

# IOT ONLINE COURSE

## Fundamentals of IoT

### F-IOT-4: Low-cost & Open-source IoT Technologies

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Université de Pau, France





# IoT Online Course



Ⓞ <http://diy.waziup.io>

The screenshot shows the website [diy.waziup.io/index.html](http://diy.waziup.io/index.html). The main heading is "ON-LINE ARDUINO SENSORS AND DIY LORA TUTORIAL". Below this, there are logos for "UNIVERSITÉ DE PAU ET DES CANTONS DE L'AQUITAINE", "WAZIUP", and "WAZIHUB". A navigation menu on the left includes "Home" and various topics like "Introduction to Arduino IDE", "Measuring temperature", "Measuring distance", "Measuring humidity", "Detecting motion", "Measuring Light", "Measuring Sound Level", "RFID", "Using GPS", and "Connecting an OLED screen". The main content area features a "Forewords" section with text about the course's development and a grid of images representing different IoT applications: Irrigation, Livestock farming, Fish farming & aquaculture, Storage & logistic, Agriculture, and Environment. At the bottom, there are logos for "WAZIUP" and "WAZIHUB" with dates "Feb 2016 - 2019" and "May 2018 - 2021".

The screenshot shows the "WAZIUP IoT Courses" page. It lists various courses and their sub-topics:

- Fundamentals of IoT**
  - 1. F-IOT-1a: What is IoT
    - Quick Introduction to IoT - WAZIUP
    - IoT and Big Data Platform - WAZIUP
    - Intel IoT -- What Does The Internet of Things Mean? - YouTube
    - Eureka -- Internet of Things (IoT) | What is IoT | How it Works? - YouTube
    - Geospatial IoT -- IoT- What is Internet of Things? - YouTube
    - IBM Think Academy -- How It Works: Internet of Things? - YouTube
  - 2. F-IOT-1b: Introduction to Basic Electronics
    - Introduction To Basic Electronics - WAZIUP
    - Introduction To Basic Electronics - Instructables
    - Basic Electronics - Instructables
    - Introducing physical sensors, part 1 - WAZIUP
    - Introducing physical sensors, part 2 - WAZIUP
  - 3. F-IOT-2a: Understanding IoT Devices
  - 4. F-IOT-2b: Introduction to IoT hardware
  - 5. F-IOT-3: Introduction to Arduino IDE
    - Introduction to Arduino IDE - YouTube
    - Presentation of the Arduino IDE - WAZIUP
    - Setting up the Arduino IDE - WAZIUP
  - 6. F-IOT-4: WAZIUP Open Technologies
- Prototyping and Testing: Getting started**
  - 1. D-IOT-1: Getting started with WaziDev
    - Overview of WaziDev and NanoLoRa
    - The WaziDev board in more detail
    - Resources on github repository
    - Installing WAZIUP software and WaziDev
    - Installing WaziDev and NanoLoRa
  - 2. D-IOT-2: WAZIUP IoT and Gateway Deployment Guidelines - WAZIUP
  - 3. D-IOT-3: Antenna Tutorial for Gateway
  - 4. D-IOT-4: Gateway Web Admin Interface
  - 5. D-GW-2: Building an Outdoor Gateway
  - 6. D-GW-3: Antenna Tutorial for Gateway
  - 7. D-GW-4: Gateway Web Admin Interface
  - 8. D-GW-5: Migrating & Using WaziGateway
- Prototyping and Testing: Getting started**
  - 1. D-GW-1: Building & Configuring a WaziGateway
    - Quick overview of WAZIUP gateway
    - Installing gateway software on gateway
    - Connecting to Gateway and Base Station
    - Configuring Gateway and Settings
  - 2. D-GW-2: Building an Outdoor Gateway
  - 3. D-GW-3: Antenna Tutorial for Gateway
  - 4. D-GW-4: Gateway Web Admin Interface
  - 5. D-GW-5: Migrating & Using WaziGateway
- Prototyping and Testing: Deployment Guidelines**
  - 1. D-IOT-2: WAZIUP IoT and Gateway Deployment Guidelines - WAZIUP
- Prototyping and Testing: Introduction to WAZIUP IoT cloud Platform**
  - 1. D-CLOUD-1: Introduction to WAZIUP cloud dashboard - WAZIUP
  - 2. D-CLOUD-2: Create your app with WAZIUP - WAZIUP
- Advanced understanding**
  - 1. A-IOT-1: LoRa & LoRaWAN explained - WAZIUP
  - 2. A-IOT-2: LoRaWAN with WAZIUP - WAZIUP
  - 3. A-CLOUD-1: WAZIUP cloud API reference - WAZIUP





# WAZIUP Open IoT and Big data platform for Africans, by Africans

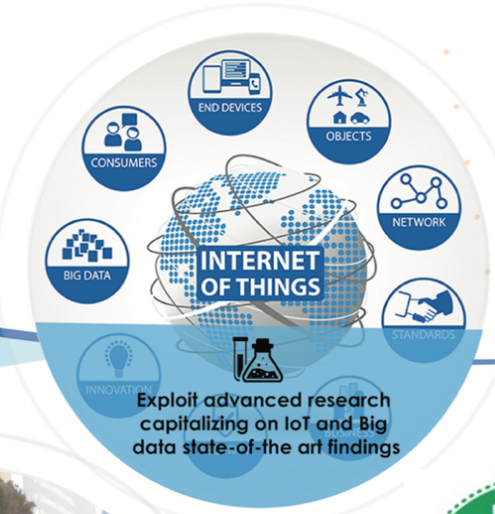
FEB2016-JAN2019



  
Affordable technologies to empower rural economies



**INTERNET OF THINGS**



Exploit advanced research capitalizing on IoT and Big data state-of-the-art findings



  
Develop IoT solutions and applications meeting African needs

**DO MORE with LESS**

-  [www.waziup.eu](http://www.waziup.eu)
-  Waziup IoT
-  Waziup IoT
-  Waziup
-  Waziup



waziup.community@create-net.org

# Most of existing system are not adapted for small holders



Needs, cost, design approach, constraints & control mechanisms

Challenge: Bridging the digital divide





# SMALLHOLDERS AND FAMILY FARMERS

## DID YOU KNOW?

ENVIRONMENT



Eighty percent of the farmland in sub-Saharan Africa and Asia is managed by smallholders (working on up to 10 hectares). While 75 percent of the world's food is generated from only 12 plants and 5 animal species, making the global food system highly vulnerable to shocks, biodiversity is key to smallholder systems who keep many rustic and climate-resilient varieties and breeds alive.

ECONOMY



Out of the 2.5 billion people in poor countries living directly from the food and agriculture sector, 1.5 billion people live in smallholder households. Many of those households are extremely poor: overall, the highest incidence of workers living with their families below the poverty line is associated with employment in agriculture.

SOCIAL



Women comprise an average of 43 percent of the agricultural labour force of developing countries up to almost 50 percent in Eastern and Southeastern Asia and sub-Saharan Africa. Should women farmers have the same access to productive resources as men, they could increase yields on their farms by 20-30 percent, lifting 100-150 million people out of hunger. Women are the quiet drivers of change towards more sustainable production systems and a more varied and healthier diet.

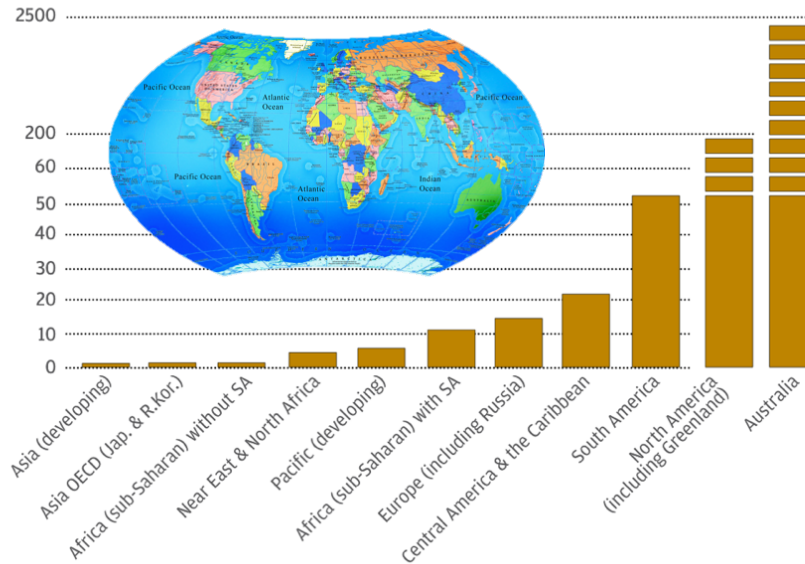
GOVERNANCE



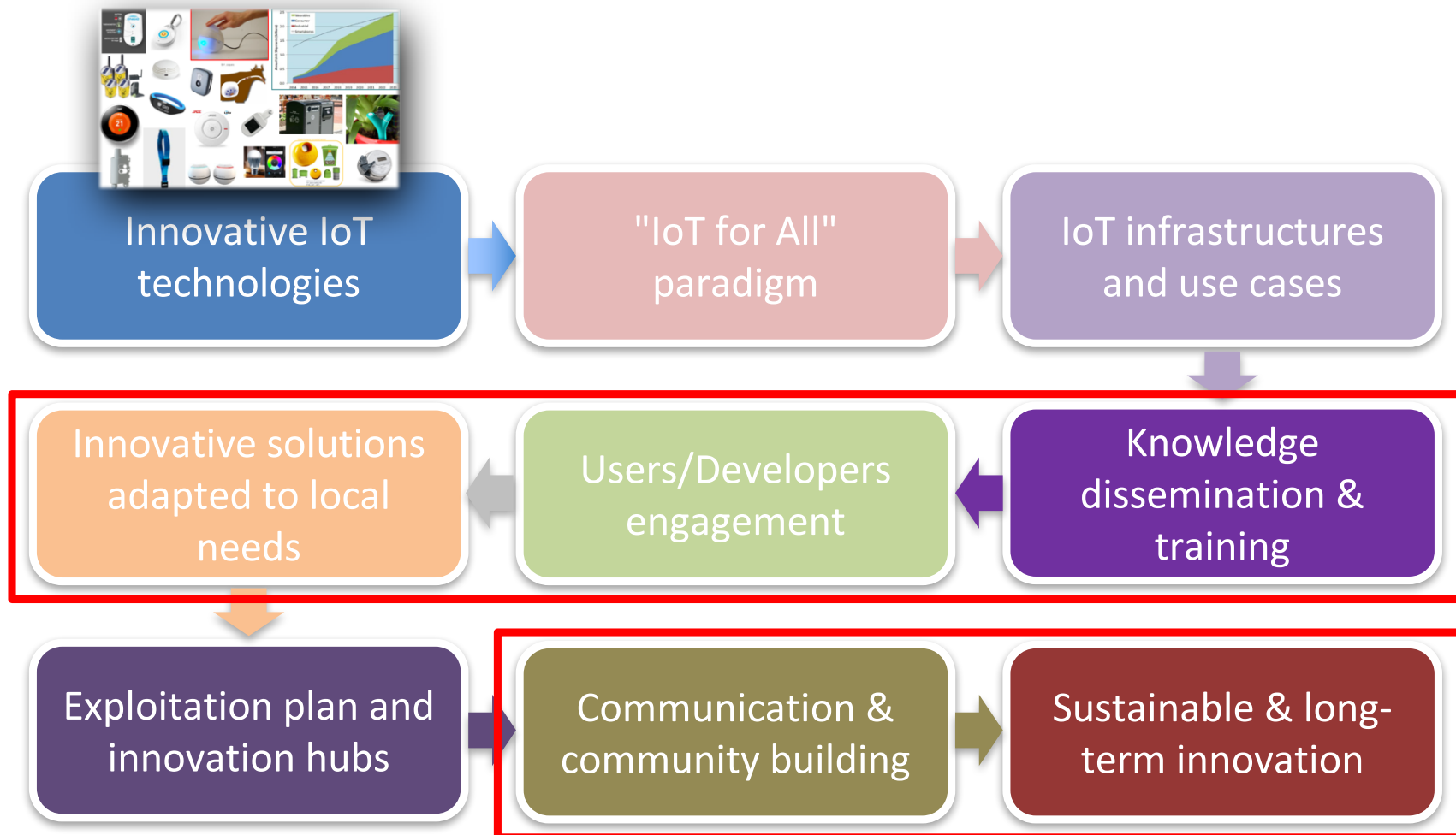
Smallholders provide up to 80 percent of the food supply in Asian and sub-Saharan Africa. Their economic viability and contributions to diversified landscape and culture is threatened by competitive pressure from globalization and integration into common economic areas; their fate is either to disappear and become purely self-subsistence producers, or to grow into larger units that can compete with large industrialized farms.

Smallholders are small-scale farmers, pastoralists, forest keepers, fishers who manage areas varying from less than one hectare to 10 hectares. Smallholders are characterized by family-focused motives such as favouring the stability of the farm household system, using mainly family labour for production and using part of the produce for family consumption.

## AVERAGE SIZE OF AGRICULTURAL HOLDINGS (ha)



# Making IoT happening!





# Community building for sustainable innovation



**International Events**  
+ 20 organized & attended



Launch event (Senegal, CTIC Dakar)



Launch event (Ghana, iSpace)

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



IoTWeek2016 (Belgrade, EGM)



IoTBigData2016 (Italy, EGM)



IoT Care Conference (Budapest, CNET)

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



Workshop at the RESSACS 2016 (France, UPPA)

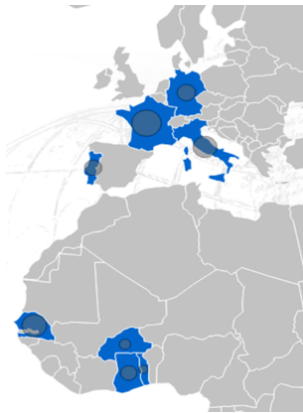




# Scaling up!



Feb 2016 - 2019

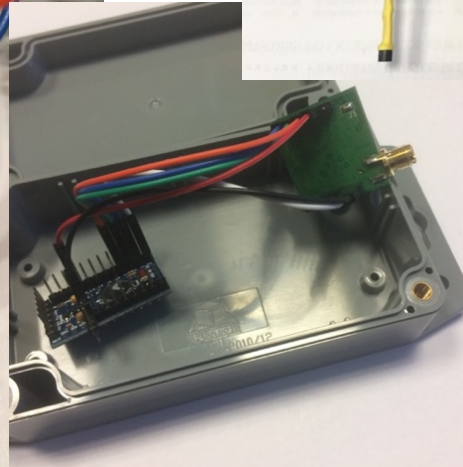
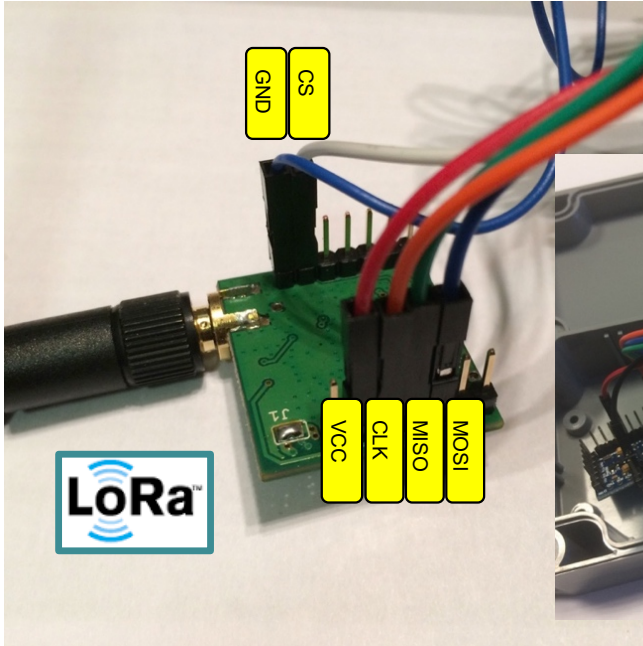
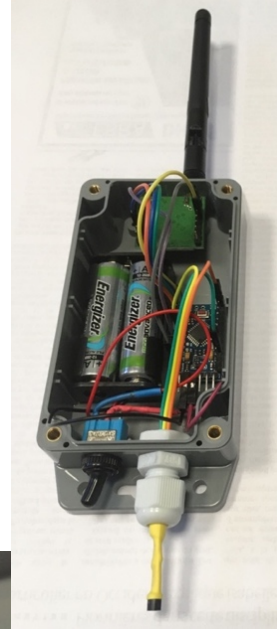
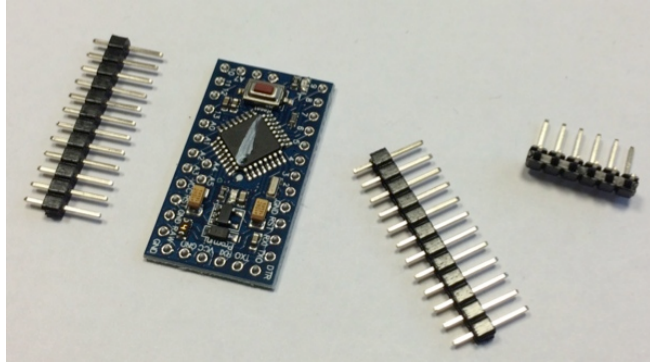


May 2018 - 2021



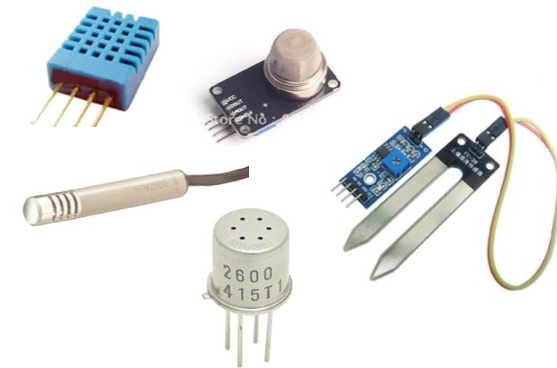
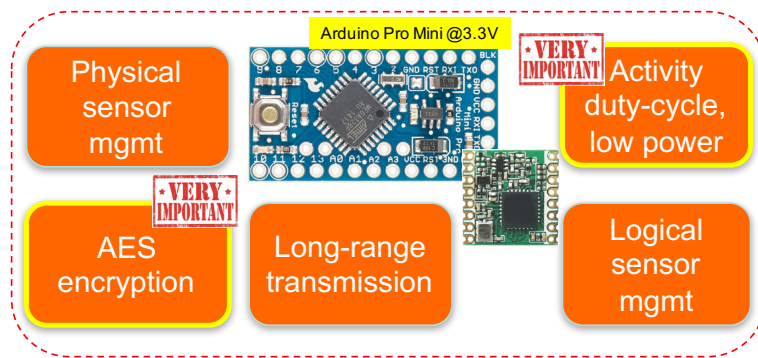


# DIY approach



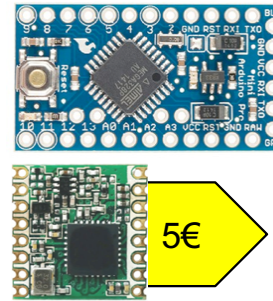
# Generic IoT v.s. highly specialized

- Build **low-cost**, **low-power**, **generic** IoT platform
- Methodology for low-cost platform design
- Technology transfers to user communities, economic actors, stakeholders,...





# Simple PCBs ease the DIY approach

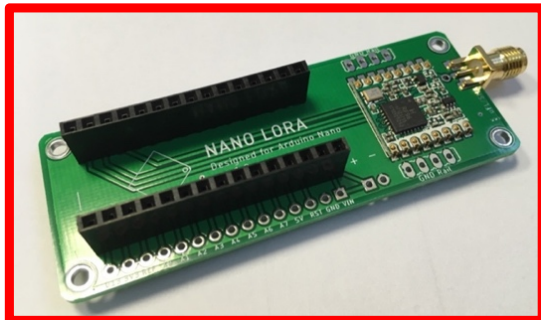
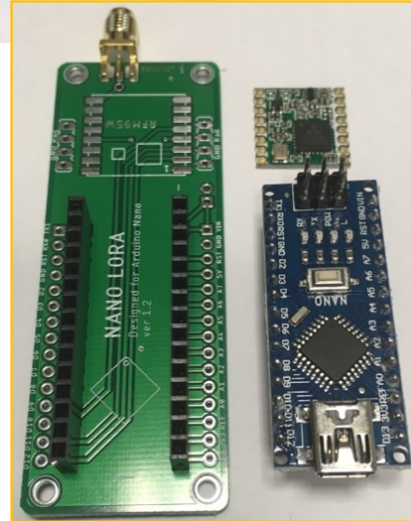
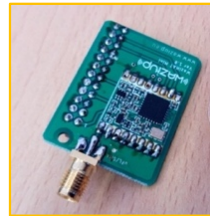
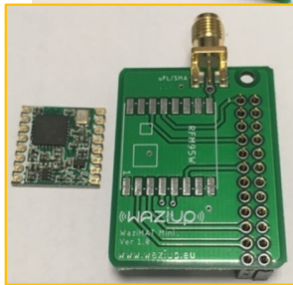
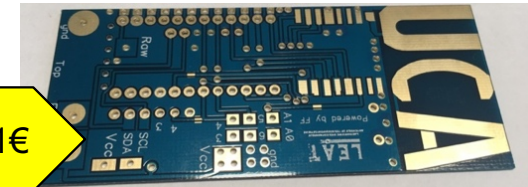


1.5€

5€

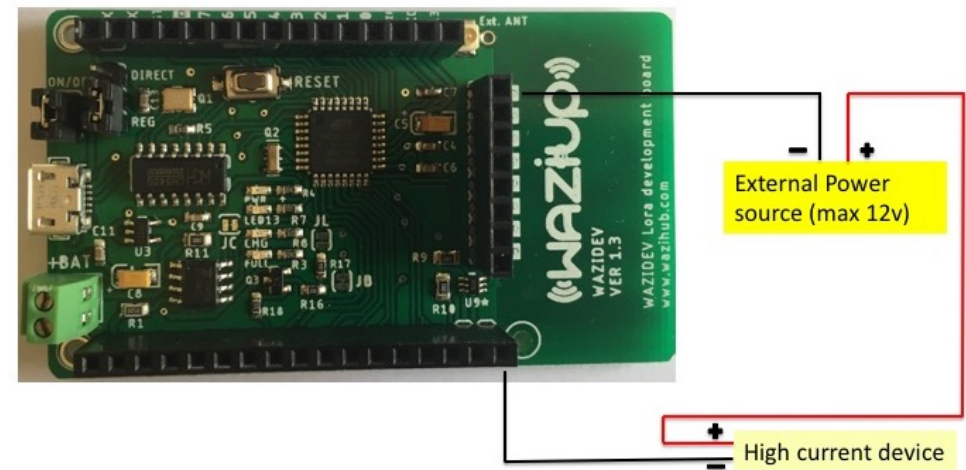
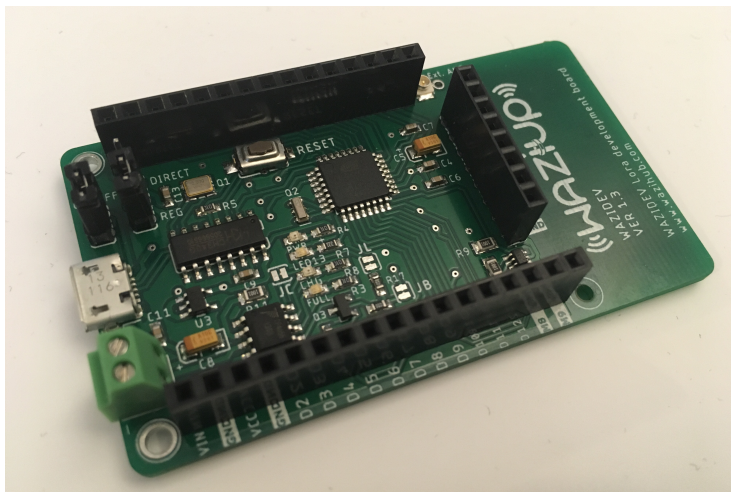
<1€

[https://github.com/FabienFerrero/UCA\\_Board](https://github.com/FabienFerrero/UCA_Board)



# WaziDev board

- ◉ Fully integrated development board: WAZIDev
  - ◉ Integrated MCU (ATMega328P, 3.3V & 8MHz)
  - ◉ On-board FTDI chip
- ◉ Features
  - ◉ All pins of MCU will be exposed
  - ◉ 2 MOSFET transistors to control energy-consuming sensors (e.g. GPS)









# 100% open-source code templates



```

Arduino_LoRa_temp | Arduino 1.6.6
-----
Arduino_LoRa_temp
/*
 * temperature sensor on analog 8 to test the LoRa gateway
 *
 * Copyright (C) 2015 Congduc Pham, University of Pau, France
 *
 * This program is free software: you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program. If not, see <http://www.gnu.org/licenses/>.
 */
// Include the SX1272
#include "SX1272.h"

// IMPORTANT
// please uncomment only :
// it seems that both Hop
// boards we set the trinit

// uncomment if your radio is an HopeRF RFM92W or RFM95W
#define RADIO_RF92_95
// uncomment if your radio is a Modtronix inA198 (the one with +20dBm features), if inA19, leave comment
// #define RADIO_INA198

// IMPORTANT
  
```

CongducPham / LowCostLoRaGw

Unwatch 62 Unstar 397 Fork 213

<> Code Issues 161 Pull requests 2 Projects 0 Wiki Insights Settings

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

Congduc Pham update SX1272.cpp Latest commit 114d66d 7 days ago

..		
Arduino_Encrypt_LSC_v2	update LSC lib and related examples	2 months ago
Arduino_GPS_ParseG_GGA	update Arduino examples	a month ago
Arduino_LoRa_Demo_Sensor	update Arduino examples	a month ago
Arduino_LoRa_GPS	update Arduino examples	a month ago
Arduino_LoRa_Gateway	update lora_gateway.cpp and SX1272.cpp	26 days ago
Arduino_LoRa_Gateway_1_4	improve management of transmission power, add channels in 863-865	2 years ago
Arduino_LoRa_Generic_DHT	update Arduino examples	a month ago
Arduino_LoRa_Generic_Simple_Mu...	update Arduino examples	a month ago
Arduino_LoRa_InteractiveDevice	update Arduino InteractiveDevice	a month ago
Arduino_LoRa_Ping_Pong	update Arduino examples	a month ago
Arduino_LoRa_Ping_Pong_LCD	update Arduino examples	a month ago
Arduino_LoRa_Radiohead_Example	update README and example sketch for RadioHead lib	a year ago
Arduino_LoRa_Simple_DHT	update Arduino examples	a month ago
Arduino_LoRa_Simple_temp	update Arduino examples	a month ago
Arduino_LoRa_temp	update Arduino examples	a month ago
Arduino_LoRa_ucaml	update image support	2 years ago

Many examples using various temp/hum sensors  
<https://github.com/CongducPham/LowCostLoRaGw/tree/master/Arduino>



# Large variety of examples to learn and adapt

CongducPham / LowCostLoRaGw
Unwatch 49   Unstar 216   Fork 120

Code
Issues 96
Pull requests 2
Projects 0
Wiki

Branch: master   **LowCostLoRaGw / Arduino /**

Congduc Pham update README files, fix MD5 digest computation of gw id, always use ...

..	
<b>Arduino_LoRa_GPS</b>	update README
Arduino_LoRa_Gateway	update gateway related files and some ske
Arduino_LoRa_Gateway_1_4	improve management of transmission pow
Arduino_LoRa_Generic_Sensor	update Arduino examples
Arduino_LoRa_InteractiveDevice	update Arduino examples
Arduino_LoRa_Ping_Pong	update Arduino examples
Arduino_LoRa_Simple_BeaconCol...	update Arduino example
<b>Arduino_LoRa_Simple_SoilHum</b>	update Arduino examples
<b>Arduino_LoRa_Simple_temp</b>	update Arduino examples
<b>Arduino_LoRa_SoilHum</b>	update Arduino examples
<b>Arduino_LoRa_temp</b>	update Arduino examples
Arduino_LoRa_ucamll	update image support
libraries	update README files, fix MD5 digest com
README.md	update README <span style="float: right;">19 days ago</span>

**Arduino\_LoRa\_Demo\_Sensor** is a very simple demo sketch for training purpose. The main program, i.e. `Arduino_LoRa_Demo_Sensor` can be left unchanged by the students. They just have to add/modify code in `my_demo_sensor_code.h` and `my_demo_sensor_code.cpp` to adapt the code for a given physical sensor. The provided example reads from either an LM35DZ or a TMP36 analog temperature sensor. The sensor is connected on pin A0 and is powered with digital pin 9.

**Arduino\_LoRa\_Simple\_temp** uses the same simple structure than `Arduino_LoRa_Demo_Sensor` where `my_temp_sensor_code.cpp` contains the code to read values from the physical sensor (which is still either an LM35DZ or a TMP36 analog temperature sensor). Additionally, this example illustrates how to implement periodic sensing with low-power mode to run on battery for years. The sensor is connected on pin A0 and is powered with digital pin 9.

**Arduino\_LoRa\_Simple\_DHT** shows how a more elaborated digital sensor such as the DHT22 (also known as AM2302) can be used. Code for DHT sensor is provided by the DHT library by Adafruit. This example therefore shows how you can use libraries provided by third-parties which is most likely the approach that you will use if you need to support a new physical sensor. Note that the DHT code can also be used for the AM2305 sensor. One advantage of the AM2305 is that it usually comes in an outdoor casing which make it suitable for outdoor and real-world deployment scenarios. Note that as it is a very simple example, only one physical measure is provided. In the example, it is the temperature even if the DHT22 sensor can provide both temperature and humidity. The sensor is connected on pin A0 and is powered with digital pin 9.

**Arduino\_LoRa\_temp** ends the simple temperature example serie. It illustrates a more complex example with AES encryption and the possibility to send LoRaWAN packet. It can also open a receive window after every transmission to wait for downlink message coming from the gateway (to do so, uncomment `#define WITH_RCVW`). The template shows for instance how an `!@Ax#` command from the gateway can be parsed to set the node's address to 'x'. It can serve as a template for a more complex LoRa IoT device with actuation capability on downlink packets from the gateway. The sensor is connected on pin A0 and is powered with digital pin 9.



# Open, versatile IoT gateway

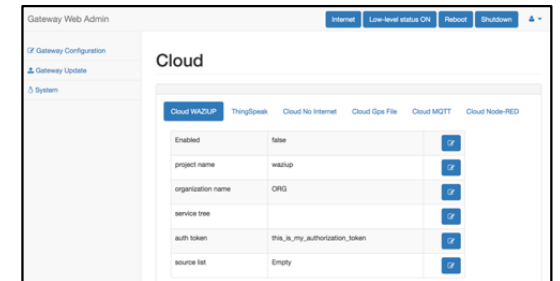
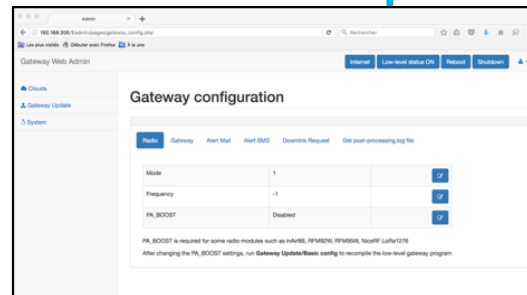
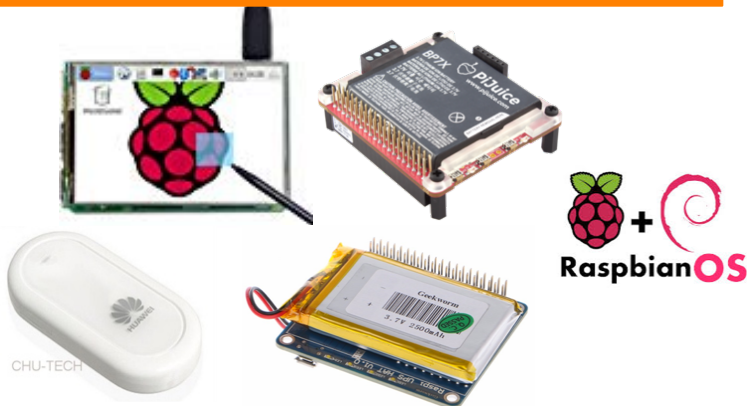
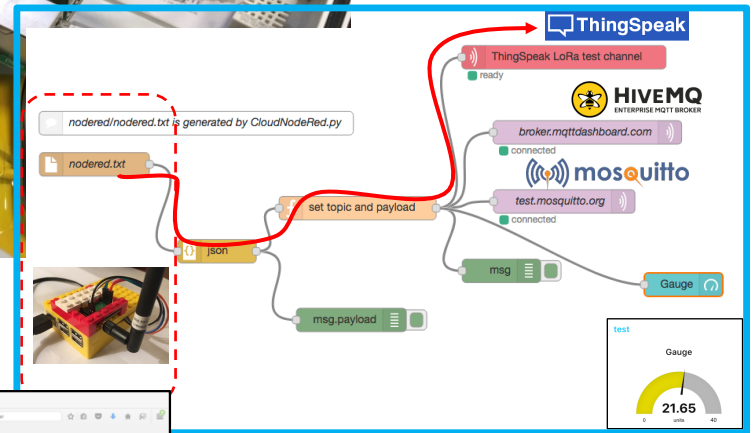


Latest distribution

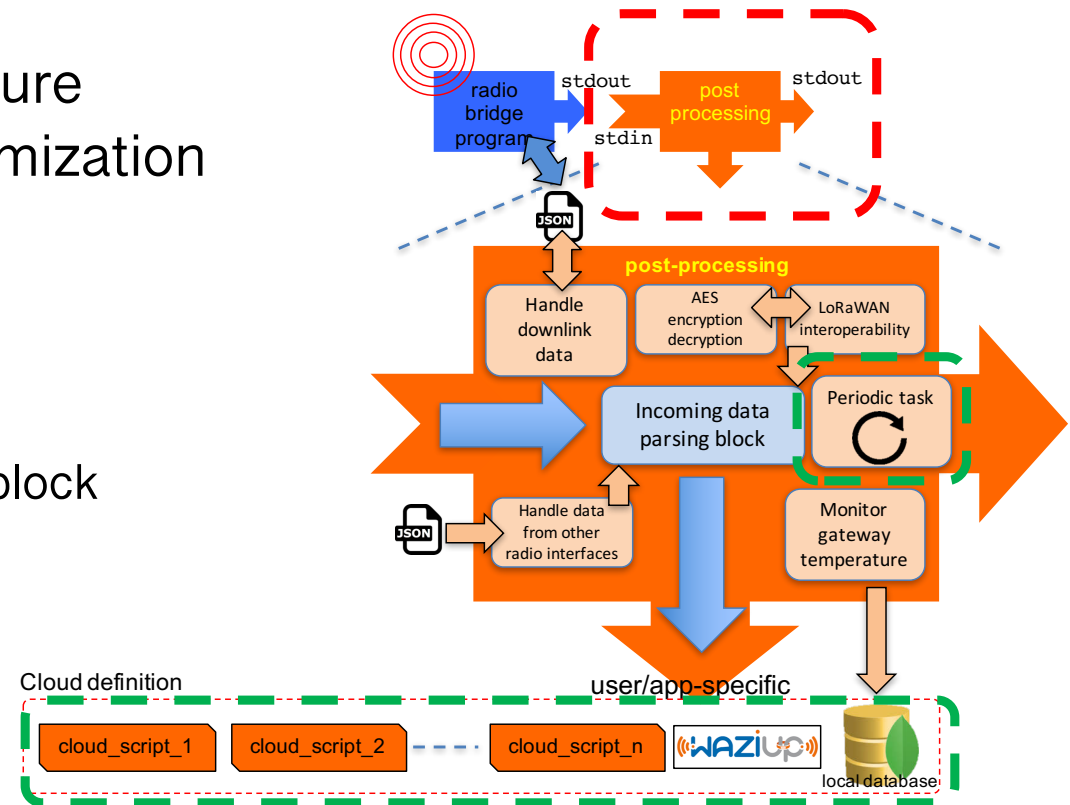
<https://github.com/CongducPham/LowCostLoRaGw>



Raspberry Pi: lots of libraries, lots of software, lots of hardware, lots of shields,...



- ⦿ The flexible gateway architecture offers high versatility by customization
- ⦿ There are 4 alternatives for customization
- ⦿ **The geek way**
  - ⦿ Modify/extend post-processing block
- ⦿ **The "smarter" way**
  - ⦿ Add "cloud" scripts
    - ⦿ On packet reception
  - ⦿ Add low rate periodic tasks
    - ⦿ Independant from packet reception
  - ⦿ Add fast rate statistic-oriented tasks





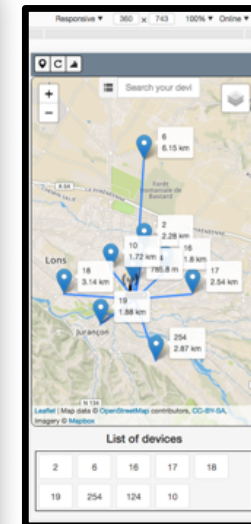
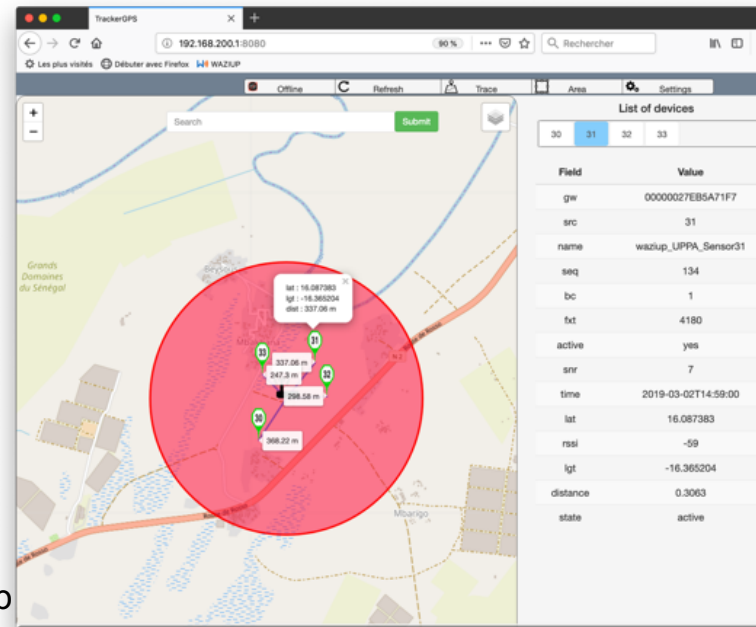
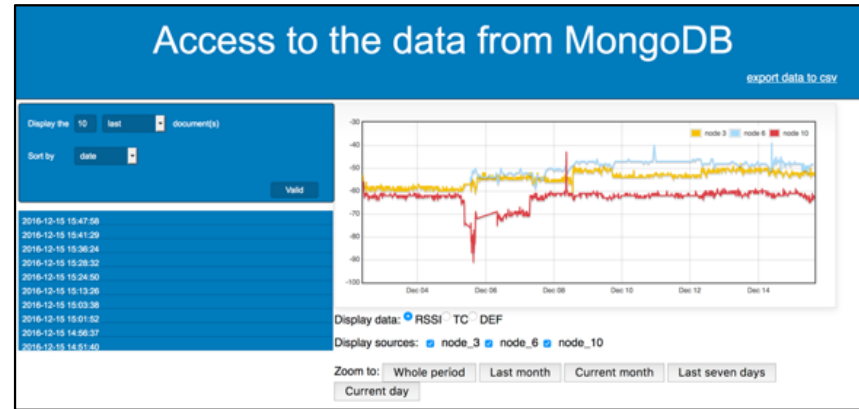
# Deployment in rural areas no Internet ☹️

- ⦿ deploying IoT in very isolated areas...
- ⦿ ... where internet and electricity are not stable!



# Deploying IoT in Africa

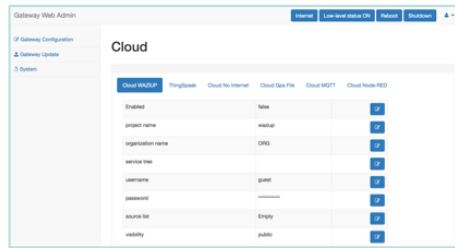
## Autonomous gateway – no Internet scenario



Link to a short demo video of the collar web interface: <https://youtu.be/meFDav1SLPI>

# "Branding" your IoT gateway

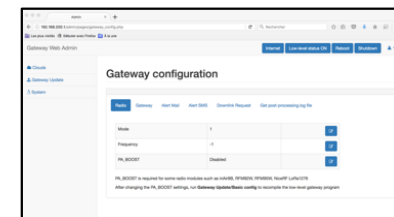
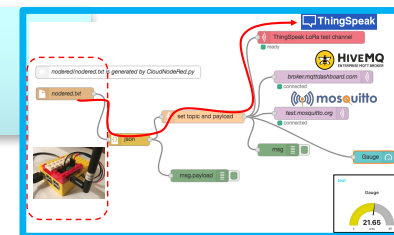
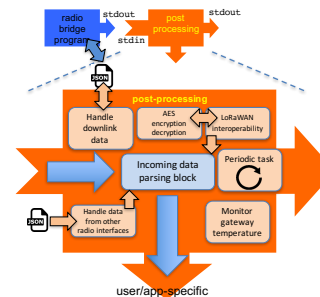
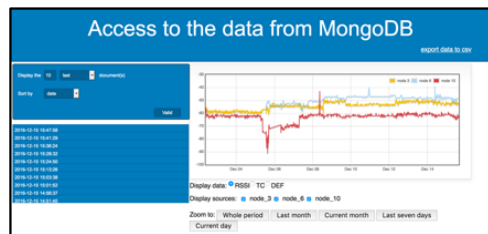
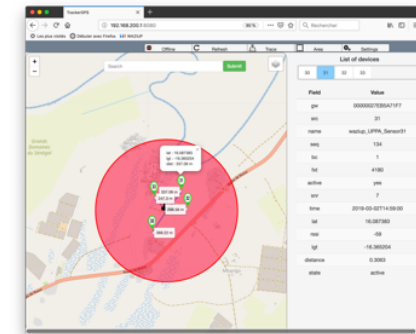
- Develop/Add project/company specific features on top of the general distribution



ADDITIONAL FEATURES SET 2

ADDITIONAL FEATURES SET 1

GENERAL DISTRIBUTION





# Tutorials/resources

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

**WAZIUP**  
 01/10/2018 open innovation number 167067  
**Low-cost LoRa IoT devices and gateway FAQ**

1) **What is Internet-of-Thing (IoT)?**  
 From ERC (European Research Cluster on the Internet of Thing)  
 The ERC 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 persistent 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, systems 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, WAZIUP engages the flourishing ICT and good practices, enterprise sector. WAZIUP proposes solutions that are:  
 - locally generated  
 - user centric  
 - open source  
 - scalable  
 - sustainable  
 WAZIUP will deliver a concrete generalizable locally the know how standards will lead to create and to radically new paradigms for others by the following vision:  
 1. Empower the African R&D community to develop and to support the necessary breeding on a new scale  
 2. Empower the African R&D community to develop and to support the necessary breeding on a new scale  
 3. Empower the African R&D community to develop and to support the necessary breeding on a new scale  
 Author : Congduc Pham, University of Pau  
 Last Update : 10/20/2018

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

**WAZIUP**

LIUPPA T21  
 PROF. CONGDUC PHAM  
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)  
 UNIVERSITÉ DE PAU ET DES PAYS DE LAUDOUR

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

**WAZIUP**

LIUPPA T21  
 PROF. CONGDUC PHAM  
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)  
 UNIVERSITÉ DE PAU ET DES PAYS DE LAUDOUR

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

**WAZIUP**

LIUPPA T21  
 PROF. CONGDUC PHAM  
[HTTP://WWW.UNIV-PAU.FR/~CPHAM](http://www.univ-pau.fr/~cpham)  
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**LOW-COST LORA IOT DEVICE: SUPPORTED PHYSICAL SENSORS**

**WAZIUP**

LIUPPA T21  
 PROF. CONGDUC PHAM  
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**LOW-COST LORA GATEWAY: A STEP-BY-STEP TUTORIAL**

**WAZIUP**

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**LOW-COST LORA IOT: USING THE WAZIUP DEMO KIT**

**WAZIUP**

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**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.

**The LoRa radio module**  
 There are various LoRa radio modules that are all based on the Semtech SX1272/1273.

**LoRa**  
 Fully featured LoRa radio modules: HopeRF RN2483/85W, Ubilium Lora, Moduhub v4/v4956

**Connect the LoRa radio module**  
 Connect the connector module to the SPI pins (MISO pin 16 and CS pin 10) and GND (orange). Then connect also the other pins of the radio module to the board (right picture). The VCC of the Pro Mini board gets 3.3v from the on-board voltage regulator.

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**LOW-COST LORA GATEWAY: WEB ADMIN INTERFACE**

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**LOW-COST LORA IOT ANTENNA TUTORIAL FOR GATEWAY**

**WAZIUP**

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**IOT DEPLOYMENT WITH WAZIUP \*\*\***

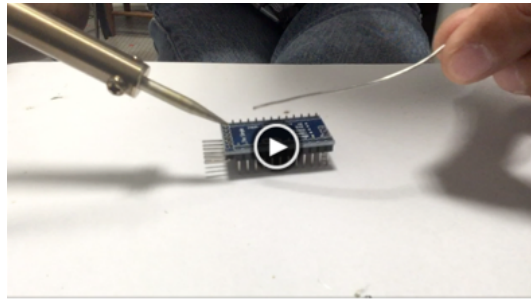
**GUIDELINES, BEST PRACTICES, TROUBLESHOOTING AND FAQ**

**WAZIUP**

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# YouTube videos

Low-cost LoRa IoT device



+87000 views

Apr2020

[https://www.youtube.com/watch?v=YsKbJeeav\\_M](https://www.youtube.com/watch?v=YsKbJeeav_M)

Low-cost LoRa IoT gateway



+19000 views

Apr2020

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

Extreme low-power LoRa IoT



+8000 views

Apr2020

[https://www.youtube.com/watch?v=2\\_VQpcCwdd8](https://www.youtube.com/watch?v=2_VQpcCwdd8)

Setting up a gateway in 5mins



+3500 views

Apr2020

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

# Training & hackathons

- ⦿ Technical training sessions
- ⦿ Hackathons, ...



Getting started with sensors x +

diy.waziup.io/index.html

Rechercher

Les plus visités Débuter avec Firefox WAZIUP

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WAZIUP

WAZIHUB

Home

- Introduction to Arduino IDE
- Measuring temperature <
- Measuring distance <
- Measuring humidity <
- Detecting motion <
- Measuring Light <
- Measuring Sound Level <
- Using GPS
- Connecting an OLED screen
- Uica Board with WiFi <

## ON-LINE ARDUINO SENSORS AND DIY LORA TUTORIAL

### Forewords

This online tutorial on Arduino, Sensors, and LoRa technologies has been developed by University of Pau, France, in the context of the **WAZIUP** and **WAZIHUB** projects funded by the European Union in the H2020 research program. The main objective of this online tutorial is to provide comprehensive and guided training materials to be used in training, hackathons, bootcamps, entrepreneur's days, ... that are organized by WAZIUP/WAZIHUB across Africa. The main contributors are Mamour Dlop, Muhammad Ehsan and **Congduc Pham**. Our main current research focus is on LoRa networks and IoT but this tutorial first start with basic of Arduino and sensor programming to understand sensing systems that are the foundation of so-called Internet-of-Things (IoT) concepts. Then in a second step, we will introduce LoRa radio technologies and show how to build low-cost, long-range and energy-efficient IoT devices.

WAZIUP is a technology-driven EU-Africa project developing a fully open source IoT end-to-end (sensors, networking and software) platform, specialized to meet African needs/applications in terms of cost, energy, internet connectivity and simplicity. Congduc Pham is the scientific leader of the "Open IoT sensing and communication platform" workpackage which tasks are to develop an open, low-cost and long-range LoRa IoT framework. Interested readers can find many resources from our [github on the low-cost LoRa IoT framework](#) and from Congduc Pham's [tutorial/talks web page](#).

Feb 2018 - 2019 May 2018 - 2014

Online Arduino & IoT step-by-step tutorial  
<https://diy.waziup.io>

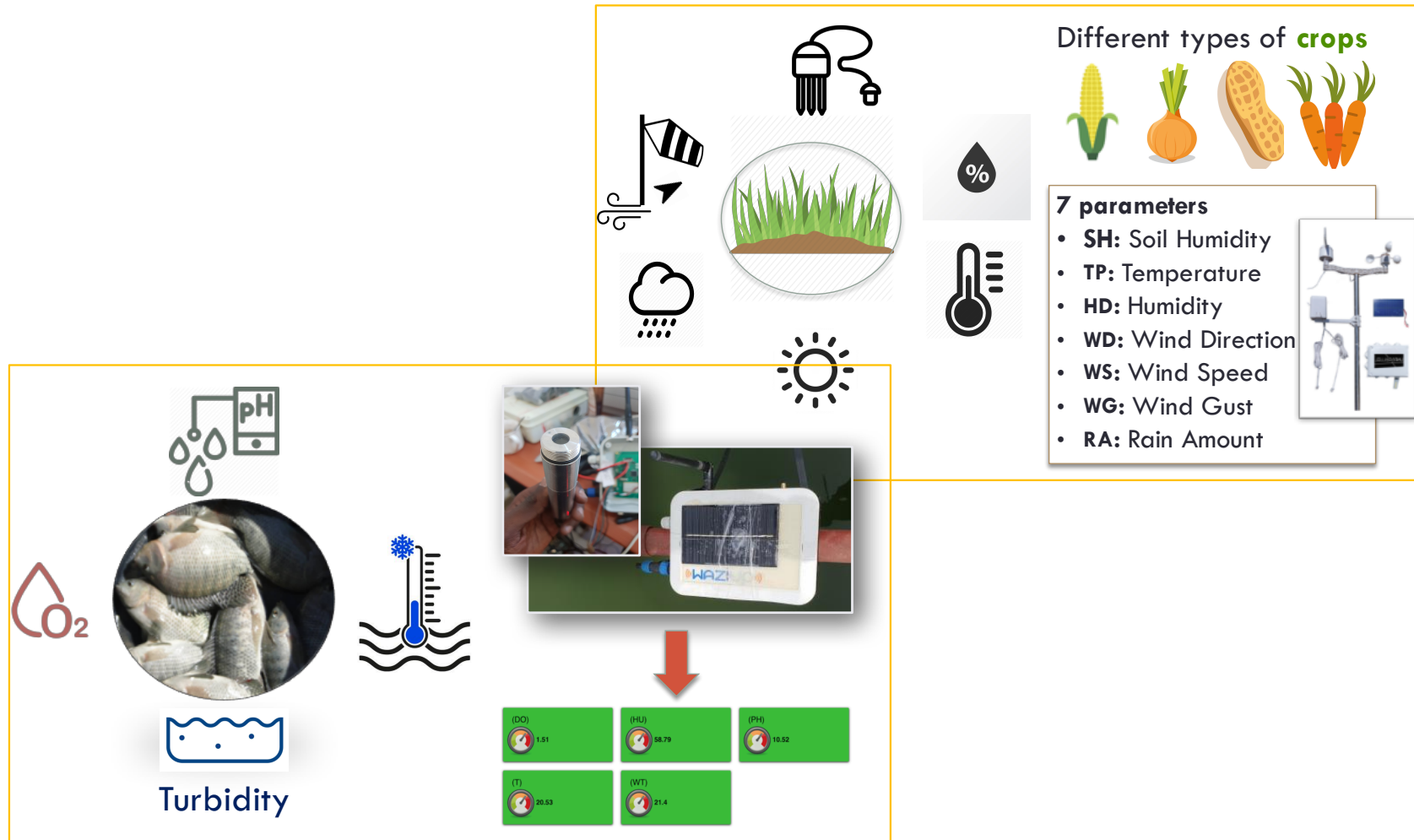




# Building domain-specific sensors



# ...to capture specific parameters





## LOW-COST COLLAR FOR CATTLE RUTLING: CIMEL FARM, SENEGAL



A web interface displays the position of the gateway those of the remote GPS devices

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)

## LOW-COST BUOY FOR FISH FARMING



**WATER MONITORING LOW-COST BUOY**

- Pipe fixed at the bottom of the pond
- Solar Panel
- Water-proof box with 2 sensors inside (temperature, humidity)
- Buoy
- 3 Water Sensors (pH, Dissolved Oxygen, Temperature) 30 cm below surface
- Mesh tube to protect the sensors

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In Sub-Saharan Africa, the volume of natural captured fish doesn't meet half of the population demand

Increasing production of aquaculture will help reduce the quantity of imported fishes in Africa

The aim is to monitor in real-time different parameters to control water quality and prevent some diseases that could affect fish in order to improve the quality and quantity of the production

## KUMAH FARM, GHANA

- ❑ The Kwame Nkrumah University of Science and Technology (KNUST)
- ❑ Located on the campus of the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana.
- ❑ The farm comprises 30 constructed fish ponds, a farm house, a recirculating aquaculture system (RAS) laboratory and store houses.



## SANAR FARM, SENEGAL

- ❑ Farm located at less than 2 km from UGB.
- ❑ One pond is dedicated for the Waziup application : 50x25m, average depth of 0.5 meters, populated by 4000 individuals of saltwater tilapia.
- ❑ The basin is irrigated via a water supply system fed by a river in proximity.
- ❑ The water in the pond is changed every 10 days

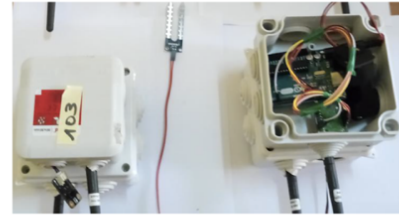




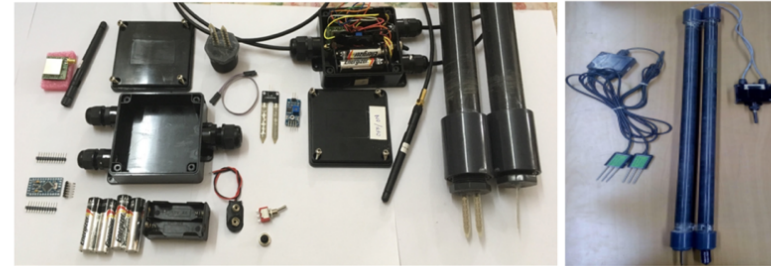
### UBG FARM, SENEGAL



### SOIL HUMIDITY SENSOR FOR AGRICULTURE



Monitoring soil moisture and other parameters to provide insightful recommendations and notifications to farmers, and advisors



### NASSO SITE, BURKINA FASO



### URBANNATIC GARDENS, TOGO



## HATCHERY EXPERIMENT, BURKINA FASO

- ❑ Laboratory named Laboratoire d'Études des Ressources Naturelles et des Sciences de l'Environnement (LERNSE)
- ❑ NAZI BONI University in a small village of Bobo-Dioulasso city
- ❑ Sensors are placed in a hatchery and the box is placed outside of the building



## LOCAL WEATHER STATION FOR AGRICULTURE

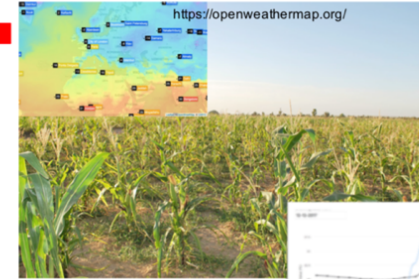
In agriculture, different factors can be monitored. Having the ability to control those factors is the key to increase the productivity.

Agriculture MVP requirements:

*Obtain and produce weather related information which will be used to advise the farmers!*

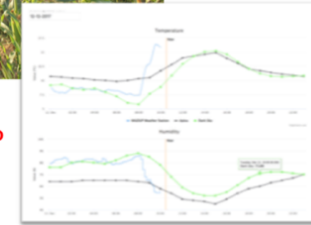


Get local weather measurements

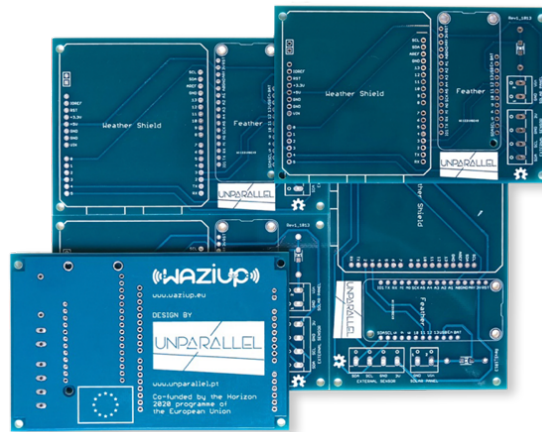


Weather Web App

Combine with open weather data to get more accurate predictions



Pilot sites: Senegal, Togo, Ghana, Burkina Faso



From Unparallel for WAZIUP



# IOT ONLINE COURSE

## Fundamentals of IoT

Continue with  
A-IOT-1: LoRa & LoRaWAN explained

