

INTRODUCING THE CONCEPTS & TECHNOLOGIES OF INTERNET-OF-THINGS

WAZIHUB ENTREPRENEUR TRAINING EVENT
HIVE COLAB, KAMPALA, UGANDA
MAY 5TH, 2018

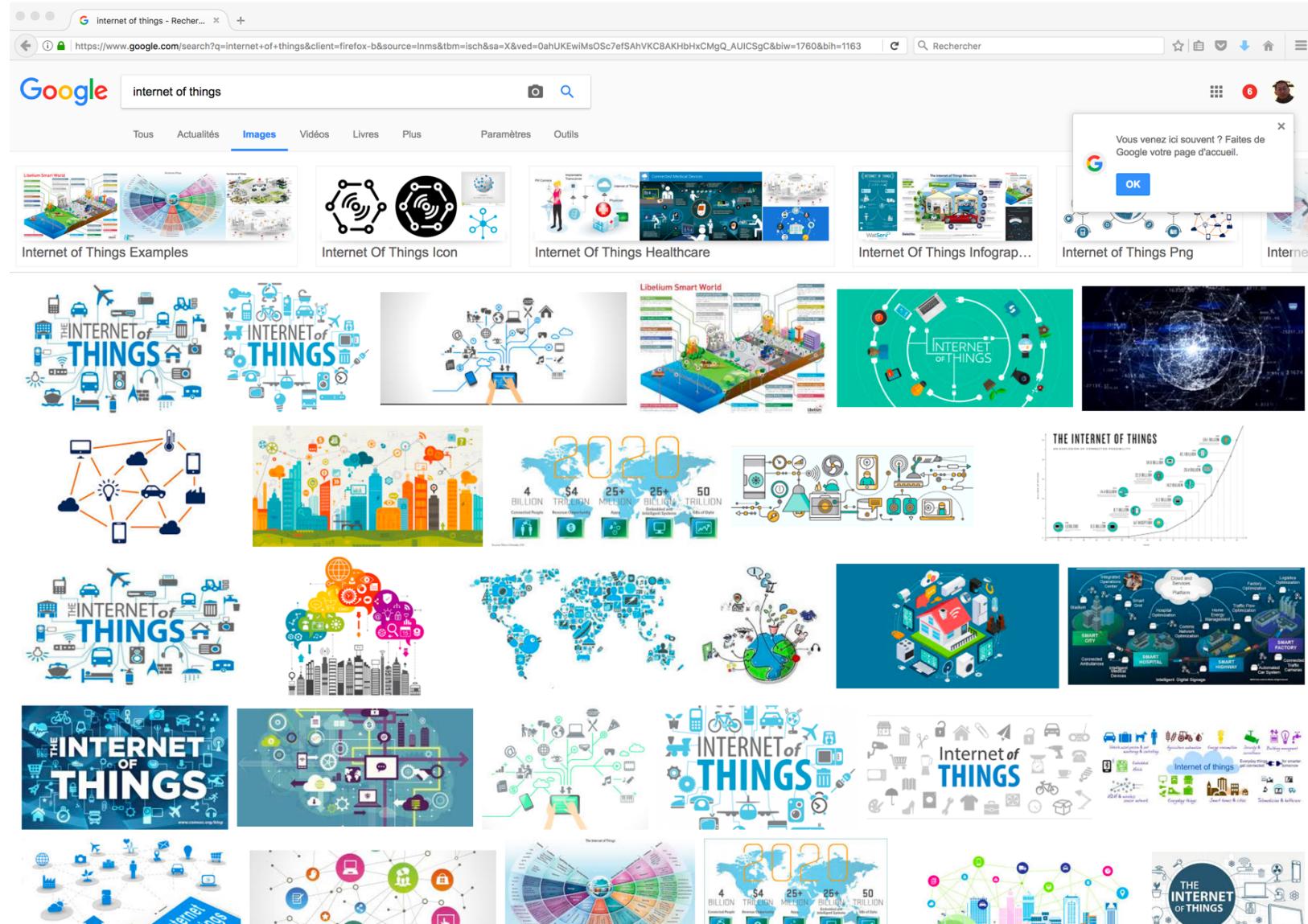


Accelerating Open IoT and Big Data Innovation in Africa

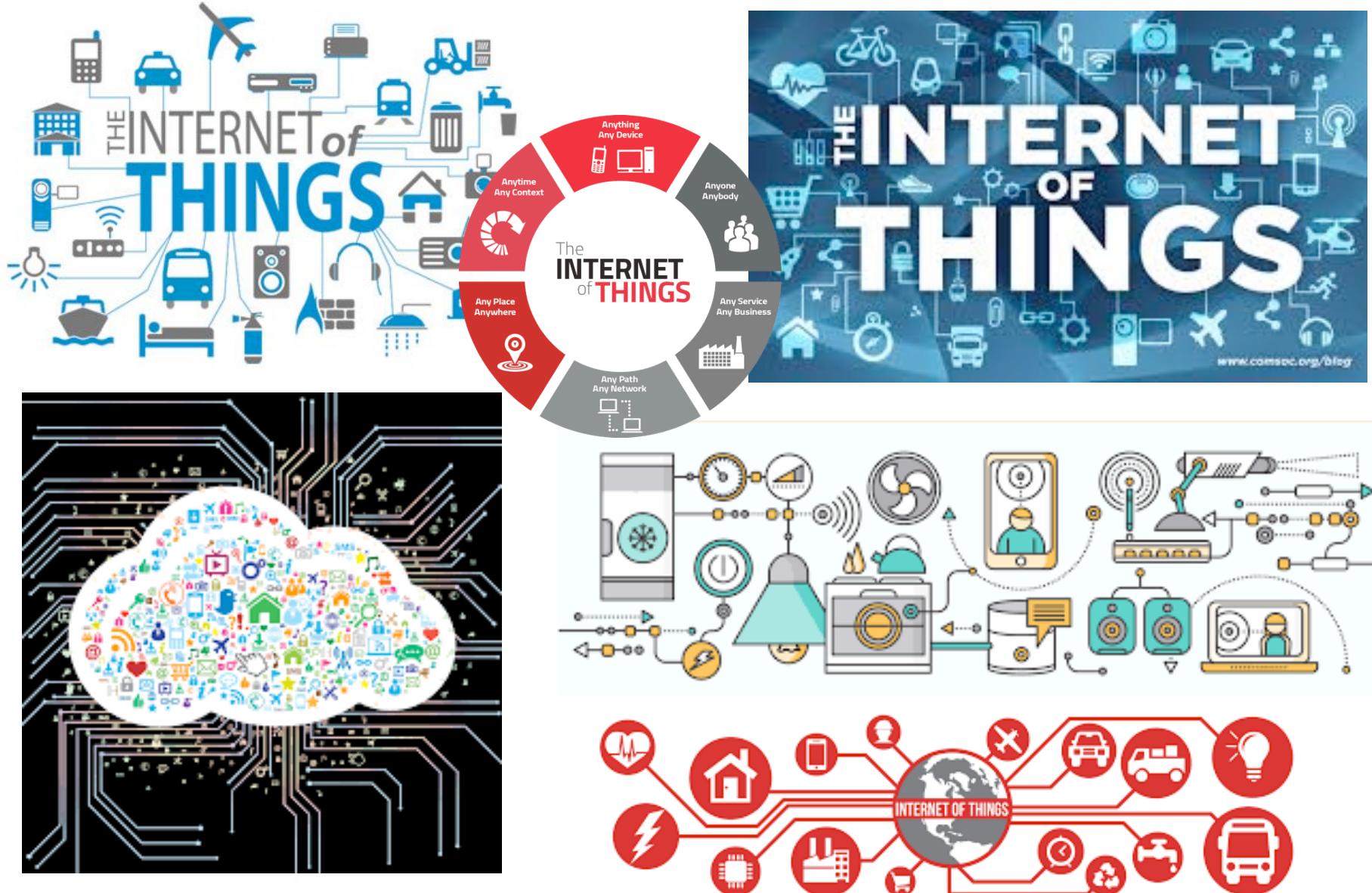


PROF. CONG DUC PHAM
[HTTP://CPHAM.PERSO.UNIV-PAU.FR/](http://CPHAM.PERSO.UNIV-PAU.FR/)
UNIVERSITÉ DE PAU, FRANCE
CONG.DUC.PHAM@UNIV-PAU.FR

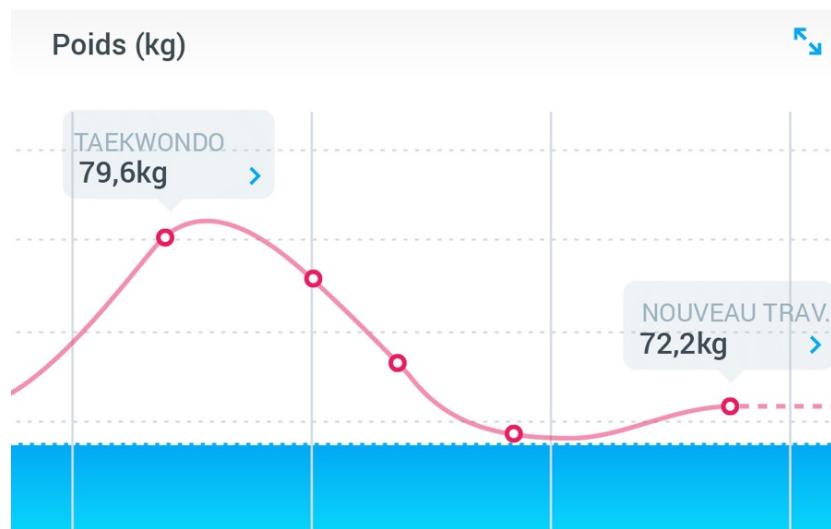
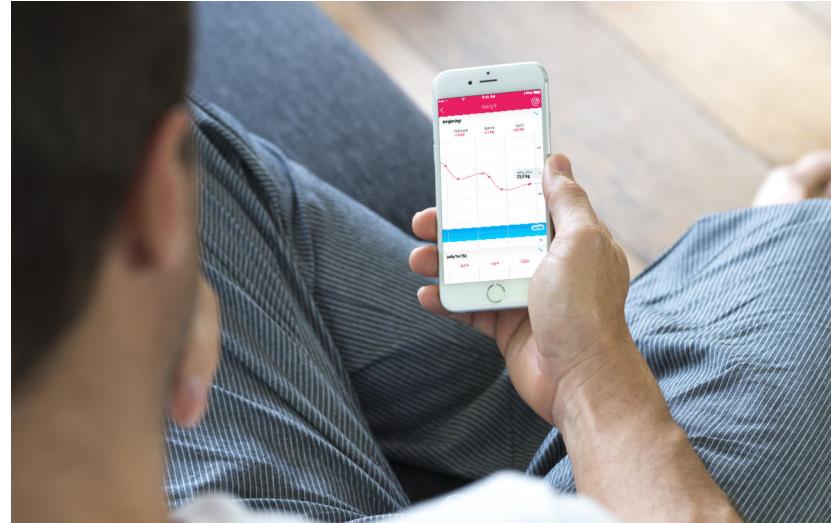
Googling for « Internet of Things »...



typically shows communicating objects

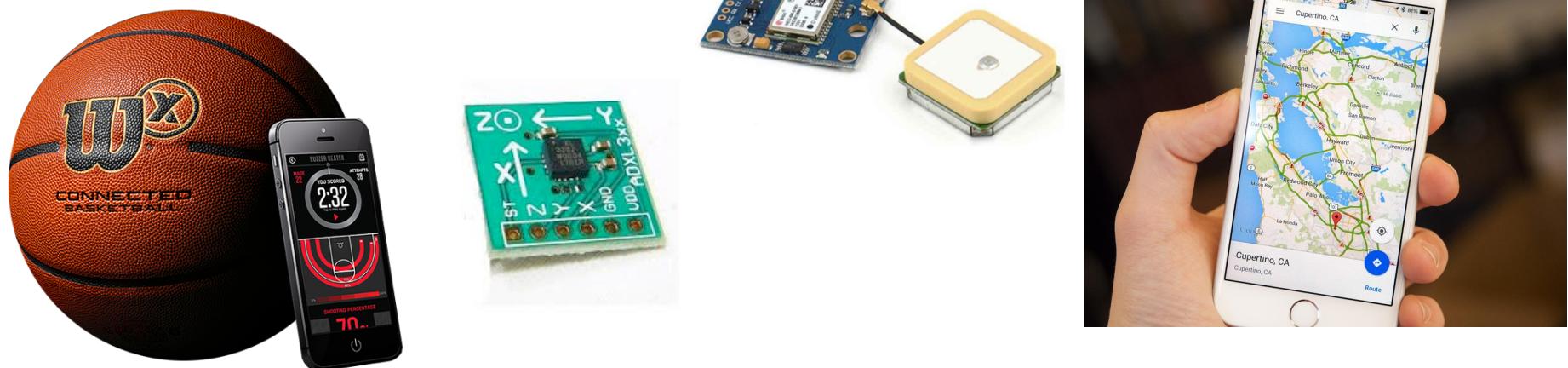


Home/consumer IoT products

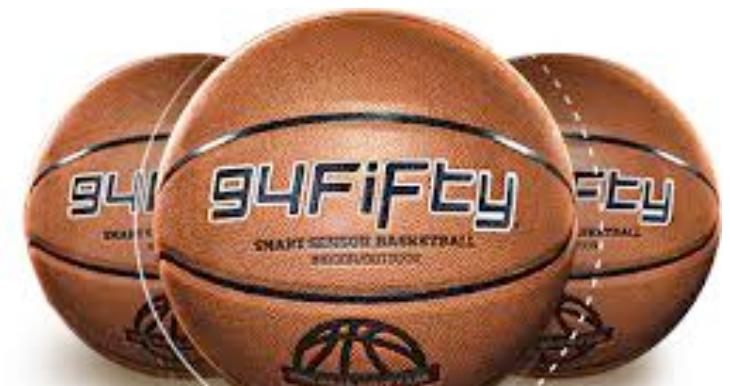


Pictures from WiThing, <https://www.withings.com/eu/fr/products/body>

IoT & physical world



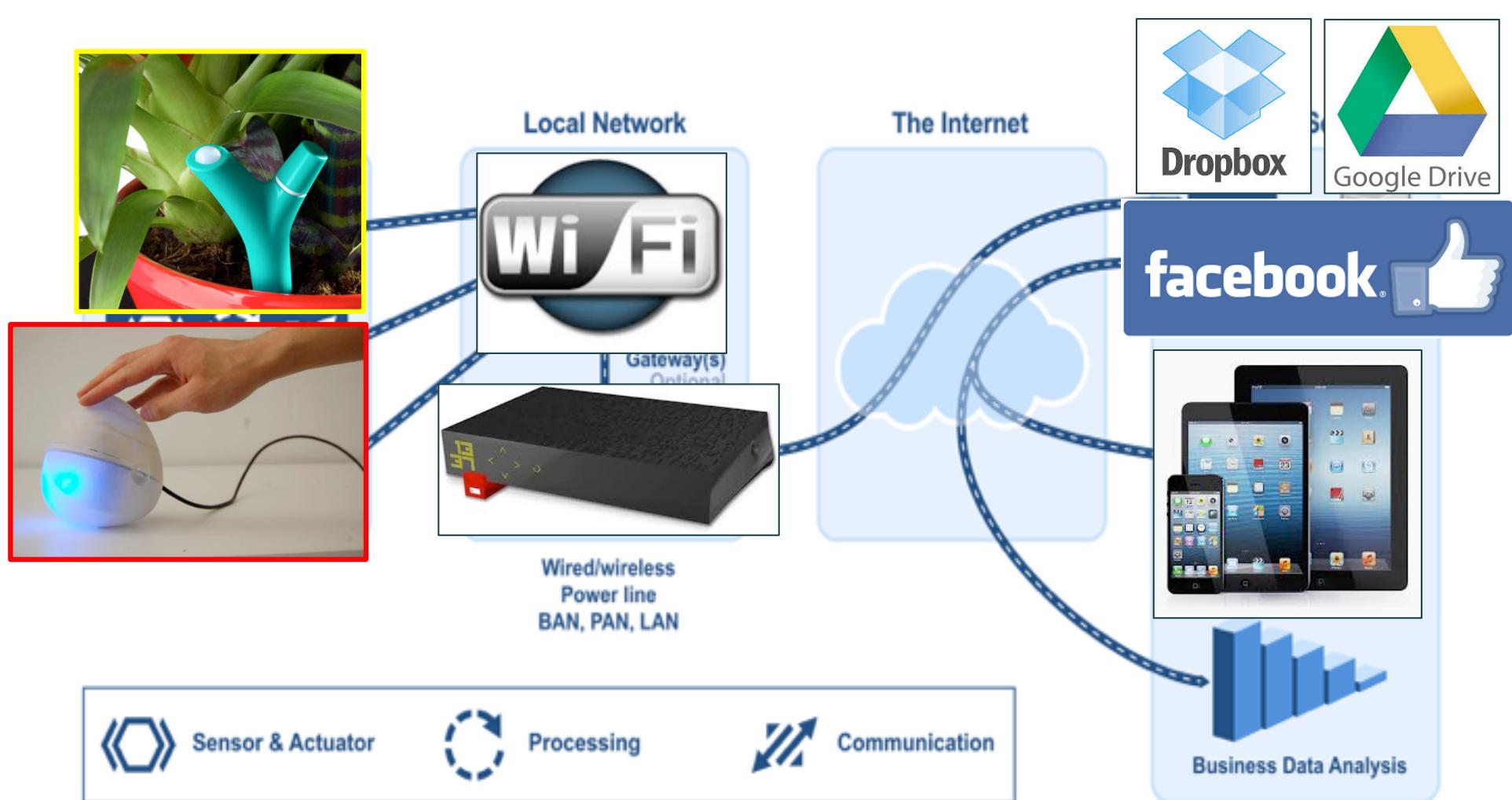
Local interaction is possible



But IoT usually means cloud data

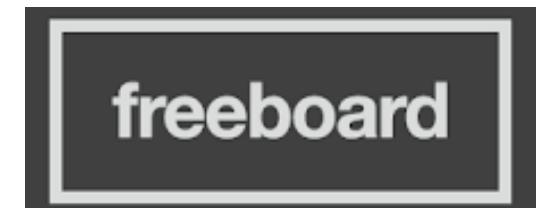


General public IoT architecture



Pictures from ArchitectCorner

Dedicated IoT cloud



Using ThingSpeak



ThingSpeak

Channels Apps Blog Support

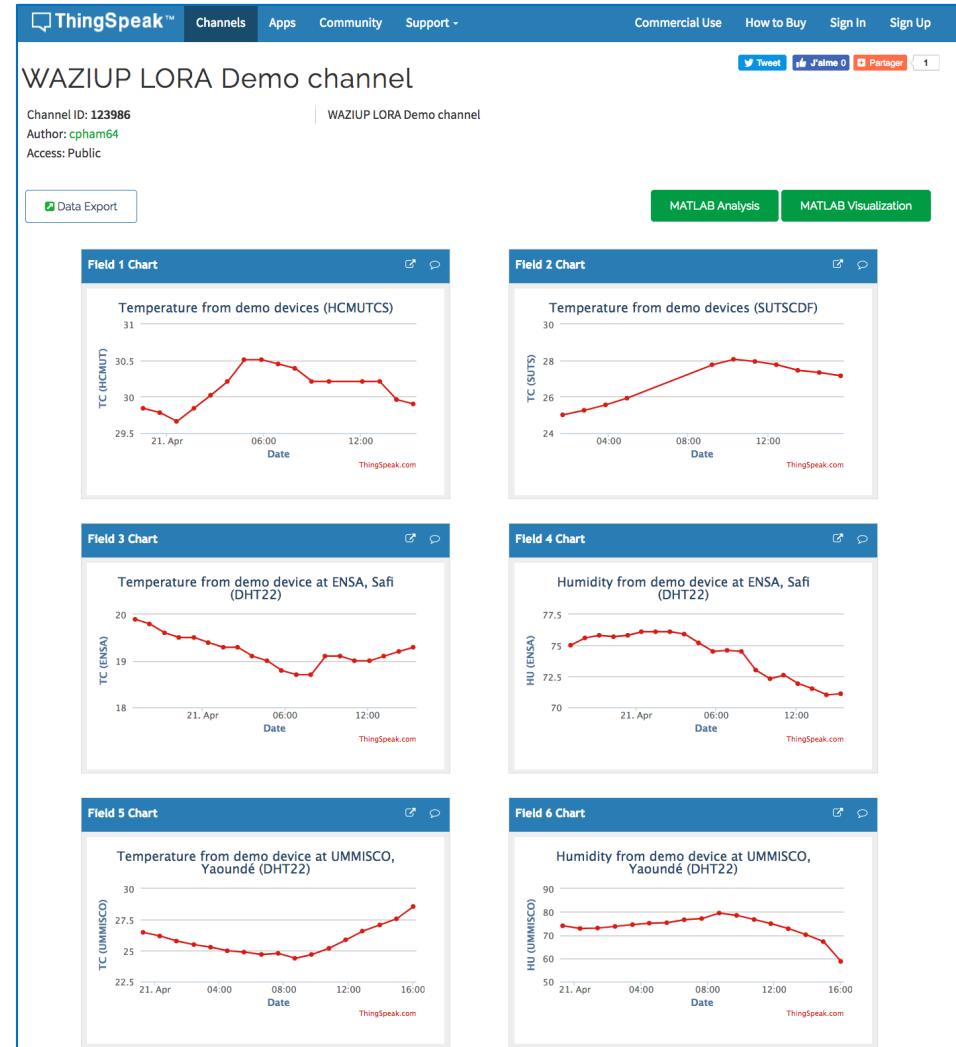
User: cpham

Test LoRa UPPA

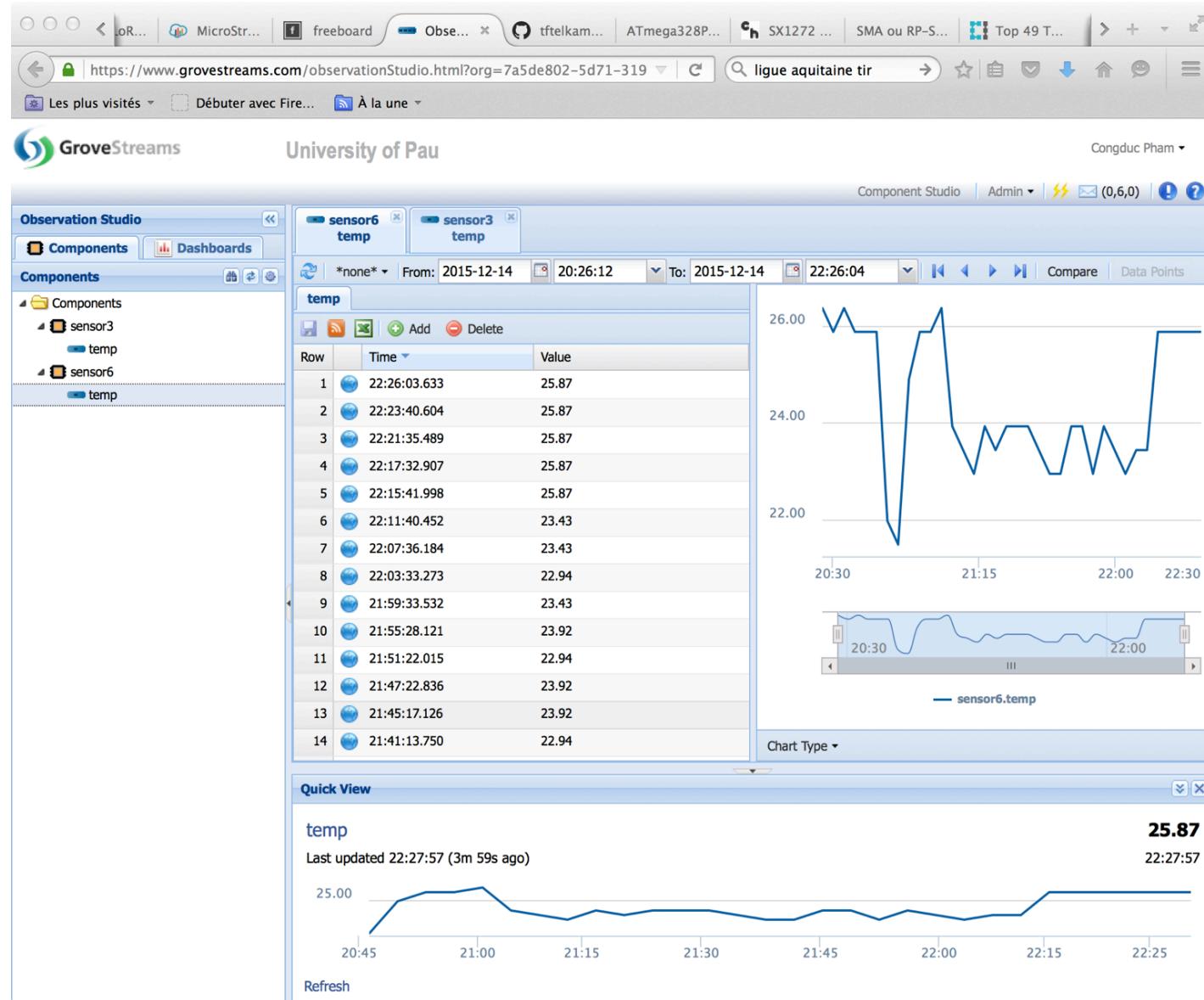
Channel ID: 66583
Author: cpham
Test of LoRa gateway at University of Pau, France

Test, lora, uppa

19.6
Node 10



Using



The WAZIUP/WAZIHUB cloud



□ dashboard.waziup.io

The screenshot displays the WAZIUP/WAZIHUB cloud dashboard interface. On the left, there are three cards representing different nodes:

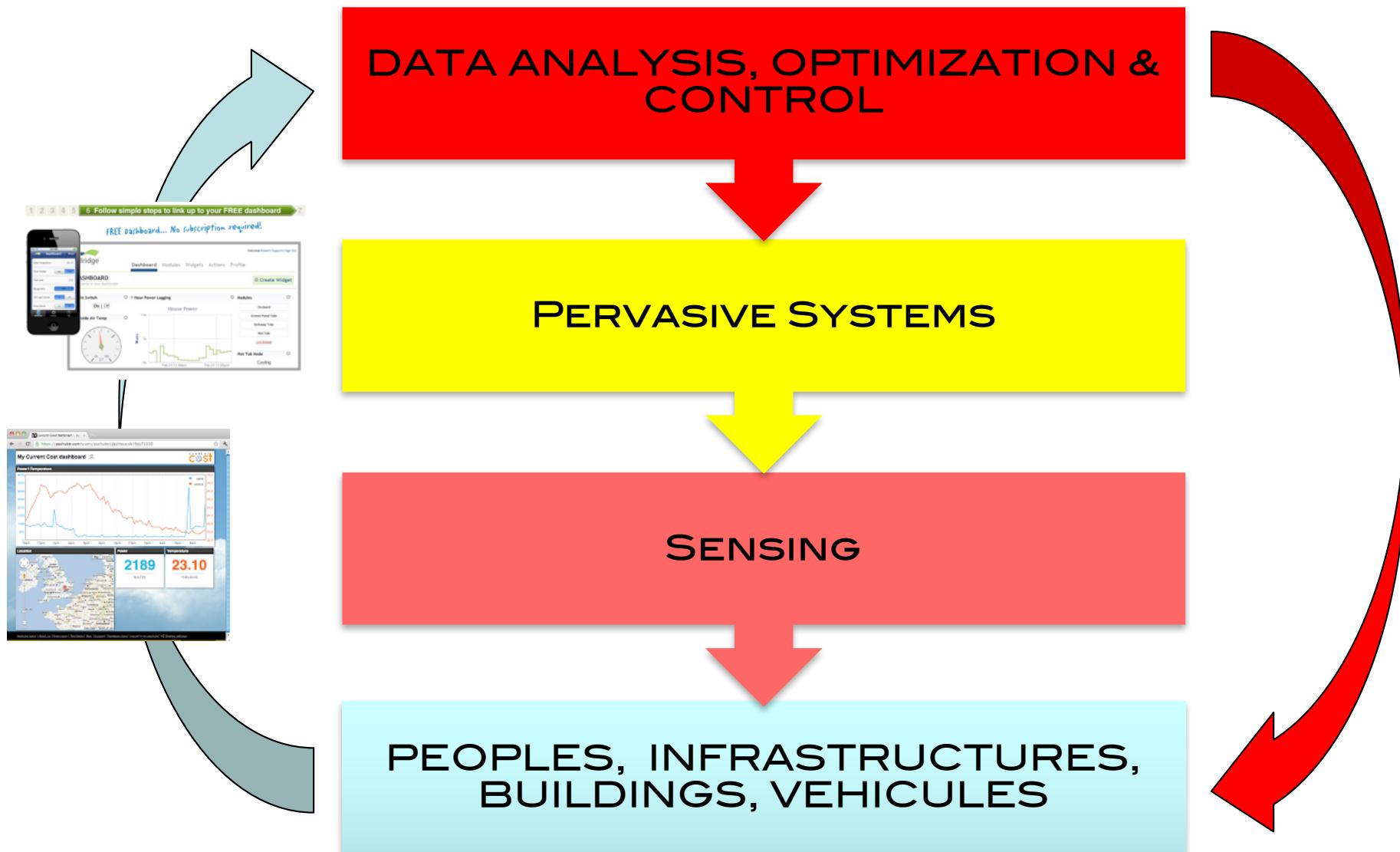
- Node UPPA Sensor 6**: Shows a green card with a temperature reading of 17.21 °C.
- Node (UPPA_Sensor3)**: Shows a green card with a temperature reading of 21.43.
- Node (UPPA_Sensor10)**: Shows a red card with a temperature reading of 23.97.

On the right, there is a detailed view for **UPPA Sensor 6**, featuring a graph showing temperature data over time, with a current reading of 17.21 °C. Below this is a map of Europe with a marker indicating the location of the sensor in France.

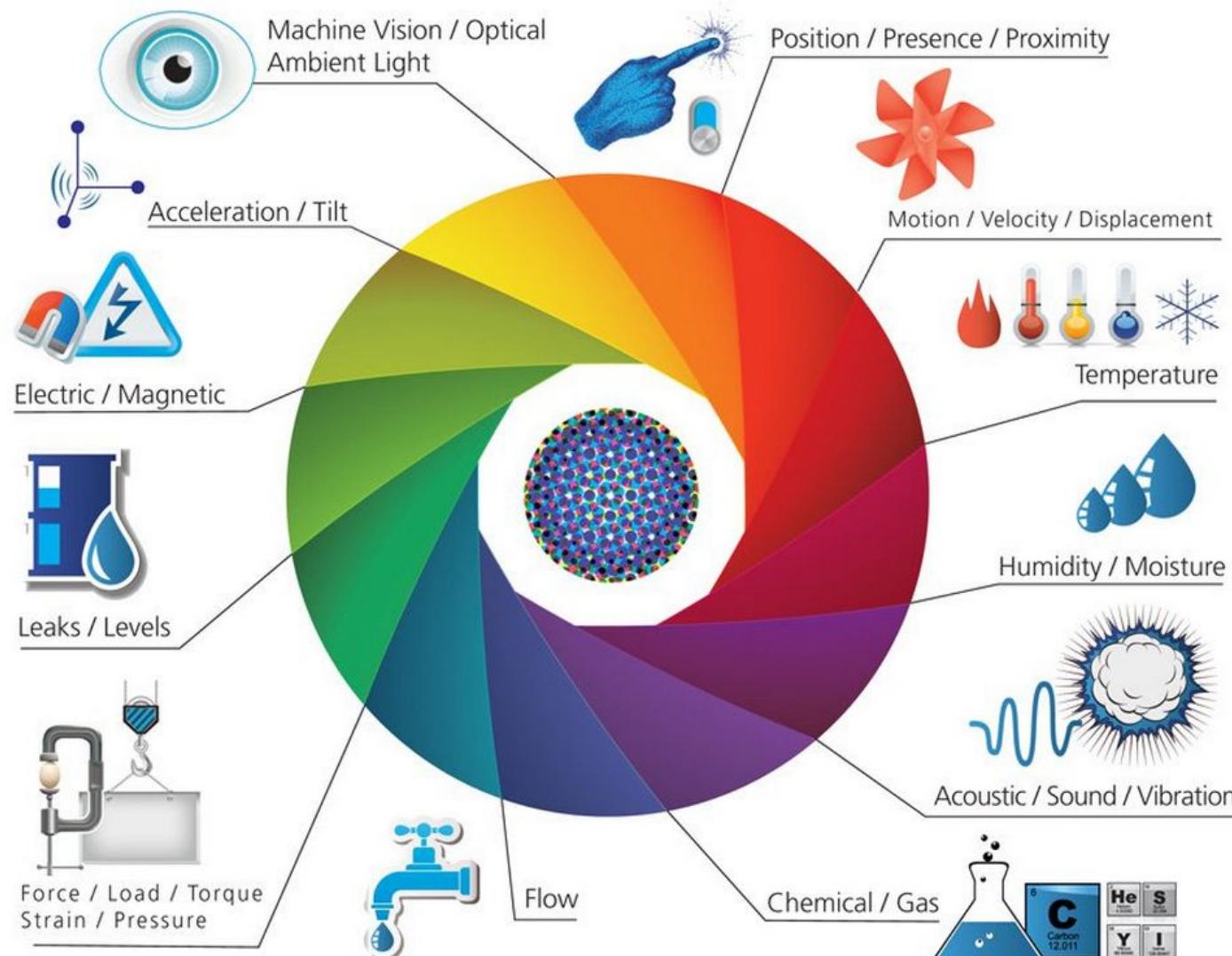
One of the most promising market is IoT!



Control, Optimize & Instrument !



Large variety of sensoring needs

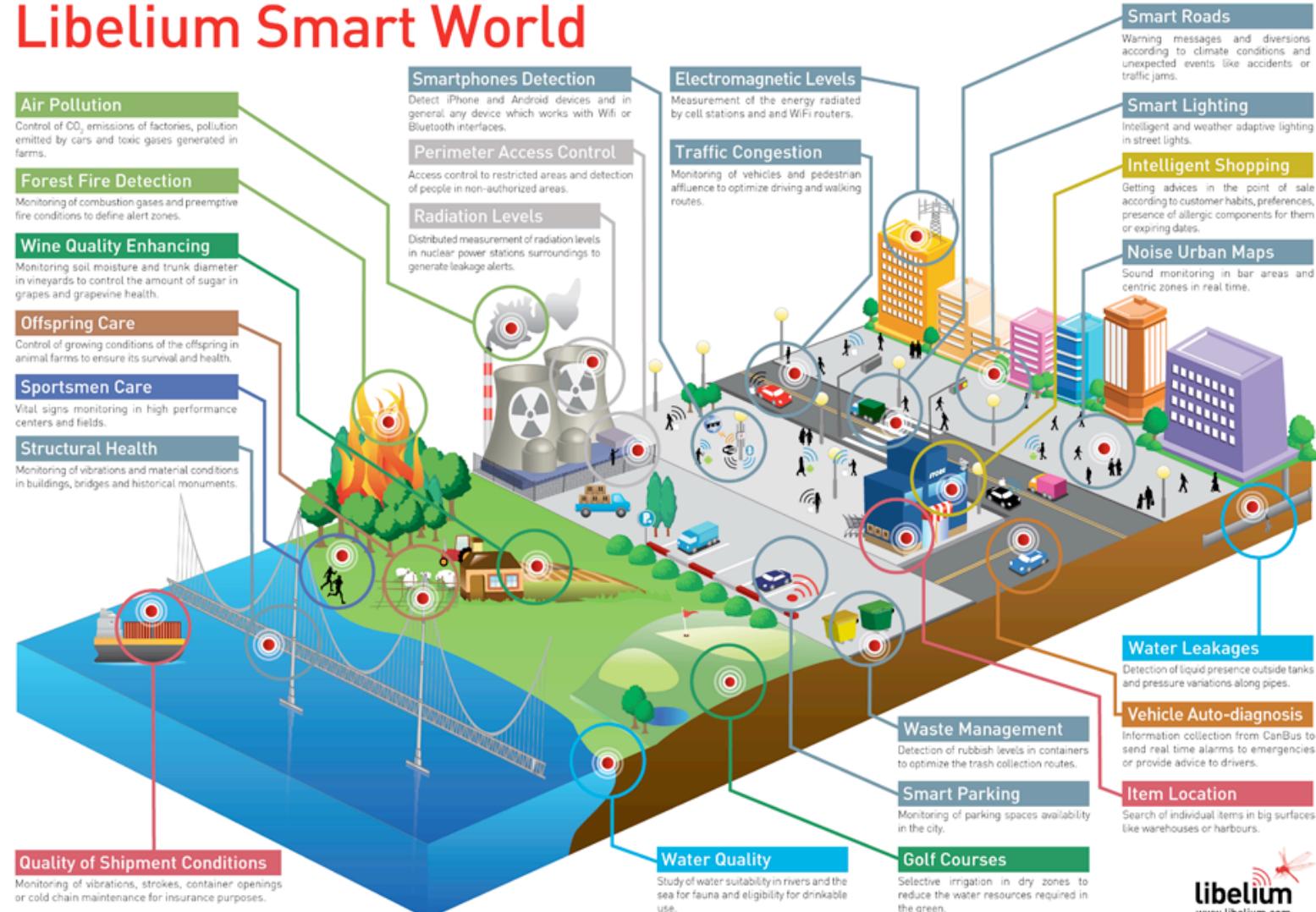


infographic made by Postscapes in collaboration with Harbor Research

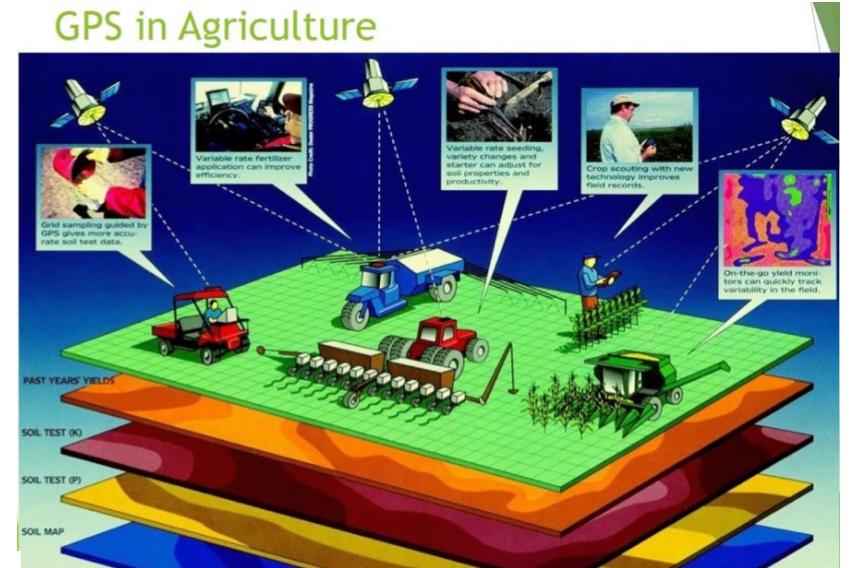
Example 1: Smart Cities



Libelium Smart World



Example 2: Farming & Agriculture



IoT4D: development for rural areas



Irrigation



Storage & logistic



Agriculture



Environment



Agriculture





The IoT ecosystem



1st issue: IoT are small devices



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



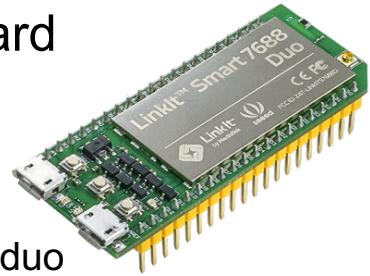
Theairboard



LoPy



Arduino Pro Mini



LinkIt
Smart7688 duo



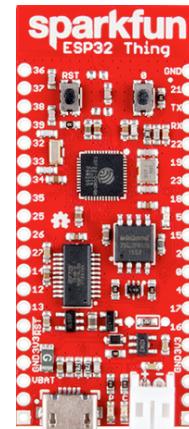
Expressif ESP32



Teensy 3.2



Adafruit Feather



Sparkfun ESP32 Thing



Tessel

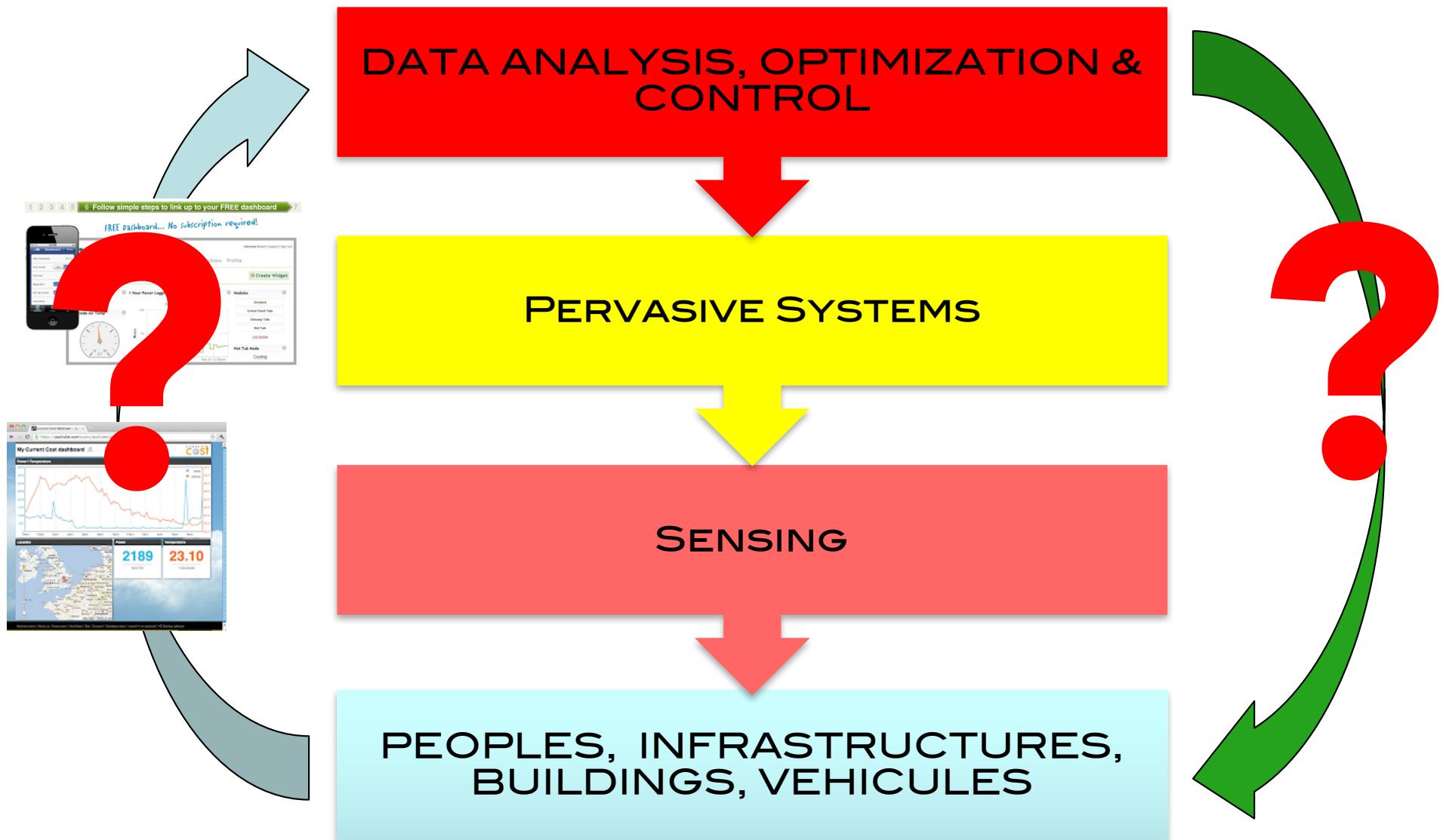


SodaqOnev2



Tinyduino

2nd issue: collect data



Wireless Communication made easy



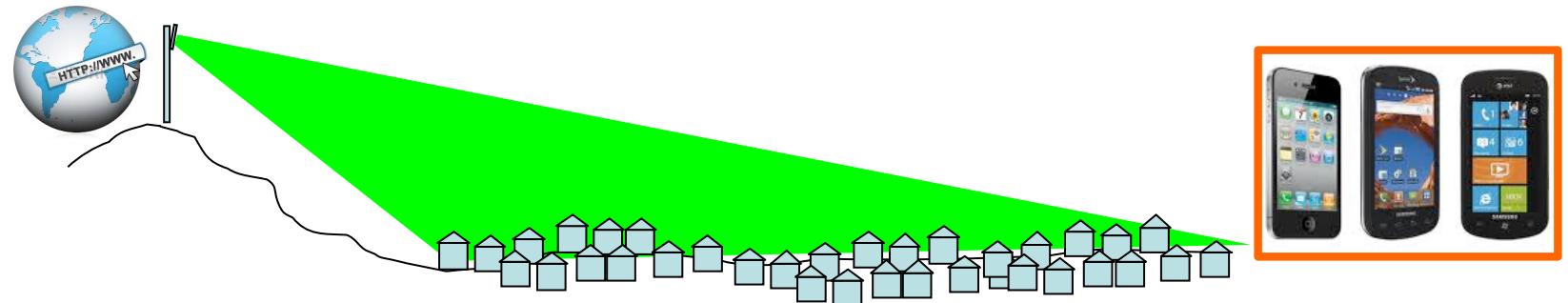
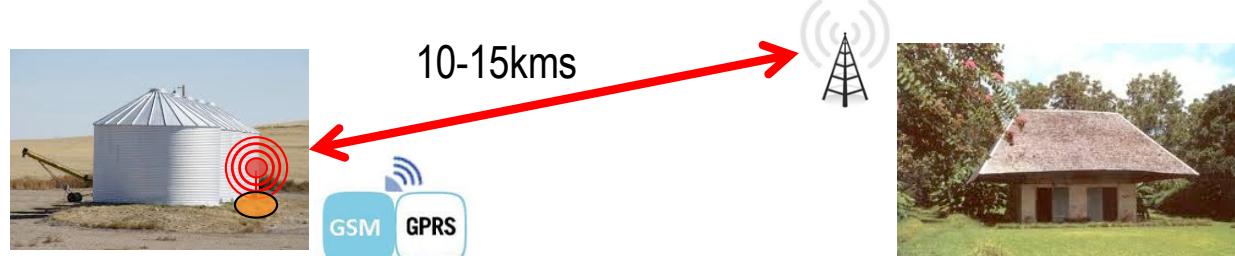
IoT=wireless+battery



Telemetry and Transmission cost



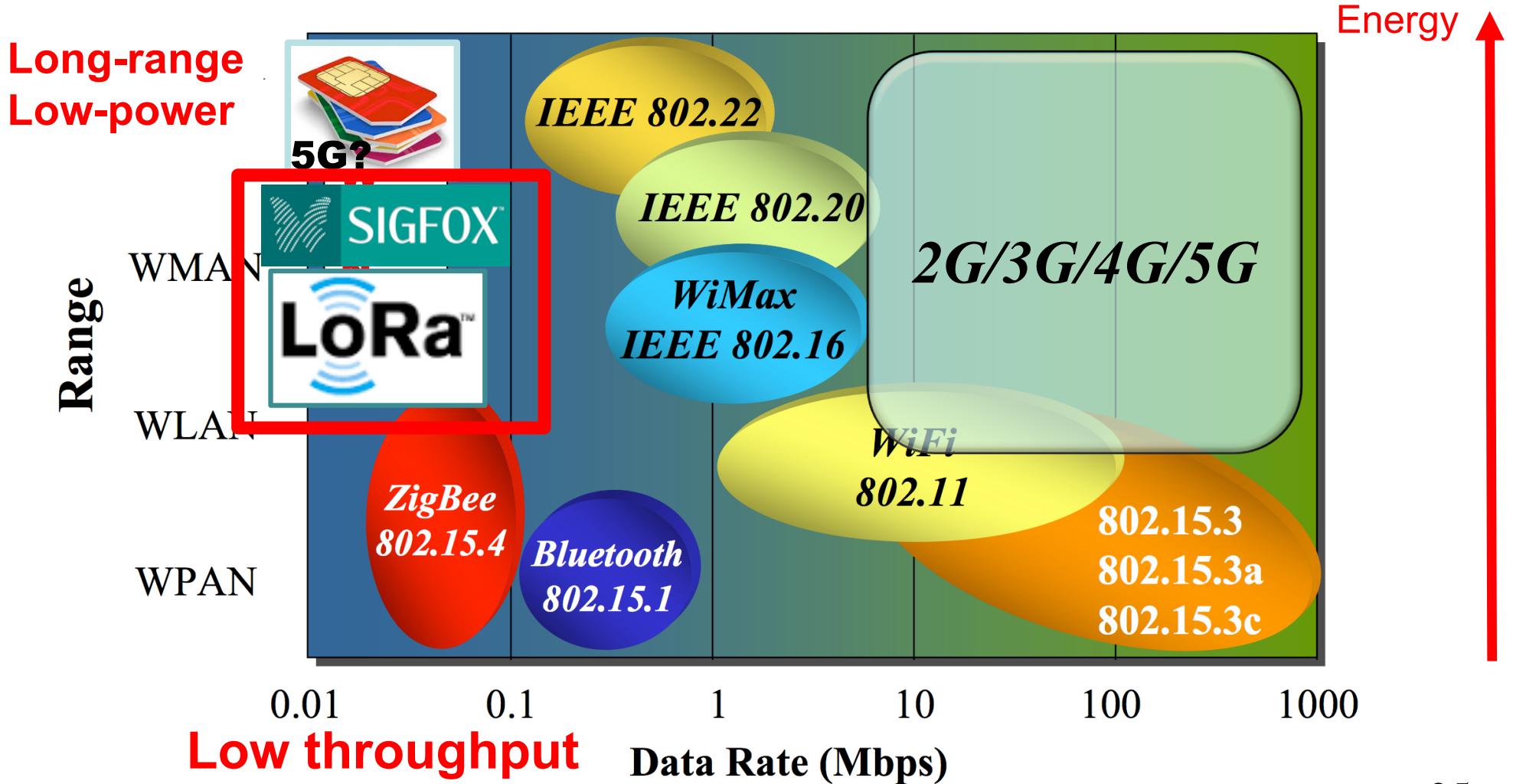
Moisture/
Temperature of
storage areas



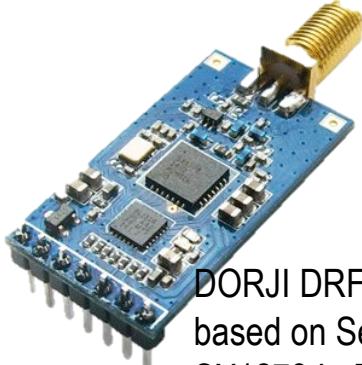
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC

Low-power & long-range radio technologies

Energy-Range dilemma



Some LoRa radio modules



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)



Multi-Tech MultiConnect mDot



Adeunis ARF8030AA- Lo868

habSupplies

AMIHO AM093



ARM-Nano N8 LoRa module from ATIM



SODAQ LoRaBee Embit

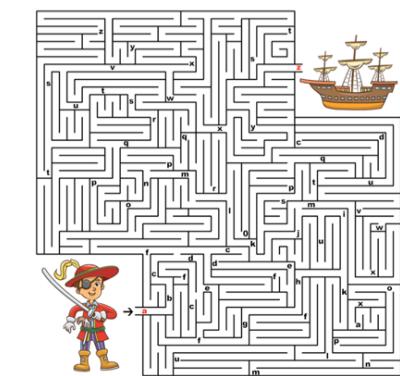


SODAQ LoRaBee RN2483

3rd issue: finding the information you need



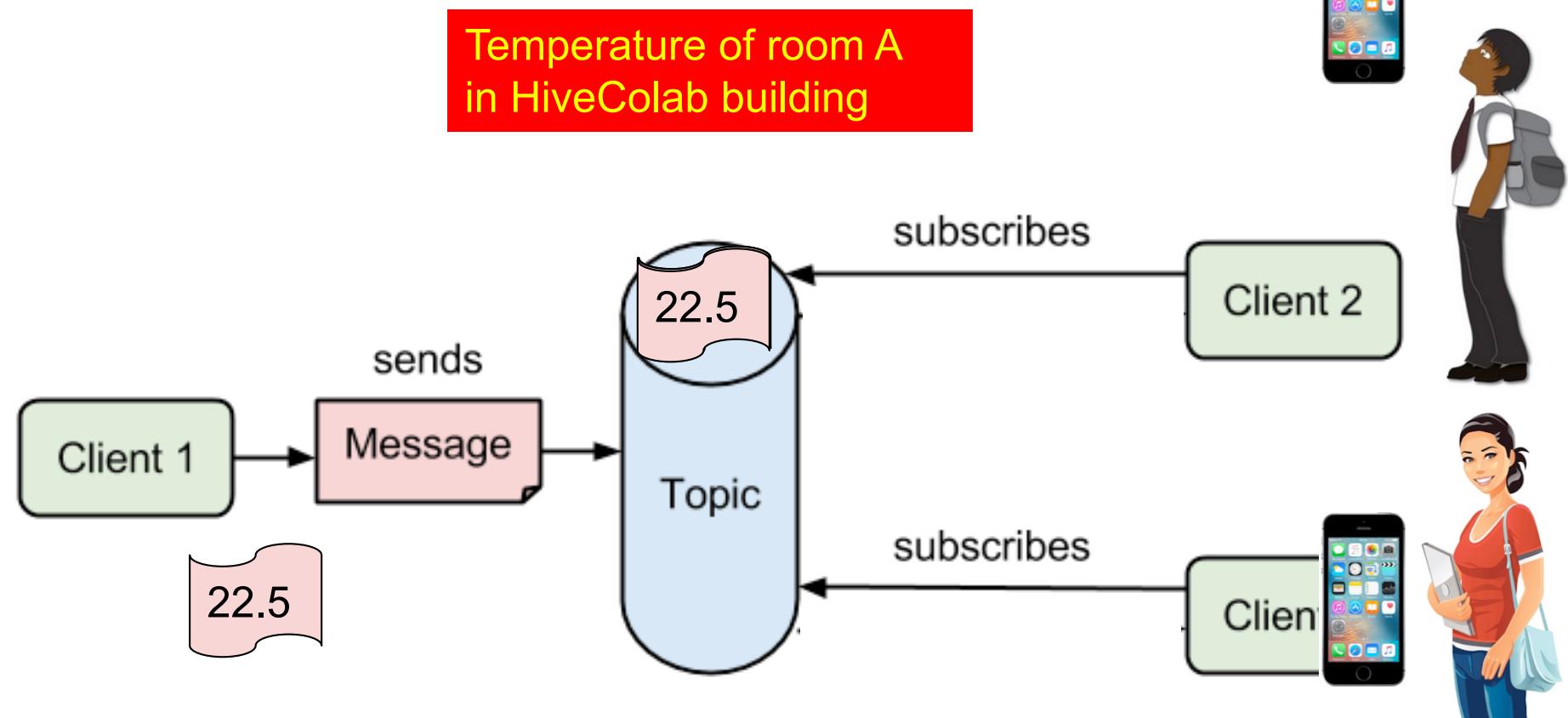
- Searching for information is a tough issue
 - Web search engine: Google,...
- Most IoT clouds uses HTTP request (GET, POST, PUT, ...) to push/store data to web platforms/servers
- If you need an information, for instance **the temperature in room A of HiveColab in Kampala**, then you have to go to 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

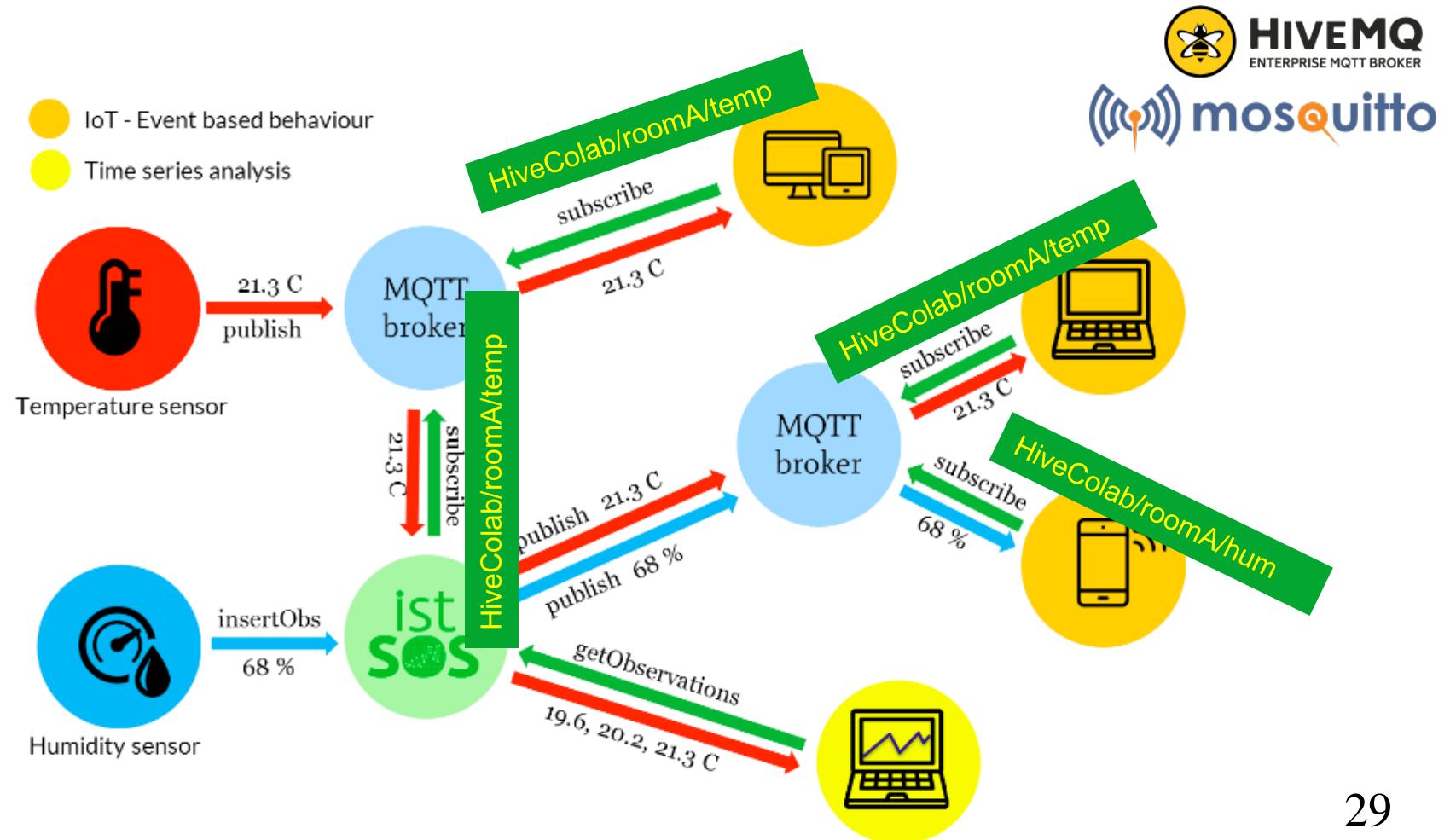


MQTT

Message Queue Telemetry Transport



- Use broker nodes to manage topics
 - HiveColab/roomA/temp, HiveColab/roomA/hum



MQTT+smartphone=



MQTT Dash (IoT, Smart Home)

Routix software Communication

3 PEGI 3

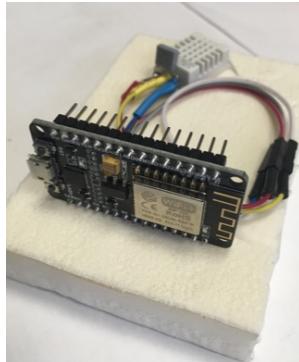
This app is compatible with all of your devices.

Installed

Towards open data

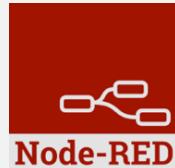
- HiveColab/roomA/#
- KPL/CITY/WEATHER/#
- KPL/CONGRESS/#

4th issue: make it simpler?

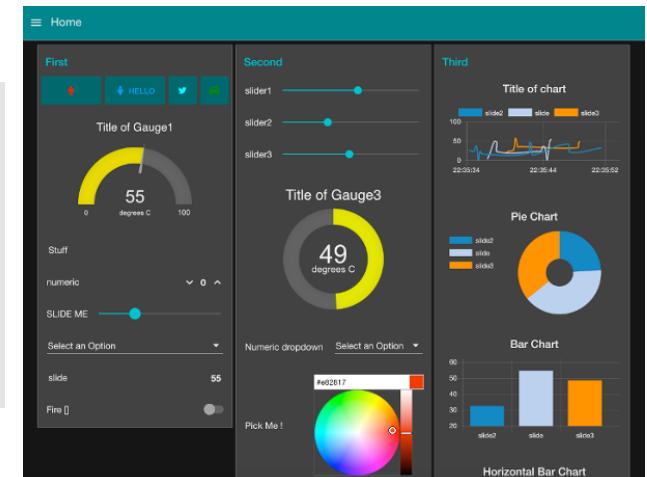
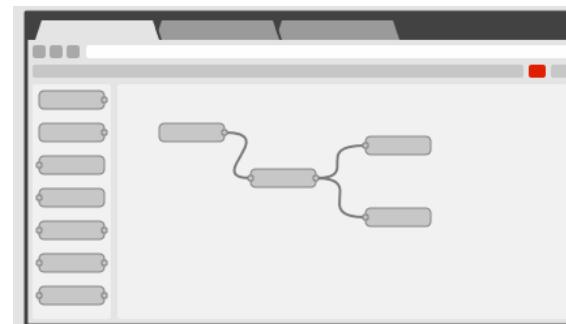
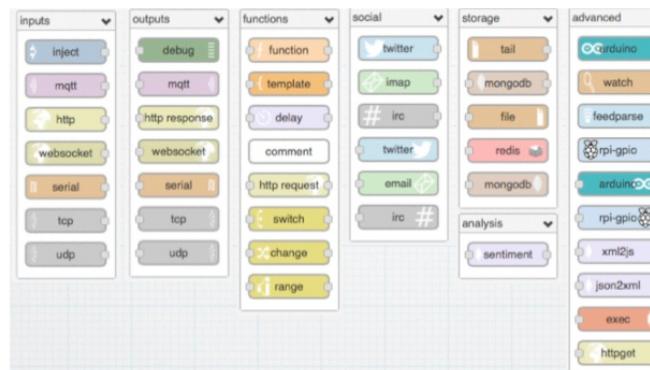


- End-users are not necessarily computer science experts nor high-skilled programmers
- Use graphical tools to build data processing flows, allowing intuitive connection from data producers to data consumers

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



Node-red enabled IoT gateway

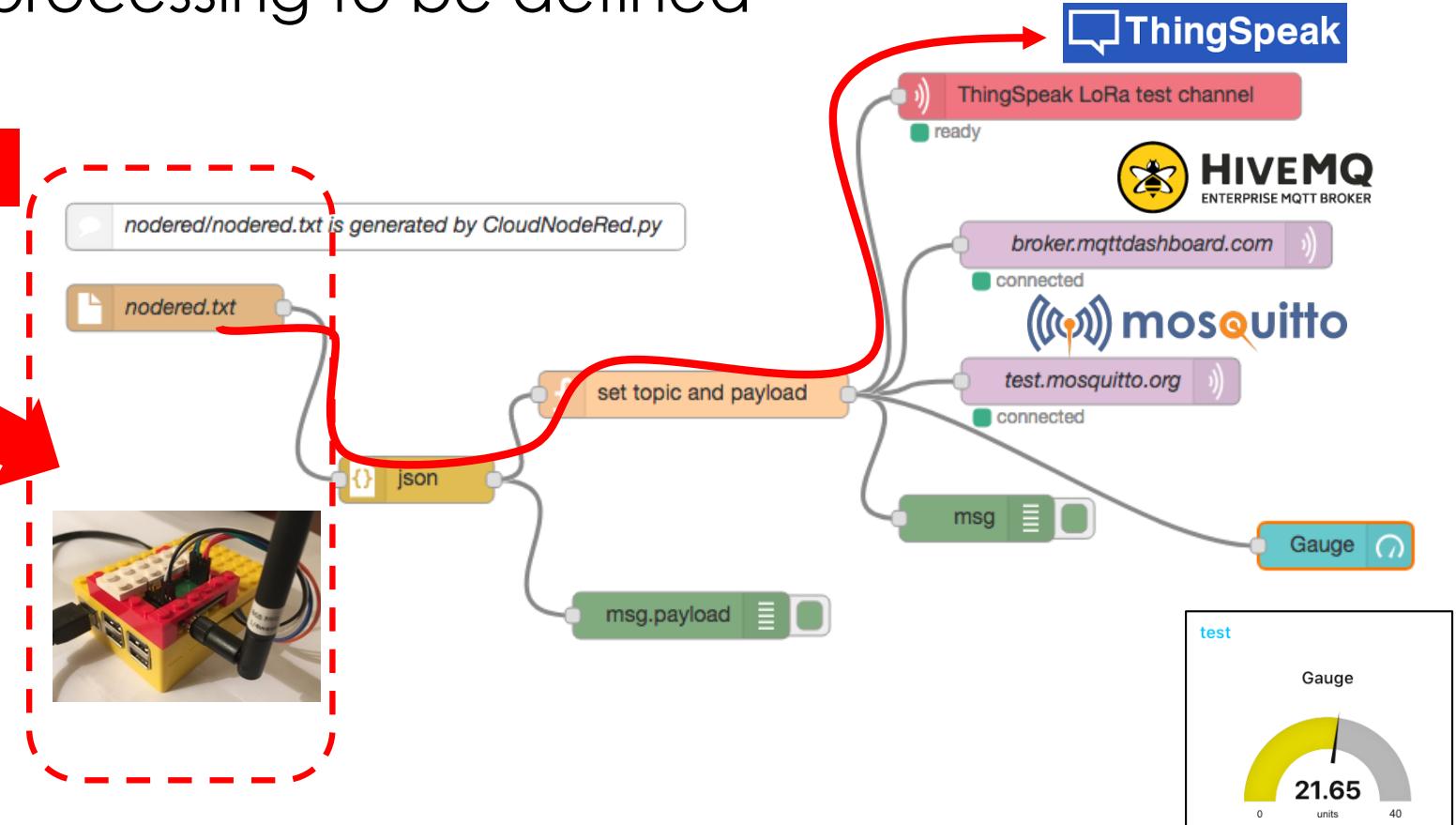


- ❑ Messages received on the IoT gateway can be injected into a Node-Red flow, allowing complex data processing to be defined

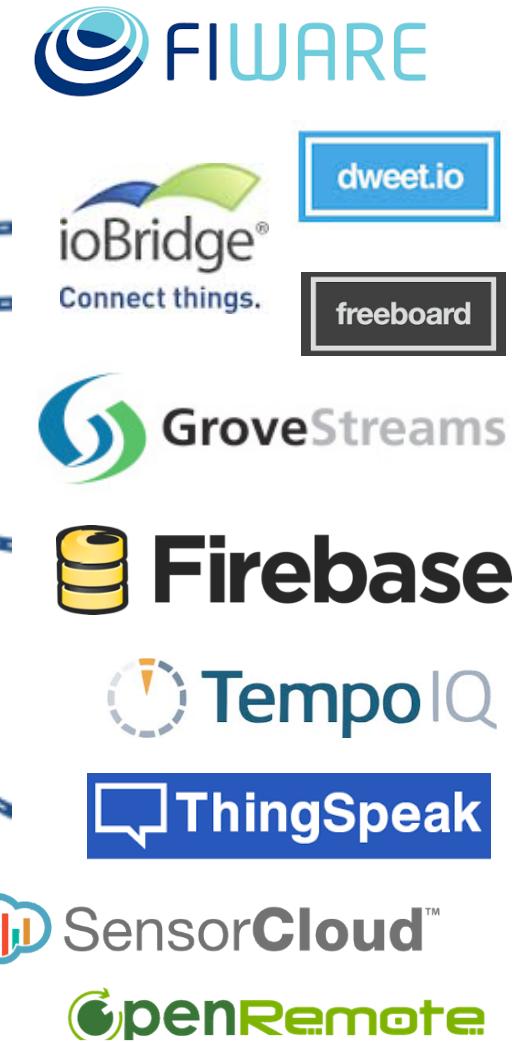
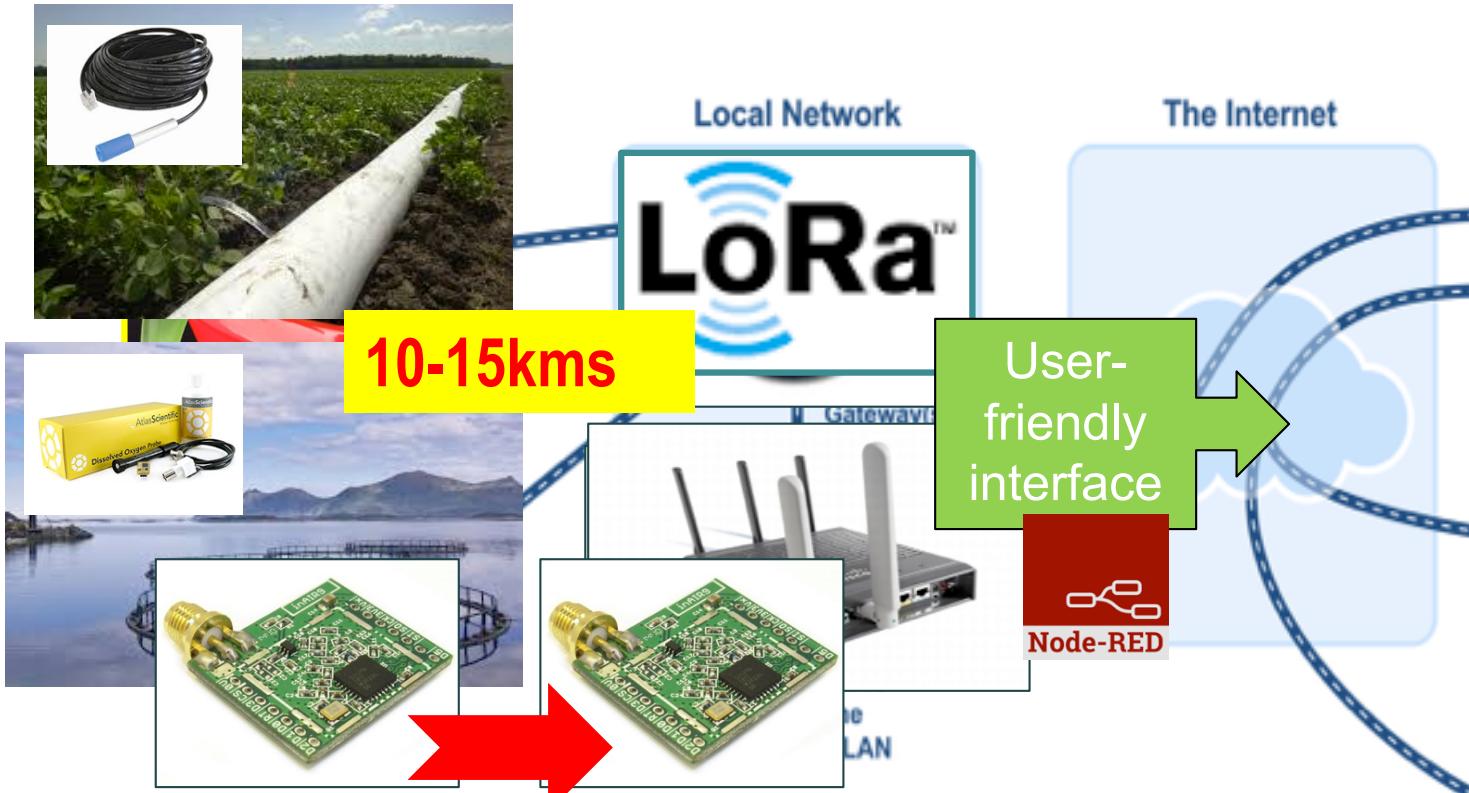


LoRa™

21.65



Global picture of long-range IoT ecosystem

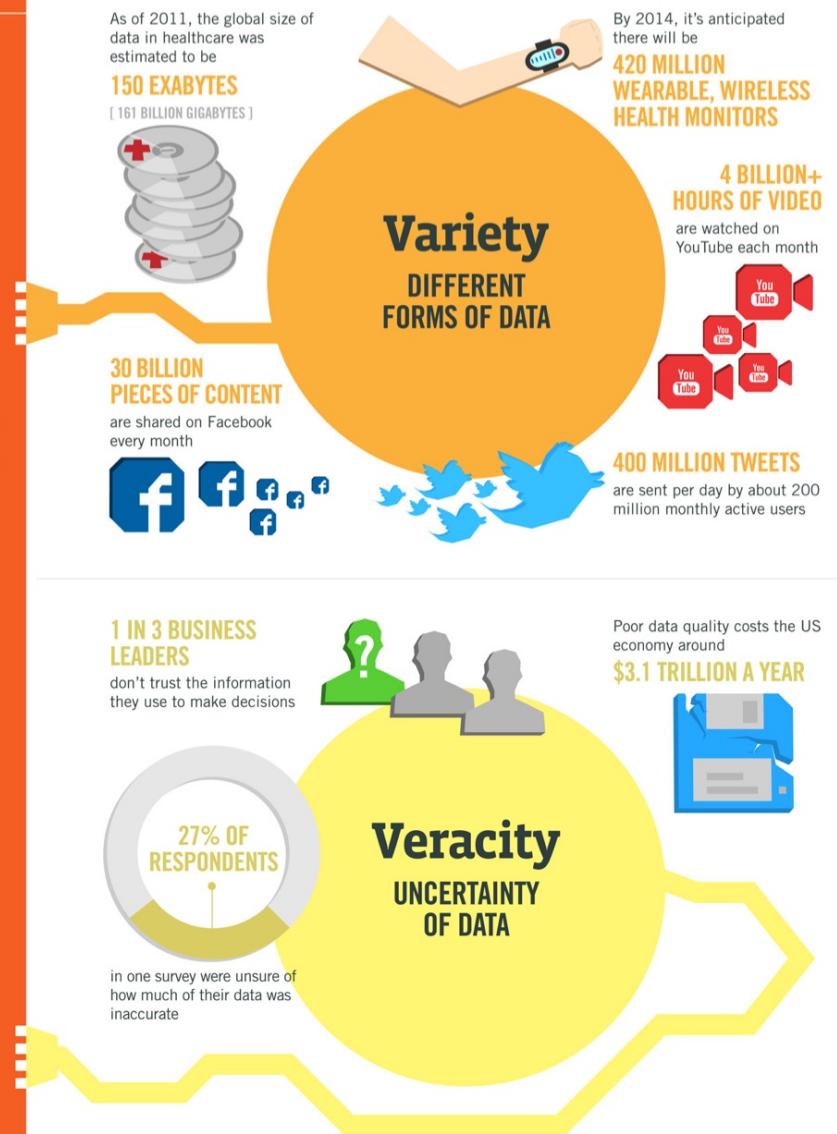
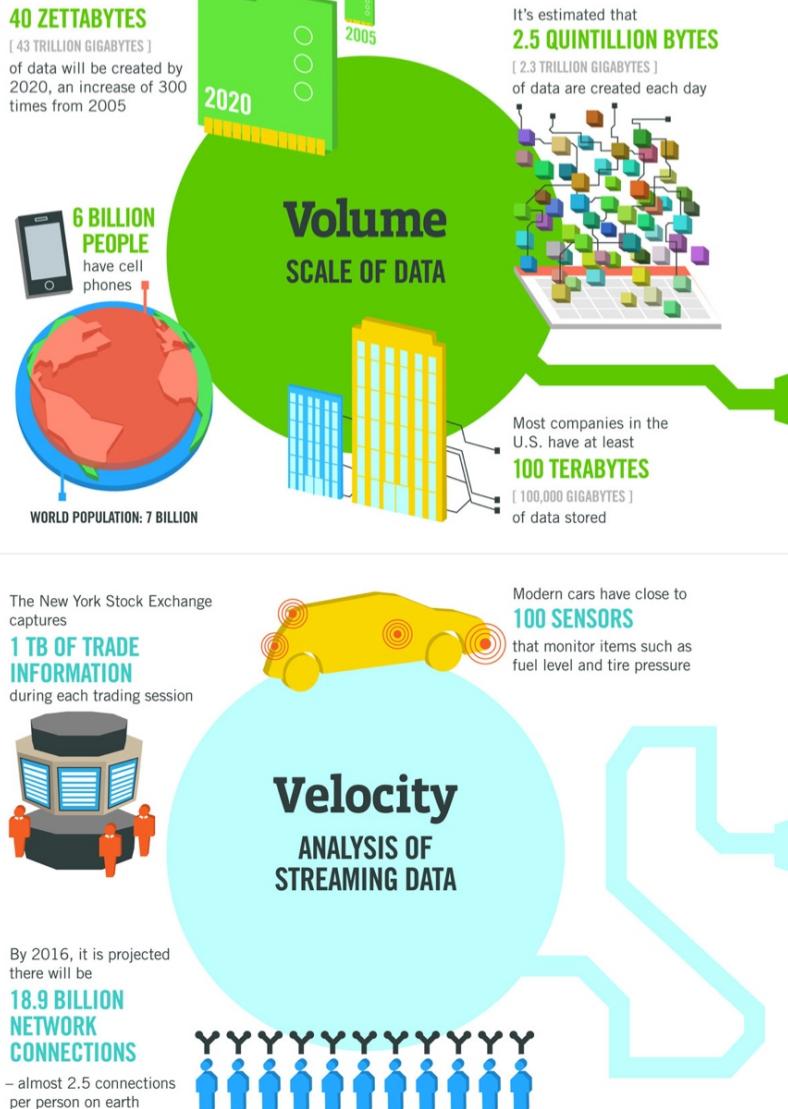


The IoT BackOffice



IoT usually means

BIG DATA



But also how to analyse the data

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

Advanced data analysis

Need of experts from the domain!

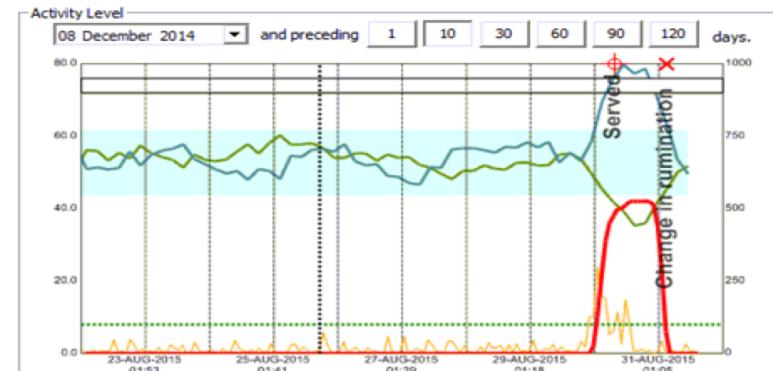
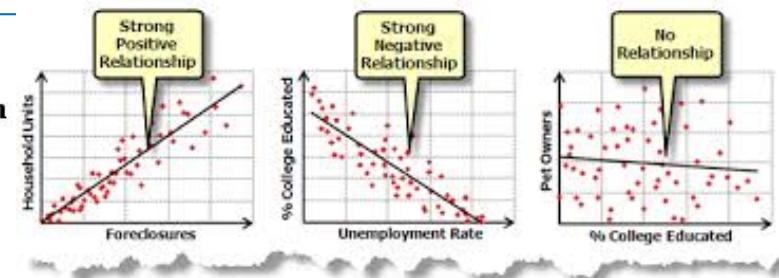
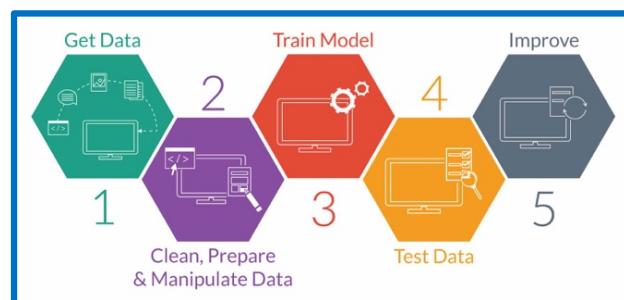
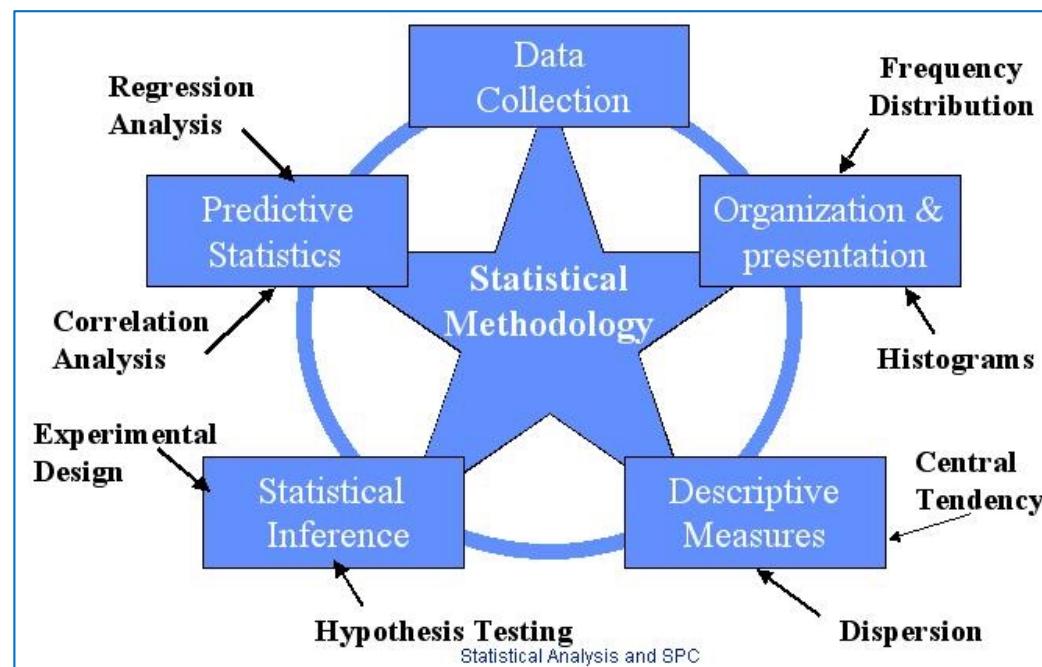


Fig. 3. Illustration of a rise in activity accompanied by a fall in rumination at the point of oestrus

Analysis techniques

- Traditional statistic methods still valid, and useful!

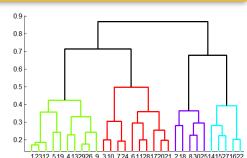


Clustering Analysis

▪ Definition
Grouping unlabeled data into clusters, for the purpose of inference of hidden structures or information

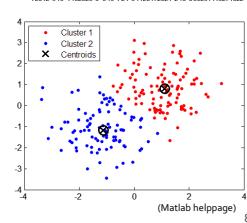
▪ Dissimilarity measurement

- Distance : Euclidean(L_2), Manhattan(L_1), ...
- Angle : Inner product, ...
- Non-metric : Rank, Intensity, ...



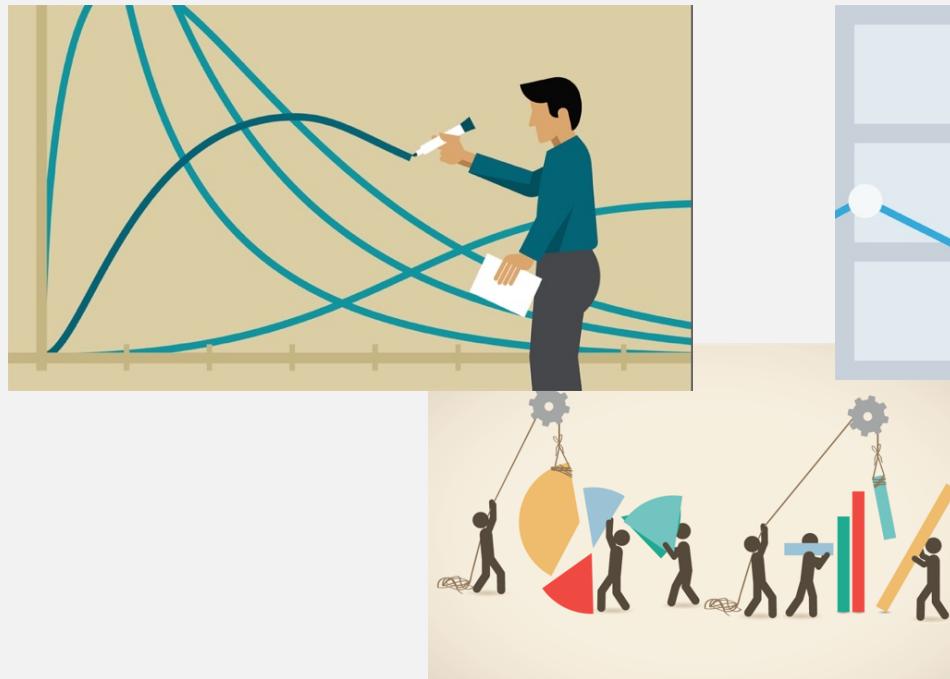
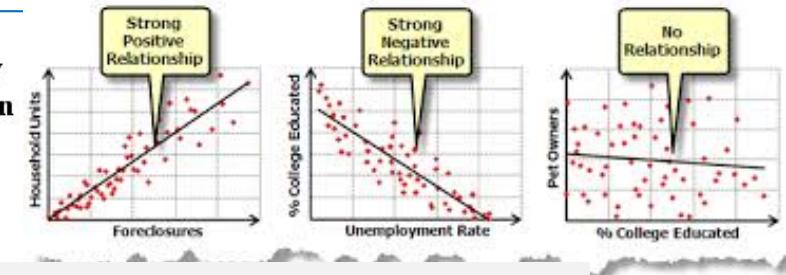
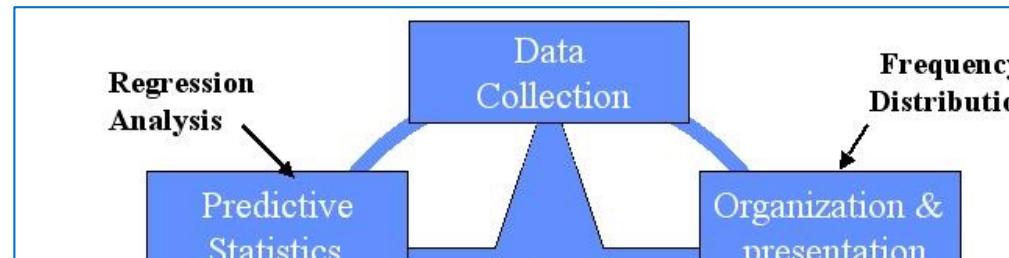
▪ Types of Clustering

- Hierarchical
 - Agglomerative or divisive
- Partitioning
 - K-means, VQ, MDS, ...

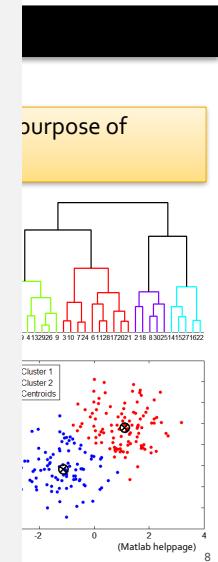


Analysis techniques

- Traditional statistic methods still valid, and useful!



Going old school ?



Machine Learning Techniques

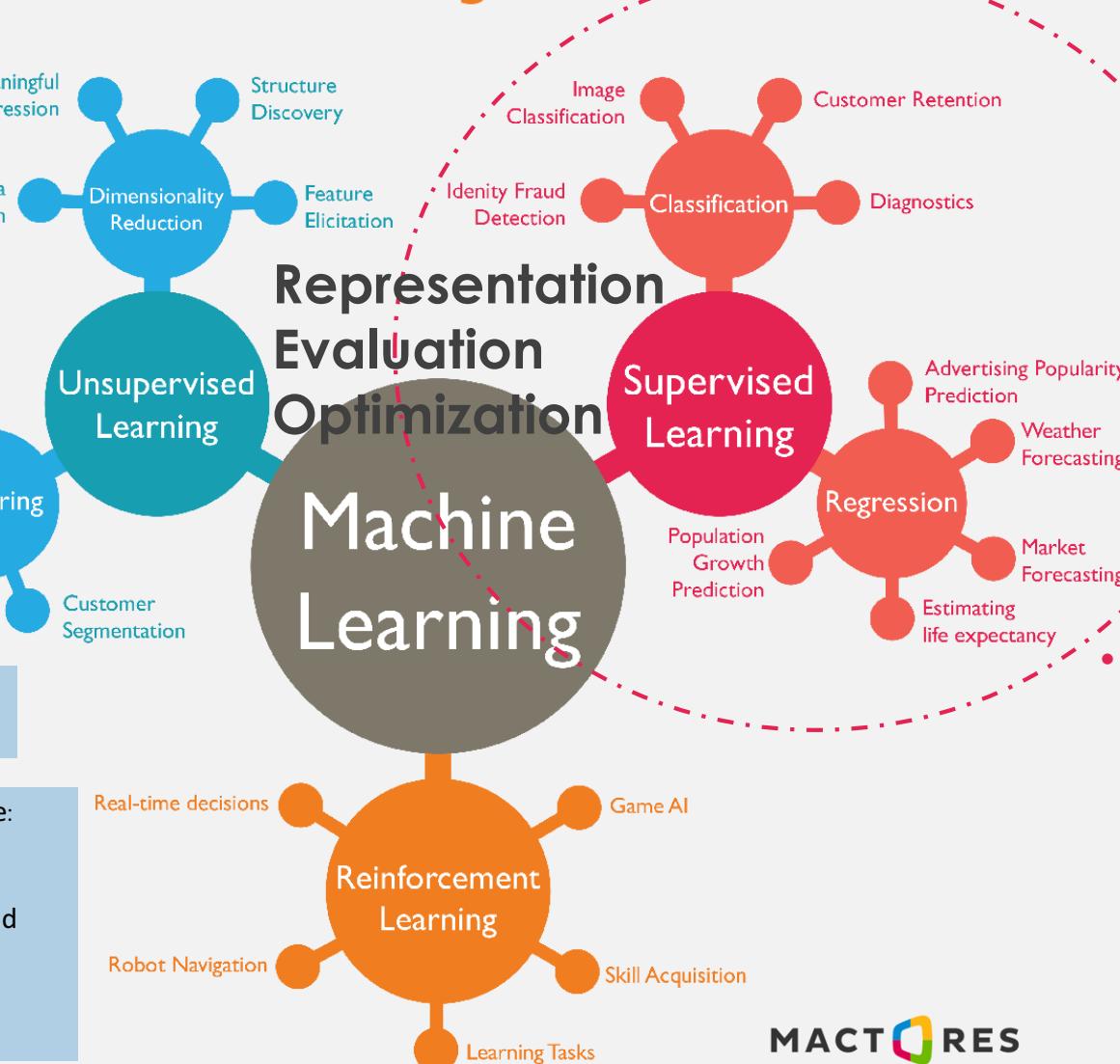
Optimize a performance criterion using example data or past experience

A lot of statistic methods

Role of Statistics:
Inference from a sample

Role of Computer science:
Efficient algorithms to (i)
solve the optimization problem (ii) represent and evaluate the model for inference

Machine Learning Bubble Chart



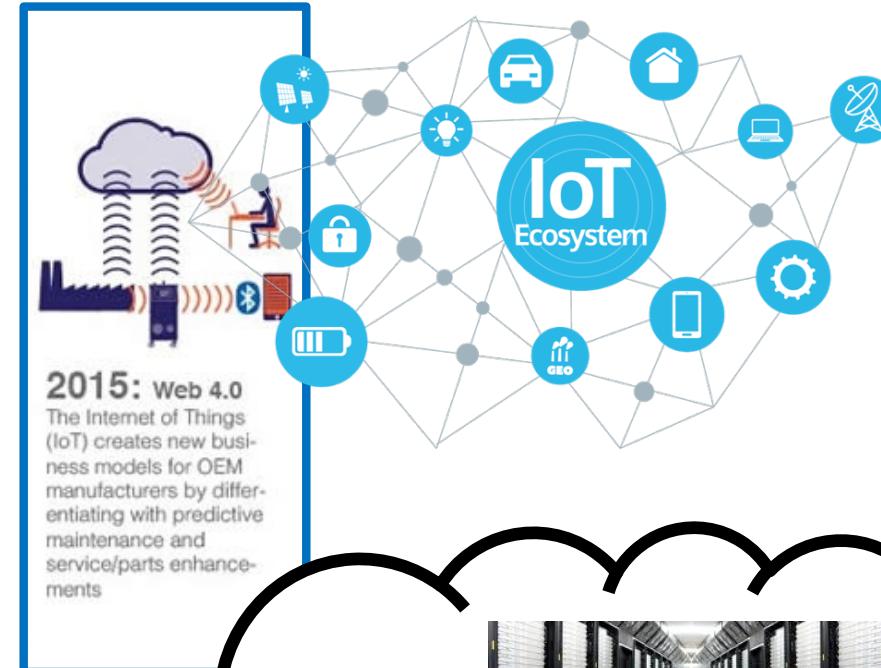
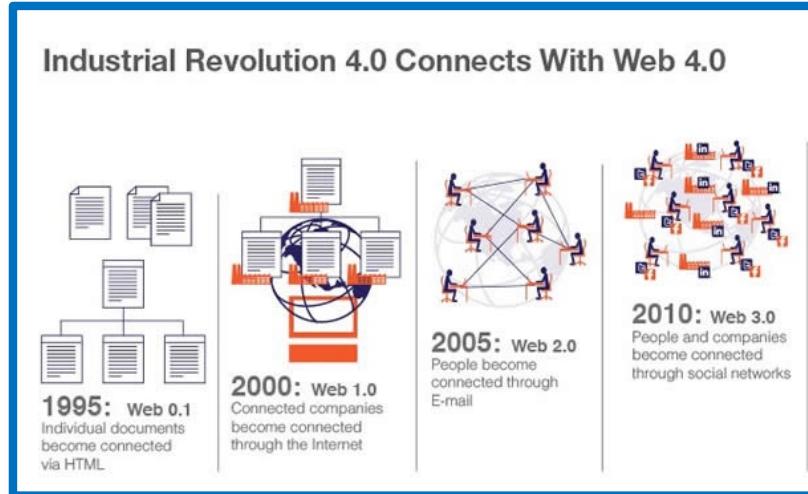
Classification

- Logic
- SVM
- Random Forest
- Hidden Markov
- ...

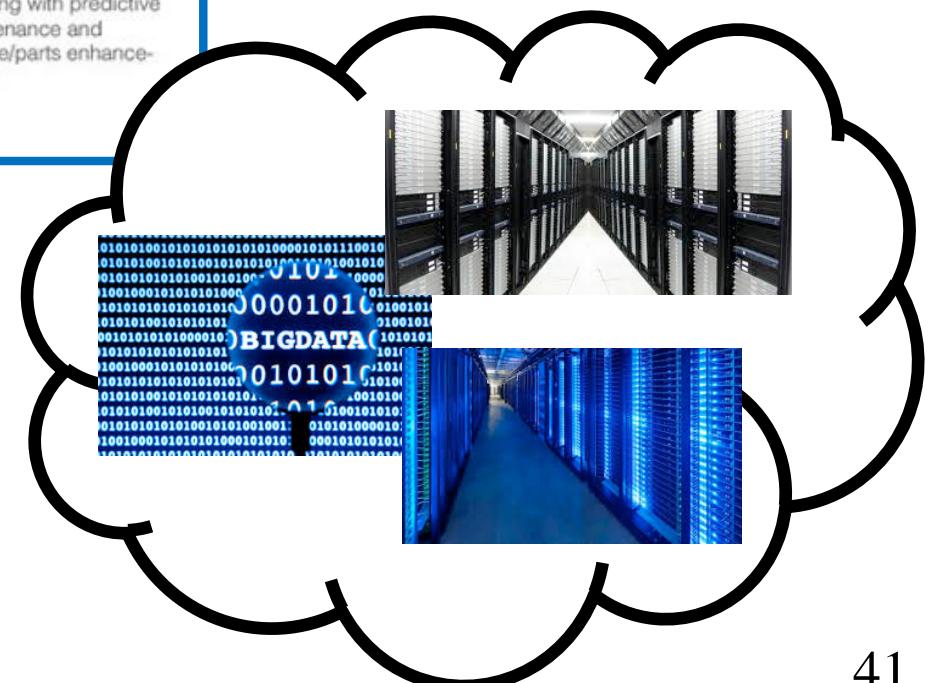
Regression

- Lasso
- Ridge
- Loes
- KNN
- Spline
- XGBoost
- ...

Use the full power of the Internet!



- IoT data are pushed on **Internet data clouds**
- Computing resources using Virtual Machines are obtained from **Internet Computing clouds**
- Parallel processing
- Optimized libraries
- Web tools to **orchestrate**



The Big Data landscape



IoT for Development



Irrigation



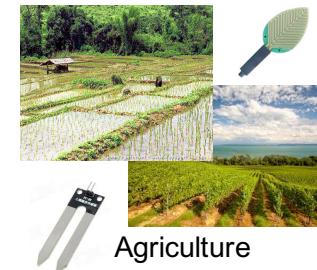
Livestock farming



Fish farming & aquaculture



Storage & logistic



Agriculture



Environment



Needs, constraints, cost, design approach, control mechanism

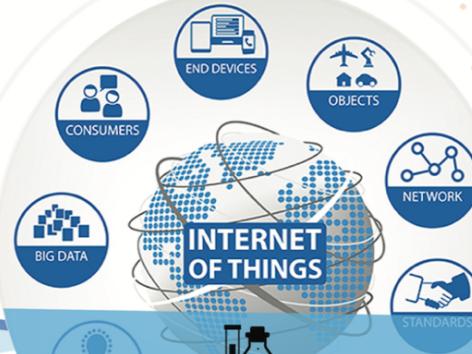
Challenge: Bridging the digital divide



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



Affordable technologies
to empower rural economies



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

Ready-to-use templates



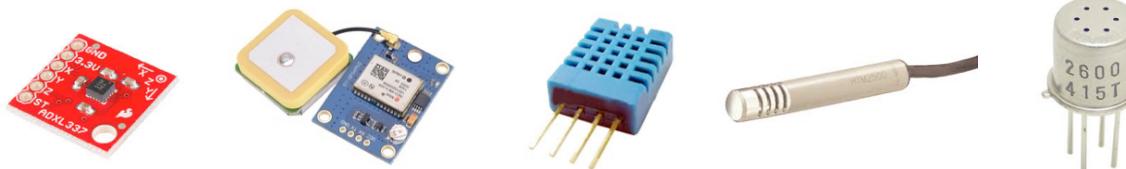
Moisture/
Temperature of
storage areas



Physical
sensor

Physical
sensor

Physical
sensor

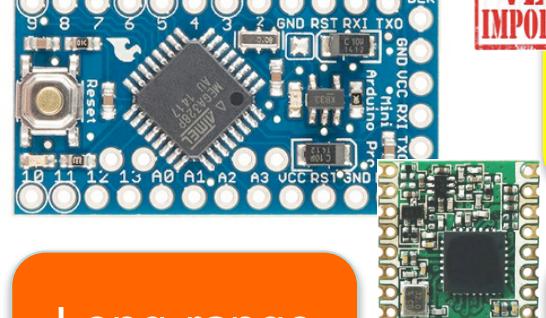


Physical
sensor
mgmt

***VERY*
IMPORTANT**

AES
encryption

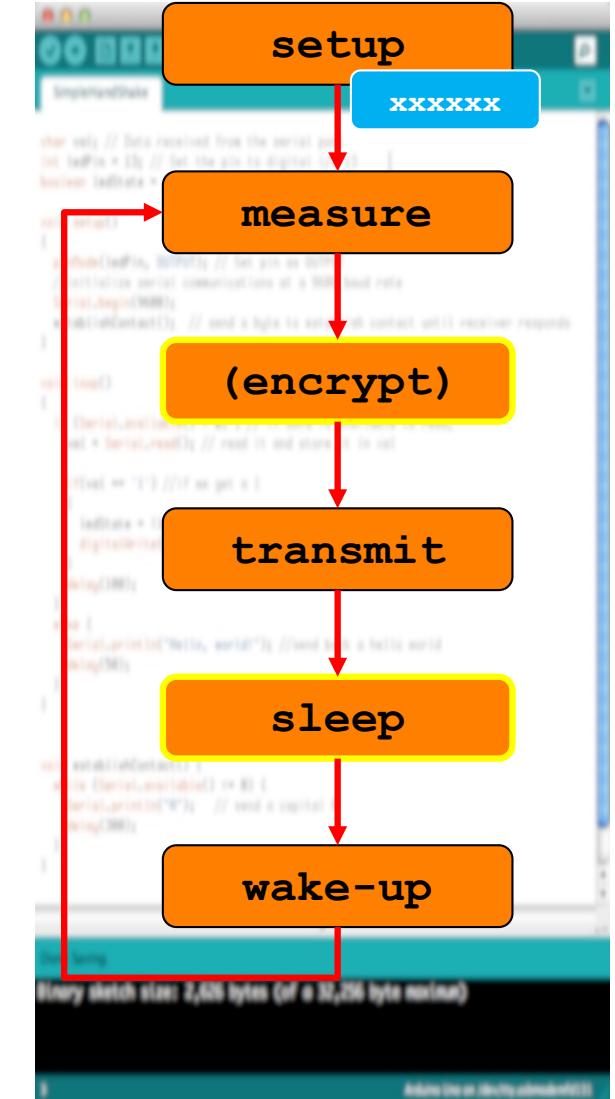
Arduino Pro Mini @3.3V



Long-range
transmission

***VERY*
IMPORTANT** Activity
duty-cycle,
low power

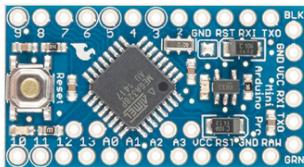
Logical
sensor
mgmt



A simple temperature sensor example



Arduino Pro Mini @3.3V



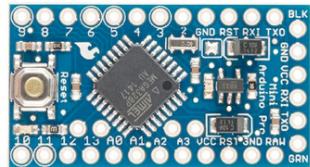
Modtronix inAir9



TMP36

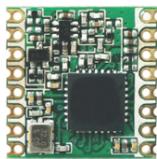


Low-cost integration



1.5€

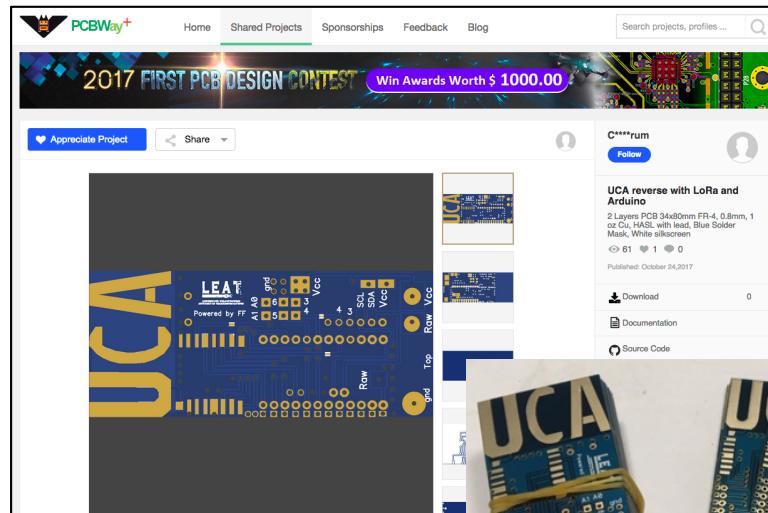
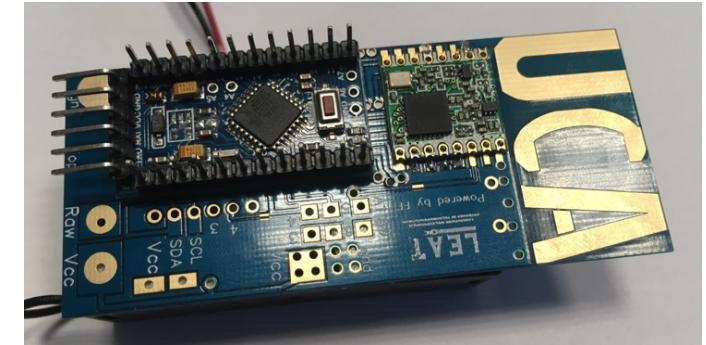
https://github.com/FabienFerrero/UCA_Board



4€



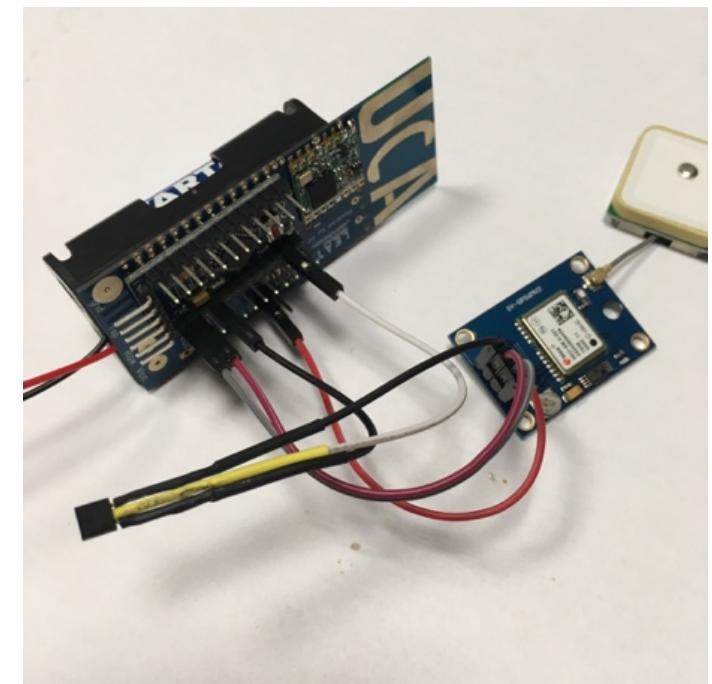
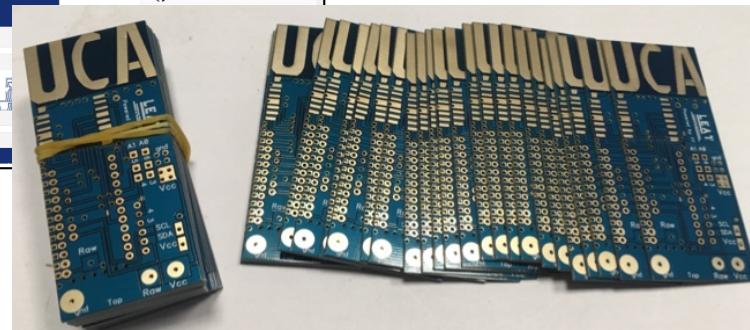
1€



A screenshot of the PCBWay website showing a project titled "UCA reverse with LoRa and Arduino". The page displays the PCB design, component placement, and assembly details. It also mentions the "2017 FIRST PCB DESIGN CONTEST" and "Win Awards Worth \$ 1000.00".

Less than
10€/device

1-click order

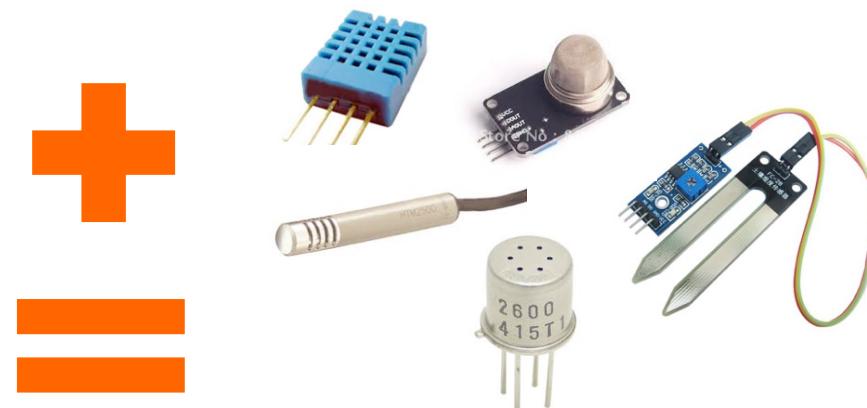
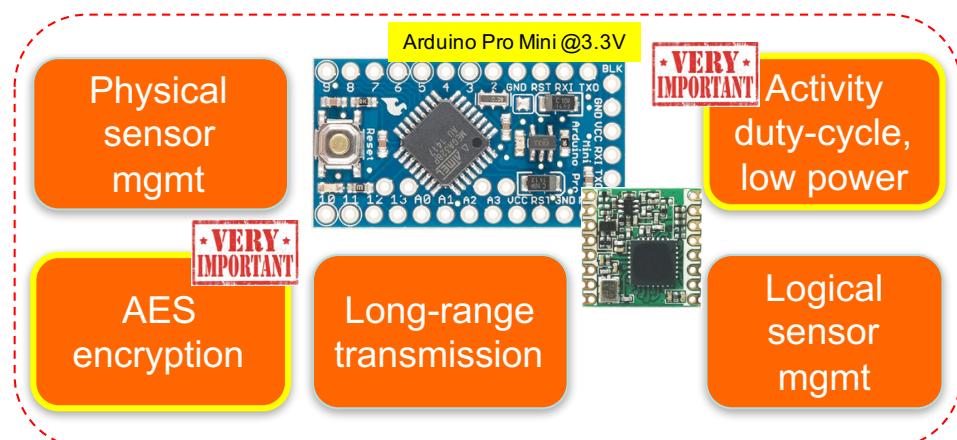


TO

Generic sensing IoT device v.s. Highly specialized



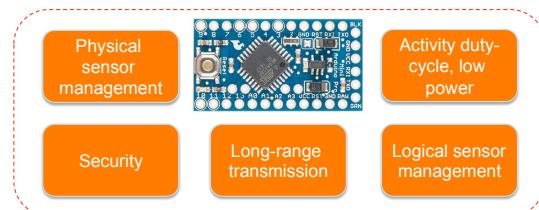
- Build low-cost, low-power, **long-range** enabled generic platform
- Methodology for low-cost platform design
- Technology transfers to user communities, economic actors, stakeholders,...



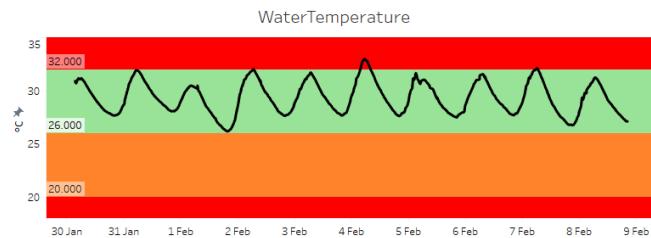
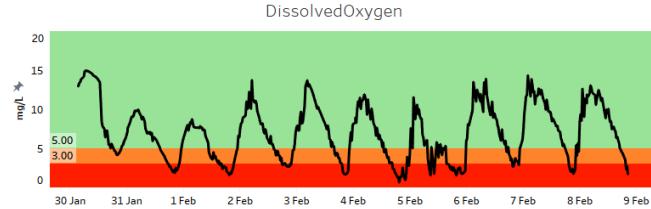
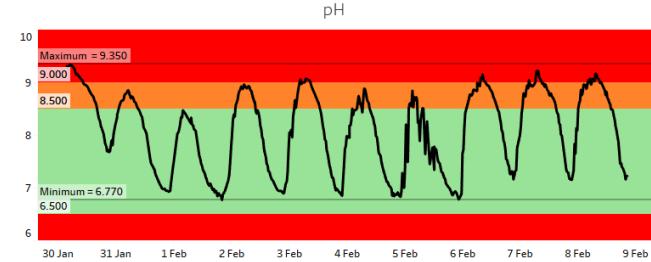
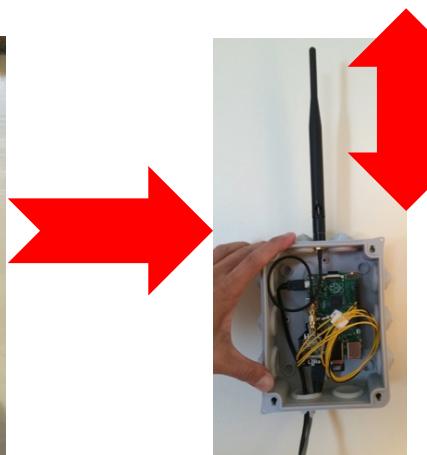
Low-cost buoy for fish farming MVP



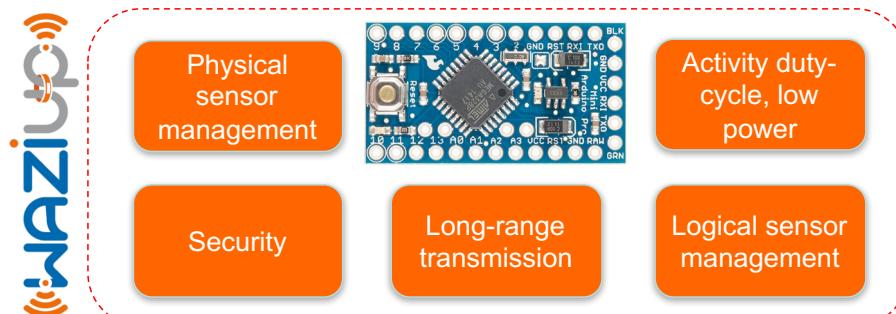
WAZIUP
Physical sensor reading



Credit: EGM



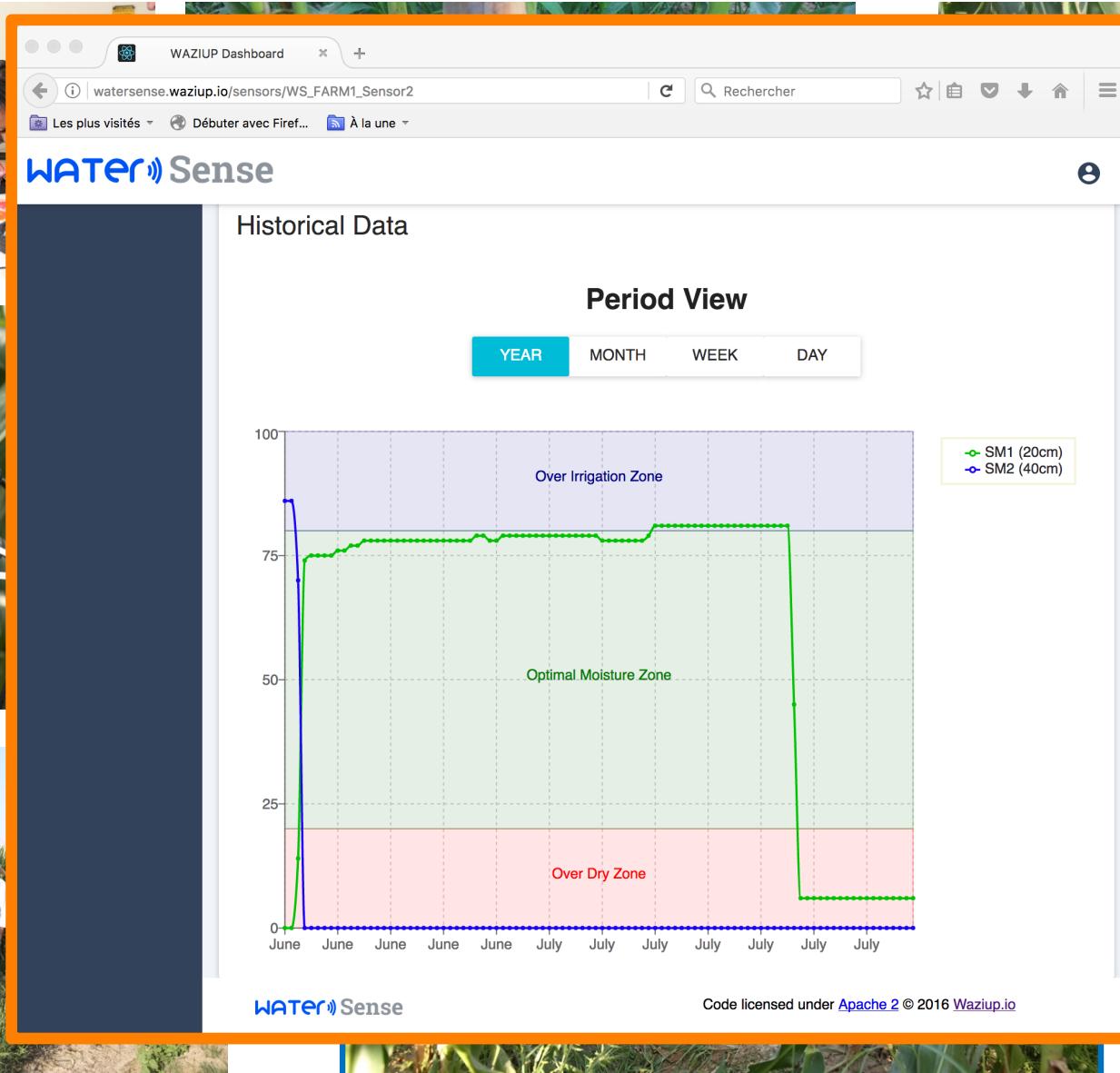
Soil humidity sensors for agri MVP



Deployment for Nestlé's WaterSense project



Deployment for Nestlé's WaterSense project



Local weather station for AGRI MVP



Photo from Unparallel



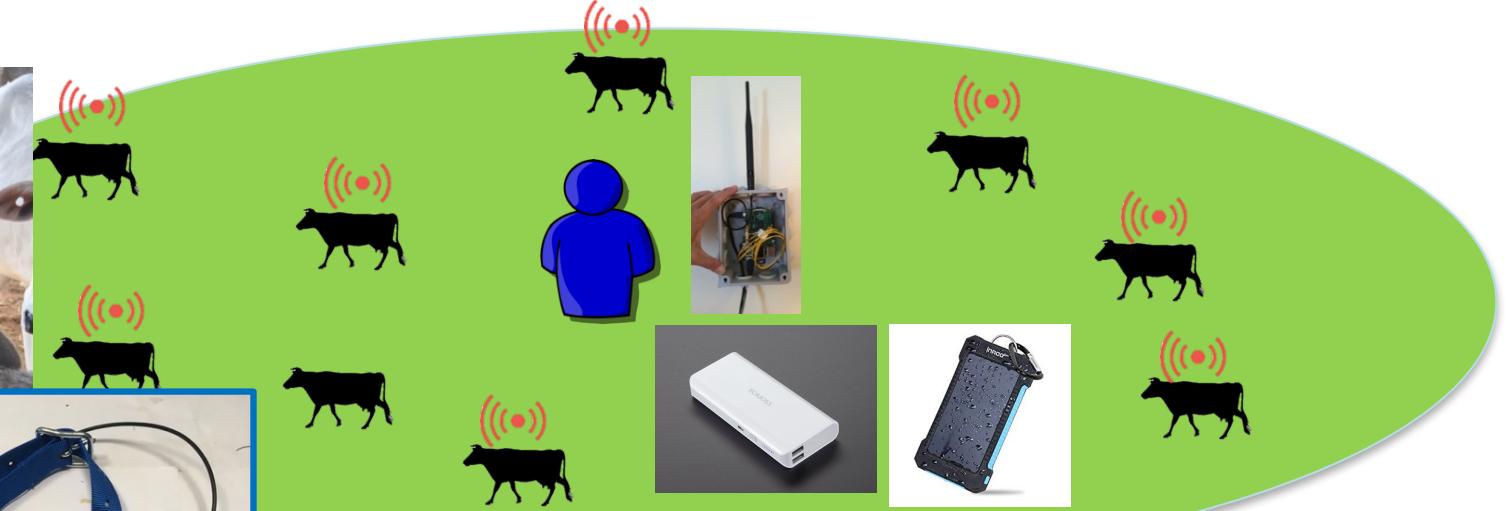
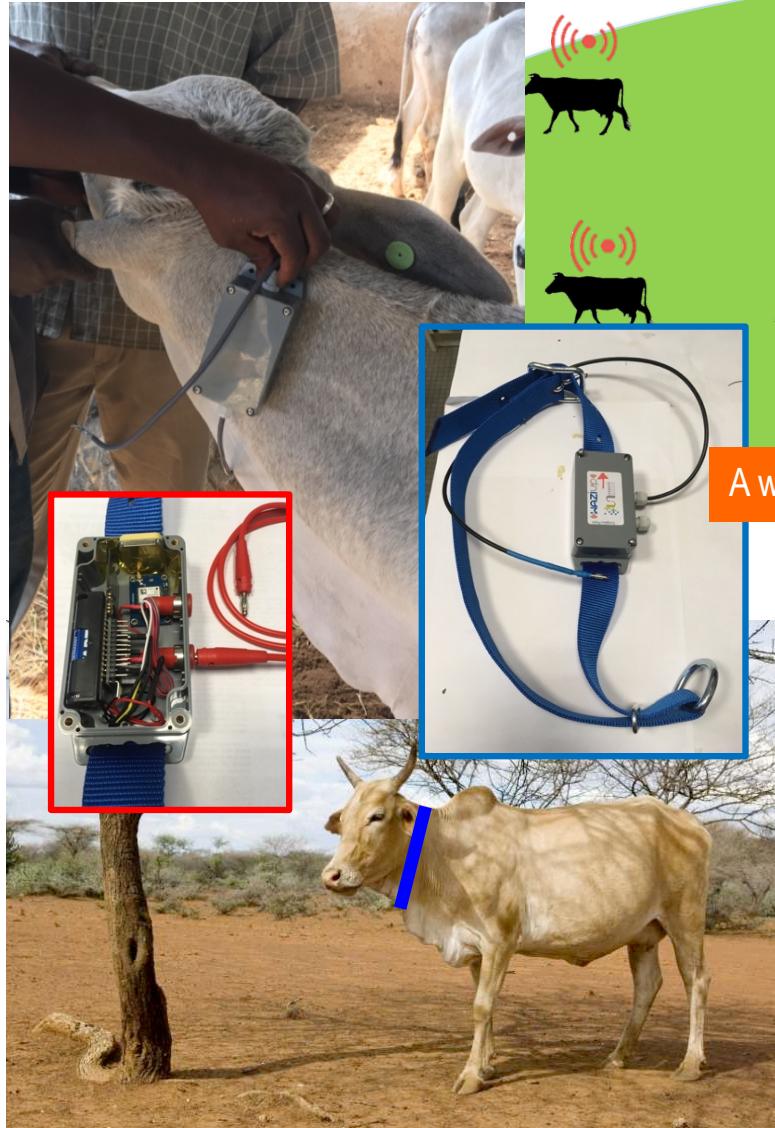
<https://openweathermap.org/>



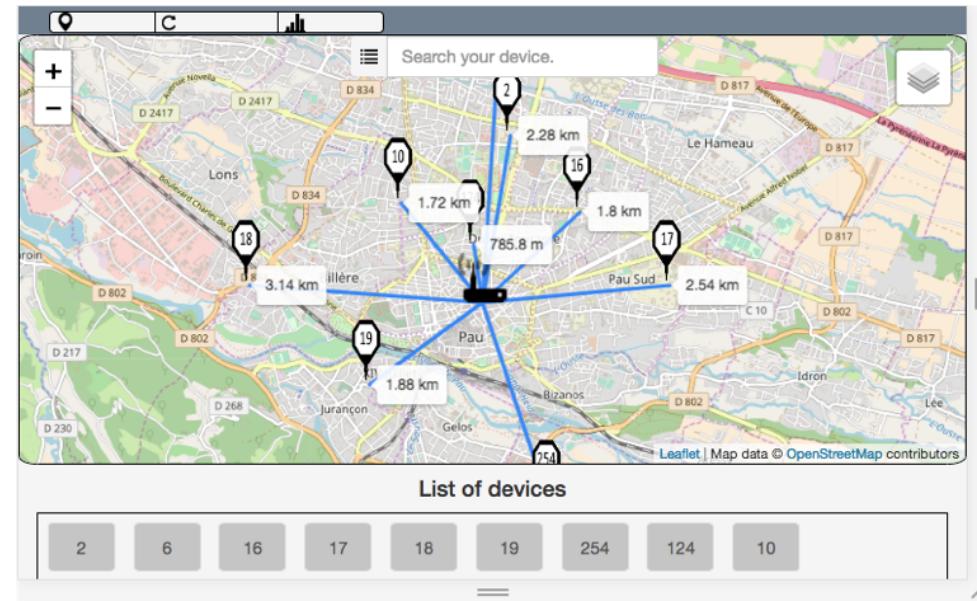
Get local weather measurements

Combine with open weather data to get more accurate predictions

Collar for Cattle Rustling MVP



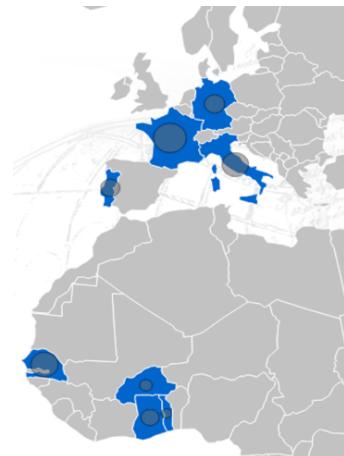
A web interface displays the position of the gateway those of the remote GPS devices



Scaling up!



Feb 2016 - 2019



May 2018 - 2021

