

DEPLOYING LOW-COST AND LONG-RANGE INTERNET OF THINGS IN DEVELOPING COUNTRIES

THE CHALLENGES OF THE  H2020 PROJECT



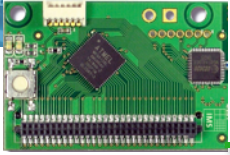
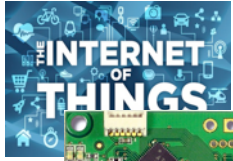
“UNDERSTAND THE ISSUES AND CHALLENGES OF THE CONNECTED WORLD”

SEPTEMBER 23RD, 2016
NEUCHÂTEL, SWITZERLAND



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





IoT DOMAIN (IN AFRICA)



Irrigation & Agriculture



Livestock farming



Fish farming & aquaculture



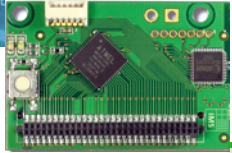
Storage & logistic



Health



Water quality



RURAL SENSING

Moisture/
Temperature
of storage
areas

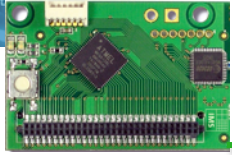


10-15kms

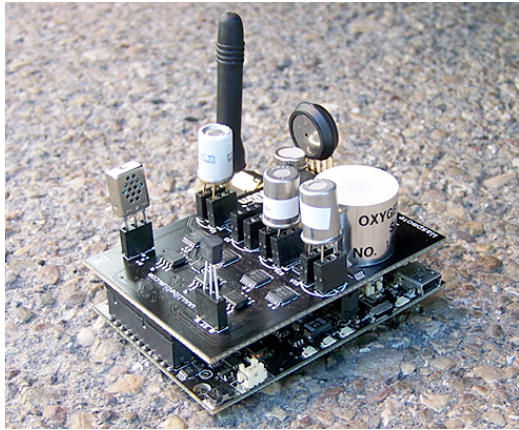


Pay subscription
Limitation of coverage
High energy consumption

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



18720 JOULES

TX power: 500mA

$P = I \times V = 500 \times 3.3 = 1650\text{mW}$

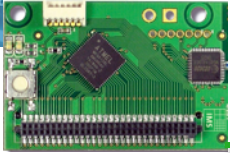
$E = P \times t \rightarrow t = E/P$

11345s or 3h9mins

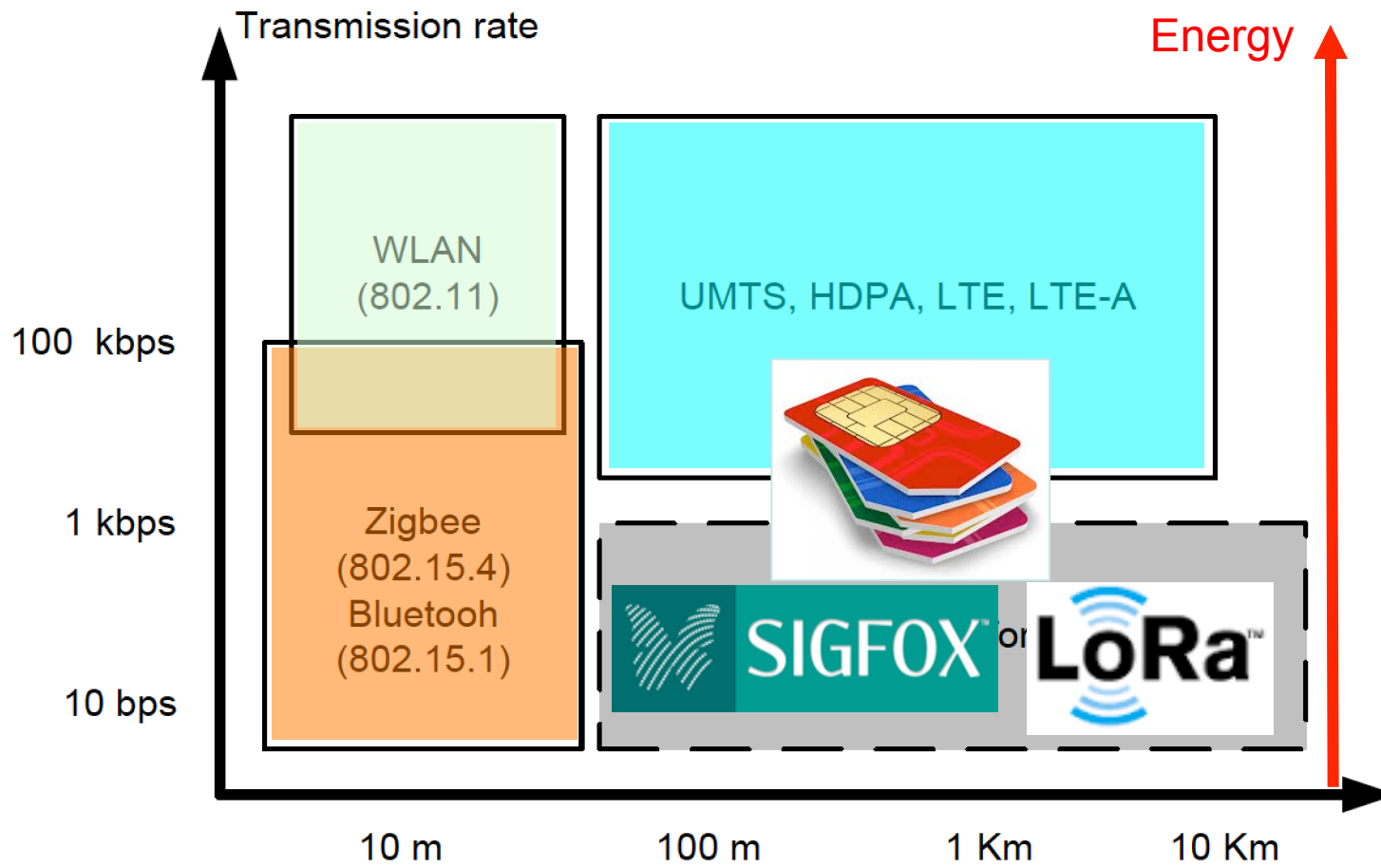
Technology	2G	3G
Range (I=Indoor, O=Outdoor)	N/A	N/A
Tx current consumption	200mA-500mA	500mA – 1000mA
Standby current	2.3mA	3.5mA

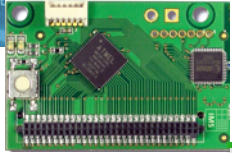
Haven't considered:

- Baseline power consumption of the sensor board
- RX consumption!
- Event capture consumption
- Event processing consumption



LOW-POWER AND LONG-RANGE?



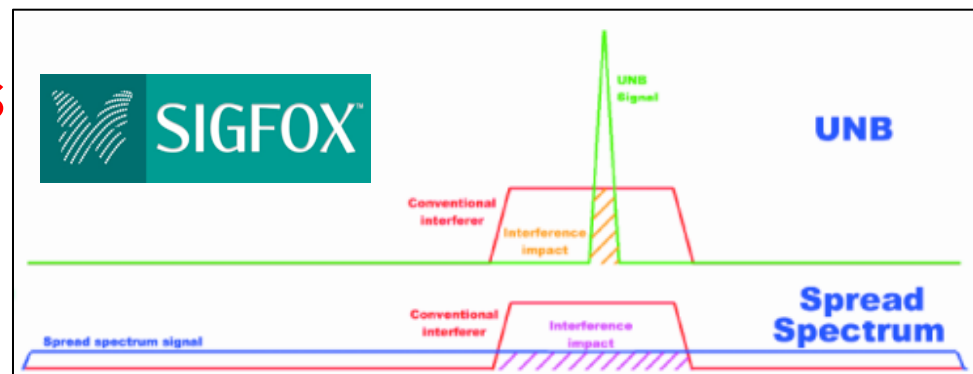
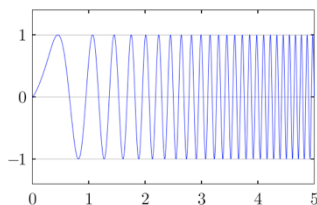


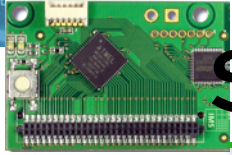
INCREASING RANGE?



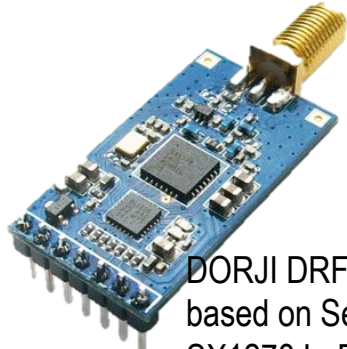
- Generally, robustness and sensitivity can be increased when transmitting (much) slower
- A [Sigfox message is sent relatively slowly in a very narrow band of spectrum (hence ultra-narrow-band) using Gaussian Frequency-Shift Keying modulation]. **Max throughput= ~ 100 bps**
- LoRa also increases time-on-air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

300bps-37.5kbps

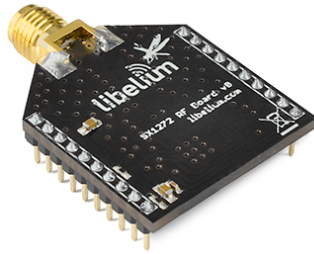




LoRa MODULES FROM SEMTECH'S SX127X CHIPS



DORJI DRF1278DM is based on Semtech SX1278 LoRa 433MHz



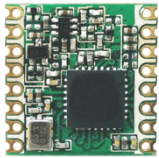
Libelium LoRa is based on Semtech SX1272 LoRa 863-870 MHz for Europe



inAir9 based on SX1276



Froggy Factory LoRa module (Arduino)



HopeRF RFM series



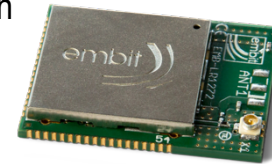
HopeRF HM-TRLR-D



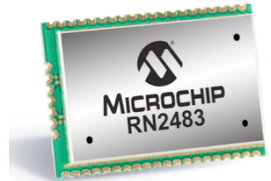
LinkLabs Symphony module



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



Embit LoRa



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

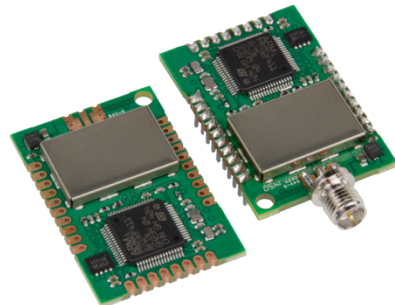
Microship RN2483



habSupplies



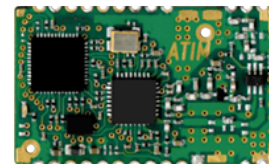
Adeunis ARF8030AA- Lo868



Multi-Tech MultiConnect mDot



AMIHO AM093



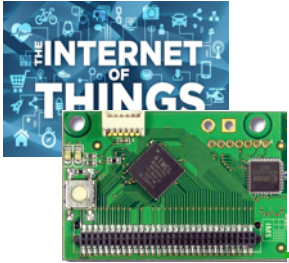
ARM-Nano N8 LoRa module from ATIM



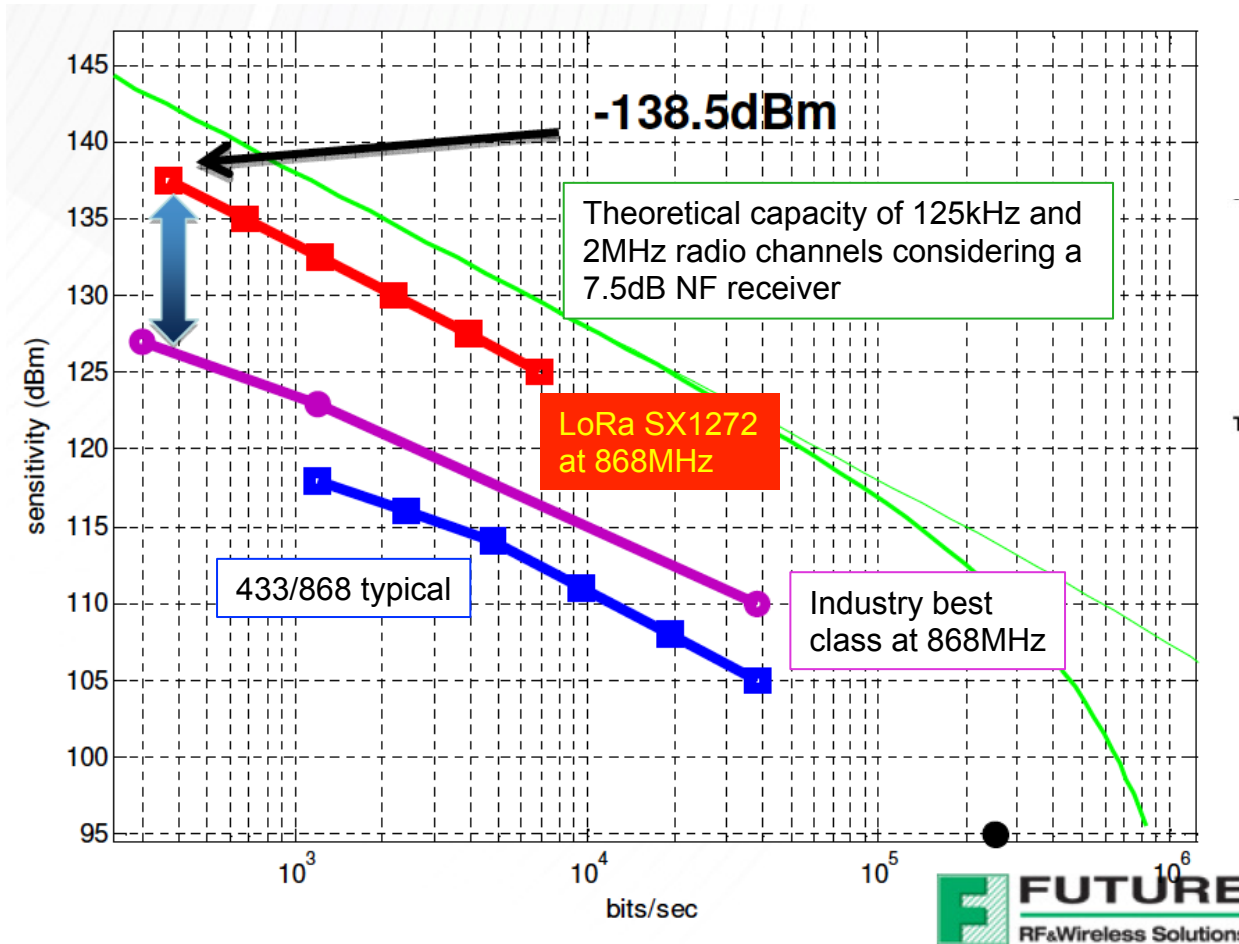
SODAQ LoRaBee Embit



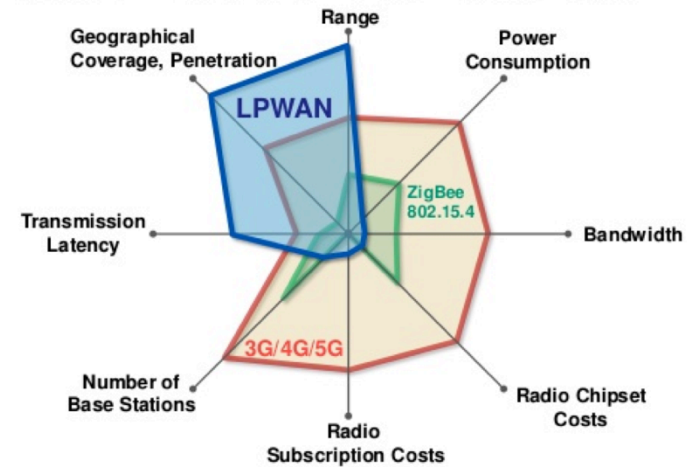
SODAQ LoRaBee RN2483



THE LONG-RANGE REVOLUTION

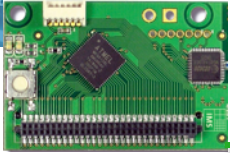


Sensitivity: lowest input power with acceptable link quality, typically 1% PER



From Peter R. Egli, INDIGOO.COM

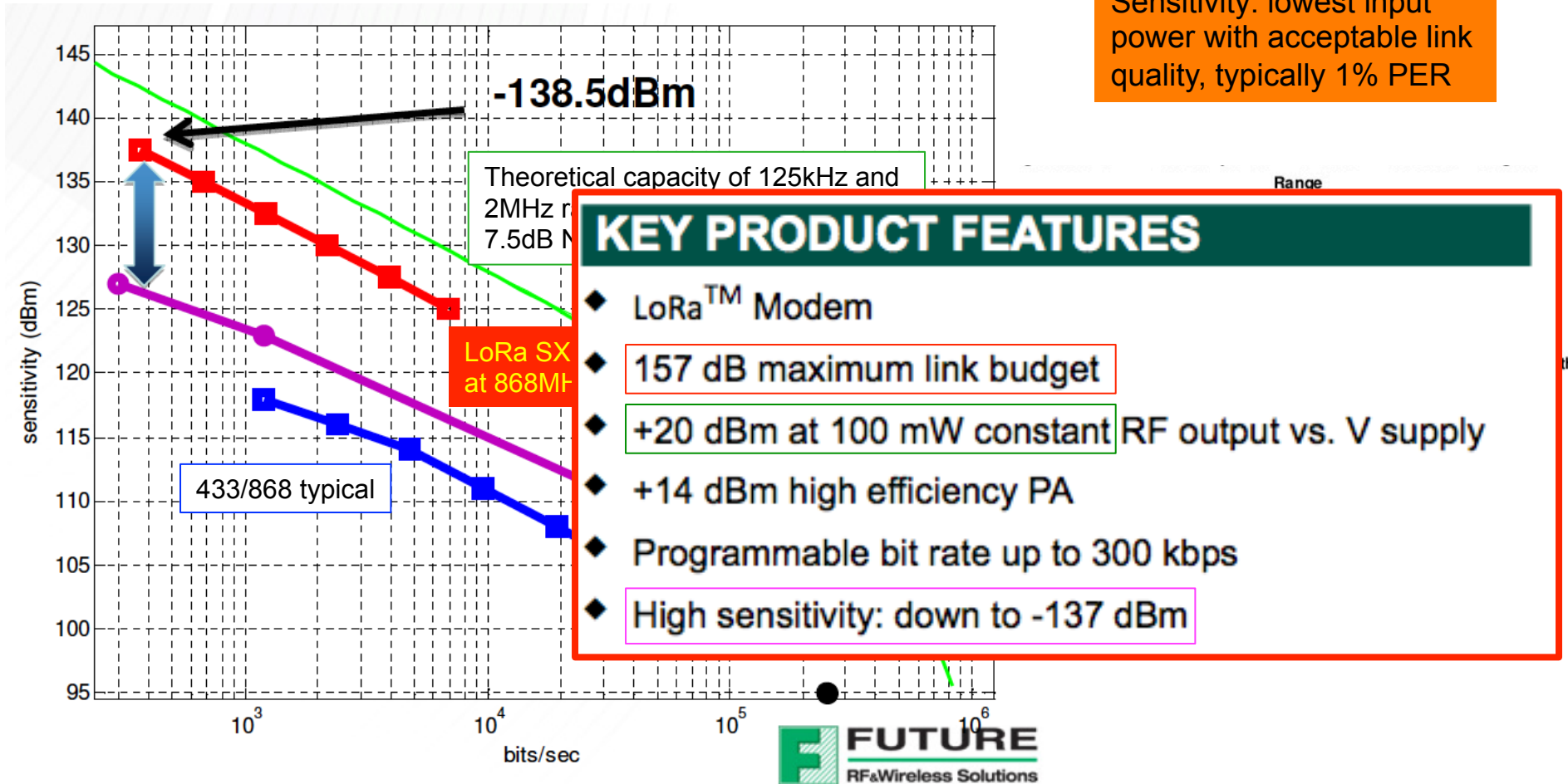
The lower the receiver sensitivity, the longer is the range!



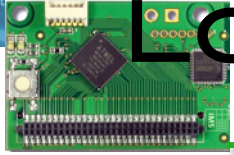
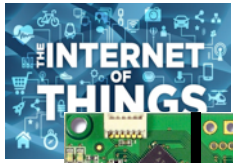
THE LONG-RANGE REVOLUTION



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



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



LOW POWER WAN (LPWAN) ?



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
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)
Module Revenue Annually	12 \$	20 \$	4 \$	\$3	3 \$

Autonomy GSM with 2000mAh -

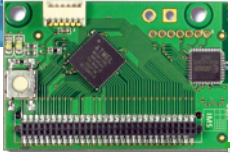


Autonomy LP WAN with 2000mAh -



Example for energy meter





LPWAN ARCHITECTURE

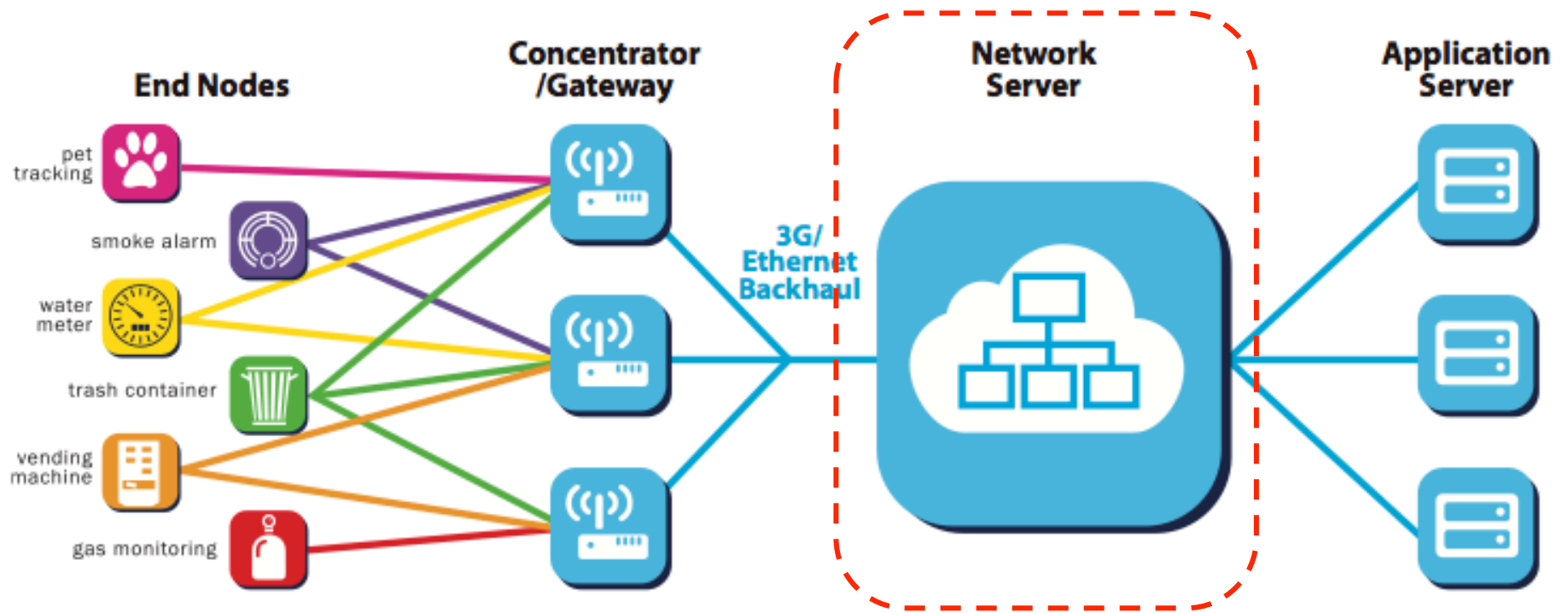
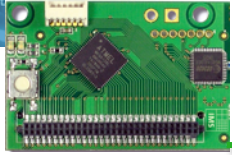
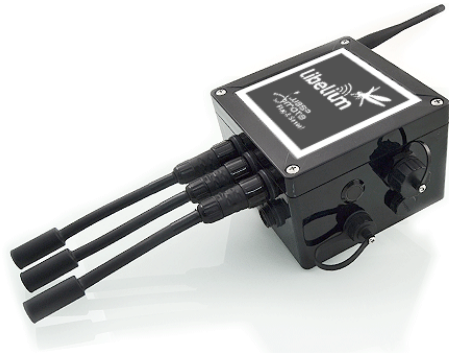
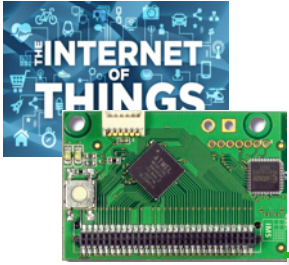


Figure from Semtech

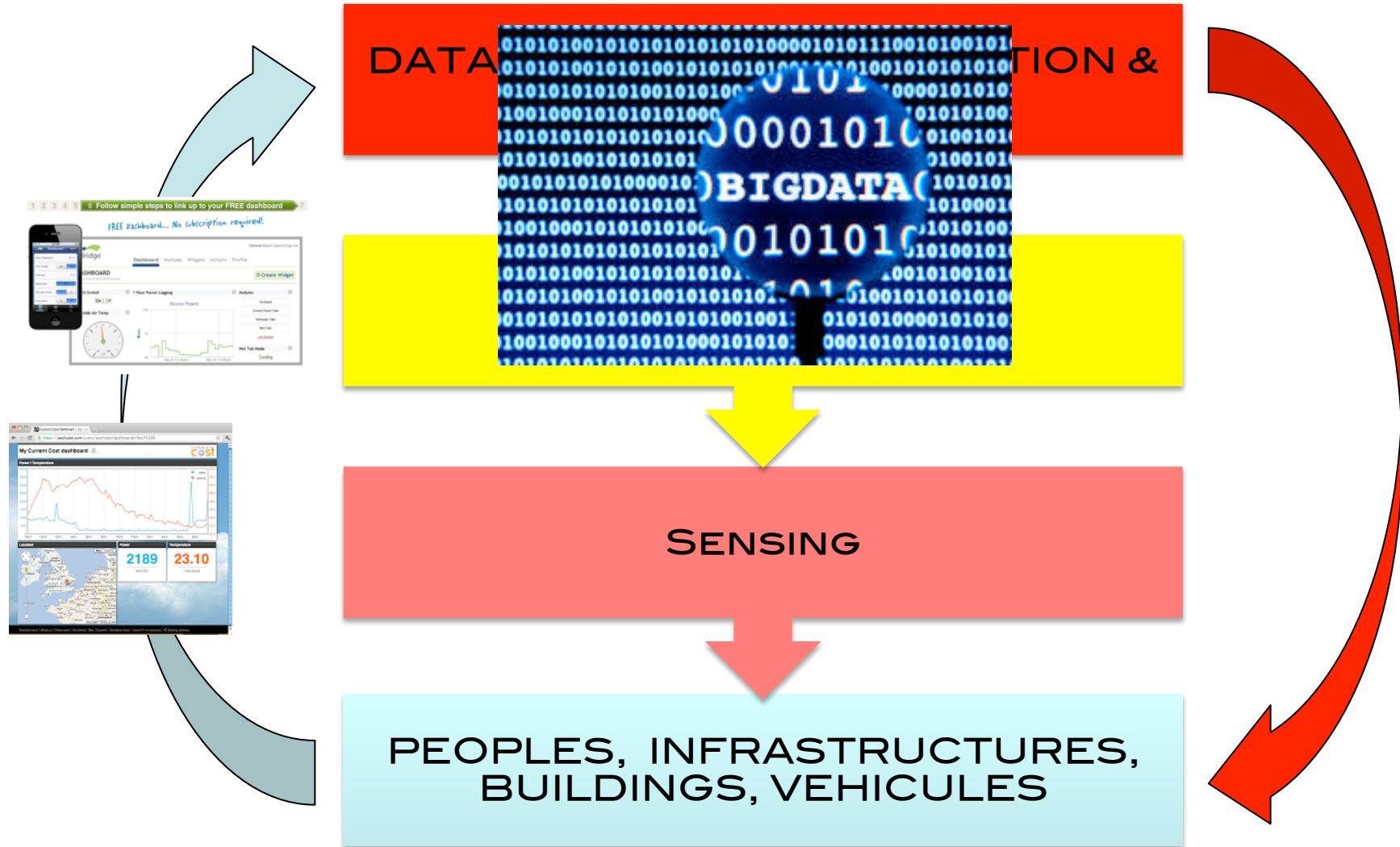


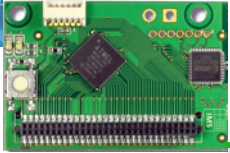
MATURATION OF THE IOT MARKET...





CONTROL, OPTIMIZE & INSTRUMENT !

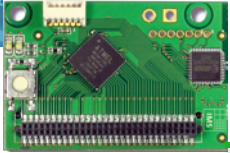




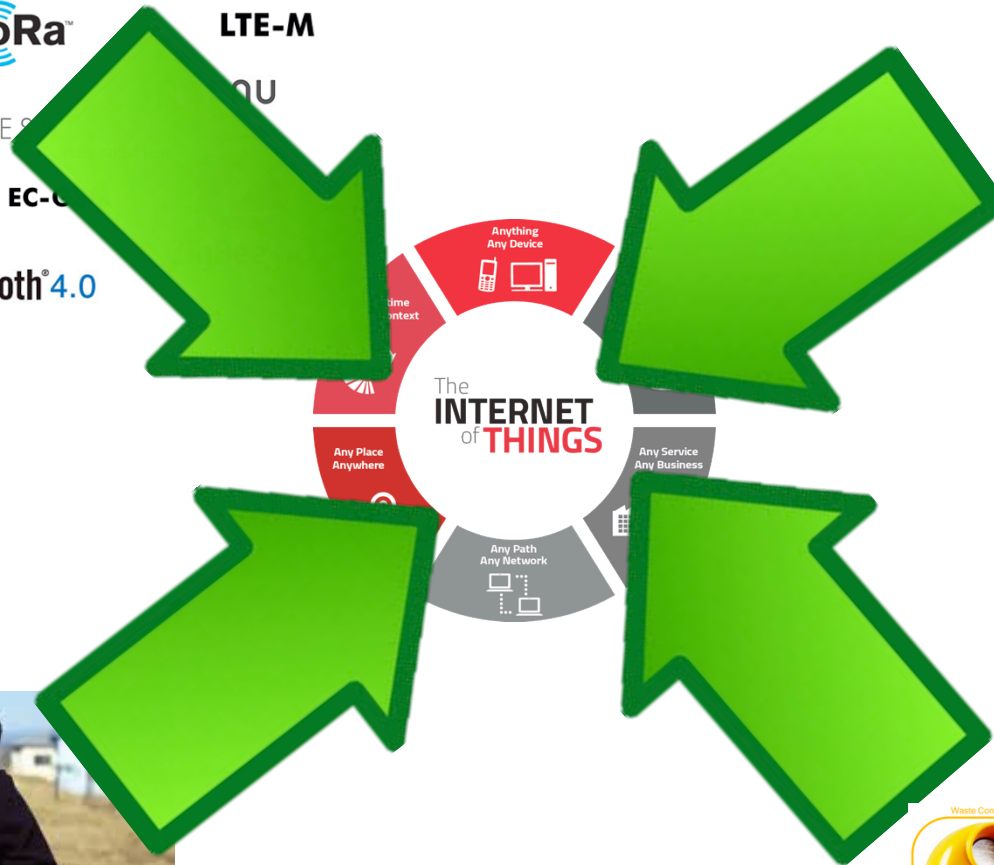
BIG DATA ANALYTICS

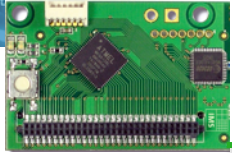


Graphics from <http://www.vitria.com/iot-analytics/>



IOT BECOMES REALITY!



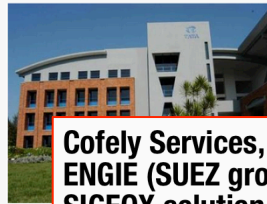


FROM SCORBIT

SIGFOX and Glen Canyon Corp. to Deploy 1 Million Smart Meters to the Internet of Things

LoRa™ technology to be integrated into FLASHNET's street lighting management solution

Tata Communication India world's largest IoT network



Cofely Services, a subsidiary of ENGIE (SUEZ group), integrates SIGFOX solution to expand services it provides for buildings



Semtech and STMicroelectronics Collaborate to Scale LoRa Technology to Meet High-Volume Demands of Internet of Things Applications

LoRa® IoT Ecosystem

From www.st.com - December 14, 2015 7:27 AM

ST to offer complete line of solutions including LoRa systems on chips (SOCs) to accelerate deployments of low-power wide-area networks by mobile network operators (MNOs)

Sogedo et Sigfox lancent les compteurs d'eau intelligents



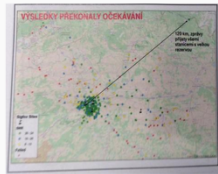
From www.sudouest.fr - December 16, 2015 2:24 PM

"Gestionnaire de réseaux dans les Landes, en Gironde et en Dordogne, Sogedo utilise les ondes radio de Sigfox pour relever les compteurs et surveiller l'état des canalisations. Le compteur..."

Mobile world Congress in Enevo

From www.enevo.com - March 6, 4:12 PM

T-Mobile to cover Czech Republic with the Internet of Things



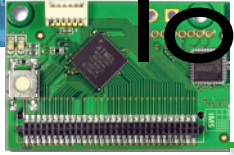
From www.theinternetofthings.com - September 10, 4:41 PM

Following a pilot operation in the Czech Republic that exceeded expectations, T-Mobile SimpleCell Networks will deploy its SIGFOX's Internet of Things network throughout the country.



"French Telecom Orange will use LoRa radio technology for its own domestic IoT and M2M network."

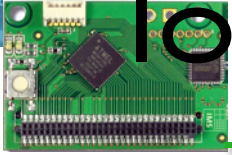
Orange network, a narrow-band technology which guarantees connectivity at a reduced energy consumption rate and at a lower cost. Orange has chosen to rely on LoRa (Long Range) technology to deploy this network that will cover the whole of metropolitan France.



IIOT IN SUB-SAHARAN AFRICA



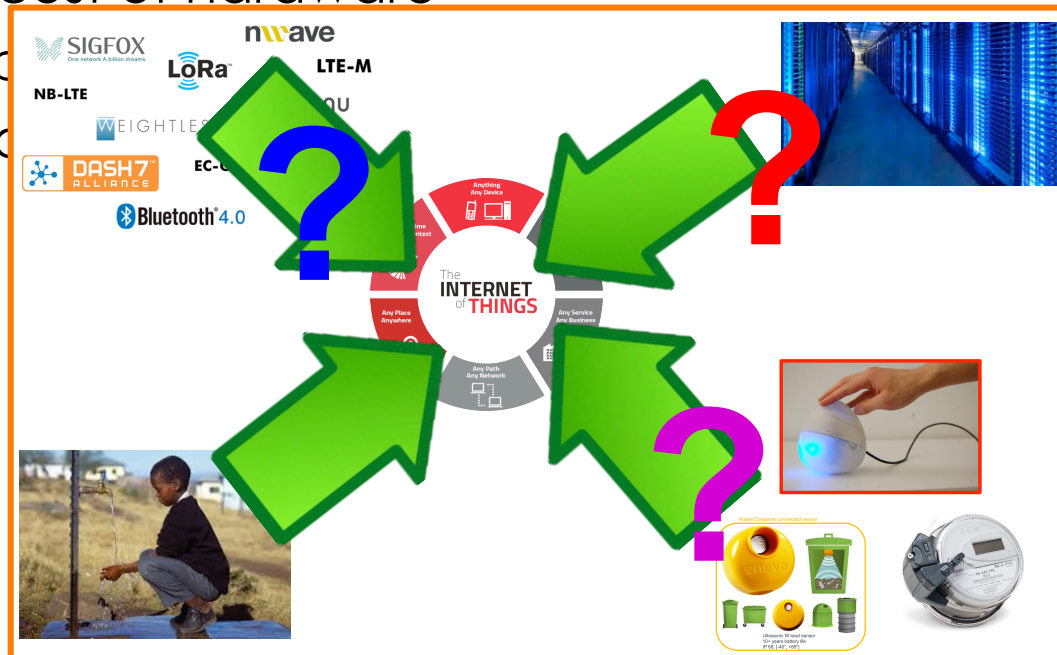
- ❑ Africa's countries are still far from being ready to enjoy the smallest benefit of IIoT
 - ❑ lack of infrastructure
 - ❑ high cost of hardware
 - ❑ complexity in deployment
 - ❑ lack of technological eco-system and background

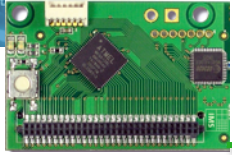


IoT IN SUB-SAHARAN AFRICA

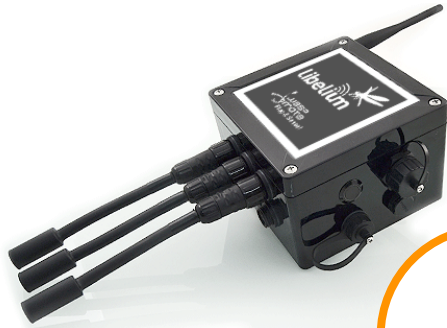
HORIZON 2020

- ❑ Africa's countries are still far from being ready to enjoy the smallest benefit of IoT
 - ❑ lack of infrastructure
 - ❑ high cost of hardware
 - ❑ comp
 - ❑ lack of



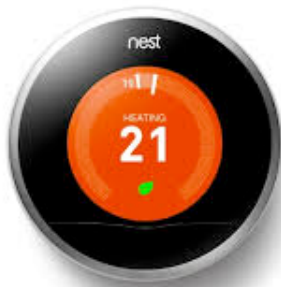


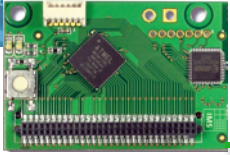
MATURATION OF THE IOT MARKET...



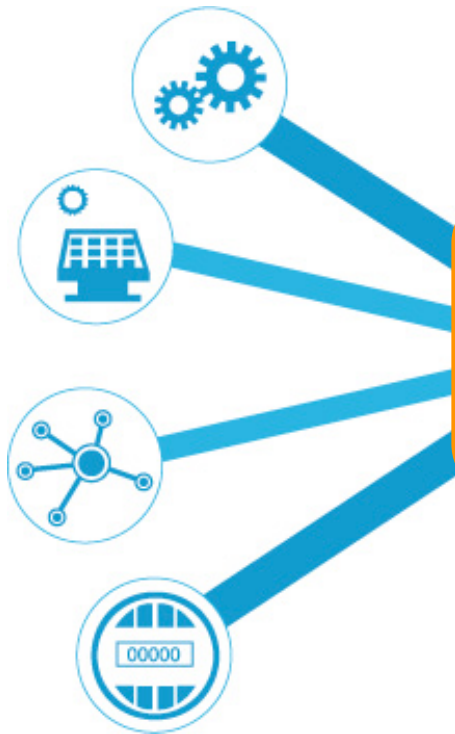
... but not adapted for rural africa context

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

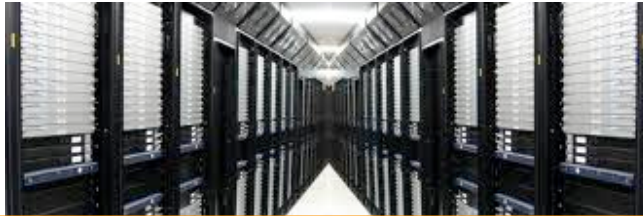




BIG DATA ANALYTICS



Internet connectivity is weak and expensive



Predictive Maintenance

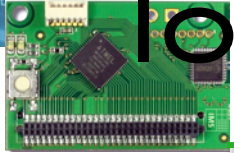
Outage Management

Fraud Detection

Demand/Supply Optimization

Customer Engagement

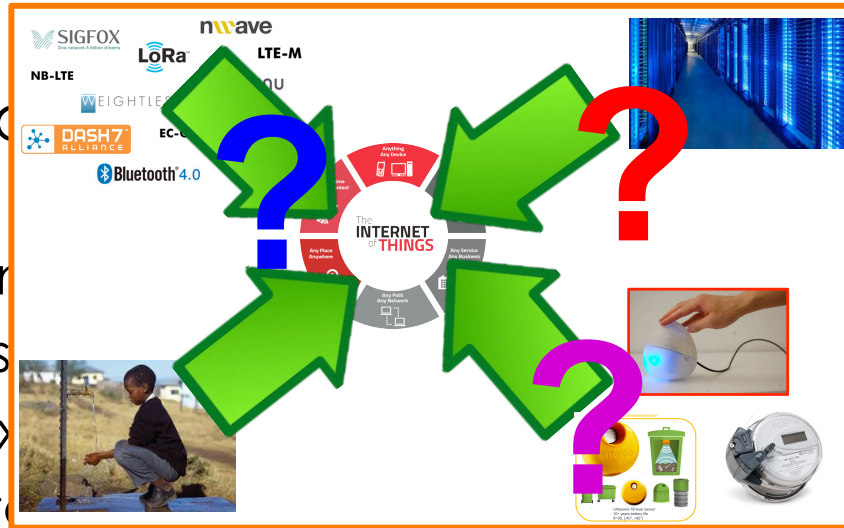
Graphics from <http://www.vitria.com/iot-analytics/>



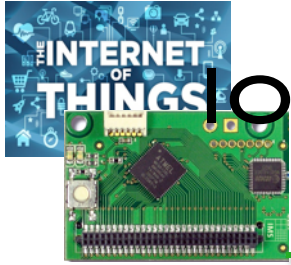
IIOT IN SUB-SAHARAN AFRICA

HORIZON 2020

- ❑ Africa's countries are not yet ready to enjoy the benefits of IIoT
 - ❑ lack of infrastructure
 - ❑ high cost of infrastructure
 - ❑ complex regulatory environment
 - ❑ lack of technical background



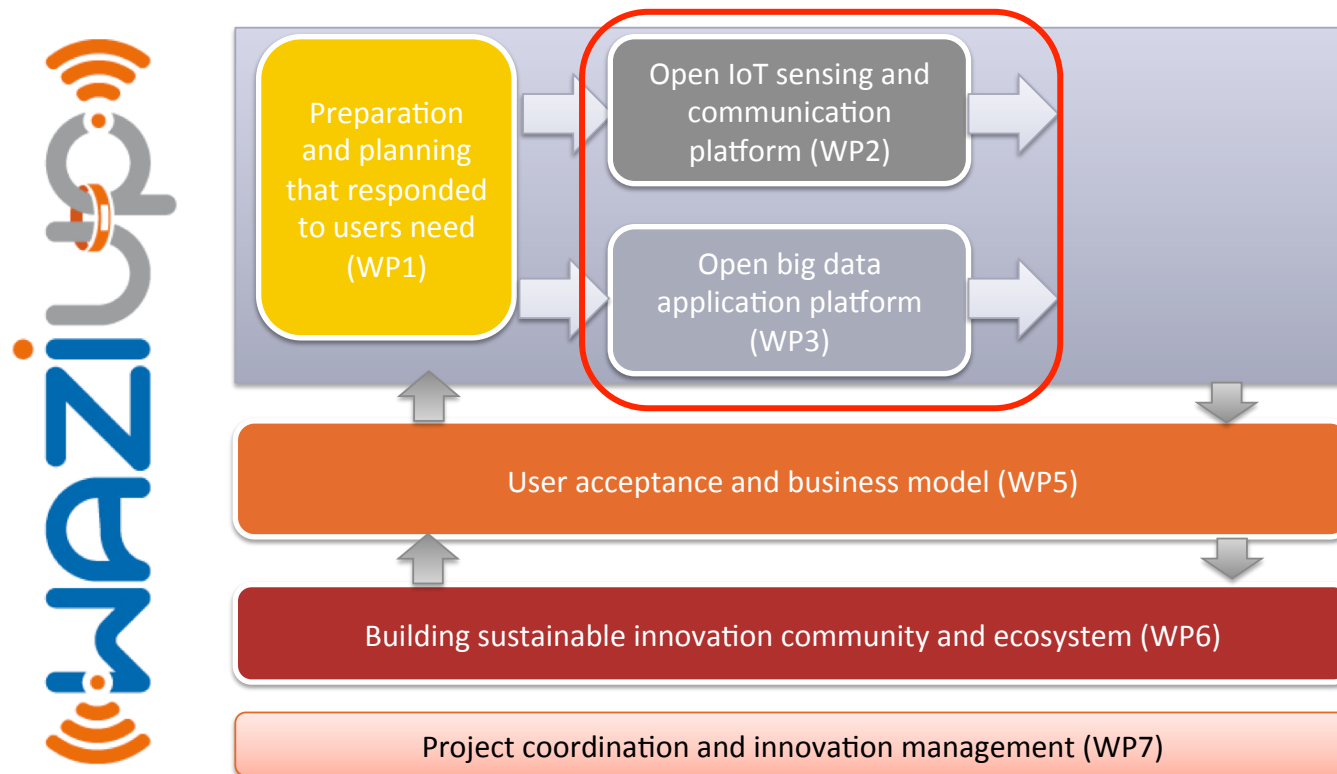
- ❑ **to deploy IIoT in Sub-Saharan Africa, it is necessary to target three major issues**
 - ❑ reduce cost of infrastructures, hardware and services
 - ❑ limit dependancy to proprietary infrastructures and provide local interaction models
 - ❑ target technology appropriation, push for local business models

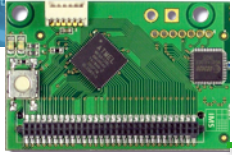


IoT FOR RURAL APPLICATIONS IN DEVELOPPING COUNTRIES



- ❑ WAZIUP is an EU H2020 project (2016-2019)
- ❑ contributes to long-range networks for rural applications with WP2 and big data with WP3





LOW-COST HARDWARE



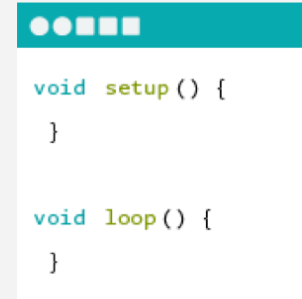
WHAT IS ARDUINO?

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.

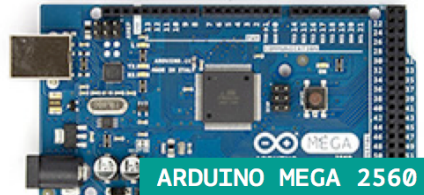


ARDUINO SOFTWARE

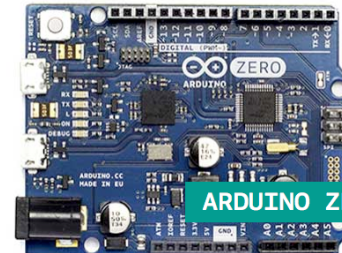
You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment.



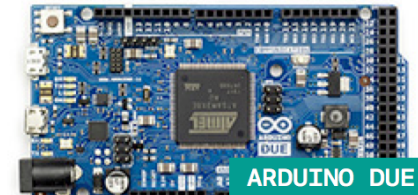
ARDUINO UNO



ARDUINO MEGA 2560



ARDUINO ZERO



ARDUINO DUE



ARDUINO MICRO



ARDUINO PRO MINI



ARDUINO NANO