

INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture



This project is part of the PRIMA
Programme supported by the
European Union



Intel-IrriS



PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION
IN THE MEDITERRANEAN AREA

Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture



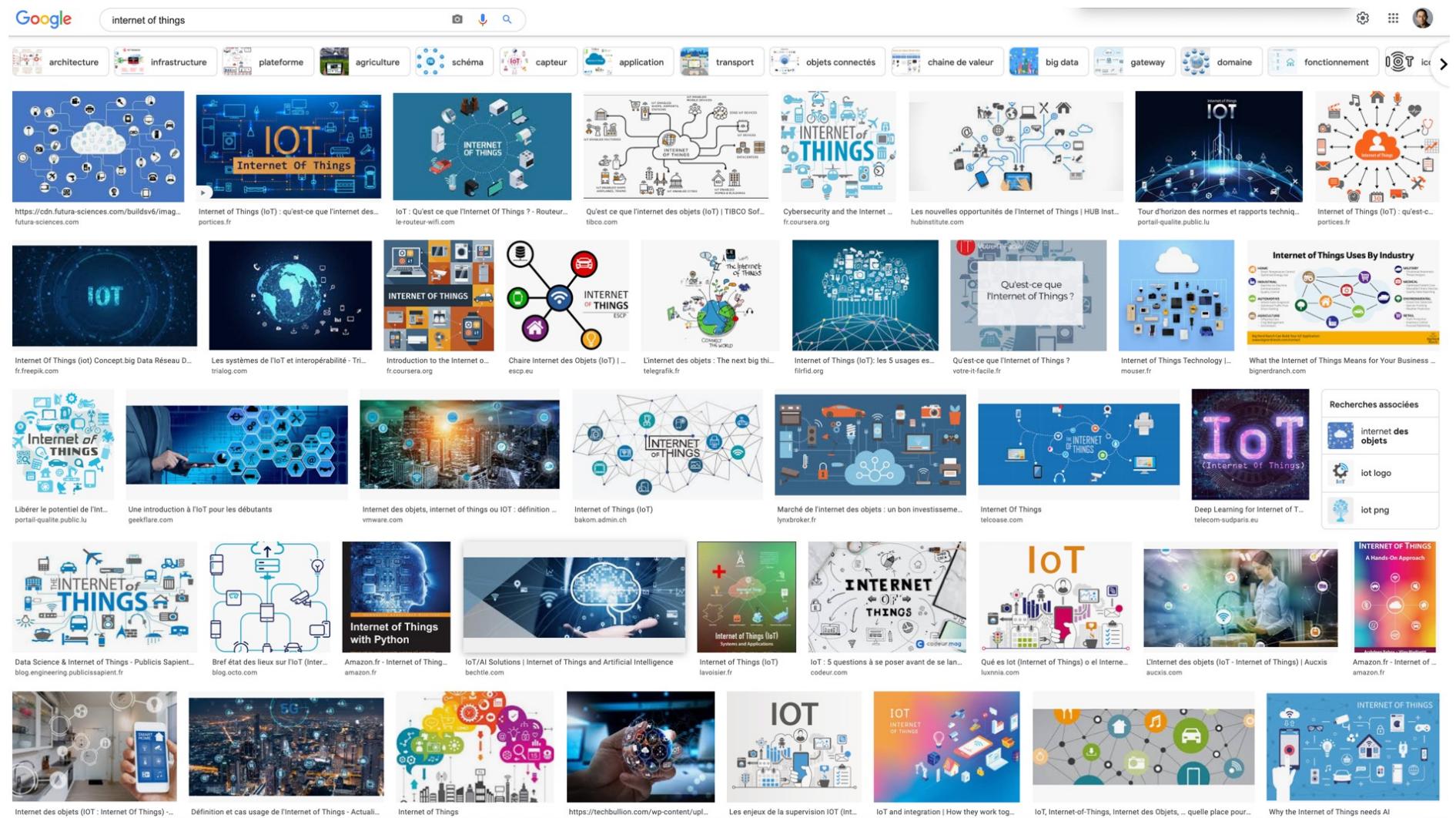
Introduction to IoT



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



Googling for « Internet of Things »



...shows communicating objects



Also on YouTube: IoT teaser & tutorial videos



Intel IoT – What Does The Internet of Things Mean?

591 k vues • il y a 8 ans

 Intel ✓

Fun, animated video answers: What does the Internet of Things mean? The Internet of Things (IoT) is an evolution of mobile, home ...



Intro | What is IoT | Transform our lives | Big picture | Example | Big Possibilities | Intelligent Traffic |... 9 chapitres ▾



IOT Tutorial | IOT Tutorial For Beginners | IOT - Internet Of Things | IOT Course | Simplilearn

25 k vues • il y a 1 an

 Simplilearn ✓

This IoT tutorial video introduces you to IoT Technology and how it is revolutionizing the world today. Internet of things or IoT ...



Internet of Things (IoT) | What is IoT | How it Works | IoT Explained | Edureka

2,1 M de vues • il y a 4 ans

 edureka! ✓

Subscribe to our channel to get video updates. Hit the subscribe button above. #Edureka #EdurekaIoT #InternetOfThings ...

Sous-titres

All communicating objects?

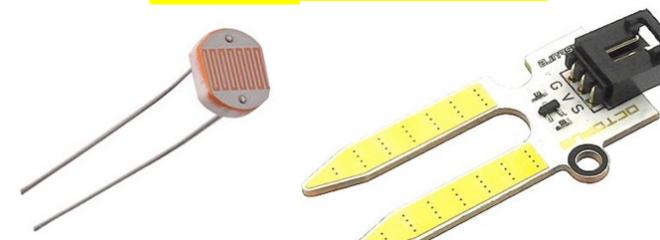
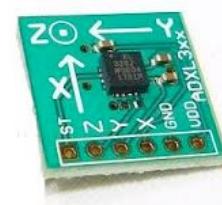
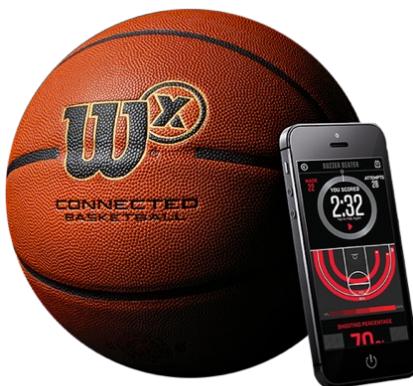


IoT=interactions with physical world



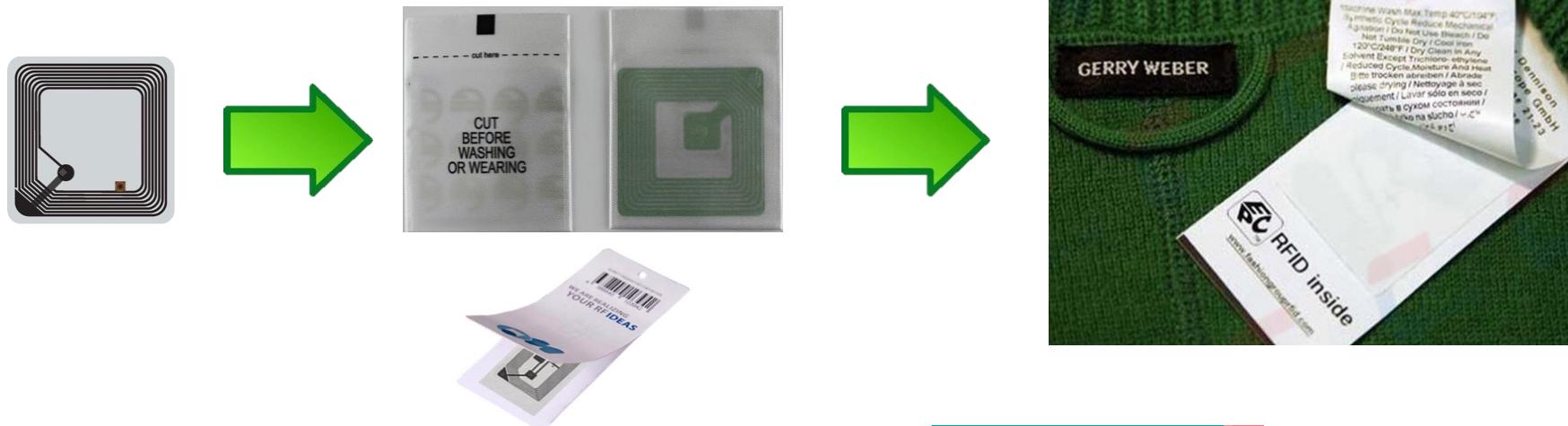
Q: Interactions? How?

Interaction: Sensors

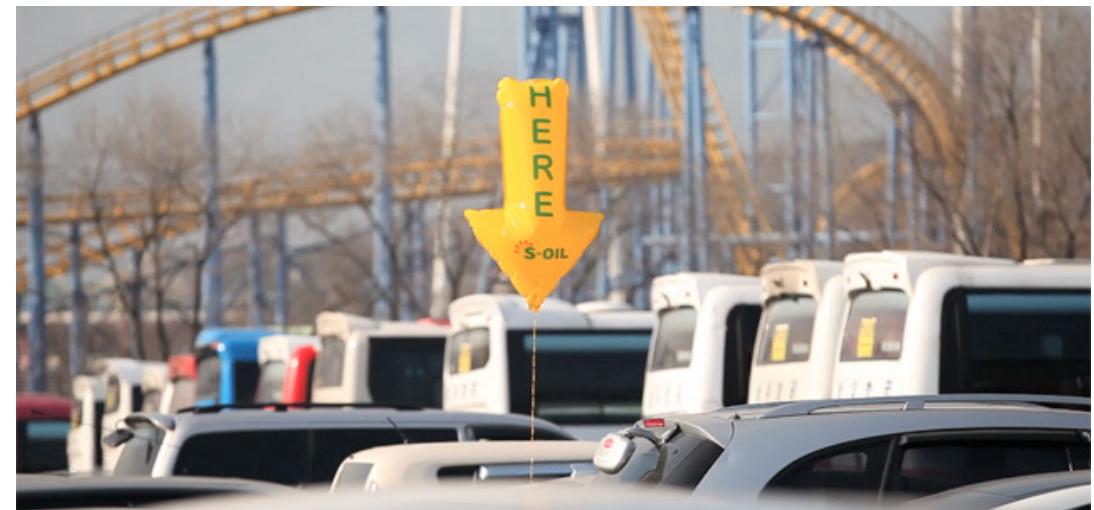
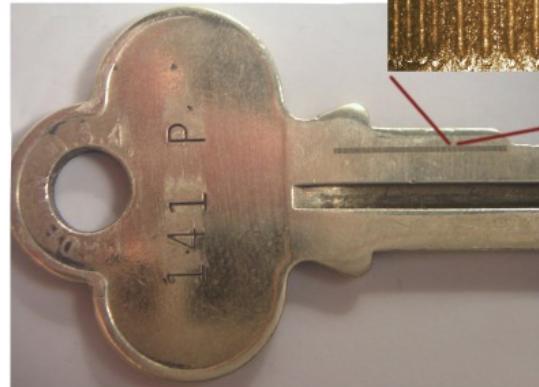


Interaction: RFID, NFC

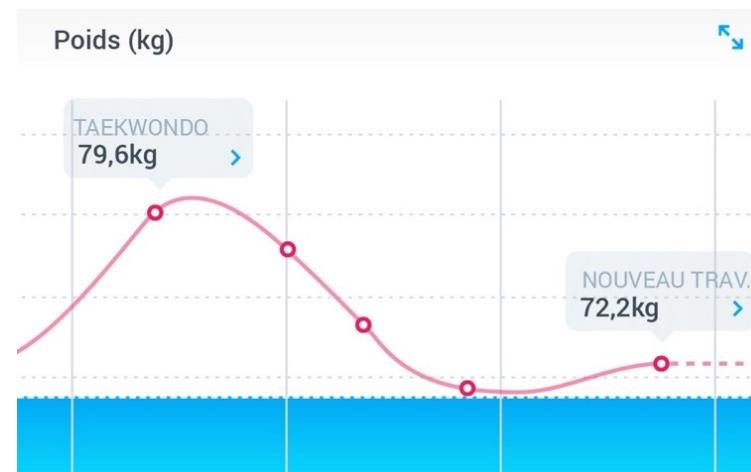
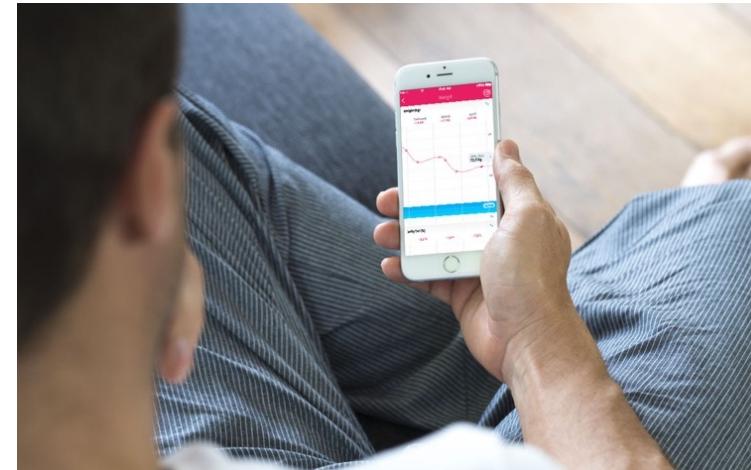
- Radio-Frequency Identification (RFID)
- Near Field Contact (NFC)



Interaction: always complex?

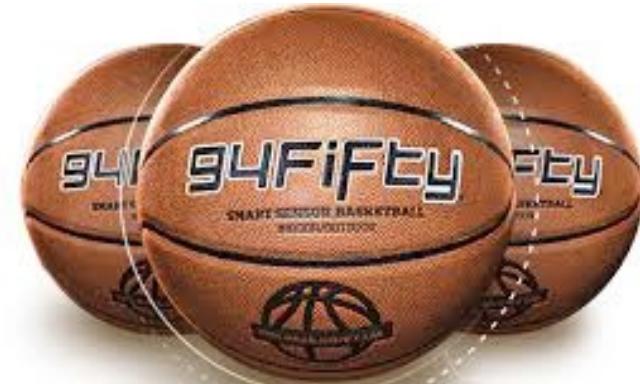
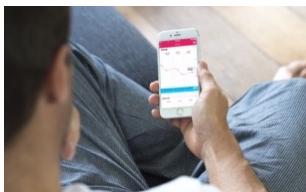


Home/consumer IoT products



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

Local interaction is possible...



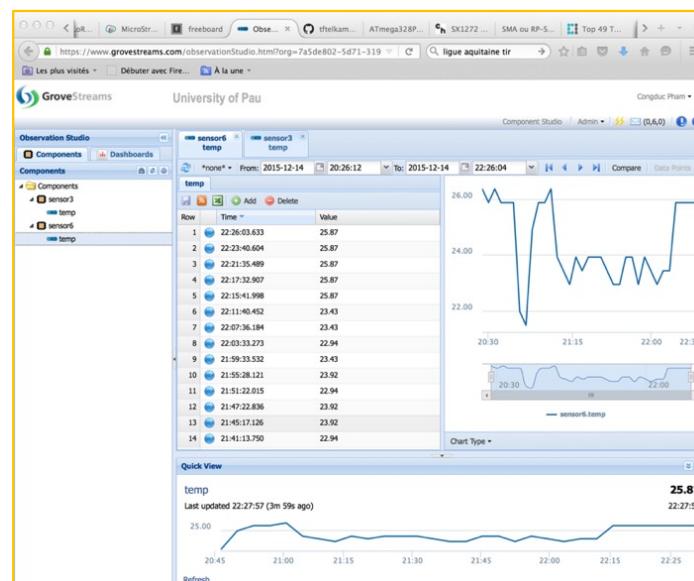
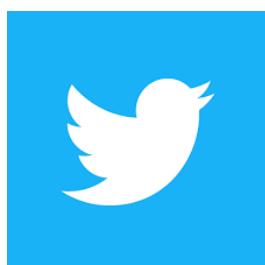
...but IoT added-values
interactions & linked data!



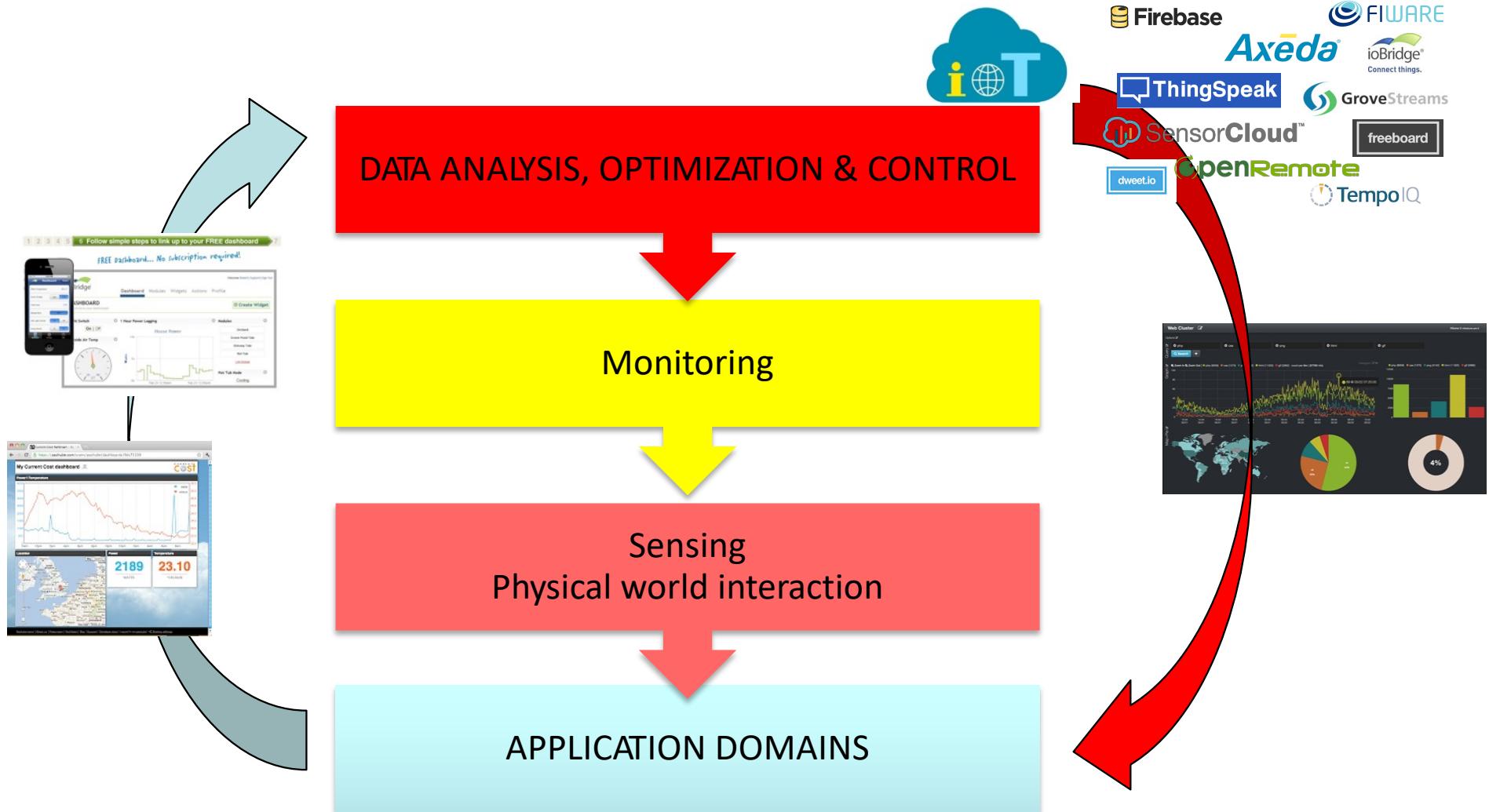
Clouds for IoT



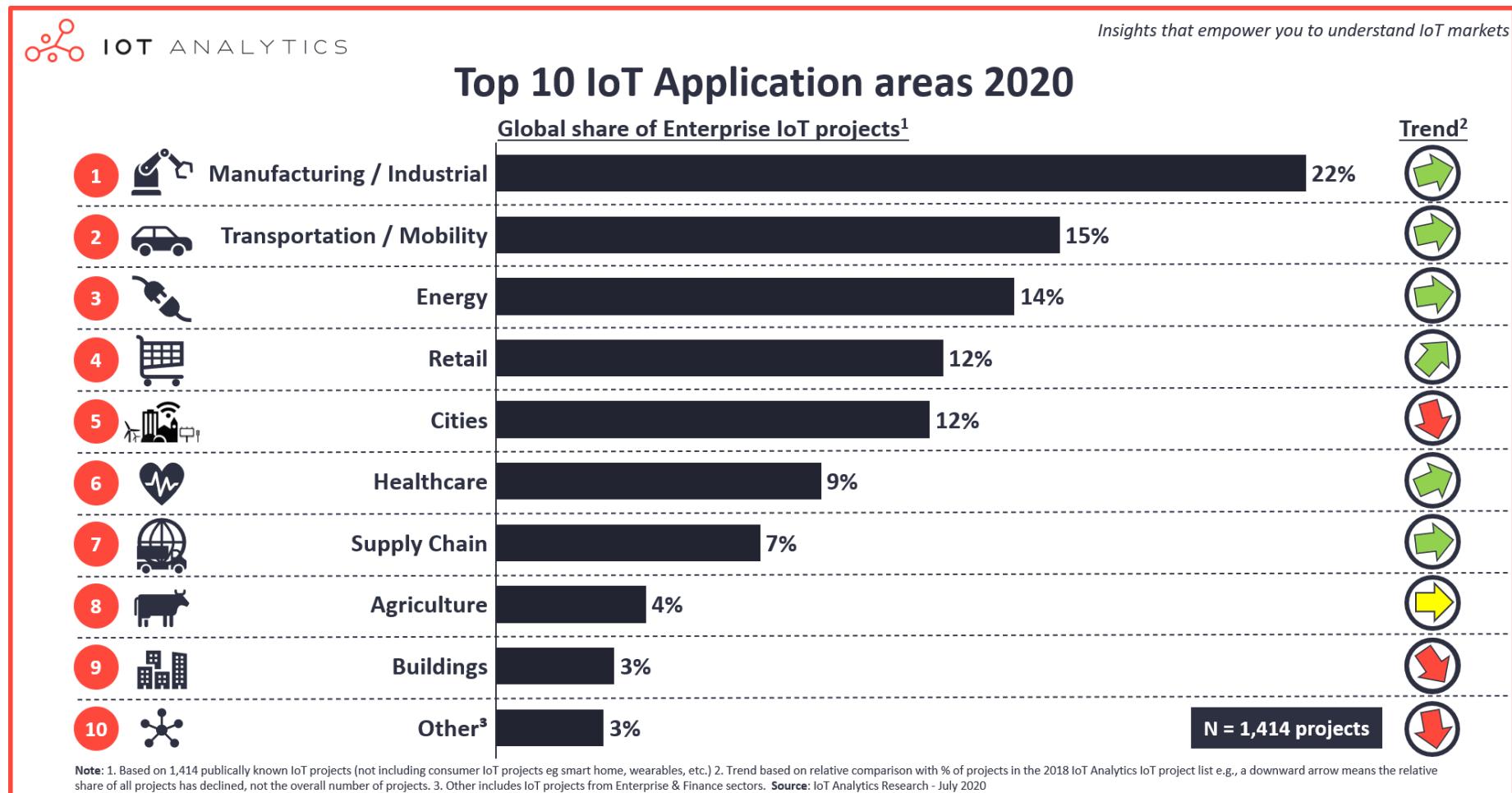
vs



Sense, Monitor, Optimize & Control



Top IoT applications, 2020



IoT in industry

- Infrastructure monitoring, Security & Safety
- Continuous process improvement, Process automation, Process optimization
- Smart logistics management, remote management, tracking,
- Connectivity to back-end system, integration of smart tools, Interoperability
- Data analysis, Supply Chain Optimization, Predictive maintenance



Industrial Internet of Things

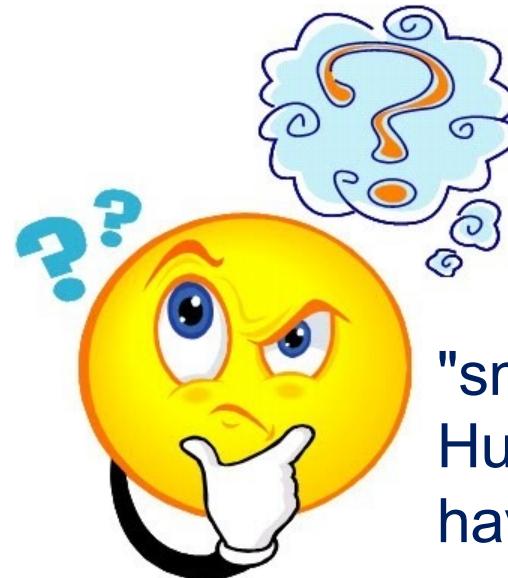


IoT for Smart Agriculture

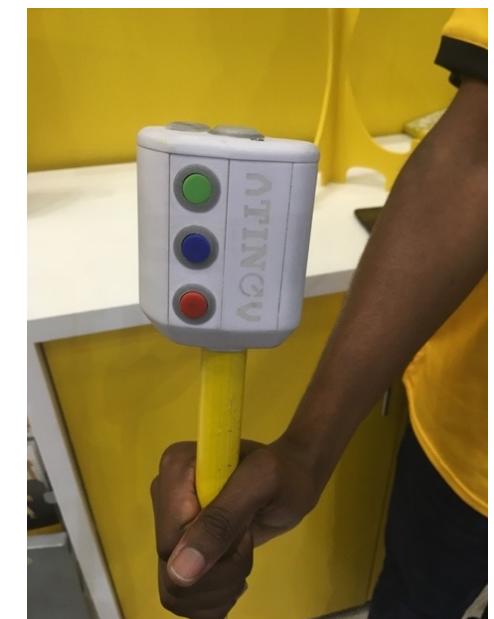


Is IoT the solution for your problem?

Q: How to enable municipal street sweepers to report illegal dumping, leaking pipes and emergencies?



"smartphone"
Hum, they only
have 2 hands...



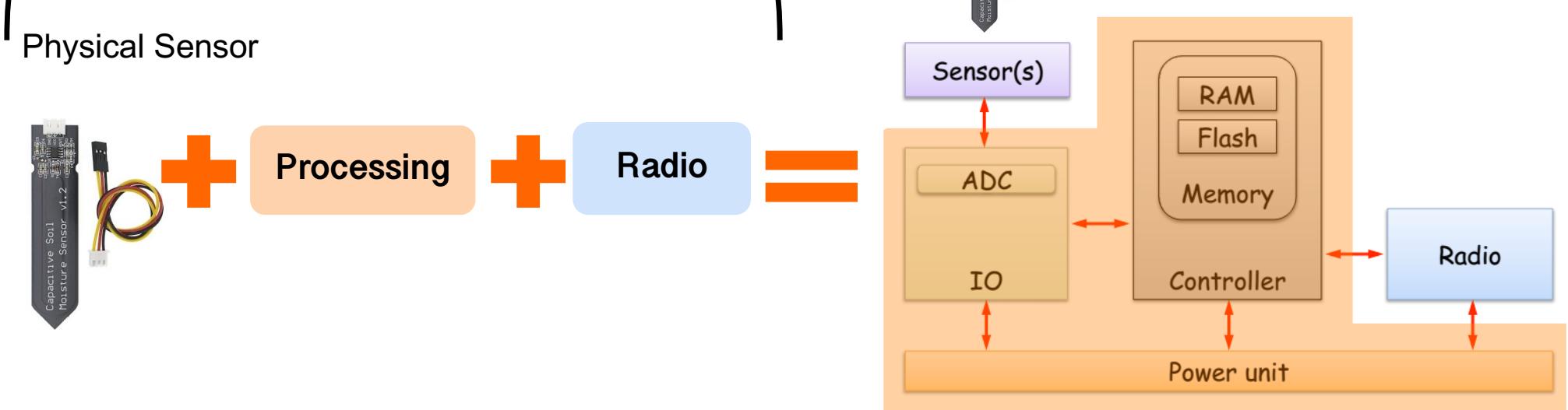
ITU Telecom World 2018
Phathwa Senene at MTN booth



IOT
TECHNOLOGY ?
CONCEPT ?

Typical IoT device

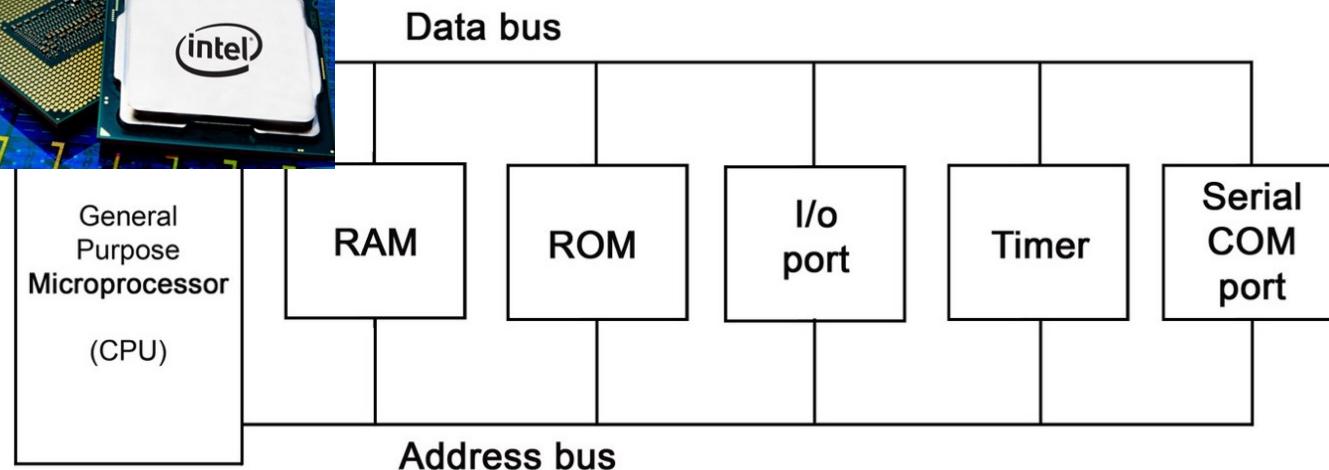
- IoT device can be viewed as a simple Embedded System



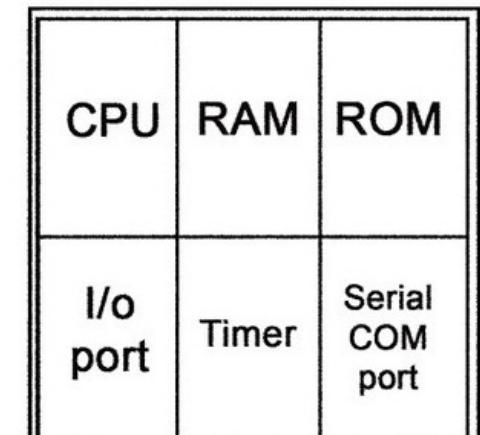
Q: uprocessor vs ucontroller?

Microprocessors & Microcontrollers

- A microprocessor unit (MPU) is a processor on one silicon chip
- A microcontroller unit (MCU) is a microprocessor with some added circuitry on one silicon chip
- Microcontrollers are used in embedded computing and **most IoT devices are based on microcontrollers**



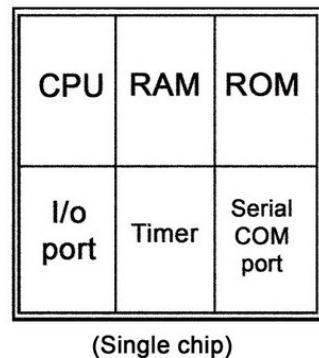
VS



From "An Embedded System Overview" by Dr. Eng. Amr T. Abdel-Hamid

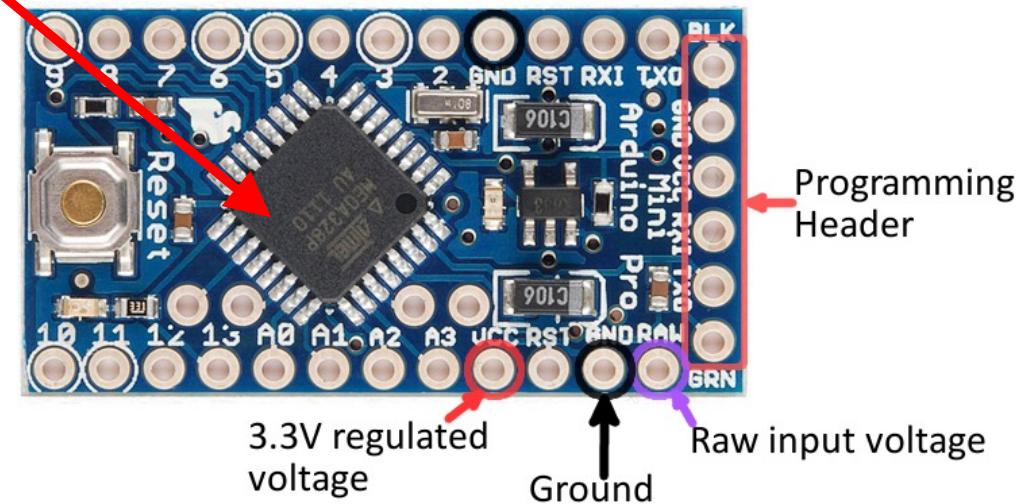
From µcontroller to µcontroller board

- A µcontroller can be standalone...



- But, it is usually mounted on a board with additional electronics parts

- Leds, Voltage regulators
- Easy access to pins
- Reset button
- Serial-USB interface



Arduino's success story starting in 2005



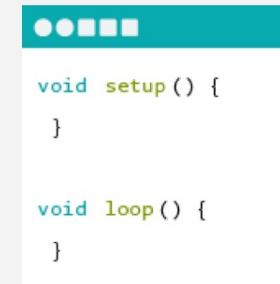
WHAT IS ARDUINO?

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects.



ARDUINO BOARD

Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators.

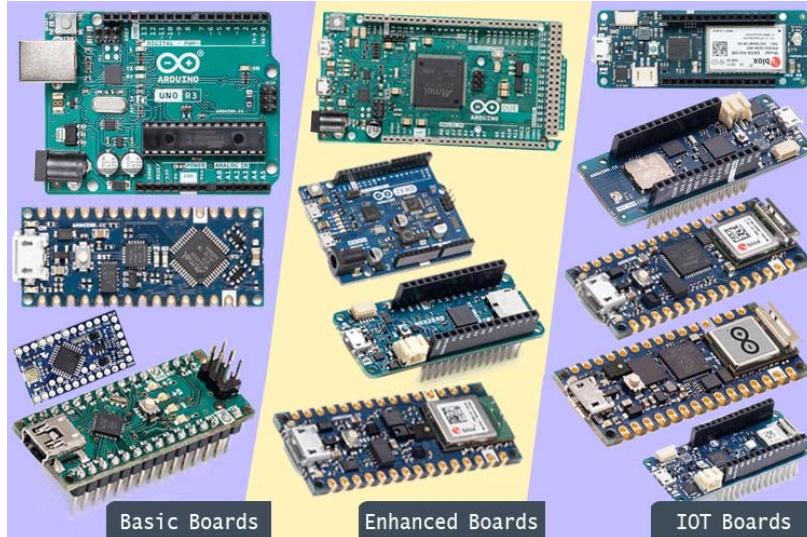


ARDUINO SOFTWARE

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



17 years later: the incredibly large microcontroller board ecosystem!



STM32 Nucleo-32



Teensy 3.2



LinkIt
Smart7688 duo



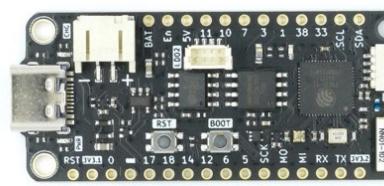
Adafruit Feather



uPesy ESP32



ePulse Feather Low Power ESP32



FeatherS3 – ESP32-S3



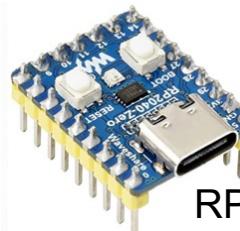
Heltec WiFi LoRa 32



XIAO SAMD21



Arduino Nicla
Sense ME



RP2040
zero



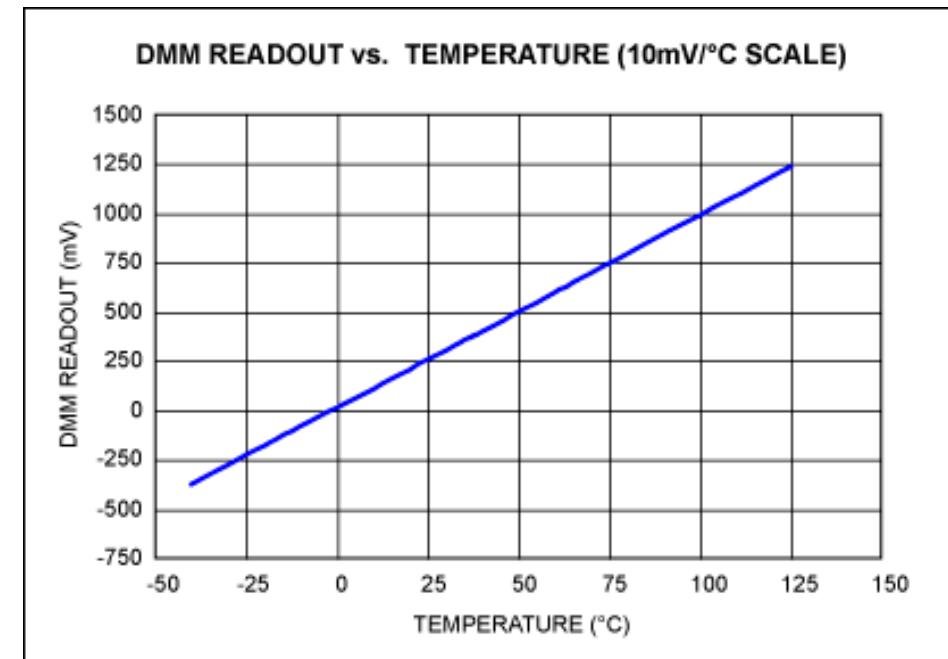
DFRobot
Beetle



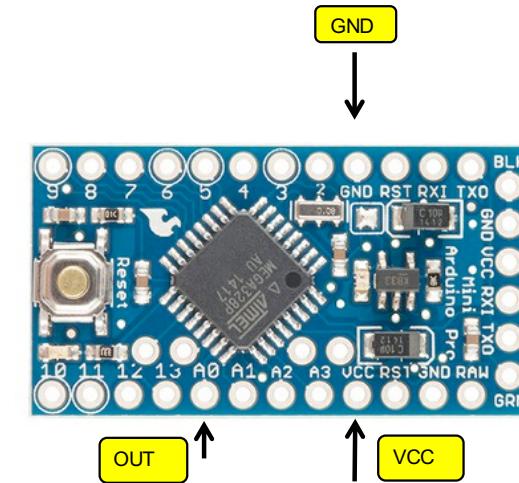
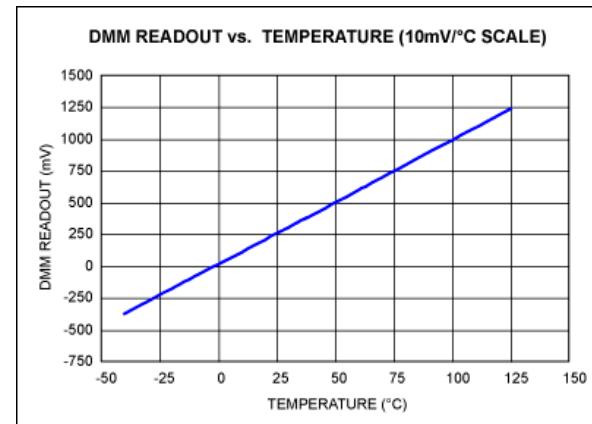
QT Py ESP32-C3

Interacting with the real world?

- Taking the simple analog sensors example
- Analog sensors provides a voltage output that varies according to a physical parameter, e.g. temperature, humidity, luminosity,...



Digitalizing the physical world!



Microcontrollers have Analog/Digital (A/D) converter to map a voltage to a numerical value. **A/D with 10-bit resolution give numerical values in $[0, 2^{10}-1] = [0, 1023]$**

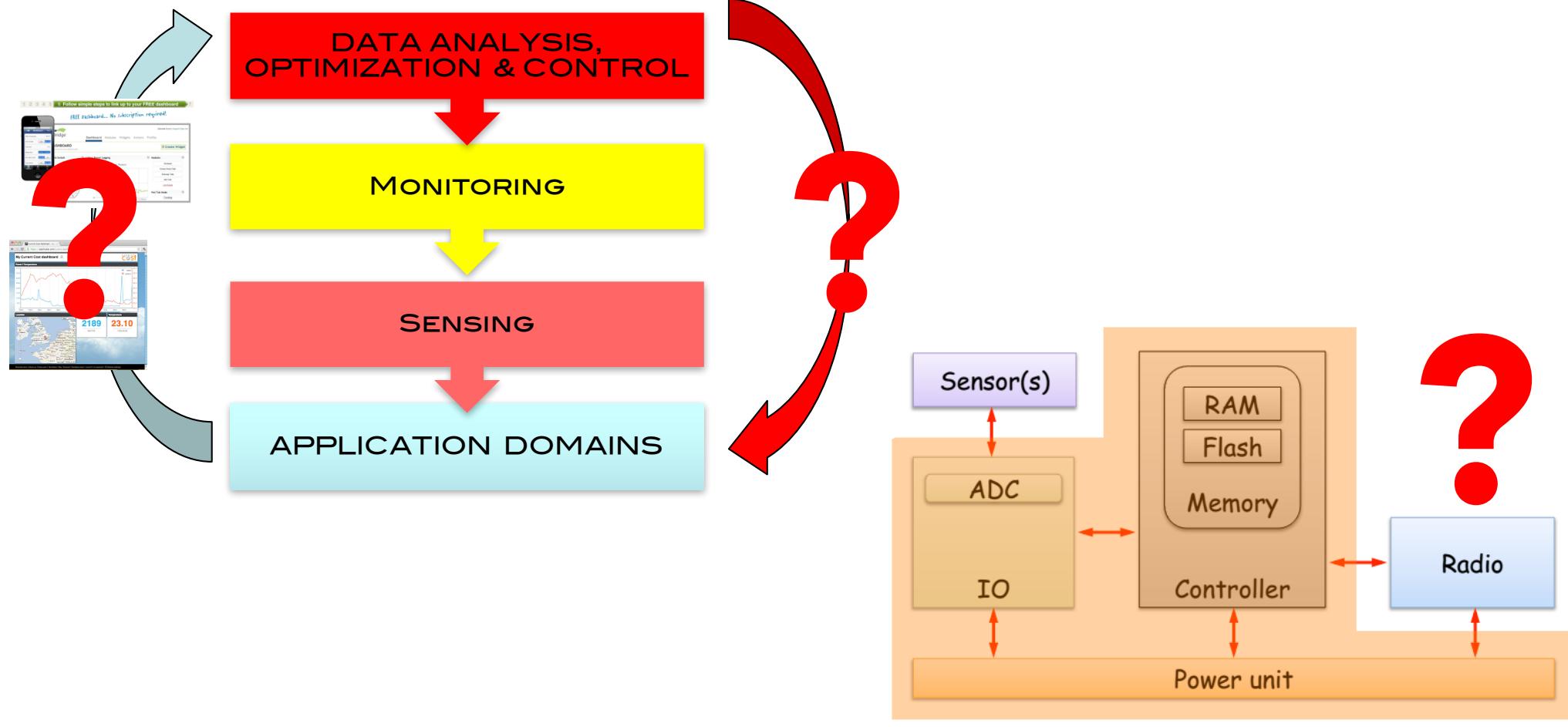
Vcc usually refers to the operating voltage of a given microcontroller. Vcc is typically 3.3V.

If $0=0V$ and $1023=3300mV$ then **$3300mV/1024=3.22mV$ is the granularity of the measure**

Reading a digital value of 100 means $100 \cdot 3.22mV = 322mV$

If the sensor output is $10mV/1°C$ then the physical temperature is $322mV/10mV=32.2°C$

How to collect data?

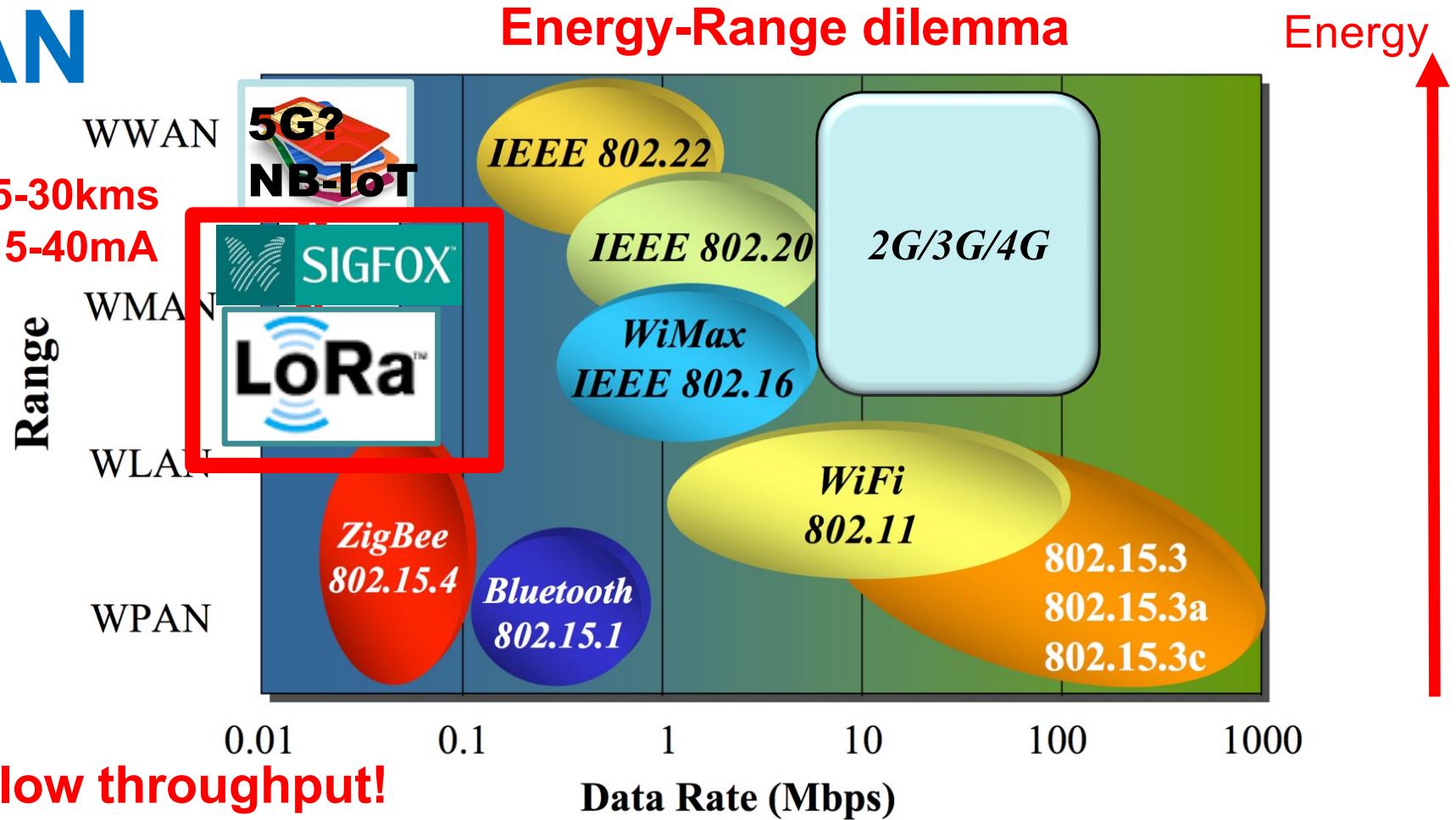


Microcontroller

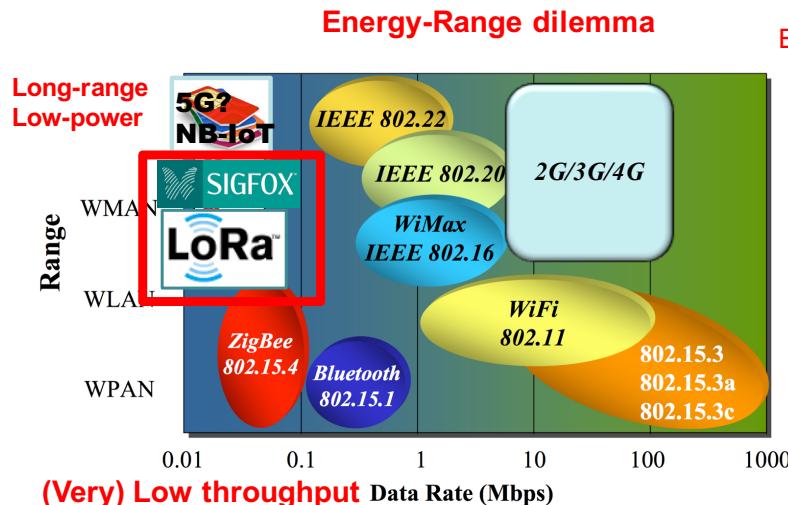
Low-power & long-range radios

LPWAN

Long-range: 5-30kms
 Low-power: 15-40mA



Energy consumption comparison



2G	3G	LAN	ZigBee	Lo Power WAN
N/A	N/A	O: 300m I: 30m	O: 90m I: 30m	Same as 2G/3G
200-500mA	500-1000mA	100-300mA	18mA	18mA-40mA
2.3mA	3.5mA	NC	0.003mA	0.001mA



TX power: 500mA. Mean consumption: $(8s \times 500 + 3592s \times 0.005)/3600 = 1.11mA$

$2500/1.11 = 2252h = 93 \text{ days} = 3 \text{ months } \ominus$

2500mAh

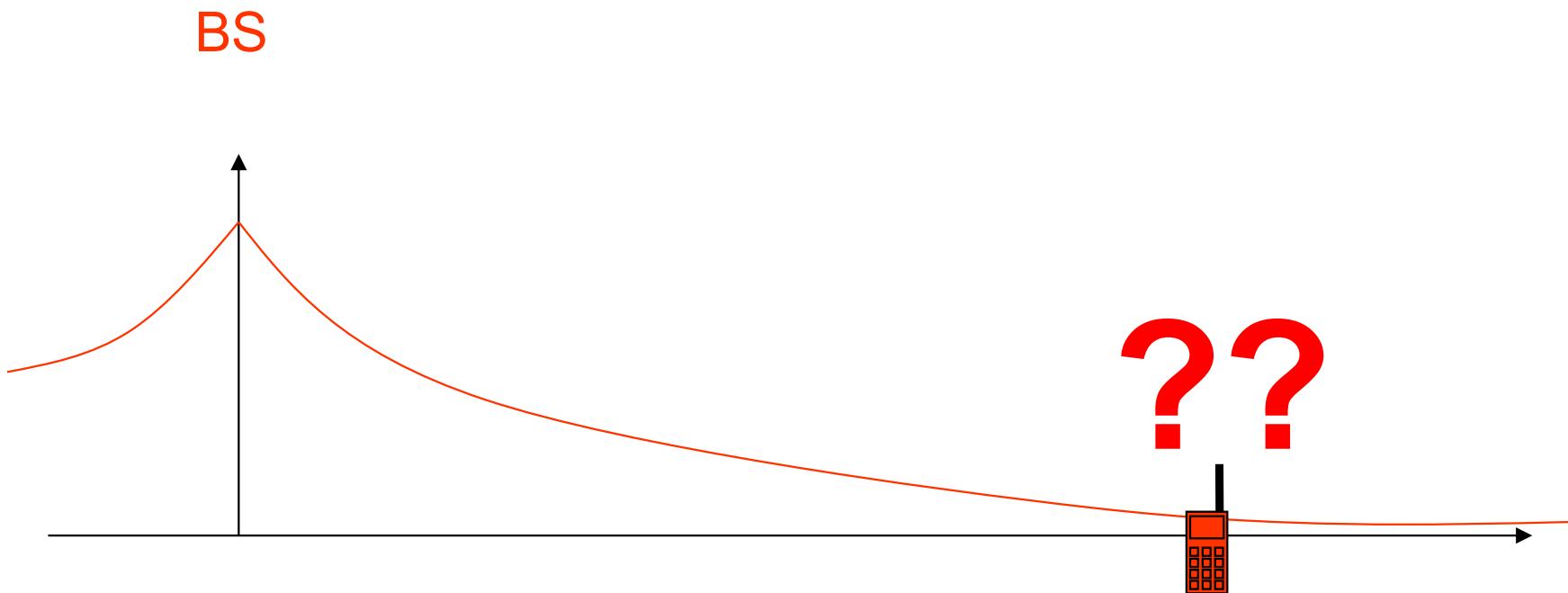
In most cellular networks, the device is still maintaining communication with BS even if it is inactive

TX power: 40mA. Mean consumption: $(2s \times 40 + 3598s \times 0.005)/3600 = 0.027mA$

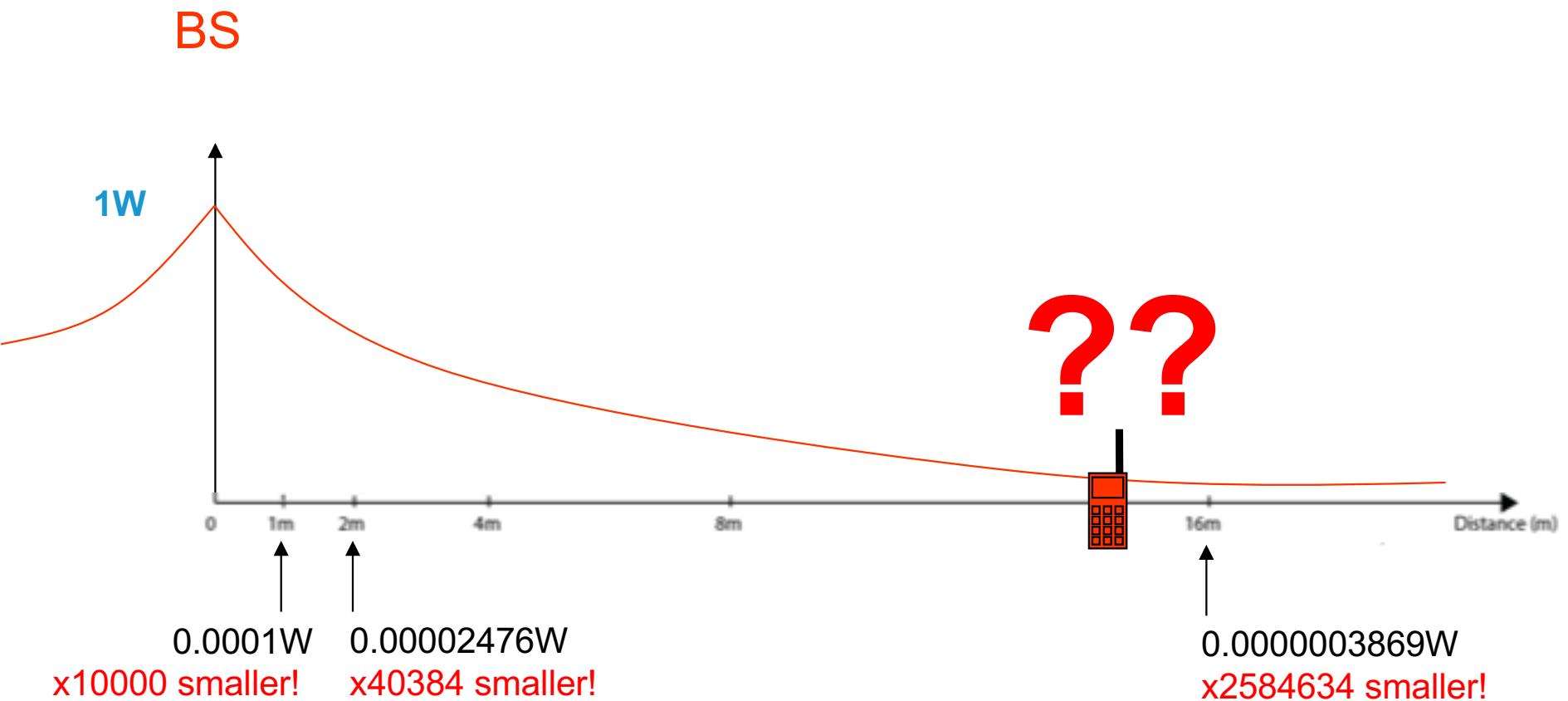
$2500/0.027 = 92592h = 3858 \text{ days} = 10 \text{ y. } \oplus$

LPWAN does not need to maintain connection if not in use

1st challenge: signal attenuation



Attenuation is the main problem!

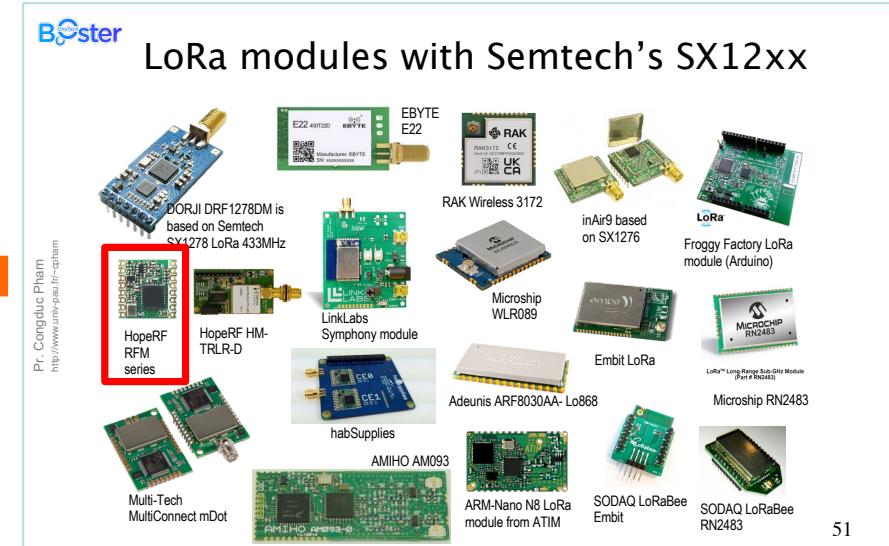
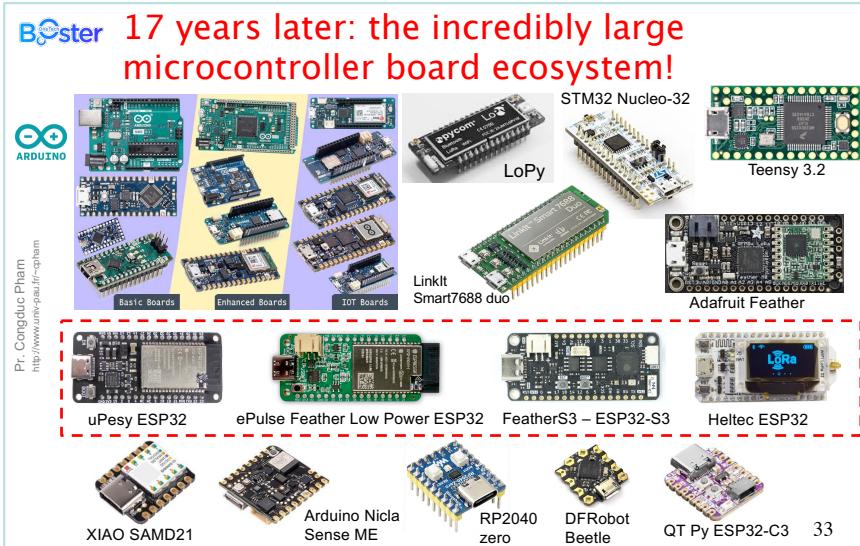


IoT for everybody?



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

Convergence of technologies



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



Do-It-Yourself (DIY) IoT
 Off-the-shelves parts
 Generic platform
 Open-source
 Modular design

INTEL-IRRIS starter-kit

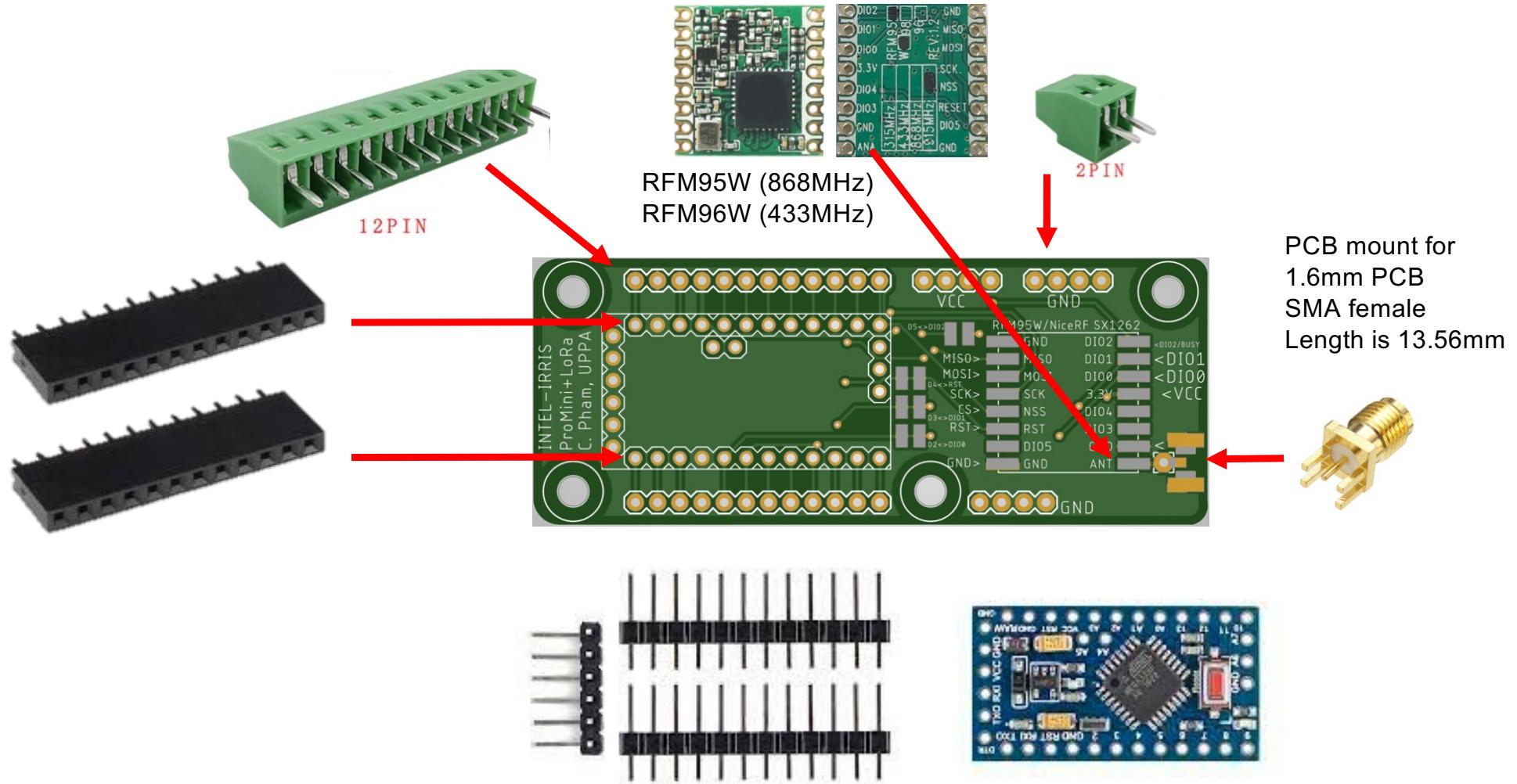
- "Intelligent Irrigation in-the-box", "plug-&-sense", fully autonomous
- From idea to reality!



< 90€

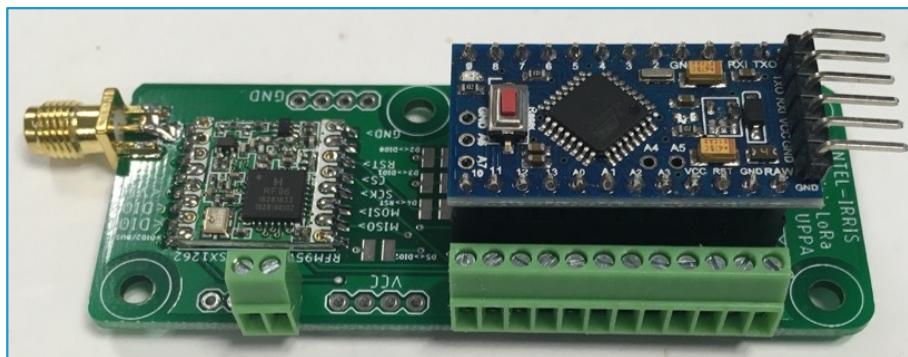
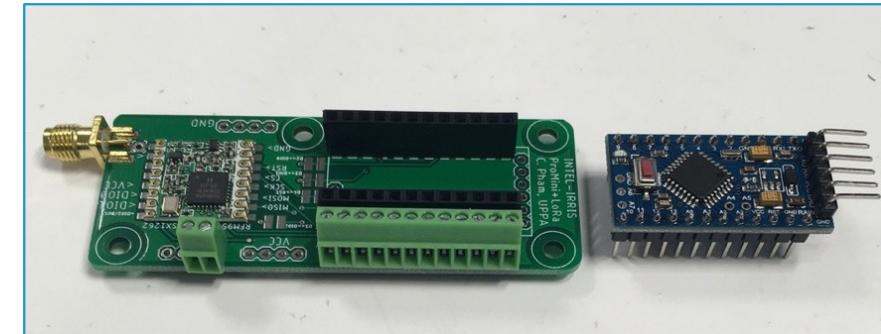
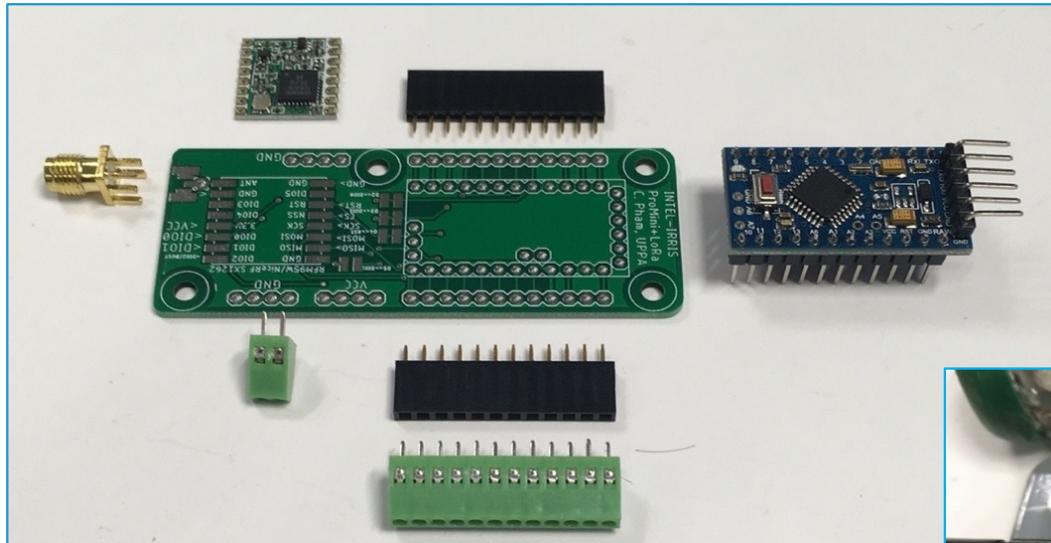


Soil sensor: electronic parts starter-kit version



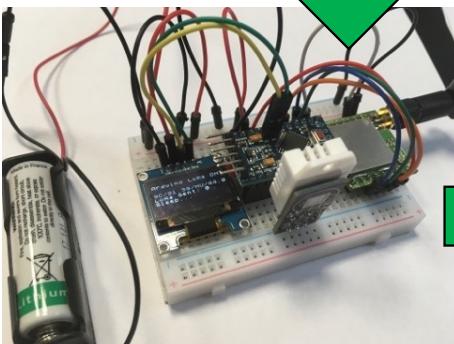
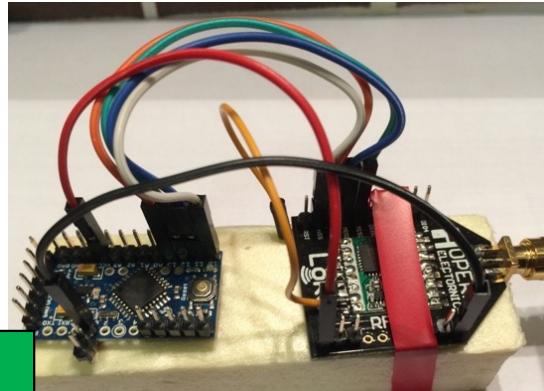
Simple & Modular design

- Simple integration on PCB of off-the-shelves components

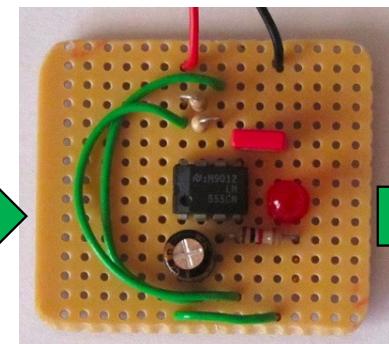


What is a PCB?

- PCB=Printed Circuit Board
 - Copper paths replace Dupont wires



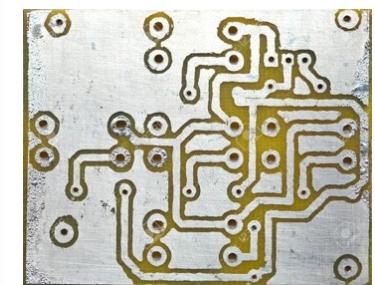
Breadboard



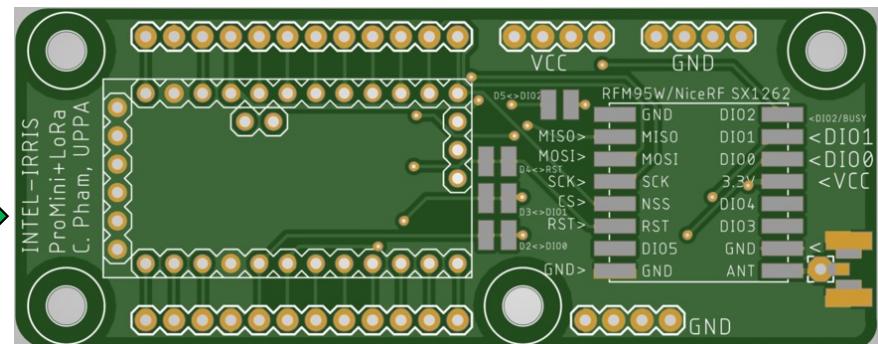
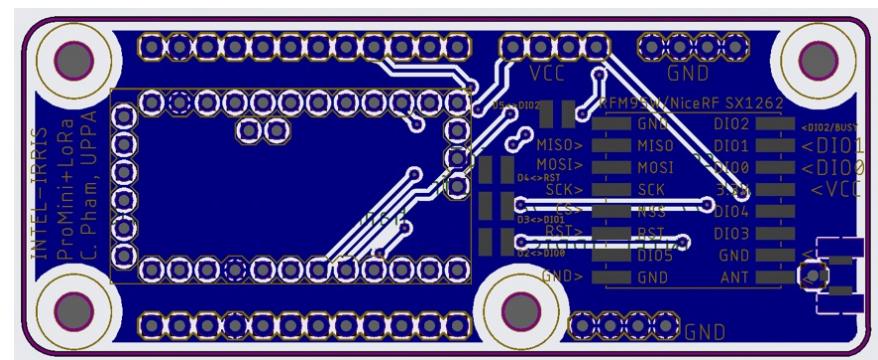
Stripboard



Raw PCB copper board



Removing copper to
create wire path

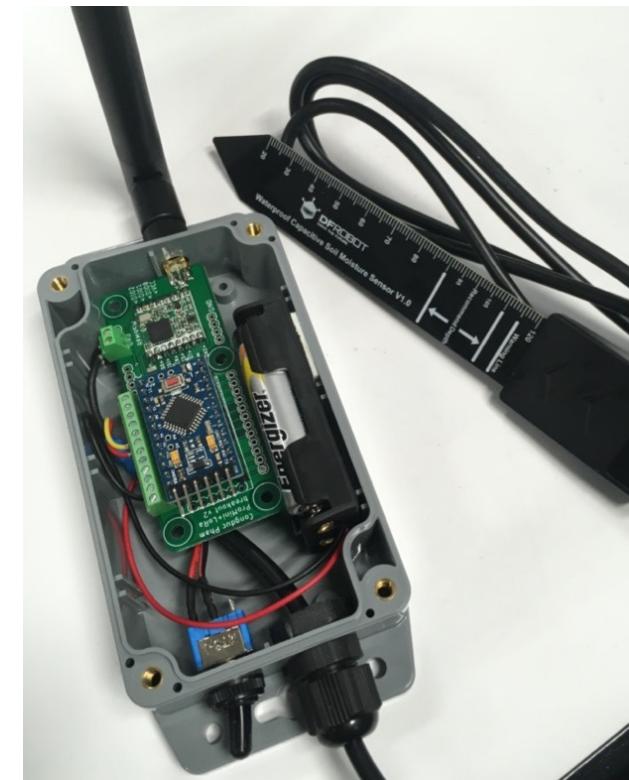
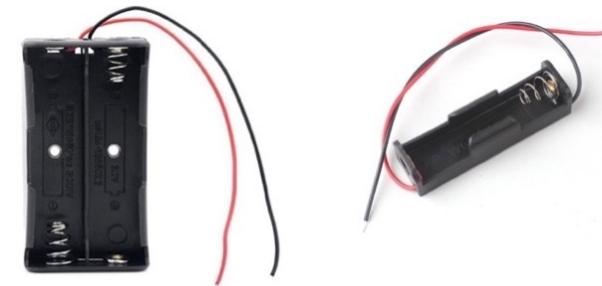


A generic sensor platform

- Low-cost: < 20€
- Off-the-shelves composants
- Easily duplicated
- Assembling by local partners
- Can connect several sensors
- Can be adapted by local partners
- Can be improved by local entrepreneurs
- Can increase capacity-building for local innovation



Final integration – DIY



Low-cost soil moisture device



A soil temperature sensor can be added

SEN0308
capacitive sensor

Watermark WM200
Water tension sensor