Why the Internet-of-Thing is becoming reality?

illustration with the H2020 WAZIUP project

Journées Scientifique URSI France
« Radiosciences au service de l'humanité »

Campus SophiaTech, Sophia Antipolis, France

Feb. 1st, 2017

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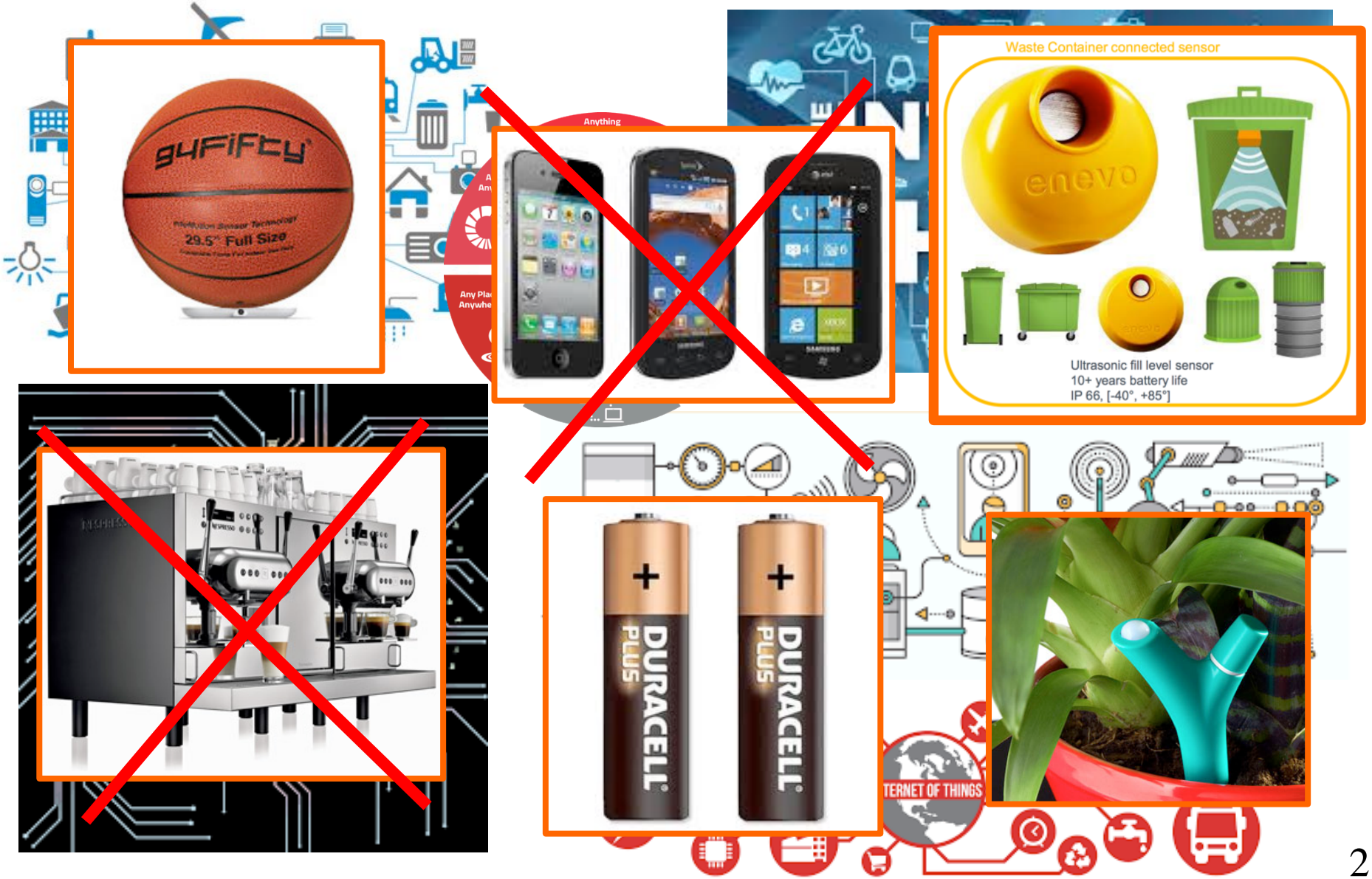
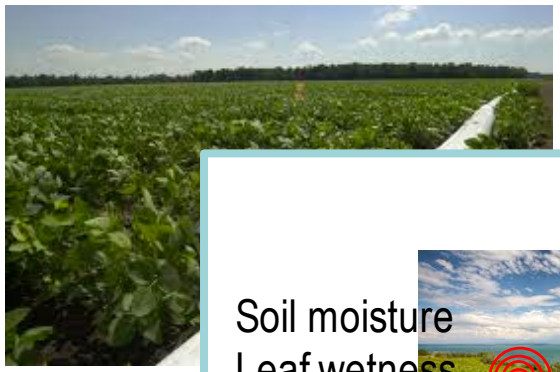
http://www.univ-pau.fr/~cpham
Université de Pau, France

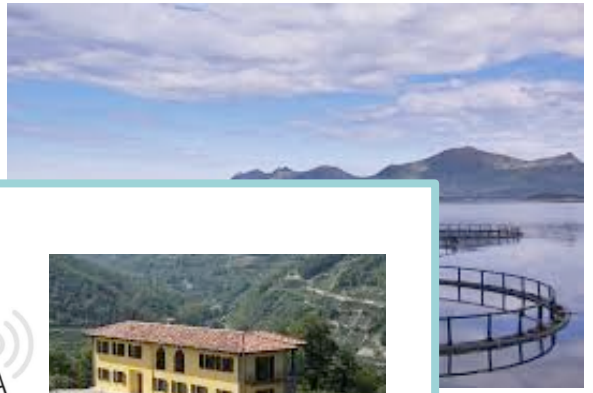
Internet of Things



Huge societal needs!



Irrig



culture

Soil moisture
Leaf wetness

10-15kms

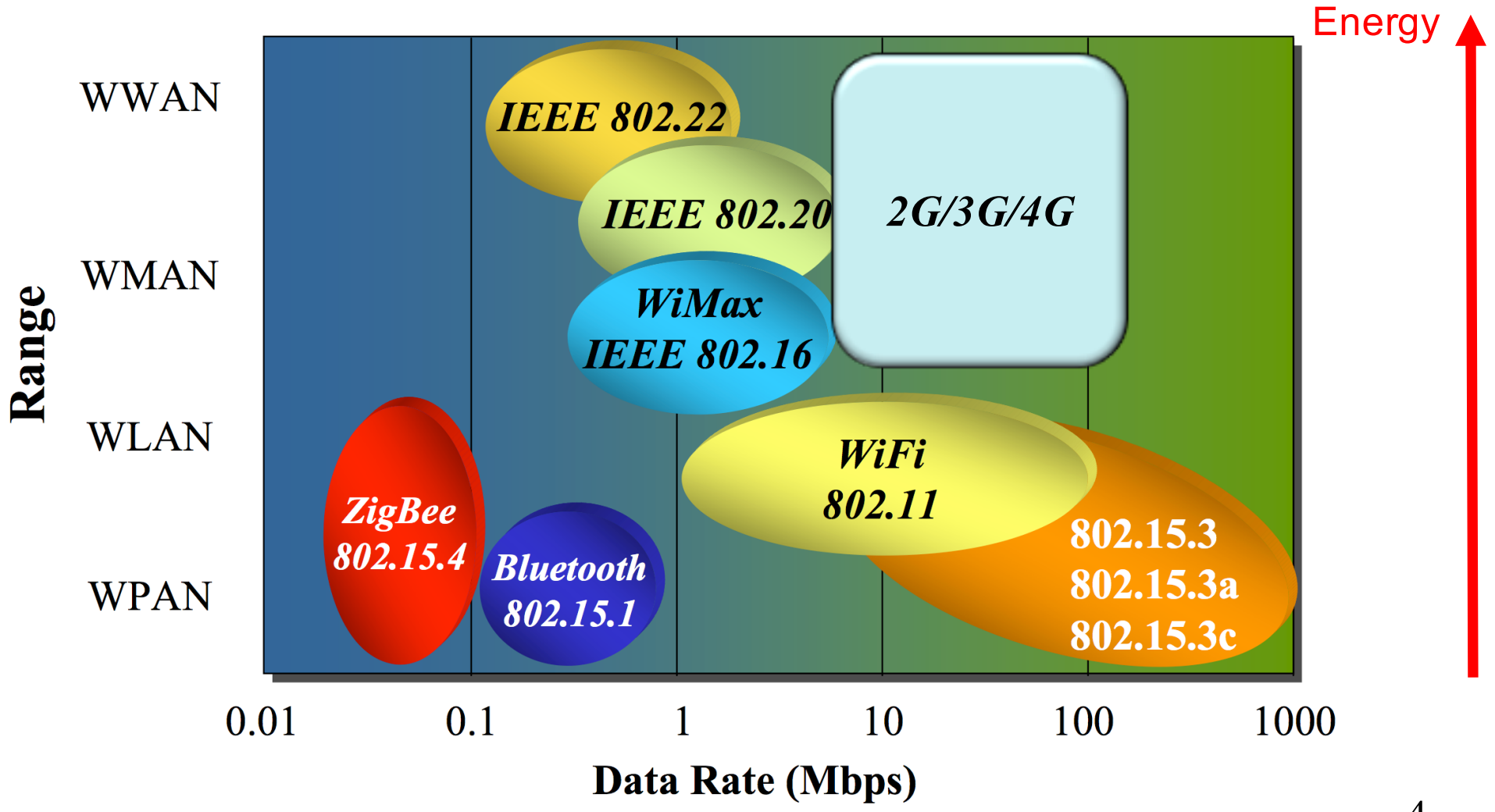
Storage & logistic

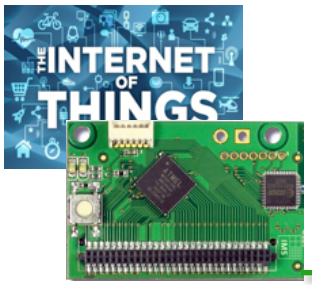
Agriculture

Fresh water

The wireless space

Energy-Range dilemma





How costly is transmission?

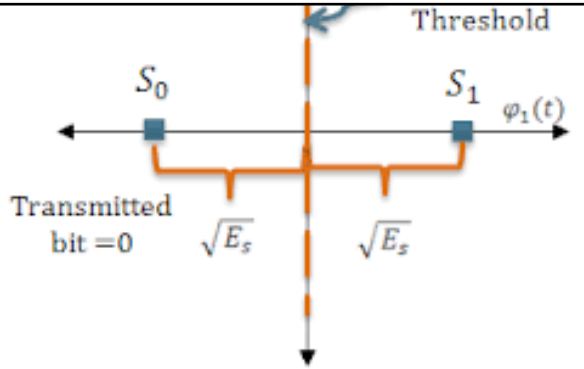
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC

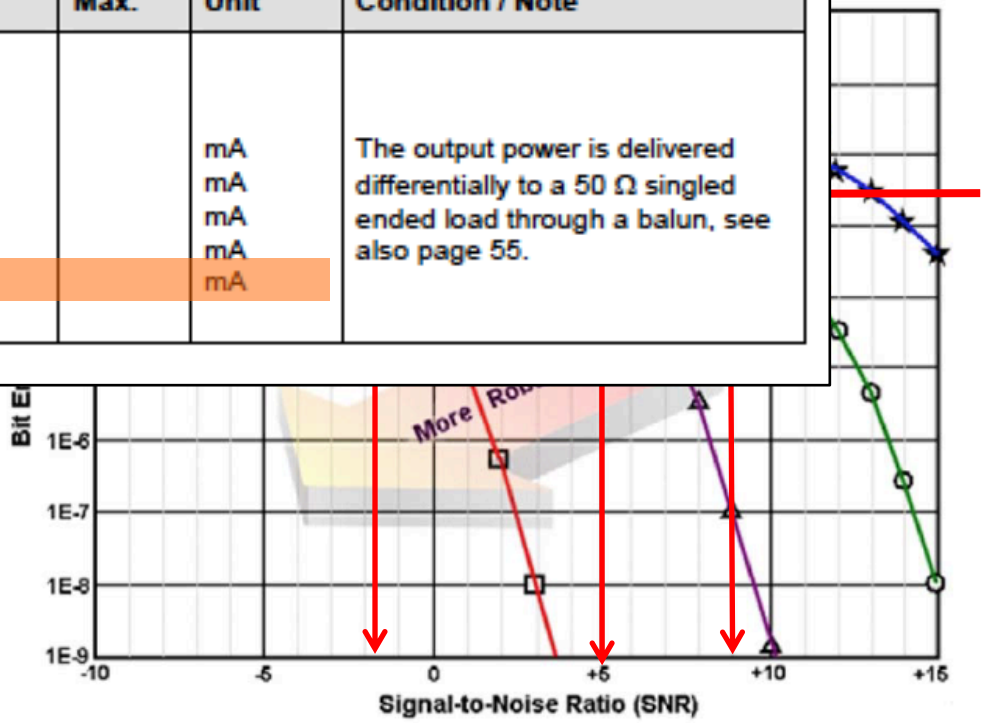
IEEE 802.15.4 in ISM 2.4GHz

- Low-power radio in the 2.4GHz band offering 250kbps throughput at physical layer
-
-
-

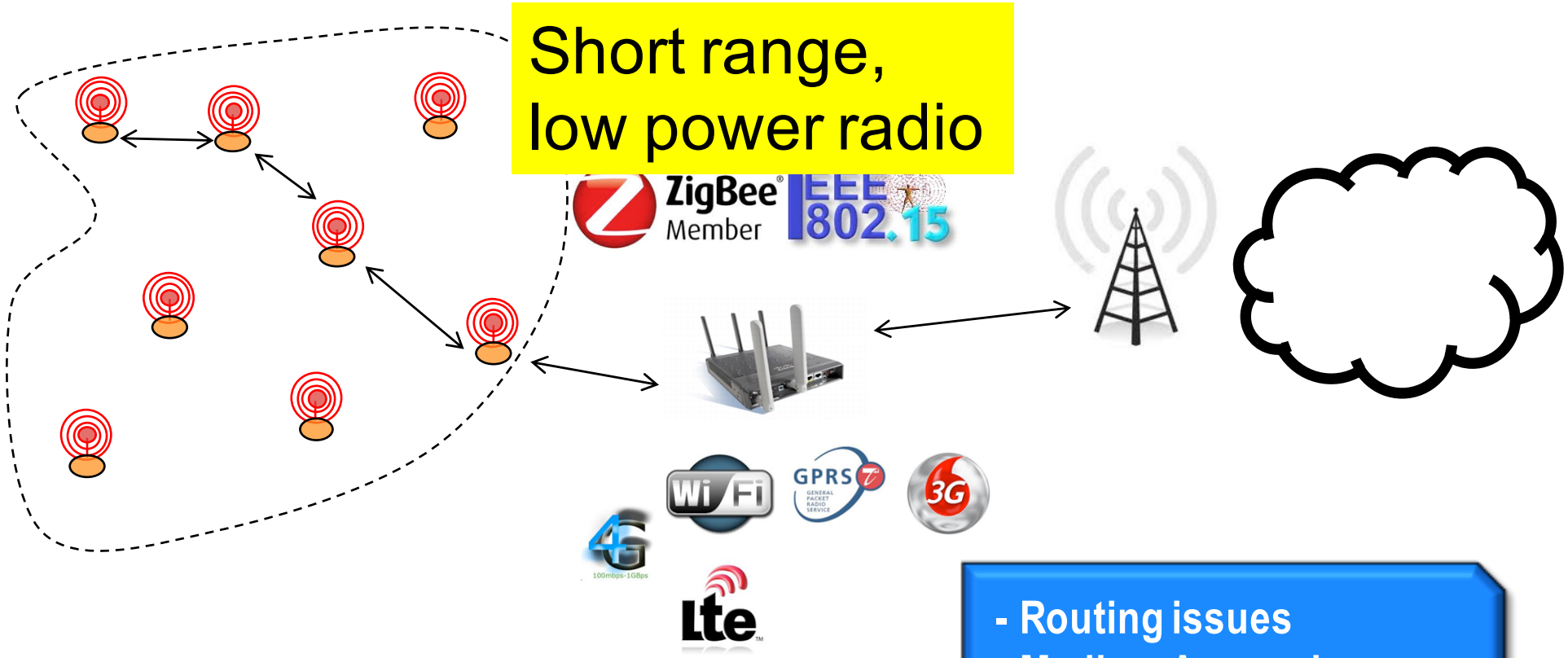
Chipcon Products from Texas Instruments — **CC2420**

Parameter	Min.	Typ.	Max.	Unit	Condition / Note
Current Consumption, transmit mode:					
P = -25 dBm		8.5		mA	The output power is delivered differentially to a 50 Ω singled ended load through a balun, see also page 55.
P = -15 dBm		9.9		mA	
P = -10 dBm		11		mA	
P = –5 dBm		14		mA	
P = 0 dBm		17.4		mA	



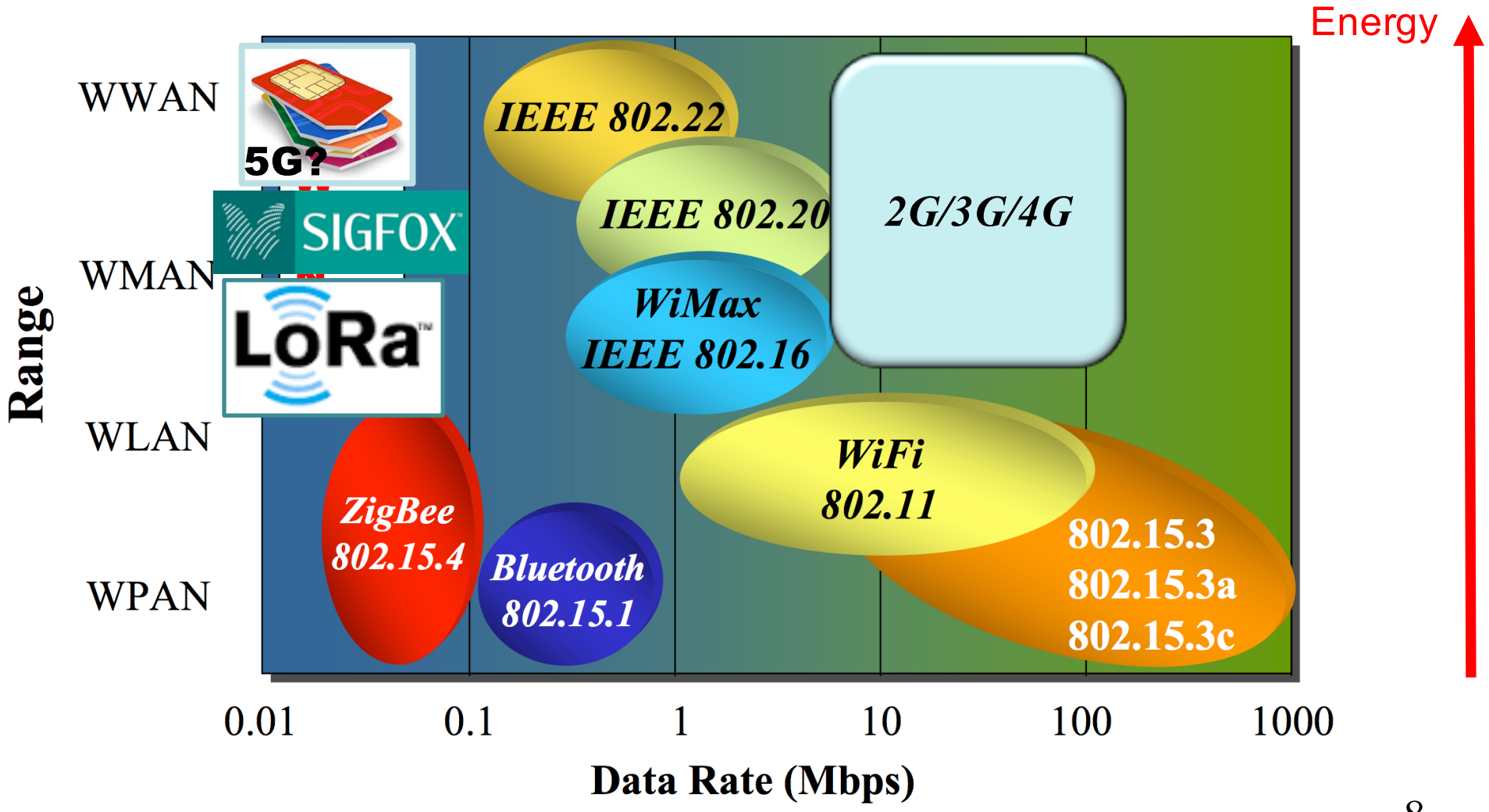


Lower energy means shorter range!



Low-power and long-range?

Energy-Range dilemma

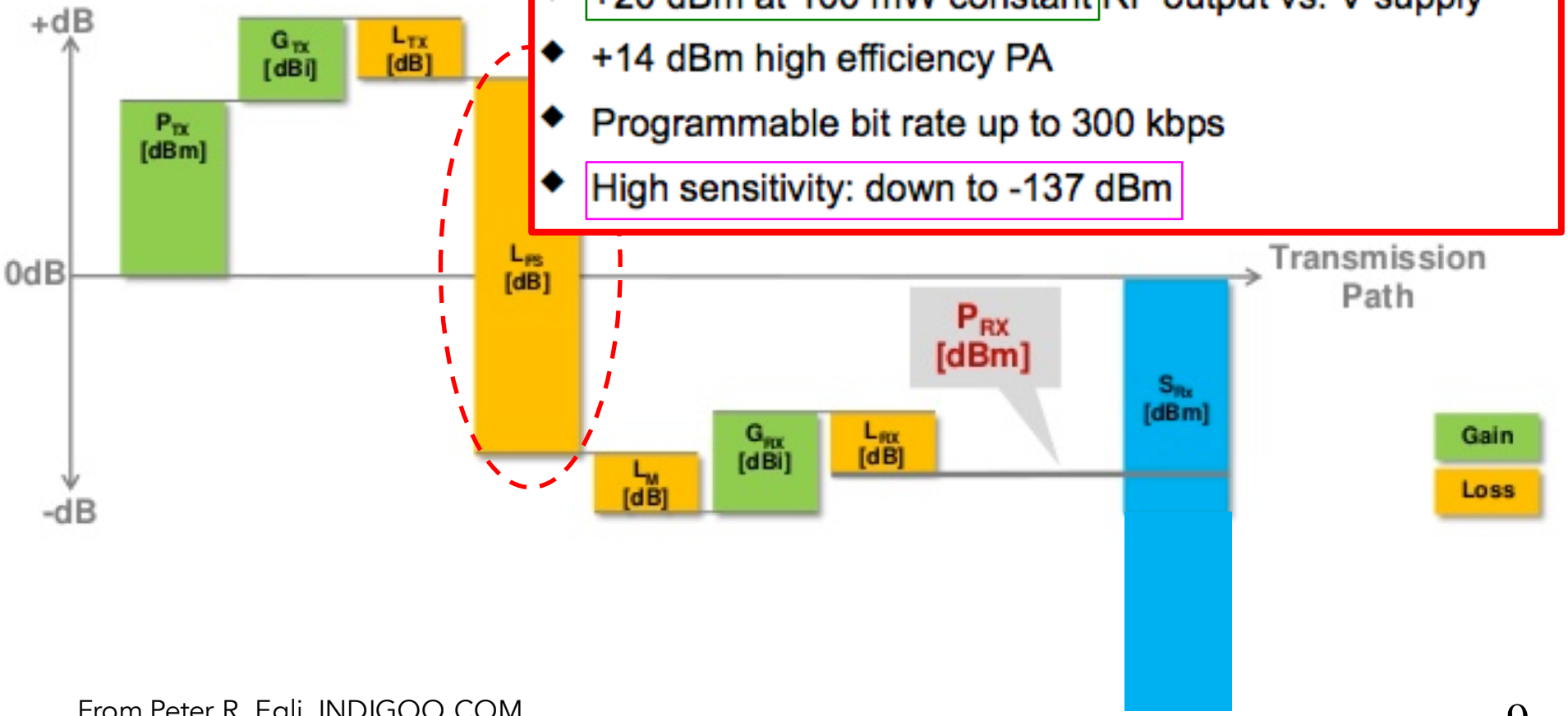


LINK BUDGET OF LPWAN

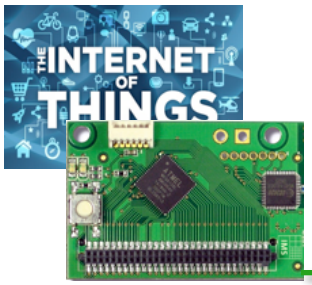
$$P_{RX} = P_{TX} + G_{TX} - L_{TX} -$$

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

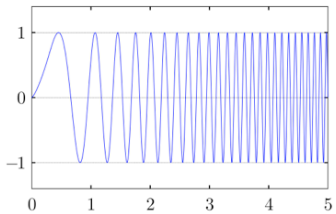


From Peter R. Egli, INDIGOO.COM

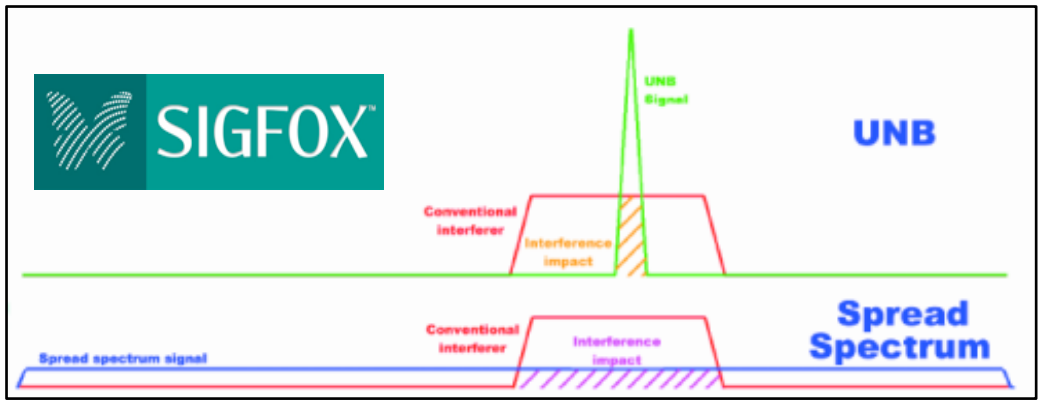


Increasing range?

- 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. Max throughput=~100bps
- LoRa also increases time-on-air when maximum range is needed. But LoRa uses spread spectrum instead of UNB. throughput=~300bps-37.5kbps



LoRa™



VERSATILE LPWAN!

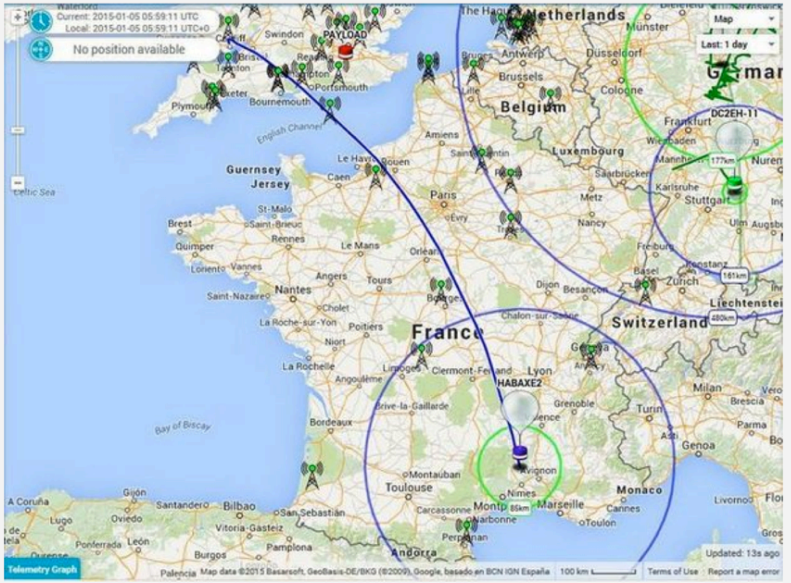
Dense urban areas

Rural areas

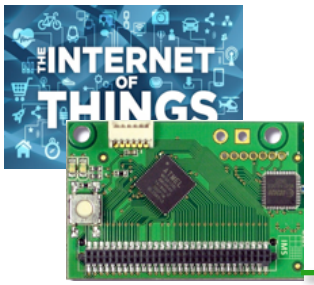
Indoor

Underground

The higher the better!



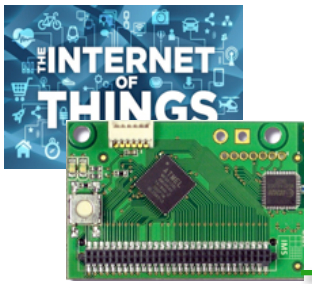
UK HAB (High Altitude Ballooning) trials gave 2 way LoRa™ coverage at up to 240 km. Lowering the data rate from 1000bps to 100bps should allow coverage all the way to the radio horizon, which is perhaps 600 km at the typical 6000-8000m soaring altitude of these balloons. Balloon tracking can be made



IoT BECOMES REALITY!

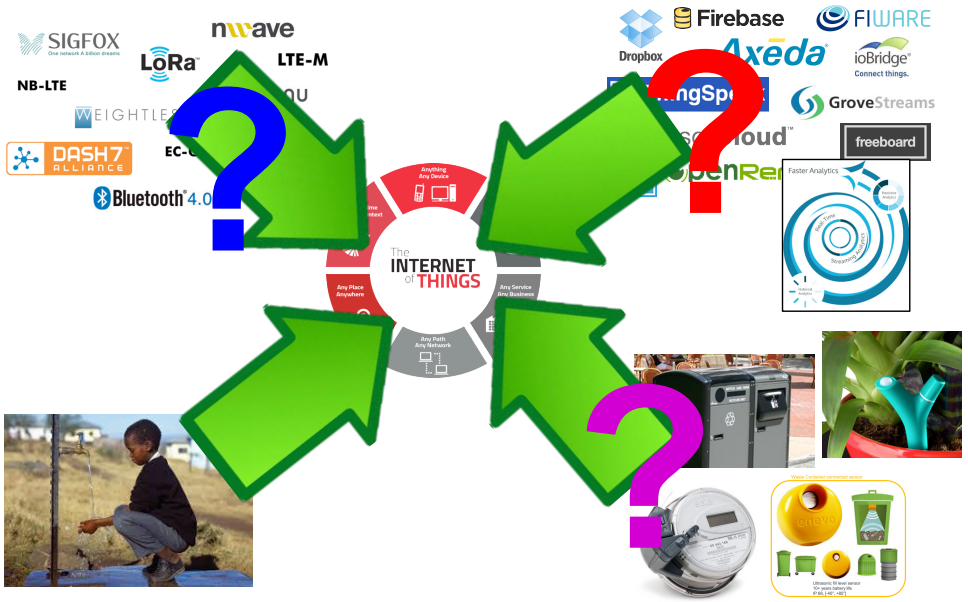
SIGFOX
One network A billion dreams
nwave
LoRa
LTE-M
NB-LTE
WEIGHTLES
DASH7 ALLIANCE
EC-
Bluetooth 4.0
Dropbox
Firebase
FIWARE
Axēda
ioBridge
Connect things.
ThingSpeak
GroveStreams
sorCloud
freeboard
penRe
Faster Analytics
Real-Time
Streaming Analytics
Predictive Analytics
Historical Analytics
Anything Any Device
Any Service Any Business
Any Path Any Network
Any Place Anywhere
The INTERNET of THINGS
Waste Container connected sensor
enevo
Ultrasonic fill level sensor
10+ years battery life
IP 66, [-40°, +85°]

A REALITY FOR EVERYBODY?



IoT in developing countries?

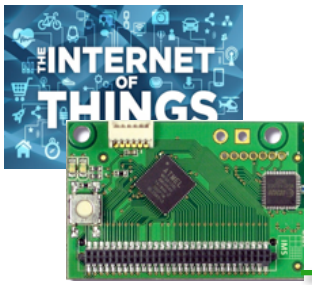
- Developing countries are still far from being ready to enjoy the smallest benefit of IoT
  - lack of infrastructure
  - high cost of hardware
  - complexity in deployment
  - lack of technological eco-system and background



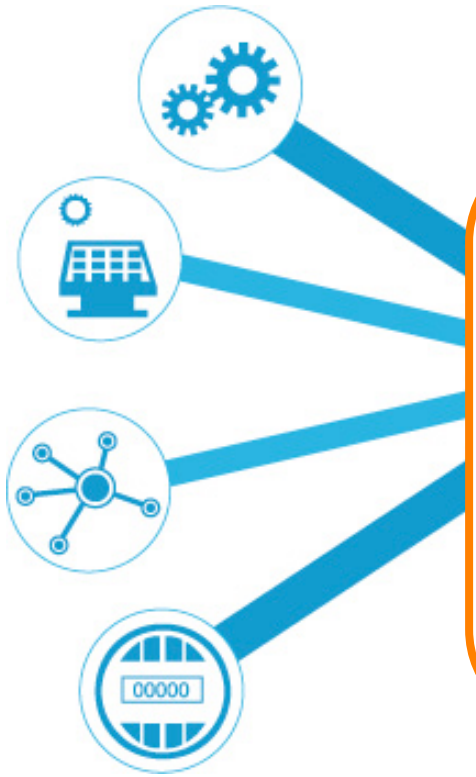
MATURATION OF THE IoT MARKET…

… but not adapted for rural developing countries context & environment

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



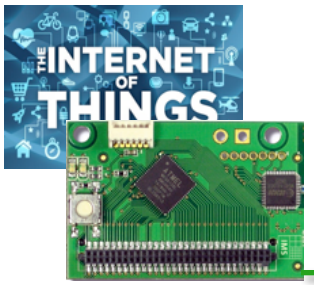
Internet, Cloud & big data analytics



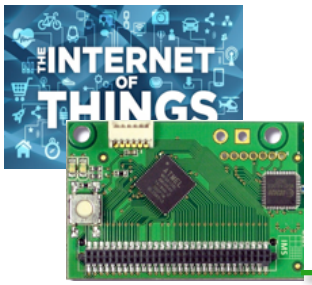
Internet connectivity is weak and expensive!

Nearly impossible in remote/rural areas

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



WAZIUP: LOW-COST IOT



Low-cost hardware

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.

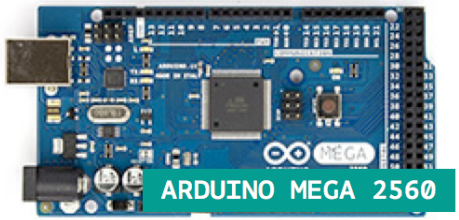
ARDUINO BOARD

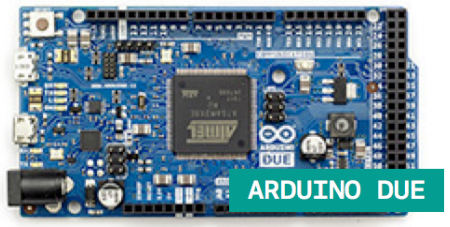
Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators.

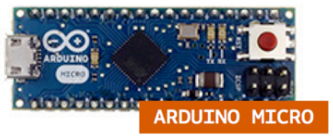
```
void setup() {
 }

void loop() {
 }
```

ARDUINO SOFTWARE

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

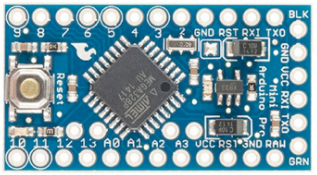






Large ecosystem, still growing!

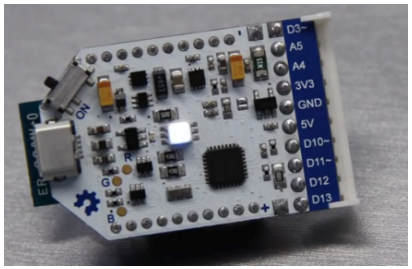
Arduino Pro Mini



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

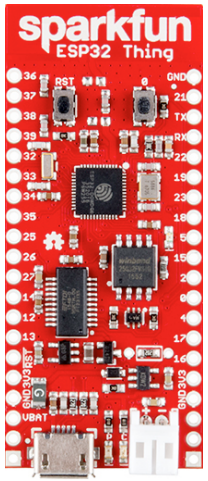
Expressif ESP32

Teensy 3.2

STM32

Nucleo-32

Adafruit Feather

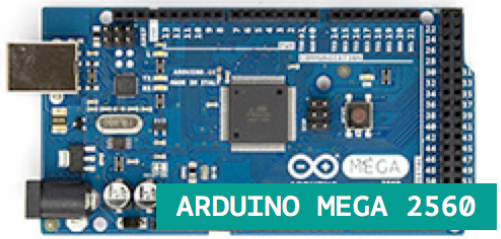


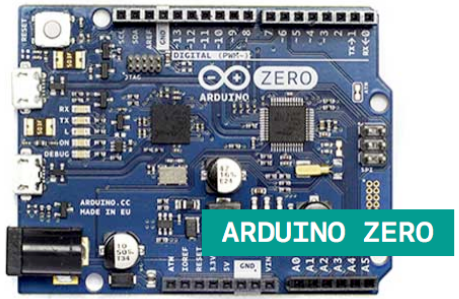
Sparkfun ESP32 thing

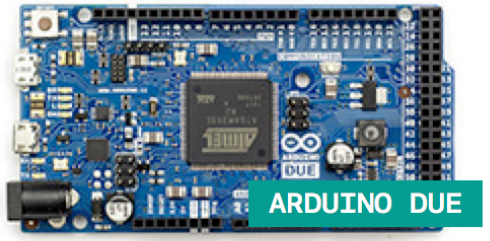
Tessel

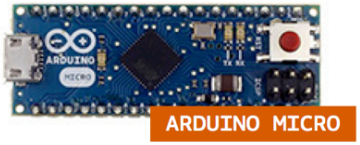
Tinyduino

SW/HW BUILDING BLOCKS INTEGRATION

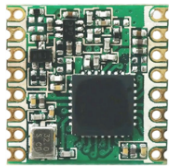








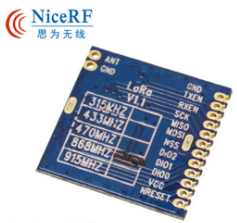
LoRa radios that our library already supports



HopeRF RFM92W/95W

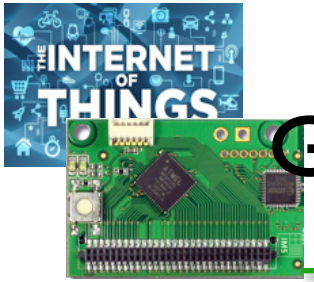
Libelium LoRa

Modtronix inAir9/9B



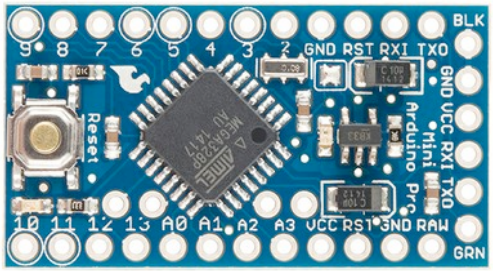
NiceRF LoRa1276

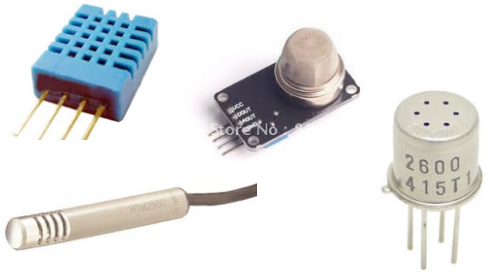
Long-Range communication library



Generic sensing IoT device

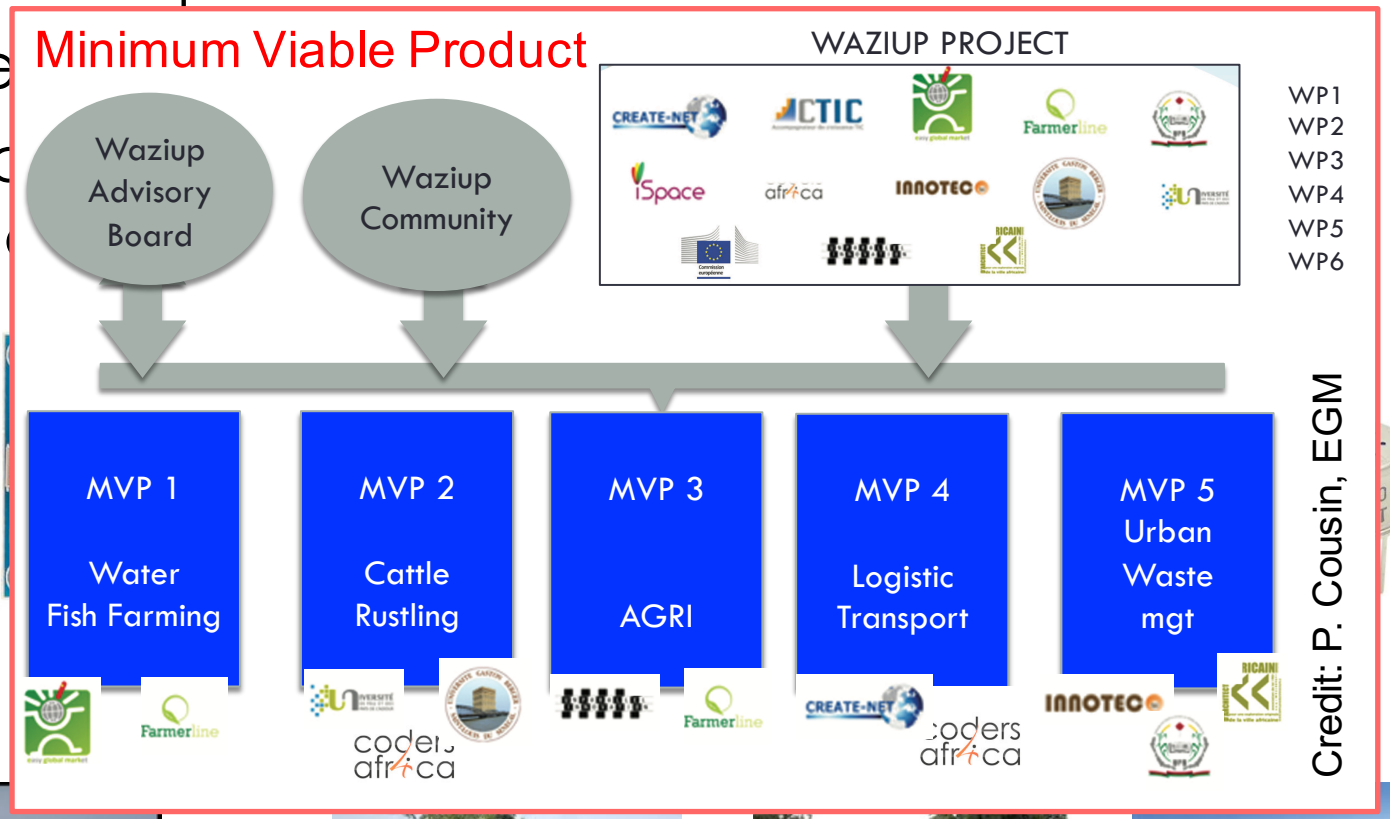
- Build low-cost, low-power, Long-range enabled generic platform
- Methodology for low-cost platform design
- Technology transfers to user communities, economic actors, stakeholders,…

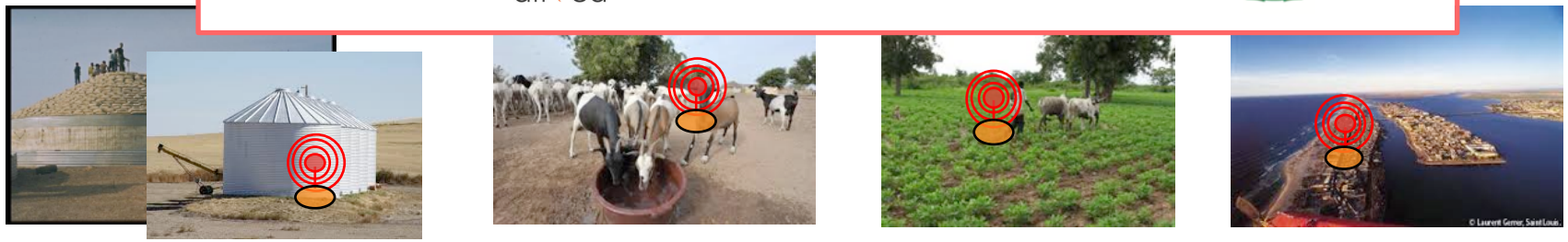




Generic sensing IoT device

- Build low-cost, low-power, Long-range enabled generic platform
- Me
- Tec
  ec



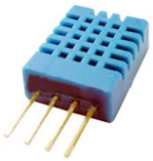


Ready-to-use templates

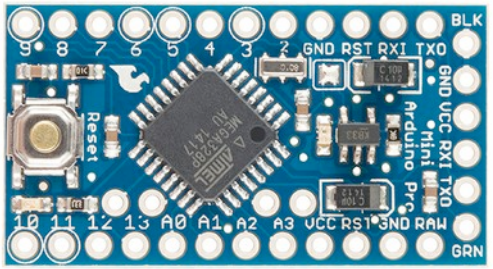
Physical sensor reading

Physical sensor reading

Physical sensor reading



Physical sensor management

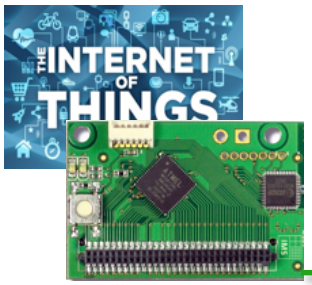


Activity duty-cycle, low power

Security

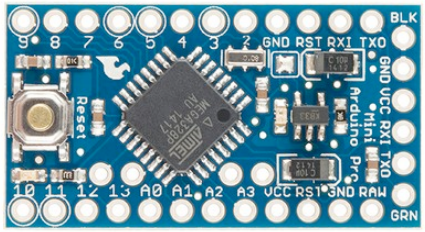
Long-range transmission

Logical sensor management

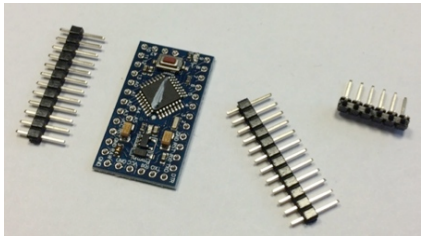


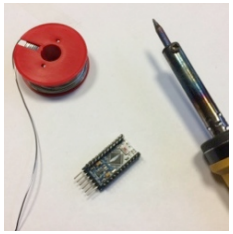
EASY INTEGRATION AND CUSTOMIZATION

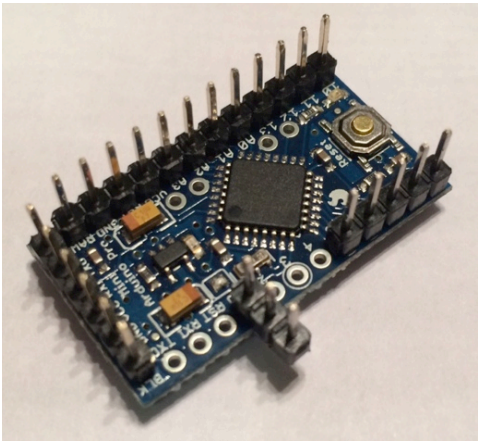
Arduino Pro Mini

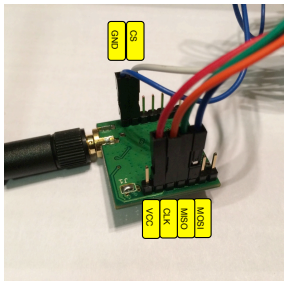


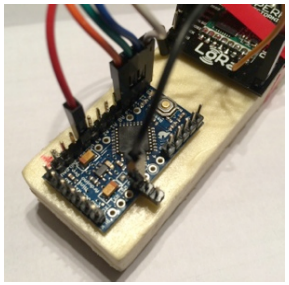
3.3v and 8MHz version

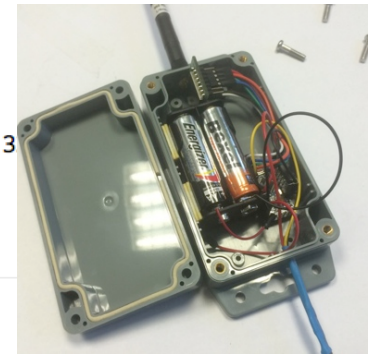


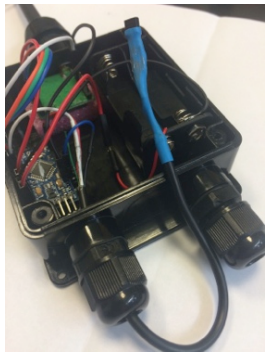


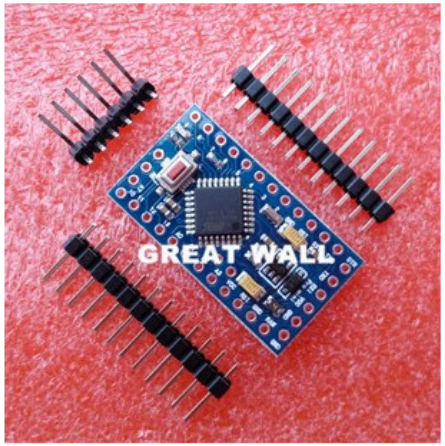












Avec la bootloader 1 pcs Pro Mini ATMEGA328 Pro Mini 3 MHz pour Arduino

View original title in English

4.9 (417 Votes) | 434 Commandes

Prix : € 1,49 / Kit

Trouvez plus de deals sur l'App

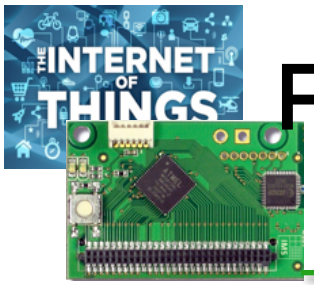
Livraison : € 0,29 vers France via China Post Ordinary Small Pac

Livraison : 15-34 jours (envoyé en 7 jours ouvrables)

Quantité : – 1 + Kit (55350 Kits available)

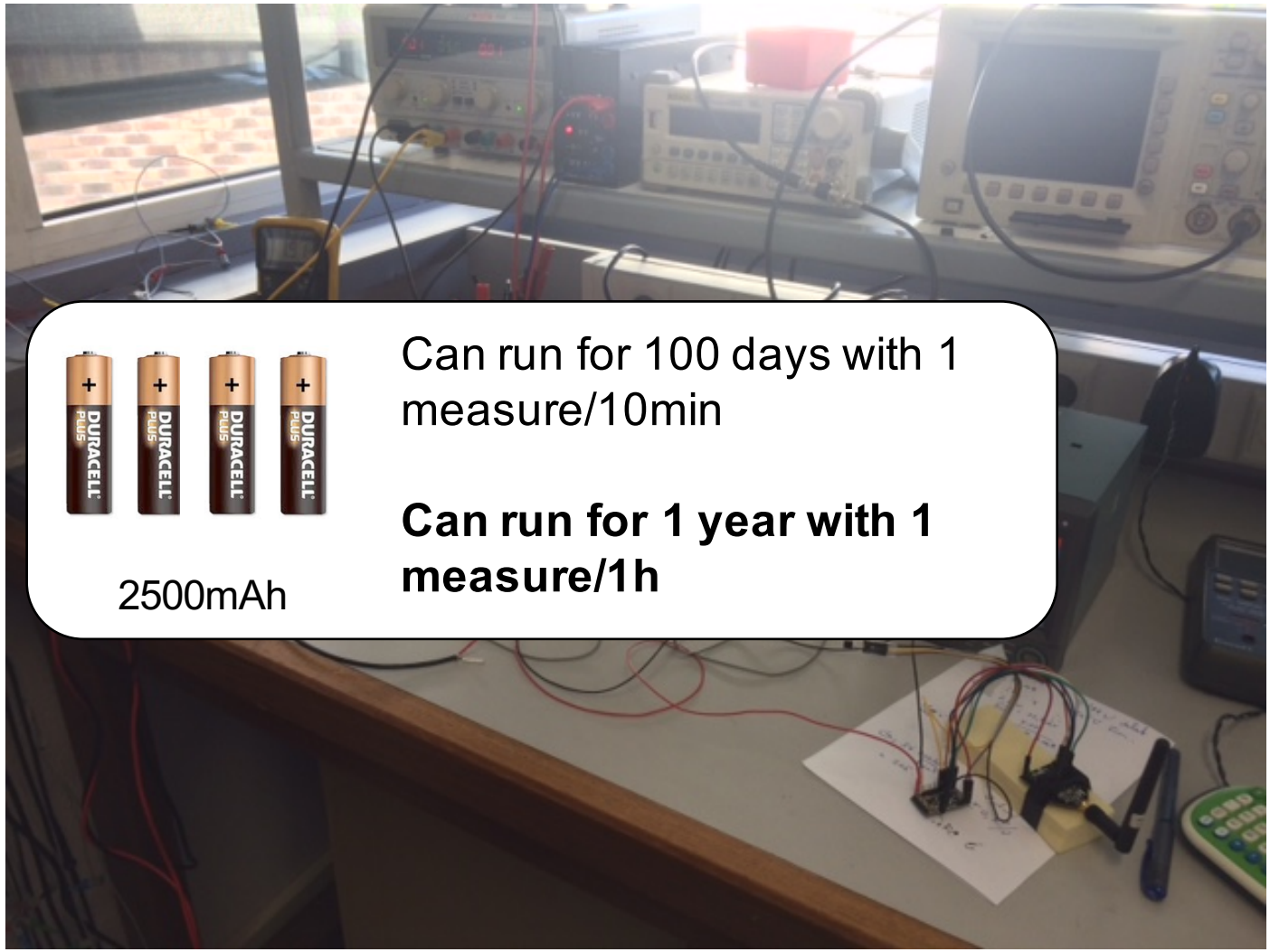
Montant total : € 1,78

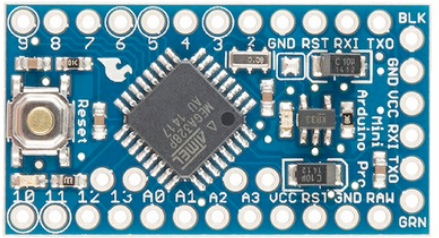
Acheter maintenant | Ajouter au panier



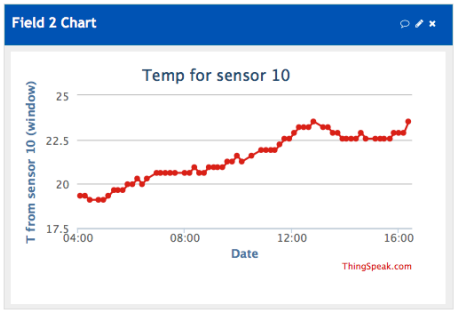
Running for 1 year with low-power mode!

Low-Power library from RocketScream





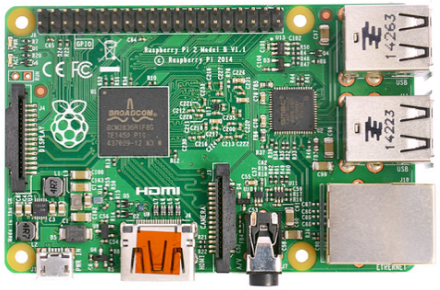
Wakes-up every 10min, take a measure (temp) and send to GW



146µA in deep sleep mode, 93mA when active and sending

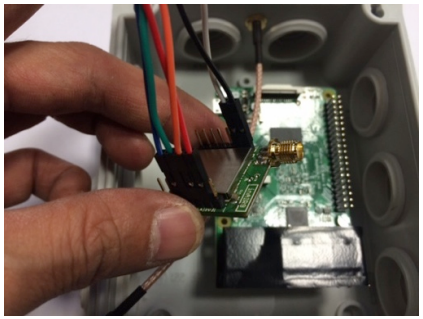
Thanks to T. Mesplou and P. Plouraboué for their help

Raspberry-based LoRa gateway

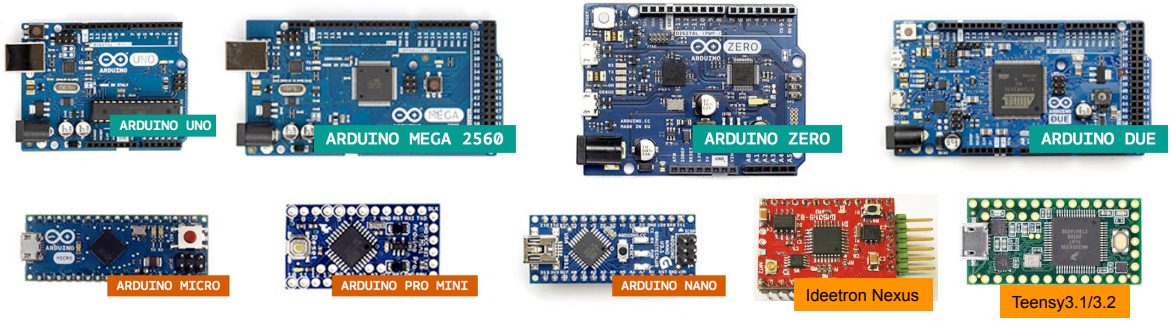


We can use all model of Raspberry. The most important usefull feature is the Ethernet interface for easy Internet connection. Then WiFi and Bluetooth can be added with USB dongles.
RPI3 provides built-in Ethernet, WiFi and Bluetooth!

Less than 50€



Simplicity!



LoRa radios that our library already supports

HopeRF RFM92W/95W

Libelium LoRa

Modtronix inAir9/9B

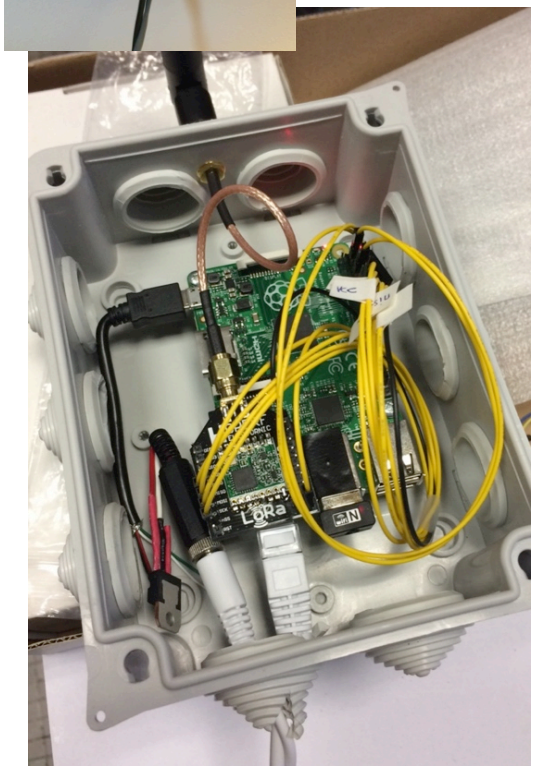
NiceRF LoRa1276

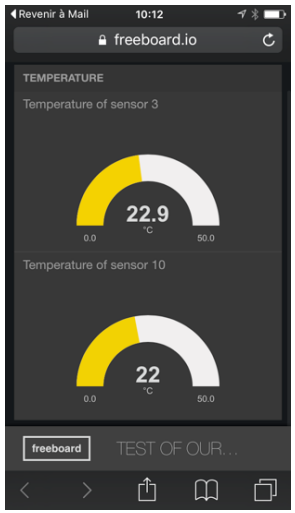
Long-Range communication library

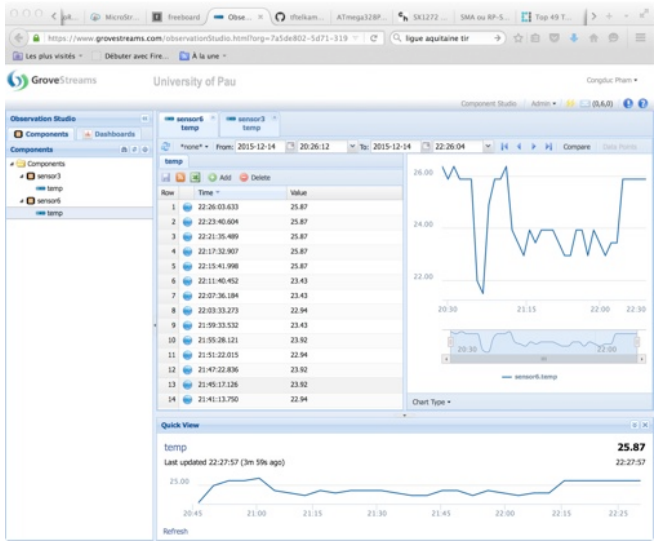
```
sendPacketTimeout("18.5");
// sends to gateway
// 18.5 : temperature message
```

1 send function!

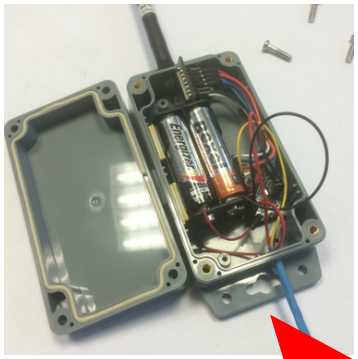
Templates for various clouds







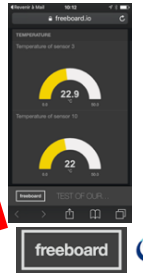
Do it yourself !

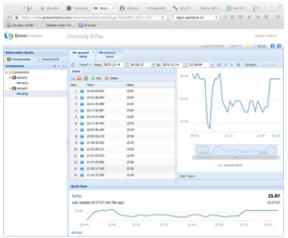


Step-by-step tutorial and source code available

Step-by-step tutorial and source code available

Python scripts available



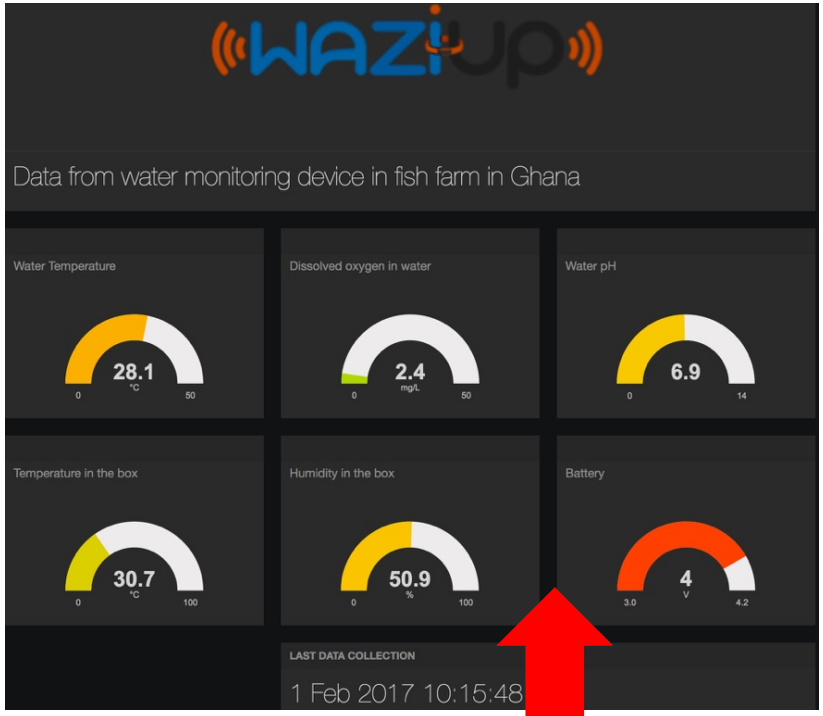


GroveStreams

SensorCloud™

https://github.com/CongducPham/LowCostLoRaGw

Low-cost buoy for fish farming MVP

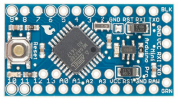


WAZIUP

Physical sensor reading

WAZIUP

Physical sensor management



Activity duty-cycle, low power

Security

Long-range transmission

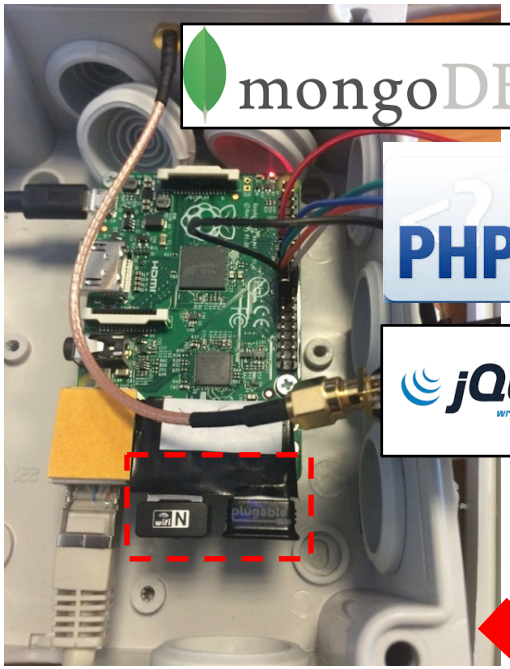
Logical sensor management

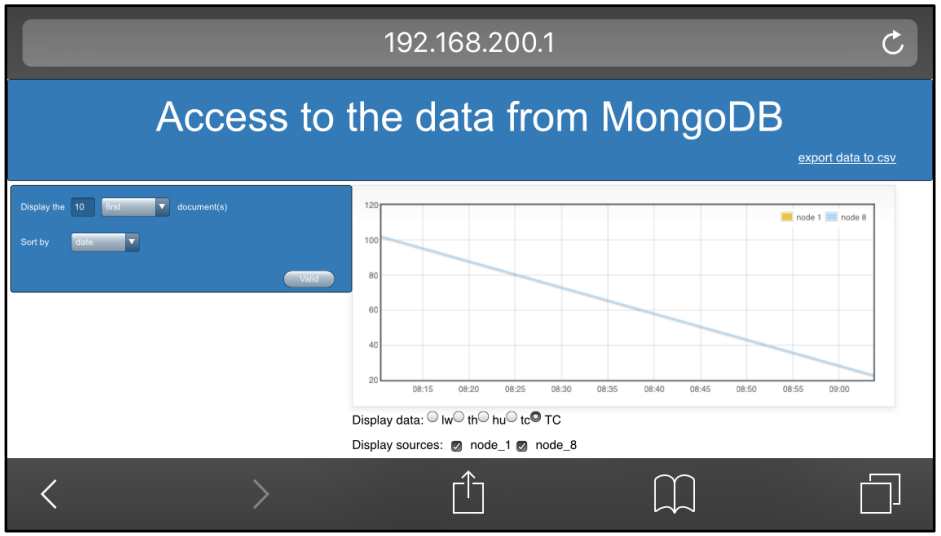
Credit: EGM

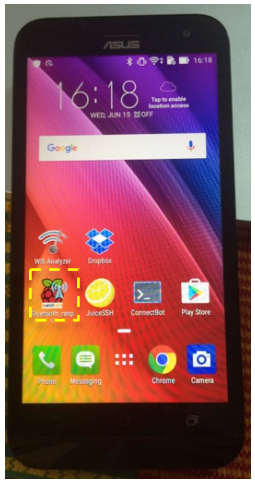
easy global market

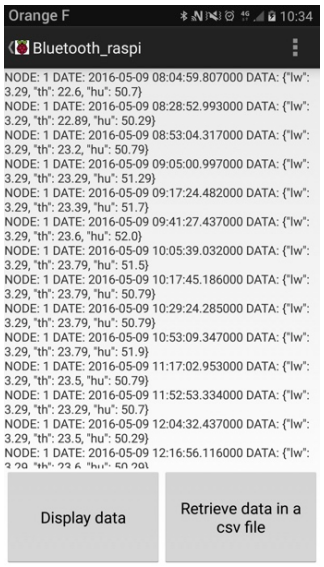
FIWARE

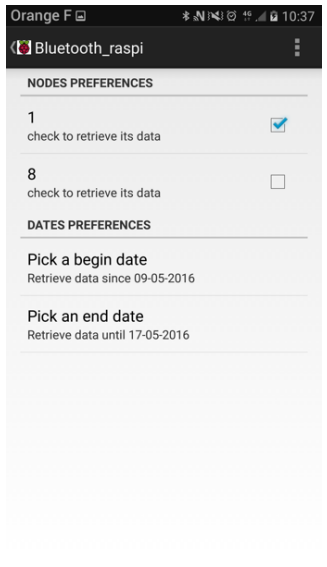
Working without Internet access

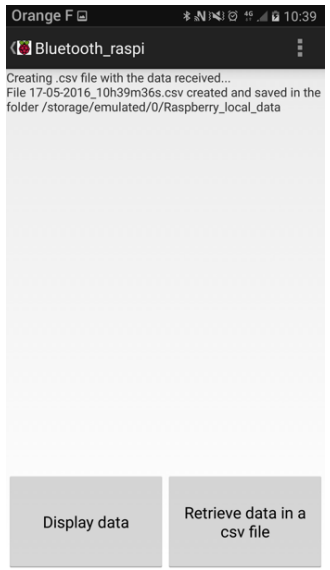




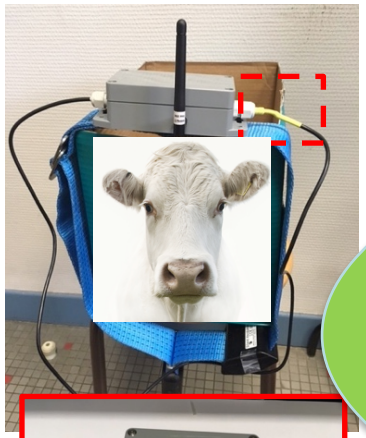


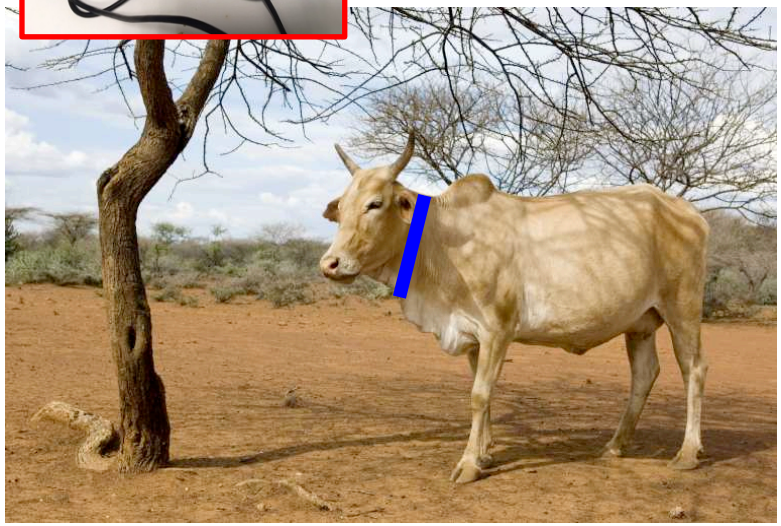


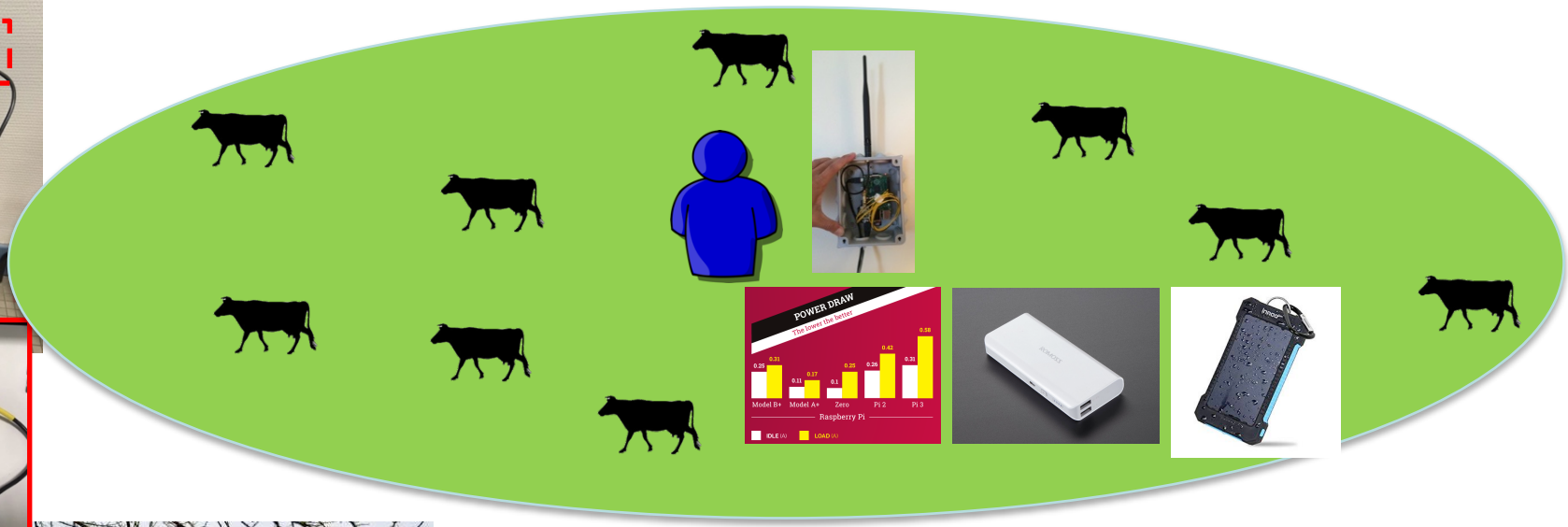


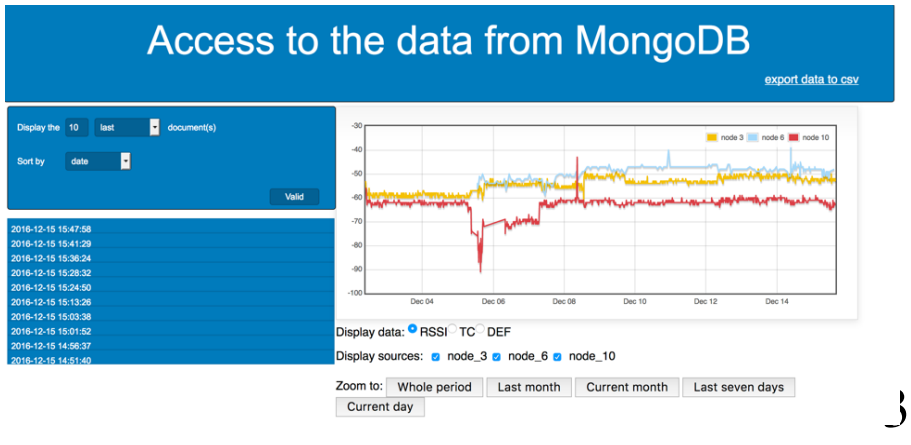


Gateway for « on-the-go » applications

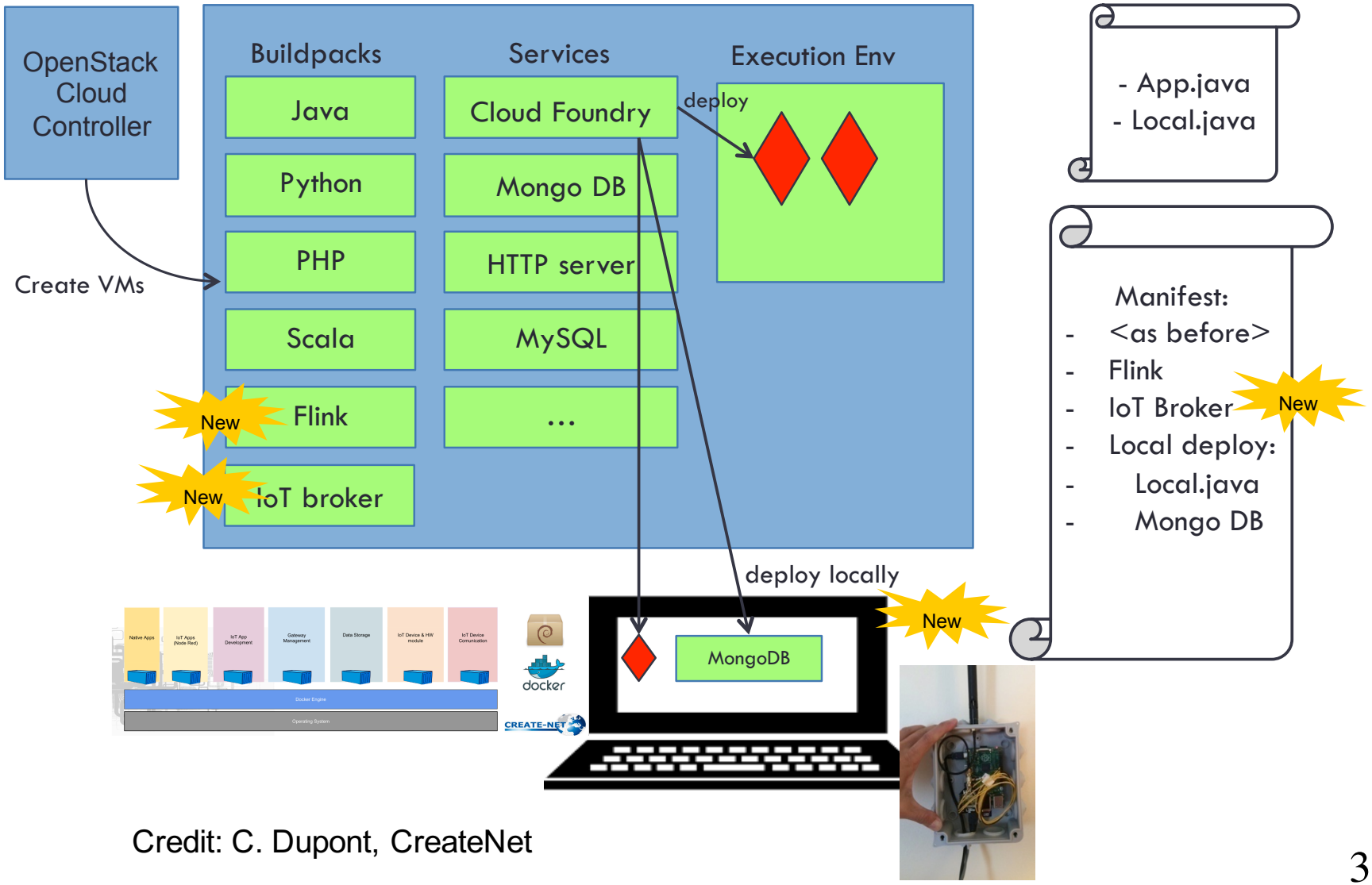




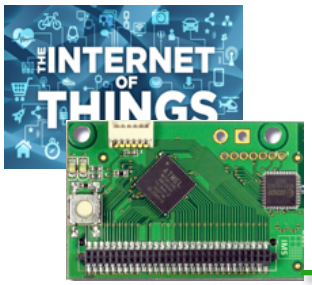




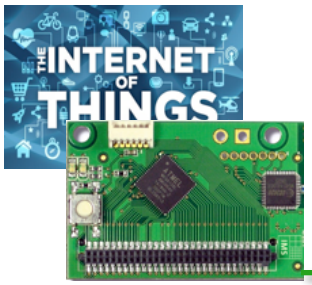
LOCAL DATA ANALYTICS



Credit: C. Dupont, CreateNet



Added-value



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 personaly & 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)

Credit: C. Vavasseur, CTIC Dakar

BUILDING WAZIUP COMMUNITY AND ECOSYSTEM

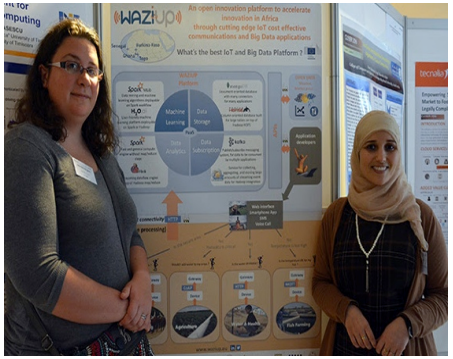
International Events
+ 20 organized & attended

Launch event (Ghana, iSpace)

Launch event (Senegal, CTIC Dakar)

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

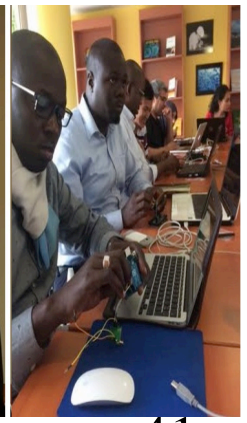
IoTWeek2016 (Belgrade, EGM)



IoTBigData2016 (Italy, EGM)

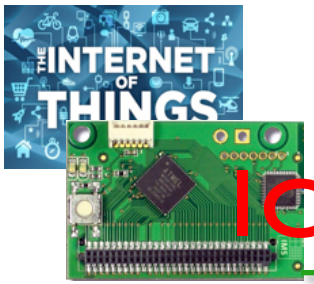
IoTCareConference (Budapest, CNET)

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



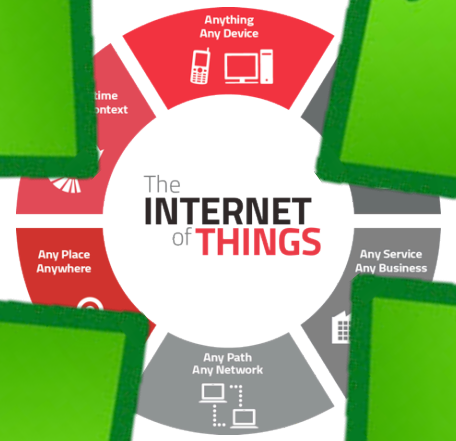
Workshop at the RESSACS 2016 (France, UPPA)

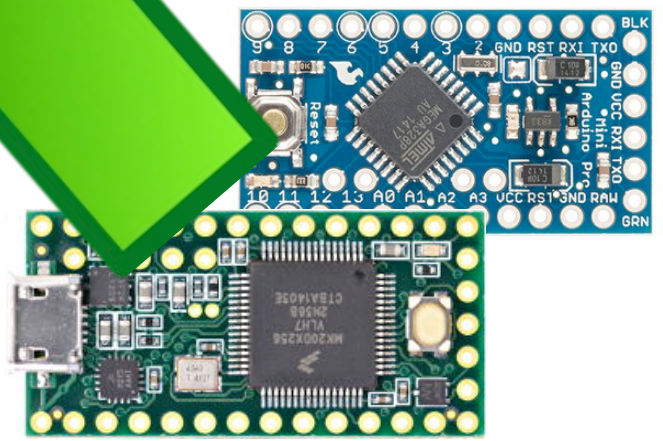
Credit: C. Vavasseur, CTIC Dakar



Now,
IoT CAN BECOMES REALITY!

SIGFOX
One network A billion dreams
LoRa
nwave
LTE-M
NB-LTE
WEIGHTLESS
DASH7 ALLIANCE
Bluetooth 4.0
Dropbox
Firebase
FIWARE
Axēda
ioBridge
Connect things.
ThingSpeak
GroveStreams
freeboard
Faster Analytics
Real-Time
Streaming Analytics
Predictive Analytics
Historical Analytics





Thanks.

Let's keep in touch

Carine VAVASSEUR

Communication & Event Manager

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