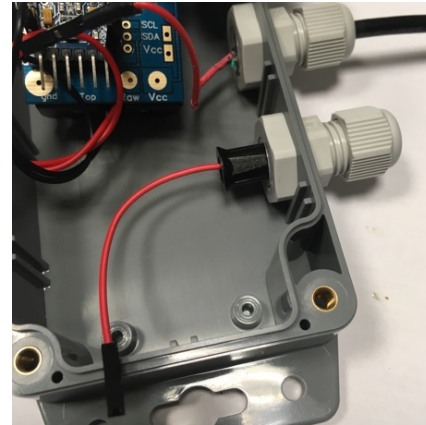
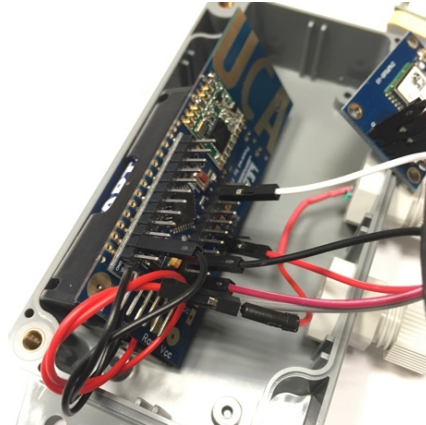
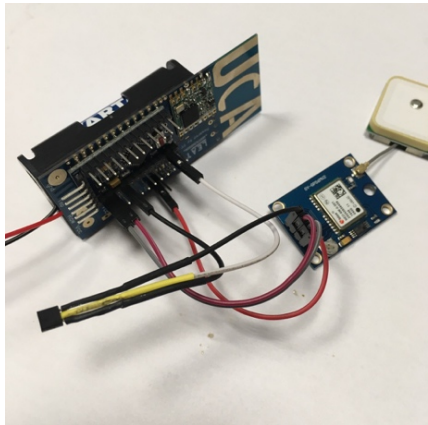
COLLAR FOR CATTLE RUSTLING MVP



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

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

EASY INTEGRATION AND CUSTOMIZATION



A web interface can be developed to display the position of the gateway and the position of the remote GPS devices

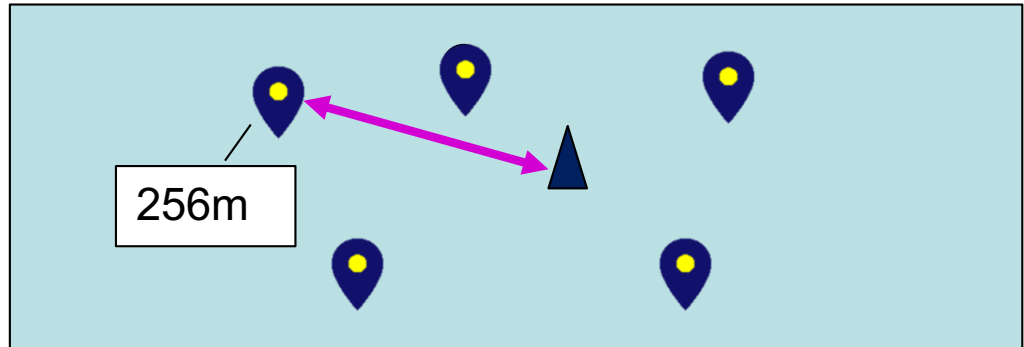
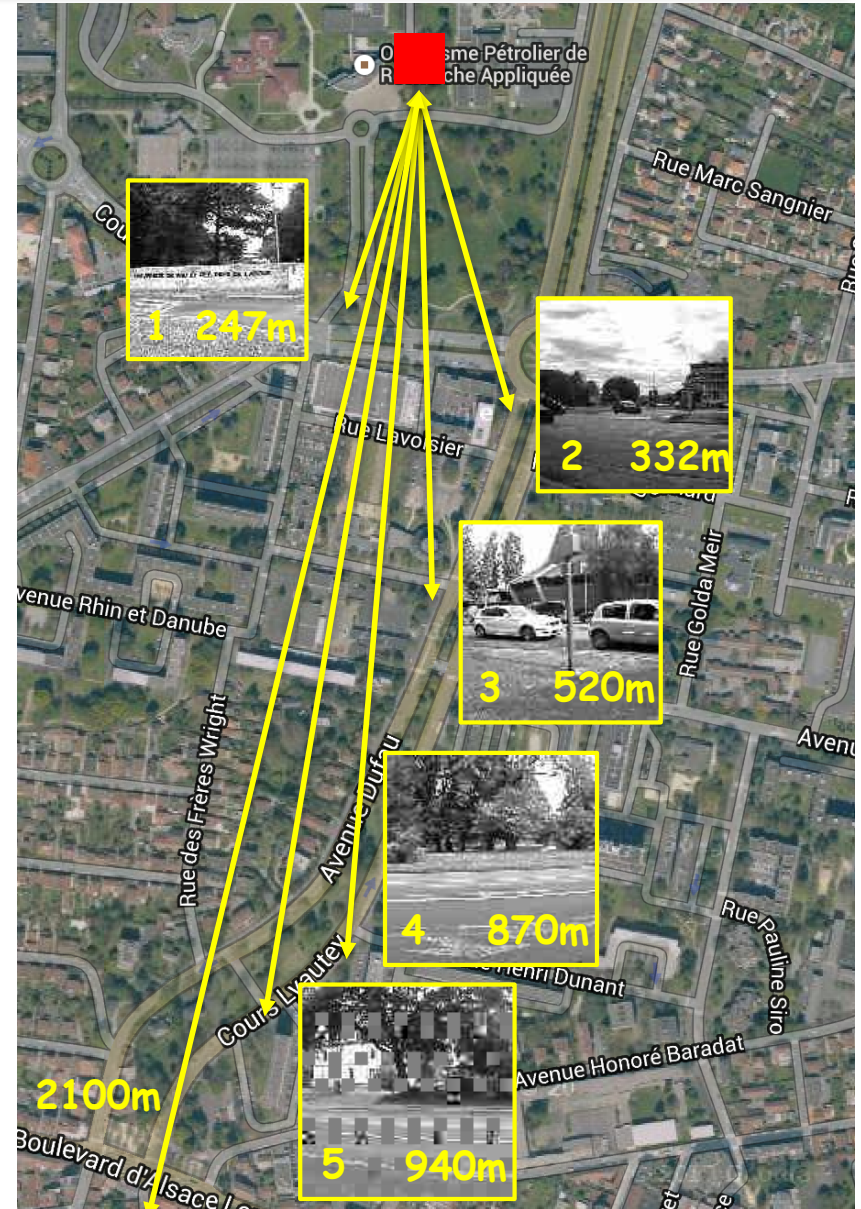
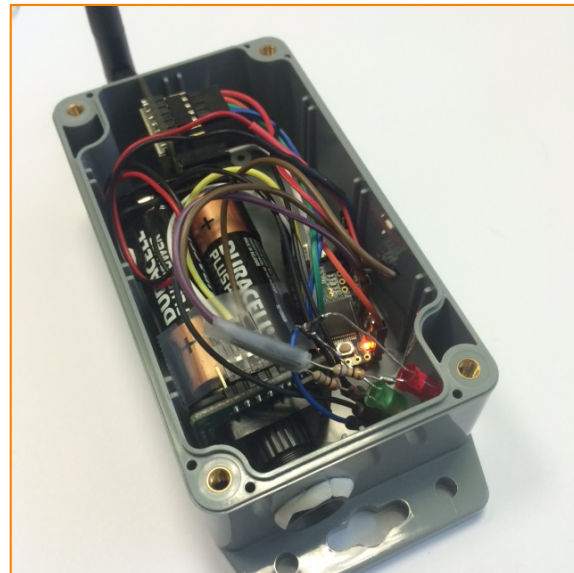
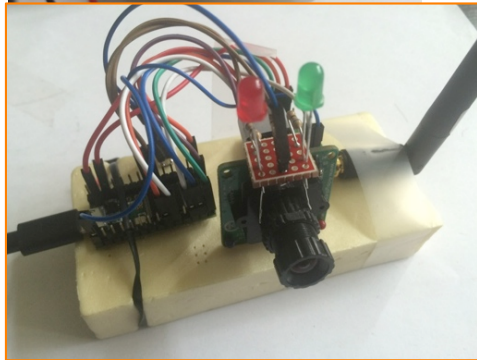
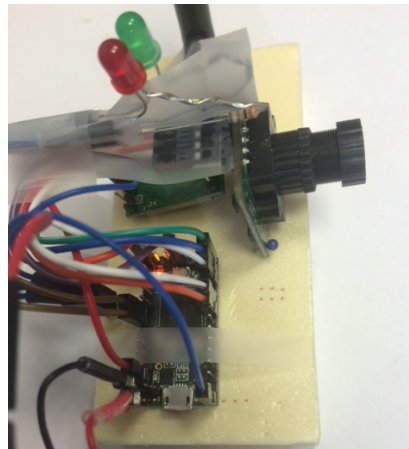
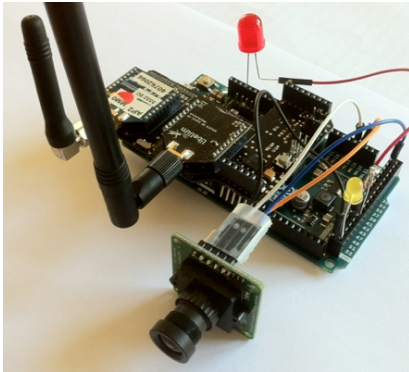


IMAGE SENSOR FOR SPECIFIC SURVEILLANCE CASES



TUTORIALS/RESOURCES

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

WAZIUP
EU H2020 grant agreement number 887047

Low-cost LoRa IoT devices and gateway FAQ

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

2) **What is WAZIUP?**
The EU H2020 WAZIUP project, namely the Open Innovation Platform for IoT-Big Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP operates by involving farmers and breeders in order to define the platform specifications in focused validation cases. Second, while tackling challenges which are specific to the rural ecosystem, it also engages the flourishing ICT ecosystem in those countries by fostering new tools and good practices, entrepreneurship and start-ups. Aimed at boosting the ICT sector, WAZIUP proposes solutions aiming at long term sustainability.
WAZIUP will deliver a communication and big data application platform and generate locally the know-how by training by use cases and examples. The use of standards will help to create an interoperable platform, fully open source, oriented to radically new paradigms for innovative applications/services delivery. WAZIUP is driven by the following visions:
1. Empower the African rural population by supporting the African rural development and support the necessary agricultural breeding on a new scale.

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

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

WAZIUP

LIUPPA T21 team

PROF. CONGDUC PHAM
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](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

LIUPPA T21 team

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

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

WAZIUP

LIUPPA T21 team

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

LOW-COST LORA IOT DEVICE: SUPPORTED PHYSICAL SENSORS

WAZIUP

LIUPPA T21 team

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

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

WAZIUP

LIUPPA T21 team

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

LOW-COST LORA IOT: USING THE WAZIUP DEMO KIT

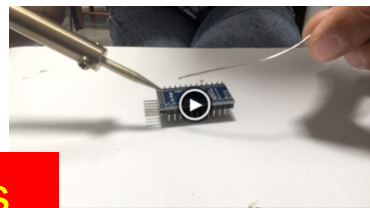
WAZIUP

LIUPPA T21 team

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

Low-cost IoT device



+53000 views

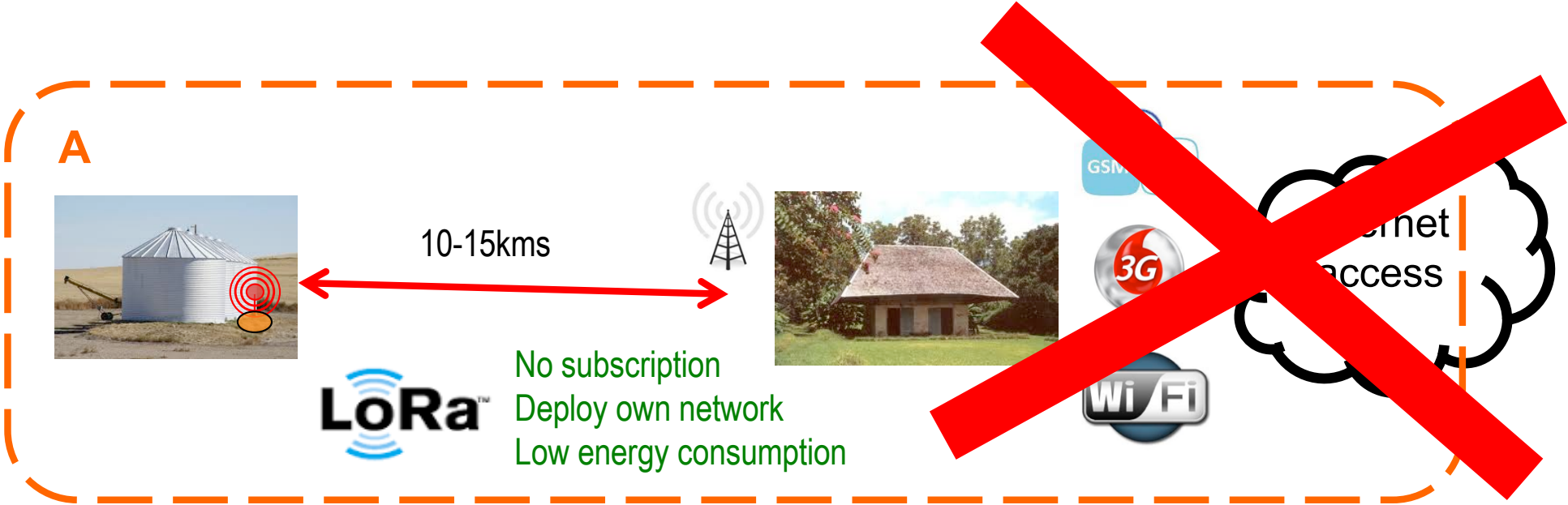
https://www.youtube.com/watch?v=YsKbJeeav_M

Low-cost IoT gateway

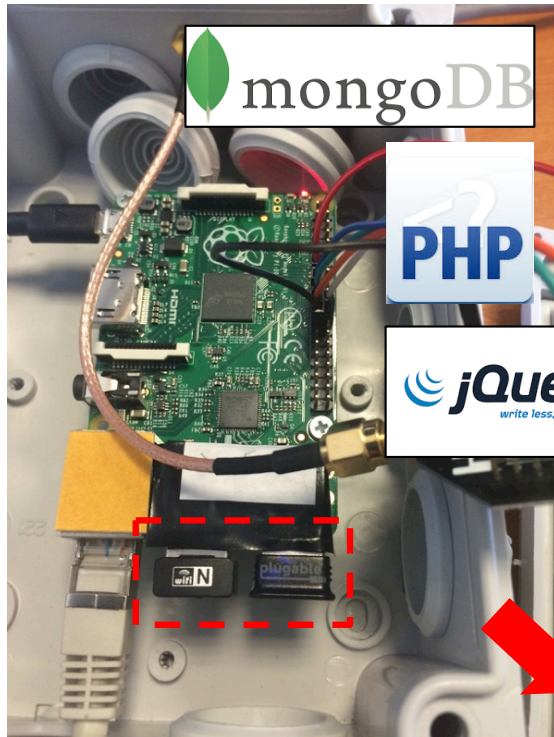


<https://www.youtube.com/watch?v=mj8ltKA14PY>

WORKING WITHOUT INTERNET ACCESS



STANDALONE GATEWAY



mongoDB



PHP

jQuery
write less, do more.

Access to the data from MongoDB

export data to csv

Display the 10 last document(s)

Sort by date

Valid

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

Display data: RSSI TC DEF

Display sources: node_3 node_6 node_10

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

Current day



Isolated areas



Orange F

Bluetooth_raspi

```

NODE: 1 DATE: 2016-05-09 08:04:59.807000 DATA: {"lw": 3.29, "th": 22.6, "hu": 50.7}
NODE: 1 DATE: 2016-05-09 08:28:52.993000 DATA: {"lw": 3.29, "th": 22.89, "hu": 50.29}
NODE: 1 DATE: 2016-05-09 08:53:04.317000 DATA: {"lw": 3.29, "th": 23.2, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 09:05:00.997000 DATA: {"lw": 3.29, "th": 23.29, "hu": 51.29}
NODE: 1 DATE: 2016-05-09 09:17:24.482000 DATA: {"lw": 3.29, "th": 23.39, "hu": 51.7}
NODE: 1 DATE: 2016-05-09 09:41:27.437000 DATA: {"lw": 3.29, "th": 23.6, "hu": 52.0}
NODE: 1 DATE: 2016-05-09 10:05:39.032000 DATA: {"lw": 3.29, "th": 23.79, "hu": 51.5}
NODE: 1 DATE: 2016-05-09 10:17:45.186000 DATA: {"lw": 3.29, "th": 23.79, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 10:29:24.285000 DATA: {"lw": 3.29, "th": 23.79, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 10:53:09.347000 DATA: {"lw": 3.29, "th": 23.79, "hu": 51.9}
NODE: 1 DATE: 2016-05-09 11:17:02.953000 DATA: {"lw": 3.29, "th": 23.5, "hu": 50.79}
NODE: 1 DATE: 2016-05-09 11:52:53.334000 DATA: {"lw": 3.29, "th": 23.29, "hu": 50.7}
NODE: 1 DATE: 2016-05-09 12:04:32.437000 DATA: {"lw": 3.29, "th": 23.5, "hu": 50.29}
NODE: 1 DATE: 2016-05-09 12:16:56.116000 DATA: {"lw": 3.29, "th": 23.6, "hu": 50.29}
    
```

Display data Retrieve data in a csv file

Orange F

Bluetooth_raspi

NODES PREFERENCES

1 check to retrieve its data

8 check to retrieve its data

DATES PREFERENCES

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

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

Display data Retrieve data in a csv file

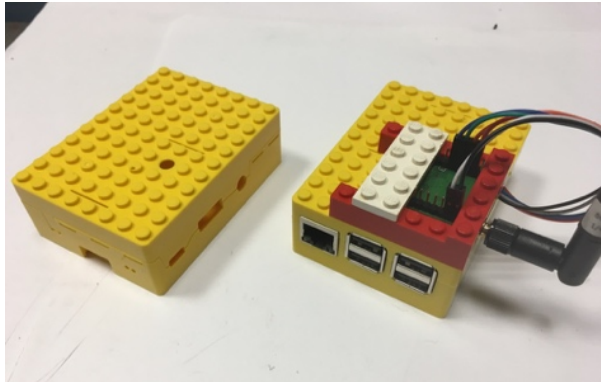
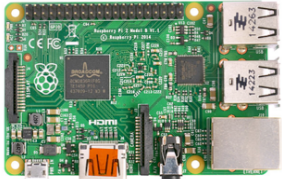
Orange F

Bluetooth_raspi

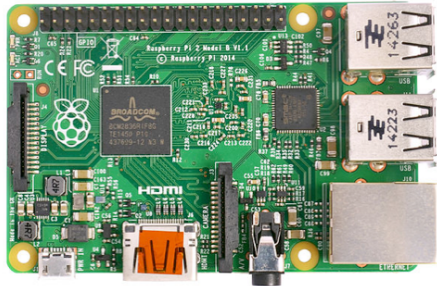
Creating .csv file with the data received...
File 17-05-2016_10h39m36s.csv created and saved in the folder /storage/emulated/0/Raspberry_local_data

Display data Retrieve data in a csv file

THE VERSATILE IOT GATEWAY



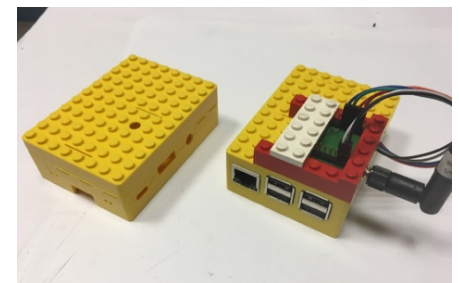
RASPBERRY-BASED LOW-COST LORA GATEWAY



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



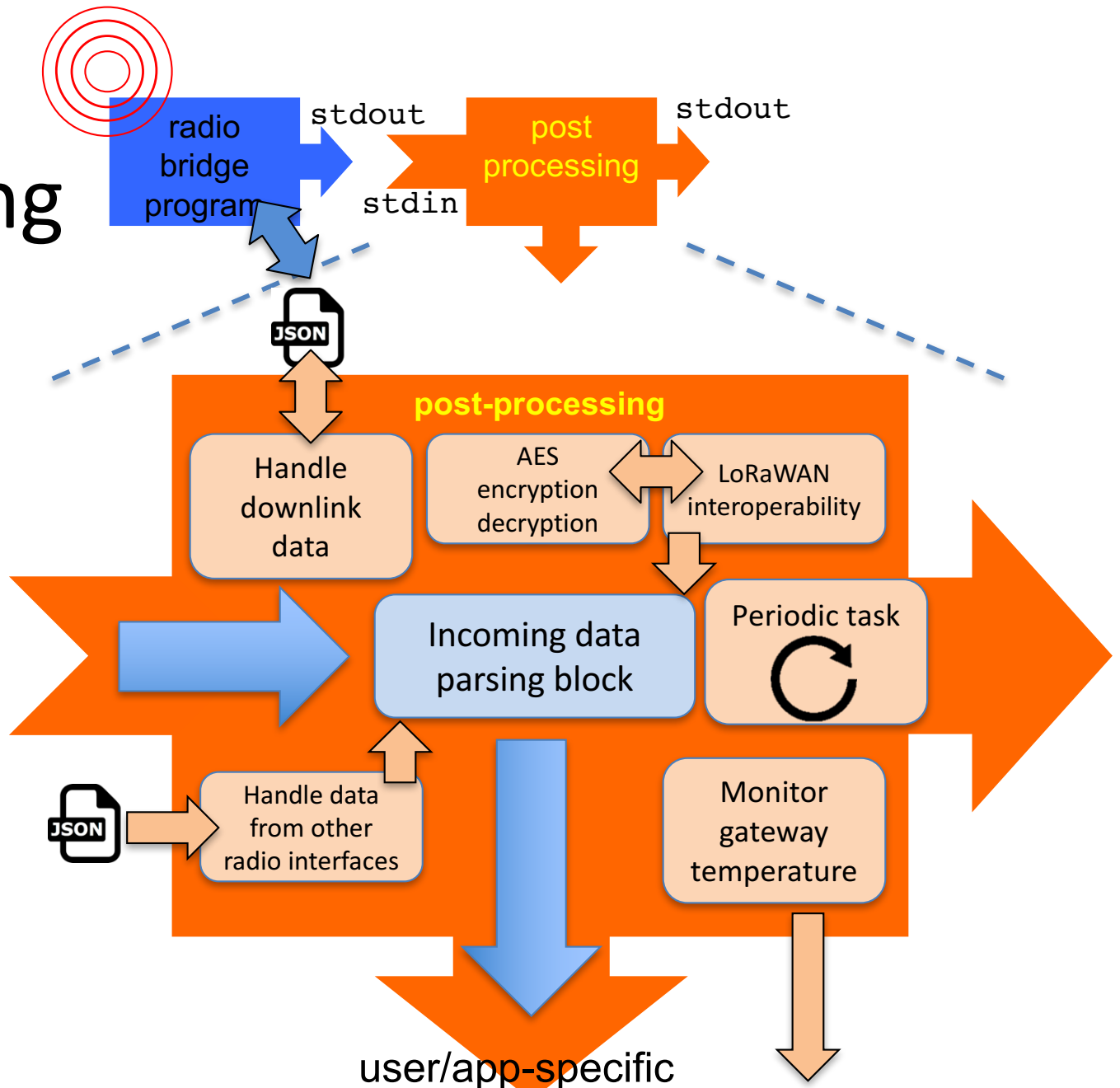
Less than 50€



Get the ready-to-use SD card image

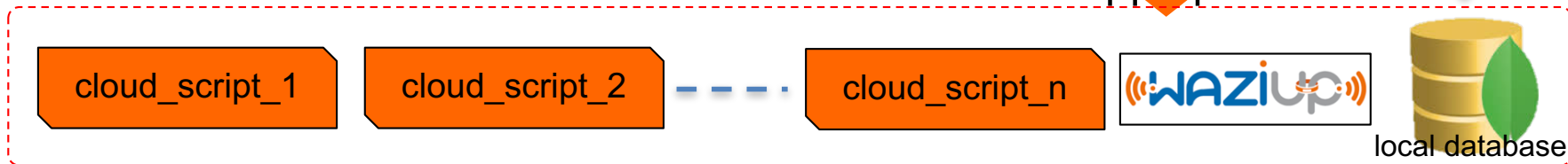
<http://cpham.perso.univ-pau.fr/LORA/WAZIUP/raspberrypi-jessie-WAZIUP-demo.dmg.zip>

Post-processing stage

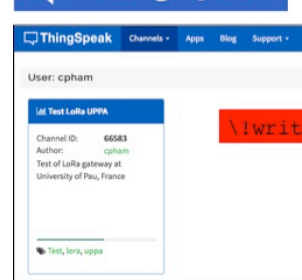
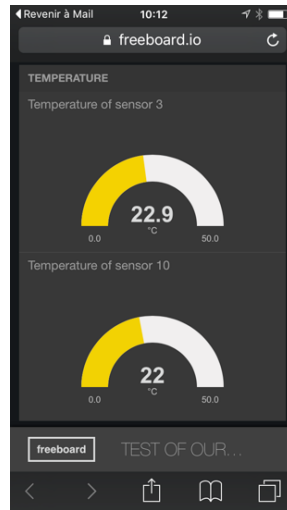
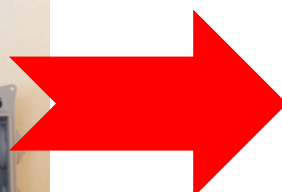
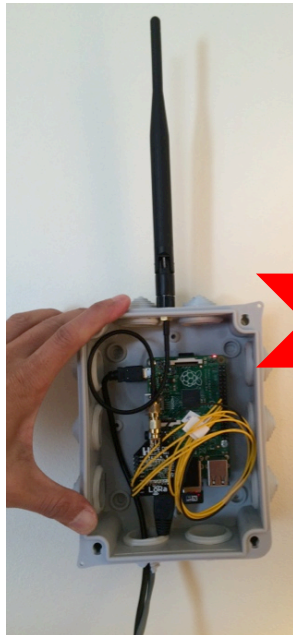


Cloud definition

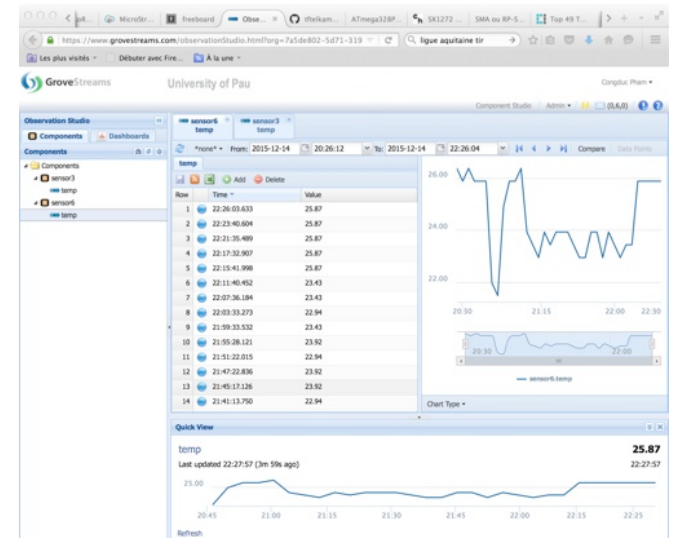
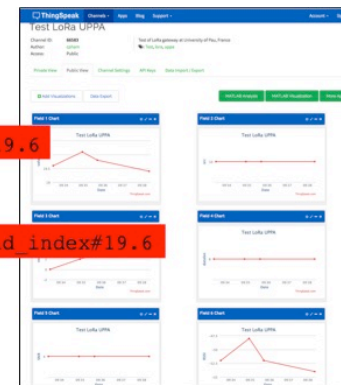
user/app-specific



TEMPLATES FOR VARIOUS CLOUDS



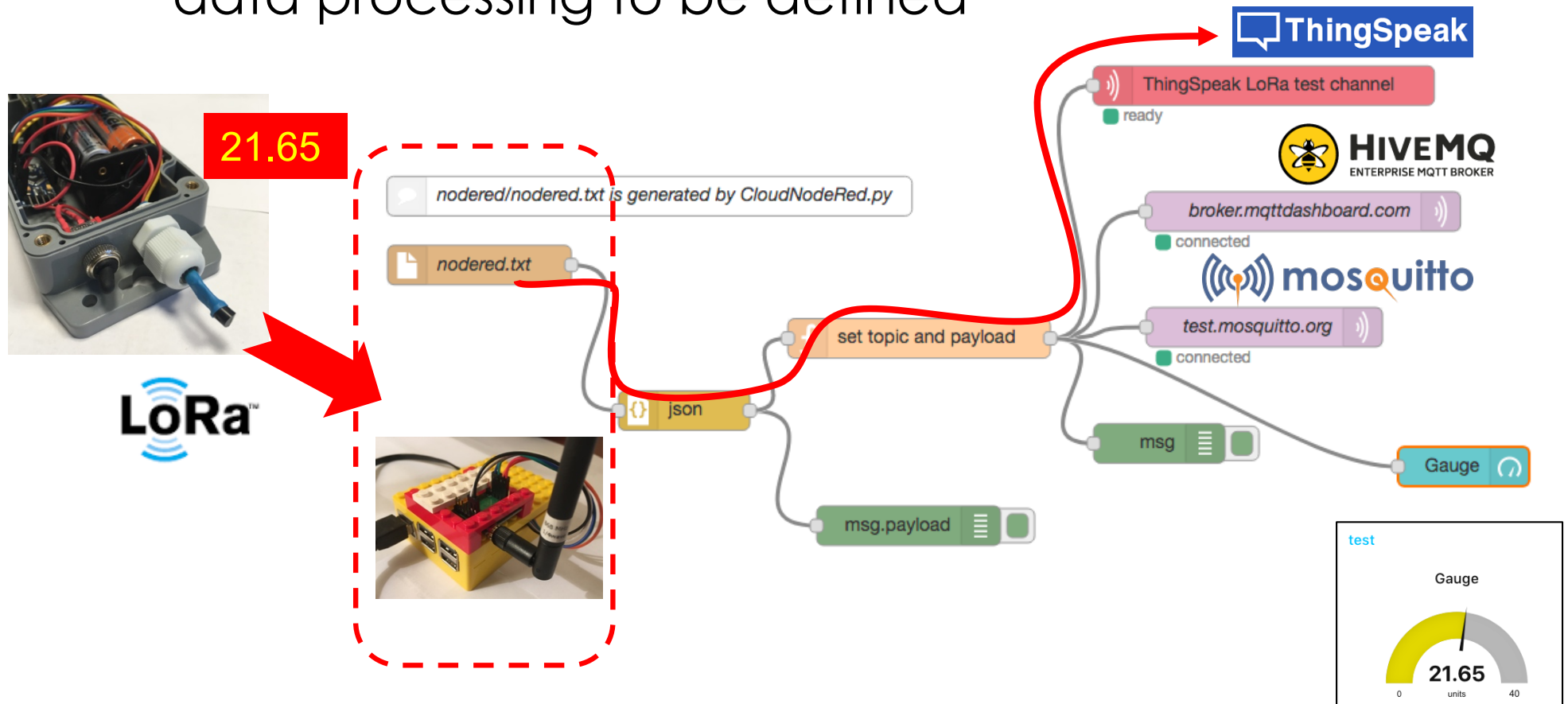
Node 10
\\!##19.6
\\!write_key#field_index#19.6



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

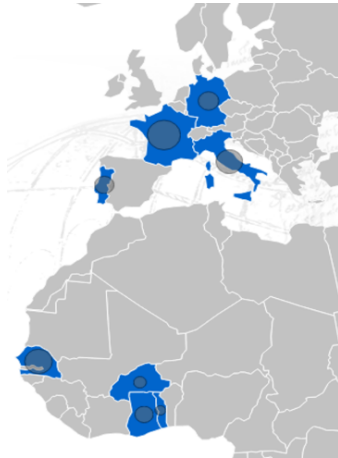
NODE-RED ENABLED GATEWAY

- Messages received on the gateway can be injected into a Node-Red flow, allowing complex data processing to be defined

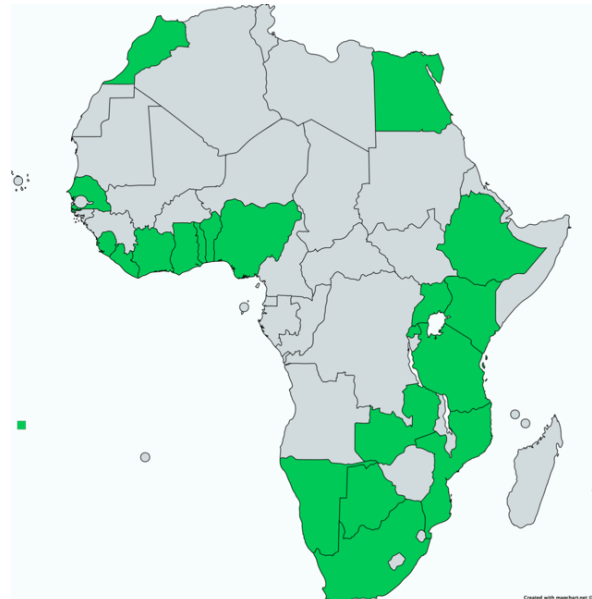


SCALING UP!

Feb 2016 - 2019



May 2018 - 2021





Thanks.
Let's keep in touch



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