



Building cost-effective, wireless sensors platforms for agroecology monitoring

UNIZAR-UPPA webinar – Jan. 13th, 2026

Agroecology for a Sustainable Transition: Cross-Border Research Activities

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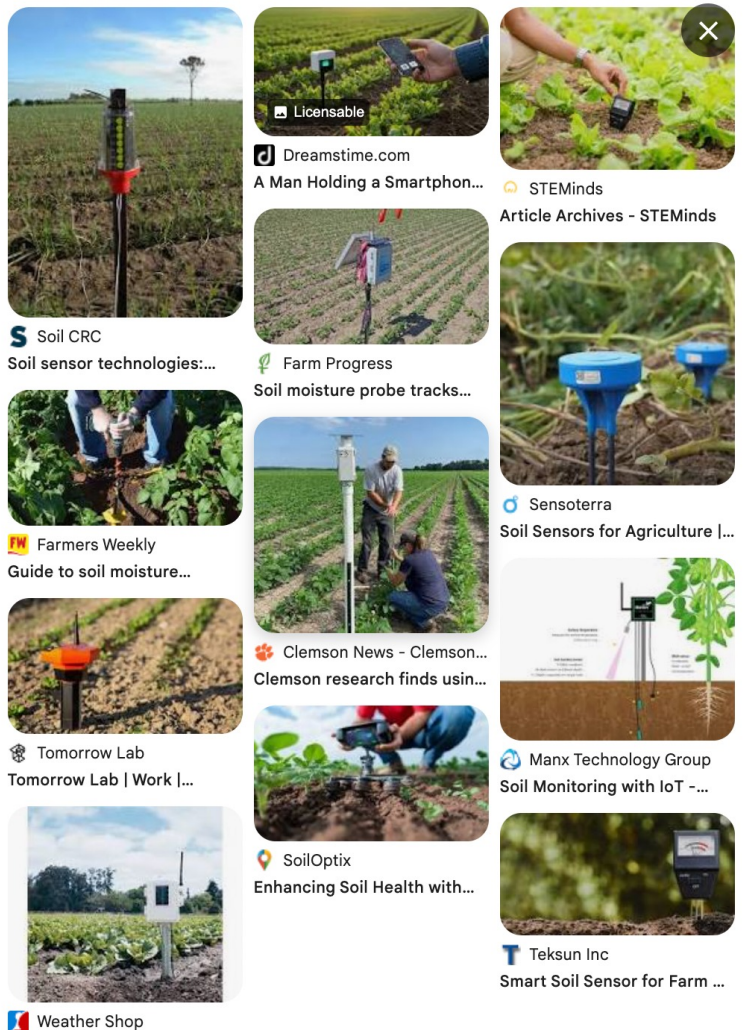


Wireless Sensors Made Simple
for agroecology & sustainable agriculture

Powered by technologies developed in  Intel-IrriS

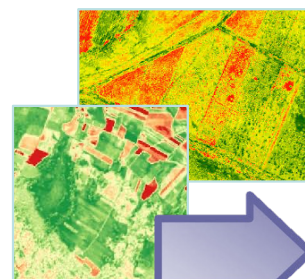
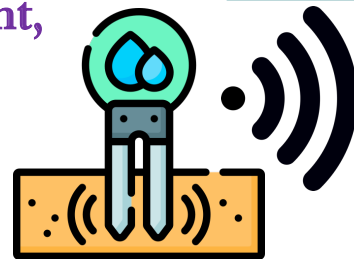


SENSORS IN AGRICULTURE

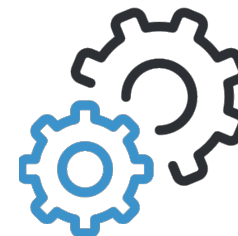


Ground Sensors

Soil, Water,
Environment,
Plant,
etc.



NDVI, etc.



REAL-TIME DATA

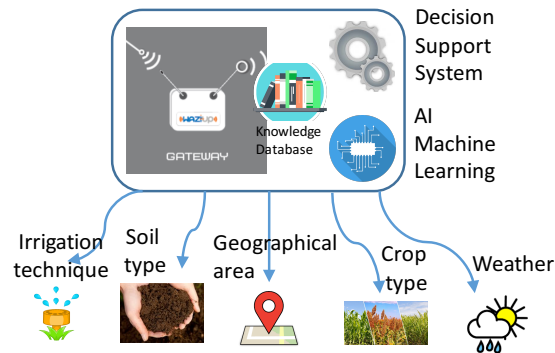
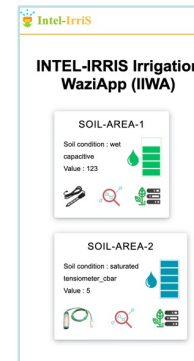


SENSORS/IOT ACTIVITIES AT UPPA

**Wireless Systems,
Cost-effective,
Open & Generic**

**Edge Computing,
Embedded AI, ...**

**Autonomous
Plug-&-Sense**



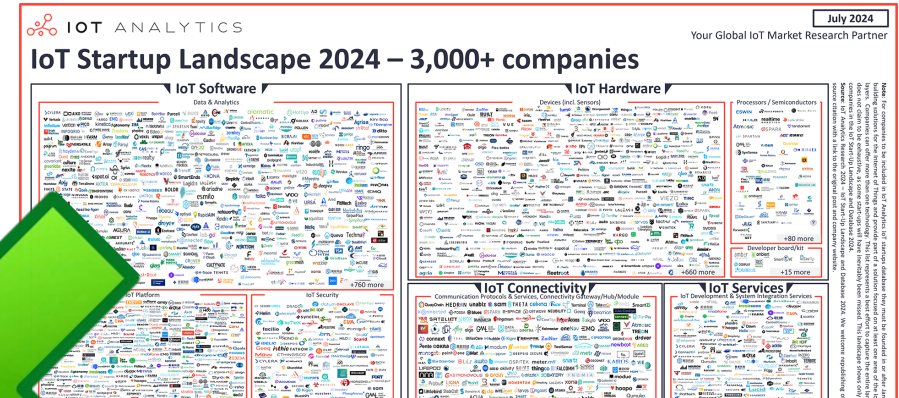
NO INTERNET ☹



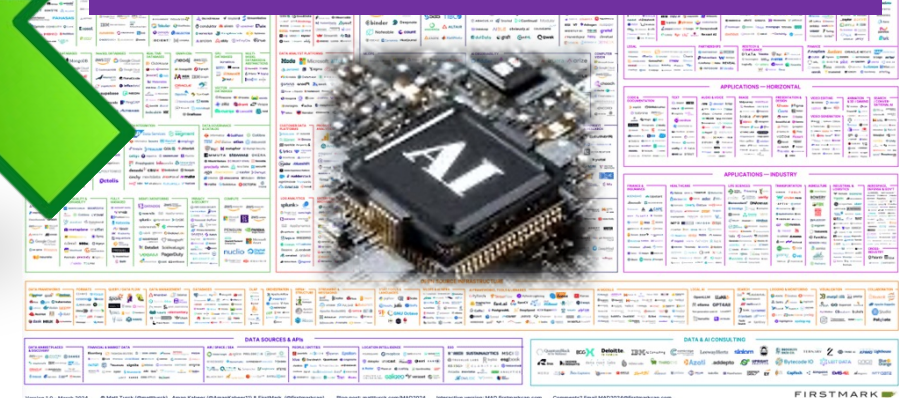
CONVERGENCE OF TECHNOLOGIES!



HARDWARE!



SOFTWARE!

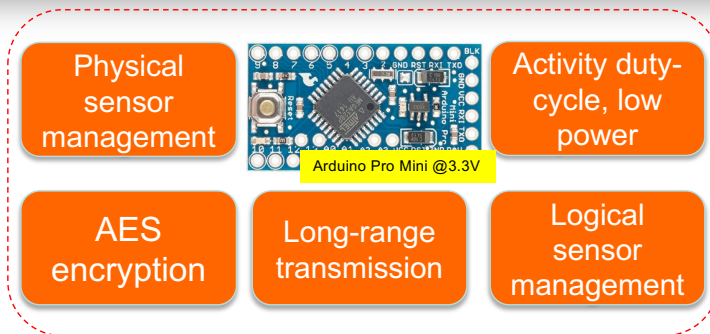




SOFTWARE!

```

1  /*
2  * Generic Simple Sensor Node
3  * support limited LoRaWAN with raw LoRa SX12XX (such as RFM9X, NiceRF, ...)
4  * full LoRaWAN with RAK3172 module
5  *
6  * Copyright (C) 2025 Congduc Pham, University of Pau, France
7  *
8  * This program is free software: you can redistribute it and/or modify
9  * it under the terms of the GNU General Public License as published by
10 * the Free Software Foundation, either version 3 of the License, or
11 * (at your option) any later version.
12 *
13 * This program is distributed in the hope that it will be useful,
14 * but WITHOUT ANY WARRANTY; without even the implied warranty of
15 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
16 * GNU General Public License for more details.
17 *
18 * You should have received a copy of the GNU General Public License
19 * along with the program. If not, see <http://www.gnu.org/licenses/>.
20 *
21 *
22 * last update: Feb. 18th, 2025
23 *
24 * Feb. 7th, 2025 -> remove unused options in the code, focus on INTEL-IRRIS PCB/PCBA v4.1 & v5 and WaziSense v2
25 * NEW: Support for up to 3 DS18B20 temperature sensors
26 * NEW: Support for ambient air temperature/humidity sensors (DHT22/AM2305/SHT1x/SHT2x/SHT3x)
27 */
  
```

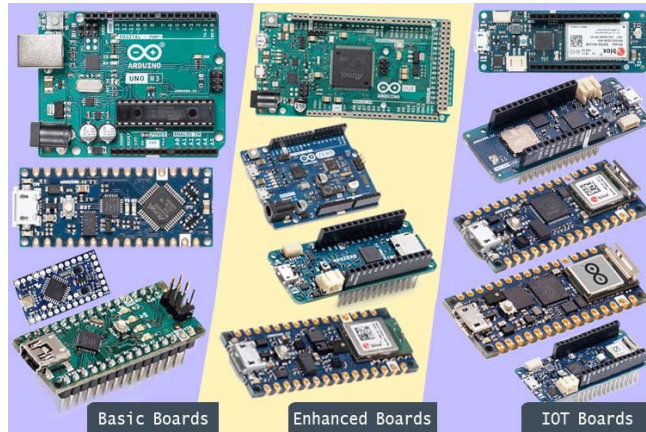




SOFTWARE!

&

HARDWARE!



Basic Boards

Enhanced Boards

IOT Boards



LoPy

STM32 Nucleo-32



Teensy 3.2



LinkIt
Smart7688 duo



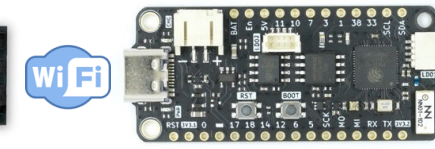
Adafruit Feather



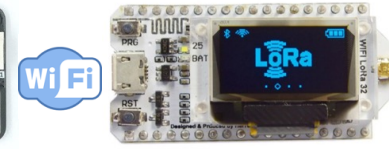
uPesy ESP32



ePulse Feather Low Power ESP32



FeatherS3 - ESP32-S3



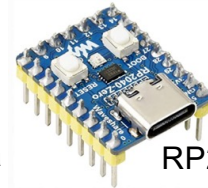
Heltec ESP32



XIAO SAMD21



Arduino Nicla
Sense ME



RP2040
zero



DFRobot
Beetle

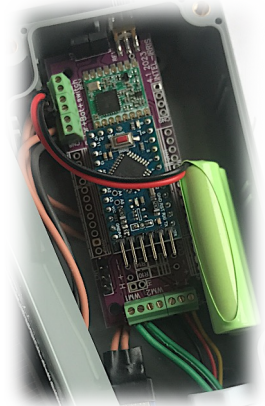
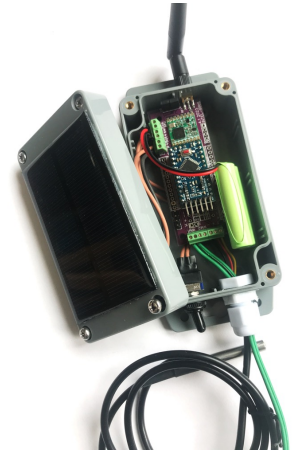


QT Py ESP32-C3

AES
encryption

Long-range
transmission

Logical
sensor
management





WHAT WE DID IN THE LAST 10 YEARS

Smarter Agriculture for Small Farms

2015-2021

IoT – from idea to reality

Integration &
Technologies

Scaling-up
with DIHs

2021-2024

Paving for the next 10 years of
innovation in IoT and AI

More scaling-up
More capacity-building

HUBiquitous

2021-2024



**Less
technology
More
applications**

2025-2030

AgriFutur



**Out-of-the box
innovative
sensing systems
for agroecology**

WAZIhub

WAZIup

PRIMA
IN THE MEDITERRANEAN AREA
 Intel-IrriS

IoT targeting the
smallholder community

FRANCE 2030
PROGRAMME DE RECHERCHE
AGROÉCOLOGIE
ET NUMÉRIQUE
 Ae anr

AgriFutur

Wireless Sensors Made Simple
for agroecology & sustainable agriculture



INTEL-IRRIS'S STARTER KIT

<https://intel-irris.eu>



This project is part of the PRIMA
Programme supported by the
European Union



June 1st, 2021 – May 31st, 2024



**Small-scale farms,
Smallholder Farmers**

**NO INTERNET
FULL EDGE
MODE 😊**



FROM IDEA TO REALITY!



~ 30€

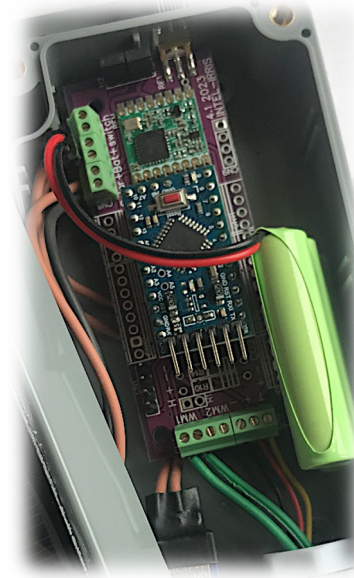
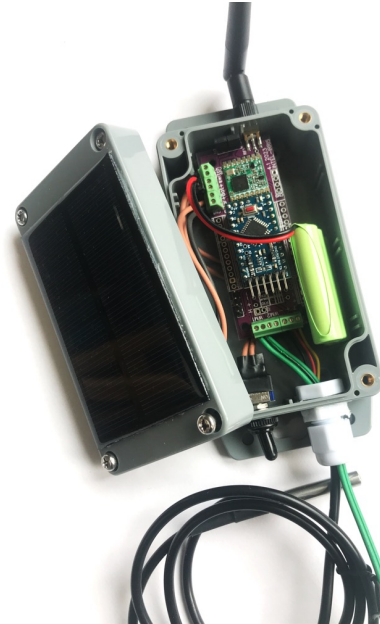
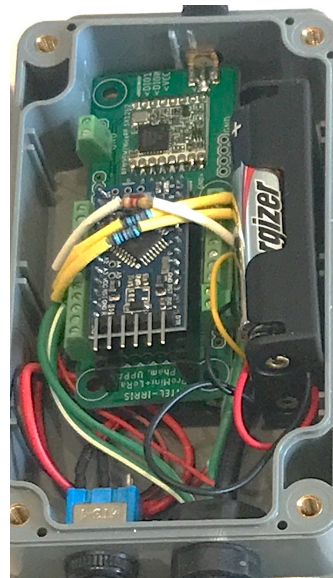
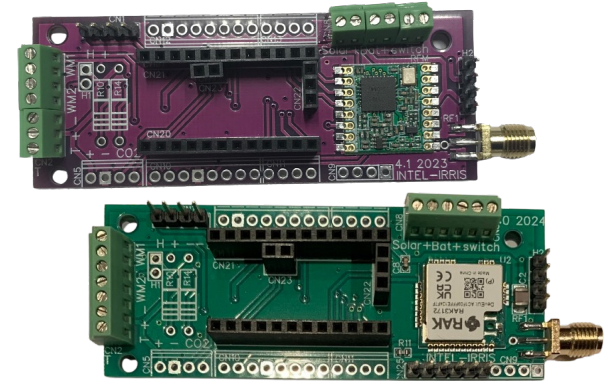
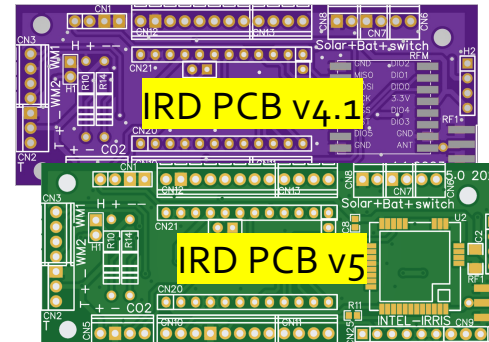
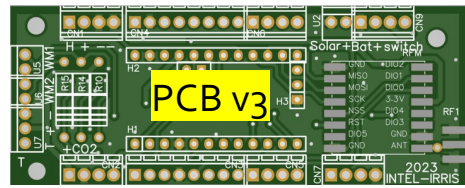
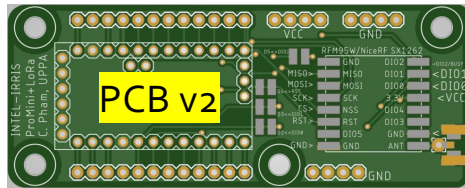
SEN0308
capacitive sensor

~ 60€

Watermark WM200
Water tension sensor



GENERIC HARDWARE PLATFORM

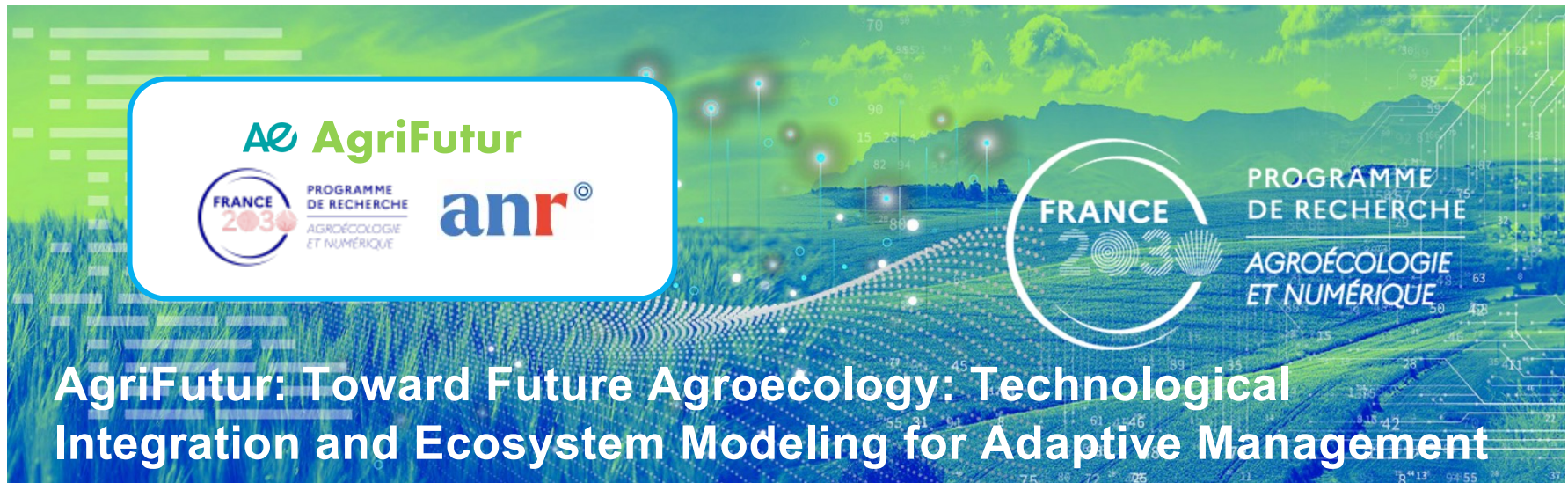


1 measure / hour by default

~ 2 year of autonomy on alkaline batteries!



AgriFutur – flagship project of PEPR program



- ⊙ **12 PARTNERS:** CNRS XLIM/U.Limoges (LEAD), CNRS LABRI/U.Bordeaux, INSERM EPICENE/U.Bordeaux, LIM/U.Réunion, LIUPPA/U.Pau, INRAE-TSCF, INRAE-LAE, INRAE-SADAPT, CIRAD-SENS, CIRAD-RR, Centre National d'Agroécologie (CNA), OSFarm
- ⊙ **60 MONTHS**, 7 566 755 €
- ⊙ **SENSORS & ROBOTICS SYSTEMS, DIGITAL TWINS, MULTISCALE MODELING, ECOSYSTEM MODELING, ERGONOMY, ETC**



GOING BEYOND IRRIGATION

AgriFutur

Wireless Sensors Made Simple
for agroecology & sustainable agriculture

Powered by technologies developed in Intel-IrriS

- Same approach of cost-efficiency and out-of-the-box deployment, expanding the sensor ecosystem
- Complementarity & Adaptability: high-end, low-end, innovative, ...
- Target Agroecology, Nature-Based Solutions & Sustainable Agriculture
- Qualify & Quantify the impact of these new practices
- More data = more correlation in agroecological system

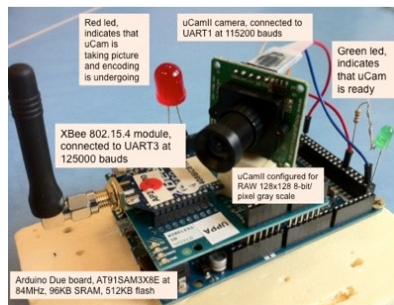




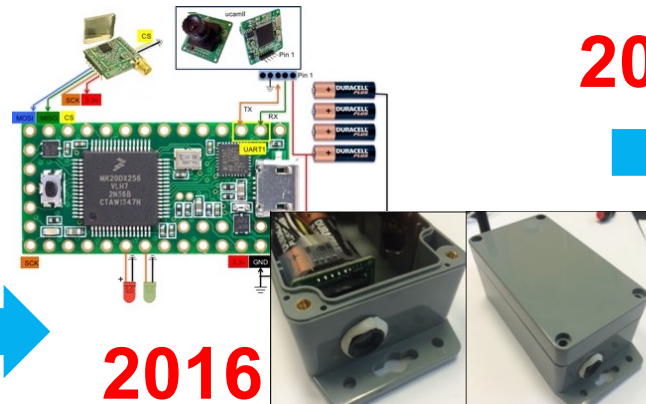
ADVANCED SENSING SYSTEMS



Many applications need visual information → Image Sensing IoT

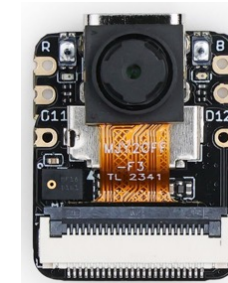


2012



2016

2024

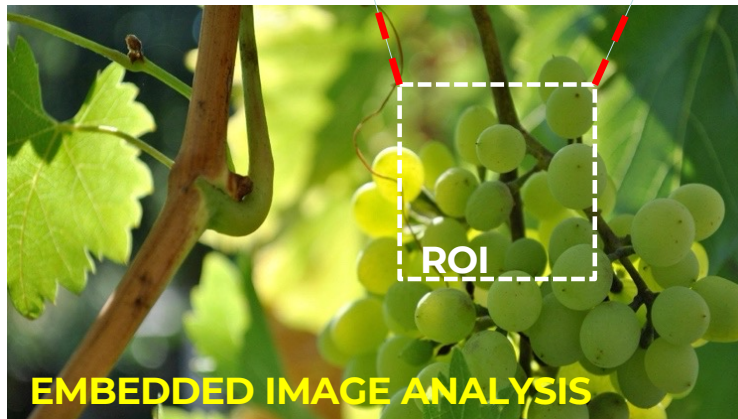
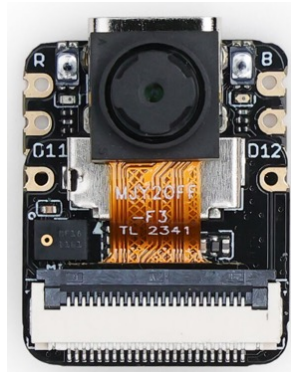


ESP32S3 32-bit, dual-core, up to 240 MHz





IMAGE SENSOR? QUITE A CHALLENGE!



Agriculture **Wildlife**
Biodiversity **Agroecology**
Environment

Surveillance

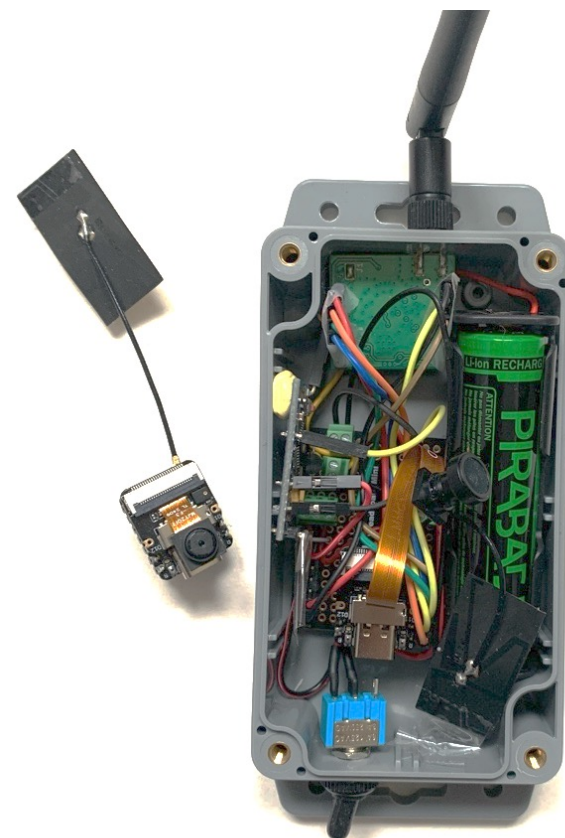
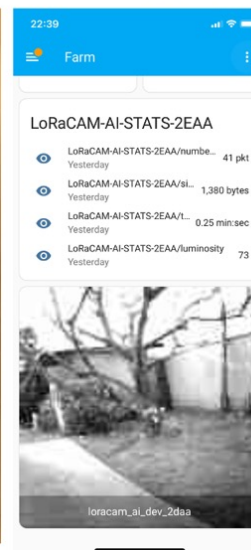
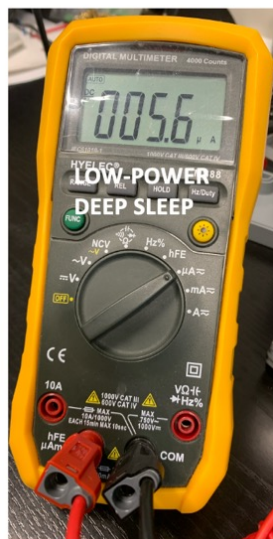
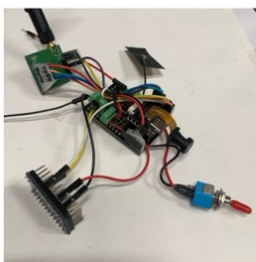
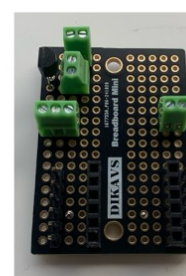
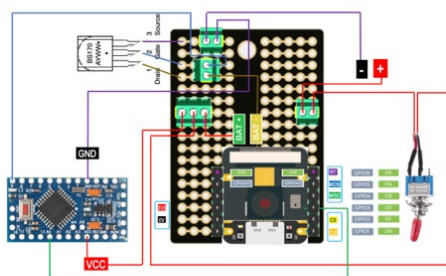
- Low Power
- Plug-and-Sense, out-of-the-box
- Embedded AI processing
- Versatile AI learning framework
- Application-specific AI models
- Robust image encoding against losses
- Long-range radio transmissions
- Efficient usage of radio resources





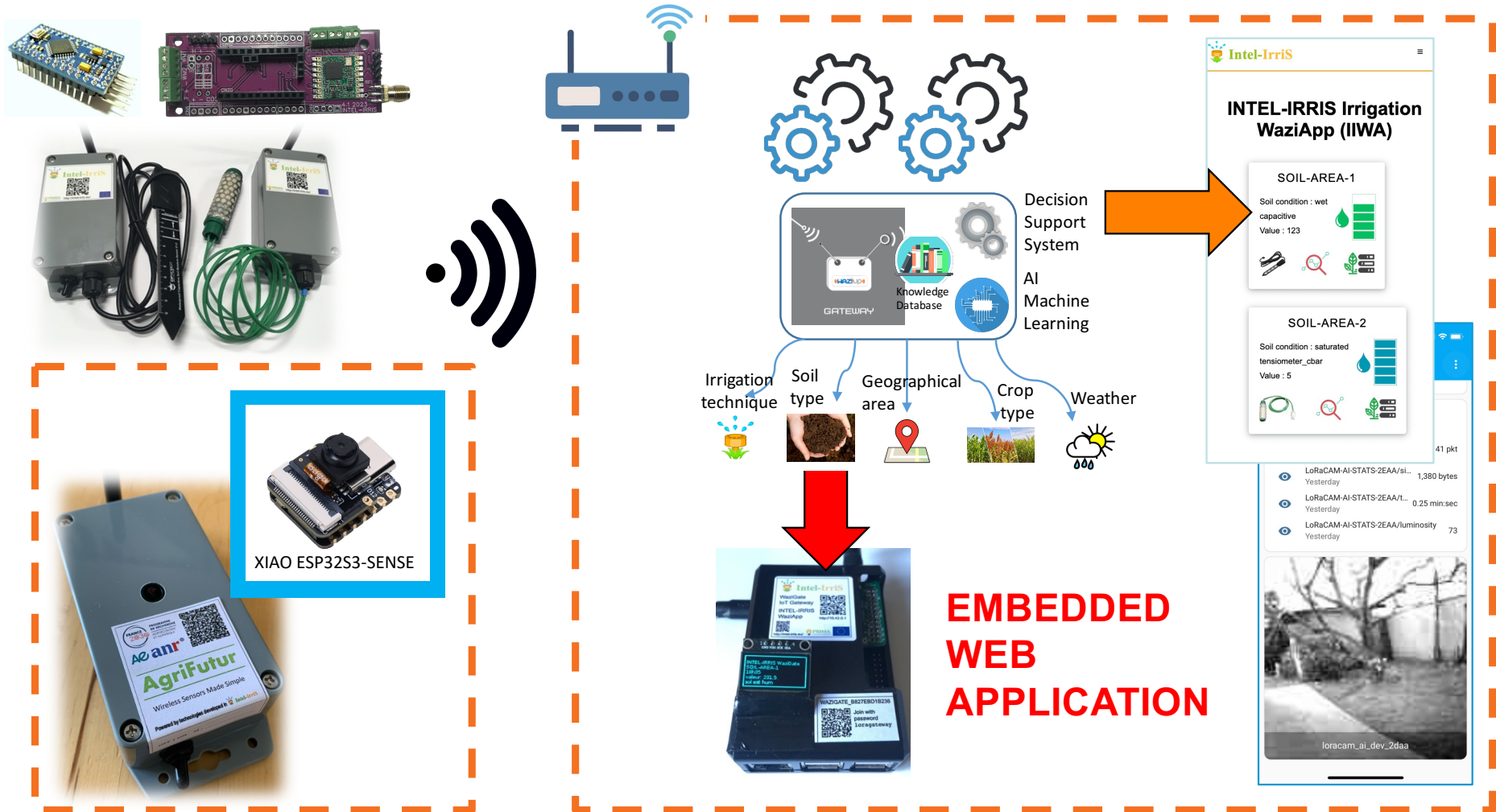
PROOF-OF-CONCEPT: LORACAM-AI

UPDATED VERSION IN 2025 FOR THE PEPR AGRIFUTUR PROJECT





INTELLIGENCE AT THE EDGE

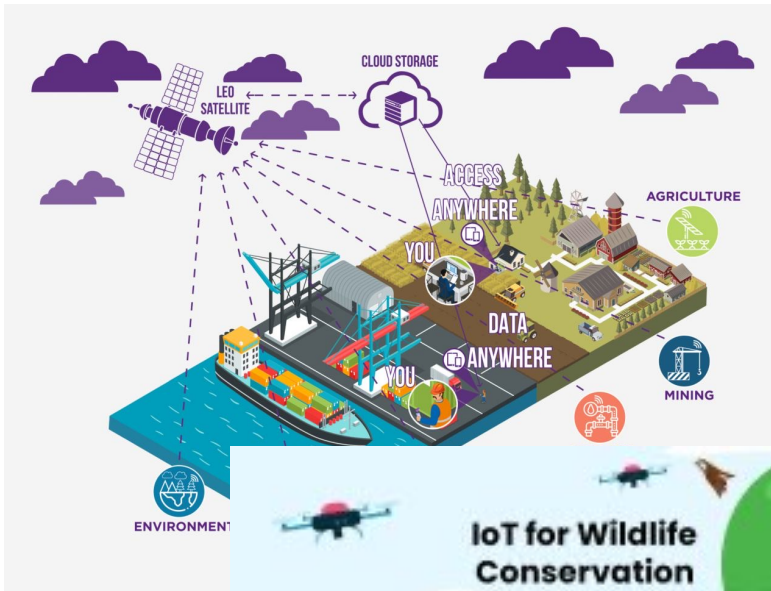


TinyML, TensorFlow Lite,
CMSIS-NN, Edge Impulse, etc

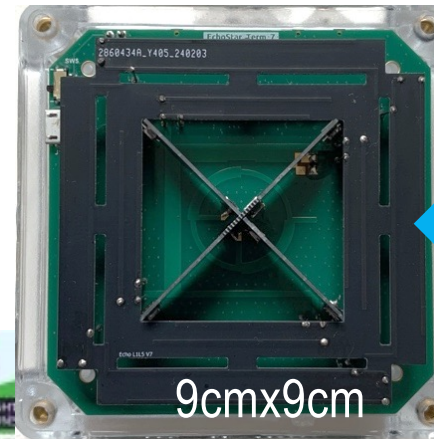


GOING BEYOND TERRESTRIAL NETWORK!

<https://www.everythingrf.com/community/what-is-satellite-iot-connectivity>

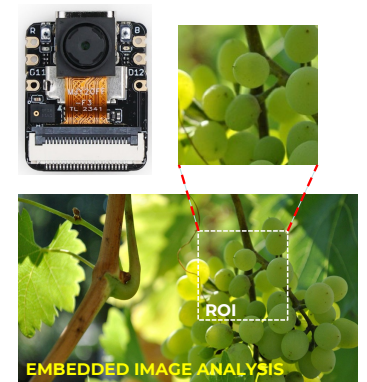


<https://github.com/nguyenmanhthao996tn/LEAT-EchoStar-Terminal-BSP>



Low-cost satellite IoT

F. Ferrero & M. T. Nguyen
LEAT laboratory
University of Nice, France



<https://www.smartsight.in/industry-insights/iot-for-wildlife-conservation-and-environmental-monitoring/>



WORKING GROUP ON SENSOR/ELECTRONIC



- ⊙ THERE IS A GROWING NEED FOR REAL-TIME MONITORING SYSTEMS WITH SENSORS
- ⊙ AGRICULTURE, ENVIRONMENT, ENERGY, CITY & BUILDING, WATER MANAGEMENT, GEOLOGY, ETC
- ⊙ **MANY PROJECTS, MANY LABORATORIES, MANY COMPETENCES**

UPPA WORKING GROUP ON SENSOR/ELECTRONIC

- ELECTRONIC, SENSORS, IT, WIRELESS SYSTEM, ETC
- DIY COST-EFFECTIVE SENSORS, INTEGRATION OF EXISTING & COMMERCIAL SYSTEMS
- SHARE KNOWLEDGE, KNOW-HOW, FABLAB, INSTRUMENTS & TOOLS
- LINK WITH CITY INITIATIVES ON CONNECTED OBJECTS



Building effective cross-border platforms for monitoring

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Agroecology for a Sustainable Transition: Cross-Border Research Activities

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