

THE IOT ECOSYSTEM AND MAKE IT HAPPENING!

LES DÉFIS DE L'AGRICULTURE CONNECTÉE DANS UNE
SOCIÉTÉ NUMÉRIQUE

ENSA, MARCH 13TH, 2018, SAFI, MOROCCO

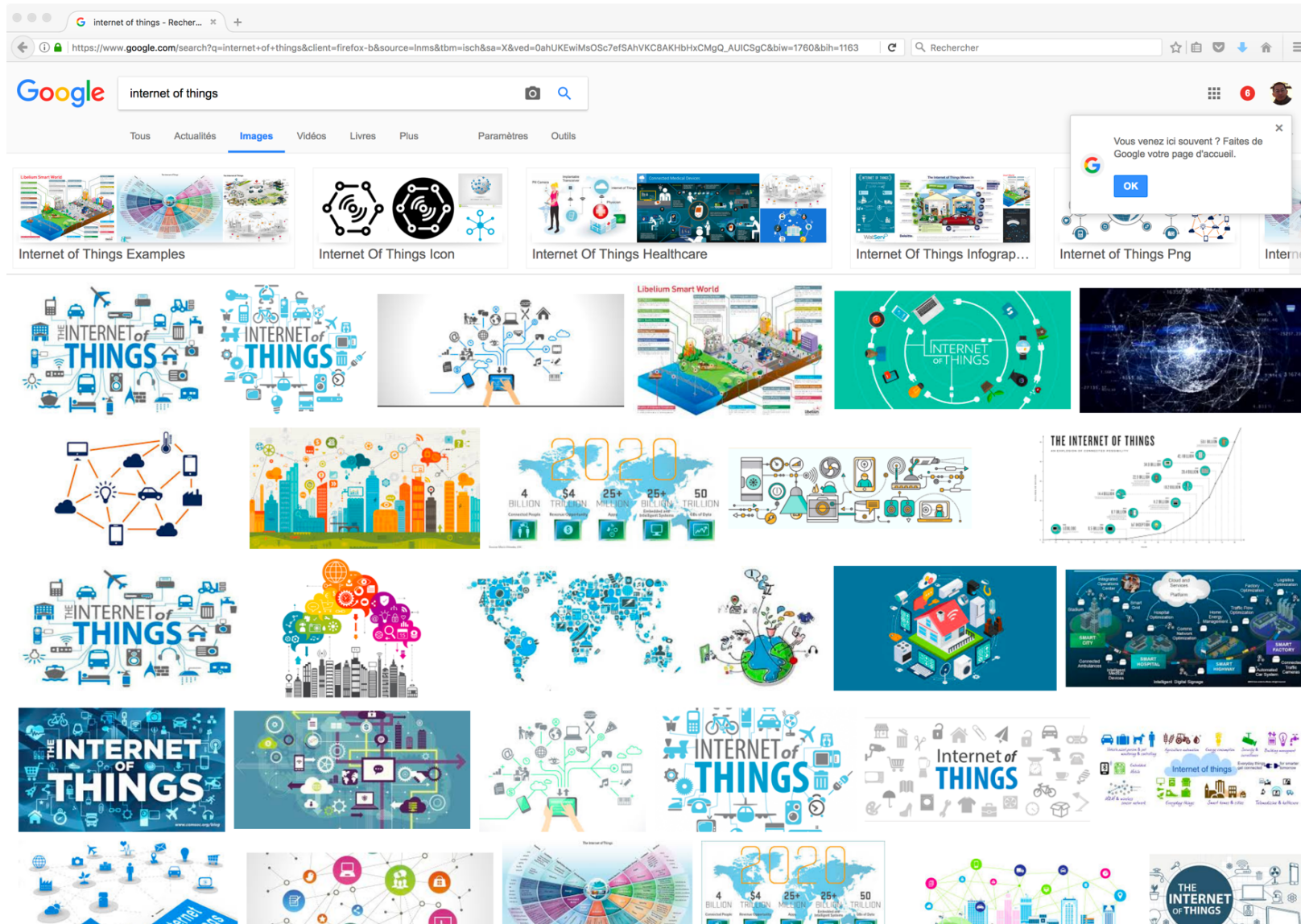


DISRUPTIVE
INTERNET
OF THINGS
APPLICATIONS
IN AFRICA

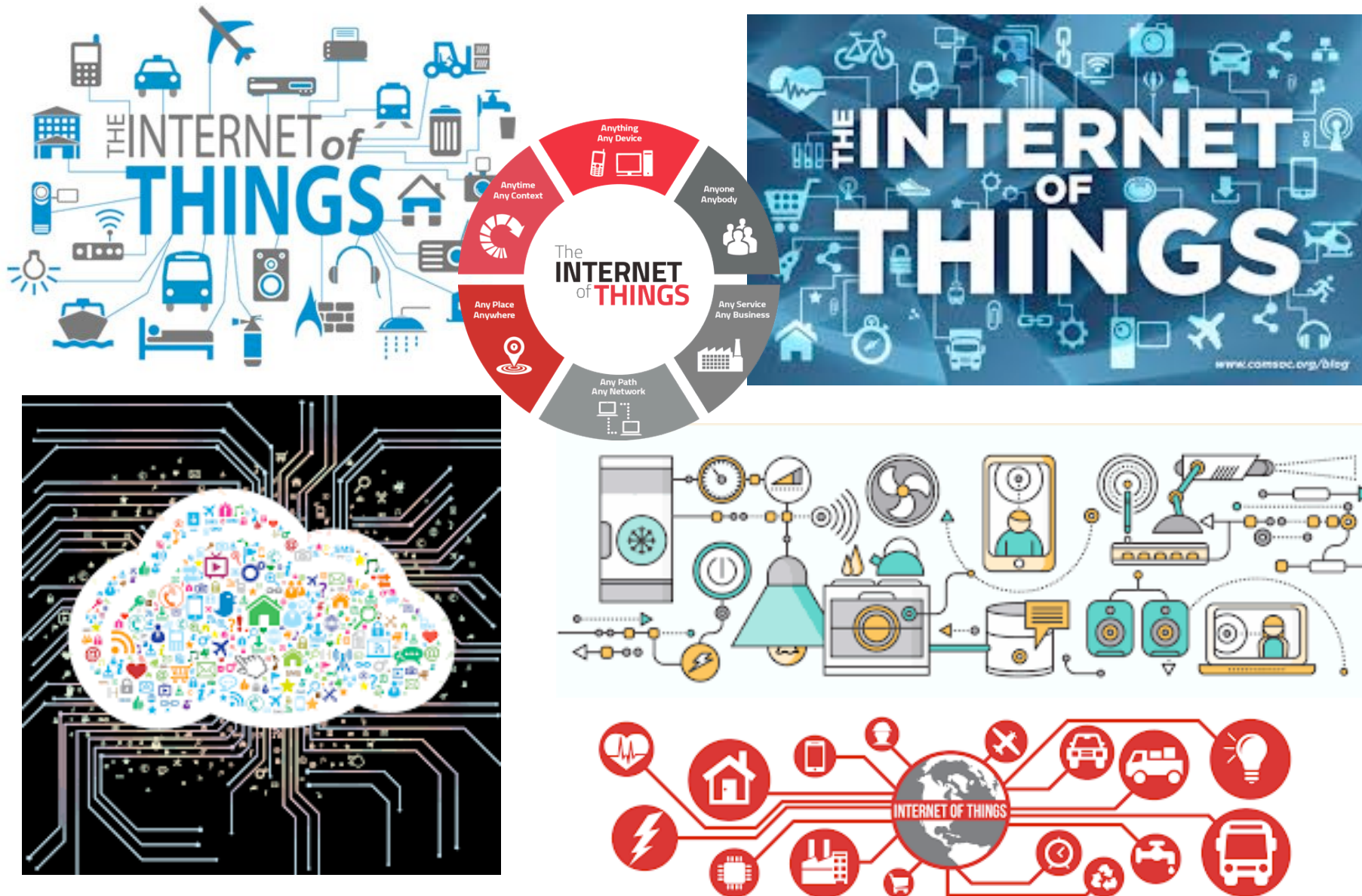


PROF. CONGDUC PHAM
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)
UNIVERSITÉ DE PAU, FRANCE

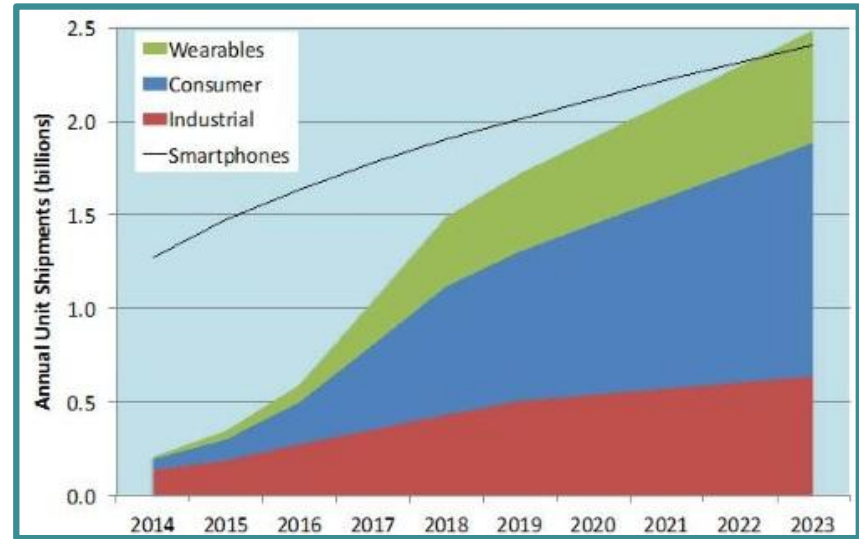
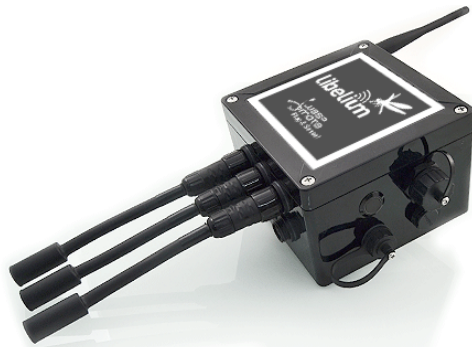
GOOGLING FOR « INTERNET OF THINGS »...



... TYPICALLY SHOWS COMMUNICATING OBJECTS



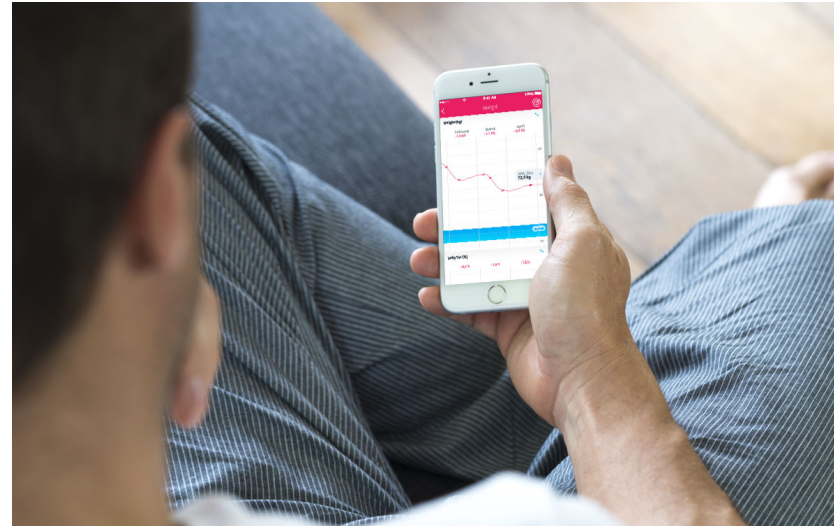
ONE OF THE MOST PROMISING MARKET IS IOT!



Waste Container connected sensor



HOME/CONSUMER IOT PRODUCTS

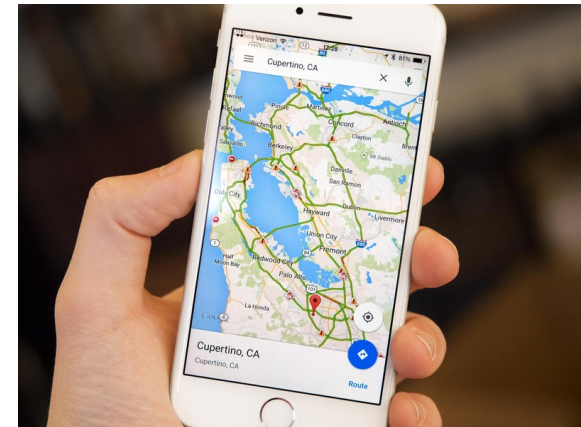


Pictures from WiThing, <https://www.withings.com/eu/fr/products/body>

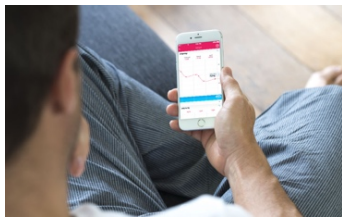
IoT & PHYSICAL WORLD



Waste Container connected sensor



LOCAL INTERACTION IS POSSIBLE

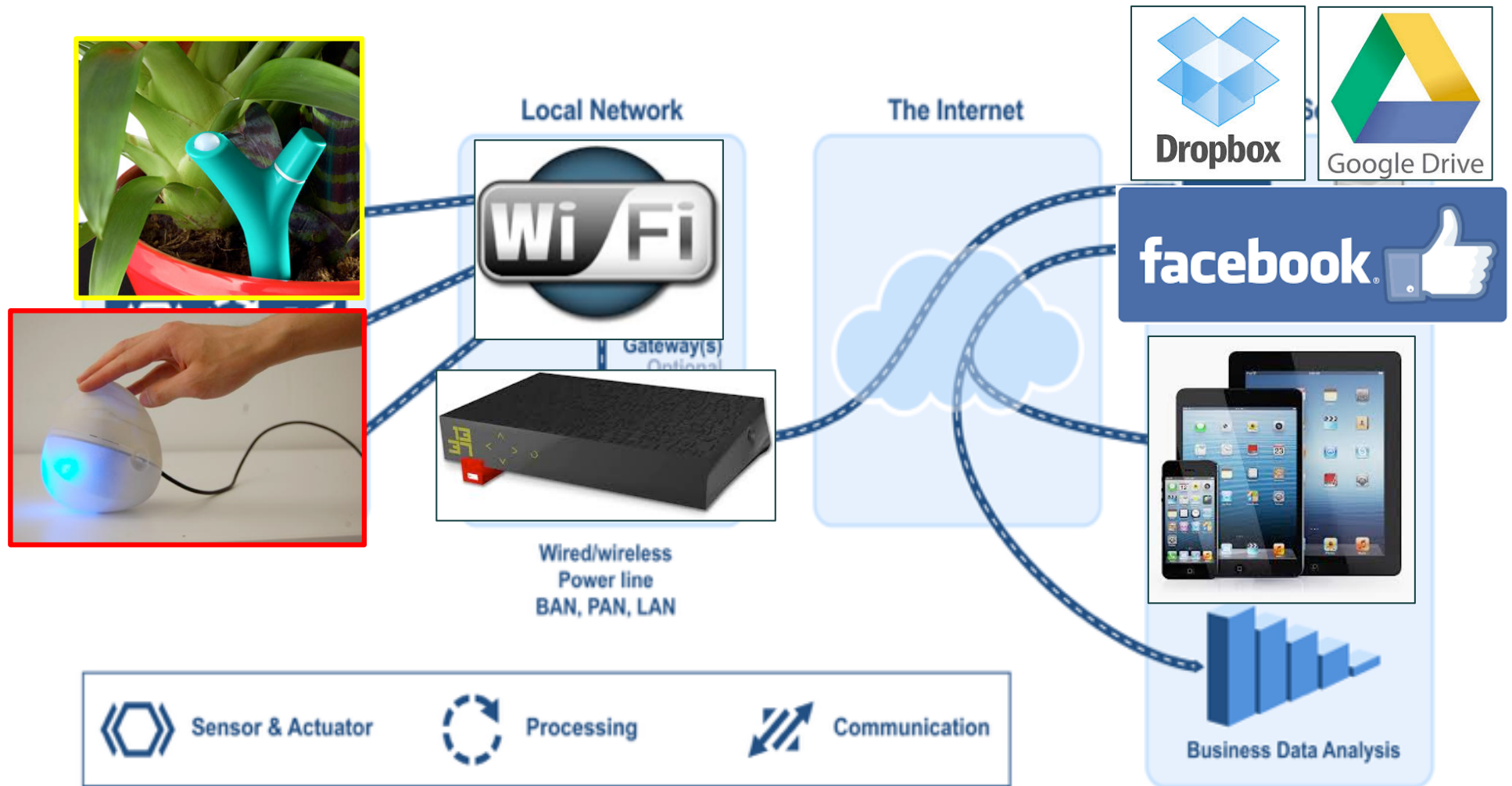


BUT IOT USUALLY MEANS CLOUD DATA

Lot's of data !



GENERAL PUBLIC IOT ARCHITECTURE



Pictures from ArchitectCorner

DEDICATED IOT CLOUD



USING ThingSpeak



ThingSpeak Channels Apps Blog Support

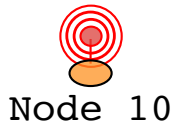
User: cpham

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

Date	value
09:34	19.5
09:35	20.5
09:36	19.8
09:37	19.6
09:38	19.4

Field 2 Chart

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

Field 3 Chart

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

Field 4 Chart

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

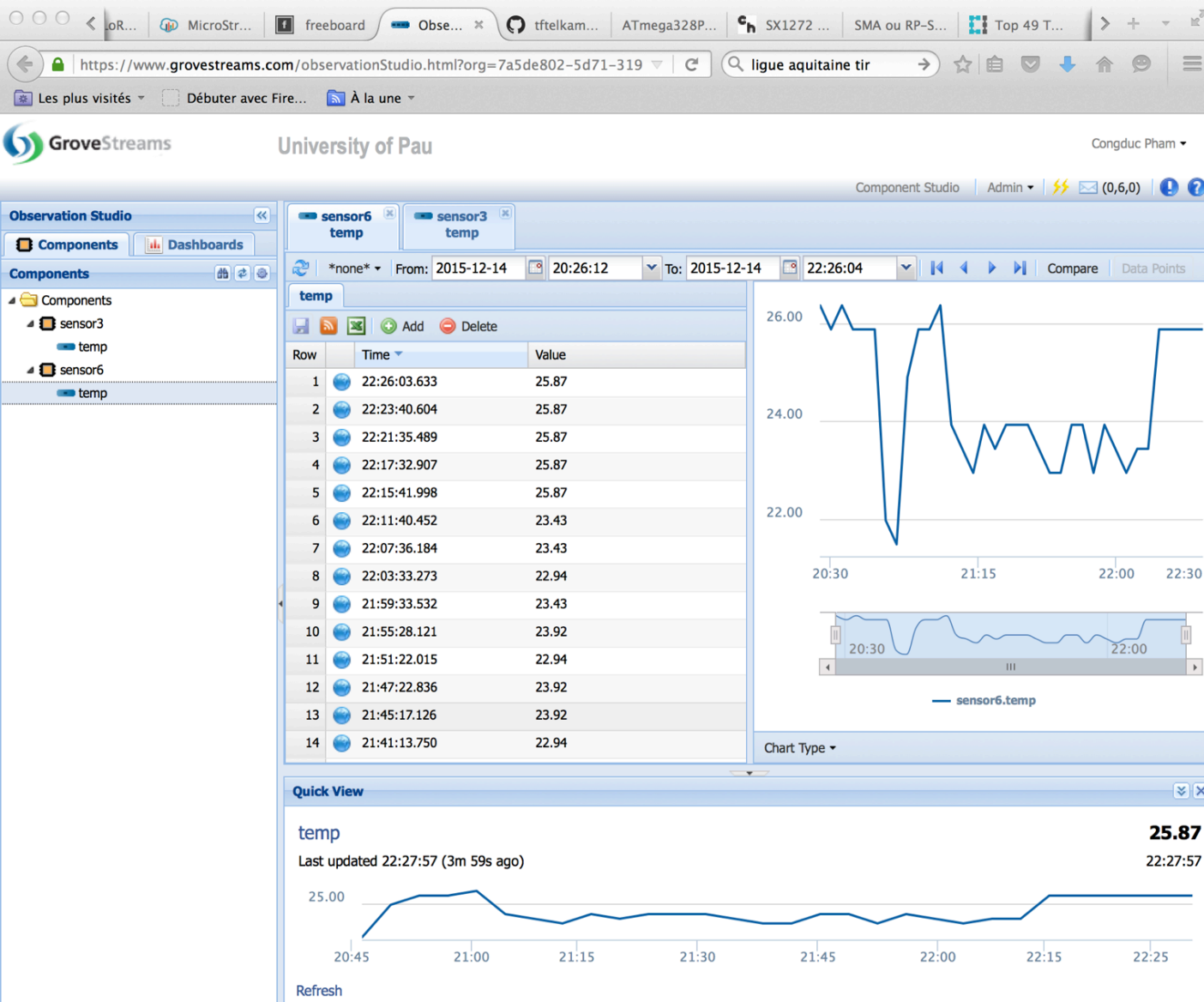
Field 5 Chart

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

Field 6 Chart

Date	RSSI
09:34	-52.5
09:35	-47.5
09:36	-52.5
09:37	-53.5
09:38	-54.5

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 components: "sensor6 temp" and "sensor3 temp". The "sensor6 temp" component is selected, displaying a table of data points and a corresponding line chart.

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

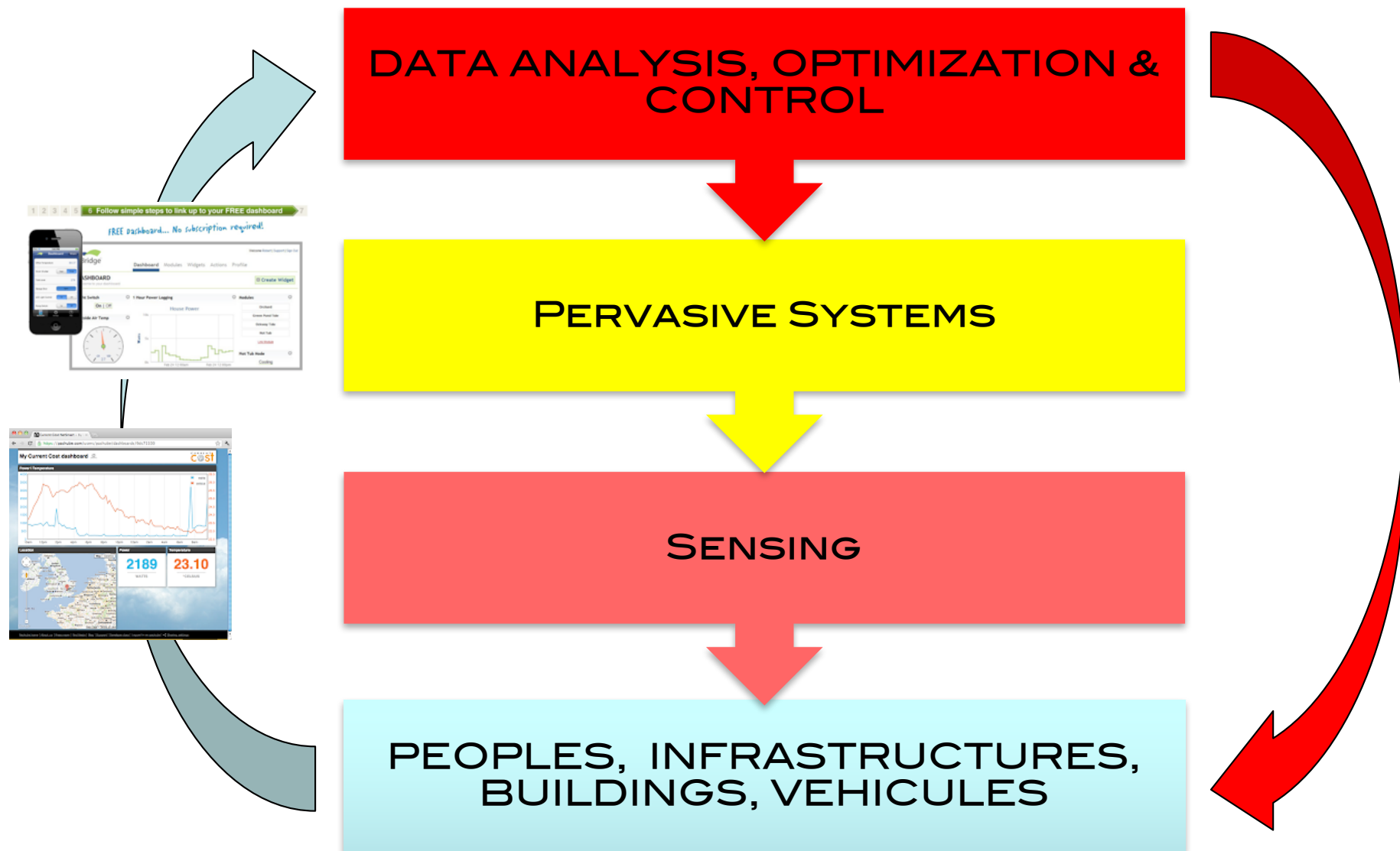
The chart on the right shows the temperature trend over time, with a zoomed-in view of the data points from 20:30 to 22:30. The current value is 25.87, last updated at 22:27:57 (3m 59s ago).

temp **25.87**
Last updated 22:27:57 (3m 59s ago) 22:27:57

25.00
20:45 21:00 21:15 21:30 21:45 22:00 22:15 22:25

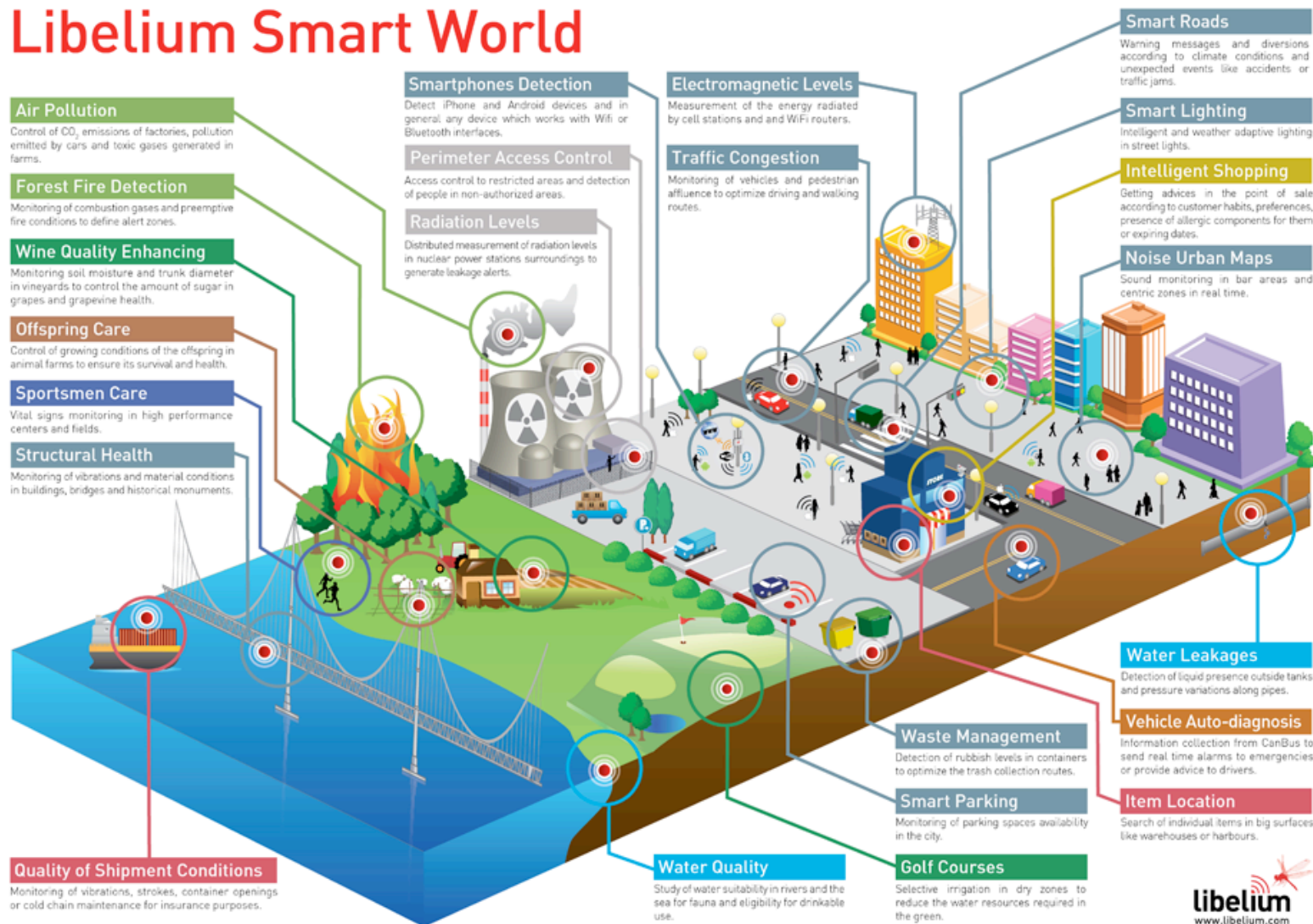
Refresh

CONTROL, OPTIMIZE & INSTRUMENT !



EXAMPLE 1: SMART CITIES

Libelium Smart World



SMARTSANTANDER

WWW.SMARTSANTANDER.EU

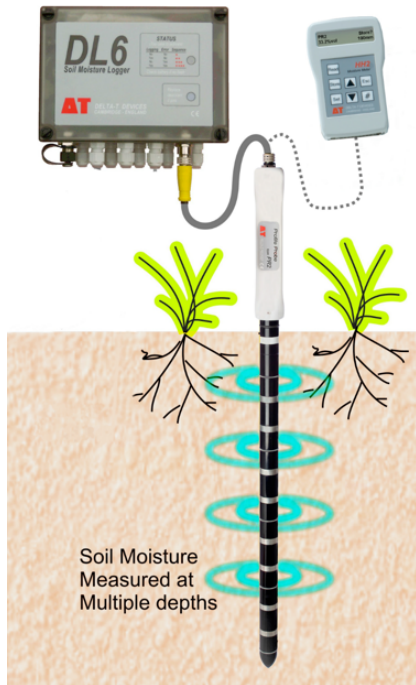
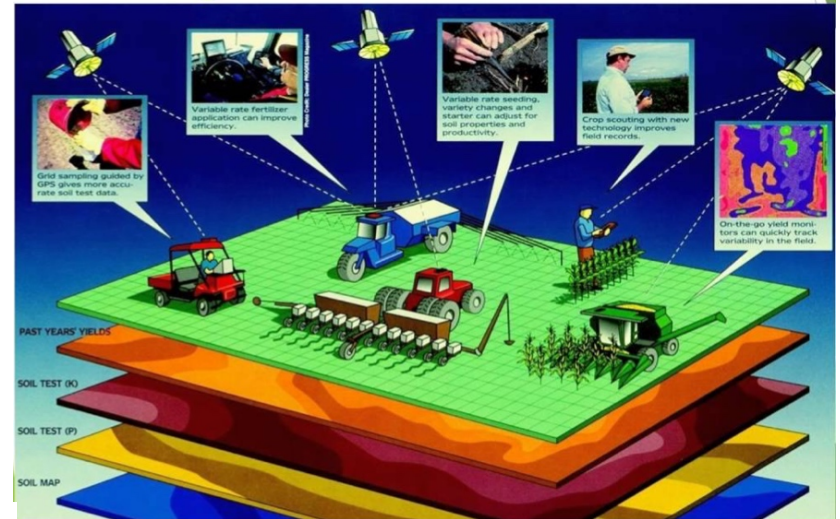


PICTURES ARE TAKEN IN THE CONTEXT OF THE EAR-IT PROJECT

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!

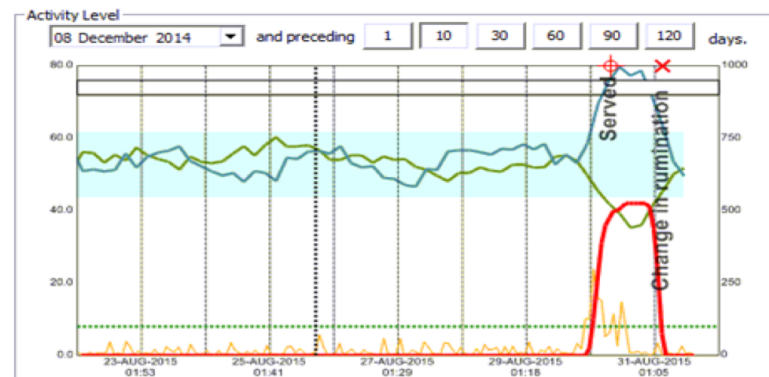
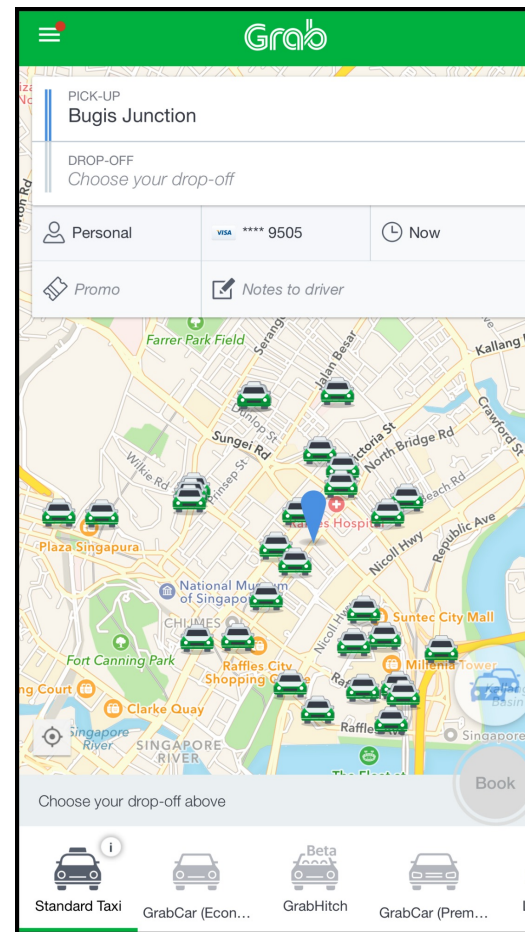


Fig. 3. Illustration of a rise in activity accompanied by a fall in rumination at the point of oestrus

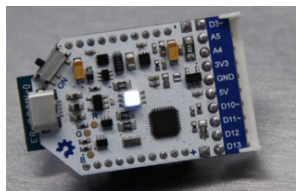
CHALLENGE 2: PROVIDE THE RIGHT SYSTEM!

- 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!



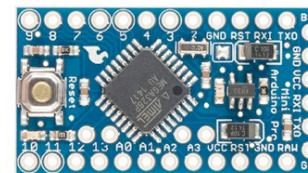
Theairboard



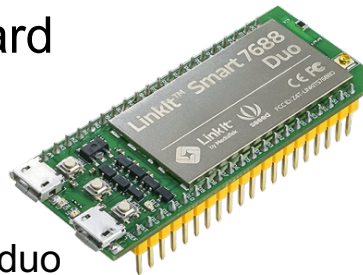
LoPy



Expressif ESP32



Arduino Pro Mini



LinkIt Smart7688 duo



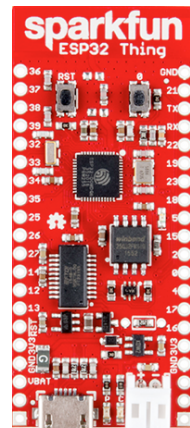
Teensy 3.2



STM32 Nucleo-32



Adafruit Feather



Sparkfun ESP32 Thing



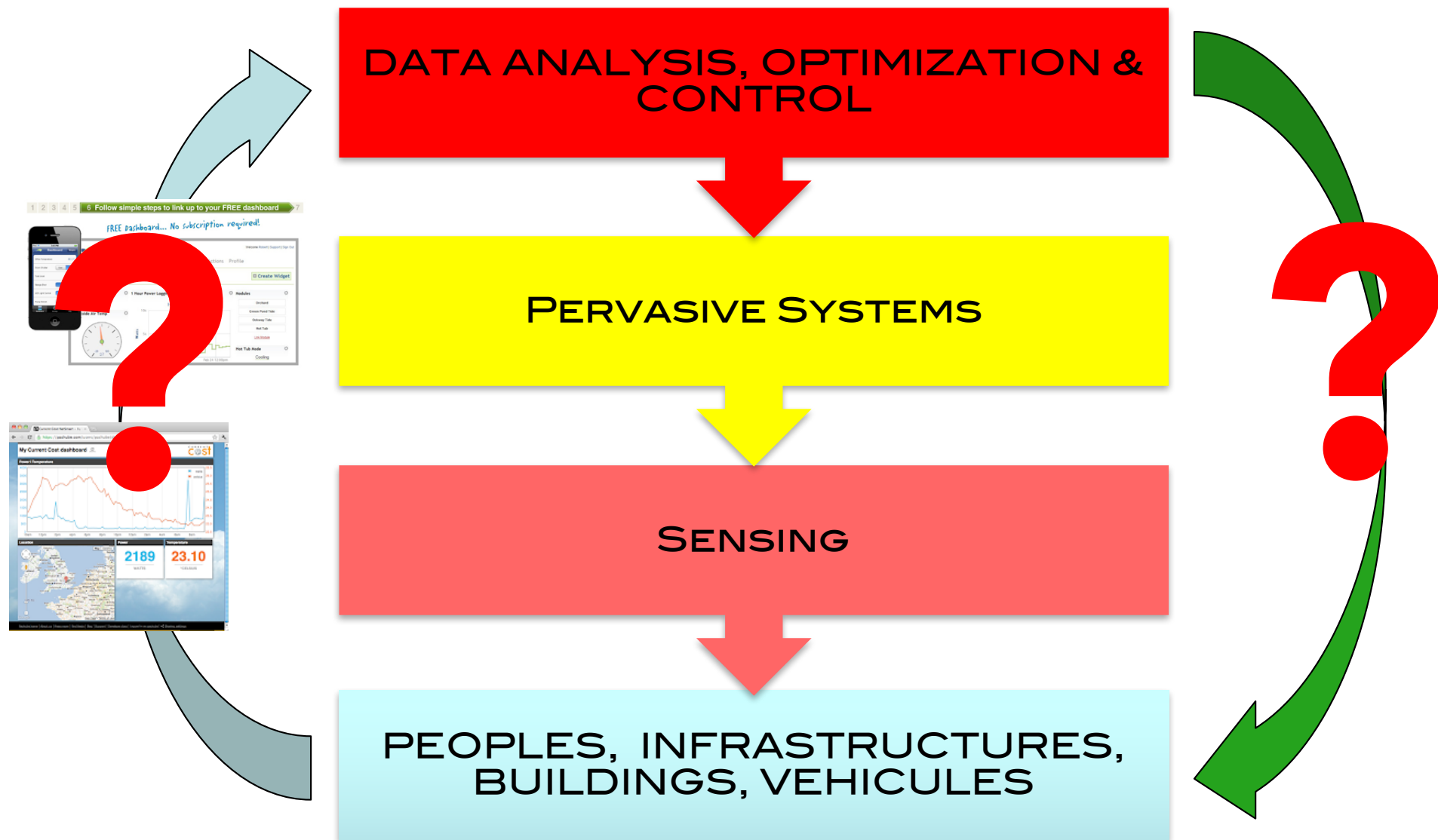
Tessel

SodaqOnev2



Tinyduino

2ND ISSUE: COLLECT DATA

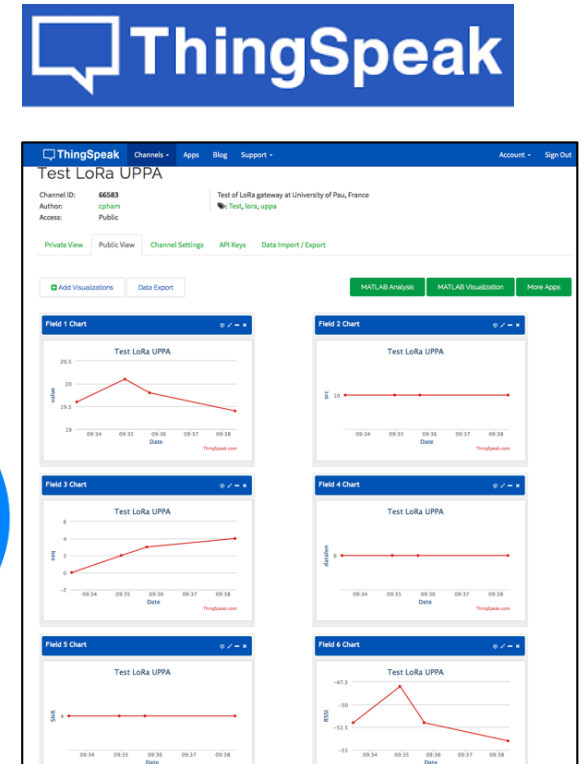
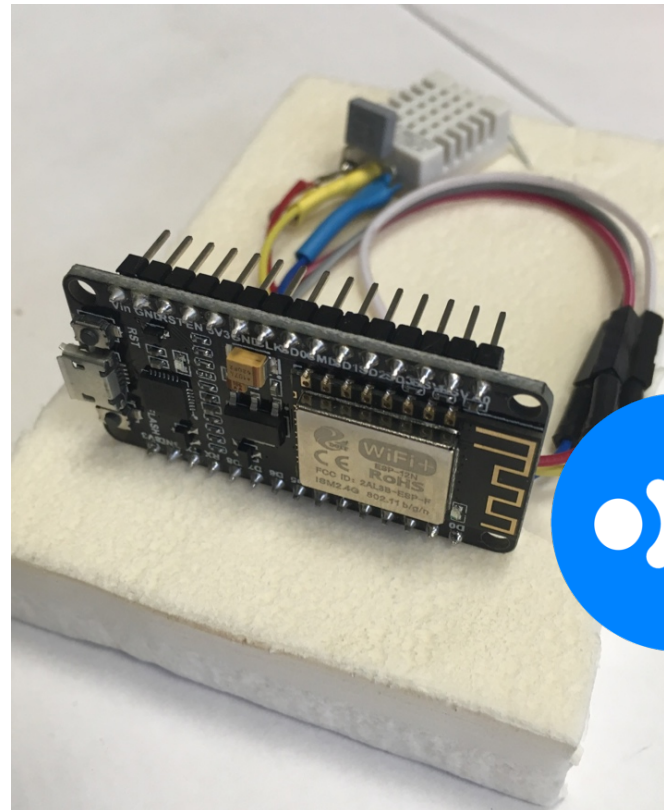
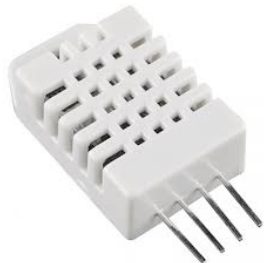
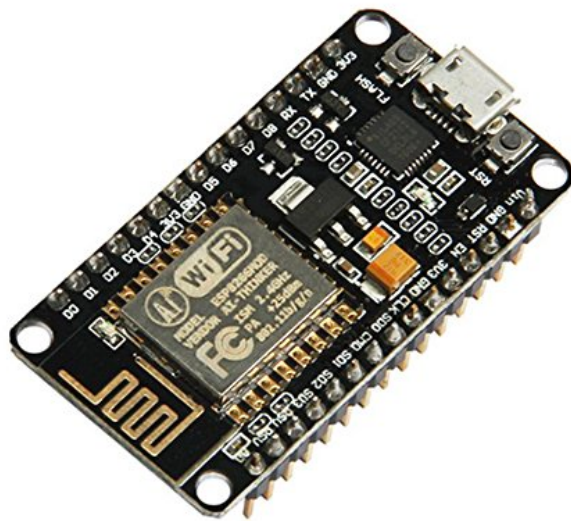


WIRELESS COMMUNICATION MADE EASY



EXAMPLE & DEMO

- ESP8266 (WiFi) and DHT22 sensor (temp, hum)

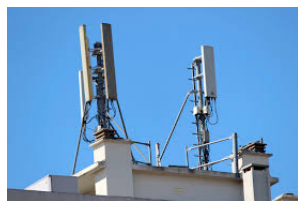
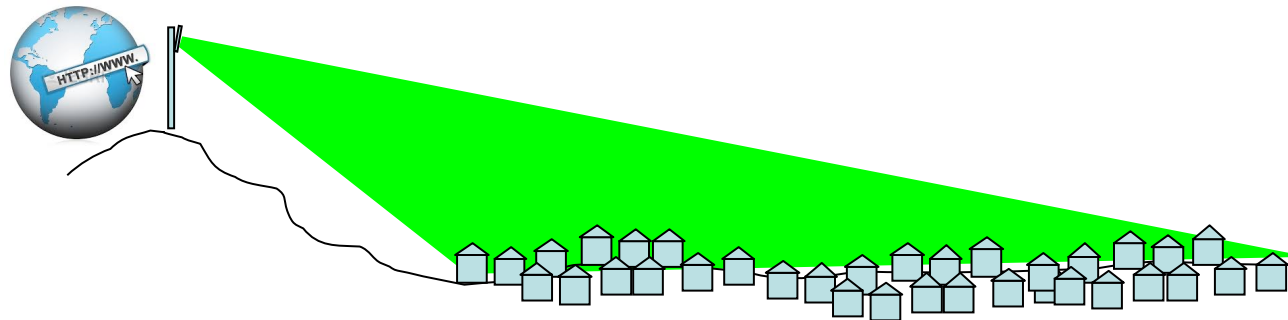


IoT=WIRELESS+BATTERY



TELEMETRY AND TRANSMISSION COST

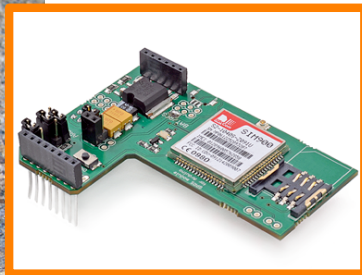
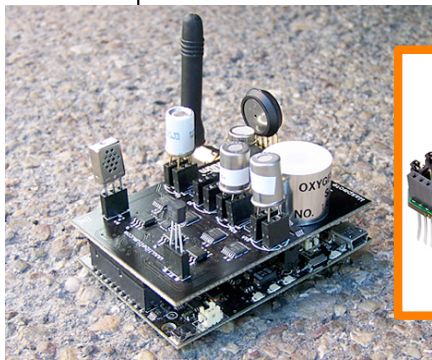
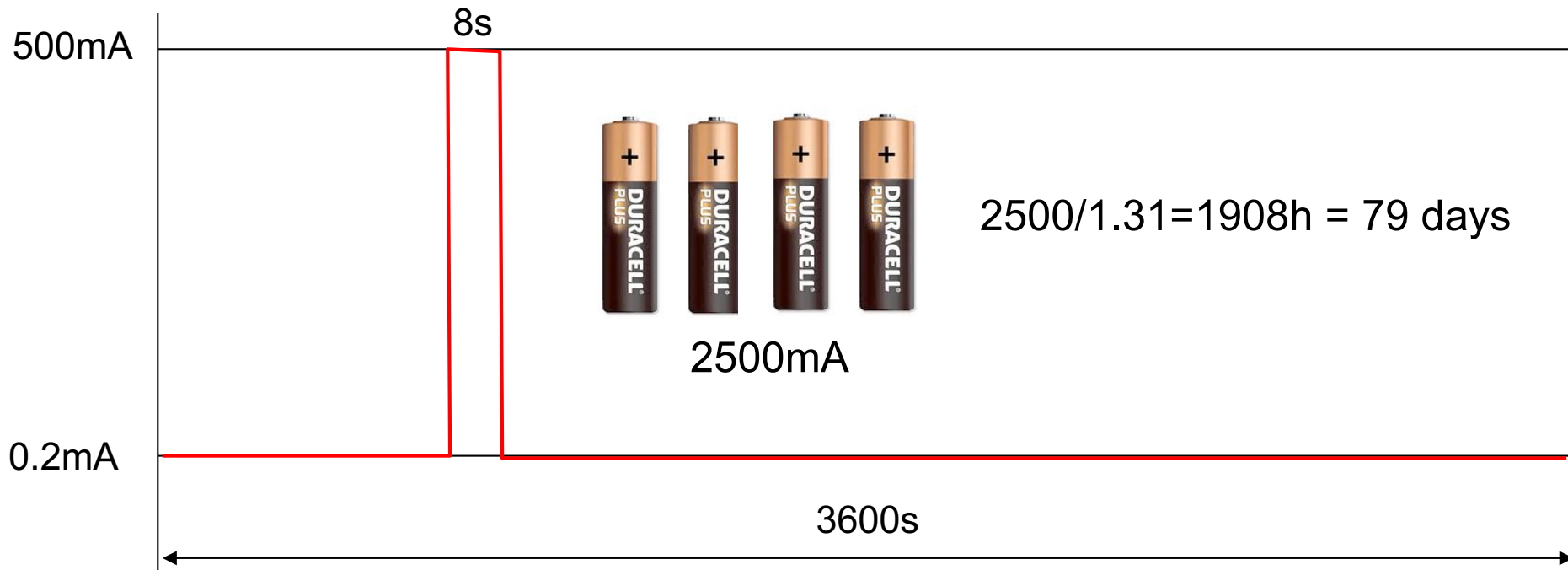
Moisture/
Temperature of
storage areas



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

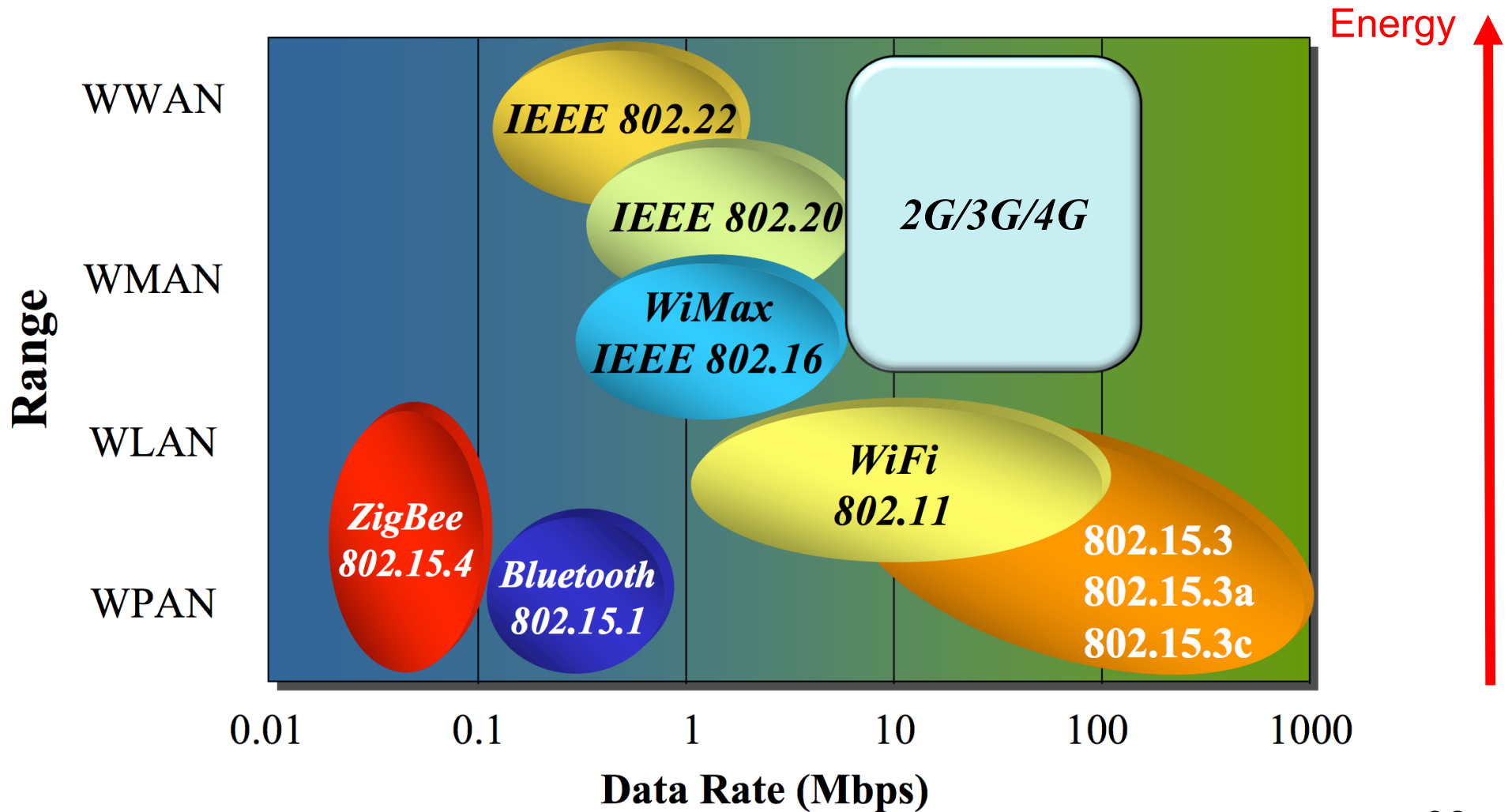
TX power: 500mA. Mean consumption: $(8 \times 500 + 3592 \times 0.2) / 3600 = 1.31 \text{mA}$



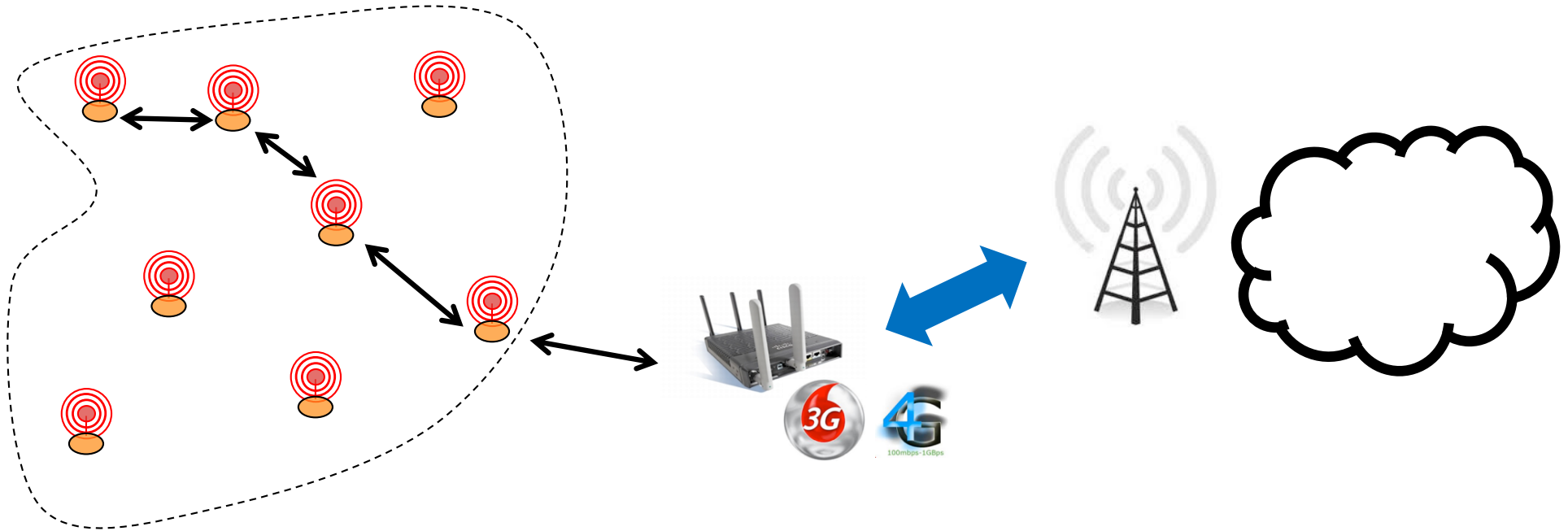
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC

THE WIRELESS SPACE

Energy-Range dilemma



LOWER ENERGY MEANS SHORTER RANGE!

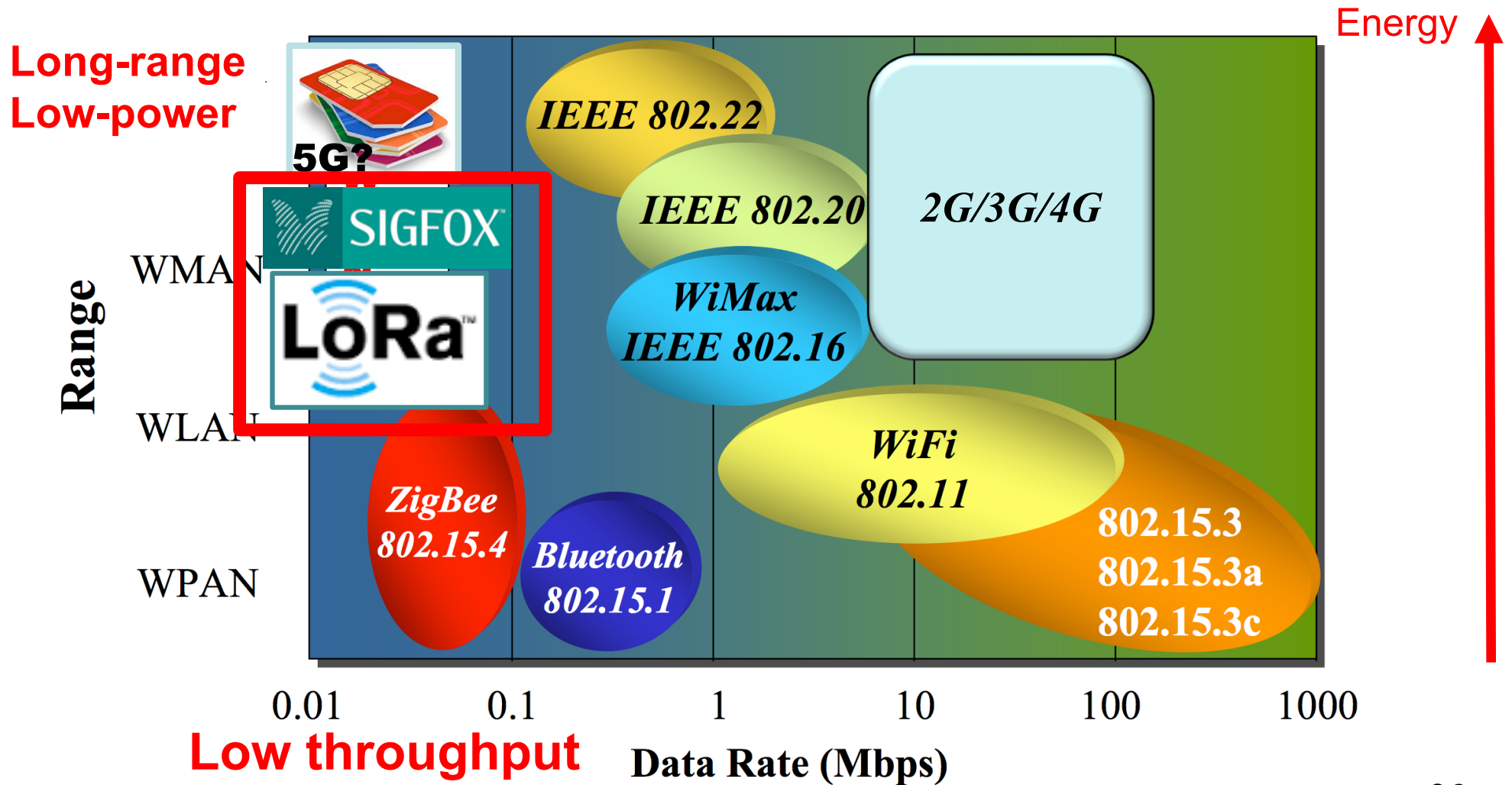


How bad is multi-hop routing?

- 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

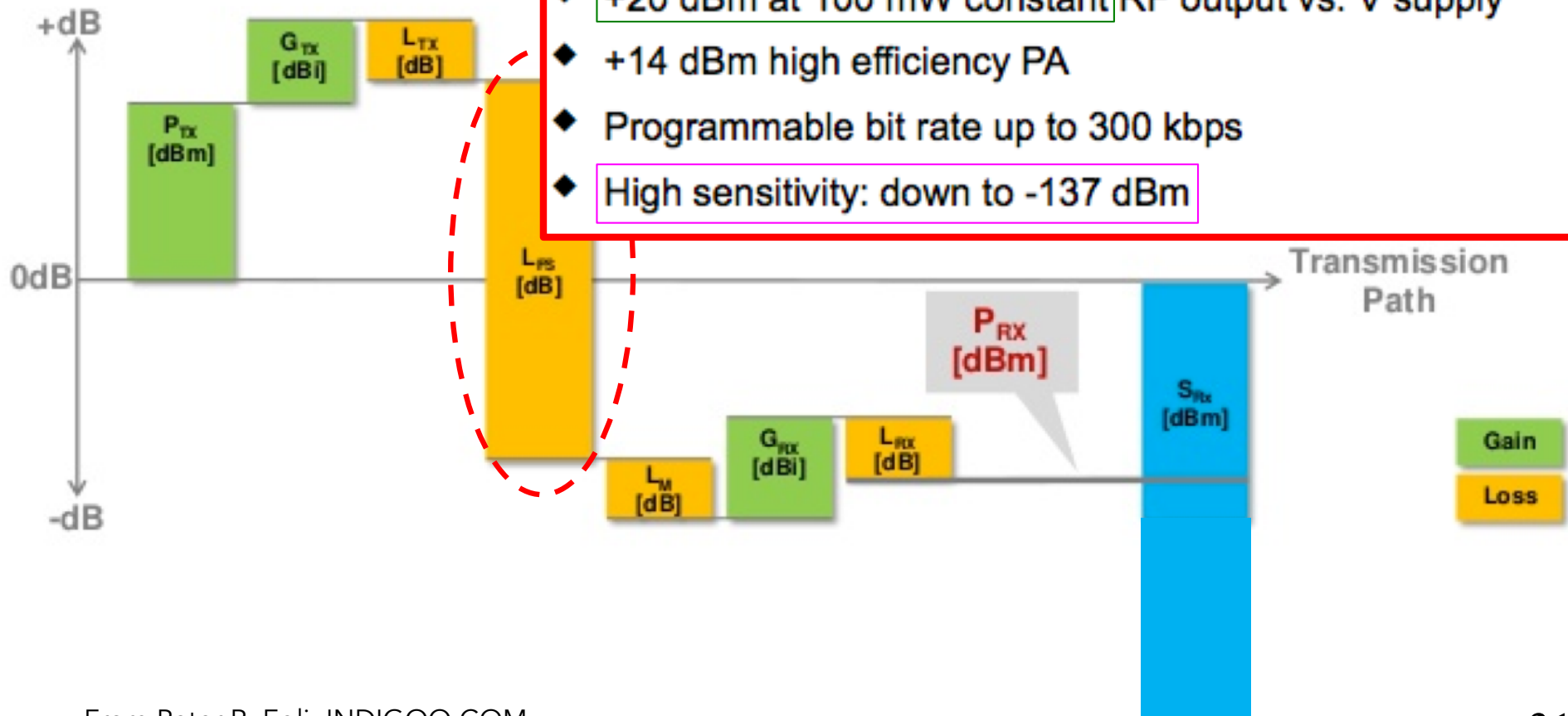


LINK BUDGET OF LPWAN

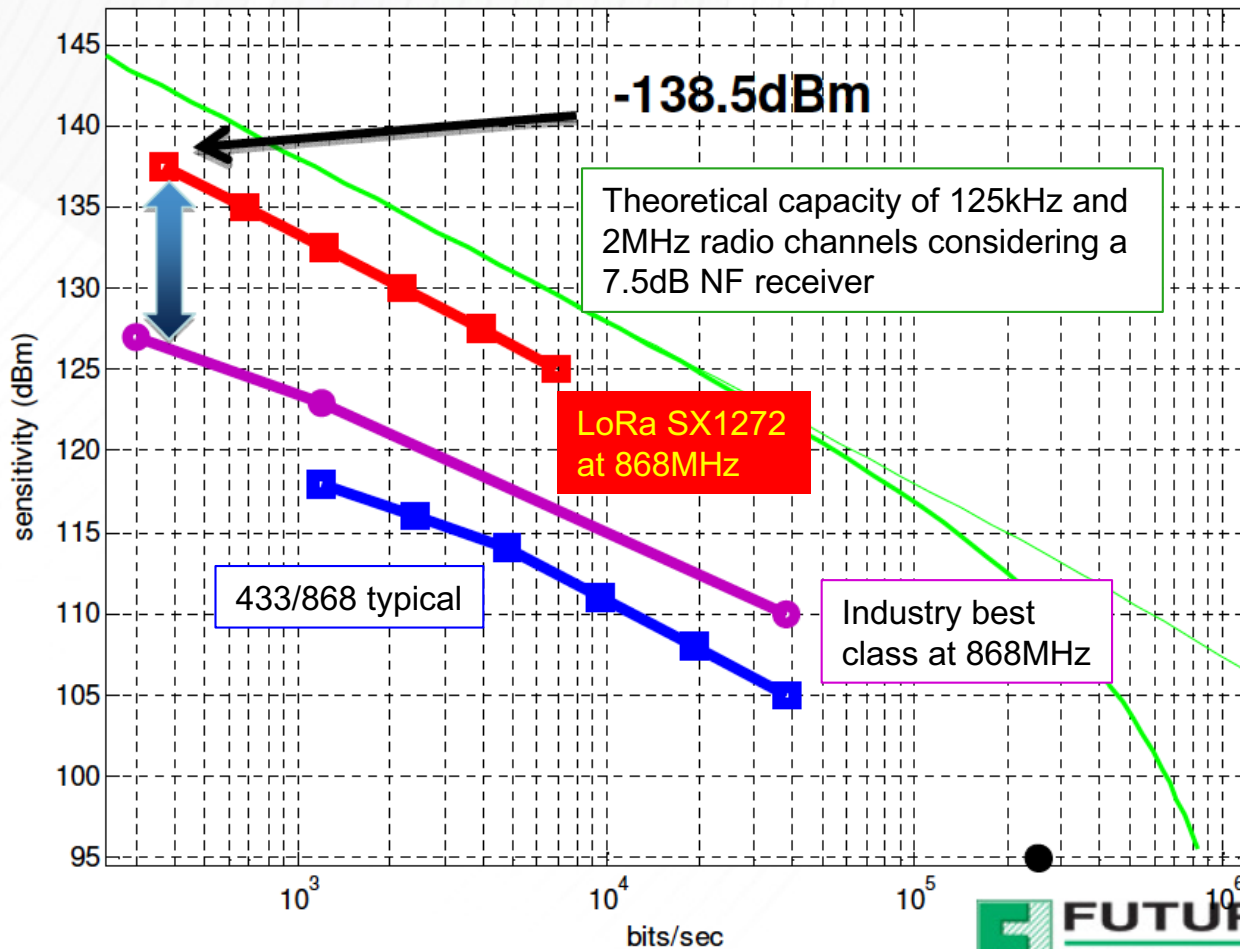
$$P_{RX} = P_{TX} + G_{TX} - L_{TX} - L_{PS} - L_M - G_{RX} - L_{RX} + S_{RX}$$

KEY PRODUCT FEATURES

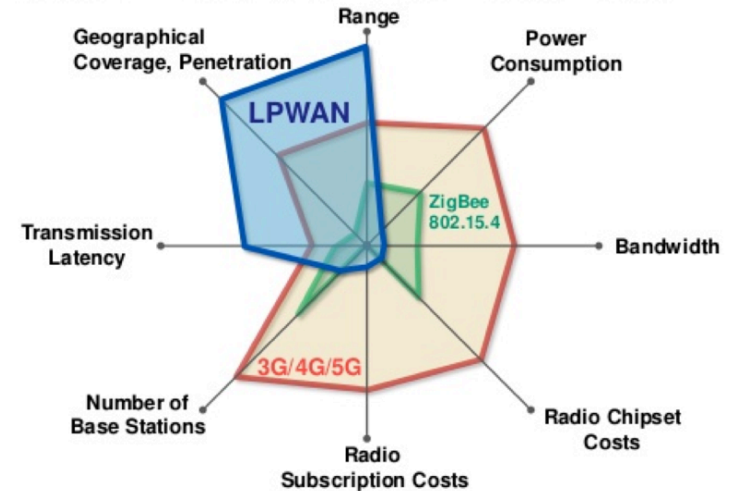
- ◆ LoRa™ Modem
- ◆ 157 dB maximum link budget
- ◆ +20 dBm at 100 mW constant RF output vs. V supply
- ◆ +14 dBm high efficiency PA
- ◆ Programmable bit rate up to 300 kbps
- ◆ High sensitivity: down to -137 dBm



THE LONG-RANGE REVOLUTION



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



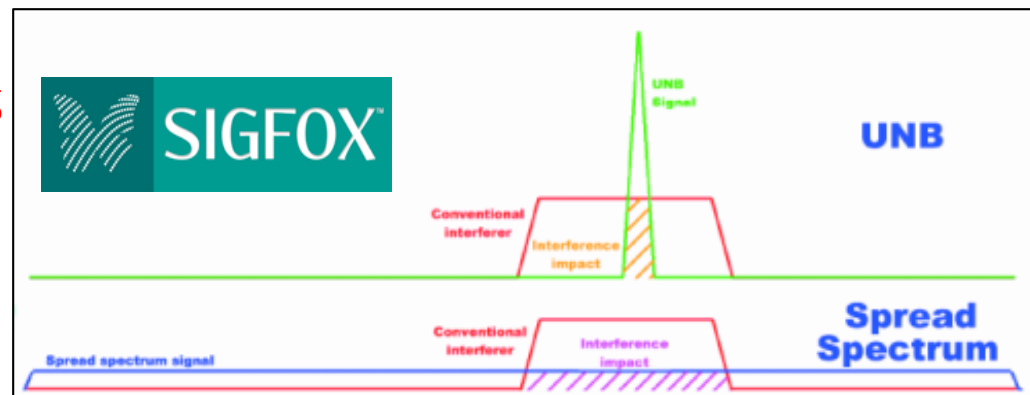
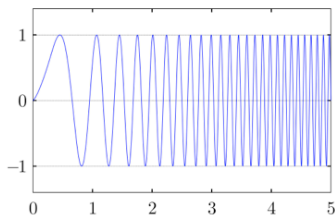
From Peter R. Egli, INDIGOO.COM

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

INCREASING RANGE?

- Generally, robustness and sensitivity can be increased when transmitting (much) slower
- A [Sigfox message is sent relatively slowly in a very narrow band of spectrum (hence ultra-narrow-band) using Gaussian Frequency-Shift Keying modulation]. **Max throughput= $\sim 100\text{bps}$**
- LoRa also increases time-on-air when maximum range is needed. But LoRa uses spread spectrum instead of UNB.

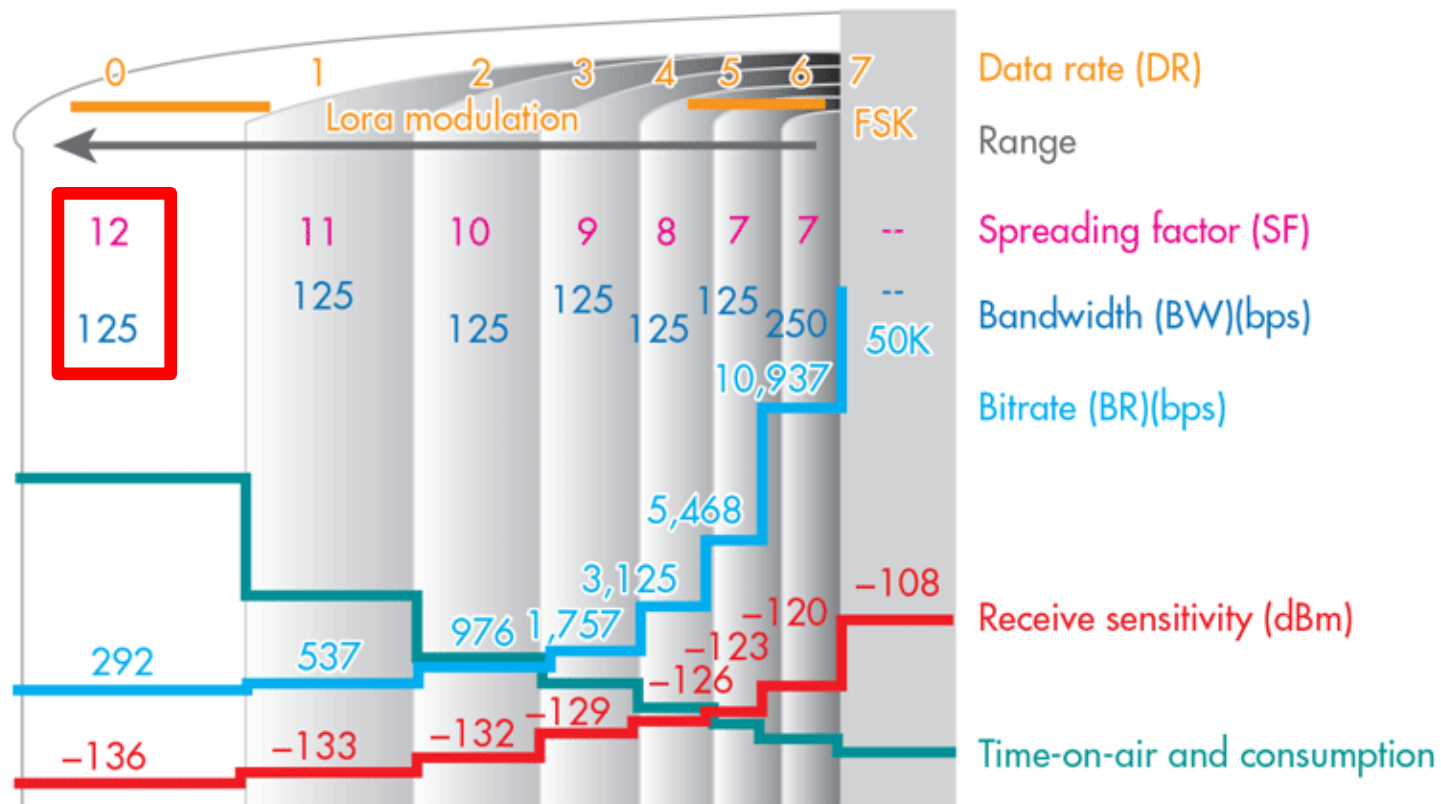
300bps-37.5kbps



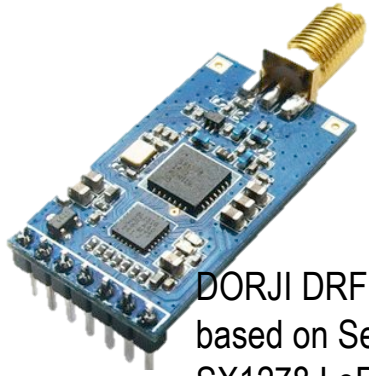
MAIN LORA PARAMETERS

□ Main parameters

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



LoRa Modules from Semtech's SX127x Chips



DORJI DRF1278DM is based on Semtech SX1278 LoRa 433MHz



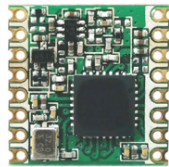
Libelium LoRa is based on Semtech SX1272 LoRa 863-870 MHz for Europe



inAir9 based on SX1276



Froggy Factory LoRa module (Arduino)



HopeRF RFM series



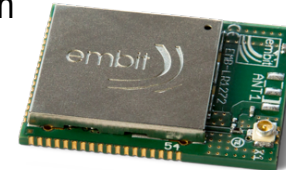
HopeRF HM-TRLR-D



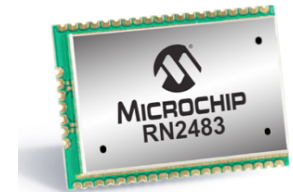
LinkLabs Symphony module



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



Embit LoRa

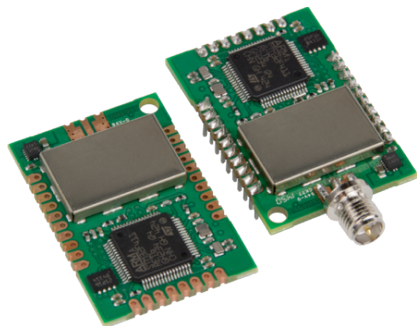


LoRa™ Long-Range Sub-GHz Module (Part # RN2483)

Microship RN2483



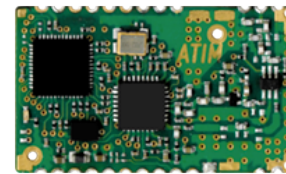
Adeunis ARF8030AA- Lo868



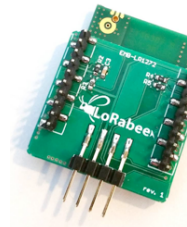
Multi-Tech MultiConnect mDot



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: $(8 \times 30 + 3592 \times 0.2) / 3600 = 0.266 \text{mA}$

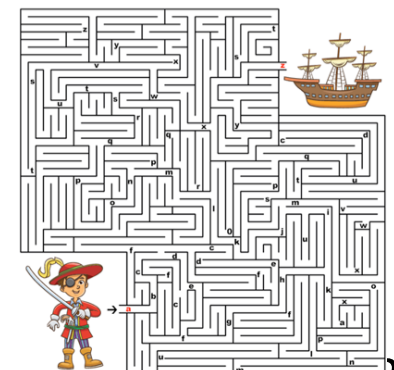
$2500 / 0.266 = 9398 \text{h} = 391 \text{ days} = 13 \text{ months}$

OTHER "LONG-RANGE" TECHNOLOGIES



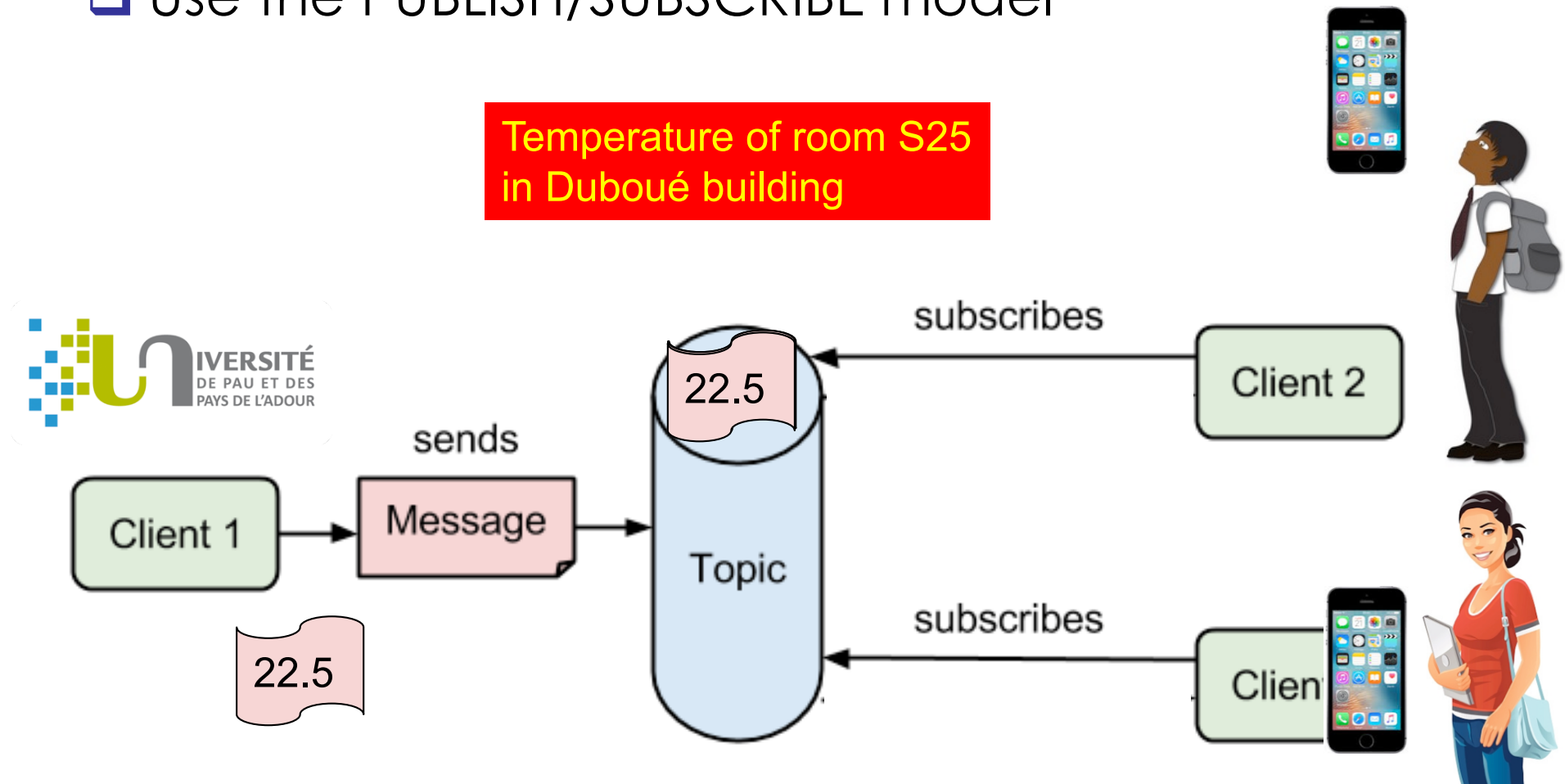
3RD ISSUE: FINDING THE INFORMATION YOU NEED

- ❑ 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"

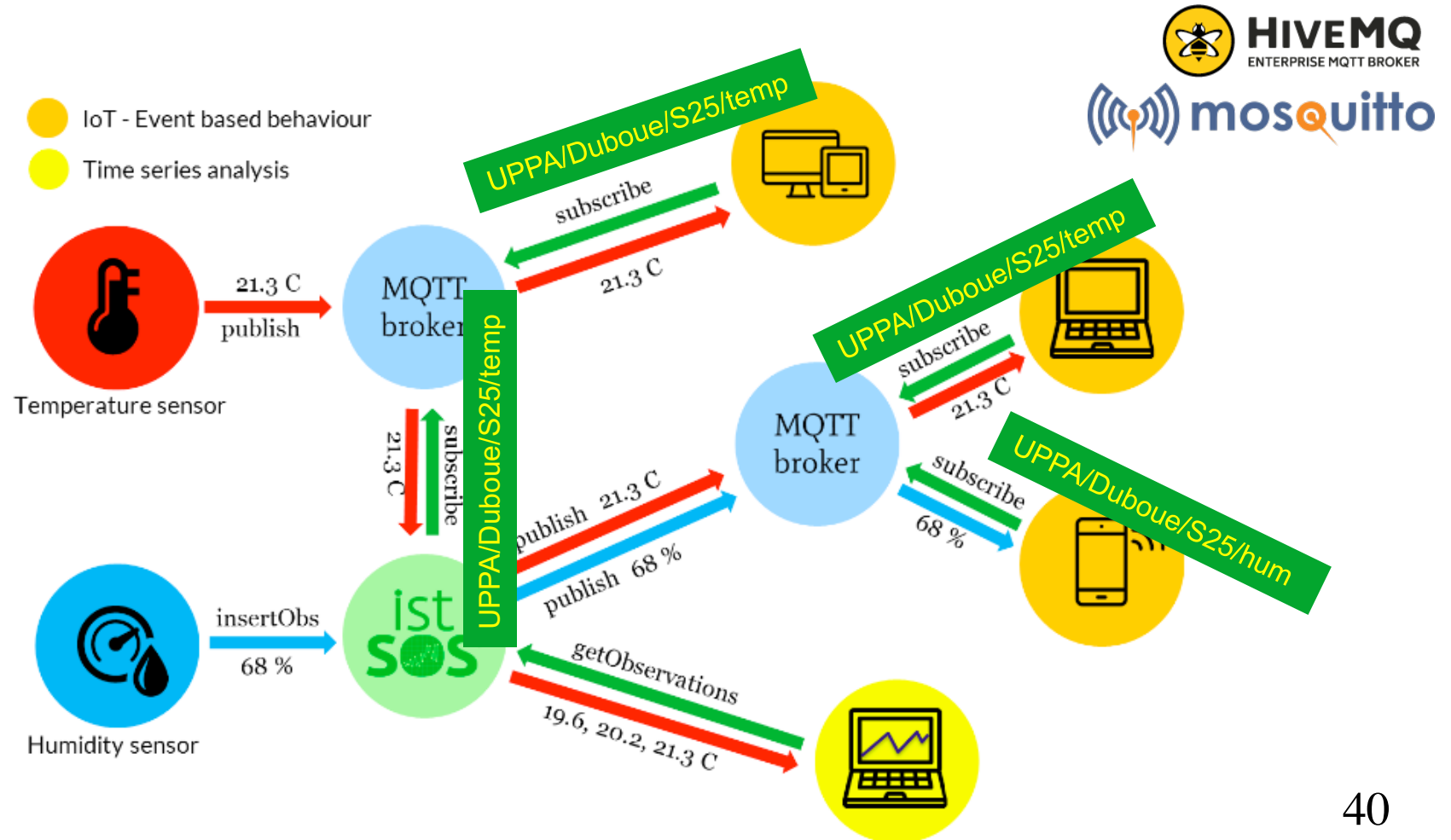
- Use the PUBLISH/SUBSCRIBE model



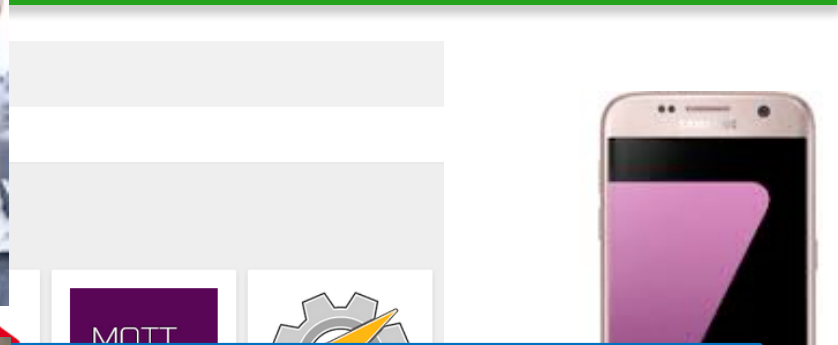
MQTT

MESSAGE QUEUE TELEMETRY TRANSPORT

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



MQTT+SMARTPHONE=



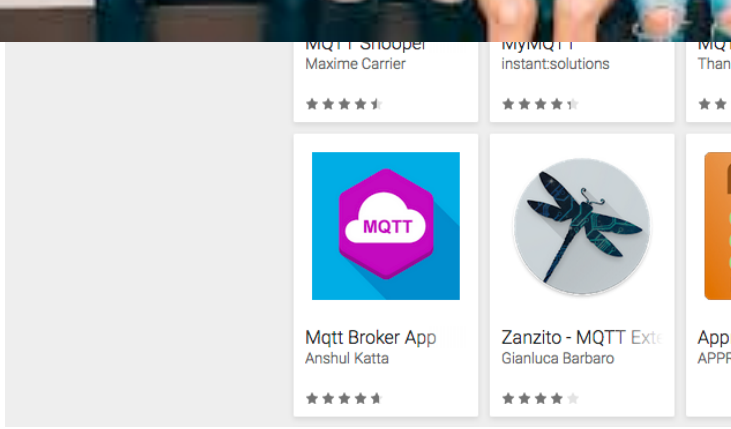
MQTT Dash (IoT, Smart Home)

Routix software Communication ★★★★★ 1,584

PEGI 3

This app is compatible with all of your devices.

Installed



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

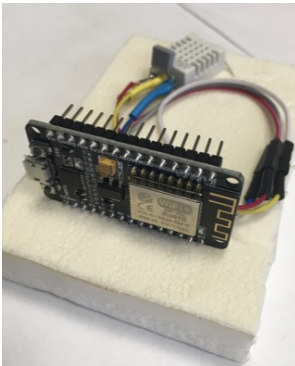
On 1 OFF 0

Other settings

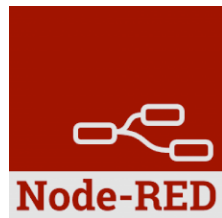
QoS(0) QoS(1) QoS(2)

Retained

4TH ISSUE: MAKE IT SIMPLER?

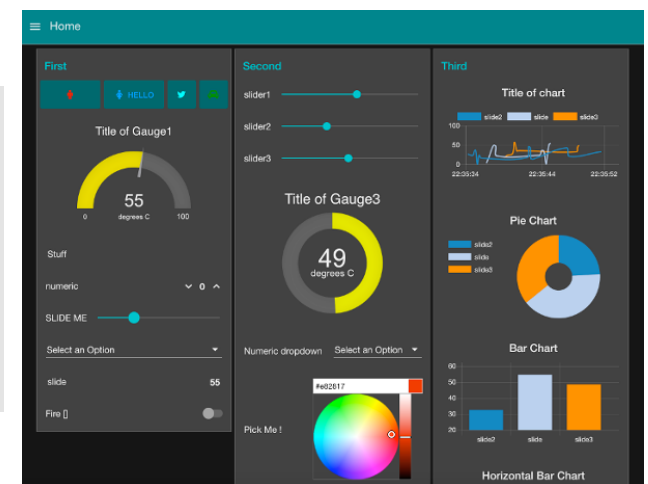
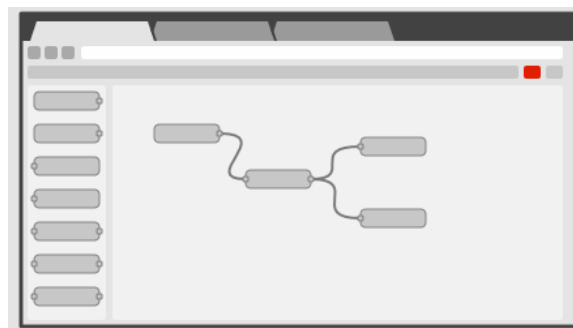


- ❑ End-users are not necessarily computer science experts nor high-skilled programmers
- ❑ Use graphical tools to build data processing flows, allowing intuitive connection from data producers to data consumers

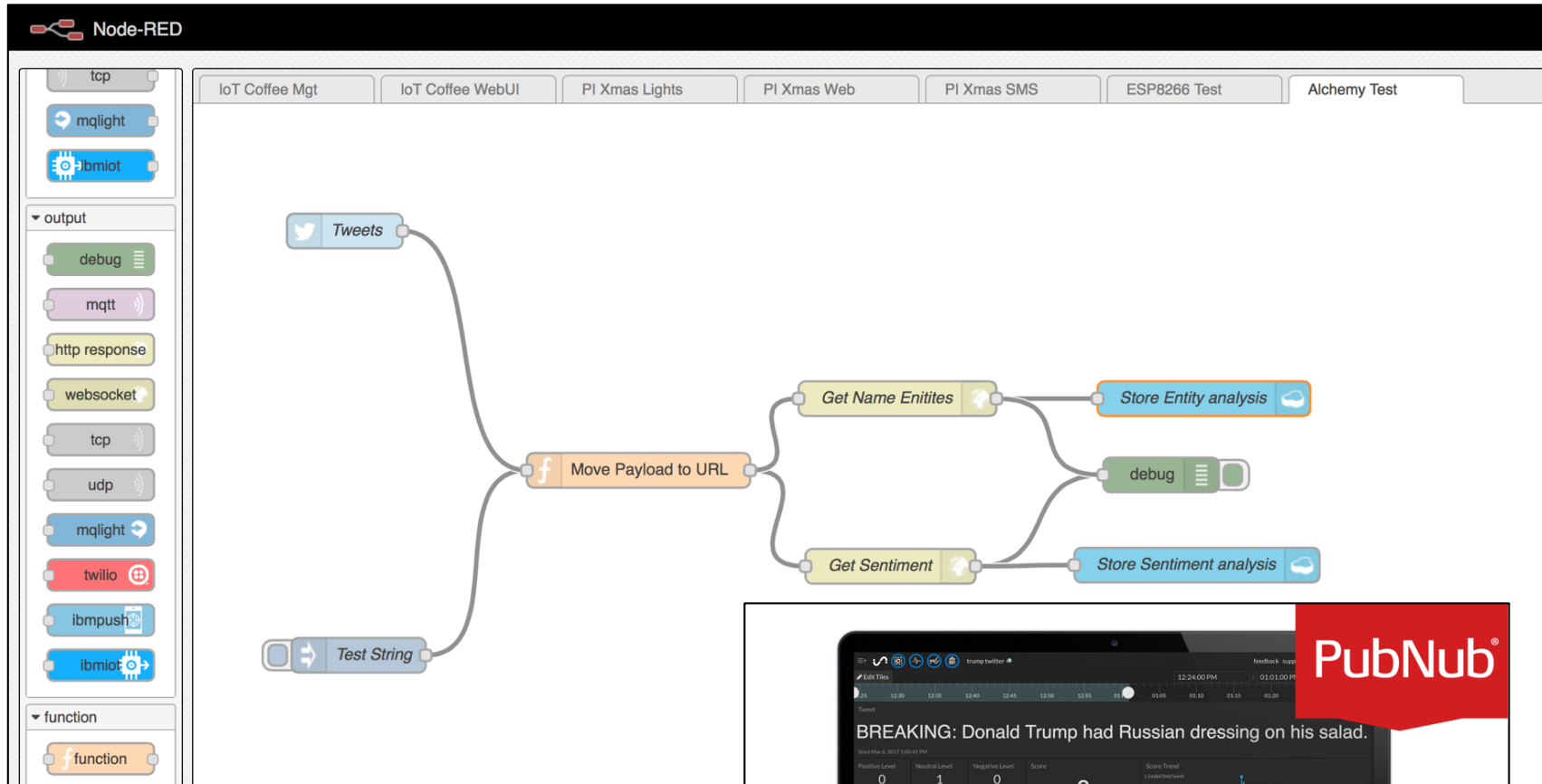


NODE-RED

- 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

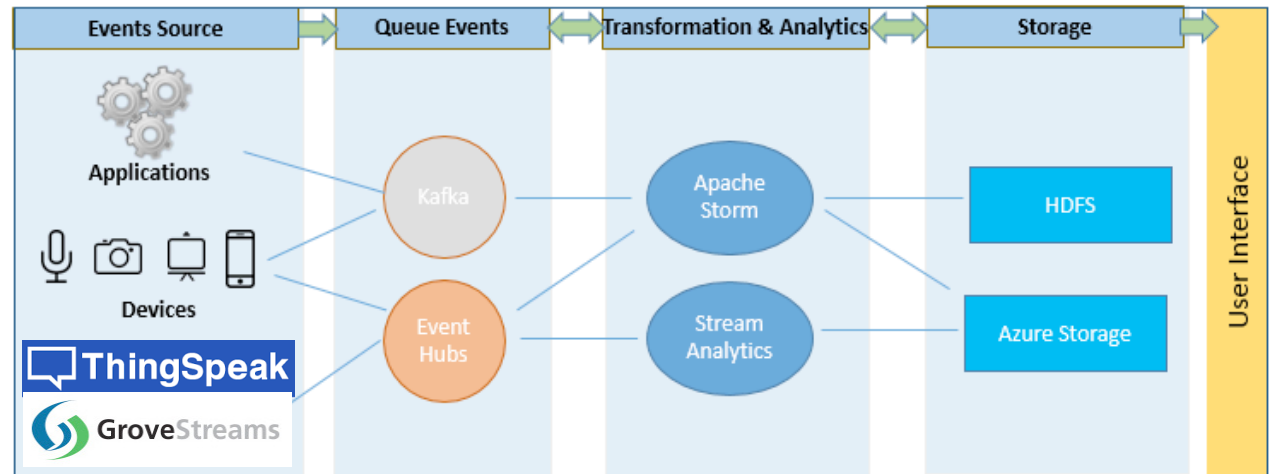


From PubNub Live Twitter Dashboard (feat. President Trump)

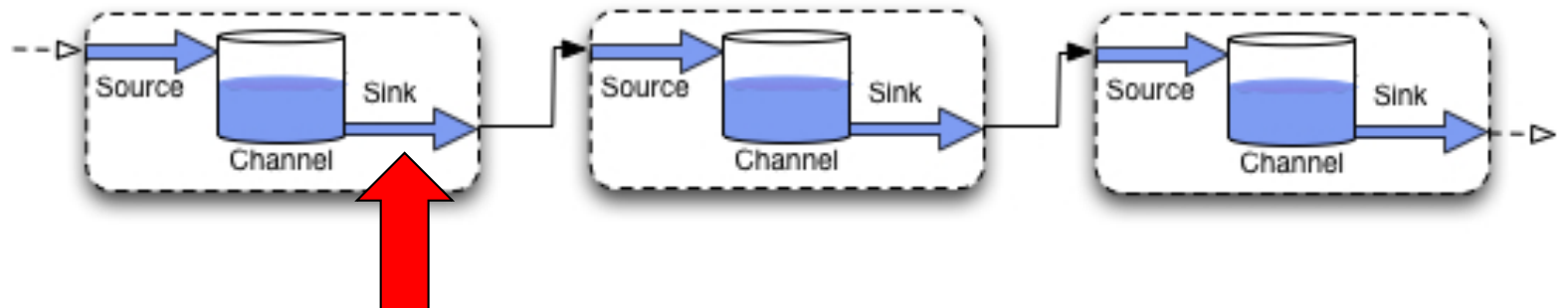
CONNECTING TO ADVANCED DATA MNGT/ANALYTIC PLATFORMS



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

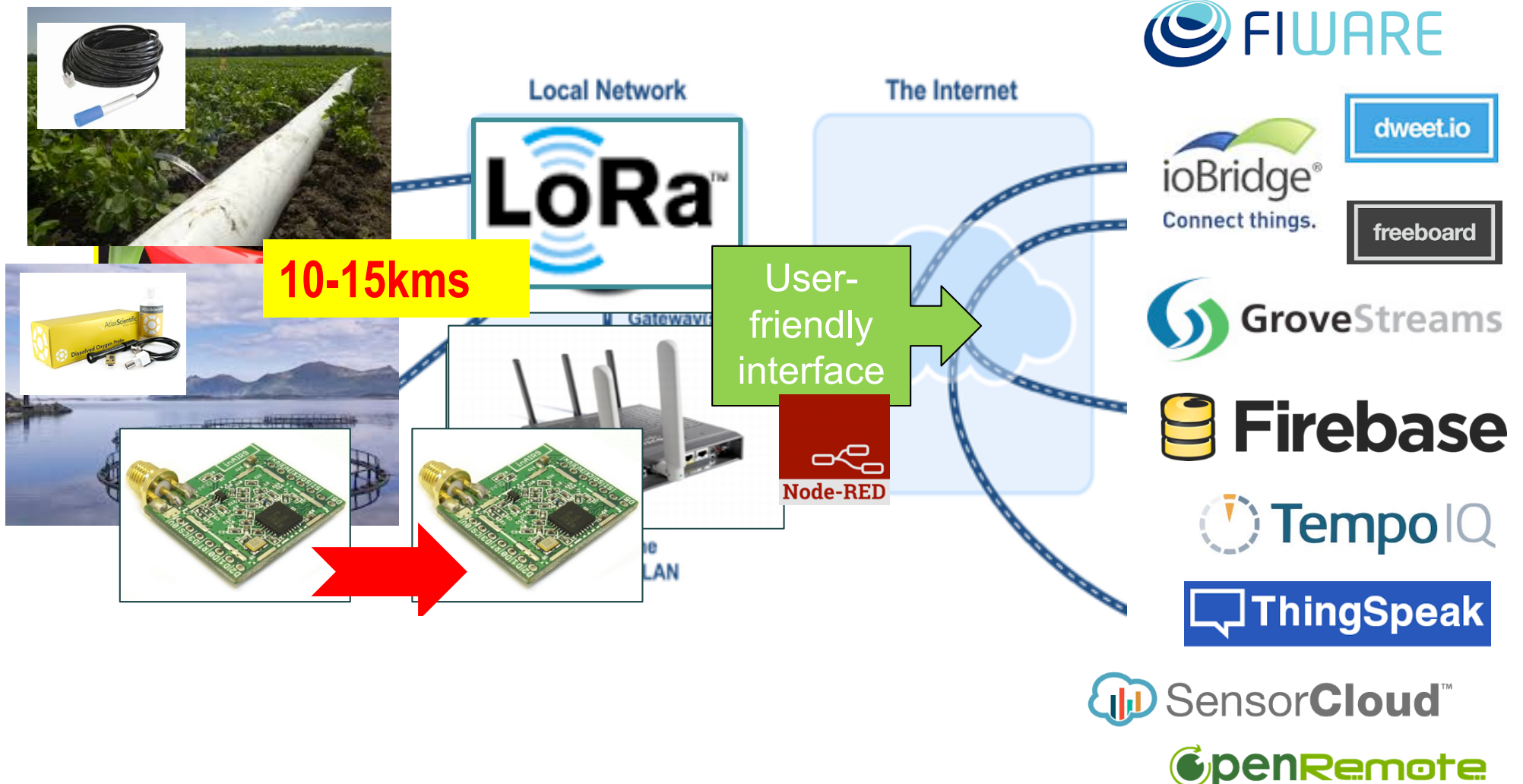


ThingSpeak

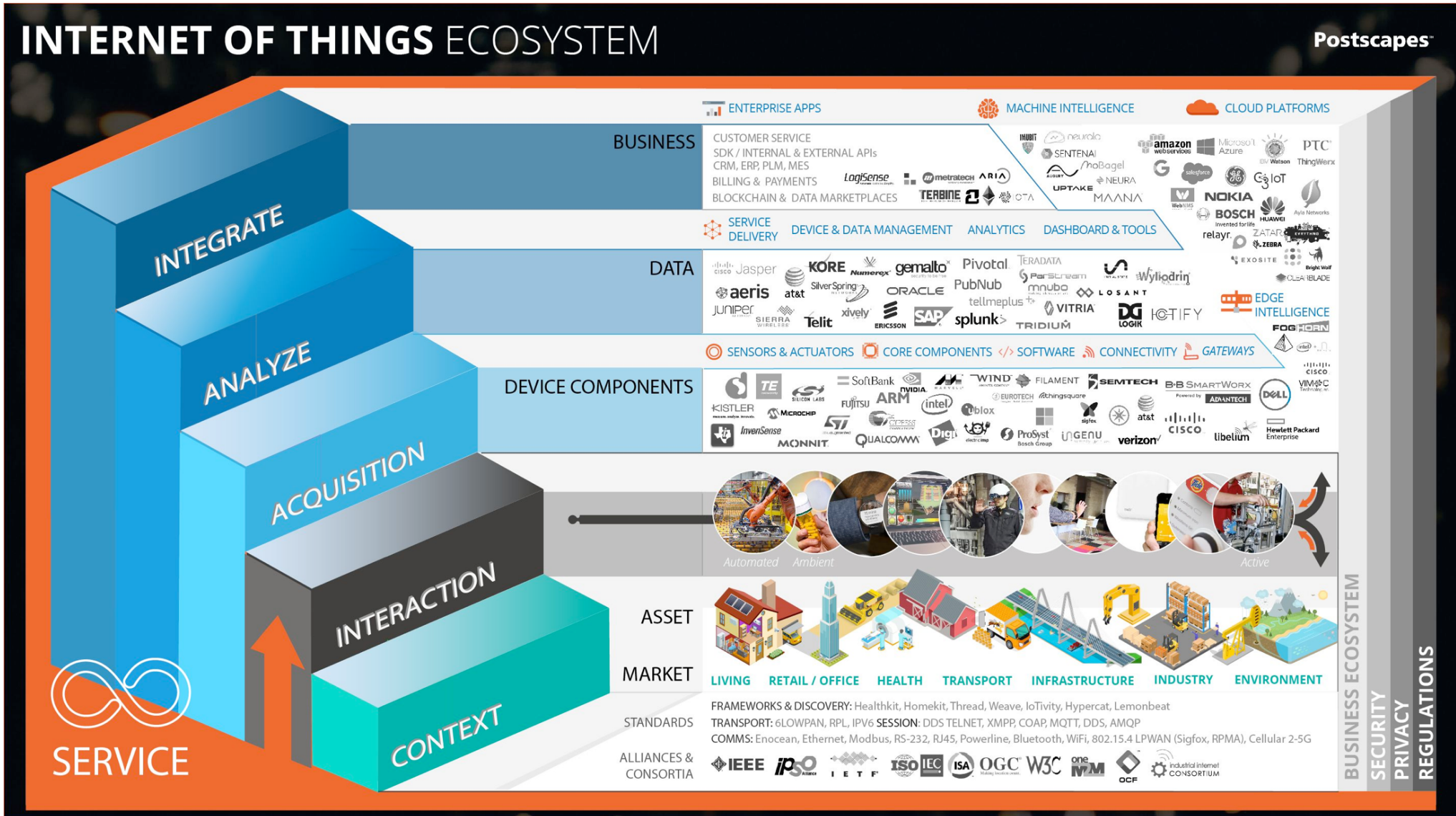


Advanced & customized data management

GLOBAL PICTURE OF LONG-RANGE IOT ECOSYSTEM



MATURATION OF IOT MARKET WITH BIG ACTORS...



...AND HIGHLY INTEGRATED DEVICES



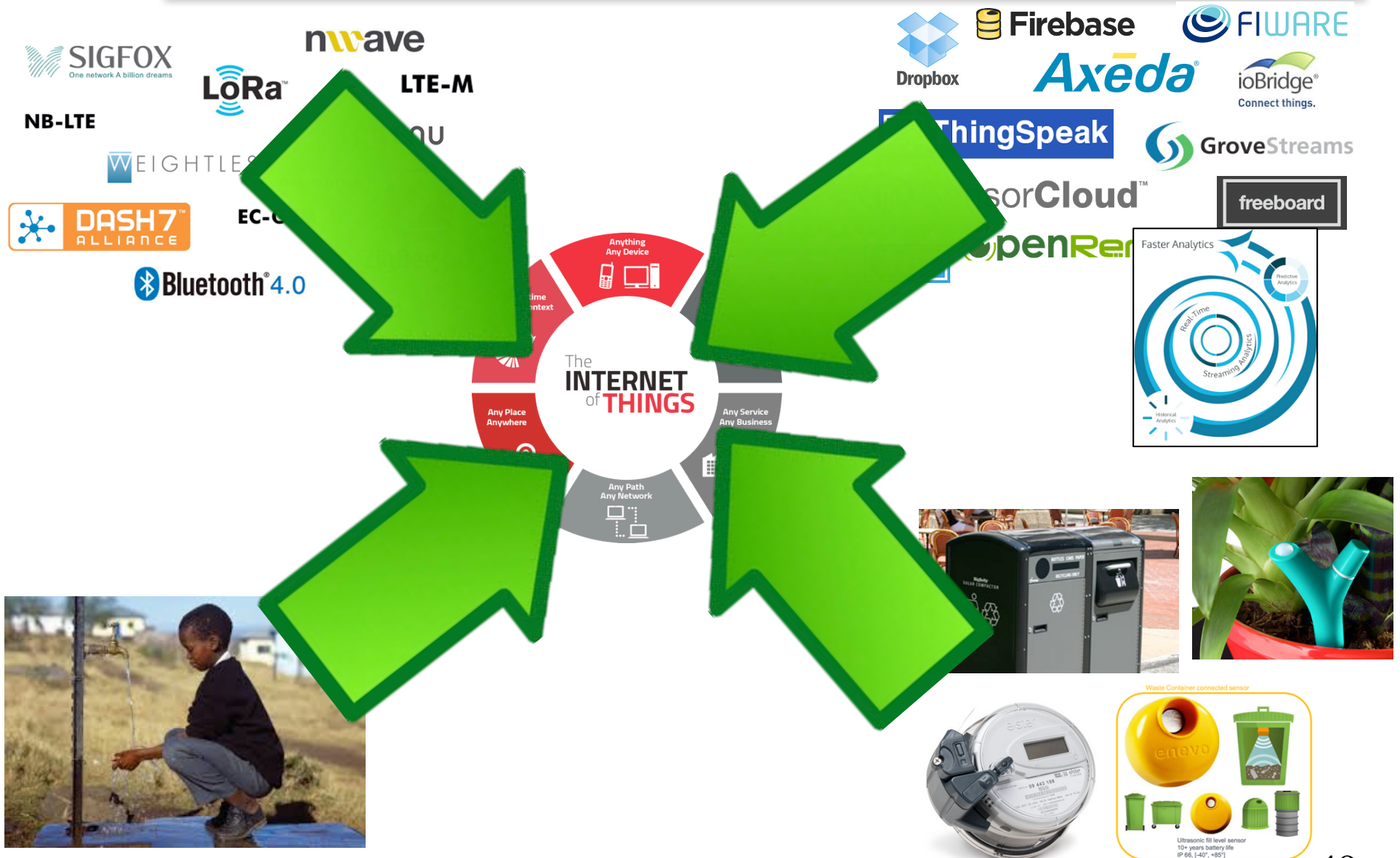
Waste Container connected sensor



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



IOT BECOMES REALITY!



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

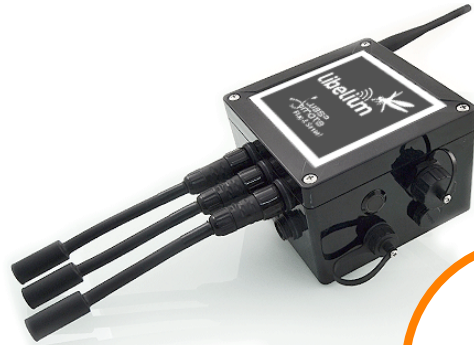


Agriculture



Environment

MATURATION OF THE IOT MARKET...



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

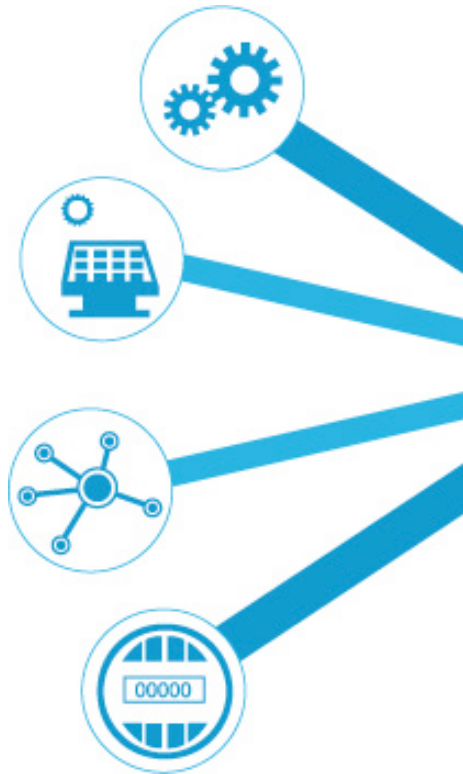
Too expensive
Too integrated
Highly specialized
Difficult to customize
Difficult to upgrade



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

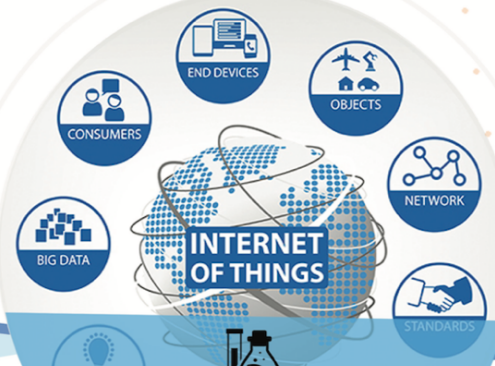
Demand/Supply Optimization

Customer Engagement

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



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

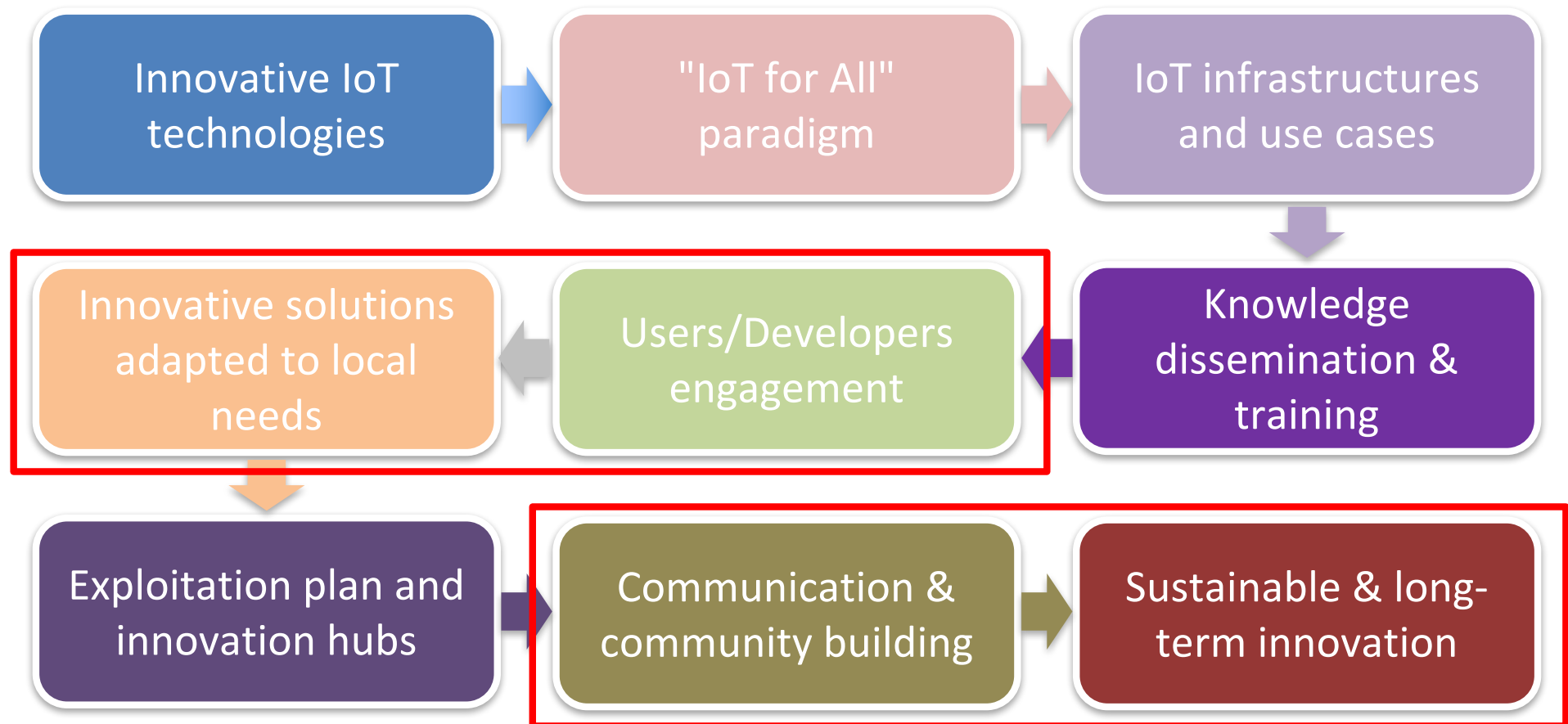
DO MORE with LESS

- www.waziup.eu
- Waziup IoT
- Waziup IoT
- Waziup
- Waziup



waziup.community@create-net.org

MAKING IOT HAPPENING!



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)



IoTBigData 2016 (Italy, EGM)



Launch event (Senegal, CTIC Dakar)



IoT Care Conference (Budapest, CNET)

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



Credit: C. Vavasseur, CTIC Dakar

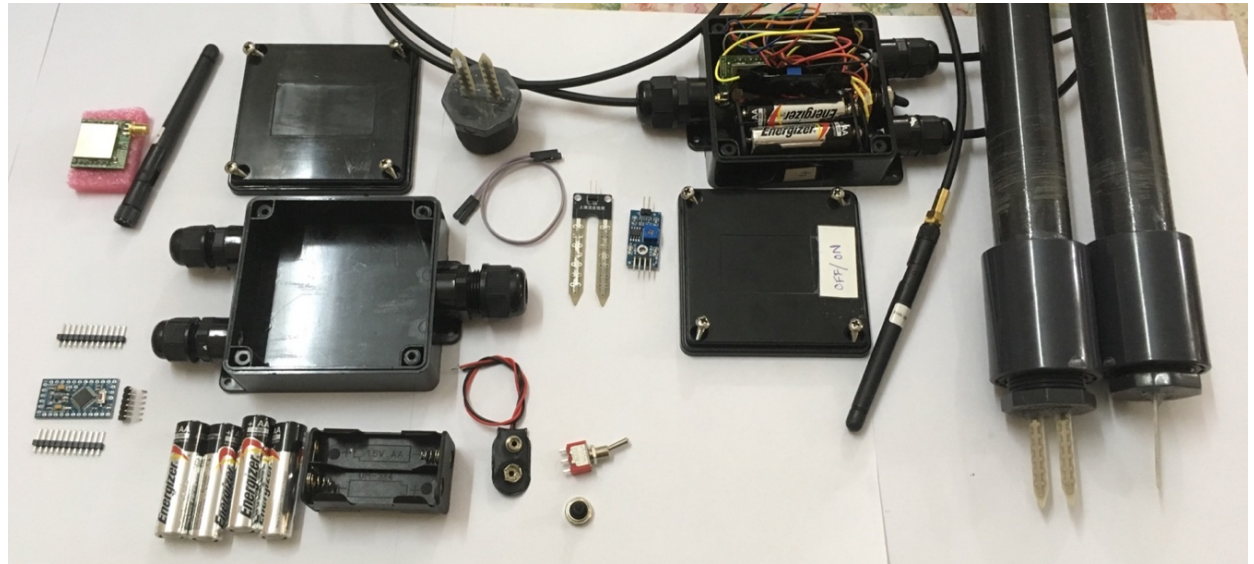
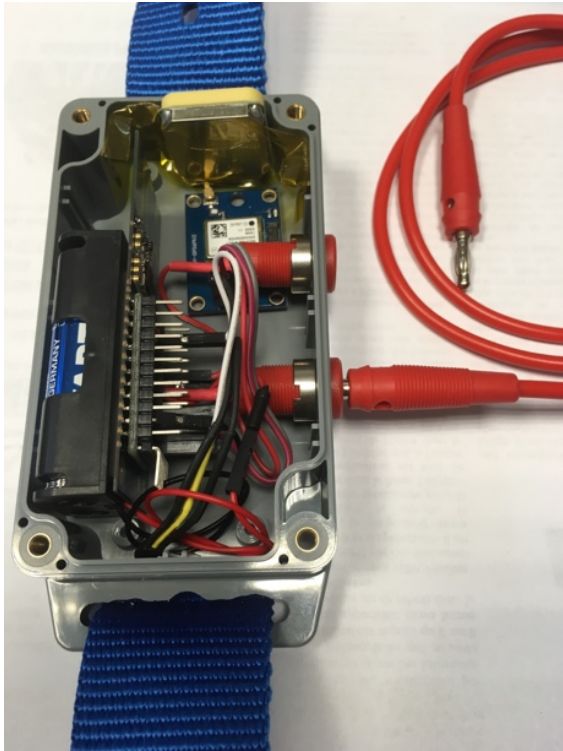


RESSACS 2016



Workshop at the RESSACS 2016 (France, UPPA)

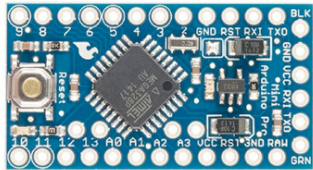
LOW-COST IOT DEVICES



LOW-COST HARDWARE



Arduino Pro Mini



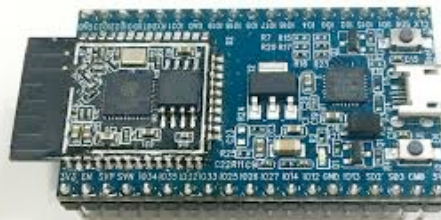
LoPy

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

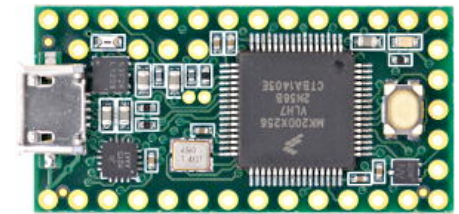
<http://blog.atmel.com/2015/04/09/25-dev-boards-to-help-you-get-started-on-your-next-iot-project/>



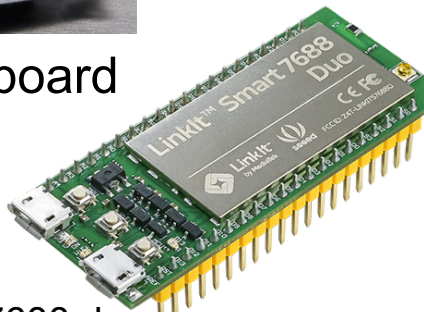
Theairboard



Expressif ESP32

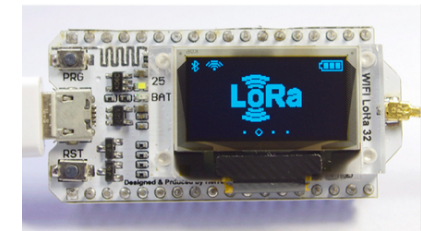


Teensy 3.2



LinkIt Smart7688 duo

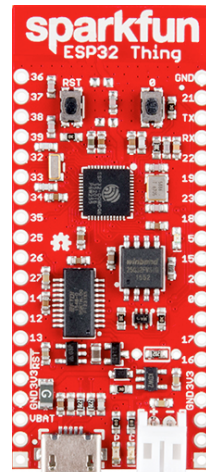
STM32 Nucleo-32



Heltec ESP32 + OLED



Adafruit Feather



Sparkfun ESP32 Thing



Tessel

SodaqOnev2



Tinyduino

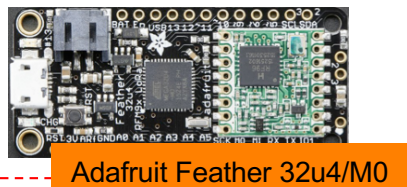
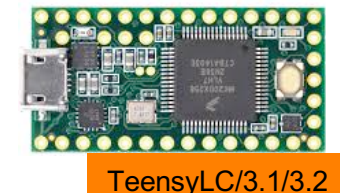
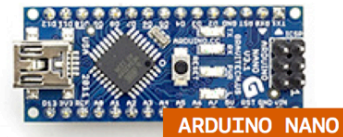
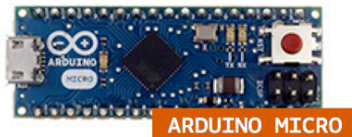
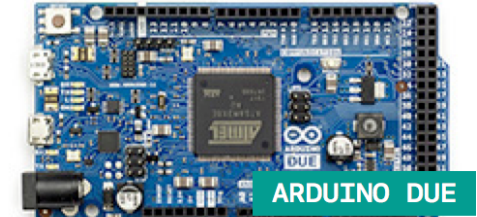
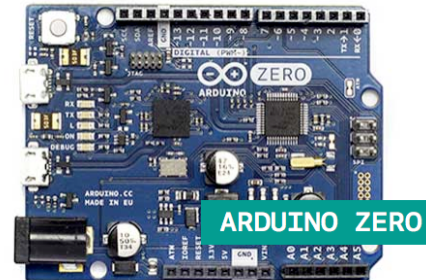
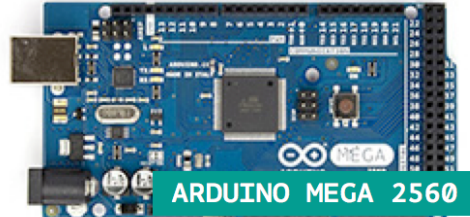
... STIMULATING "DO-IT-YOURSELF" WORLDWIDE

- 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 logo and navigation links for various technologies like Arduino, Raspberry Pi, and Impression 3D. 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 'Circuit arduino'. 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 'Se connecter' button.

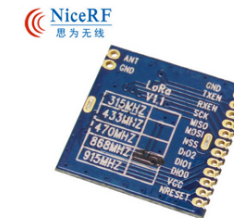
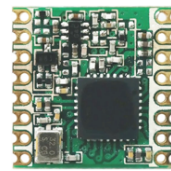
WAZIUP PROVIDES SW/HW BUILDING BLOCKS INTEGRATION



More to come...



LoRa radios that our library already supports



Long-Range communication library

WAZIUP PROPOSES 100% OPEN-SOURCE SOFTWARE

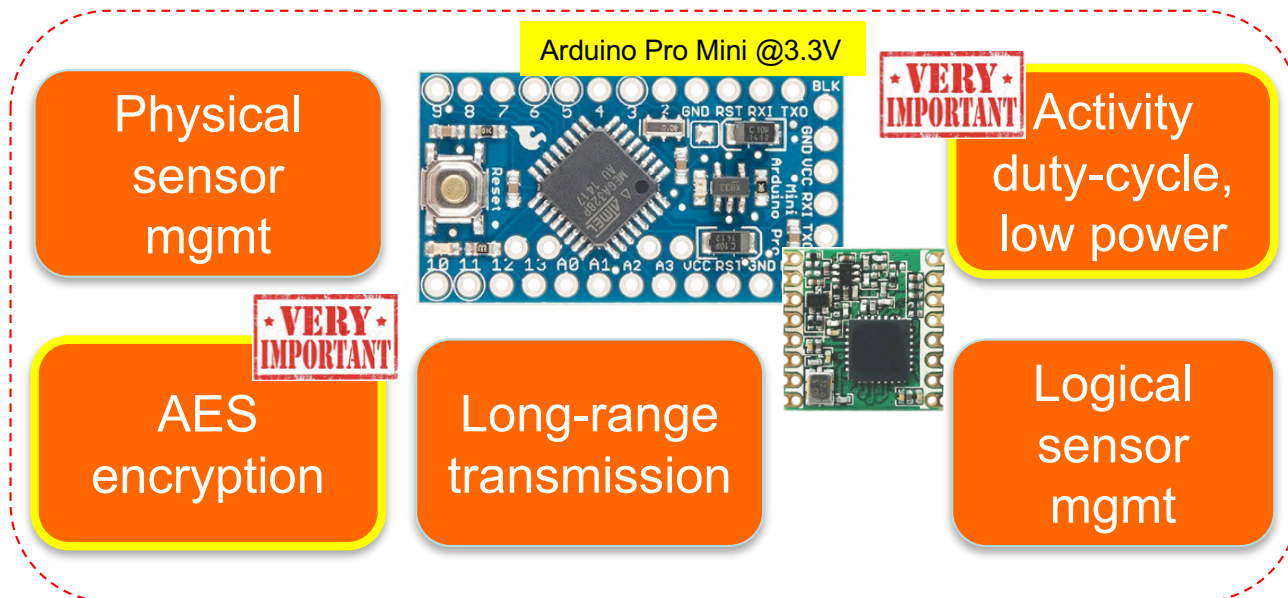
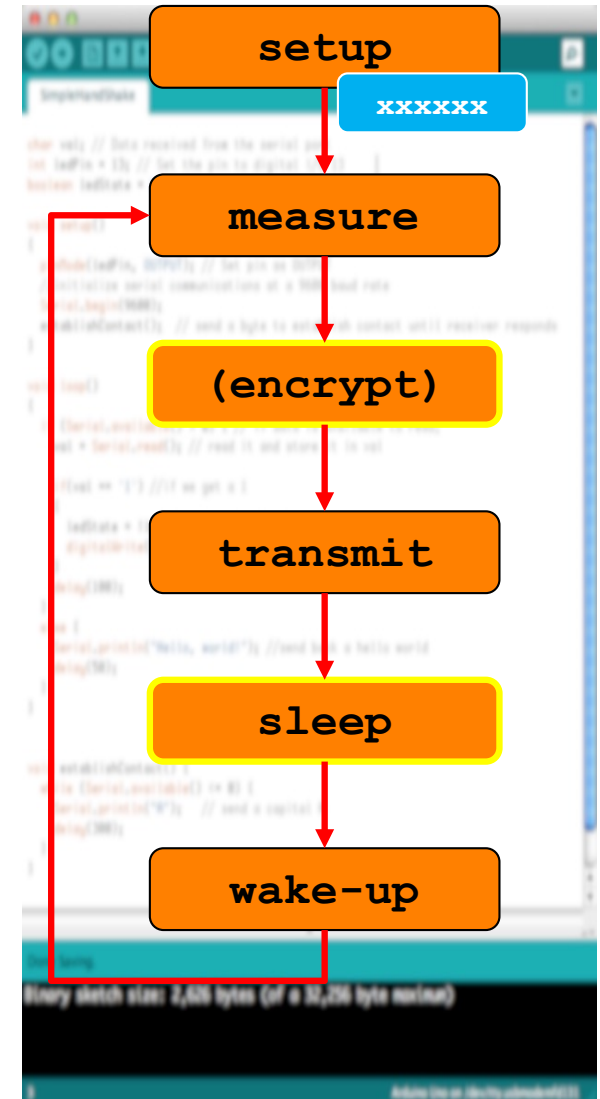
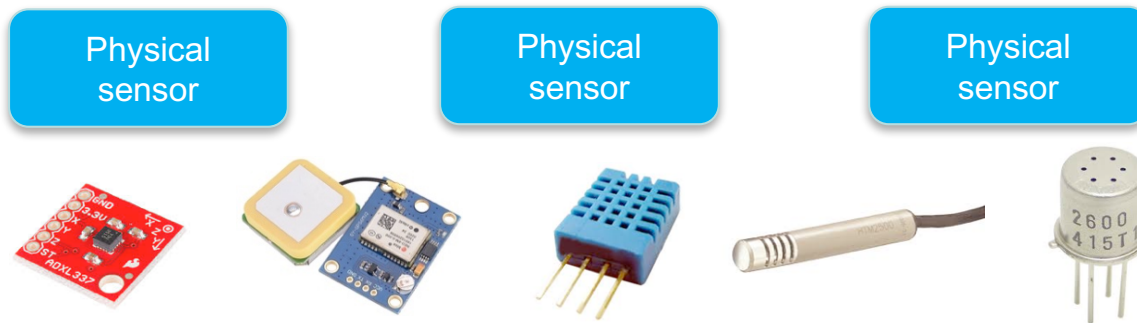
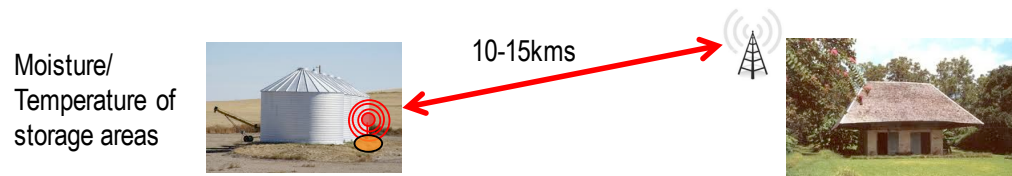
The screenshot shows the Arduino IDE interface. The main window displays the source code for 'Arduino_LoRa_temp'. The code includes comments about the license and a copyright notice for Congduc Pham. It also includes a header for the SX1272 module. A Teensyduino board is connected to the IDE, and the status bar at the bottom indicates 'Teensy 3.2 / 3.1, Serial, 72 MHz optimized, US English on /dev/cu.usbmodem1433801'.

The screenshot shows the GitHub repository page for 'CongducPham / LowCostLoRaGw'. The repository is titled 'Low-cost LoRa IoT & gateway with SX1272/76, Raspberry and Arduino'. It has 122 commits, 1 branch, 0 releases, and 2 contributors. The repository is licensed under the GNU General Public License. The repository contains several files and folders, including 'Arduino', 'gw_full_latest', 'tutorials', '.gitignore', and 'README.md'. The latest commit is 'Congduc Pham bug fix in lora_gateway.cpp' by Congduc Pham, committed a day ago.

File/Folder	Commit Message	Time Ago
Arduino	update SMS scripts	15 days ago
gw_full_latest	bug fix in lora_gateway.cpp	a day ago
tutorials	update SMS scripts	15 days ago
.gitignore	.DS_Store banished	10 months ago
README.md	update README	11 days ago

LowCostLoRaGw github has latest general distribution:
<https://github.com/CongducPham/LowCostLoRaGw>
WAZIUP-specific configuration can be found on
<https://github.com/Waziup/waziup-gateway>

READY-TO-USE TEMPLATES



LARGE VARIETY OF EXAMPLES TO LEARN AND ADAPT

CongducPham / LowCostLoRaGw

Unwatch 49 Unstar 216 Fork 120

Code Issues 96 Pull requests 2 Projects 0 Wiki Insights Settings

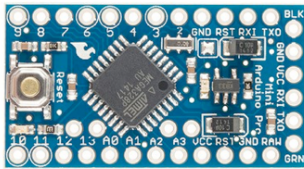
Branch: master LowCostLoRaGw / Arduino / Create new file Upload files Find file History

Congduc Pham update README files, fix MD5 digest computation of gw id, always use ... Latest commit aba3ed2 2 days ago

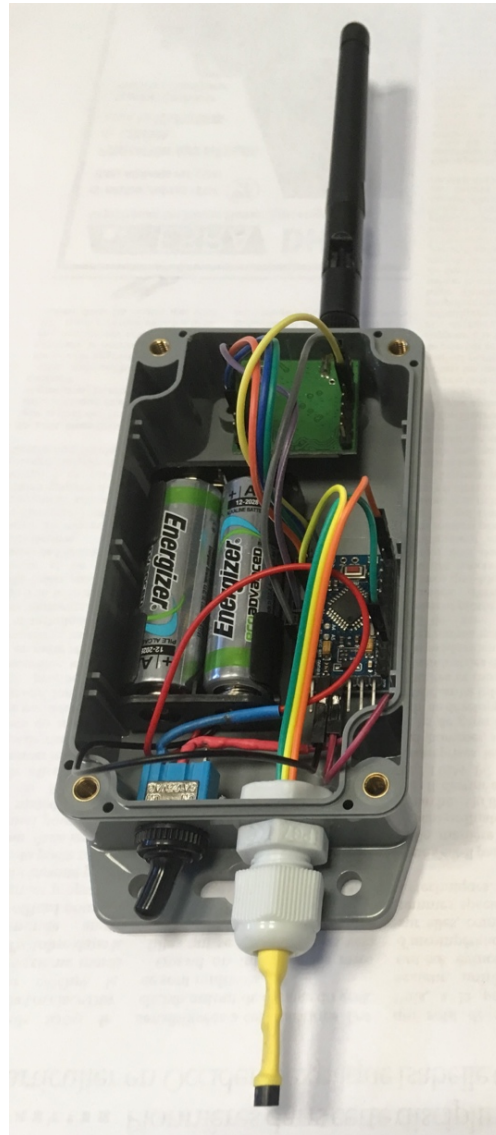
..		
Arduino_LoRa_GPS	update README	19 days ago
Arduino_LoRa_Gateway	update gateway related files and some sketch	4 months ago
Arduino_LoRa_Gateway_1_4	improve management of transmission power, add channels in 863-865	a year ago
Arduino_LoRa_Generic_Sensor	update Arduino examples	a month ago
Arduino_LoRa_InteractiveDevice	update Arduino examples	a month ago
Arduino_LoRa_Ping_Pong	update Arduino examples	a month ago
Arduino_LoRa_Simple_BeaconCol...	update Arduino example	23 days ago
Arduino_LoRa_Simple_SoilHum	update Arduino examples	a month ago
Arduino_LoRa_Simple_temp	update Arduino examples	a month ago
Arduino_LoRa_SoilHum	update Arduino examples	a month ago
Arduino_LoRa_temp	update Arduino examples	a month ago
Arduino_LoRa_ucamII	update image support	3 months ago
libraries	update README files, fix MD5 digest computation of gw id, always use ...	2 days ago
README.md	update README	19 days ago

A SIMPLE TEMPERATURE SENSOR EXAMPLE

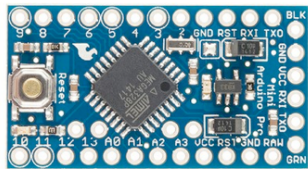
Arduino Pro Mini @3.3V



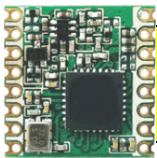
Modtronix inAir9



LOW-COST INTEGRATION

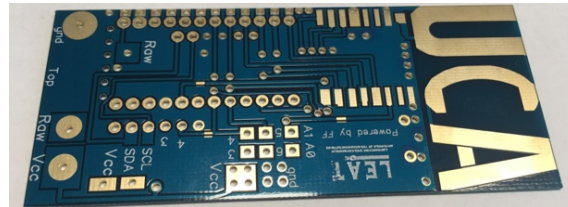


1.5€

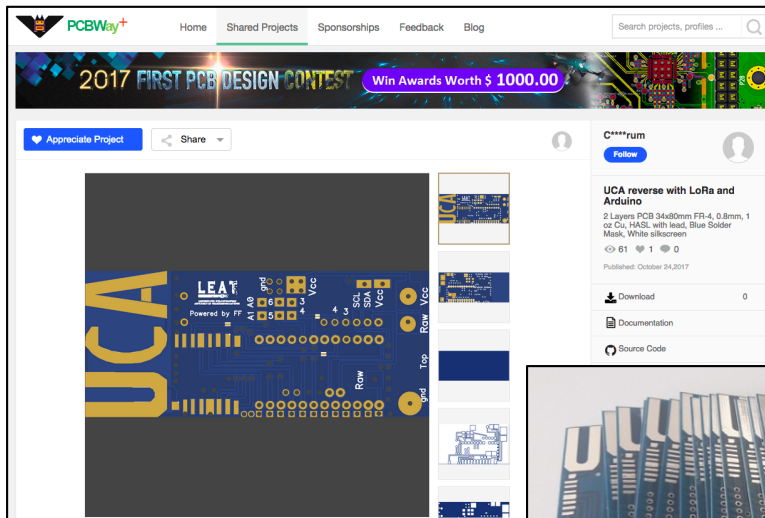
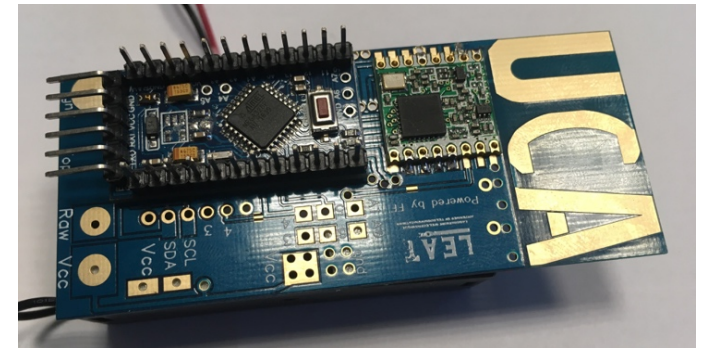


5€

https://github.com/FabienFerrero/UCA_Board

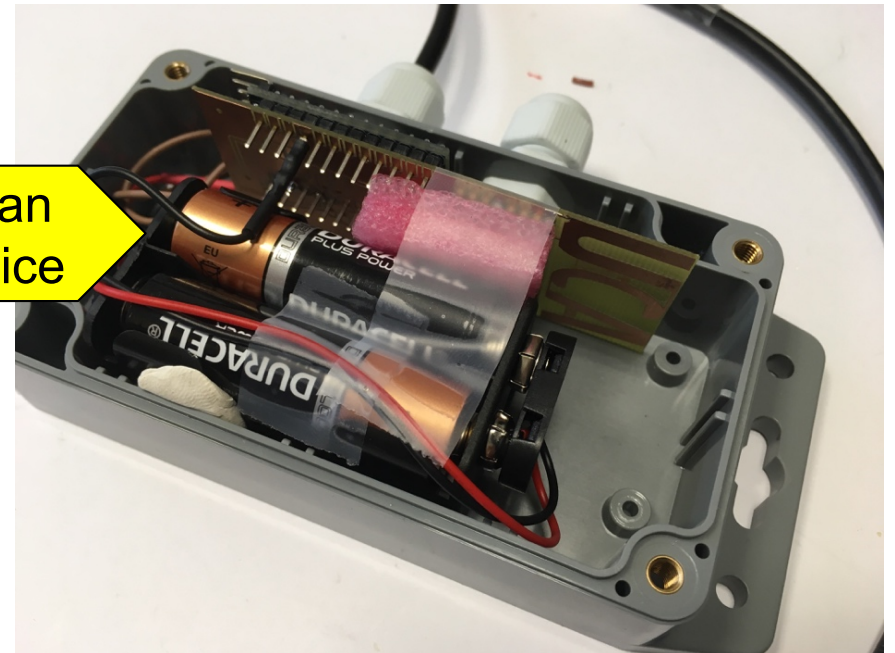


1€



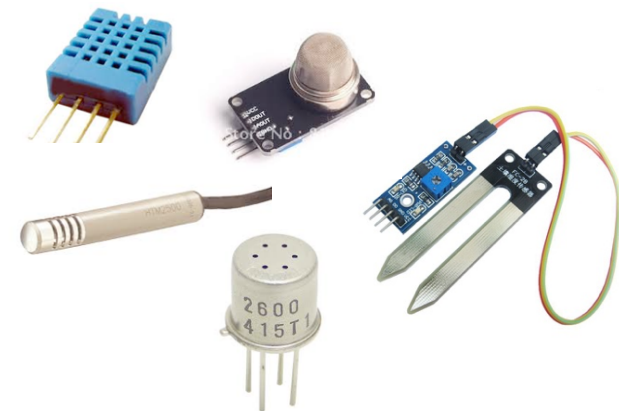
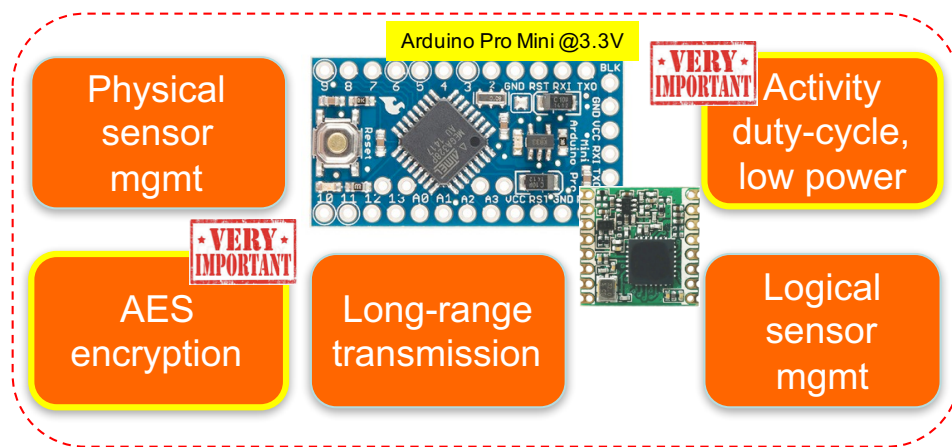
1-click order

Less than 10€/device



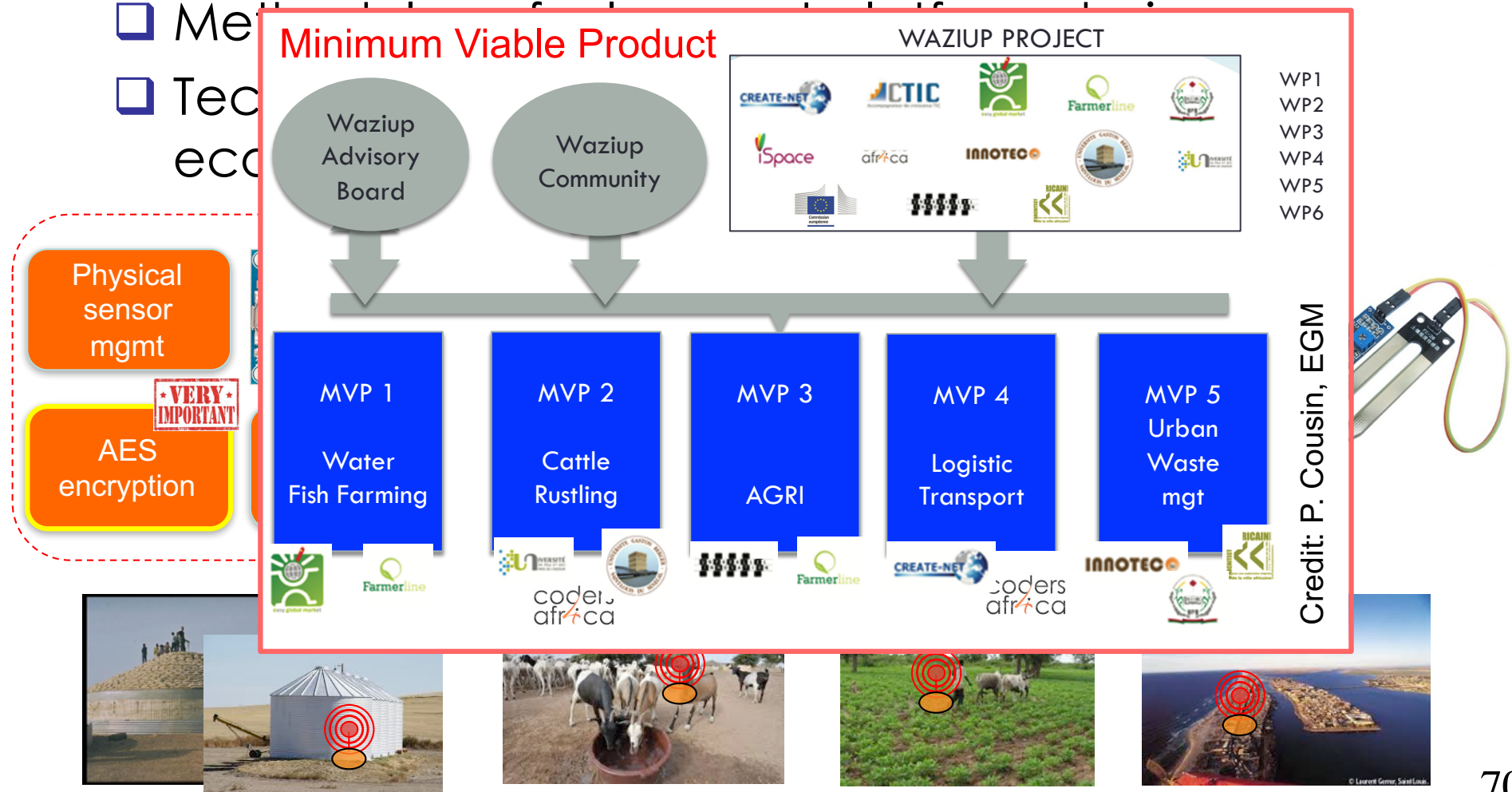
GENERIC SENSING IOT DEVICE VS HIGHLY SPECIALIZED

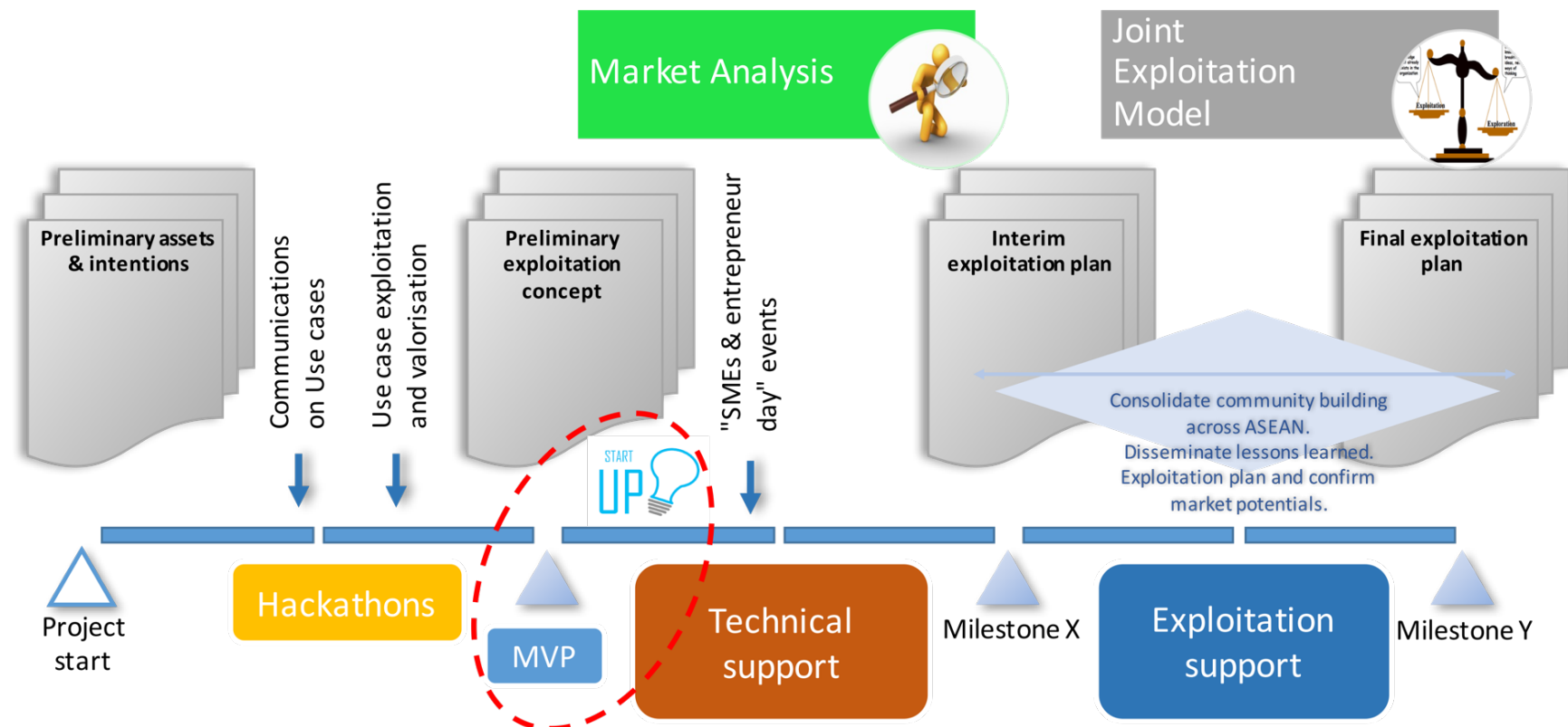
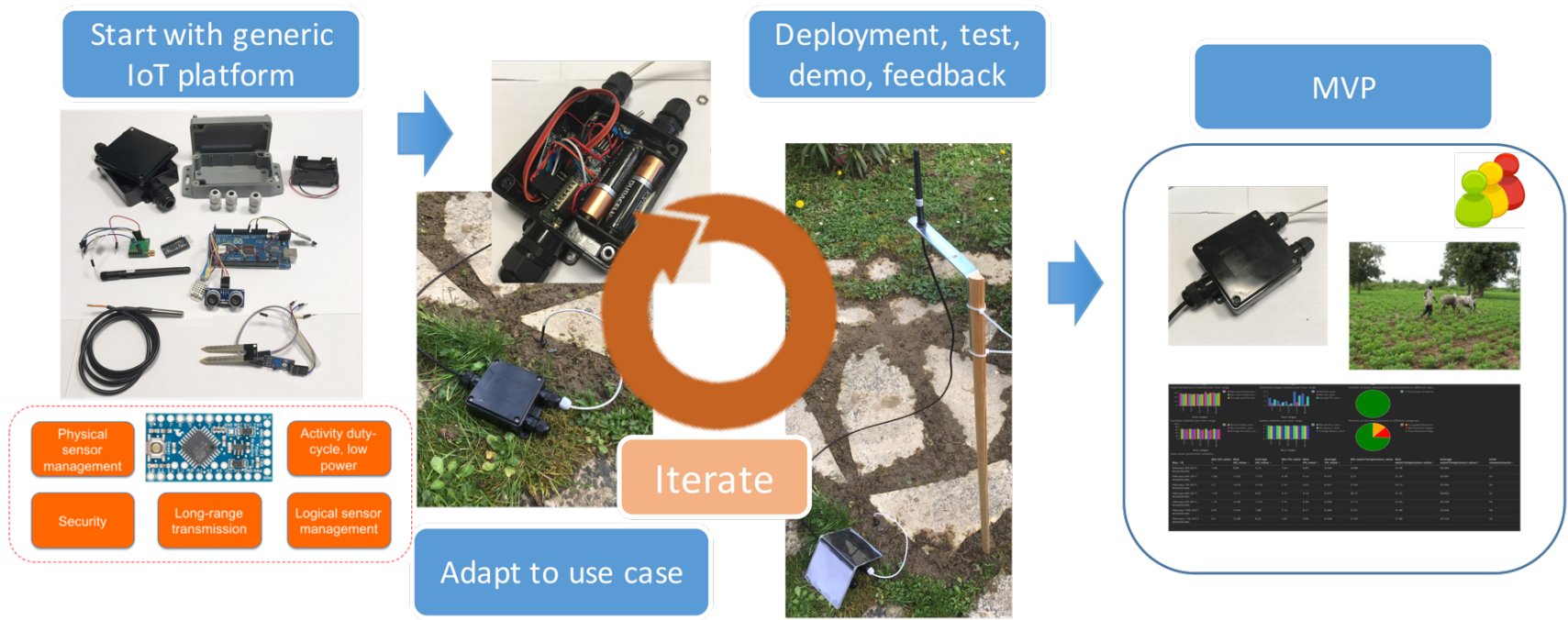
- ❑ Build low-cost, low-power, **long-range** enabled generic platform
- ❑ Methodology for low-cost platform design
- ❑ Technology transfers to user communities, economic actors, stakeholders,...



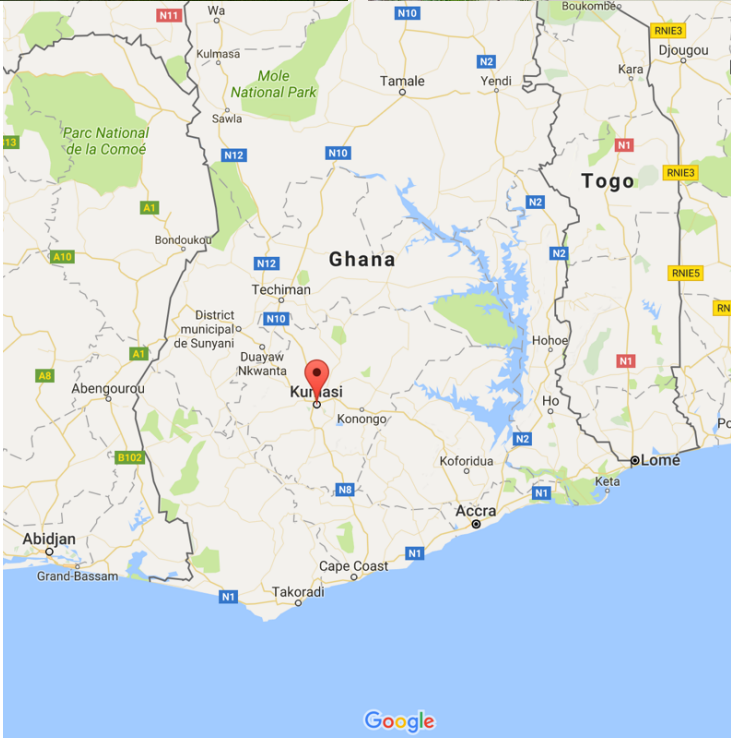
GENERIC SENSING IOT DEVICE

- Build low-cost, low-power, Long-range enabled generic platform
- Meet the needs of the African continent
- Technical and economic viability

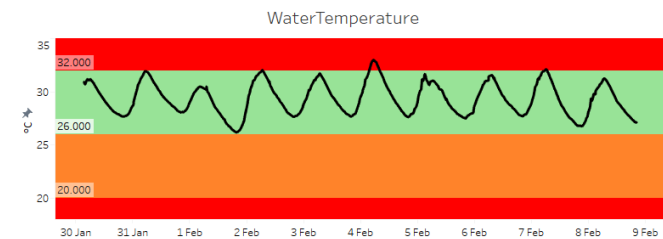
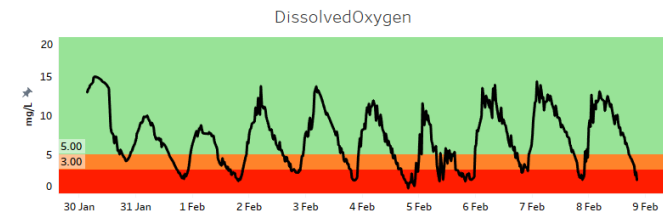
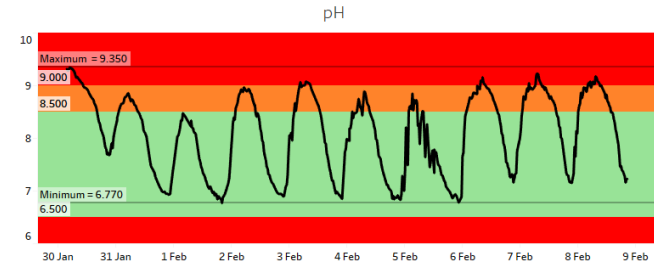




FISH FARMING IN KUMASI, GHANA

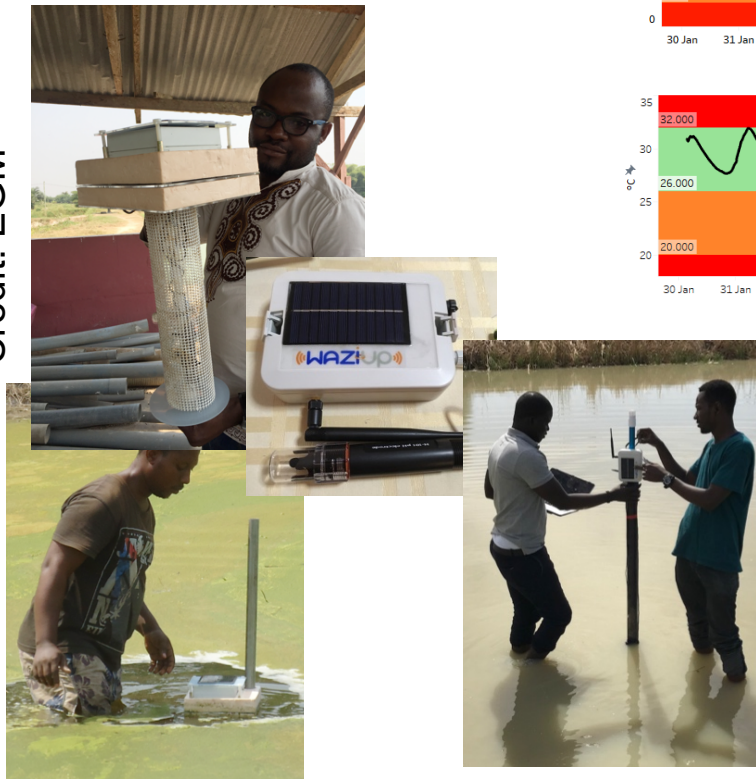


LOW-COST BUOY FOR FISH FARMING MVP

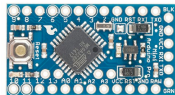


Physical sensor reading

Credit: EGM



Physical sensor management

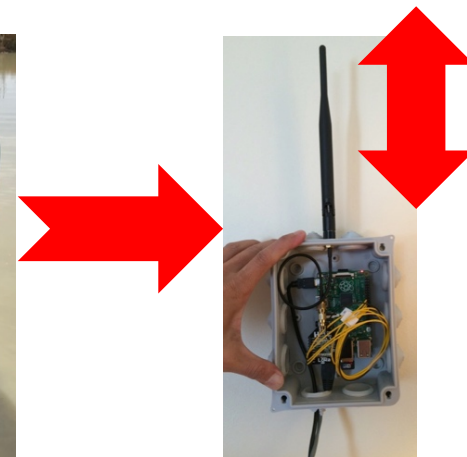


Activity duty-cycle, low power

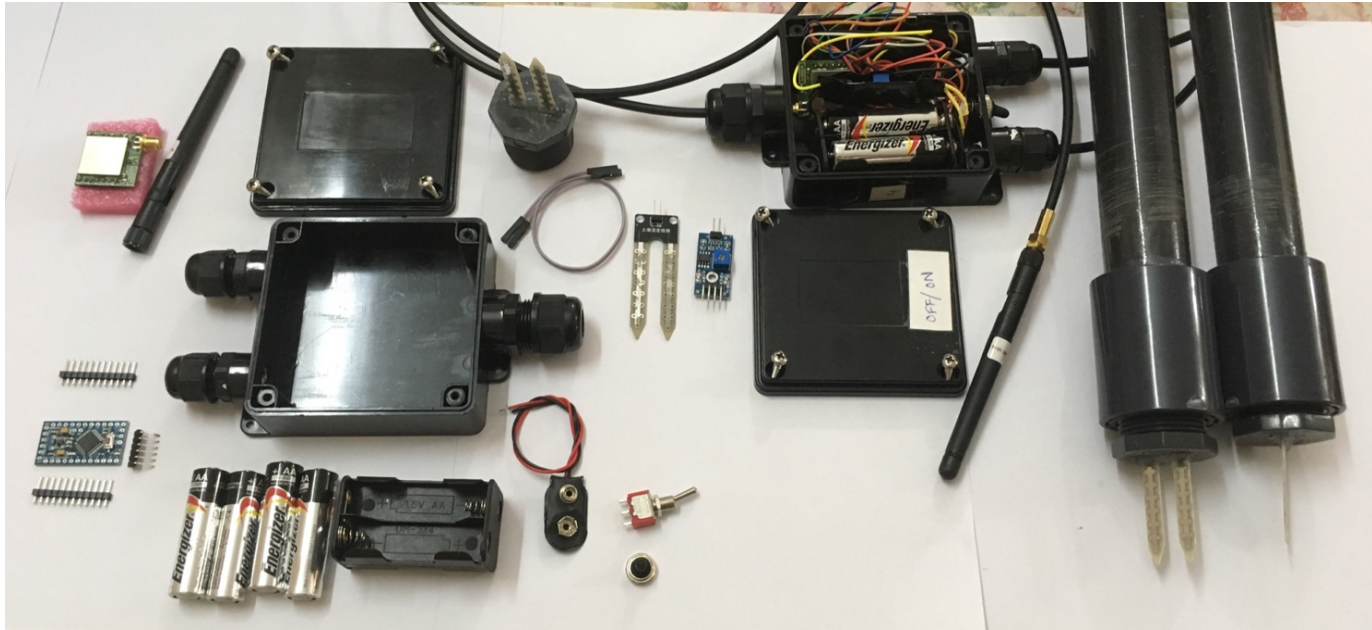
Security

Long-range transmission

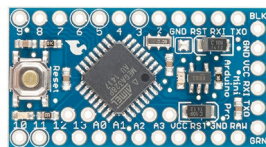
Logical sensor management



SOIL HUMIDITY SENSORS FOR AGRI MVP



Physical sensor management



Activity duty-cycle, low power

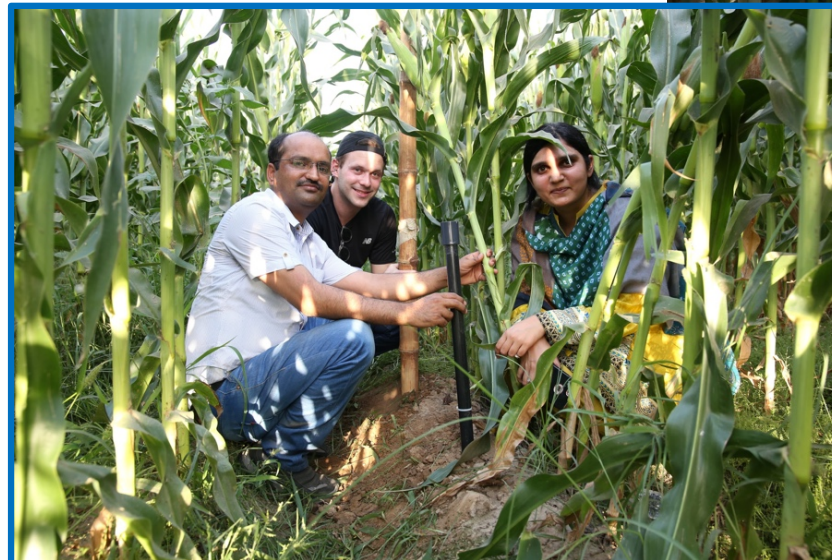
Security

Long-range transmission

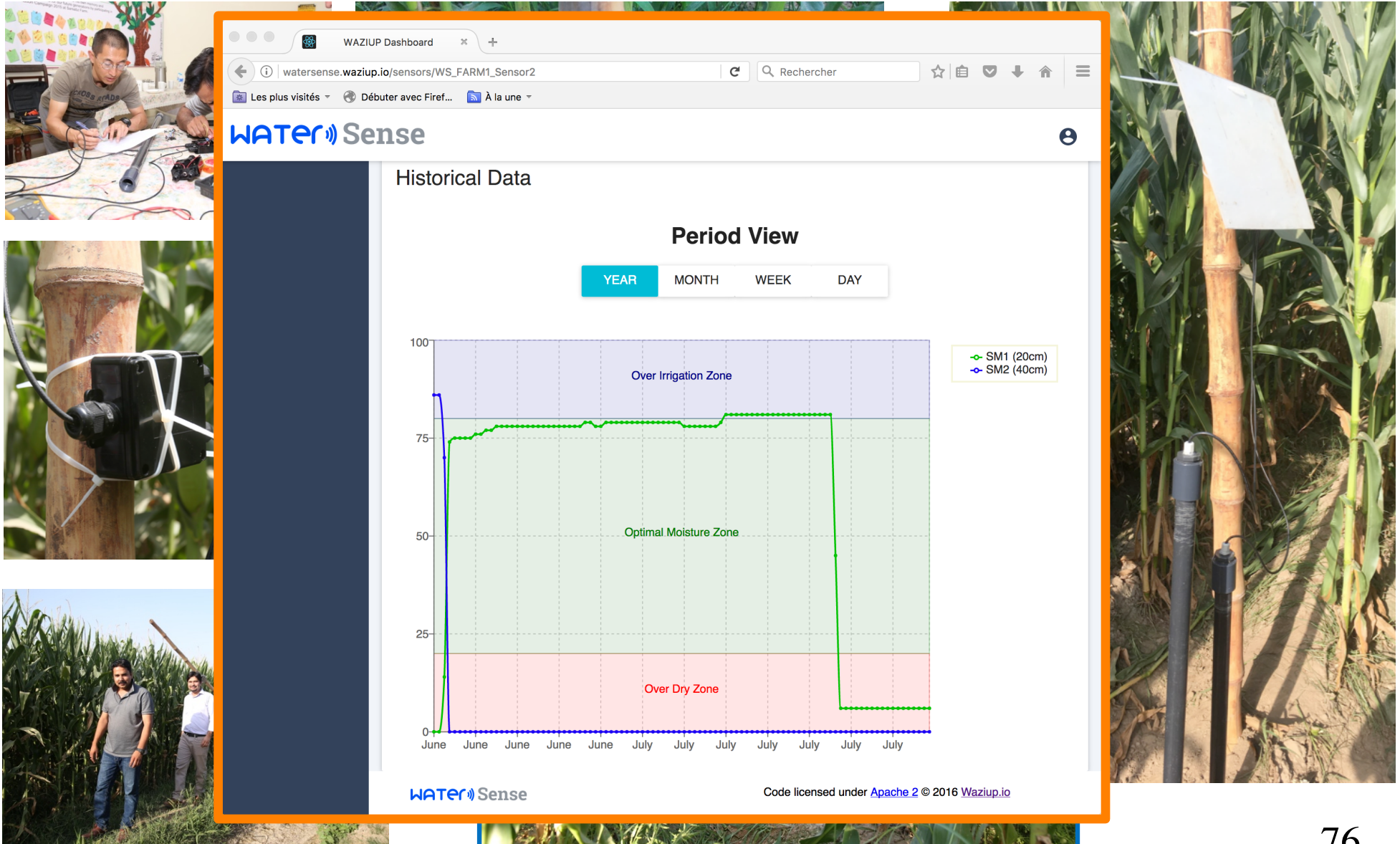
Logical sensor management



DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT



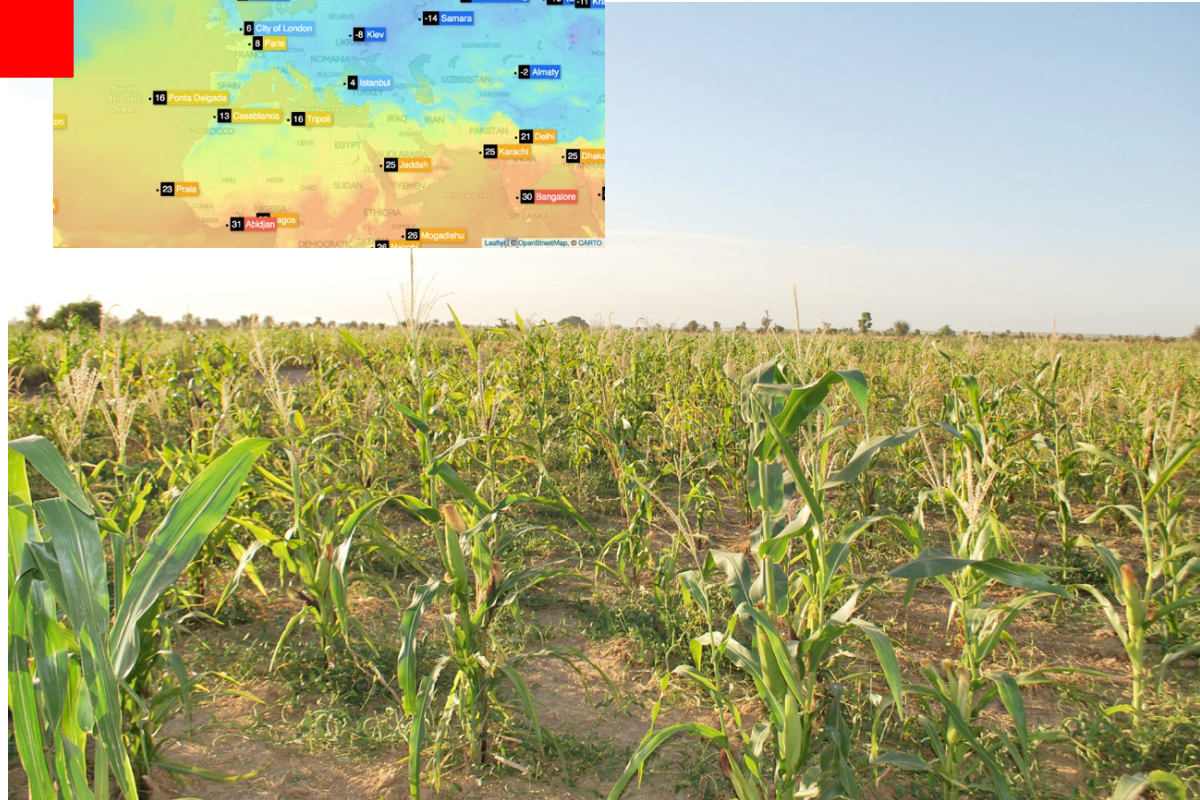
DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT



LOCAL WEATHER STATION FOR AGRI MVP

<https://openweathermap.org/>

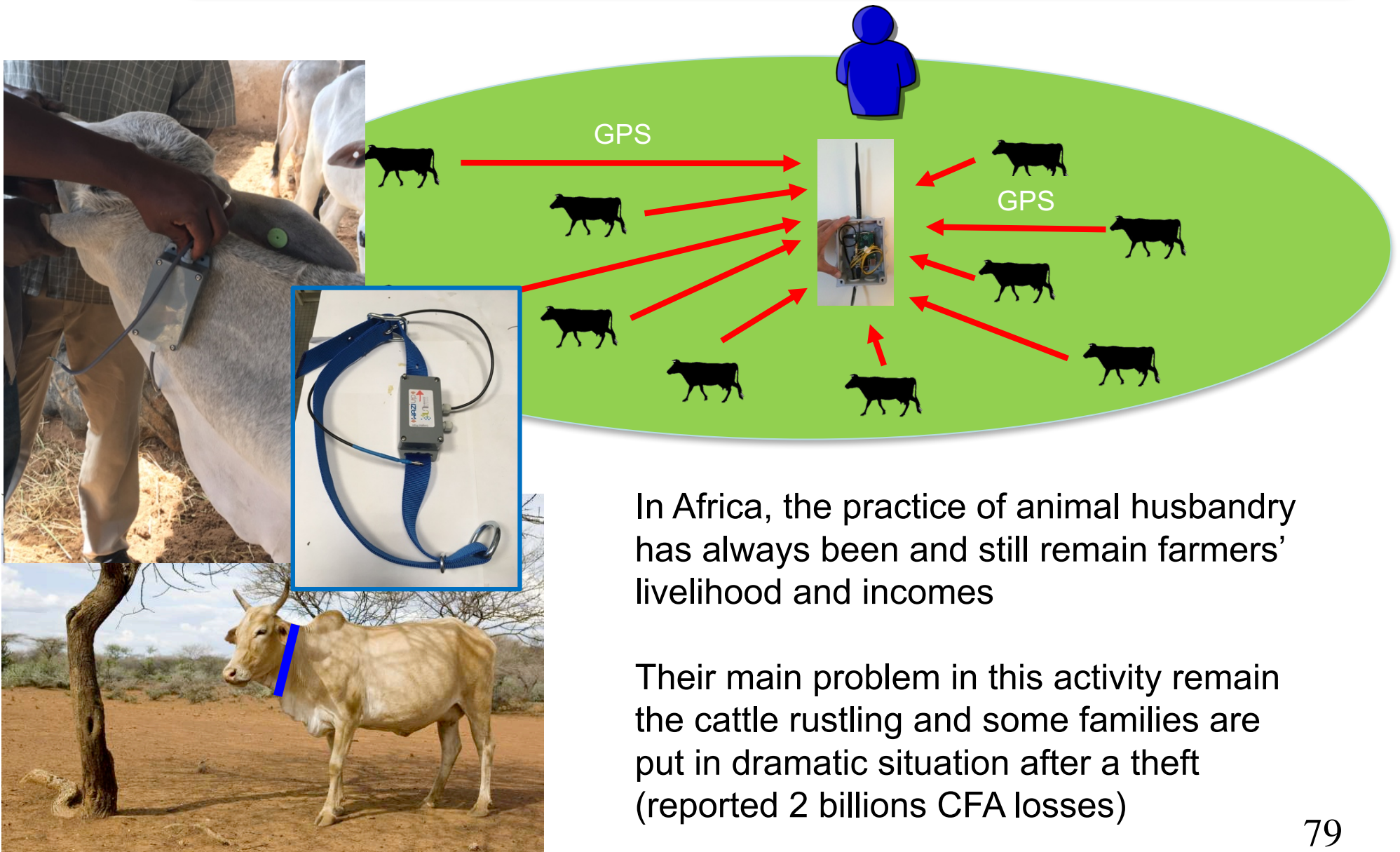
Photo from Unparallel



**Get local weather
measurements**

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

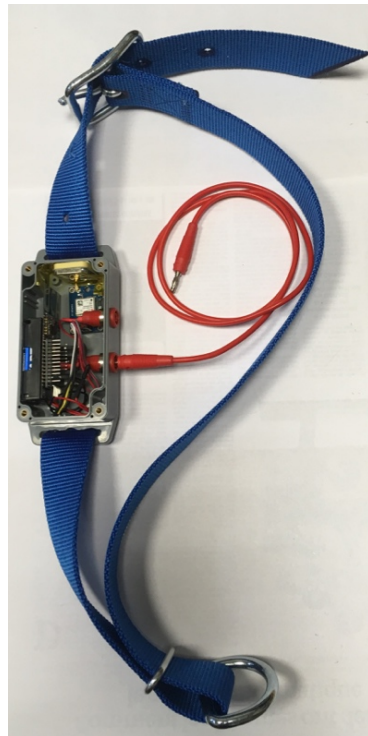
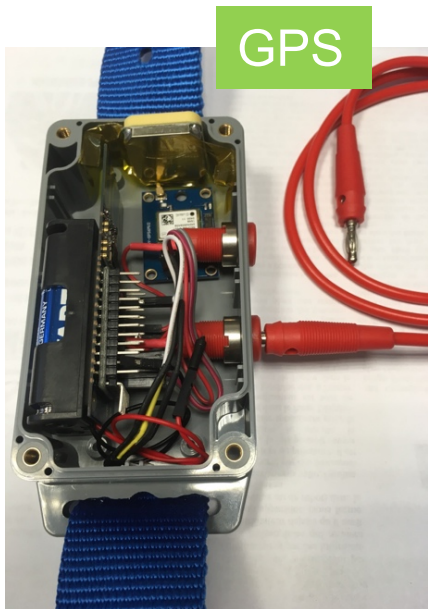
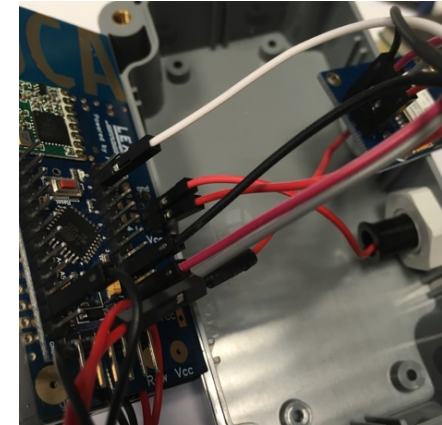
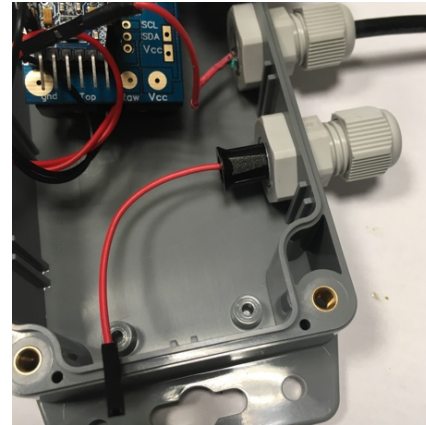
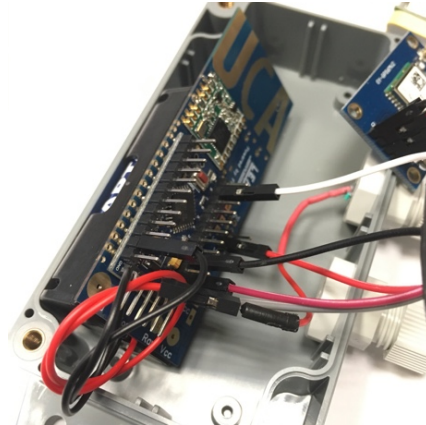
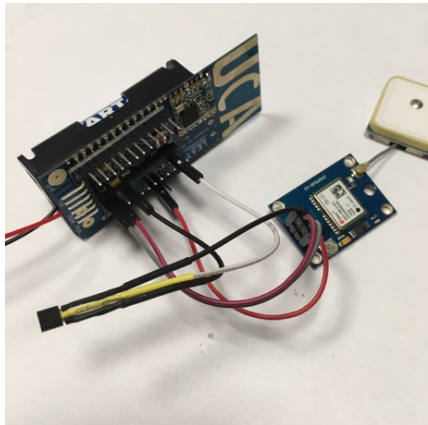
COLLAR FOR CATTLE RUSTLING MVP



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

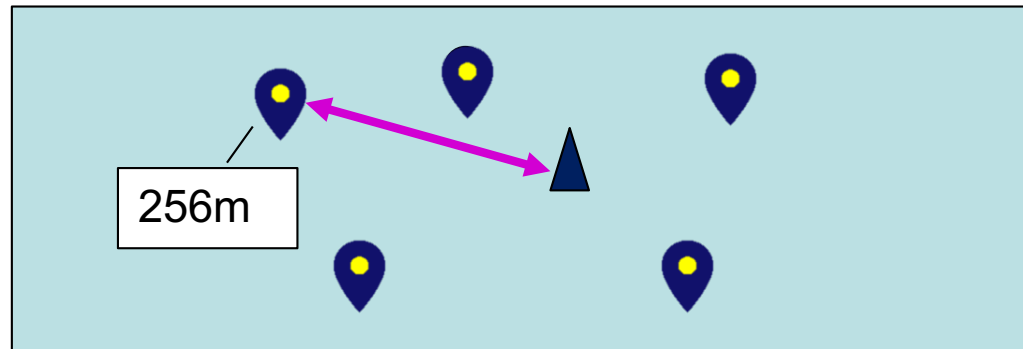
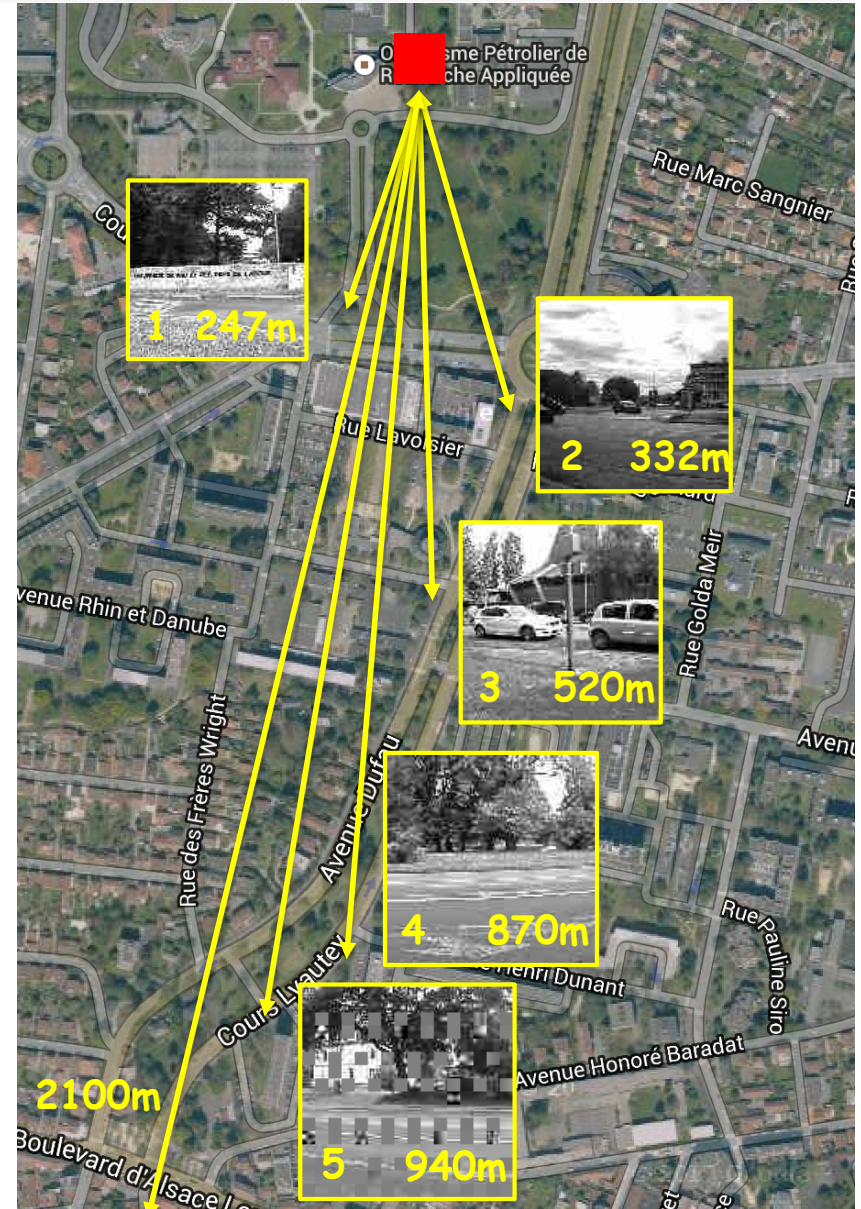
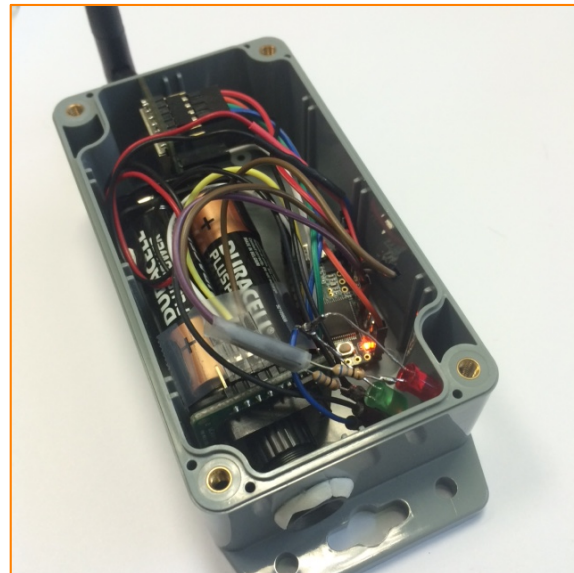
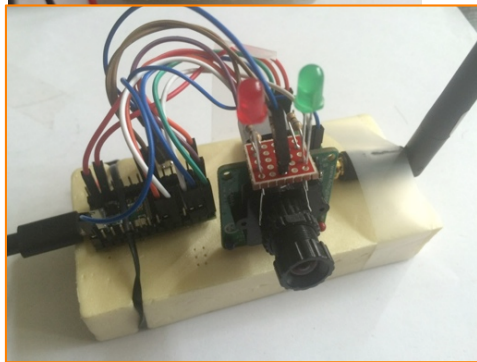
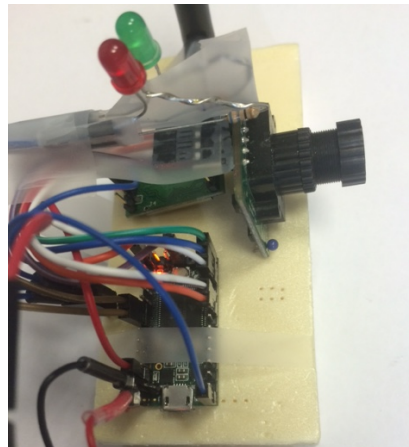
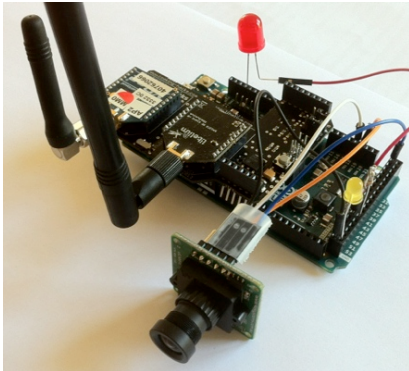


IMAGE SENSOR FOR SPECIFIC SURVEILLANCE CASES



TUTORIALS/RESOURCES

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

WAZIUP
EU H2020 grant agreement number 807047

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 role of rapid urbanization 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 T2i 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 T2i team

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

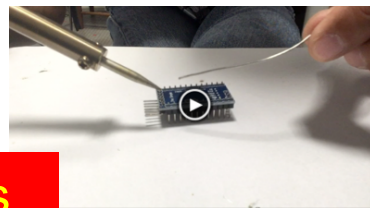
WAZIUP

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

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Low-cost IoT device



+53000 views

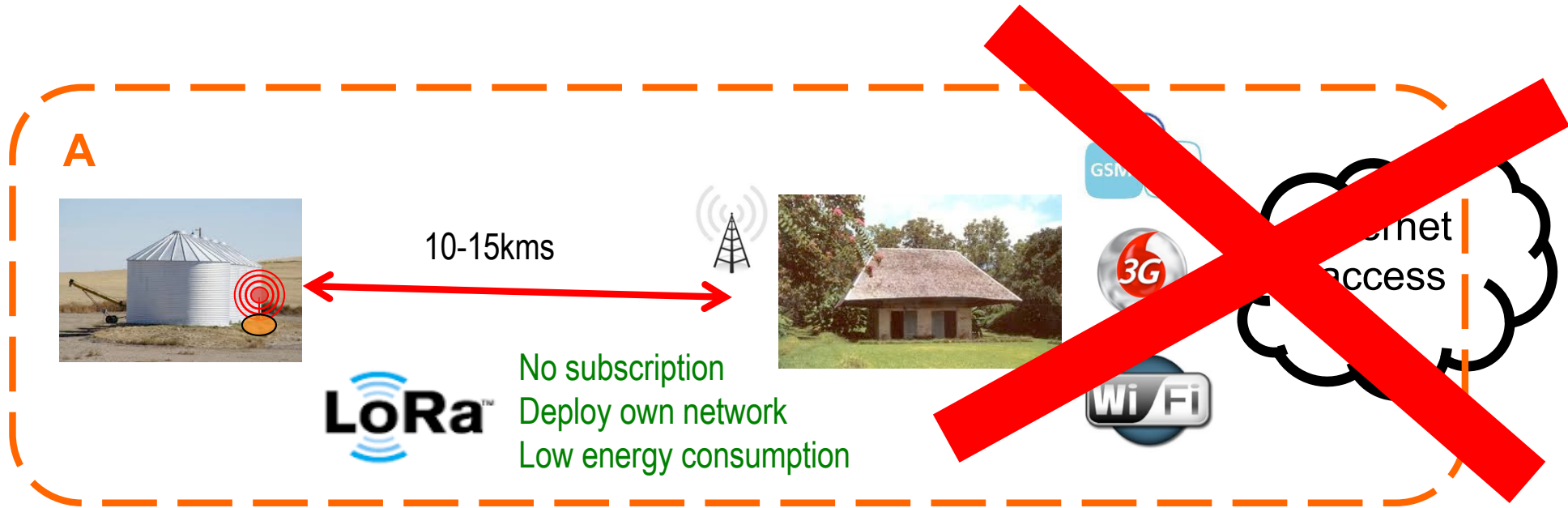
https://www.youtube.com/watch?v=YsKbJeeav_M

Low-cost IoT gateway

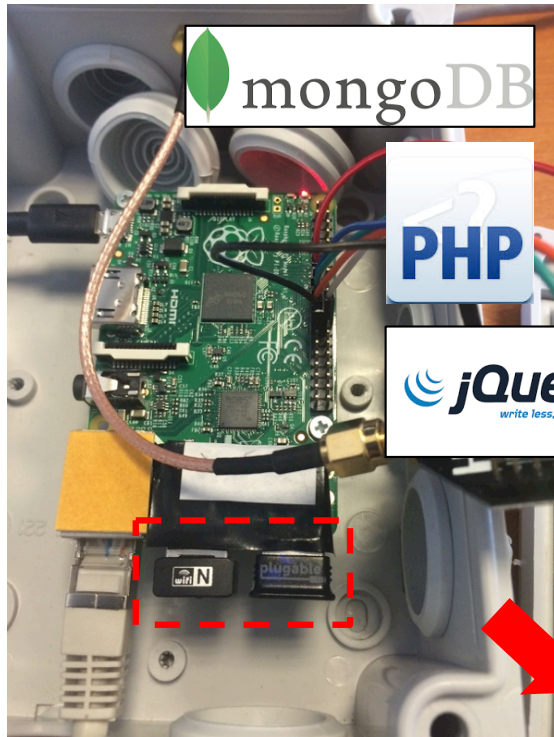


<https://www.youtube.com/watch?v=mj8ltKA14PY>

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

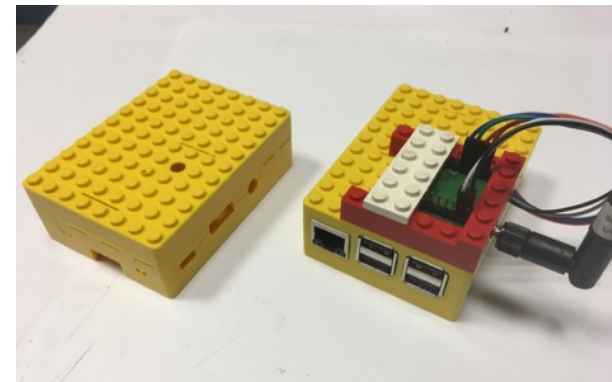
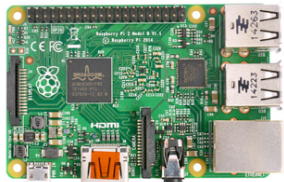
Orange F

Bluetooth_raspi

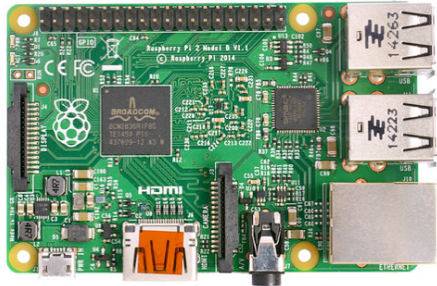
Creating .csv file with the data received...
File 17-05-2016_10h39m36s.csv created and saved in the folder /storage/emulated/0/Raspberry_local_data

Display data Retrieve data in a csv file

THE VERSATILE IOT GATEWAY



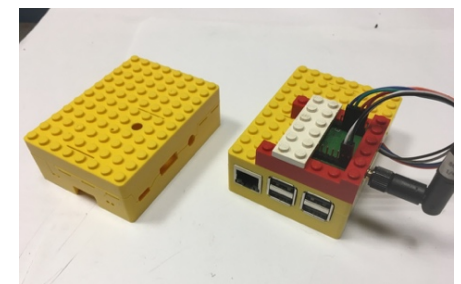
RASPBERRY-BASED LOW-COST LORA GATEWAY



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!



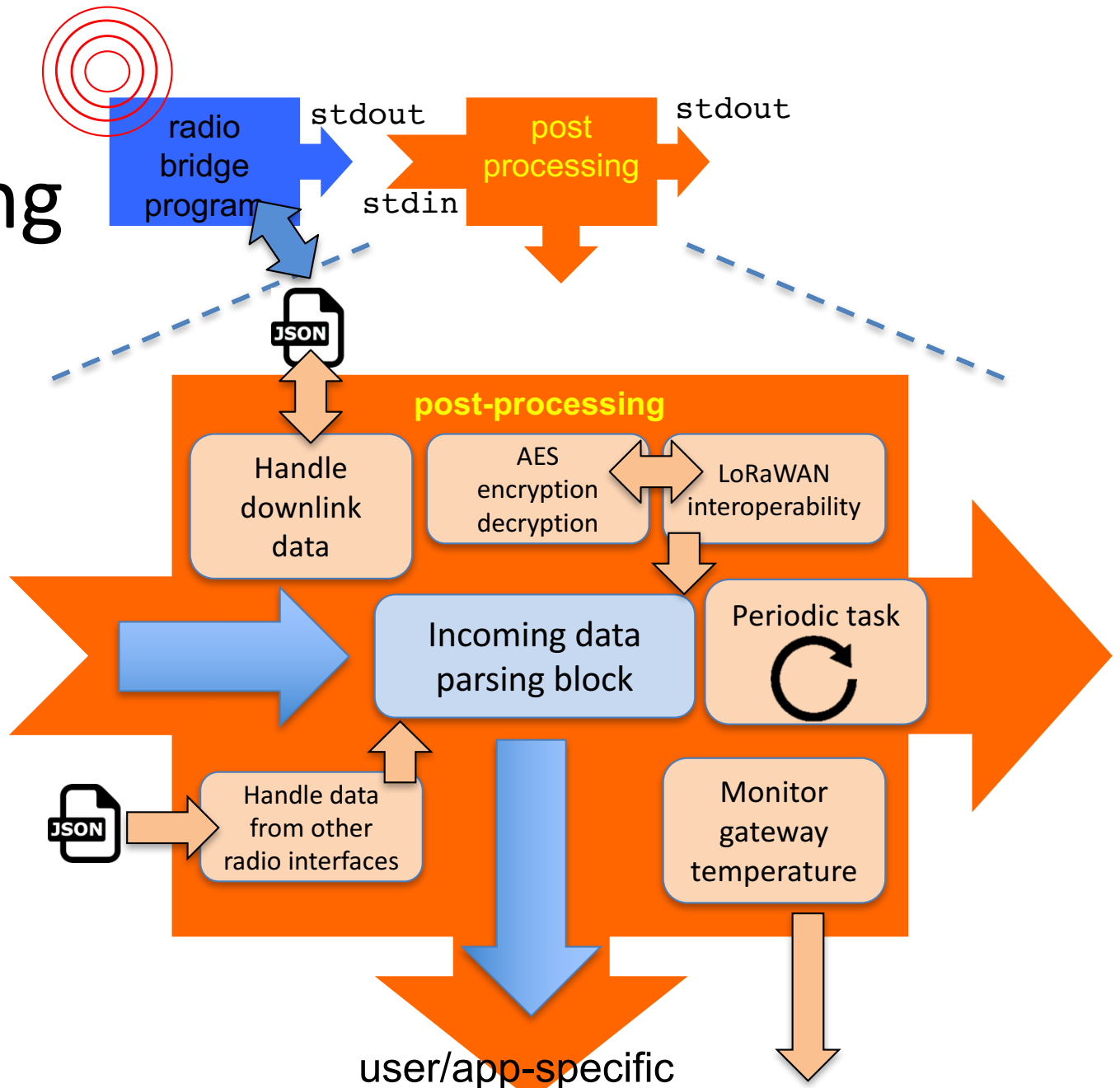
Less than 50€



Get the ready-to-use SD card image

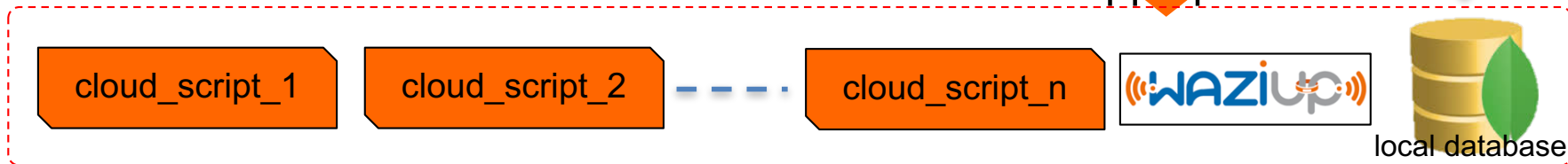
<http://cpham.perso.univ-pau.fr/LORA/WAZIUP/raspberrypi-jessie-WAZIUP-demo.dmg.zip>

Post-processing stage

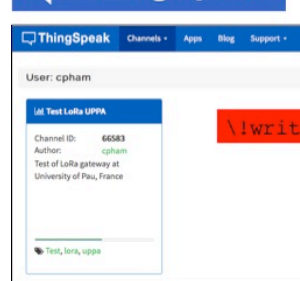
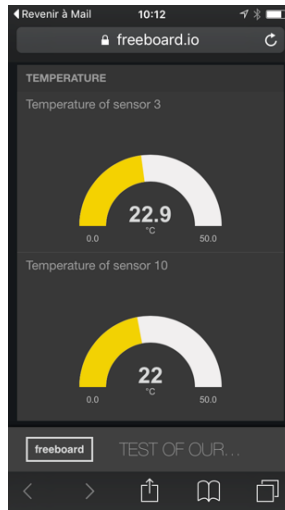
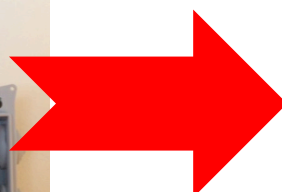
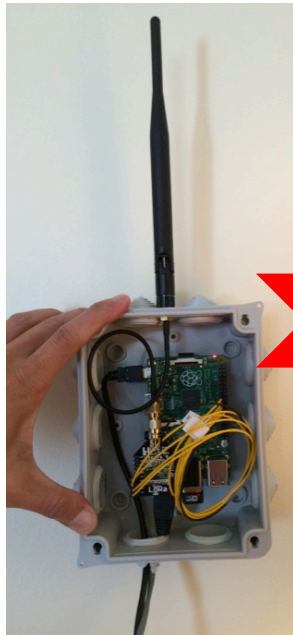


Cloud definition

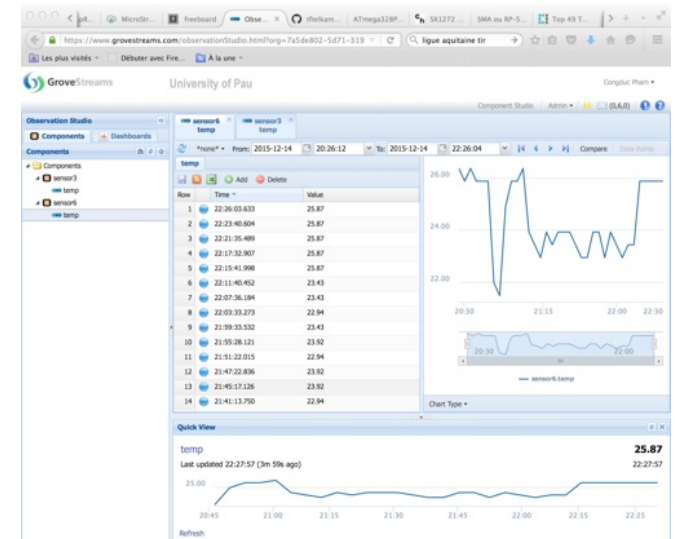
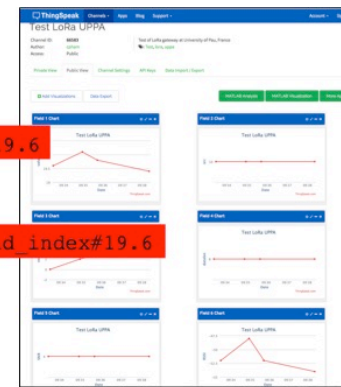
user/app-specific



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

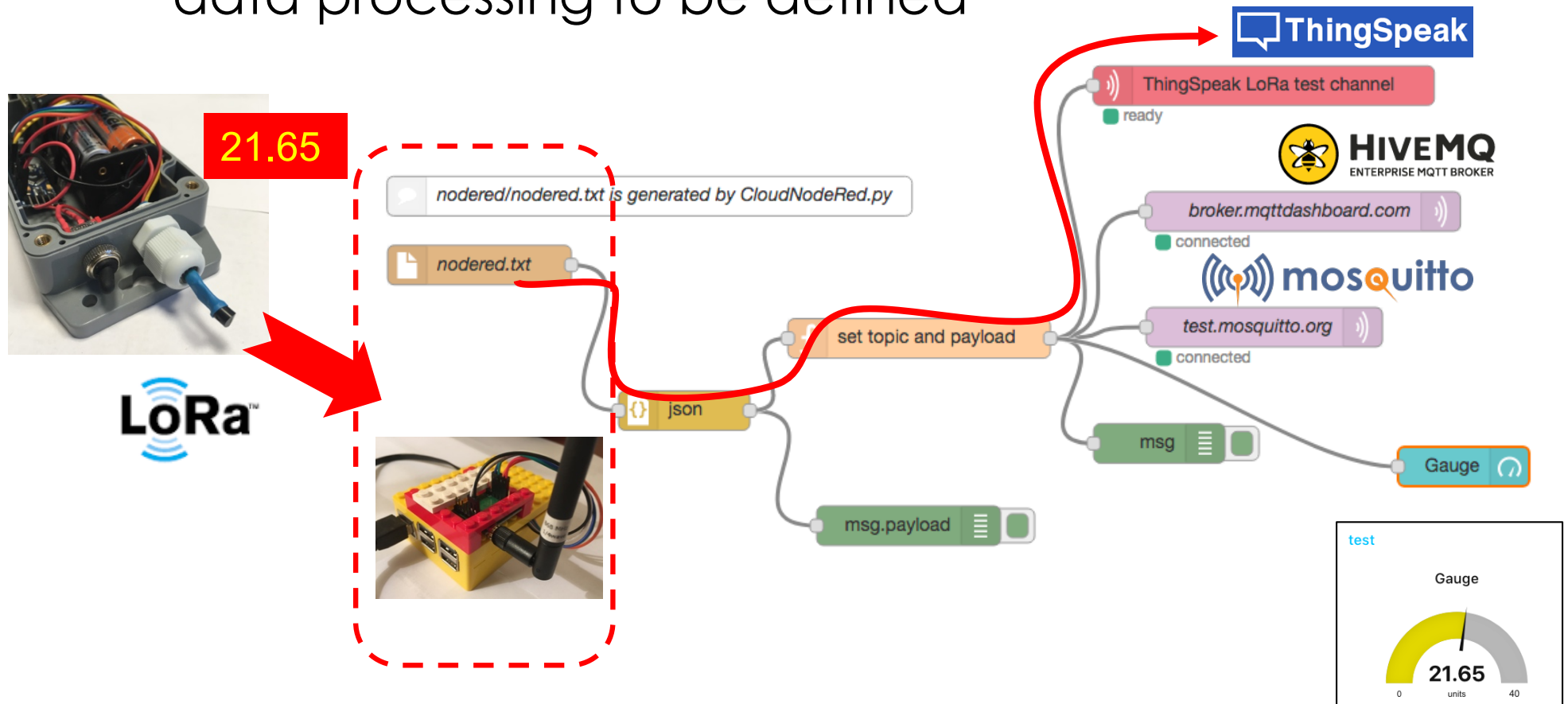
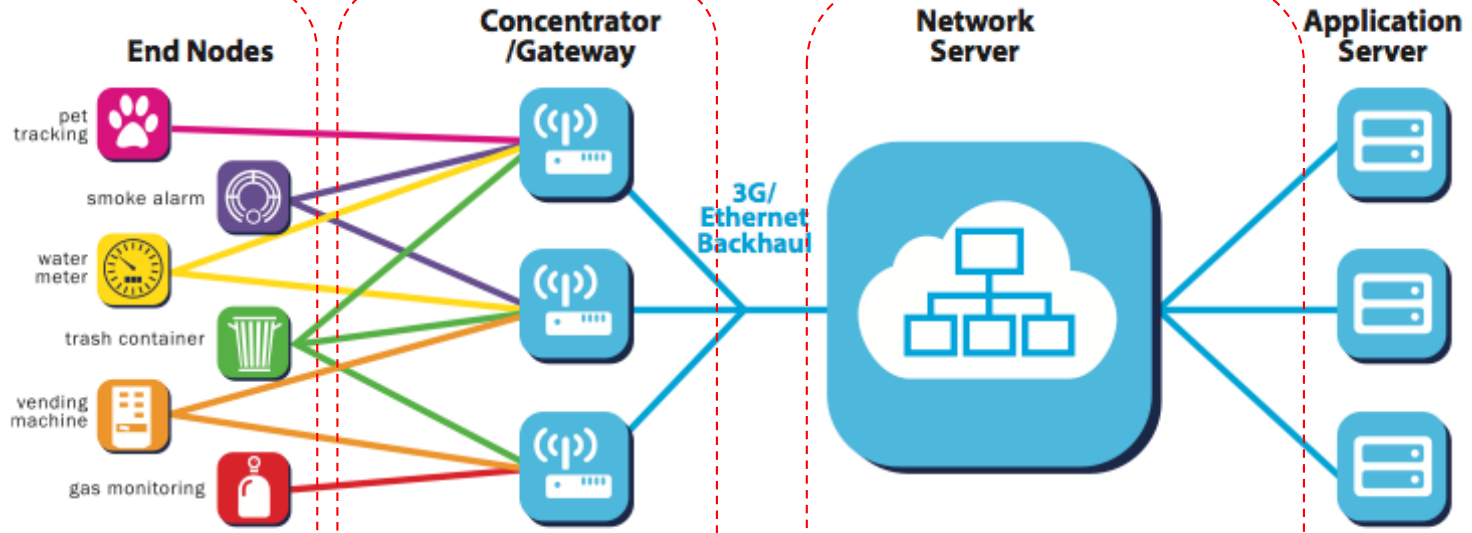


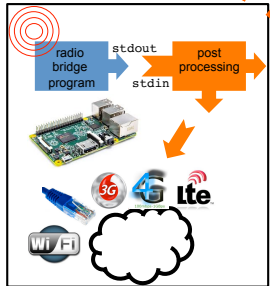
Figure from Semtech



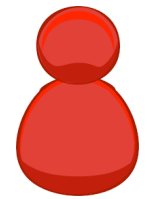
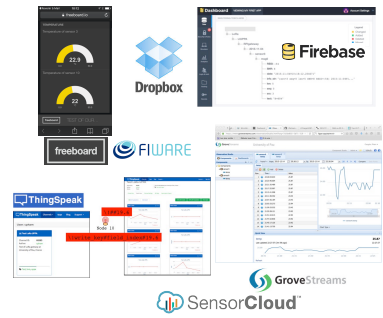
A



Application
WAZIUP Sensor platform

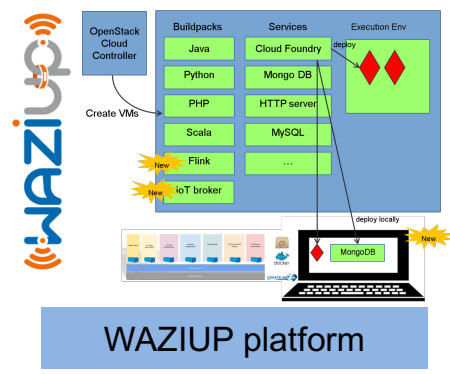


WAZIUP gateway platform



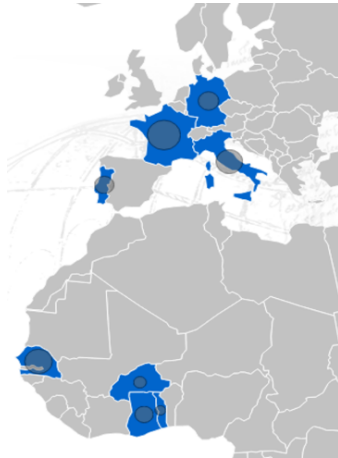
B

Towards Edge Computing

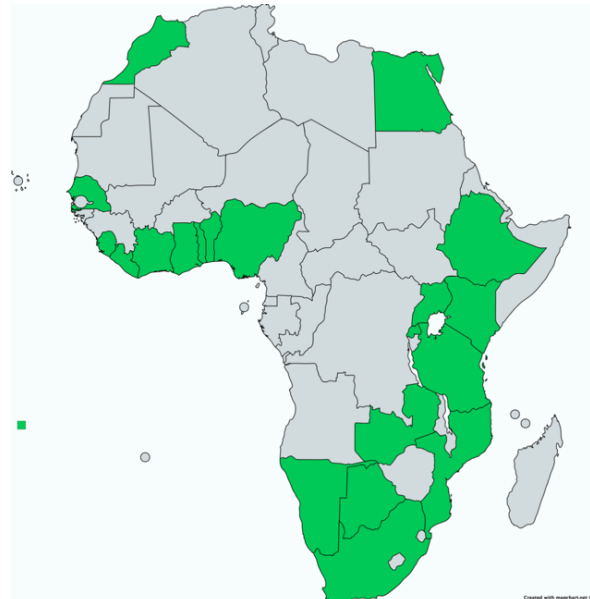


SCALING UP!

Feb 2016 - 2019



May 2018 - 2021





Thanks.
Let's keep in touch



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linkedin.com/groups/8156933



github.com/waziup