PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

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

INTEL-IRRIS
Intelligent Irrigation Systems for Low-Cost Autonomous Water Control in Small-Scale Agriculture

FINAL EVENT

SAVE YOUR DATE!

MOROCCO May 22nd, 2024

Intel-IrriS

INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

THE INTEL-IRRIS STARTER-KIT AND MAIN SCIENTIFIC RESULTS

C. Pham, University of Pau, France

INTEL-IRRIS's starter-kit

⦿ From idea to reality!

Small-scale farms,
Smallholder Farmers

NO INTERNET ☹

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

2 versions of the soil device

A soil temperature sensor can be added

Especially for tensiometer

~ 30€

SEN0308
capacitive sensor

~ 60€

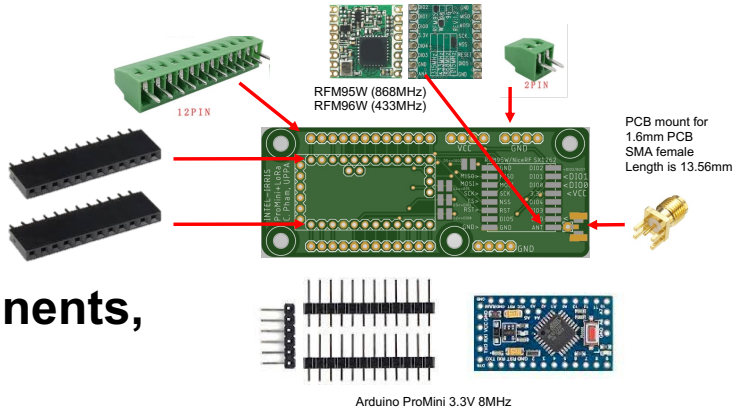
Watermark WM200
Water tension sensor

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
THE INTEL-IRRIS
STARTER-KIT v3
1 – the soil device

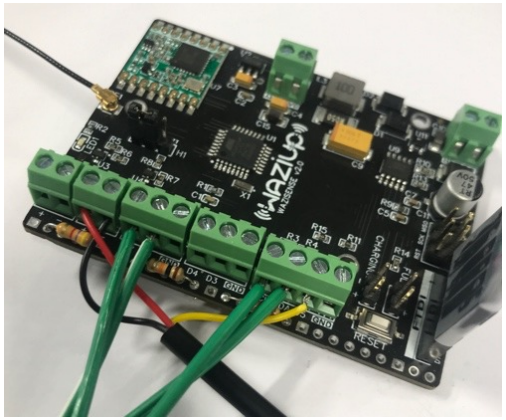
Low-cost design space

1



Simple design, off-the-shelves components, 100% DIY

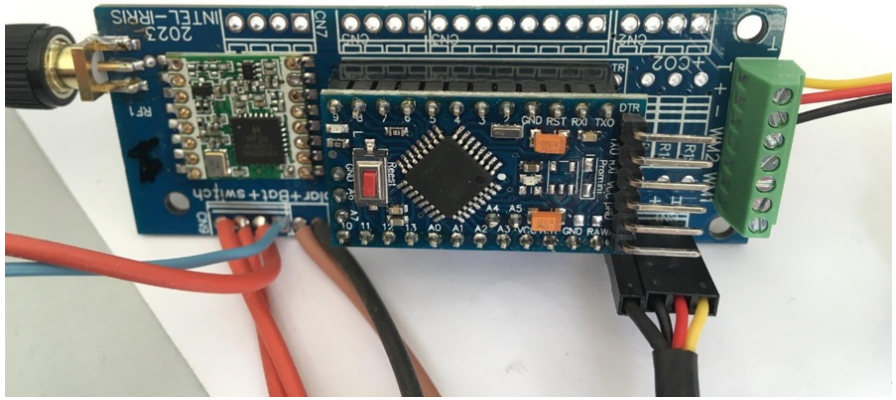
3



Integrated design, off-the-shelves components, full support for solar panel, all components already soldered

Simple design, off-the-shelves components, low-cost support for solar panel, some components already soldered, mixed-DIY

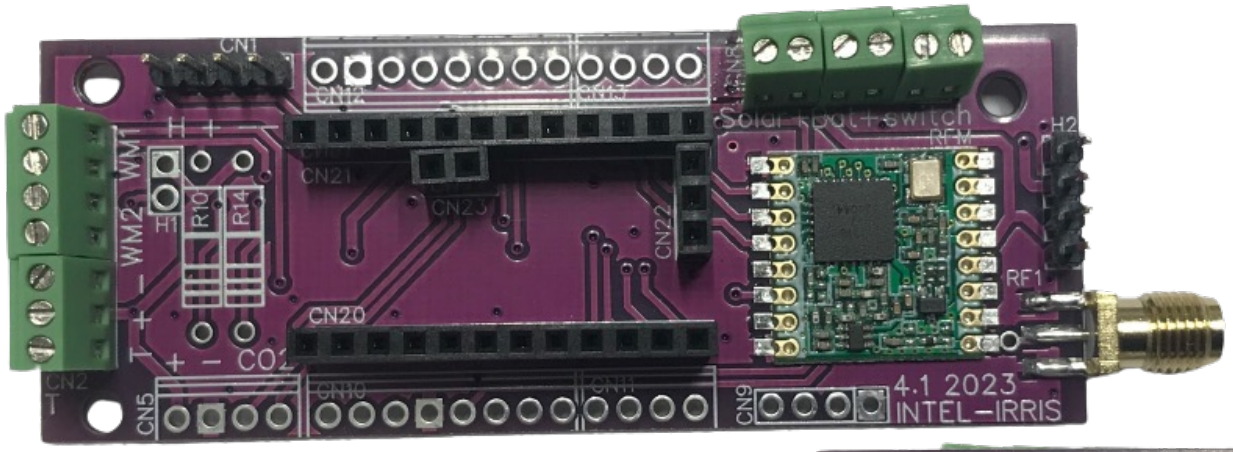
2



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

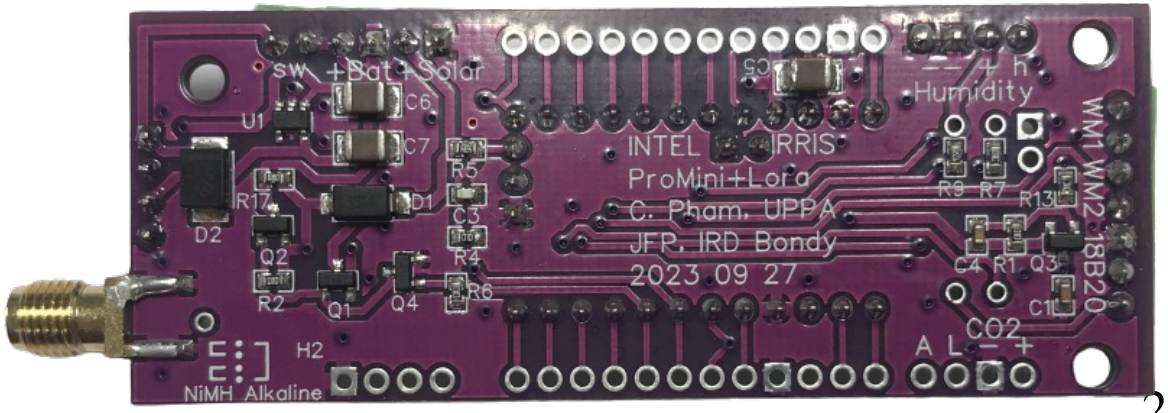
The latest INTEL-IRRIS sensor board

- The PCB is already fully assembled, including the resistors for the temperature and watermark sensors (on the back side)



Radio module is already mounted, as well as connectors

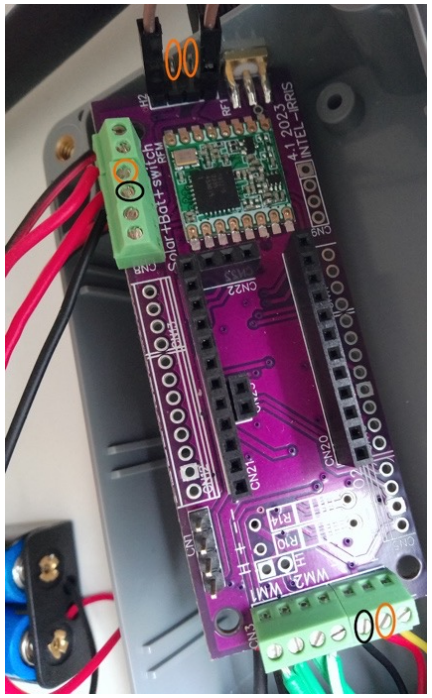
Solar charging is available and the solar circuit is on the back side

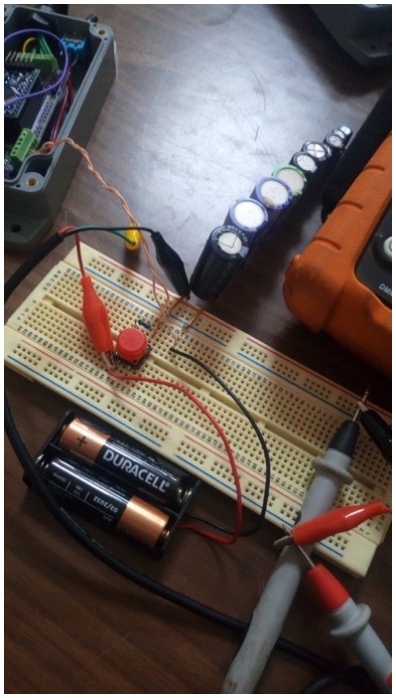


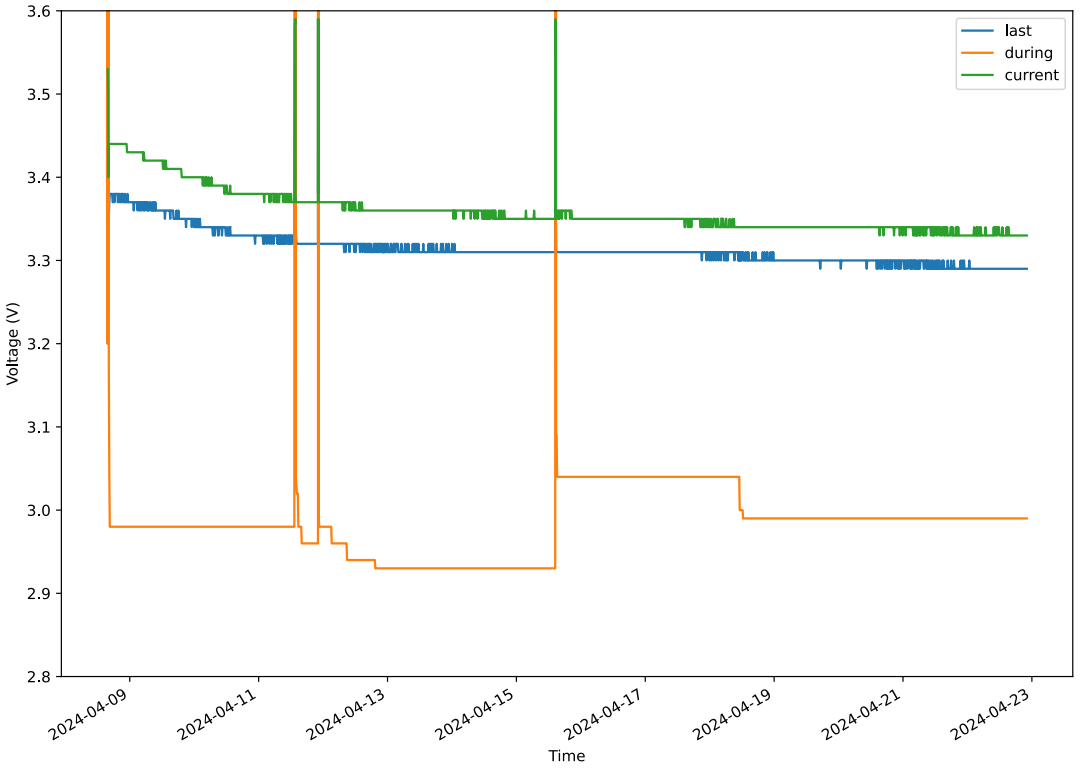
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Energy management

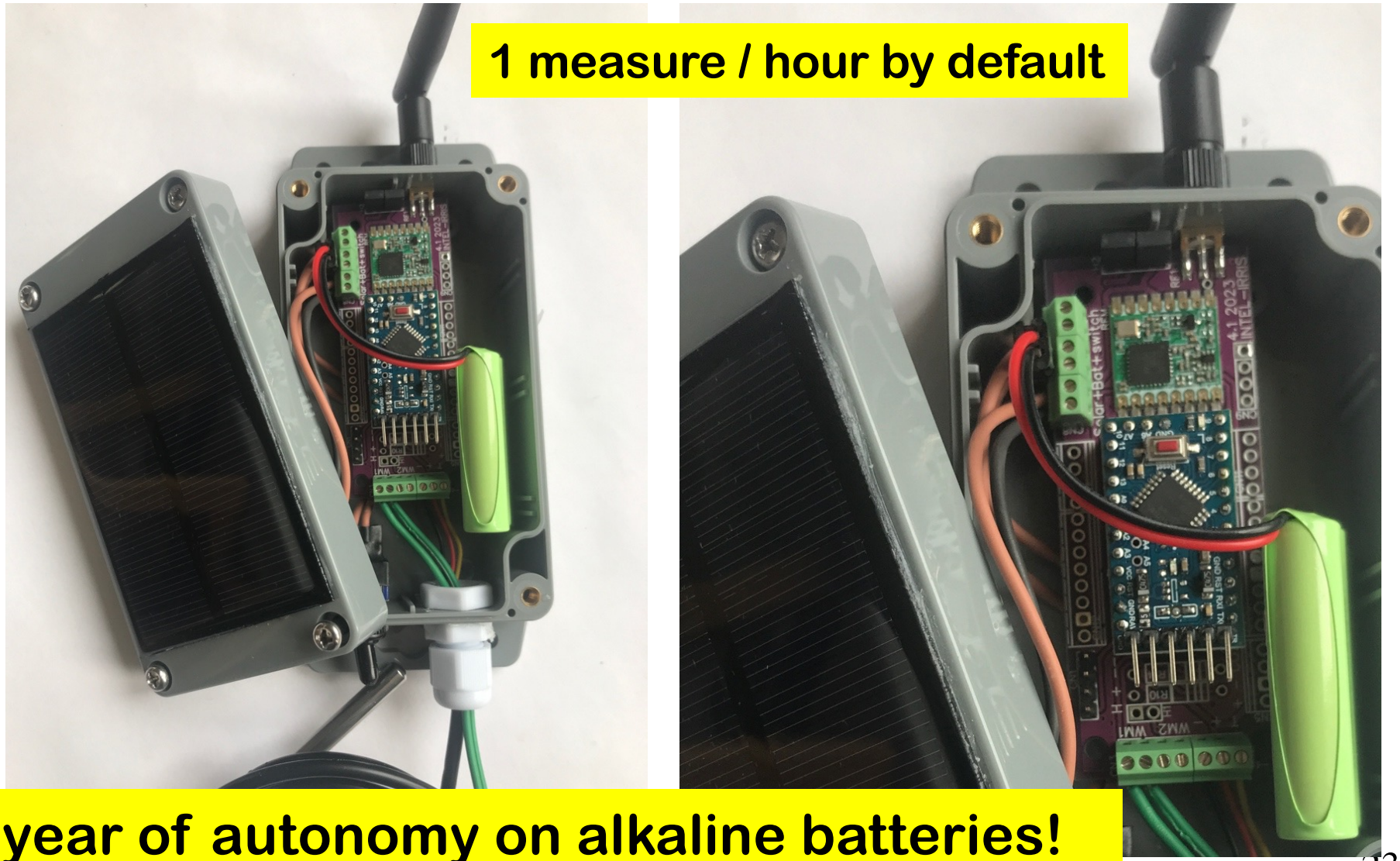
- A lot of efforts have been devoted to carefully measure energy consumption and to optimize energy management







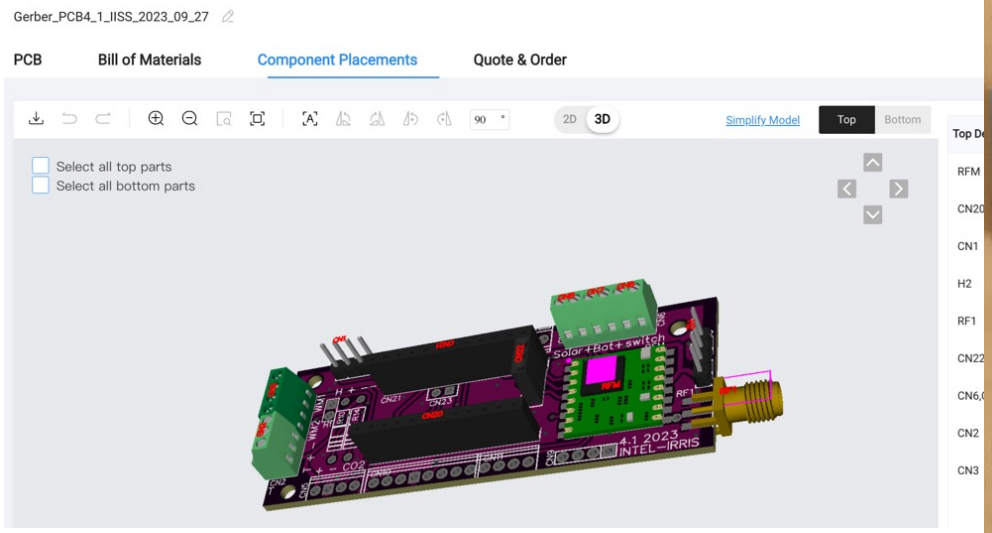
The INTEL-IRRIS soil device

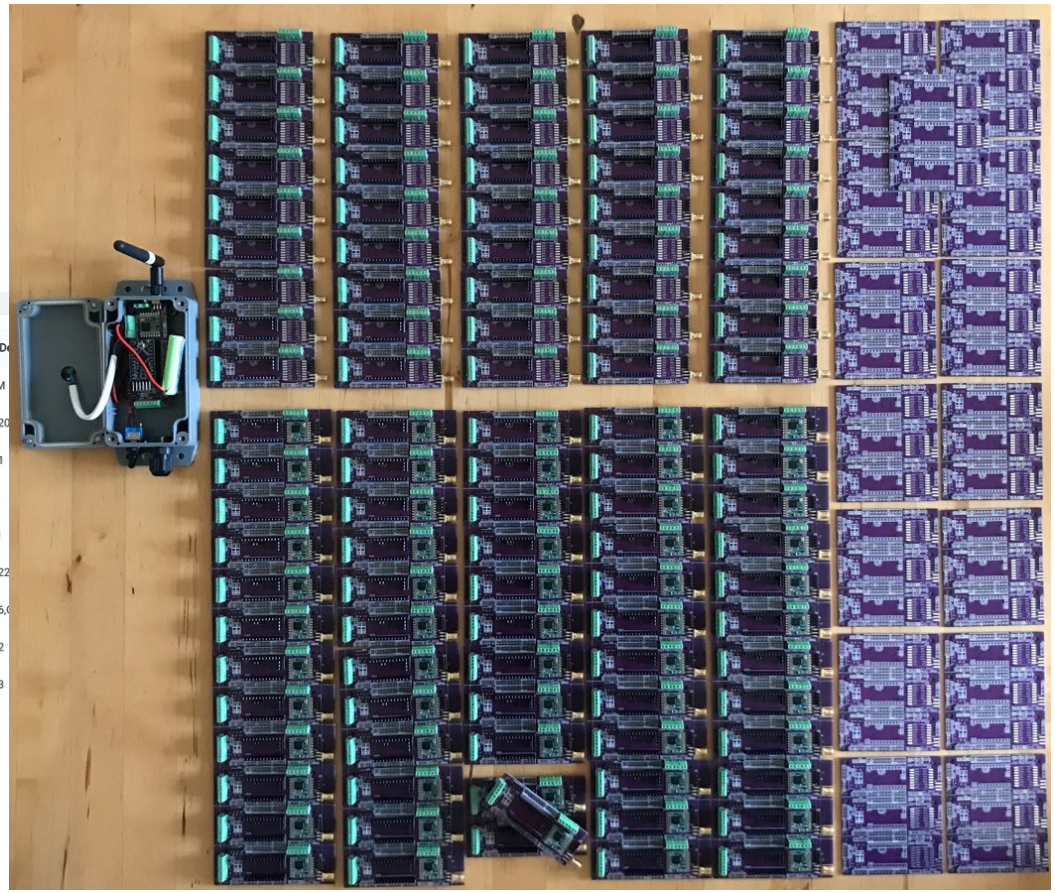


Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Ordering the fully assembled PCB

- Ordering the fully assembled PCB is very simple from PCB manufacturer
- Manufacturing files are freely availlable

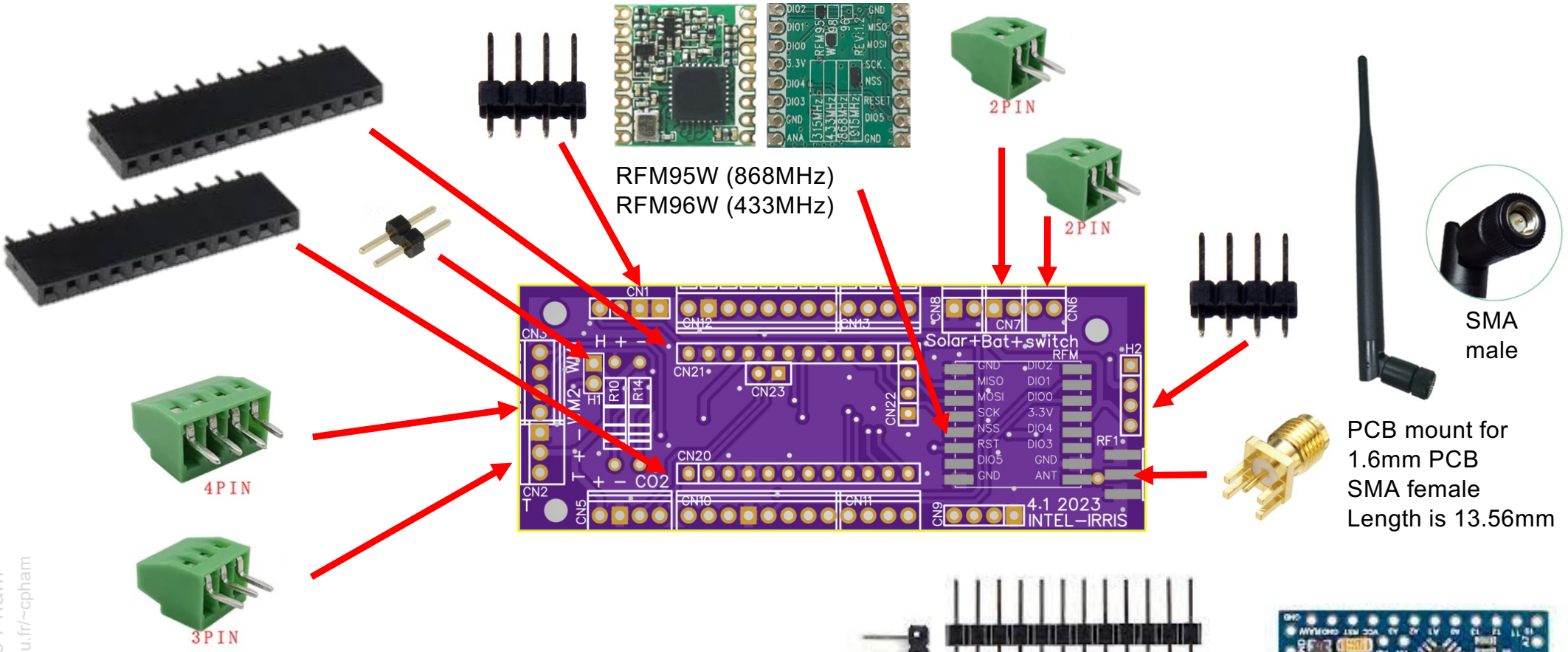




~ 8€/piece if QT > 100

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

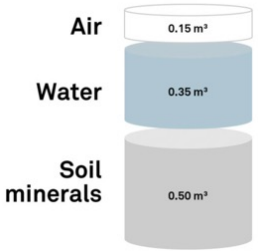
100% DIY is still possible!

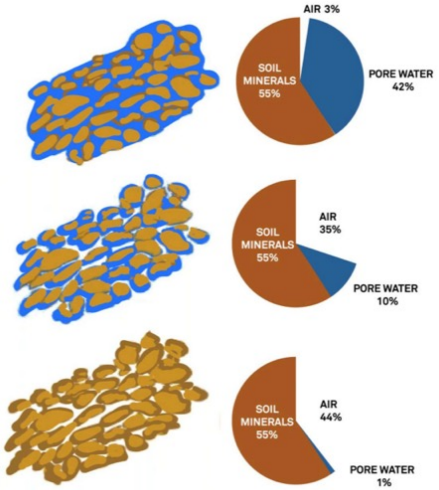


https://github.com/CongducPham/PRIMA-Intel-IrriS/blob/main/Tutorials/Intel-IrriS-low-cost-sensor-hardware-parts.pdf

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

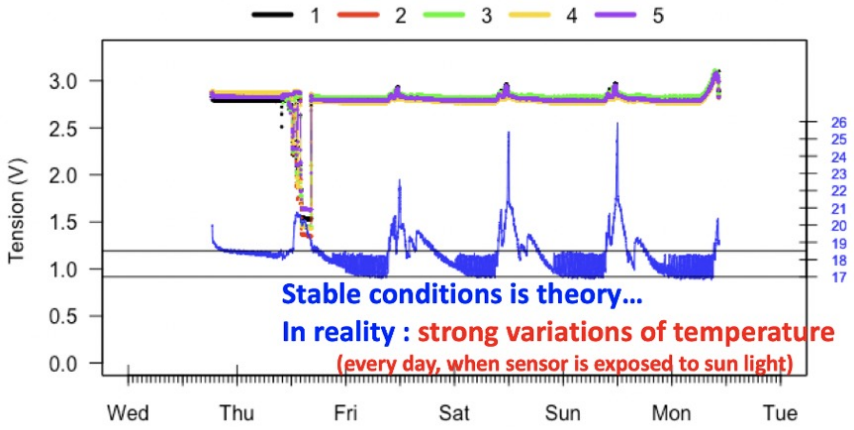
Capacitive sensor





From METER group

- Capacitive soil moisture sensors usually measure volumetric water content
- Soil density & soil texture are important parameters



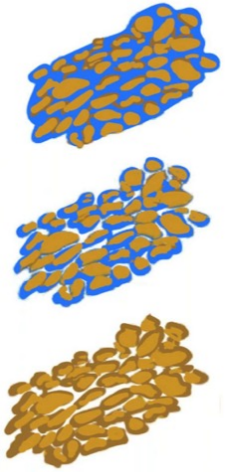
Impact of temperature ?

IRD in conducting extentise test on the accucary and the stability of the low-cost SEN0308 capacitive sensor

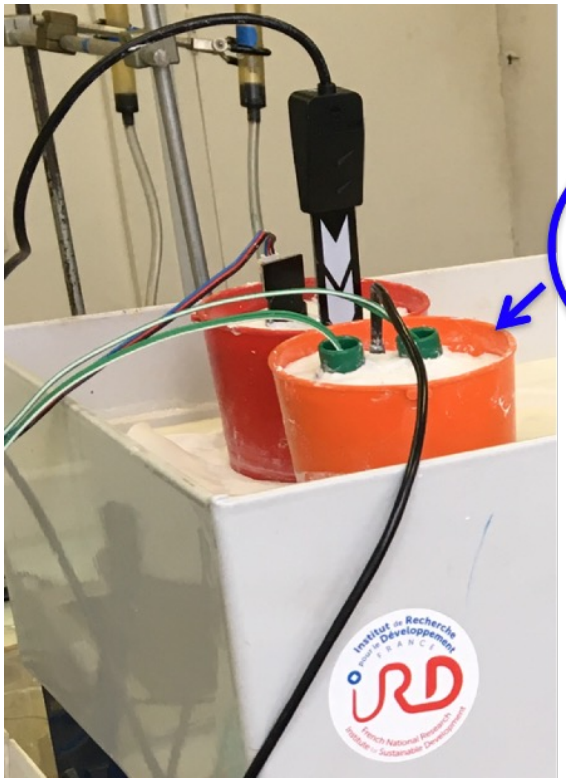
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

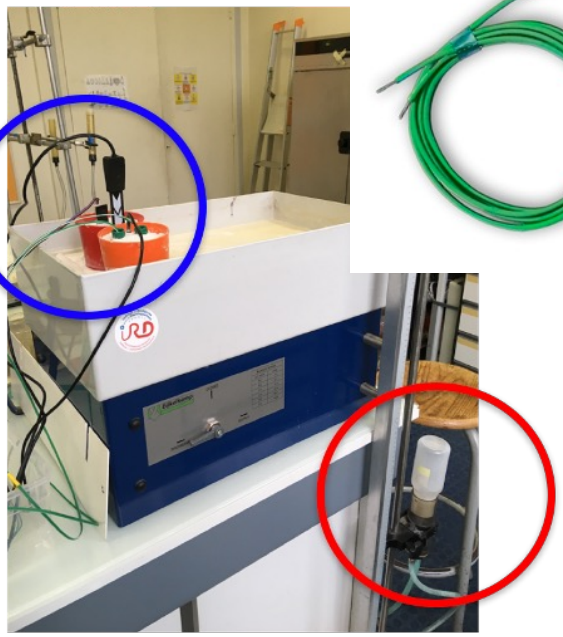
Water tension sensor

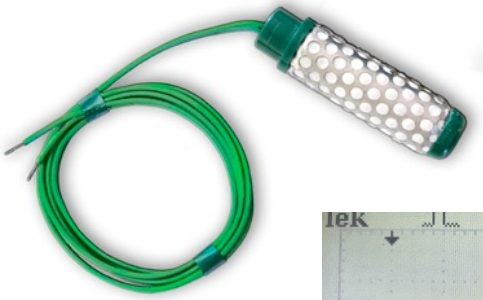
- Water tension sensor measures the amount of force required to extract water from soil's pores

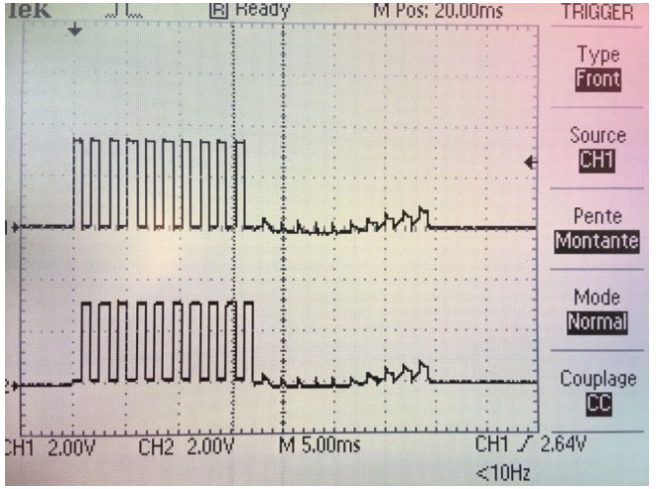


From METER group







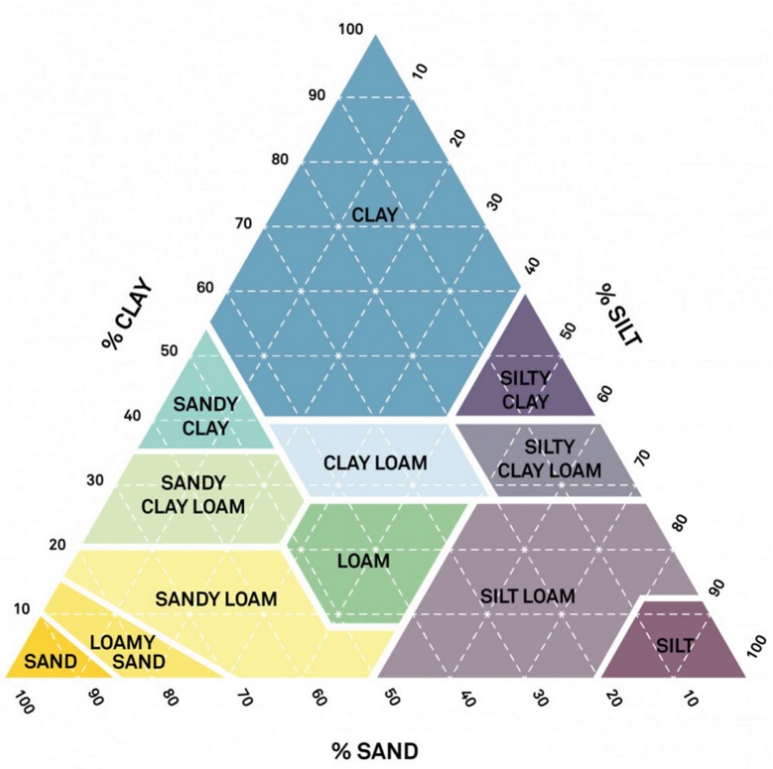


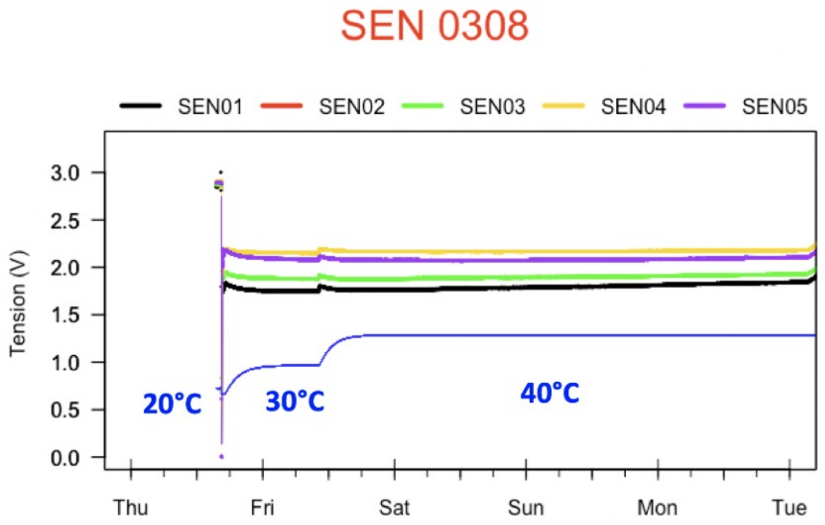
IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

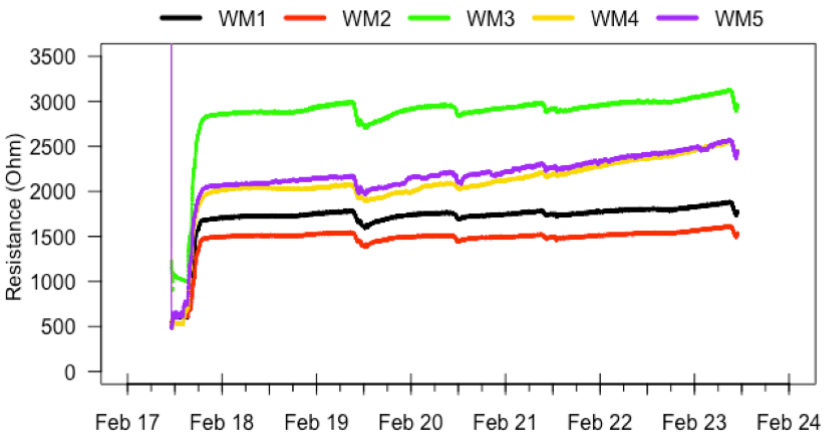
Calibration

- Soil-specific calibration
- Impact of external "noise"





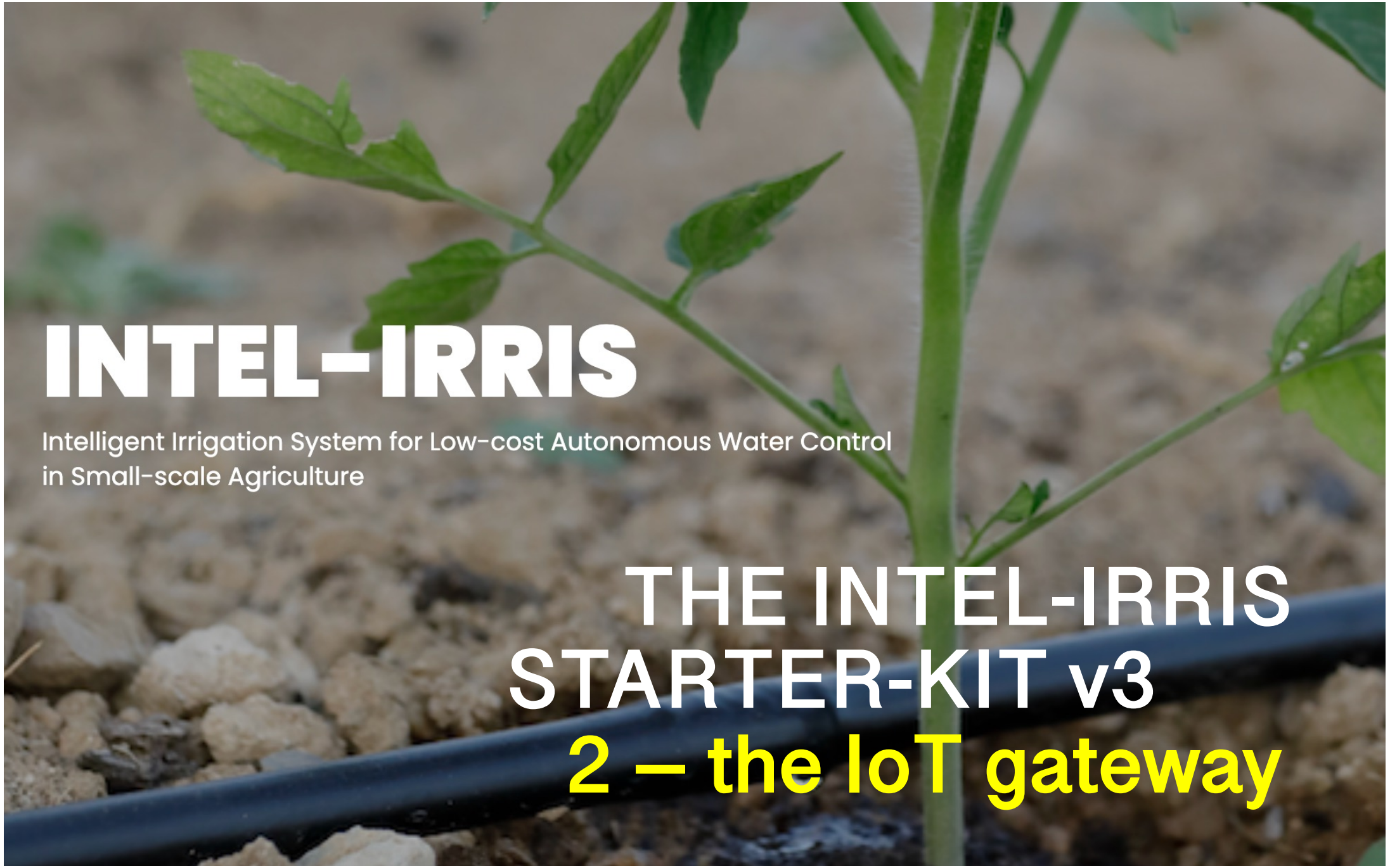
Ambient air emperature has low impact, except...



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

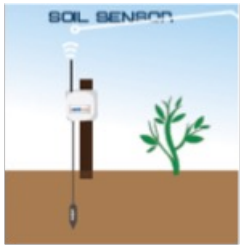
Tests in controlled environments

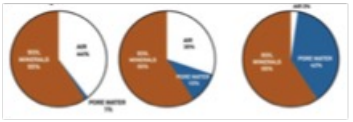
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham


INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
THE INTEL-IRRIS
STARTER-KIT v3
2 – the IoT gateway

Towards Plug-&-Sense

NO INTERNET ☹





THE IOT GATEWAY

LoRa

LONG-RANGE RADIO TECHNOLOGY
VERY LOW POWER CONSUMPTION

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Gateway: collect sensor data

WAZIGATE GATEWAY

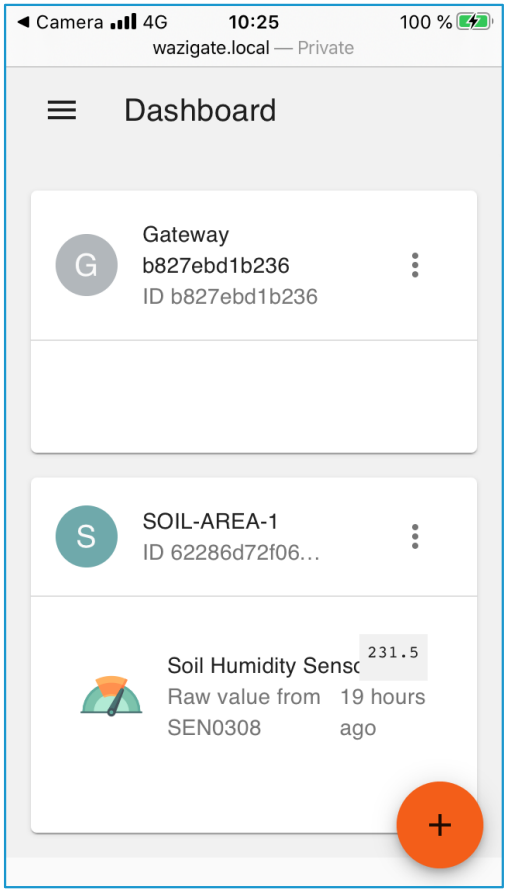
FULL EDGE-COMPUTING (NO INTERNET)

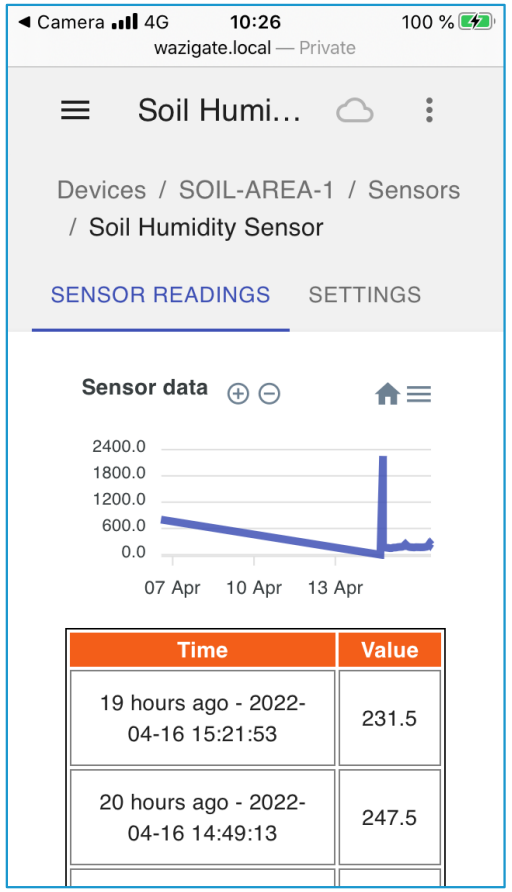
ALL DATA PROCESSING CAN BE DONE LOCALLY

1 GATEWAY HANDLES SEVERAL DEVICES

< 50€

EMBEDDED WEB INTERFACE





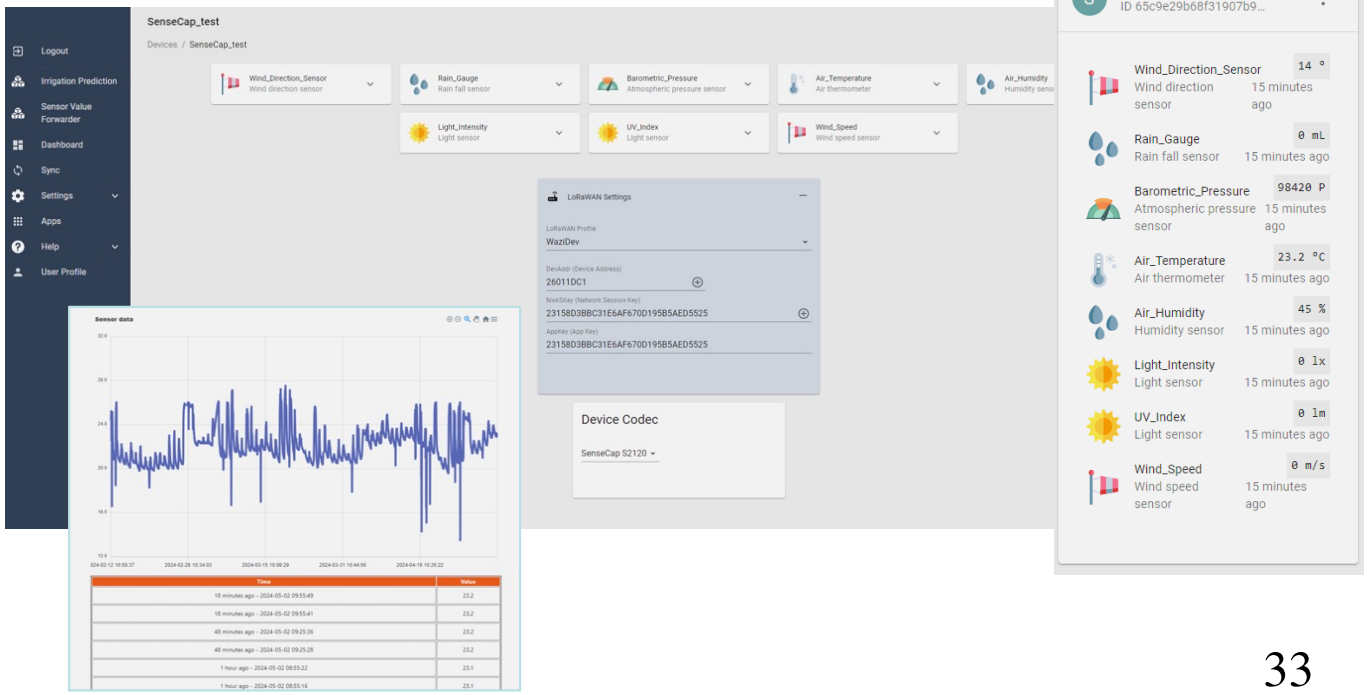
EASILY ACCESSED FROM A SMARTPHONE

Prof. Congduc Pham
http://www.univ-pau.fr/

Integration of other sensors

- The gateway dashboard can be extended to receive, decode and display data from third-party sensors
- e.g. the SenseCAP S2120 8-in-1 LoRaWAN Weather Sensor

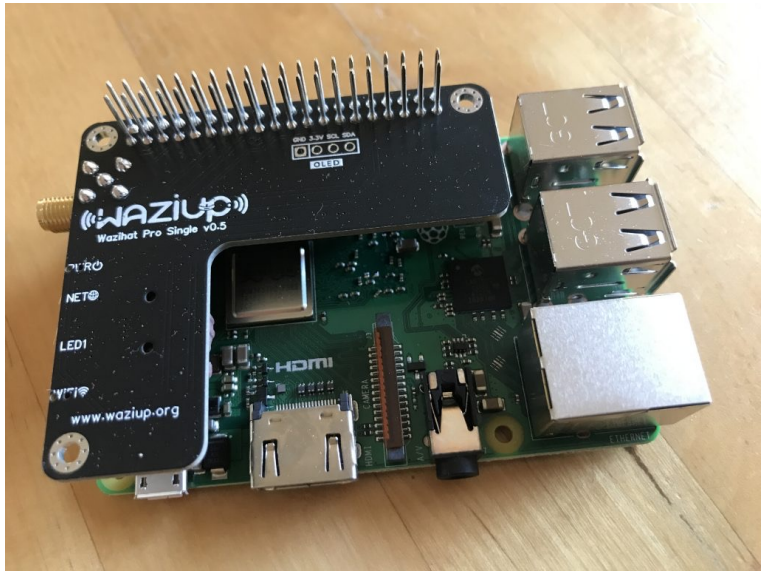
https://github.com/Waziup/WaziGate-SenseCap-S2120-integration



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

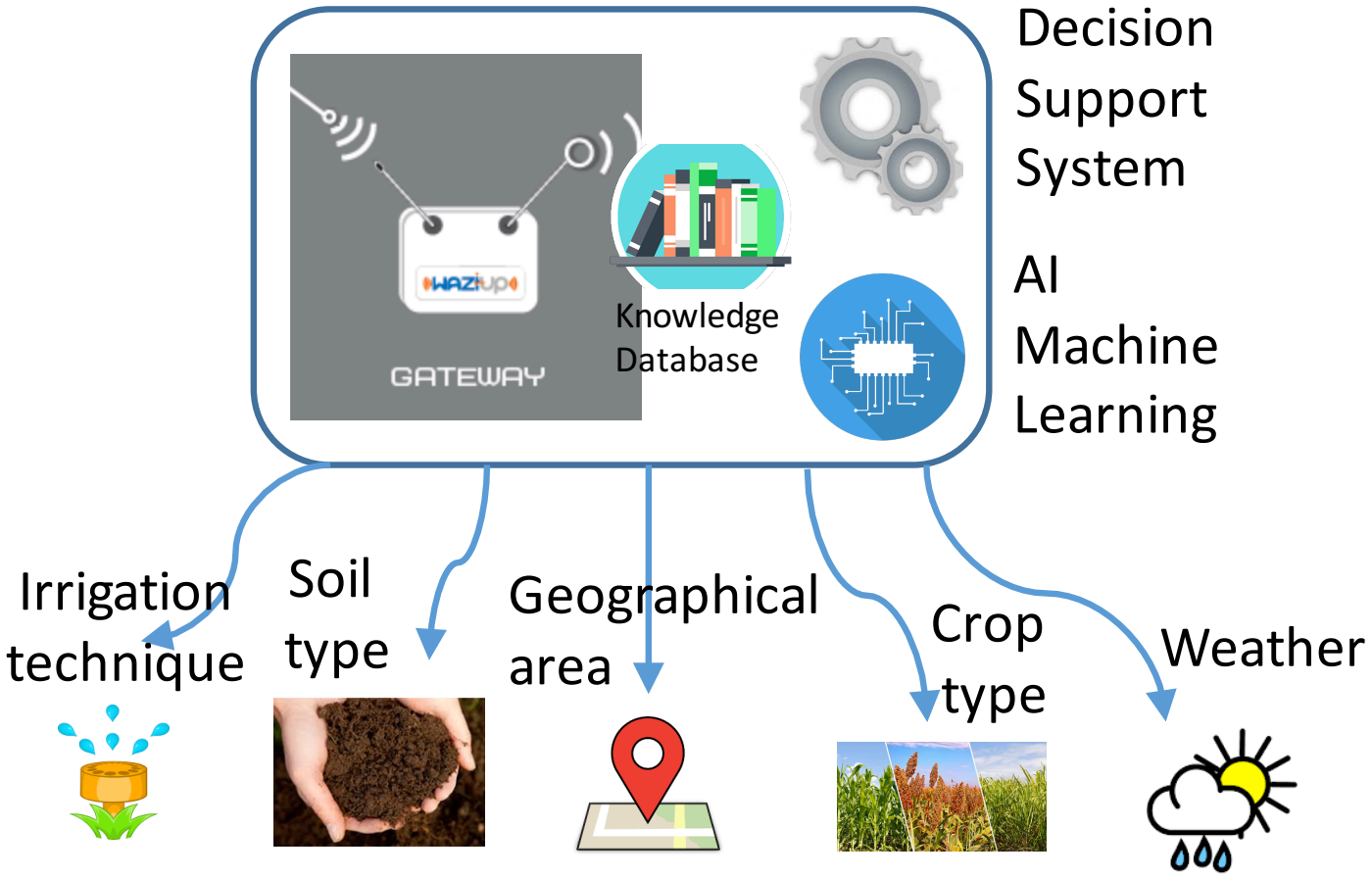
The latest gateway version

- New LoRa radio hat
  - With embedded Real Time Clock for full edge-mode operation
  - On-board OLED connectors
  - LED indicator for Internet connectivity
- New casing with open-source 3D design



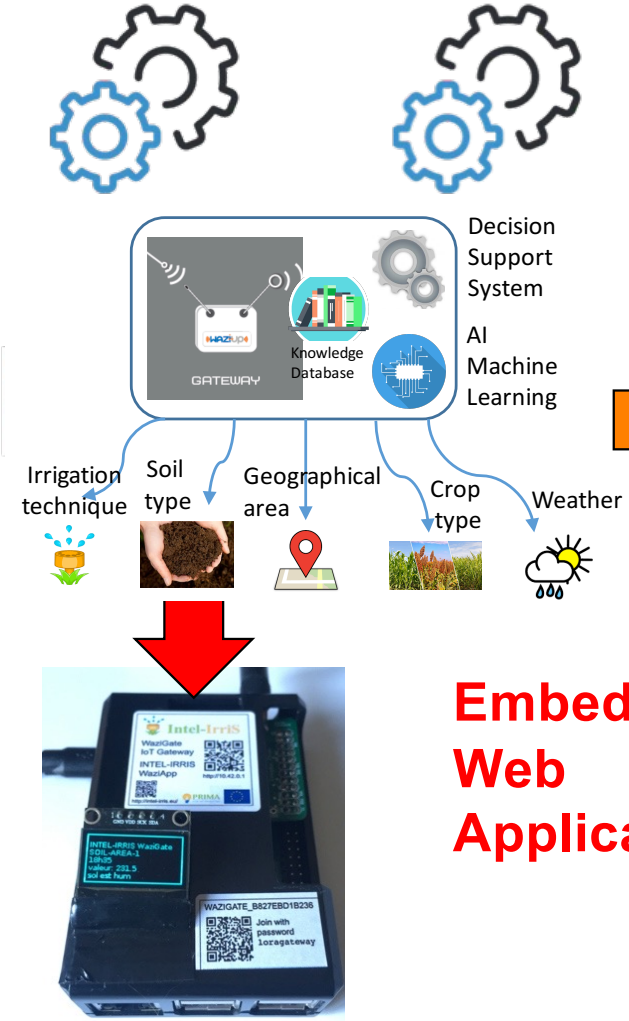
INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
MAKE IT SMARTER?

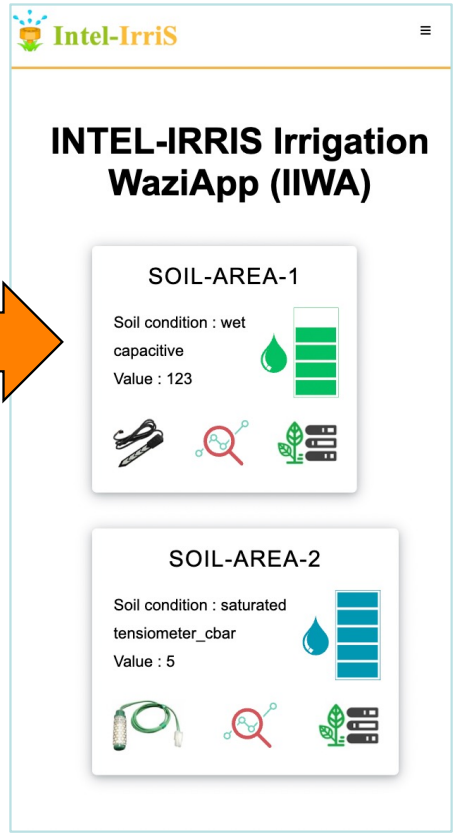
Added value: embedded intelligence!



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

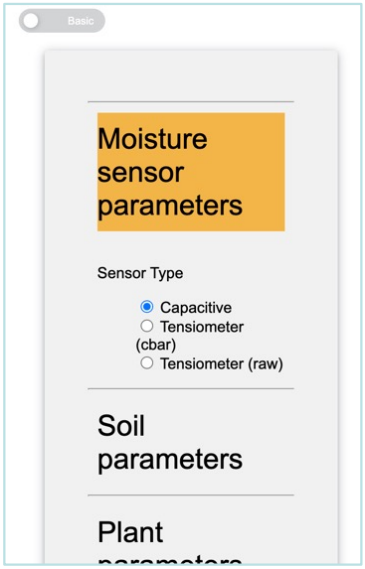
INTEL-IRRIS: add intelligence

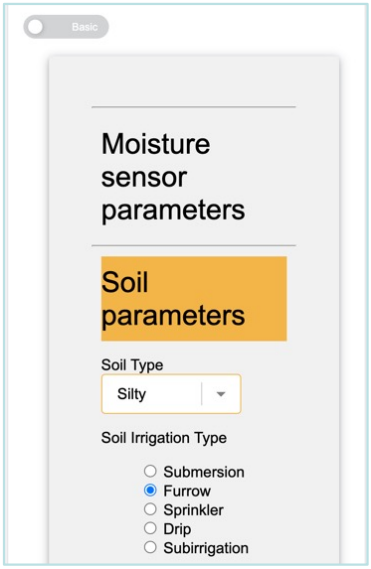


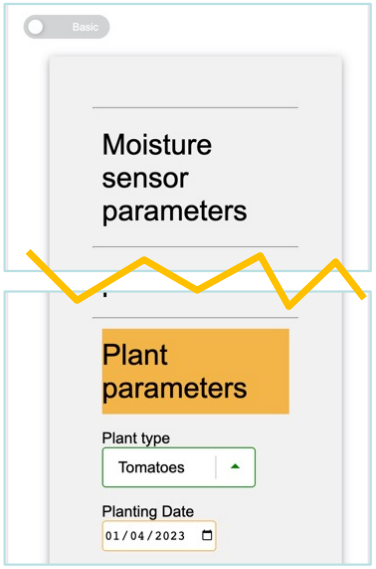


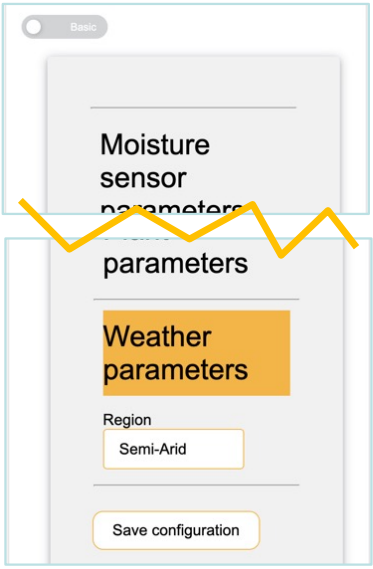
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

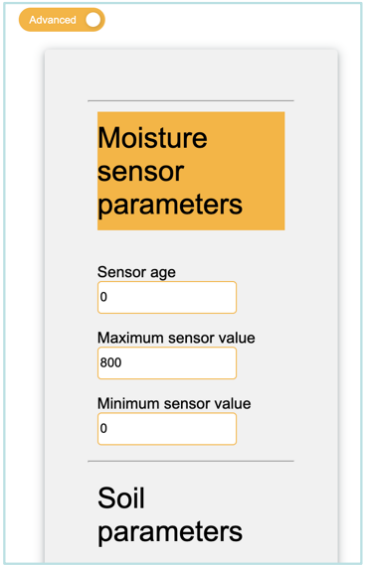
IIWA advanced parameters

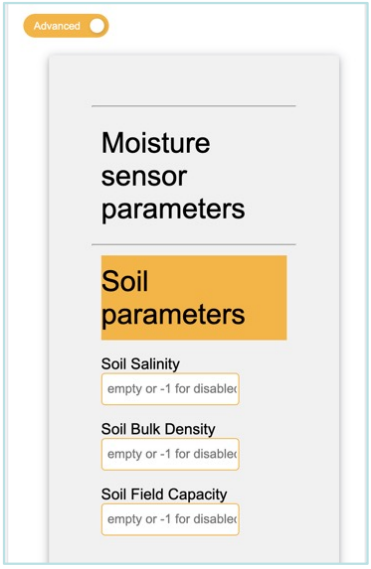


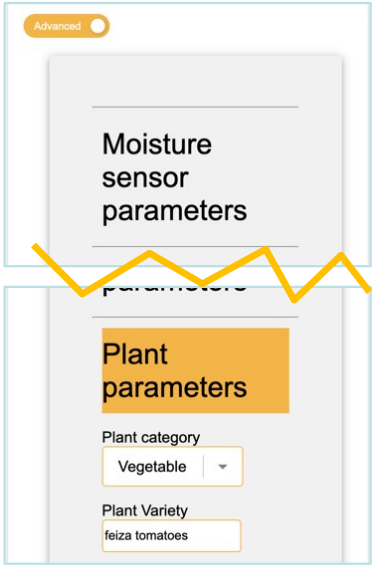


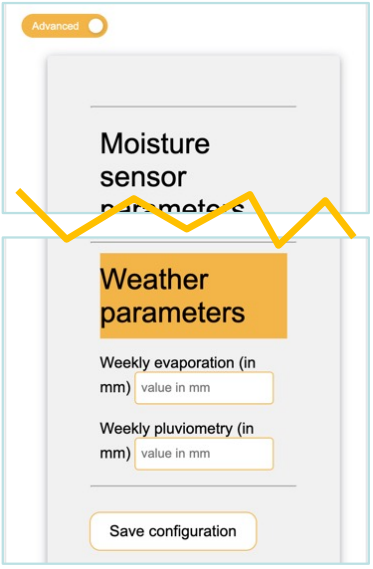








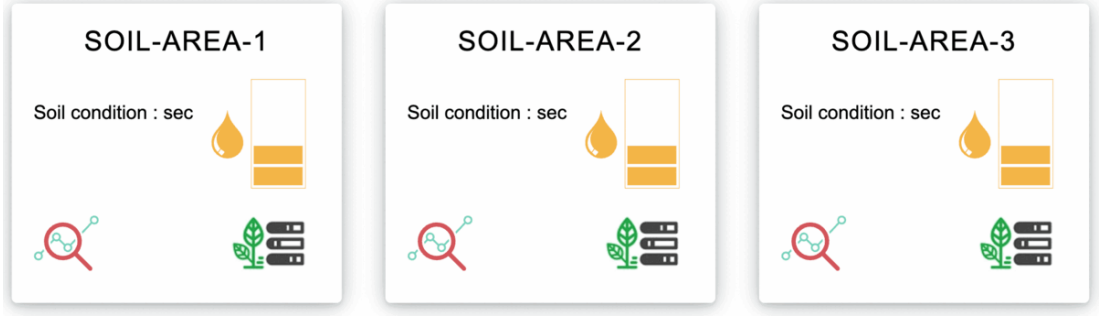




Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

First IIWA demo at Mostaganem event

- March 7th, 2023
- Real-time demo of soil sensor + IIWA

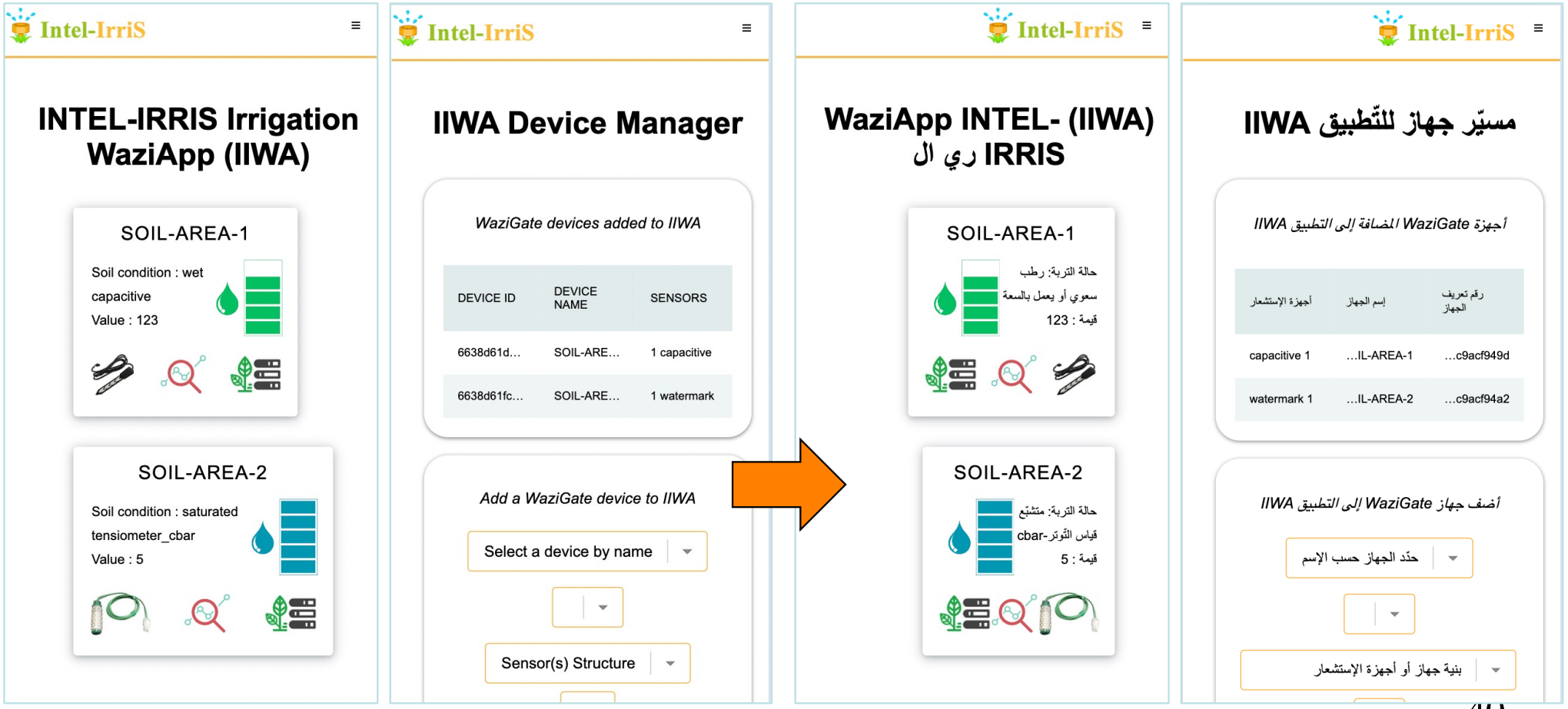


https://intel-irris.eu/presentation-of-intel-irris-starter-kit-for-smallholder-farmers-in-mostaganem-algerie

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Arabic version

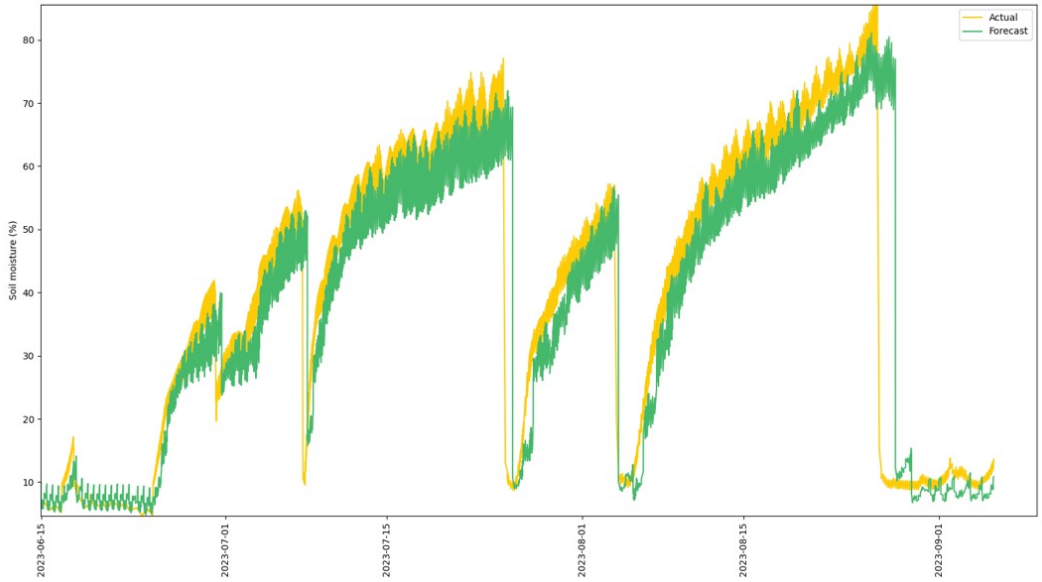
- NEW! Arabic language is supported in IIWA!



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Embedded AI forecast

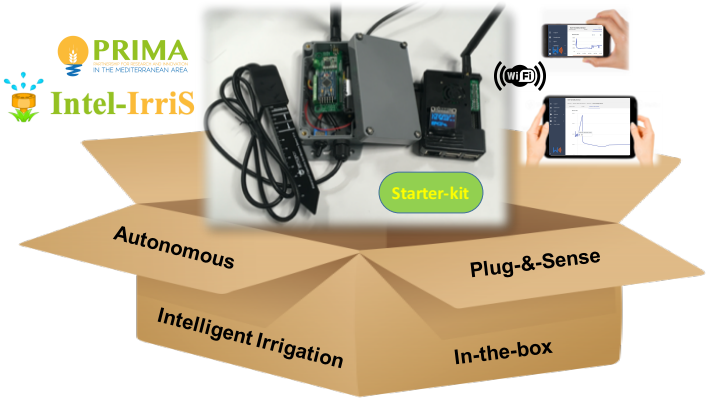
- The INTEL-IRRIS gateway can embed advanced AI processing on real-time sensor data
- **Current techniques**: sliding windows pre-treament and LSTM Neural Networks (Long Short-Term Memory)



INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
PILOTING WITH
FARMERS & USERS

Smallholder Piloting Program

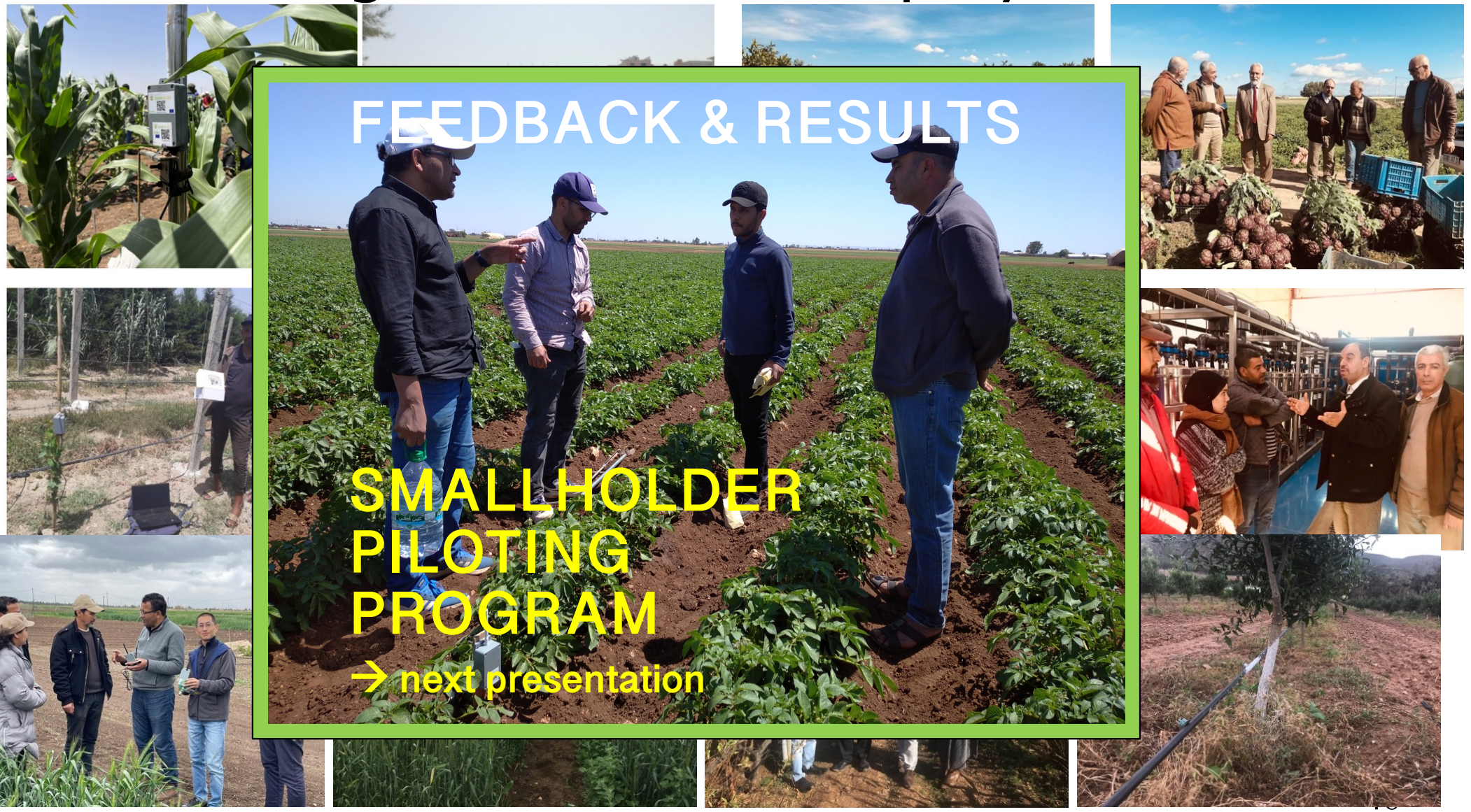
- Participatory approach to co-design & test the innovative solutions in fields
- Benefit from smallholders' expertise to improve efficiency of the irrigation system
- Take into account region-dependent technical, agricultural, social, climatic and environmental aspects
- Will run for 24 months to ensure that the proposed irrigation systems are well tailored for the specificities of the regional context



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

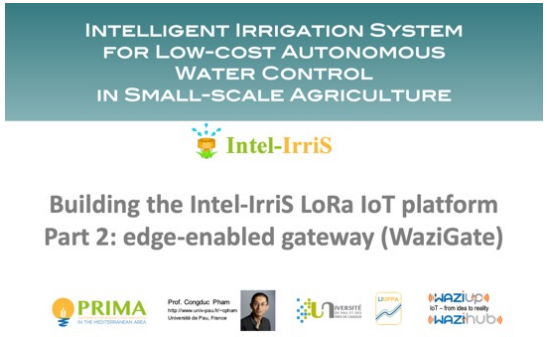
Piloting farms, visits, deployment,...

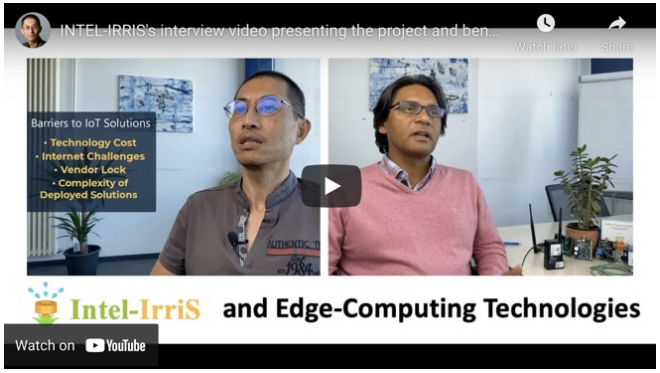
Piloting farms, visits, deployment,...



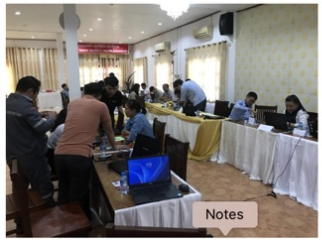
INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
CAPACITY-BUILDING
& TRAINING

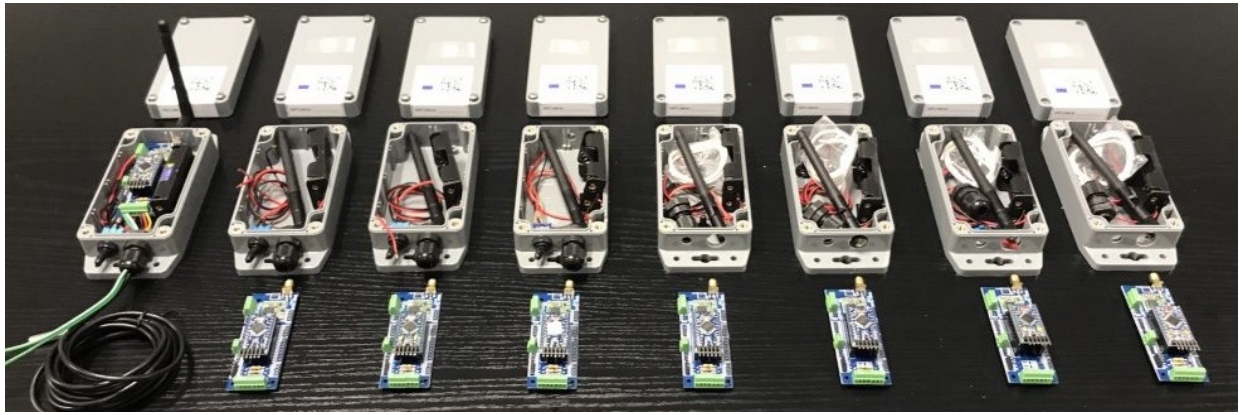
Tutorial materials





Training & capacity-building sessions

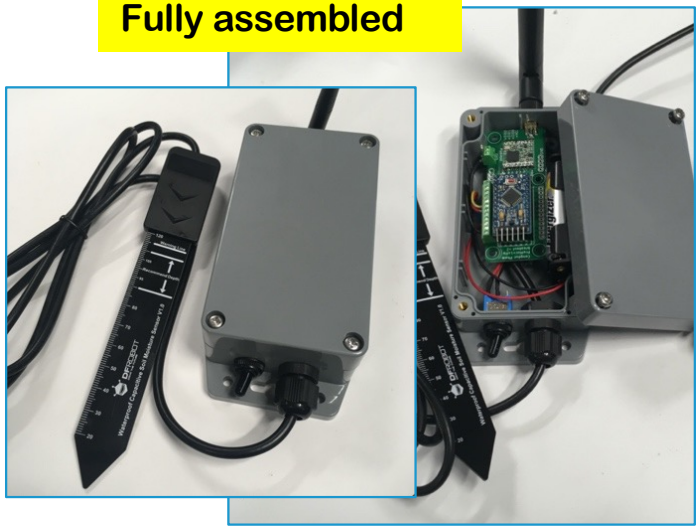




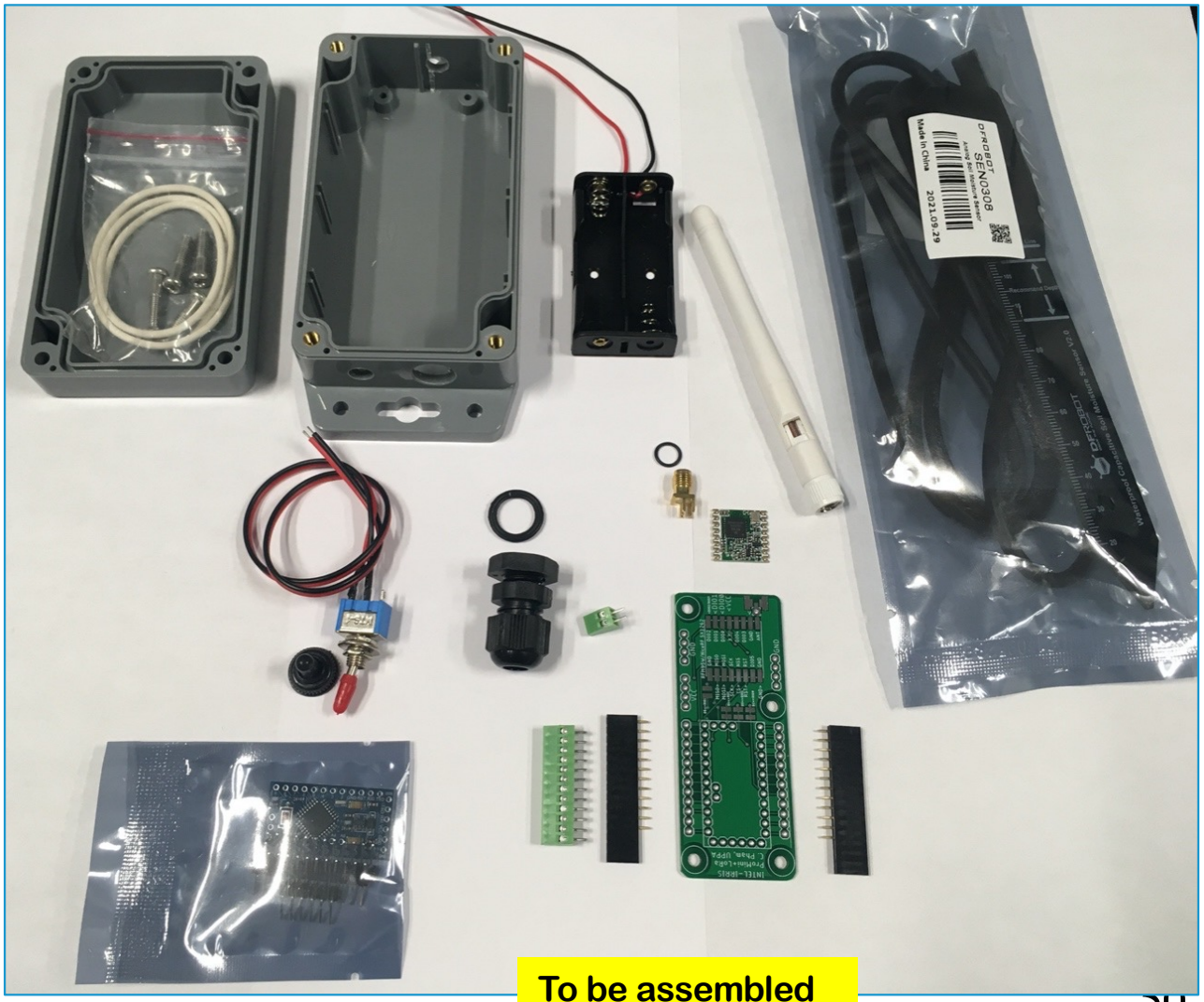
Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Starter-kit…in kit!

Fully assembled



Packaging in enclosure

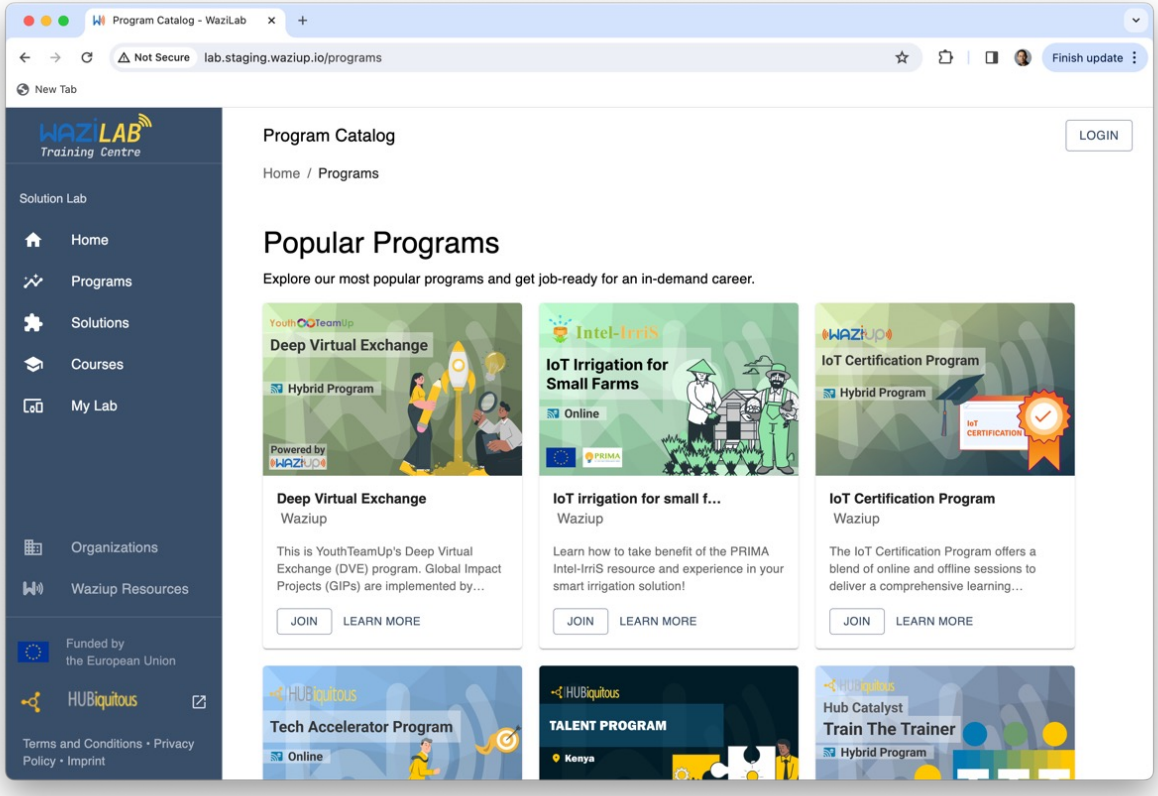


To be assembled

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Capacity-building program

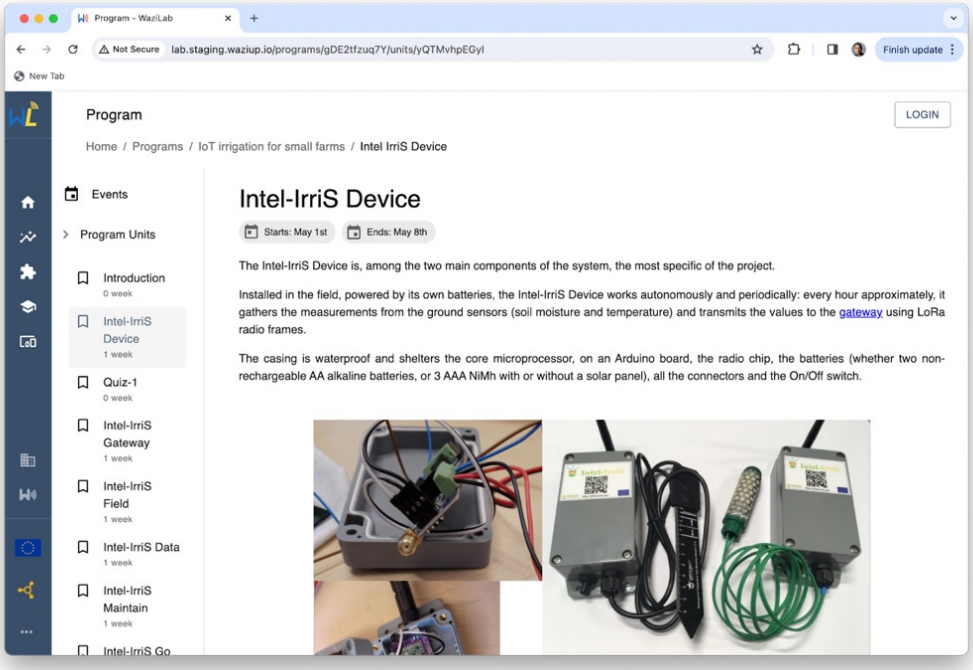
- Integrated into the WaziLab Training Center platform
  → testing phase: http://lab.staging.waziup.io/programs

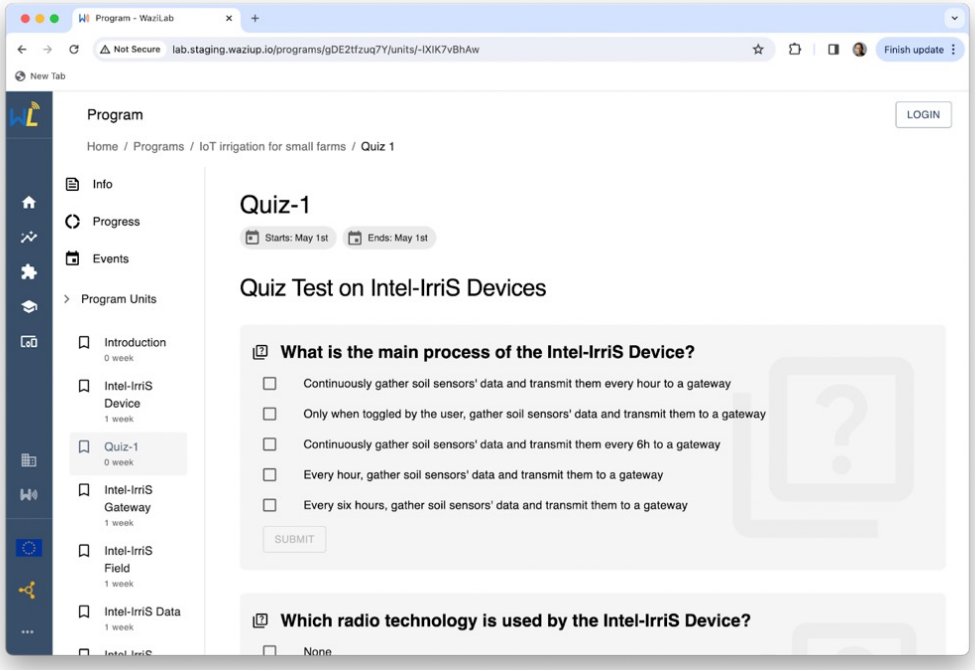


Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Learn & validate competencies

- At your own pace!

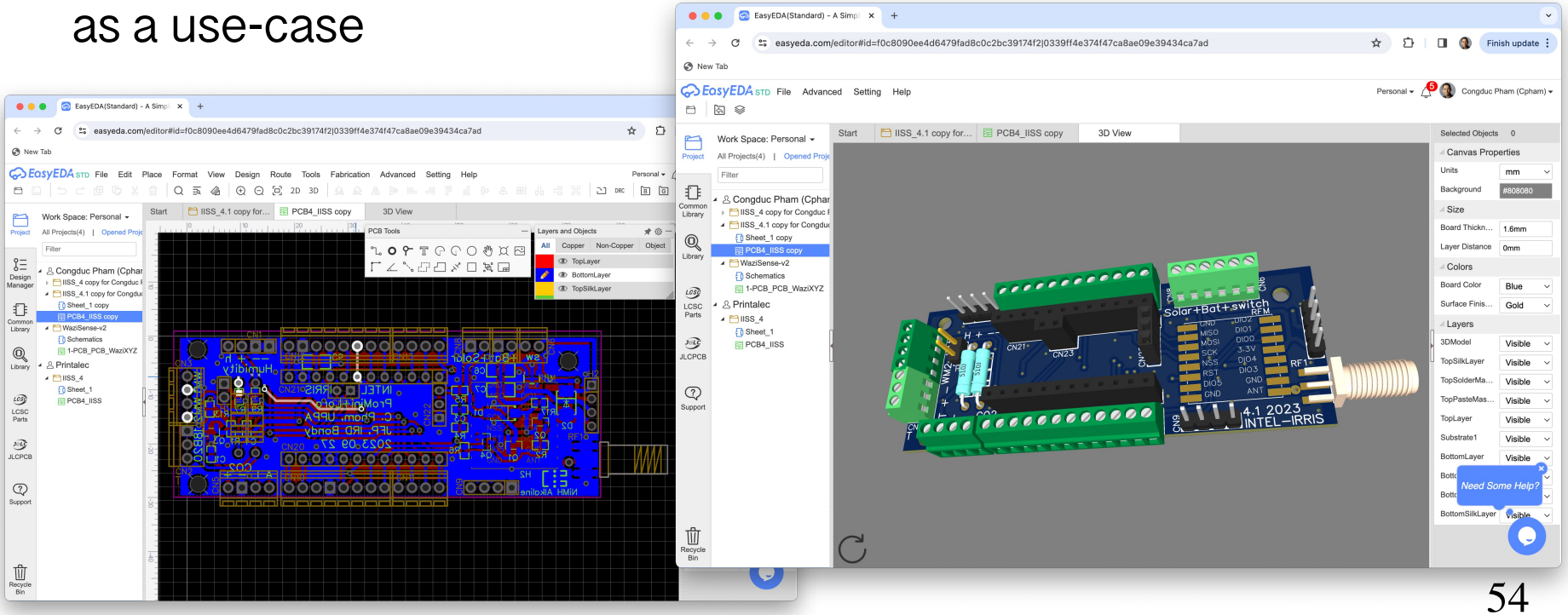




Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Capacity-building in PCB design

- A workshop took place on May 14-15, 2024 in Oran, animated by J.-F. Printanier from IRD
- The INTEL-IRRIS PCB will serve as a use-case



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

INTEL-IRRIS
Intelligent Irrigation System for Low-cost Autonomous Water Control
in Small-scale Agriculture
DISSEMINATION &
PARTNERSHIPS

Dissemination & partnerships

– for testing/using starter-kit
– scientific collaborations

- **Collaboration with PRIMA projects:** WATERMED 4.0, OurMED, NatMED, MED-WET, DROMAMED, ReCROP
- **"spin-off" projects**: S2IEA PNR Algeria
- **Collaboration with research organizations/institution**: INDICATIC AIP Panama, IICA Panama, iEES Paris, NECTEC Thailand, U. Laos Vientiane, CNRS GRDI CompactSol, U. Angers – IPPN network, U. Côte d'Azur – Satellite LoRa
- **Collaboration with companies**: CALESA Panama, NTPC – Nam Theun 2 Laos, MounoyDev Laos, MakerBox Laos, EGM France, Senseen France,
- **Participation in project consortiums**: HE ZepoBox, HE NureBox, HE LEAAF, PRIMA S1 AgriMedWise, PRIMA S1 NexMed

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Publications

- https://intel-irris.eu/publications
- 2 journals, 4 international conferences

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

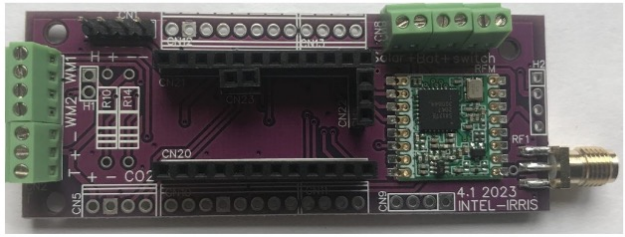
Open-source, GitHub

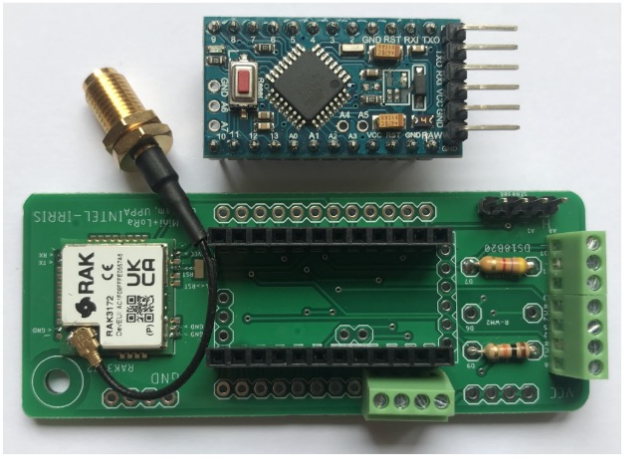
- All PCB resources & all softfware

GitHub Intel-IrriS

INTEL-IRRIS GitHub

this is where all the source code, the Gerber files for the PCBs and all the tutorials slides can be found to build your own INTEL-IRRIS platform!



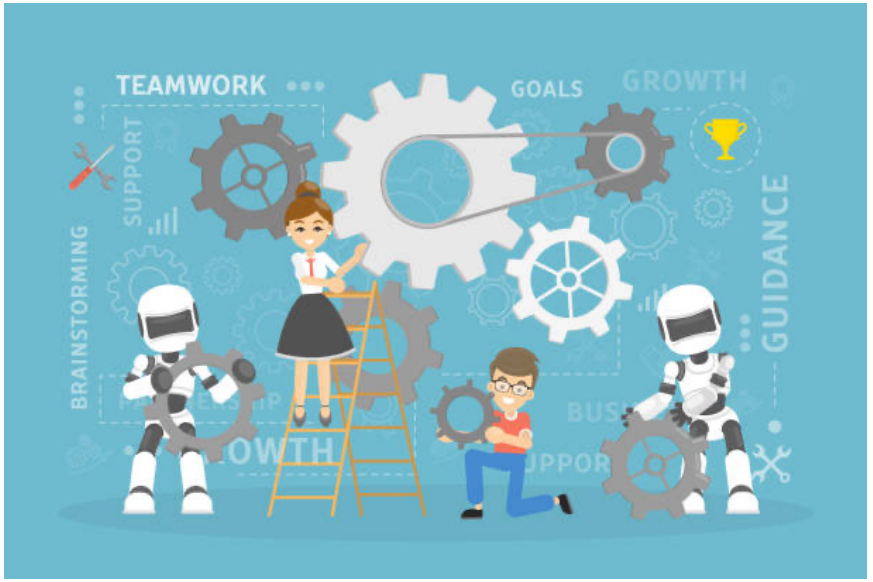


SCAN ME

INTEL-IRRIS GITHUB

INTEL-IRRIS's SolutionLab

- Provide access to technologies developed by INTEL-IRRIS SolutionLab = FabLab + INTEL-IRRIS's technologies
- Hardware + all software frameworks
- Learn, Prototype, Develop, Improve, Innovate & Tests



Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

IT IS A TEAM WORK!

AUA: Agricultural University of Athens — Greece

T. Bartzanas
D. Giannopoulos
G. Chatzipavlidis
A. Giakoumatos
S. Fountas

ENSA-Safi: National School of Applied Sciences – Safi — Morocco

K. Baraka
O. Chabouni

INRA: National Institute of Agronomic Research — Morocco

T. Benabdelouahab
A. El Assaoui
A. Harkani
Y. Bouchiar
A. El Mghari
H. Lionbui

IRD: Institute for Research & Development — France

C. Hartmann
J-F Printanier

UMAB: University A. Benbadis — Algeria

M. Benkhelifa
S. Nemmiche
L. Kradia
A. Gacemi
A. Toiti
M. Bouamrane
R. Thelaidjia

UORAN1: University of Oran 1 — Algeria

B. Kechar
A. Dahane
R. Benameur
B. Zahia
H. Haffaf
A. Benyamina
Y. Bidai

UPPA: University of Pau & Adour Country — France (coordinator)

C. Pham
G. Gaillard
Admin staff
C. Fernandez
K. Hamidi

WAZIUP eV: WAZIUP association — Germany

A. Rahim
C. Dupont
F. Markwordt
J. Jorster
S. Githu
P. Banini

ORAN & MOSTAGANEM (ALGERIA)

Direction des Services Agricoles de la Wilaya d'Oran
Chambre d'Agriculture de la Wilaya d'Oran
L'Association des irrigateurs des eaux traitées de la Wilaya d'Oran
Direction des Services Agricoles de Mostaganem
Chambre d'Agriculture de Mostaganem
Institut National des Sols, de l'Irrigation et du Drainage (INSID El Matmore Relizane)
Institut National de la Recherche Agronomique d'Algérie (INRAA El Hmadena Relizane)
Association des Maraichers de Mostaganem

SETTAT & BERRECHID (MOROCCO)

Office National du Conseil Agricole de Berrichid
Office National du Conseil Agricole de Settat
Direction Provinciale de l'Agriculture de Berrechid
Direction Provinciale de l'Agriculture de Settat
Coopérative Ennahda
Coopérative Sidi Aidi

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham

Results, Newsletters, Publications, …

- Web site: https://intel-irris.eu

AUA: Agricultural University of Athens — Greece
ENSA-Safi: National School of Applied Sciences – Safi — Morocco
INRA: National Institute of Agronomic Research — Morocco
IRD: Institute for Research & Development — France
UMAB: University A. Benbadis — Algeria
UORAN1: University of Oran 1 — Algeria
UPPA: University of Pau & Adour Country — coordinator — France
WAZIUP eV: WAZIUP association — Germany

- Twitter: https://twitter.com/Intel_IrriS

Intel_Irris
@Intel_IrriS

Prof. Congduc Pham
http://www.univ-pau.fr/~cpham