

LOW-COST ANTENNA TECHNOLOGY FOR LPWAN IOT IN RURAL APPLICATIONS

C. PHAM¹, F. FERRERO², M. DIOP¹, L. LIZZI², O. DIENG³, O. THIARÉ³

¹University of Pau, LIUPPA, France

²Université Côte d'Azur, LEAT, France

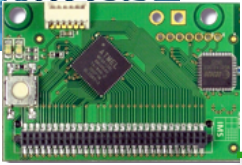
³University Gaston Berger, Senegal

7th IEEE IWASI Intl Conference
Friday, June 16th, 2017
Vieste, Italy



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



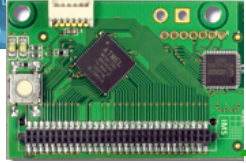


BIG DATA & LOW-COST IOT



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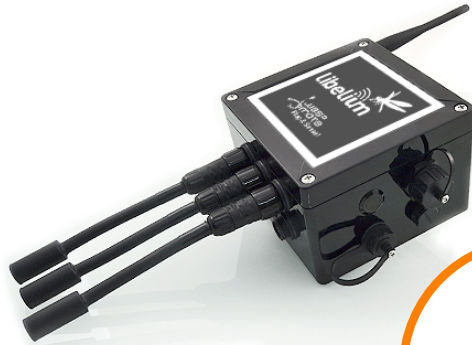
OBJECTIVES



- ❑ To propose **low-cost and energy-efficient hardware** platforms that fit to African context
- ❑ To design and develop **IoT long-range communication** framework (**device+gateway**)
- ❑ To develop and validate the **open IoT and Big data** and advanced analytic application platform
- ❑ To offer **open sources WAZIUP** (hardware and software) platform for developer and SMEs communities
- ❑ To **engage local communities/entrepreneurs** for sustainable innovation



MATURATION OF THE IOT MARKET...



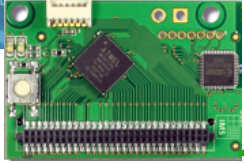
... but not adapted for rural developing countries context & environment

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

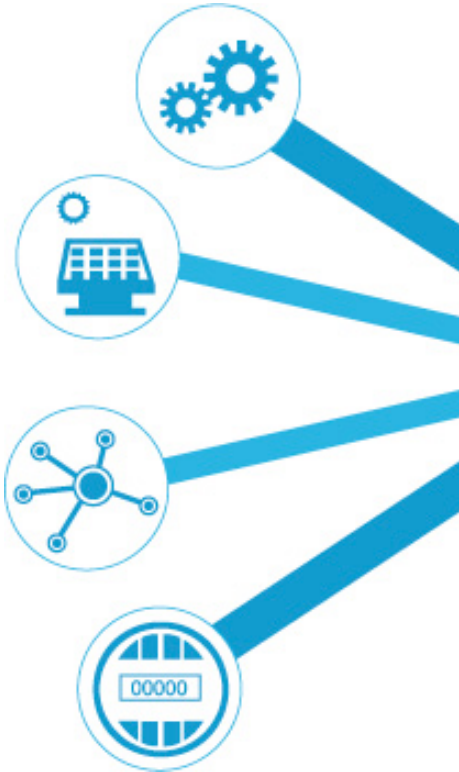


Ultrasonic fill level sensor
10+ years battery life
IP 66, [-40°, +85°]





INTERNET, CLOUD & BIG DATA ANALYTICS



Internet connectivity is weak and expensive!

Nearly impossible in remote/rural areas



Predictive Maintenance

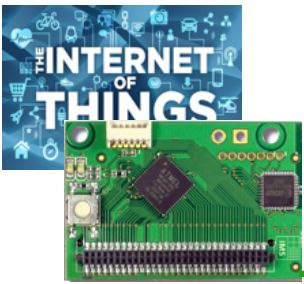
Outage Management

Fraud Detection

Demand/Supply Optimization

Customer Engagement

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



LOW-COST HARDWARE



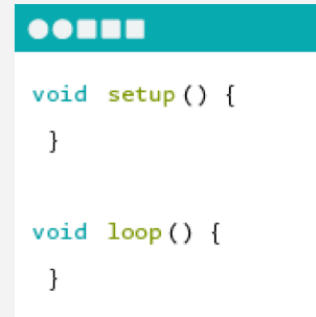
WHAT IS ARDUINO?

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.

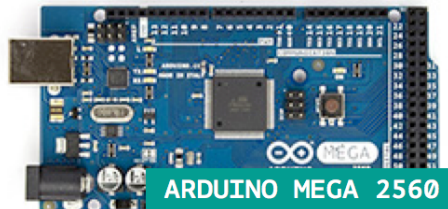


ARDUINO SOFTWARE

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



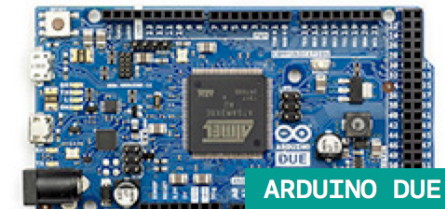
ARDUINO UNO



ARDUINO MEGA 2560



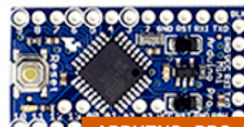
ARDUINO ZERO



ARDUINO DUE



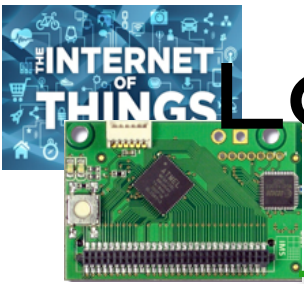
ARDUINO MICRO



ARDUINO PRO MINI

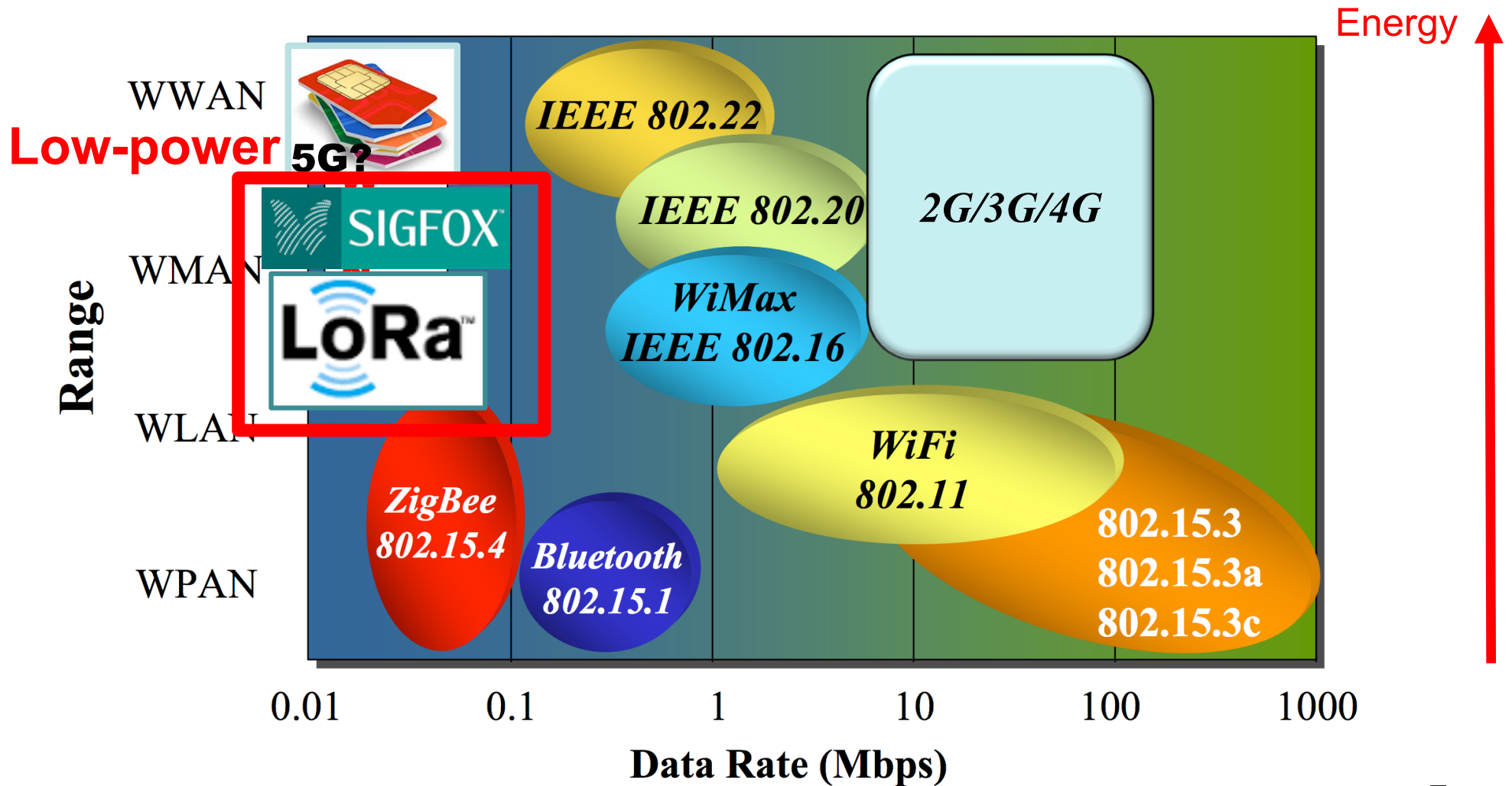


ARDUINO NANO



LOW-POWER & LONG-RANGE RADIO TECHNOLOGIES

Energy-Range dilemma





LPWAN ARCHITECTURE

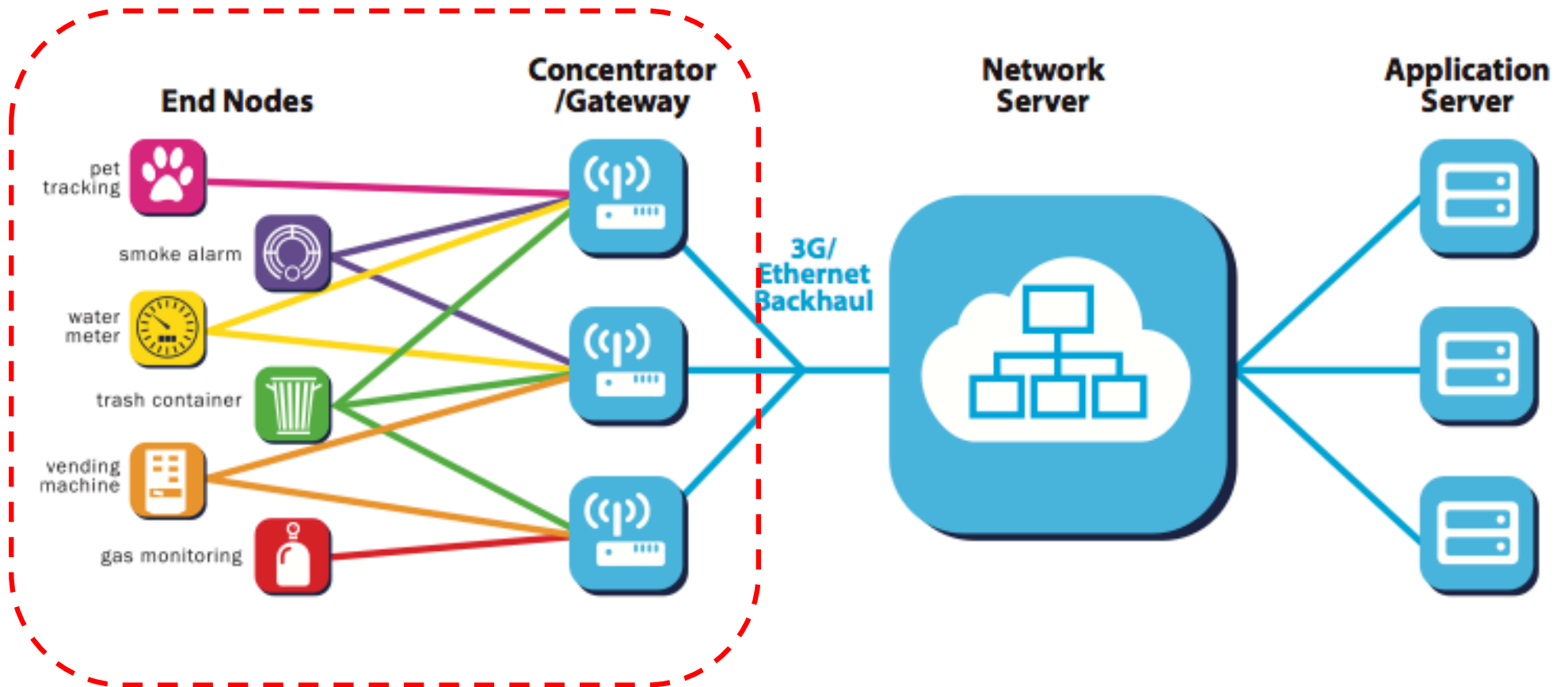
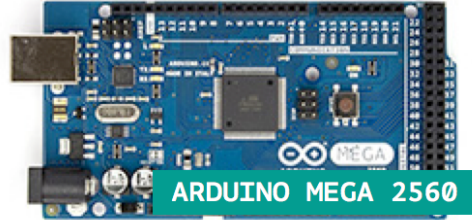


Figure from Semtech

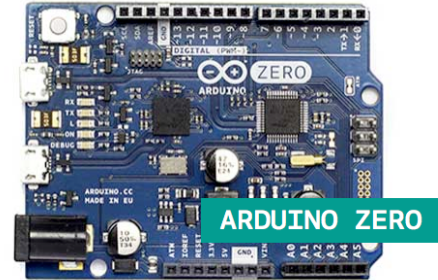
SW/HW BUILDING BLOCKS INTEGRATION



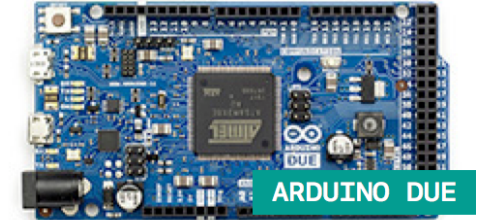
ARDUINO UNO



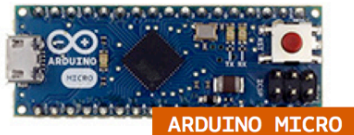
ARDUINO MEGA 2560



ARDUINO ZERO



ARDUINO DUE



ARDUINO MICRO



ARDUINO PRO MINI



ARDUINO NANO



Ideeatron Nexus



Teensy3.1/3.2

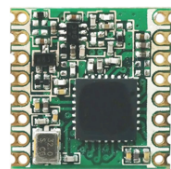


Adafruit Feather 32u4/M0

More to come...



LoRa radios that our library already supports



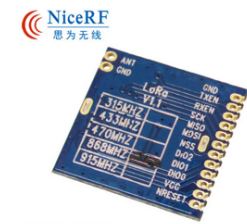
HopeRF RFM92W/95W



Libelium LoRa

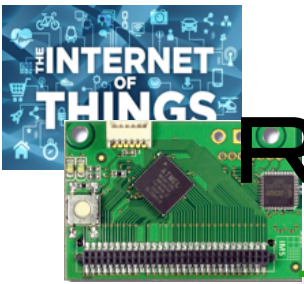


Modtronix inAir4/9/9B



NiceRF LoRa1276

Long-Range communication library



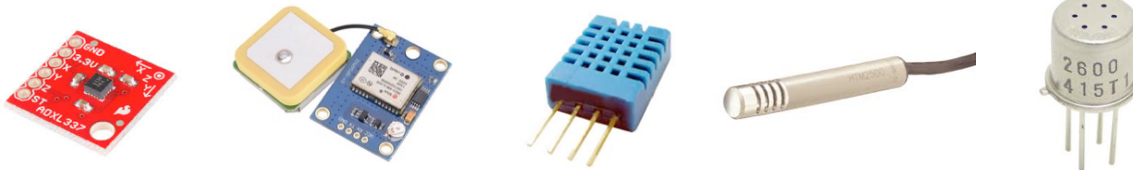
READY-TO-USE TEMPLATES



Physical sensor reading

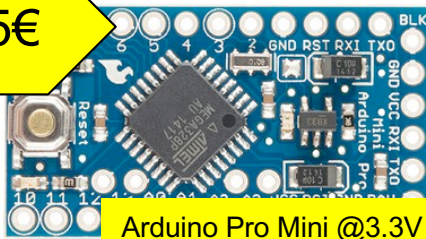
Physical sensor reading

Physical sensor reading



Physical sensor management

1.5€

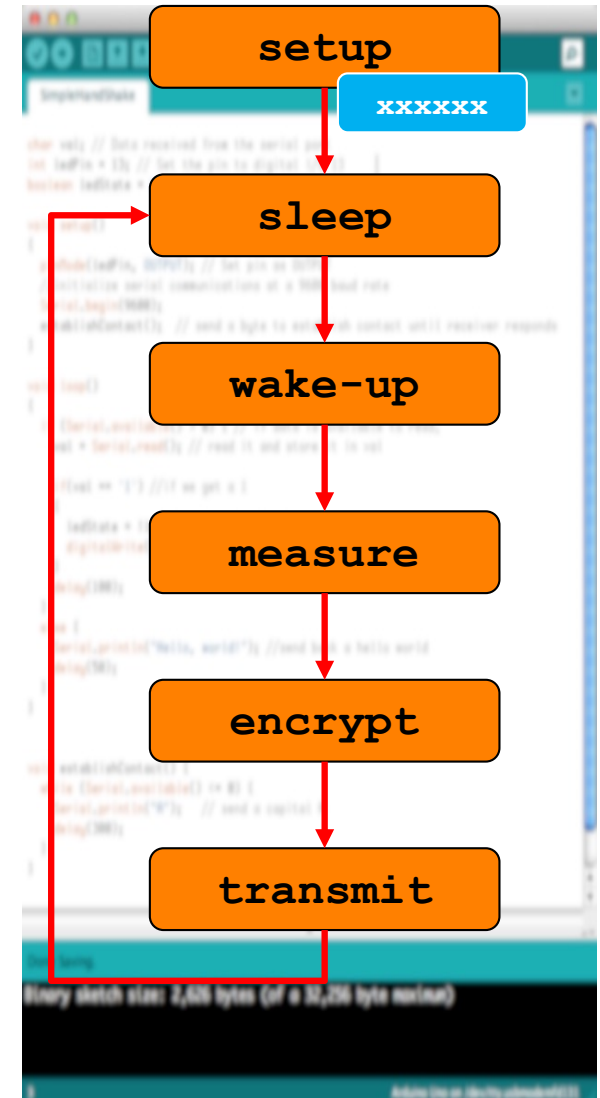


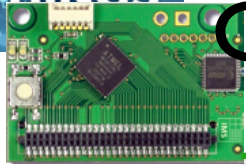
Activity duty-cycle, low power

AES encryption

Long-range transmission

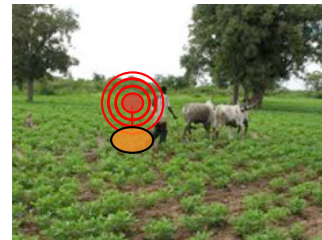
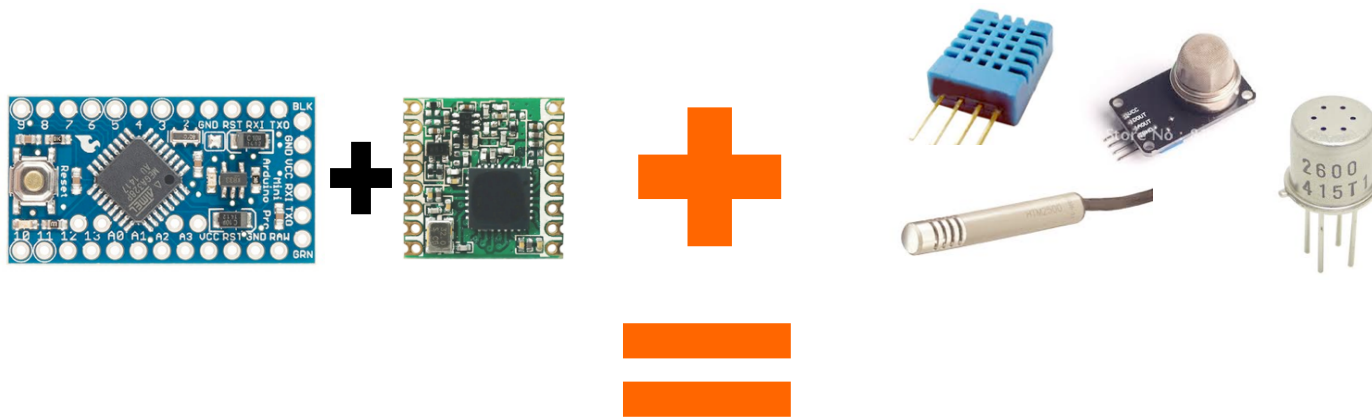
Logical sensor management

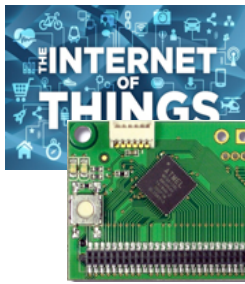




GENERIC SENSING IOT DEVICE

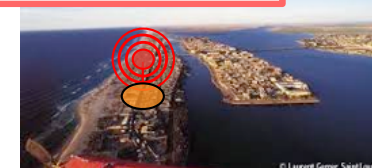
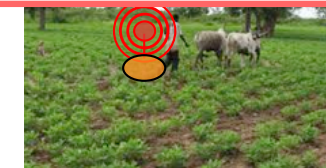
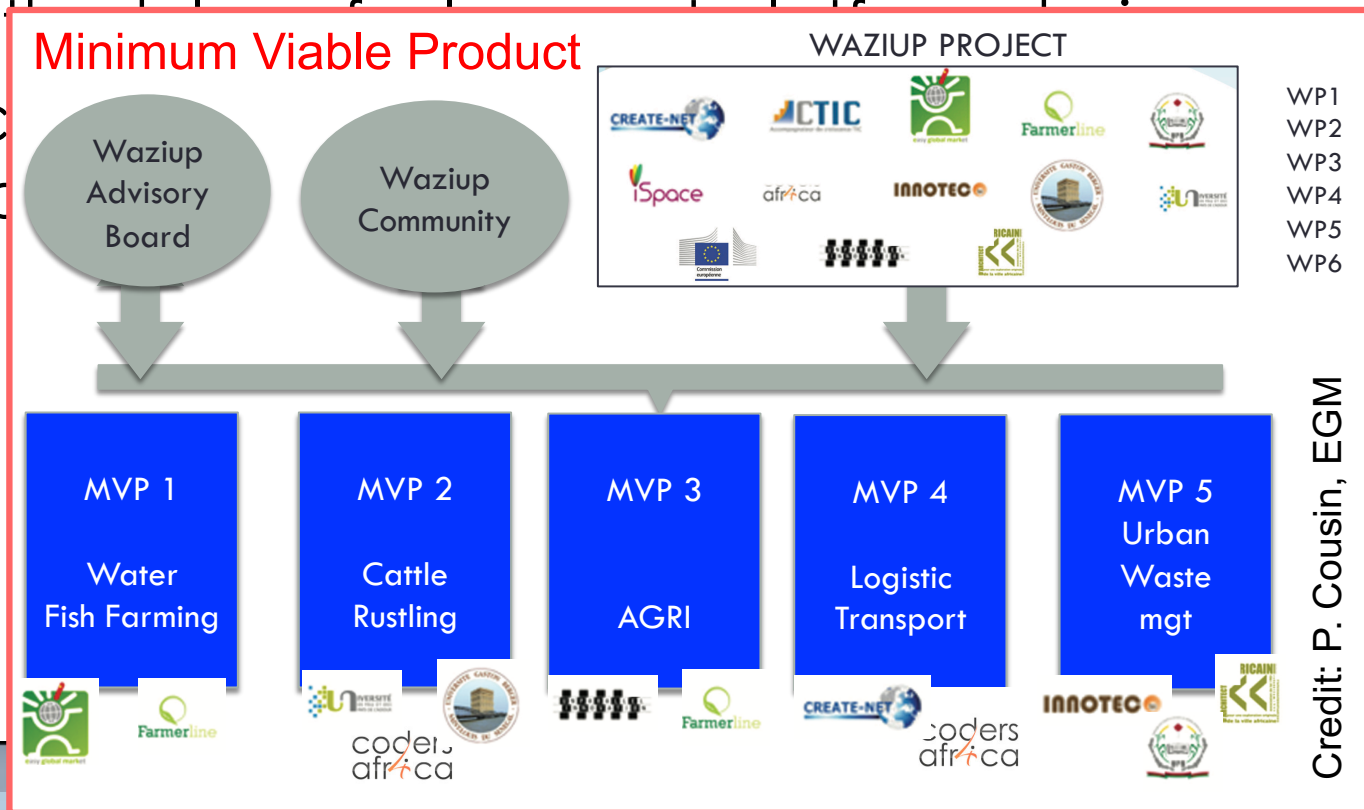
- ❑ Build low-cost, low-power, Long-range enabled generic platform
- ❑ Methodology for low-cost platform design
- ❑ Technology transfers to user communities, economic actors, stakeholders,...

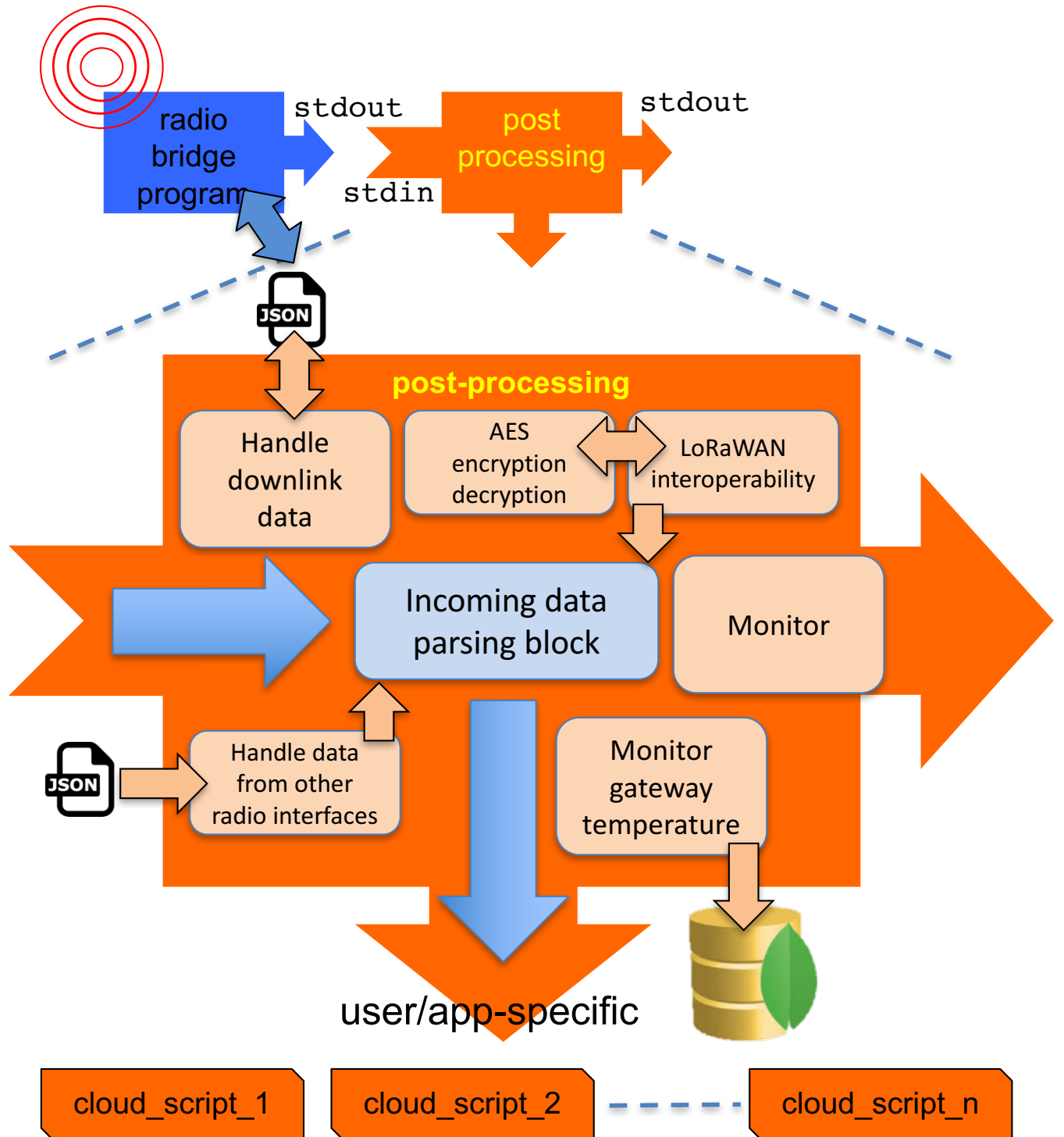


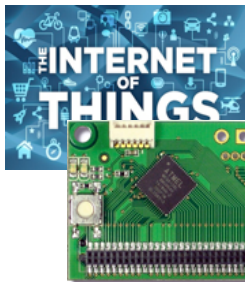


GENERIC SENSING IOT DEVICE

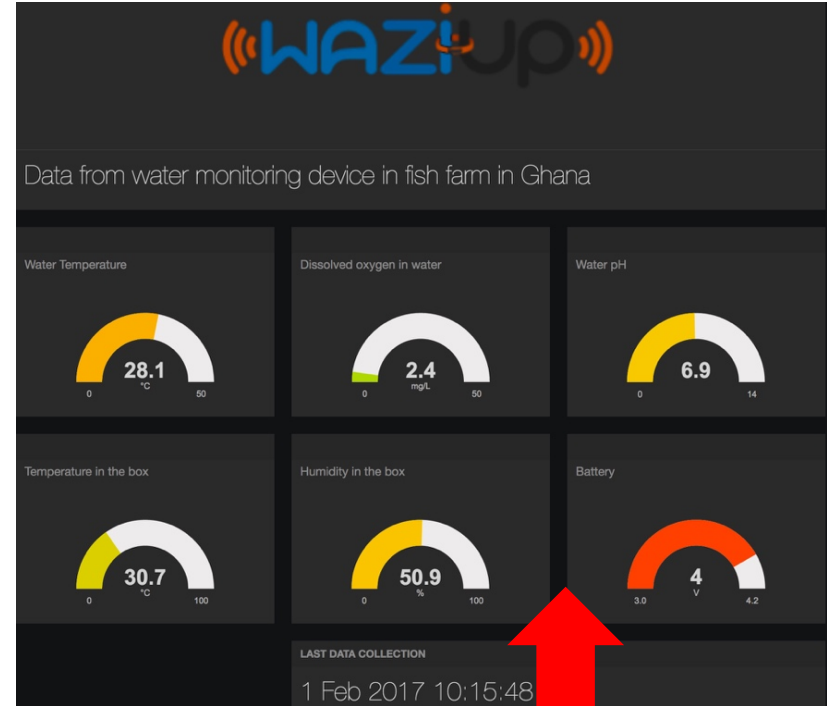
- Build low-cost, low-power, Long-range enabled generic platform
- Meet the needs of the African continent
- Technical and economic viability







LOW-COST BUOY FOR FISH FARMING MVP



WAZIup
Physical sensor reading

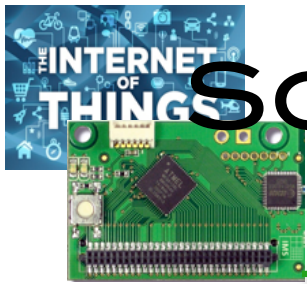


Credit: EGM

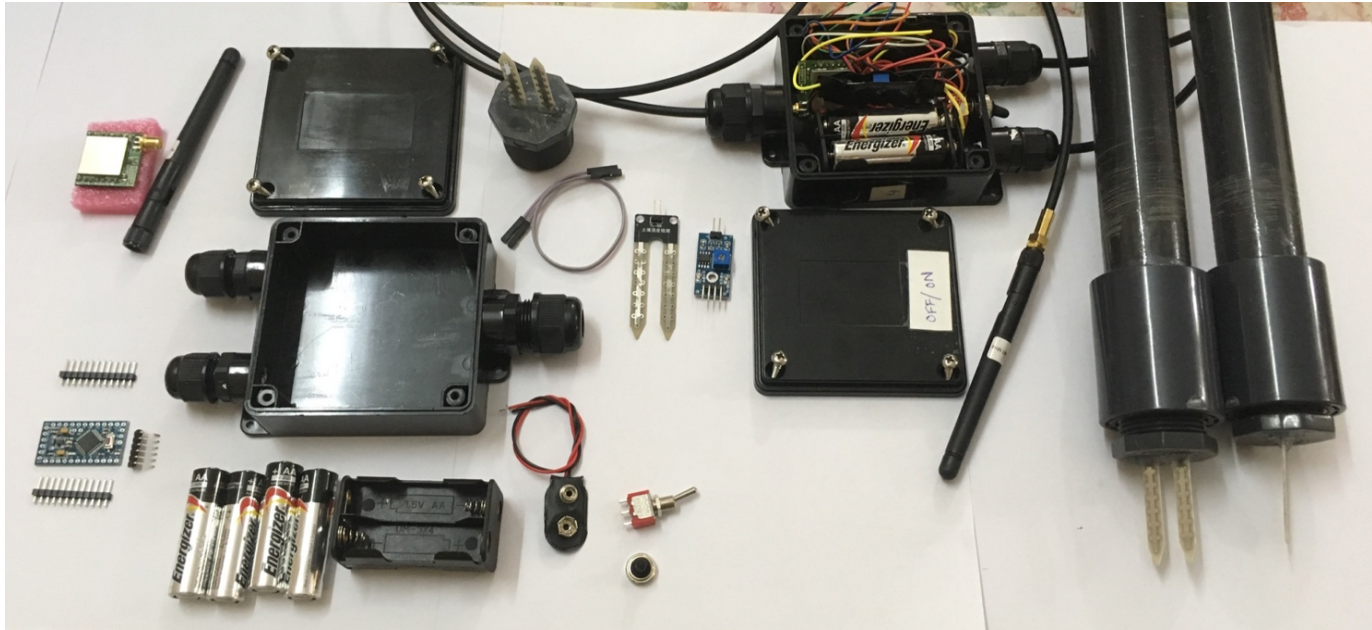


- Physical sensor management
- Activity duty-cycle, low power
- Security
- Long-range transmission
- Logical sensor management

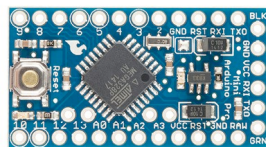




SOIL HUMIDITY SENSORS FOR AGRI MVP



Physical sensor management



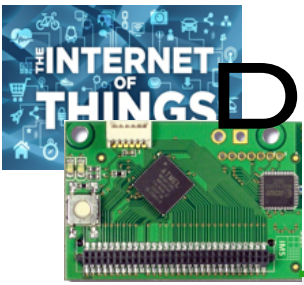
Activity duty-cycle, low power

Security

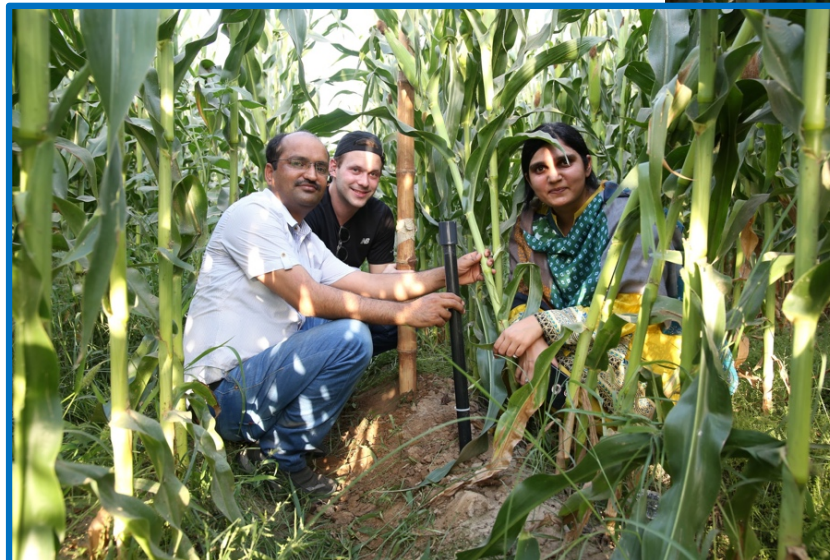
Long-range transmission

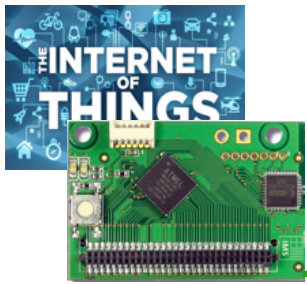
Logical sensor management



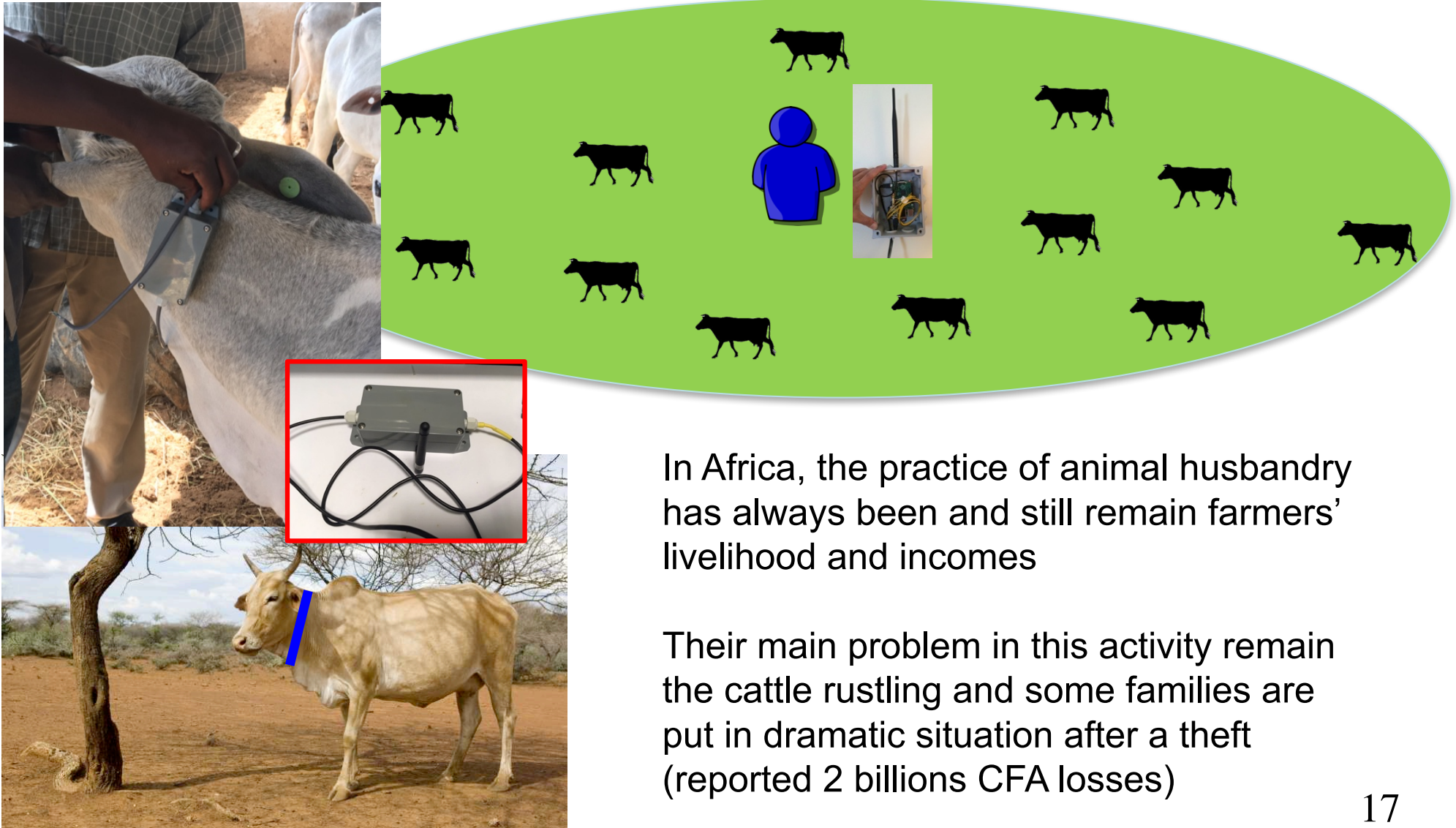


DEPLOYMENT FOR NESTLÉ'S WATERSENSE PROJECT



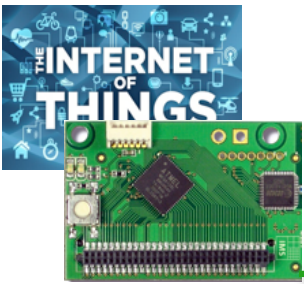


COLLAR FOR CATTLE RUSTLING MVP

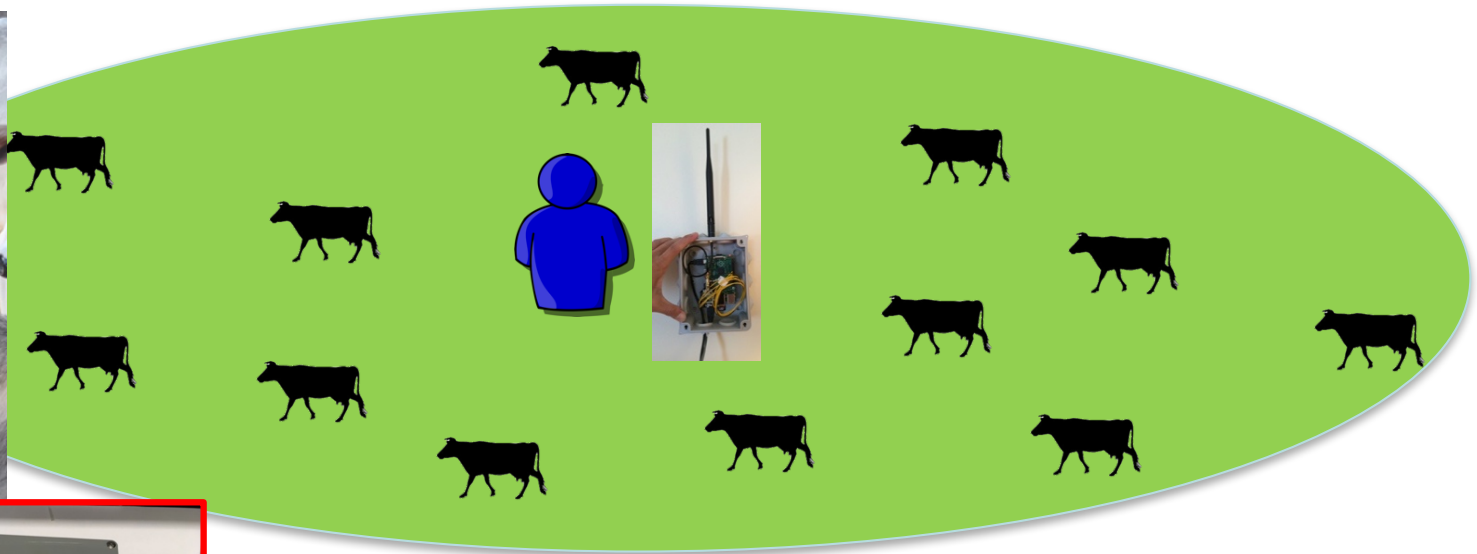
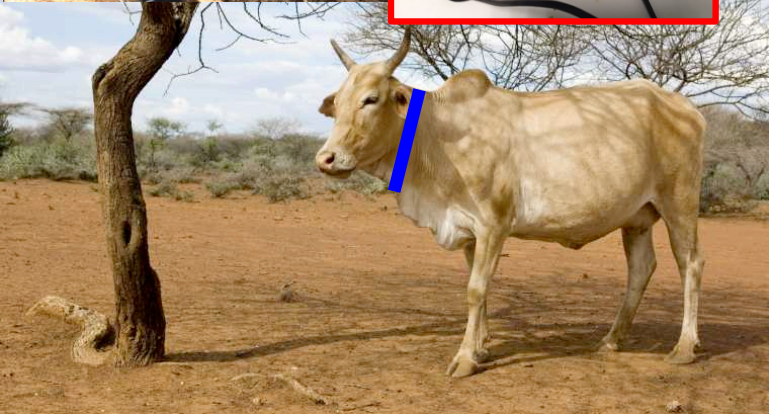


In Africa, the practice of animal husbandry has always been and still remain farmers' livelihood and incomes

Their main problem in this activity remain the cattle rustling and some families are put in dramatic situation after a theft (reported 2 billions CFA losses)



COLLAR FOR CATTLE RUSTLING MVP



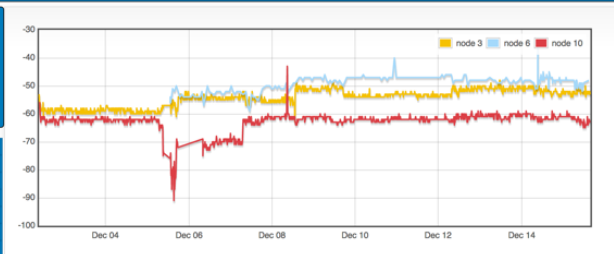
Access to the data from MongoDB

[export data to csv](#)

Display the last document(s)

Sort by

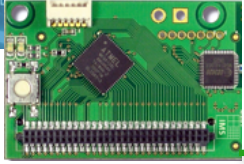
2016-12-15 15:47:58
2016-12-15 15:41:29
2016-12-15 15:36:24
2016-12-15 15:28:32
2016-12-15 15:24:50
2016-12-15 15:13:26
2016-12-15 15:03:38
2016-12-15 15:01:52
2016-12-15 14:58:37
2016-12-15 14:51:40



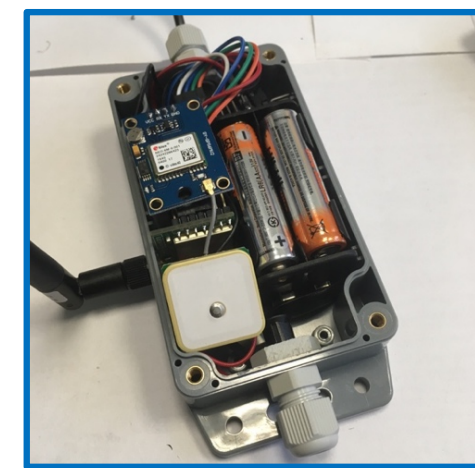
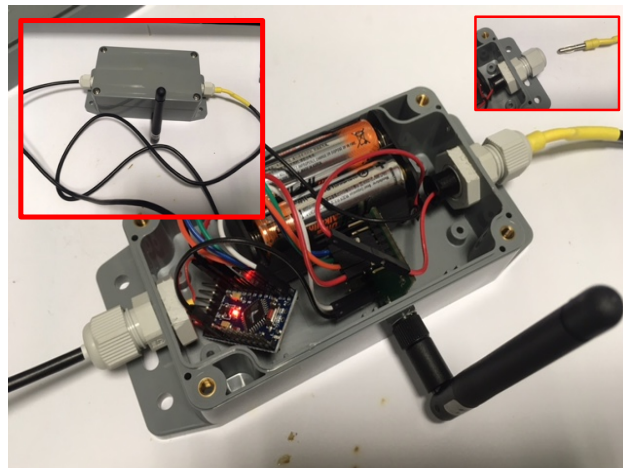
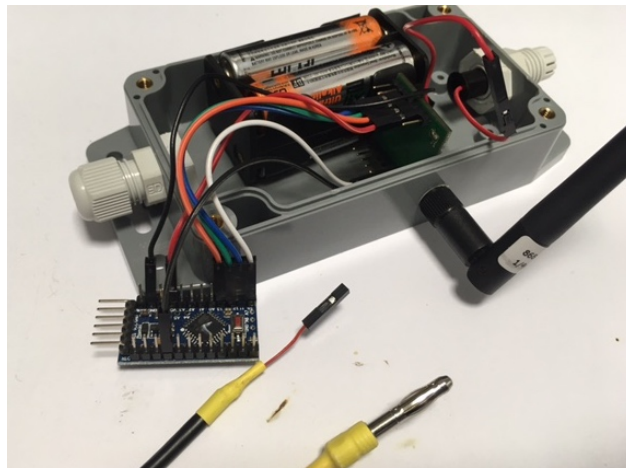
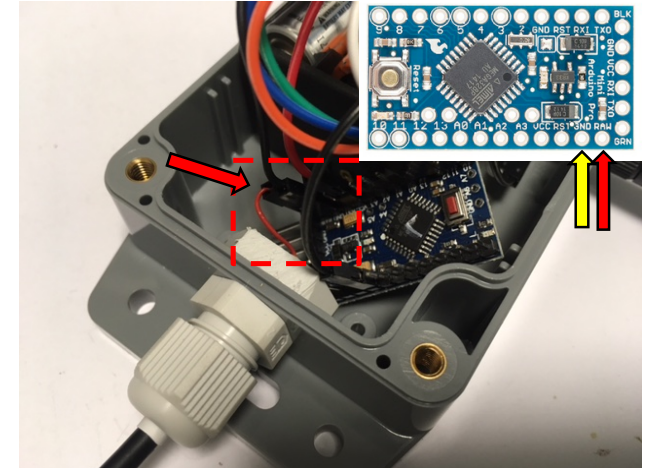
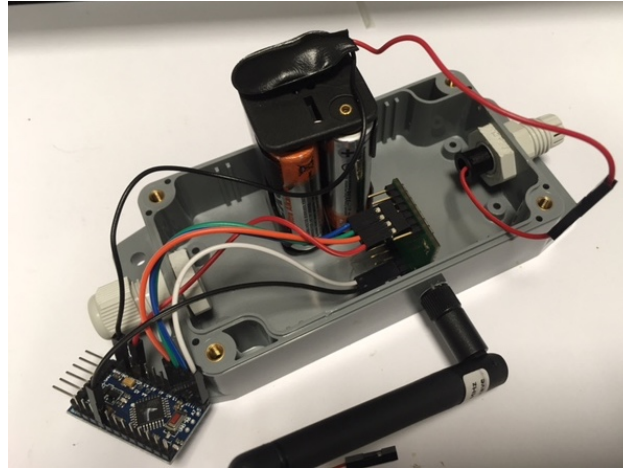
Display data: RSSI TC DEF

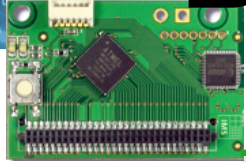
Display sources: node_3 node_6 node_10

Zoom to:



EASY INTEGRATION AND CUSTOMIZATION





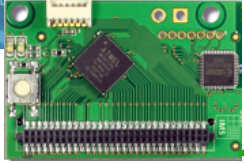
DESIGN OF COST EFFICIENT ANTENNA @868MHZ

❑ Cost reduction

- ❑ Avoids RF connectors, use less expensive LoRa module
- ❑ Avoid external antenna
- ❑ A PCB is needed for component integration
- ❑ The cost for an extension of the PCB is negligible, so PCB integrated antenna is very cost efficient

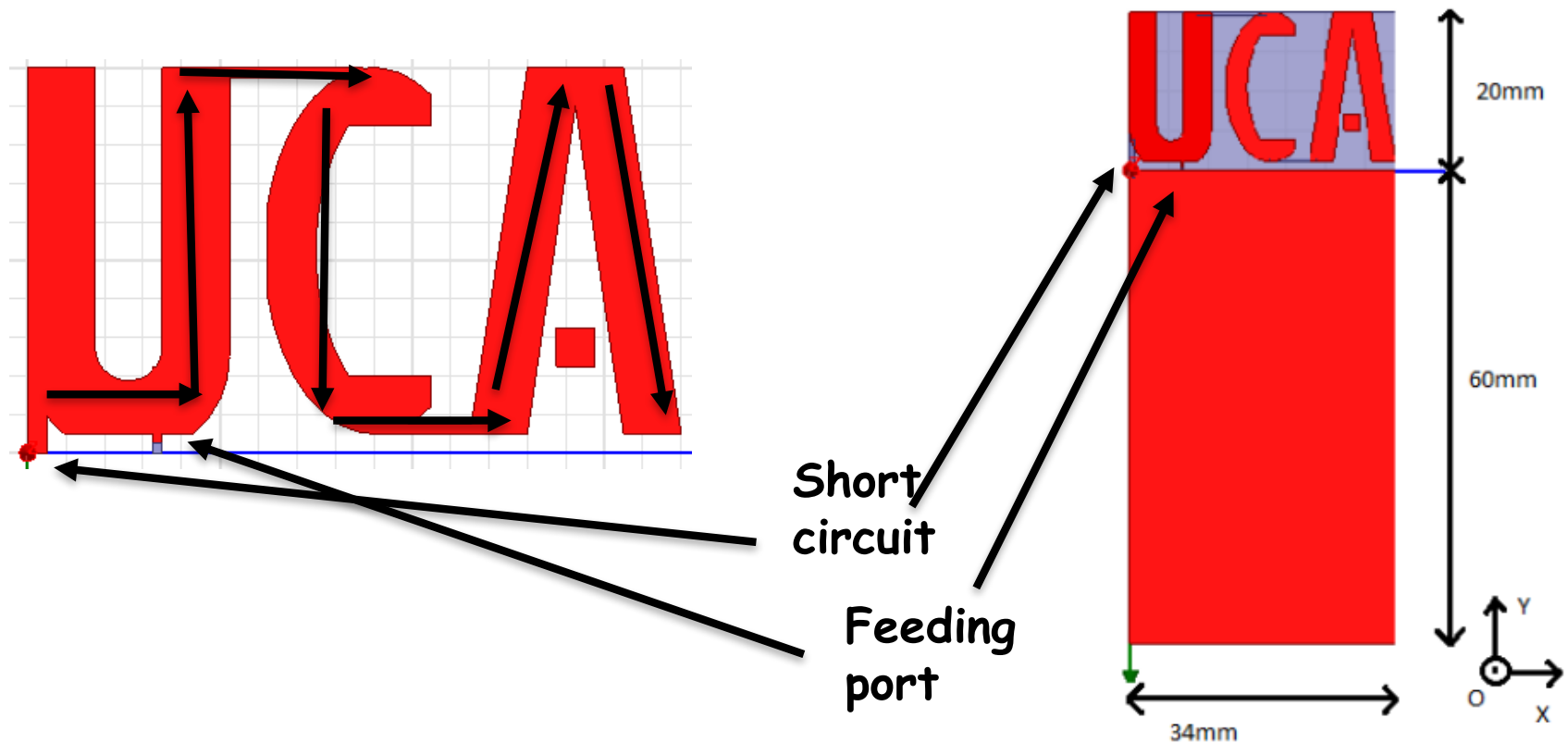
❑ Radiation performance

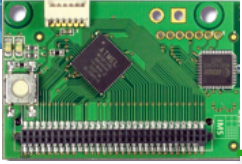
- ❑ Two parameters need to be optimized : impedance matching and radiation efficiency
- ❑ Impedance matching can be easily optimized with antenna geometry
- ❑ Radiation efficiency mainly depend on the antenna size



ANTENNA DESIGN

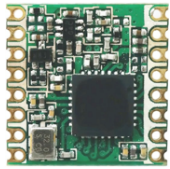
- ❑ Open-source layout
 - ❑ Inverted F antenna (IFA) topology
 - ❑ Antenna meandered for miniaturization
 - ❑ Logo of Université Côte d'Azur used for the design



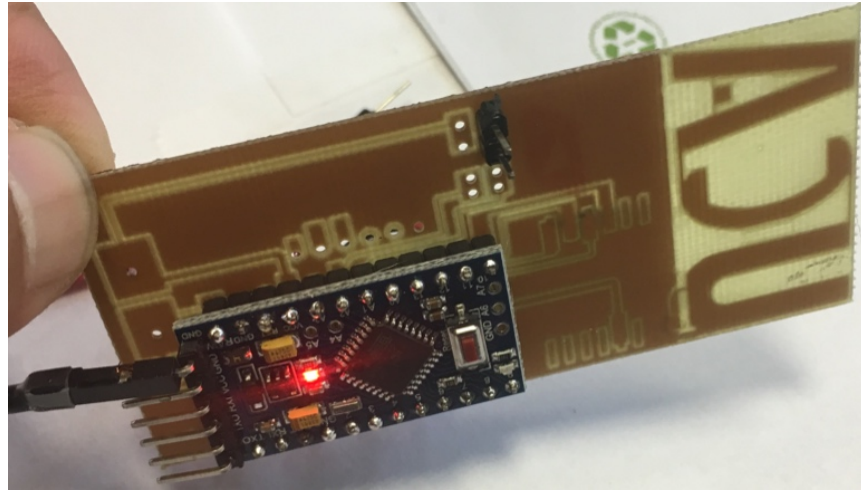


LOW-COST INTEGRATION

5€



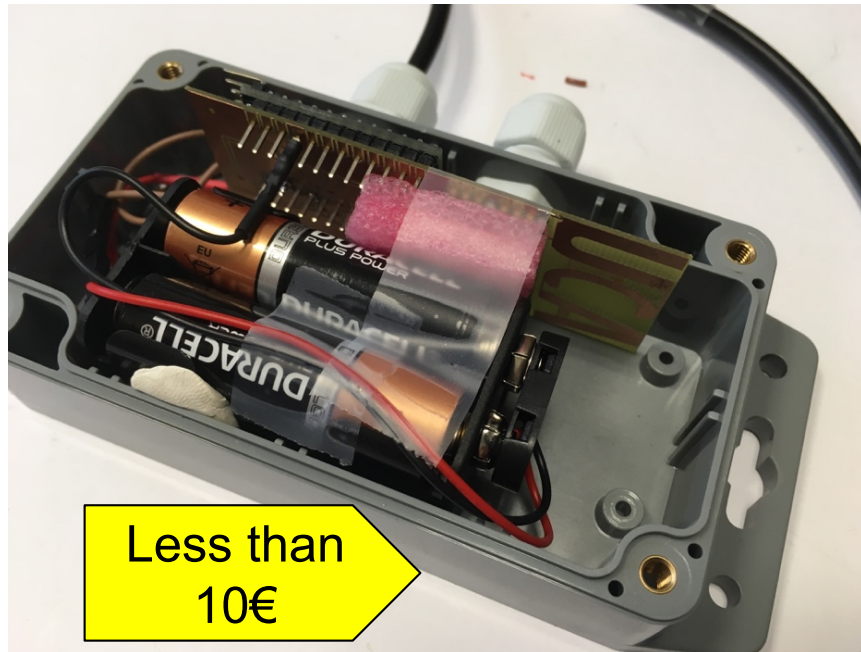
HopeRF
RFM92W/95W



10€

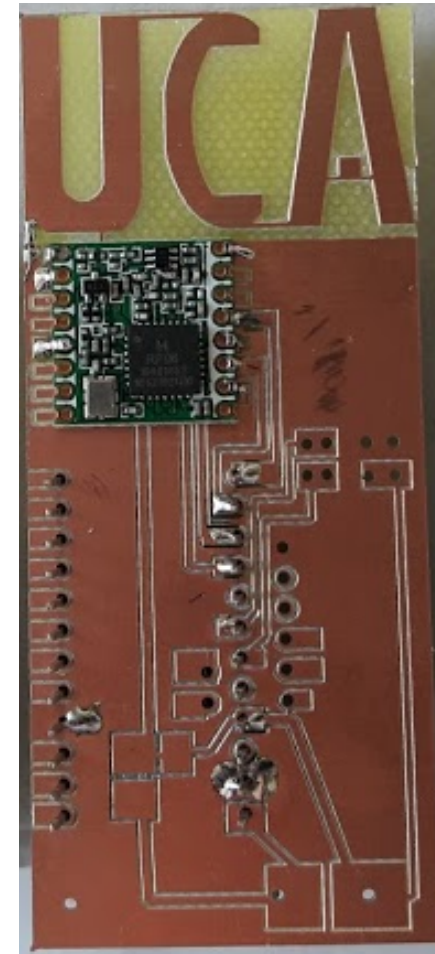


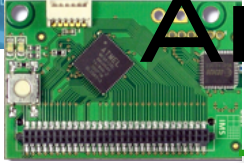
Modtronix
inAir4/9/9B



Less than
10€

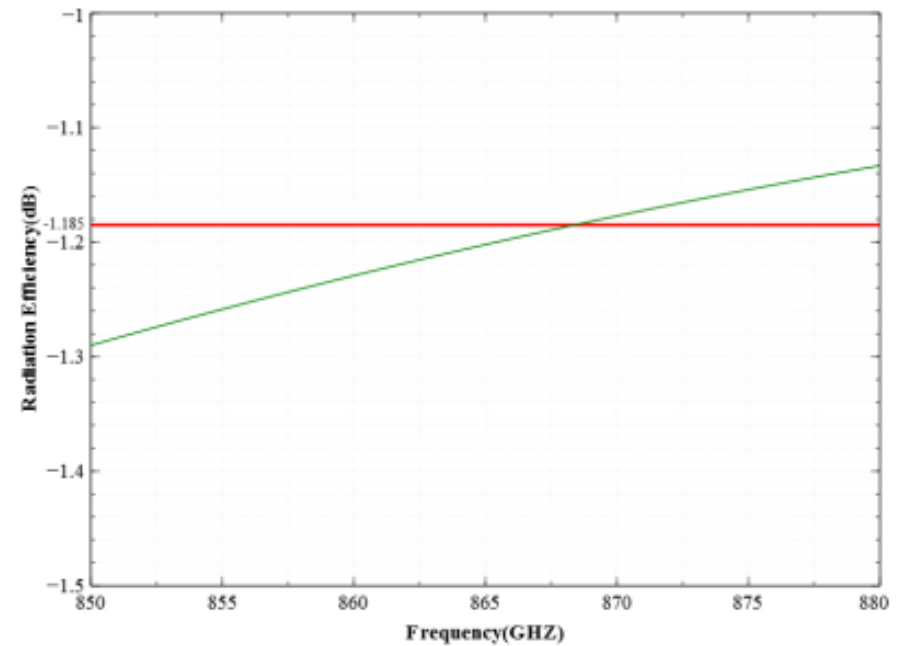
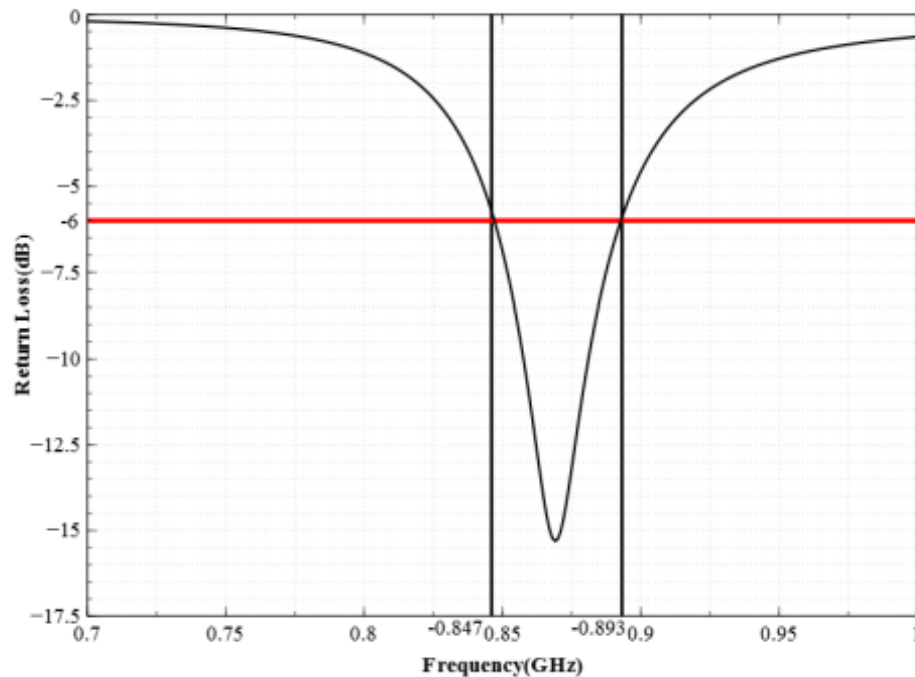
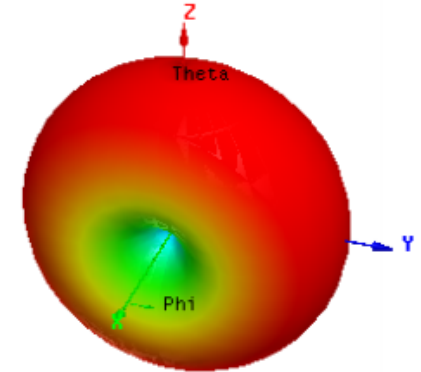
3€

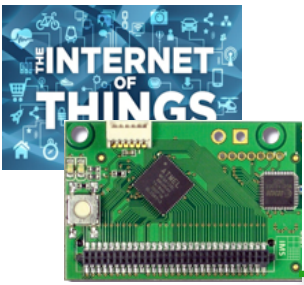




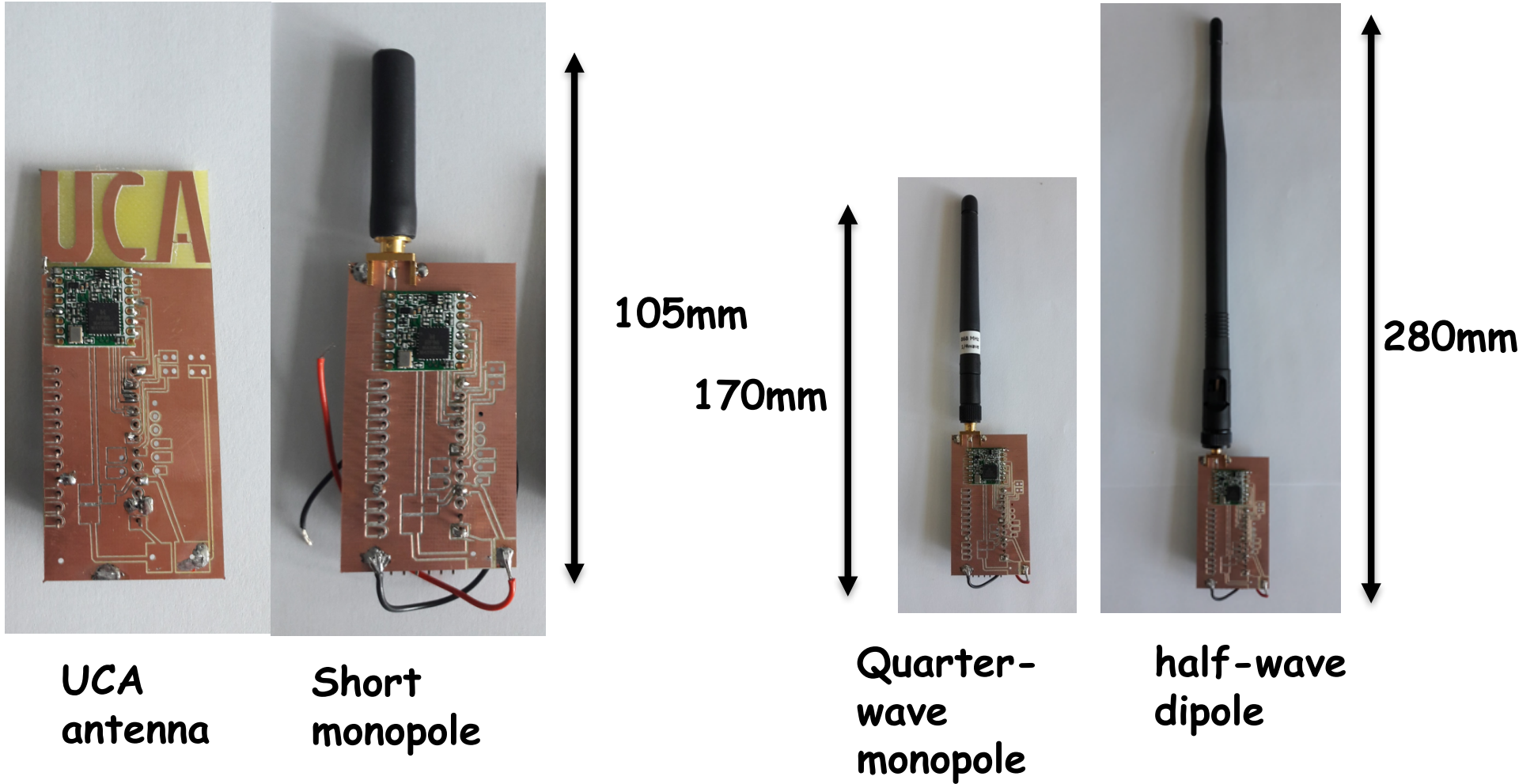
ANTENNA CHARACTERISTICS

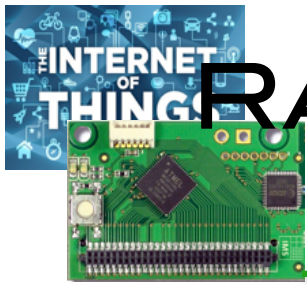
- Antenna simulation
 - -6dB reflection coefficient 850- 893MHz band
 - -1.2 dB radiation efficiency (75%)
 - Dipole radiation pattern





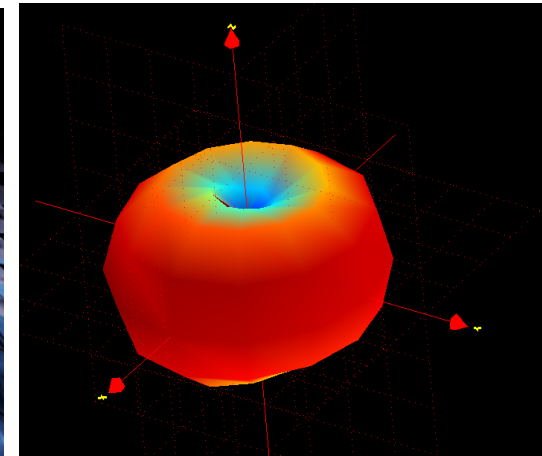
COMPARISON WITH EXTERNAL ANTENNAS



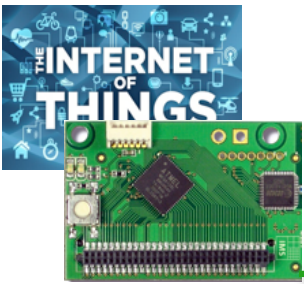


RADIATION MEASUREMENTS : SYNTHESIS

- ❑ Measurement on Satimo Starlab station
 - ❑ Continuous wave with 14 dBm power
 - ❑ Efficiency calculated from the 3D antenna measurement



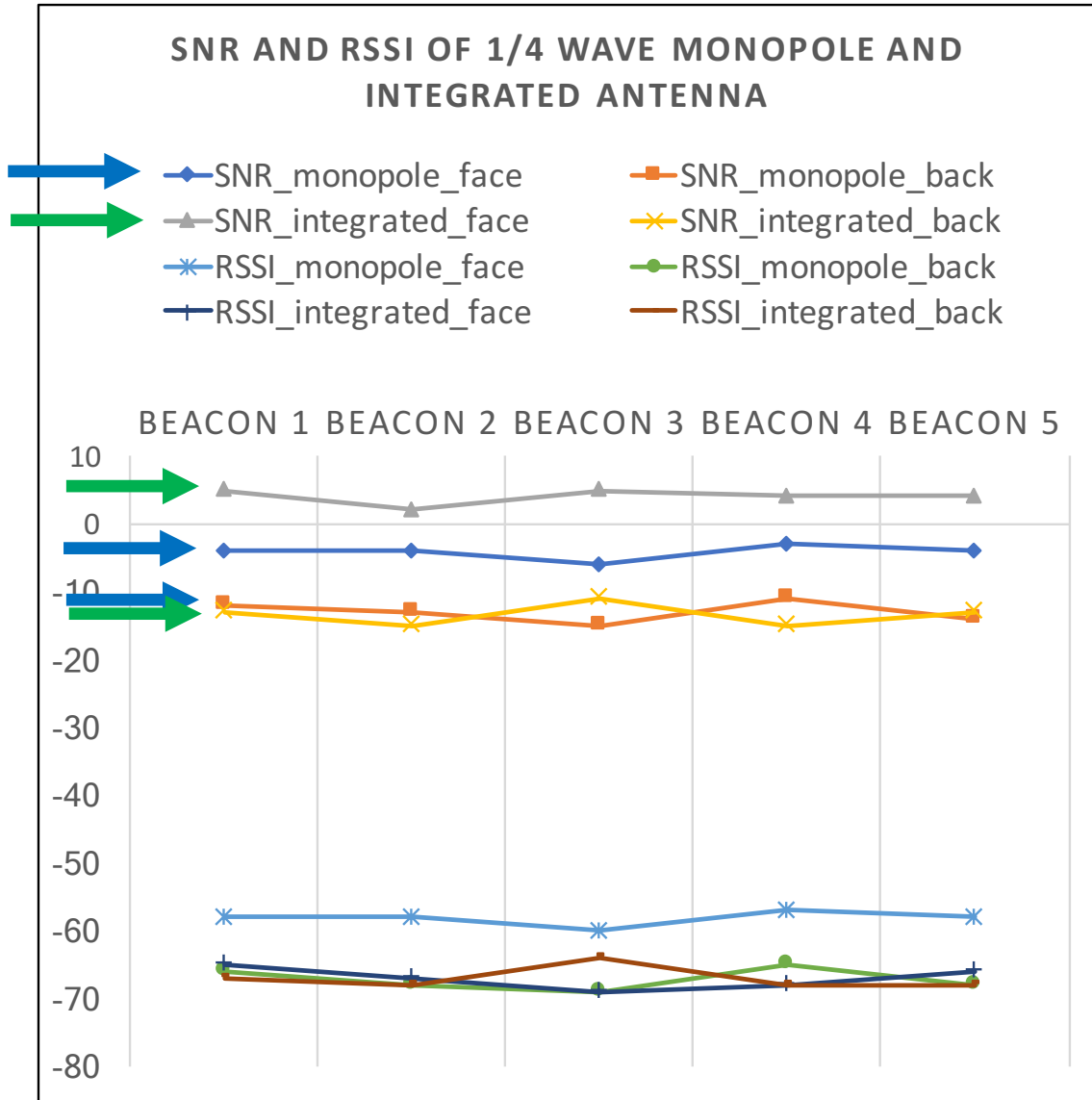
Antenna structure	TRP (dBm)	Total efficiency	Max Dimension
Small monopole	14.7	74%	105 mm
Quarter-wave monop.	15.7	94%	170 mm
Half-wave monop.	13.9	61%	280 mm
UCA without casing	13.8	60%	80mm
UCA with casing	14.8	76%	80mm

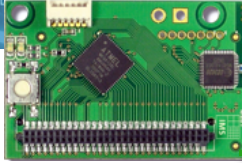


FIELD TESTS



800m with vegetation





TUTORIALS/RESOURCES



EU H2020 grant agreement number 887167

Low-cost LoRa IoT devices and gateway FAQ

1) What is Internet-of-Thing (IoT)?

From IERC (European Research Cluster on the Internet of Thing)

The IERC definition states that IoT is "A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network."

From <http://www.gartner.com/it-glossary/internet-of-things/>

"The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment."

From <http://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT>

"The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction."

2) What is WAZIUP?

The EU H2020 WAZIUP project, namely the Open Innovation Platform for IoT-Big Data in Sub-Saharan Africa is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP operates by involving farmers and breeders in order to define the platform specifications in focused validation cases. Second, while tackling challenges which are specific to the rural ecosystem, it also engages the flourishing ICT ecosystem in those countries by fostering new tools and good practices, entrepreneurship and start-ups. Aimed at boosting the ICT sector, WAZIUP proposes solutions aiming at long term sustainability.

WAZIUP will deliver a communication and big data application platform and generate locally the know-how by training by use cases and examples. The use of standards will help to create an interoperable platform, fully open source, oriented to radically new paradigms for innovative applications/services delivery. WAZIUP is driven by the following visions:

1. Empower the African Rural Economy. Develop new technological enablers to empower the African rural economy now threatened by the concurrent action of rapid urbanization and of climate change. WAZIUP technologies can support the necessary services and infrastructures to launch agriculture and breeding on a new scale.

Author : Congduc Pham, University of Pau, France
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TUTORIAL ON HARDWARE & SOFTWARE FOR LOW-COST LONG-RANGE IOT



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LOW-COST LORA IOT DEVICE: A STEP-BY-STEP TUTORIAL



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BUILDING AN IOT DEVICE FOR OUTDOOR USAGE: A STEP-BY-STEP TUTORIAL



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LOW-COST LORA GATEWAY: A STEP-BY-STEP TUTORIAL



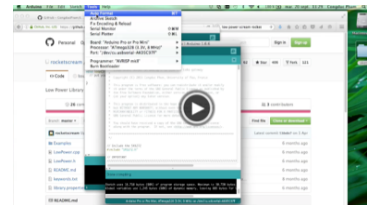
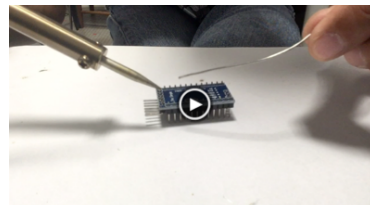
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LOW-COST LORA IOT: USING THE WAZIUP DEMO KIT



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Thanks.
Let's keep in touch



Carine VAVASSEUR

Communication & Event Manager

Carine.vavasseur@cticdakar.com

www.cticdakar.com
contact@cticdakar.com



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