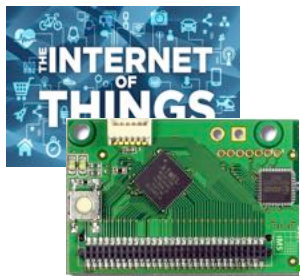


DEPLOYER L'INTERNET-DES-OBJETS À FAIBLE COÛT ET AVEC UNE APPROCHE OPEN-SOURCE



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





IOT POUR LE DEVELOPPEMENT



Irrigation



Elevage



Aquaculture



Logistique



Agriculture

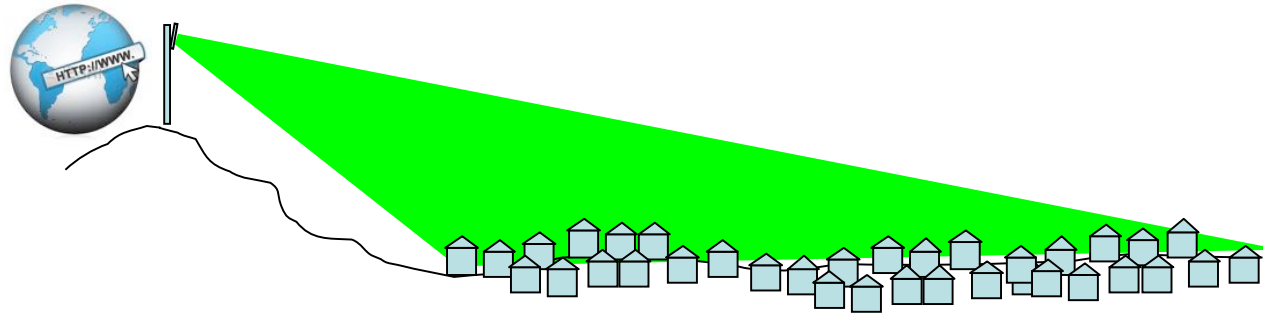


Gestion de l'eau

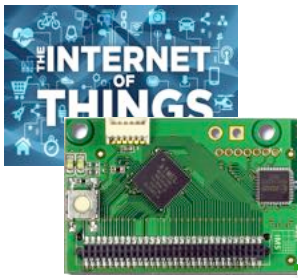


APPLICATIONS DE TÉLÉMÉTRIE

- Température
- Humidité du sol
- pH
- concentration
- ...



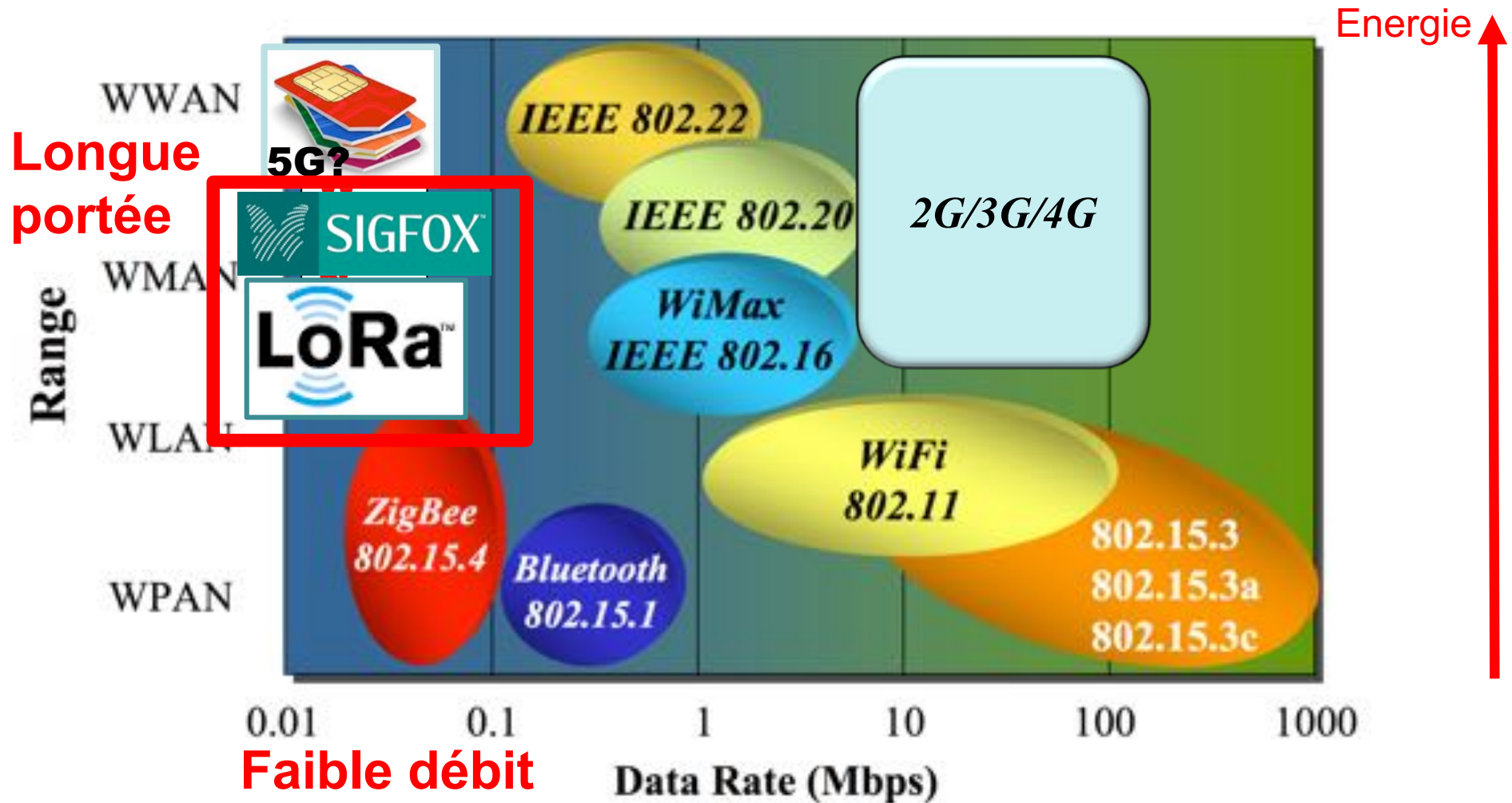
Technology	2G	3G	LAN
Range (I=Indoor, O=Outdoor)	N/A	N/A	O: 300m I: 30m
Tx current consumption	200-500mA	500-1000mA	100-300mA
Standby current	2.3mA	3.5mA	NC



RADIO LONGUE-PORTÉE, BASSE CONSOMMATION



Dilemme entre portée et consommation





RADIOS LoRa



HopeRF
RFM92W/95W



Libelium LoRa

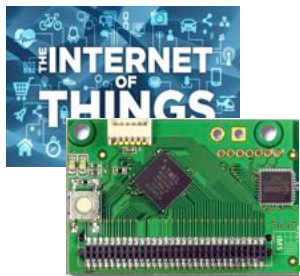


Modtronix
inAir9/9B



LoRa1276
NiceRF
LoRa1276

- ❑ Les radio LoRa sont de type longue-portée et faible consommation
- ❑ Elles permettent de créer et déployer des réseaux simplement, sans passer par des opérateurs
- ❑ Ces modules sont parfait pour intégrer une communication à faible coût à des petits objets



MATURATION DU MARCHÉ IoT...





MATURATION DU MARCHÉ IoT...



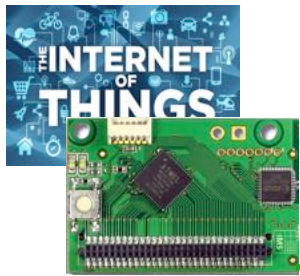
... mais pas forcément adaptée à tous les besoins

Produits chers
Très intégrés
Très spécialisés
Difficile à adapter
Difficile à mettre à jour



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





OBJECTIF: DÉPLOYER L'IOT À FAIBLE COÛT POUR TOUS!



- ❑ WAZIUP est un projet européen (2016-2019)
- ❑ 5 partenaires européens et 7 partenaires Africain
- ❑ Propose des solutions open-source pour déployer l'IoT à bas-coût dans les pays en voie de développement et les zones rurales



- ❑ Un accent particulier est mis sur les applications du domaine agricoles



DES PLATE-FORMES MATÉRIELLES À BAS-COÛT...



Arduino Pro Mini



LoPy

<http://www.postscapes.com/internet-of-things-hardware/>

<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



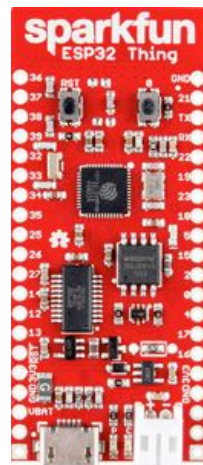
Teensy 3.2



STM32 Nucleo-32



LinkIt Smart7688 duo



Sparkfun ESP32 Thing



Tessel

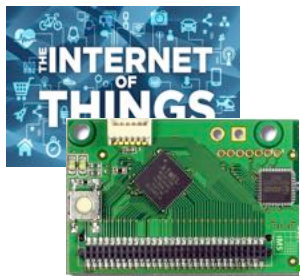
SodaqOnev2



Tinyduino



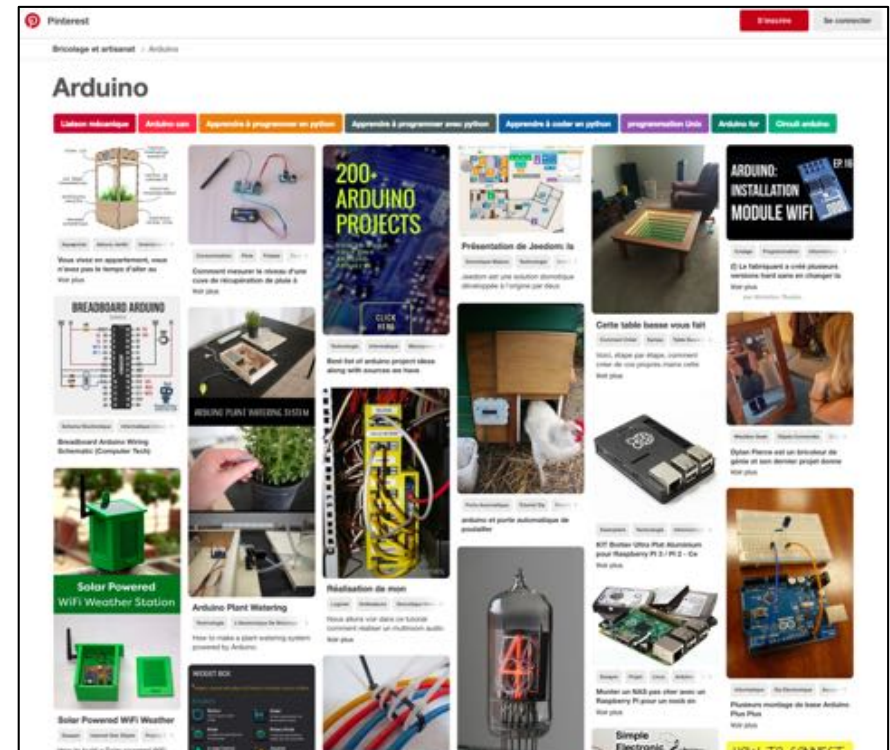
Adafruit Feather



... POUR LE "DO-IT-YOURSELF!"



- ❑ Do-it-Yourself = "À faire soi-même"
- ❑ Mais sous-entend aussi logiciel libre, meilleure réactivité et plus grande flexibilité





MODÈLES PRÊTS À L'EMPLOI



- Température
- Humidité du sol
- pH
- concentration
- ...



10-15kms



Capteur physique

Capteur physique

Capteur physique



Arduino Pro Mini @3.3V

VERY IMPORTANT

Gestion du capteur physique

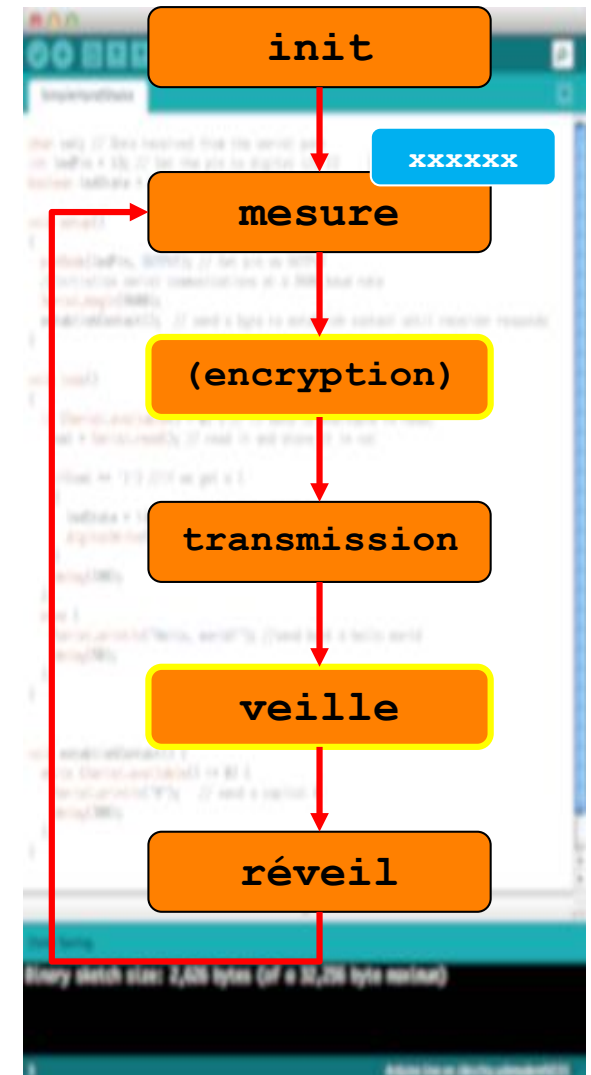
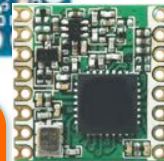
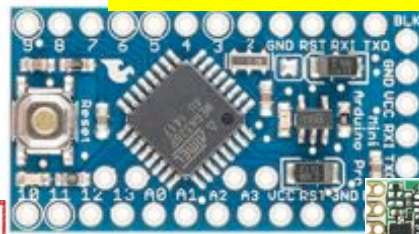
Gestion de l'activité, énergie

VERY IMPORTANT

Encryption des données

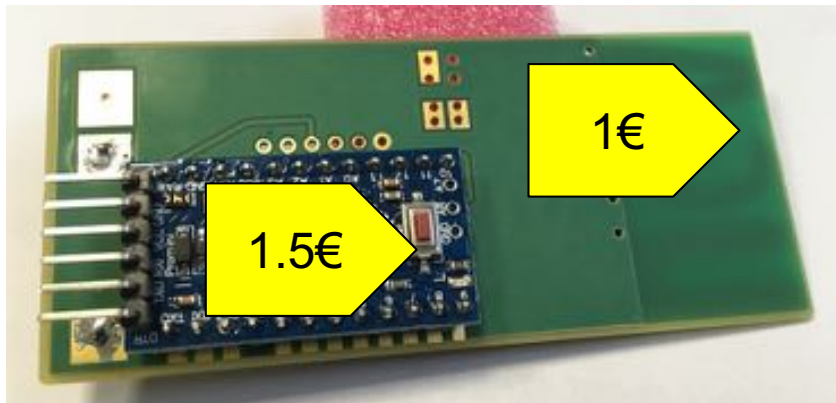
Transmission radio longue distance

Gestion du capteur logique





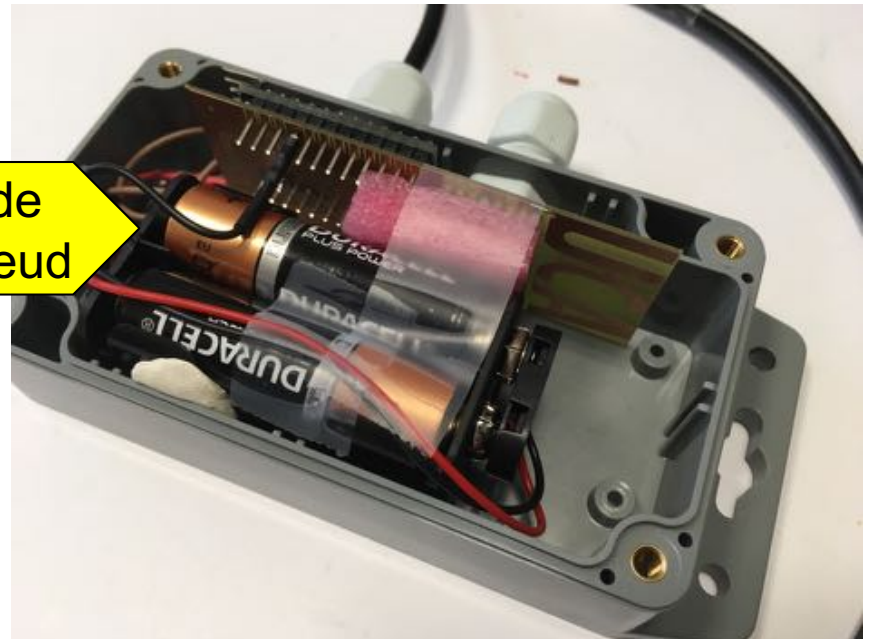
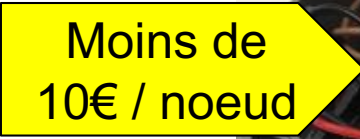
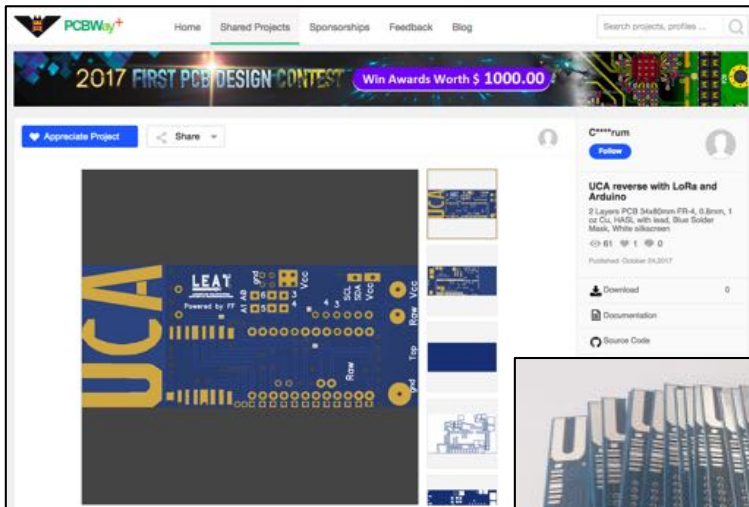
INTÉGRATION À BAS-COÛT



HopeRF
RFM92W/95W



https://github.com/FabienFerrero/UCA_Board

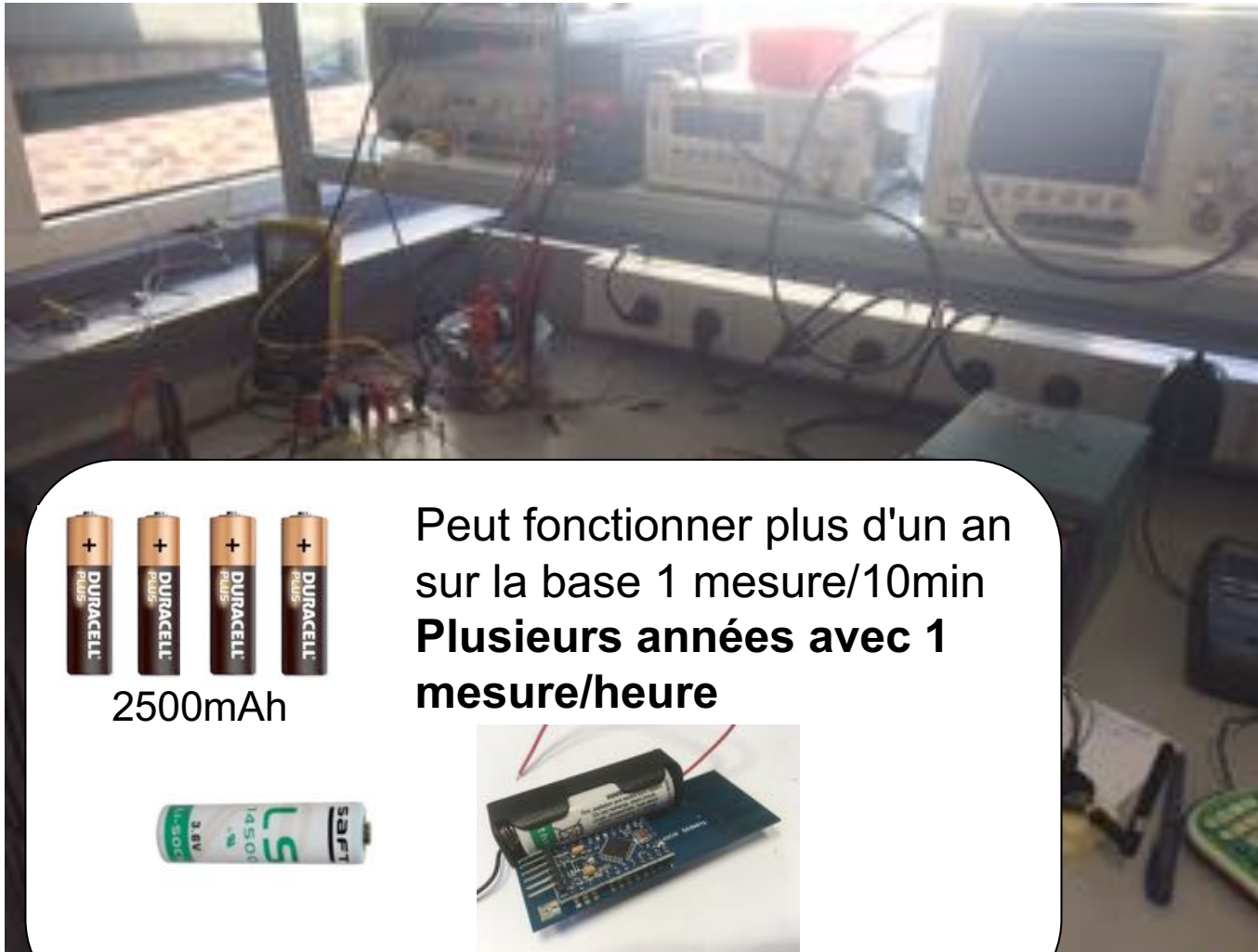


Commande en 1-click



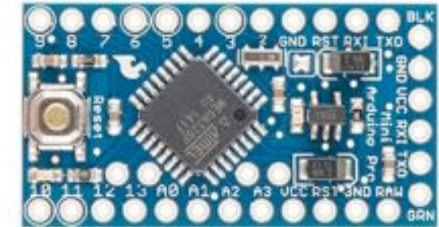


FAIBLE CONSOMMATION POUR GRANDE AUTONOMIE

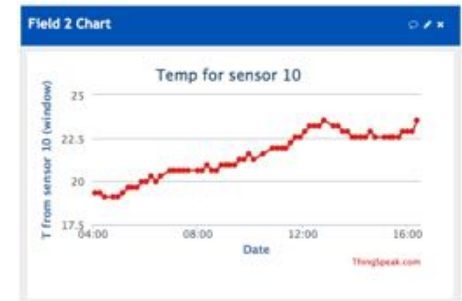


2500mAh

Peut fonctionner plus d'un an
sur la base 1 mesure/10min
**Plusieurs années avec 1
mesure/heure**



Réveil toutes les
10min, mesure et
envoi à la
passerelle/gateway



**5µA en veille,
environ 40mA en
activité**



DE NOMBREUX EXEMPLES POUR APPRENDRE ET ADAPTER



CongducPham / LowCostLoRaGw

Unwatch 49 Unstar 216 Fork 120

Code Issues 96 Pull requests 2 Projects 0 Wiki Insights Settings

Branch: master - LowCostLoRaGw / Arduino / Create new file Upload files Find file History

Congduc Pham update README files, fix MD5 digest computation of gw id, always use ... Latest commit aba3ee2 2 days ago

Arduino_LoRa_GPS	update README	19 days ago
Arduino_LoRa_Gateway	update gateway related files and some sketch	4 months ago
Arduino_LoRa_Gateway_1_4	improve management of transmission power, add channels in 863-865	a year ago
Arduino_LoRa_Generic_Sensor	update Arduino examples	a month ago
Arduino_LoRa_InteractiveDevice	update Arduino examples	a month ago
Arduino_LoRa_Ping_Pong	update Arduino examples	a month ago
Arduino_LoRa_Simple_BeaconCol...	update Arduino example	23 days ago
Arduino_LoRa_Simple_SoilHum	update Arduino examples	a month ago
Arduino_LoRa_Simple_temp	update Arduino examples	a month ago
Arduino_LoRa_SoilHum	update Arduino examples	a month ago
Arduino_LoRa_temp	update Arduino examples	a month ago
Arduino_LoRa_ucamfil	update image support	3 months ago
libraries	update README files, fix MD5 digest computation of gw id, always use ...	2 days ago
README.md	update README	19 days ago



TUTOS ET VIDÉOS



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



PROF. CONGDUC PHAM
HTTP://WWW.UNIV-PAU.FR/~CPHAM
UNIVERSITÉ DE PAU, FRANCE



HORIZON 2020
UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR
Congduc Pham, <http://cpham.perso.univ-pau.fr>

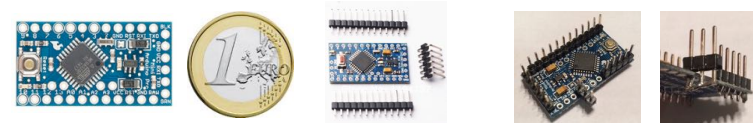


<http://www.waziup.eu>

The generic hardware platform

The Arduino Pro Mini

The Arduino Pro Mini is a compact form factor Arduino board based on the ATmega328P microcontroller. Use the **3.3v and 8MHz version** of the Arduino Pro Mini for lower power consumption.



You can get the original board designed by Sparkfun or get one of the various clones available mainly from Chinese manufacturer. The last solution is very cost-effective as the Pro Mini board can be purchased for a bit more than 1€ a piece.

Depending on how many sensors you want to connect, the number of ground (GND) pins may be limited. You can extend a GND pin with a header pin where all pins are soldered together.

The LoRa radio module

There are various LoRa radio modules that are all based on the Semtech SX1272/1276 chips family.



Fully tested LoRa radio modules



HopeRF RFM92W/95W



Libelium LoRa



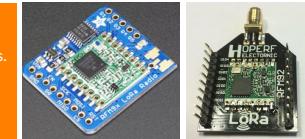
Modtronix inAir4/9/9B



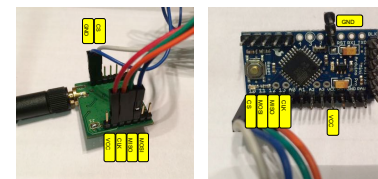
LoRa1276
NiceRF LoRa1276

Most of SPI-based LoRa radio modules are supported. We recommend the Modtronix inAir model if you don't have delicate soldering experience as this module can come with header pins ready to be connected with Dupont wires.

The RFM95W can be found assembled (Adafruit) or an adapter can be purchased (from Ideetron for instance).



Connect the LoRa radio module

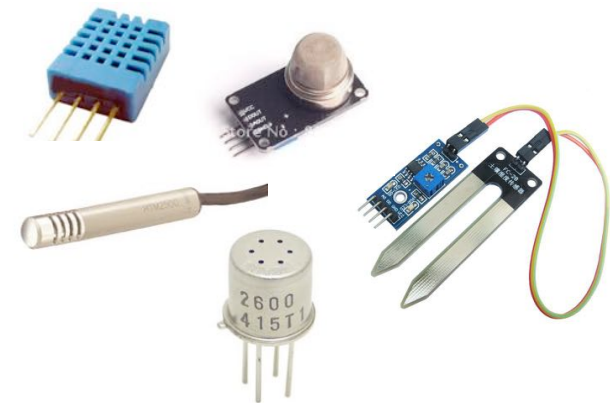
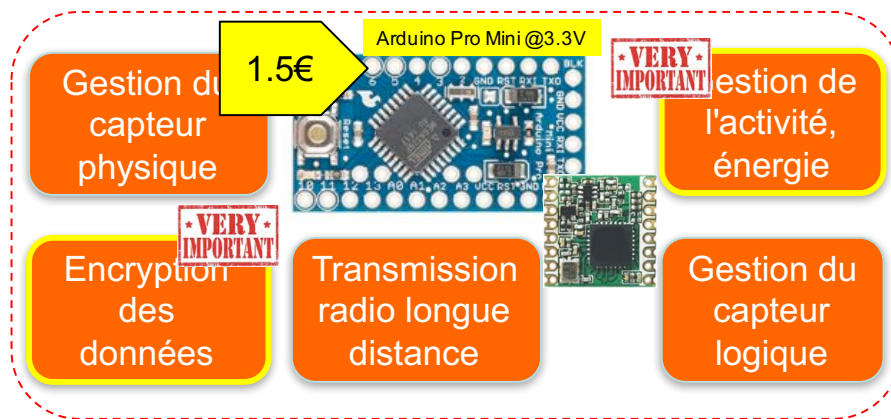


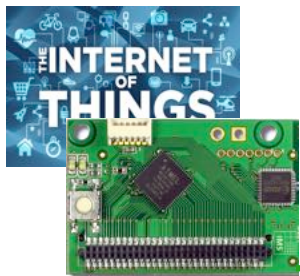
Connect the corresponding SPI pins of the radio module to the SPI pins on the Pro Mini board. MOSI (blue) is pin 11, MISO (green) is pin 12, CS (white) is pin 10 and CLK (orange) is pin 13 (right picture). Then connect also the VCC (red) and the GND (black) of the radio module to the VCC and the GND of the board (right picture). The VCC of the Pro Mini board gets 3.3v from the on-board voltage regulator.



PLATEFORME GÉNÉRIQUE

- ❑ Plateforme générique offrant faible coût, faible consommation, longue portée, grande fiabilité
- ❑ Transfert de technologie vers les communautés d'utilisateurs, FabLab, startups,...





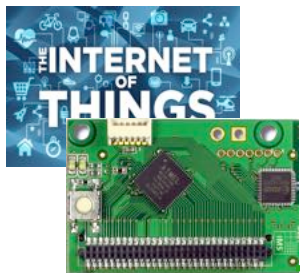
BOUÉE POUR LA QUALITÉ DE L'EAU EN AQUACULTURE



Physical sensor reading

Credit: EGM

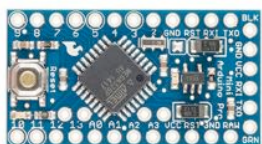




MESURE MULTI-NIVEAUX DE L'HUMIDITÉ DANS LE SOL



Physical sensor management



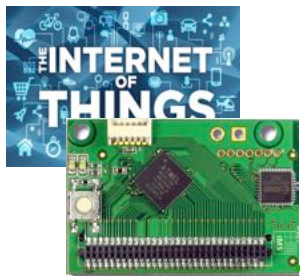
Activity duty-cycle, low power

Security

Long-range transmission

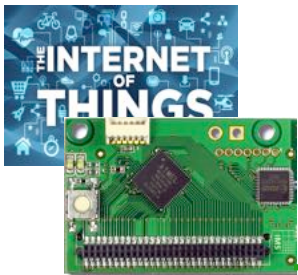
Logical sensor management



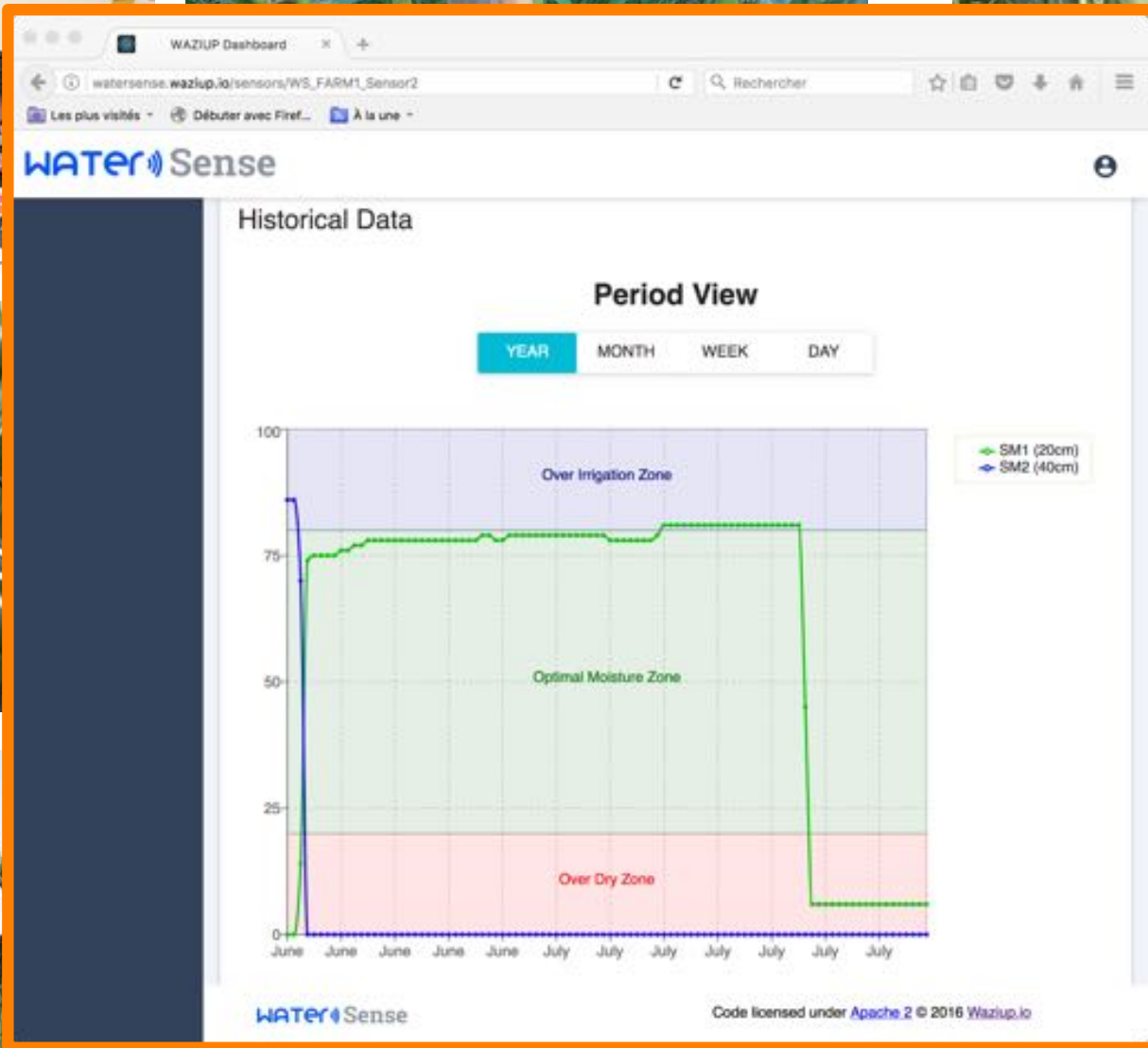


DEPLOIEMENT POUR LE PROJET WATERSENSE AVEC NESTLÉ





DEPLOIEMENT POUR LE PROJET WATERSENSE AVEC NESTLÉ



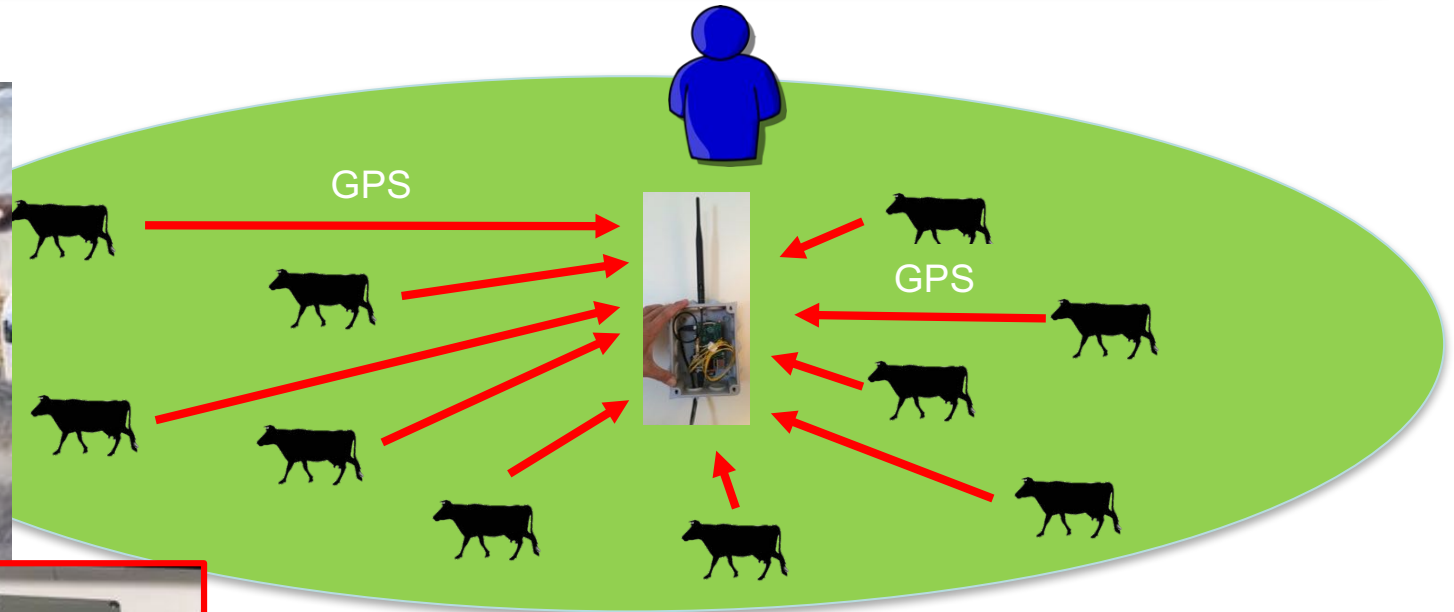
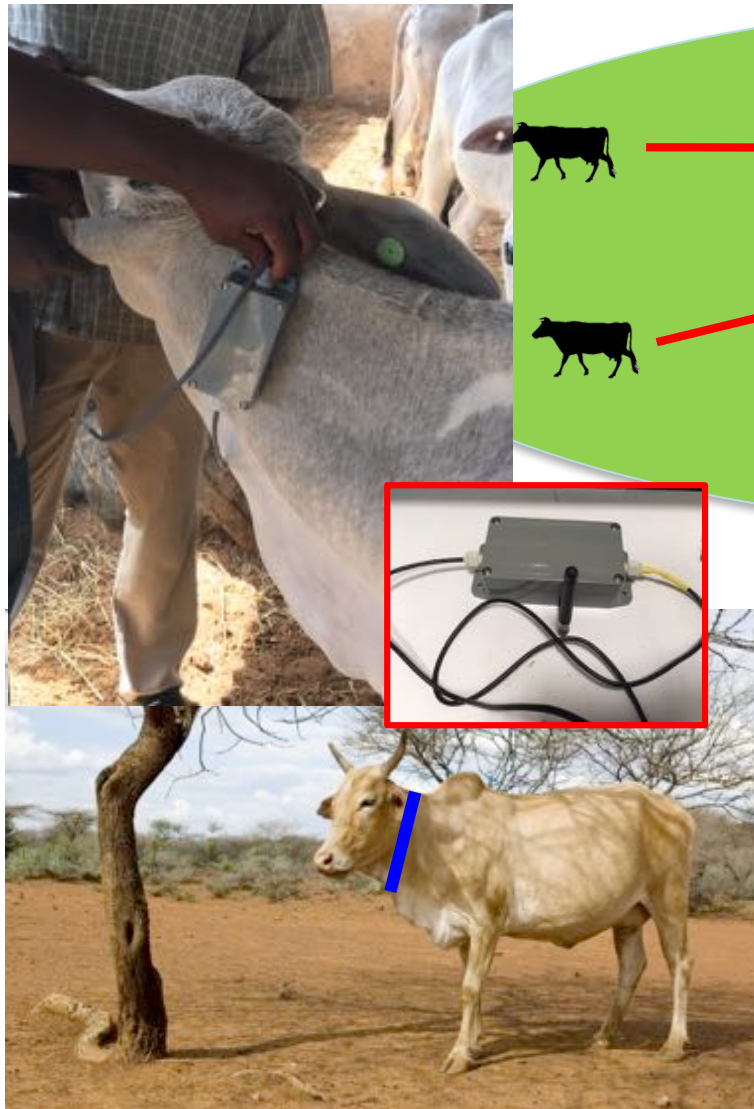


EXEMPLE D'INTÉGRATION LOCALE





COLLIER POUR LA SURVEILLANCE DU BÉTAIL



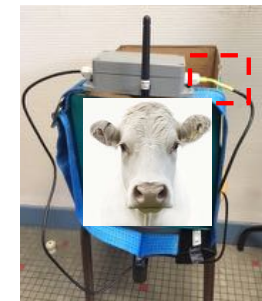
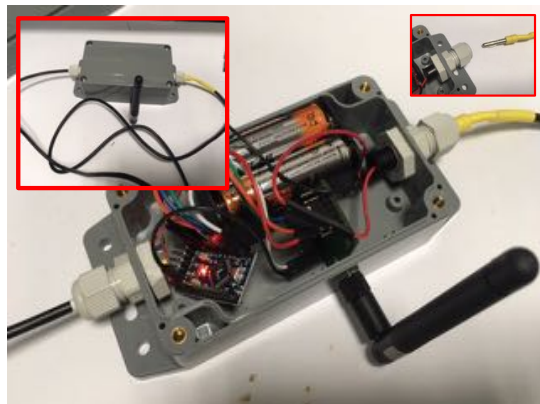
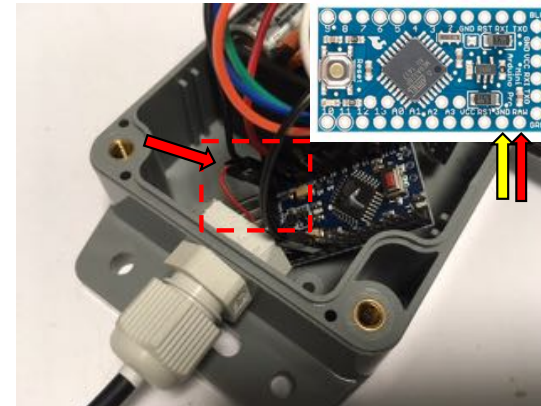
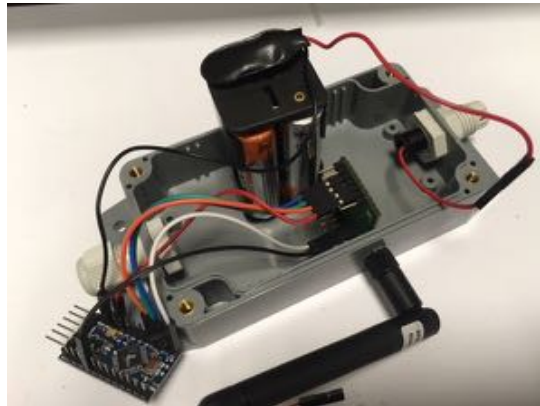
Le vol de bétail est un problème tragique dans les pays en voie de développement

Un collier permet de détecter très rapidement si le bétail s'éloigne (vol?) afin de réagir

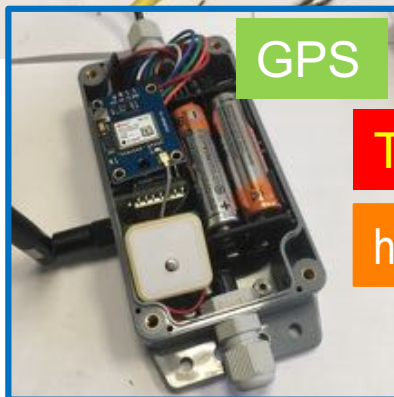
Bien sûr, couper le collier ou le débrancher signifie une alerte



INTÉGRATION FACILE, ADAPTATION ET ÉVOLUTION



Afimilk collar courtesy of I. Andonovic from University of Strathclyde



Tutoriel sur un collier GPS

<https://github.com/CongducPham/tutorials/blob/master/Low-cost-LoRa-Collar.pdf>



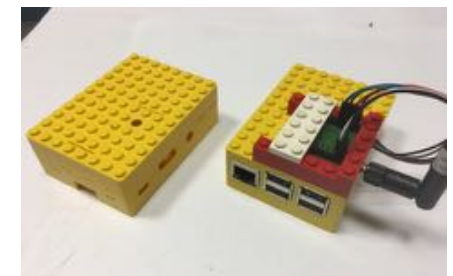
PASSERELLE LORA À BAS-COÛT



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!

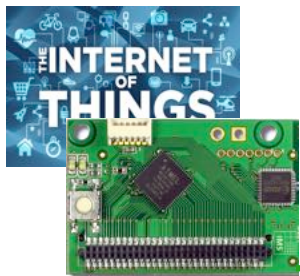


Less than 50€



Get the ready-to-use SD card image

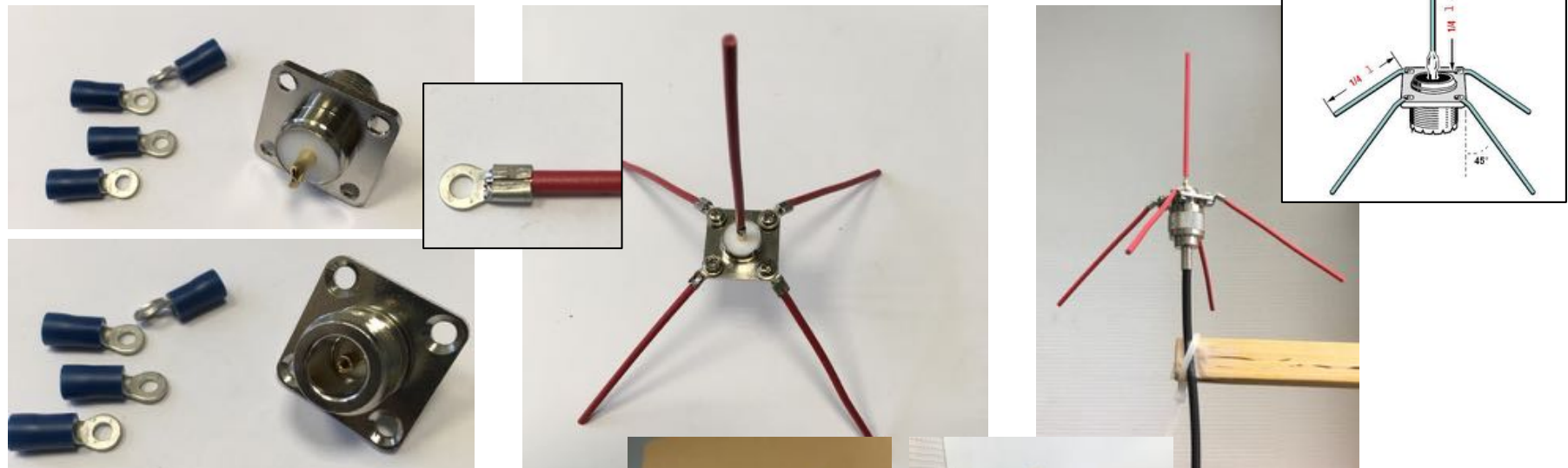
<http://cpham.perso.univ-pau.fr/LORA/WAZIUP/raspberrypi-jessie-WAZIUP-demo.dmg.zip>



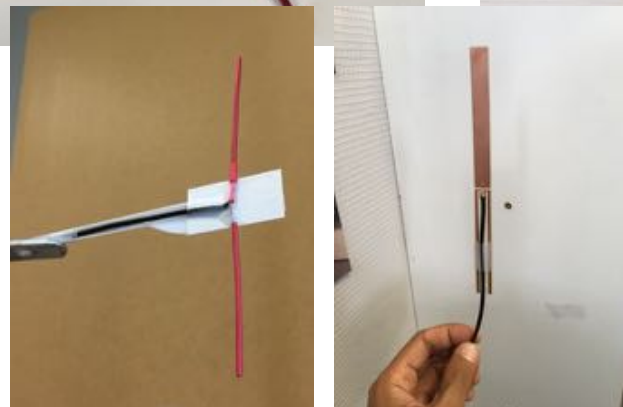
ANTENNE À FAIRE SOI-MÊME



- Une antenna "ground plane" peut être réalisée avec 5 éléments $\frac{1}{4}$ d'onde. $\frac{1}{4}$ d'onde en 868MHz est 8.2cm.

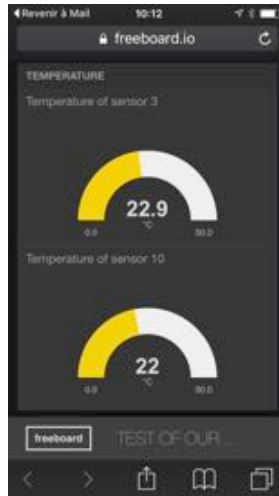
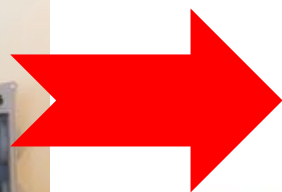


- Simple antenne dipole

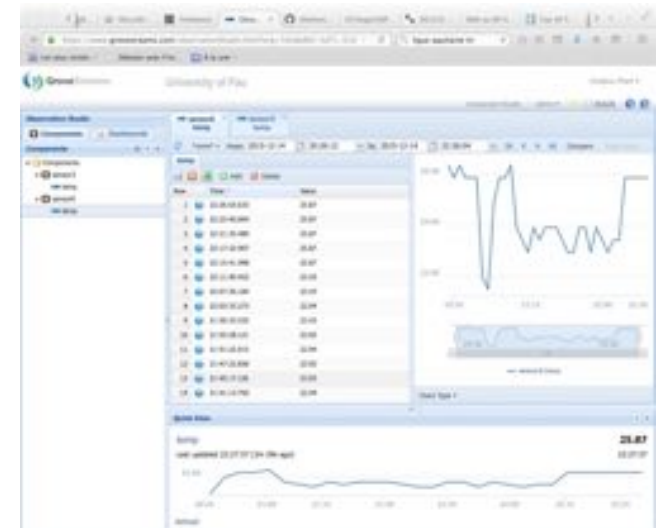




POUSSER VERS LE CLOUD



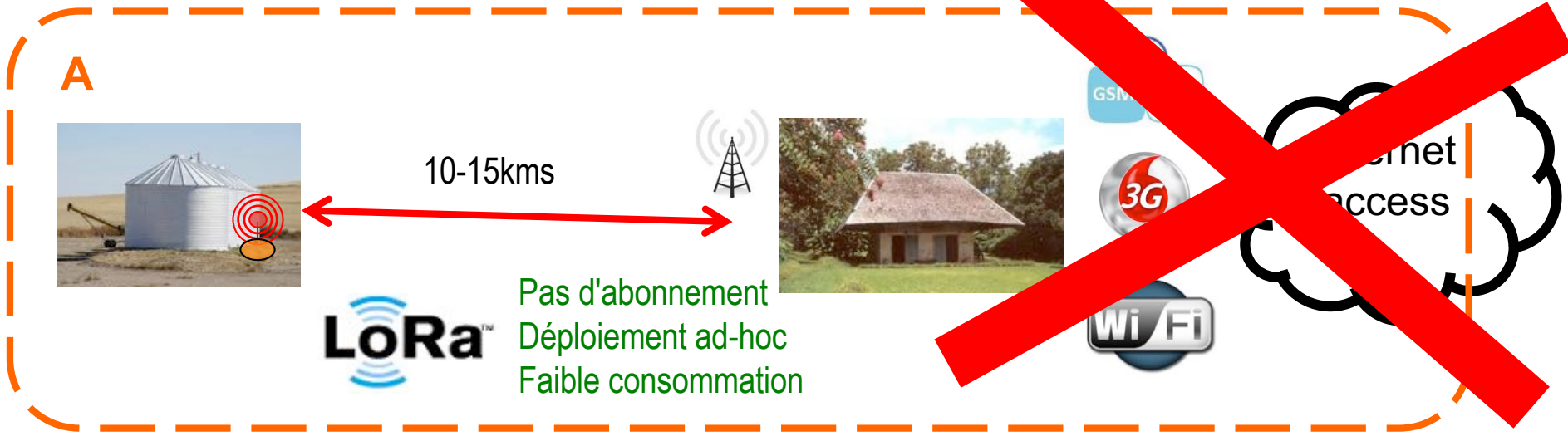
freeboard



Et bien plus: HTTP, FTP, MQTT, ...

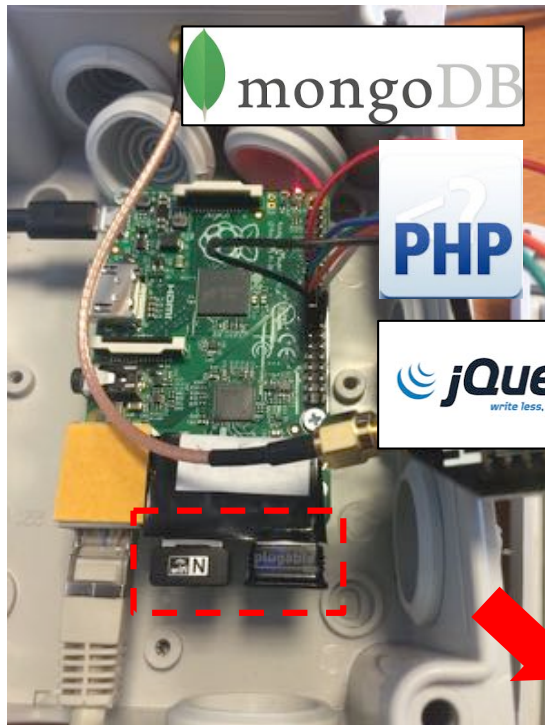


TRAVAILLER SANS INTERNET !





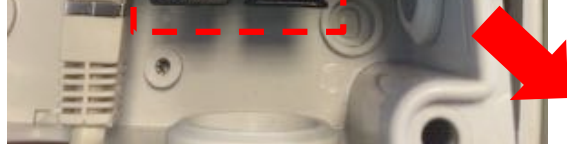
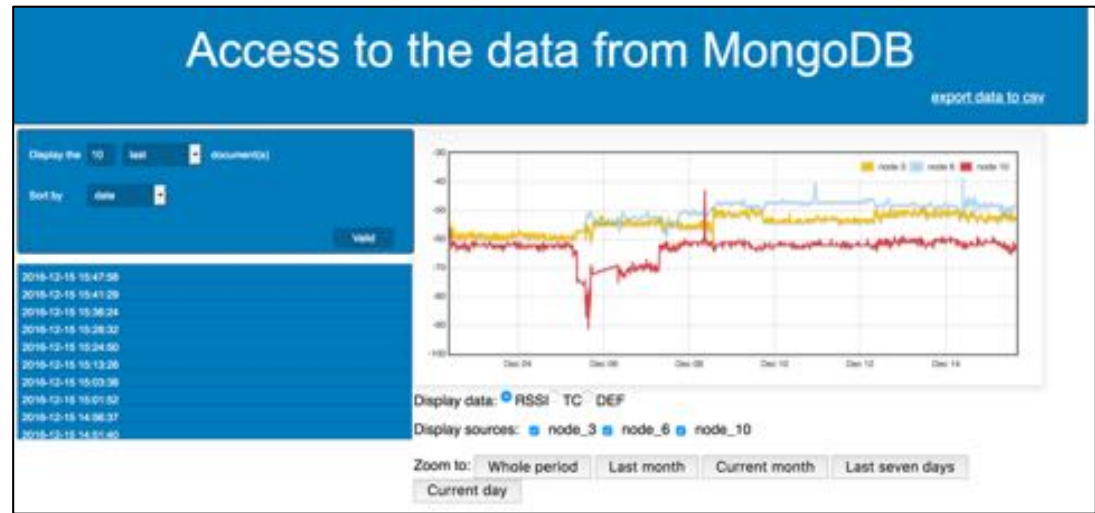
PASSERELLE AUTONOME



mongoDB

PHP

jQuery
write less, do more.



Zones isolées/reculées



Orange F Bluetooth_raspi

NODE: 1 DATE: 2016-05-09 08:04:59.807000 DATA: (Twi: 3.29, "rh": 22.6, "hu": 50.7)
 NODE: 1 DATE: 2016-05-09 08:28:52.993000 DATA: (Twi: 3.29, "rh": 22.89, "hu": 50.29)
 NODE: 1 DATE: 2016-05-09 08:53:04.317000 DATA: (Twi: 3.29, "rh": 23.2, "hu": 50.79)
 NODE: 1 DATE: 2016-05-09 09:05:00.997000 DATA: (Twi: 3.29, "rh": 23.29, "hu": 51.29)
 NODE: 1 DATE: 2016-05-09 09:17:24.482000 DATA: (Twi: 3.29, "rh": 23.39, "hu": 51.7)
 NODE: 1 DATE: 2016-05-09 09:41:27.437000 DATA: (Twi: 3.29, "rh": 23.6, "hu": 52.0)
 NODE: 1 DATE: 2016-05-09 10:05:39.032000 DATA: (Twi: 3.29, "rh": 23.79, "hu": 51.5)
 NODE: 1 DATE: 2016-05-09 10:17:45.186000 DATA: (Twi: 3.29, "rh": 23.79, "hu": 50.79)
 NODE: 1 DATE: 2016-05-09 10:29:24.285000 DATA: (Twi: 3.29, "rh": 23.79, "hu": 50.79)
 NODE: 1 DATE: 2016-05-09 10:53:09.347000 DATA: (Twi: 3.29, "rh": 23.79, "hu": 51.9)
 NODE: 1 DATE: 2016-05-09 11:17:02.953000 DATA: (Twi: 3.29, "rh": 23.5, "hu": 50.79)
 NODE: 1 DATE: 2016-05-09 11:52:53.334000 DATA: (Twi: 3.29, "rh": 23.29, "hu": 50.7)
 NODE: 1 DATE: 2016-05-09 12:04:32.437000 DATA: (Twi: 3.29, "rh": 23.5, "hu": 50.29)
 NODE: 1 DATE: 2016-05-09 12:16:56.116000 DATA: (Twi: 3.29, "rh": 23.4, "hu": 50.29)

Display data Retrieve data in a csv file

Orange F Bluetooth_raspi

NODES PREFERENCES

1 check to retrieve its data
 8 check to retrieve its data

DATES PREFERENCES

Pick a begin date
Retrieve data since 09-05-2016

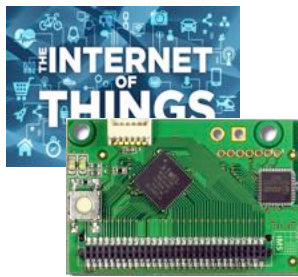
Pick an end date
Retrieve data until 17-05-2016

Display data Retrieve data in a csv file

Orange F Bluetooth_raspi

Creating csv file with the data received...
File 17-05-2016_10h39m36s.csv created and saved in the folder /storage/emulated/0/Raspberry_local_data

Display data Retrieve data in a csv file



TUTORIELS & DOCUMENTATIONS



<https://github.com/CongducPham/tutorials>

WAZIUP
 11/10/2020 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, and 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 engages in order to define the platform specifications in focused validation cases. Second, while facing 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 vision:

1. Empower the African farmer to improve the African rural of rapid urbanization and support the necessary breeding on a new scale

Author : Congduc Pham, University of Pau
 Last update : 07/09/2018

TUTORIAL ON HARDWARE & SOFTWARE FOR LOW-COST LONG-RANGE IOT

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LIUPPA T2i team

PROF. CONGDUC PHAM
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[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)
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LIUPPA T2i team

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

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LIUPPA T2i team

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

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LOW-COST LORA IOT: USING THE WAZIUP DEMO KIT

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LIUPPA T2i team

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

UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR

IoT à faire soi-même



+45000 vues

Passerelle à faire soi-même



https://www.youtube.com/watch?v=YsKbJeeav_M

<https://www.youtube.com/watch?v=mj8ltKA14PY>



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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