TERRA FORMA : réseaux de capteurs environnementaux pour mieux comprendre les changements environnementaux

Journées LPWAN, Pau, July 8-9, 2024

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https://terra-forma-web.osug.fr/

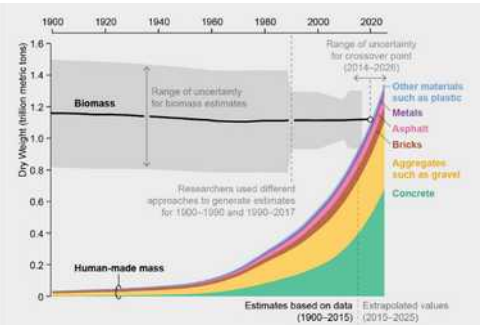
Contact: Arnaud Elger, Laurent Longuevergne, Virginie Girard

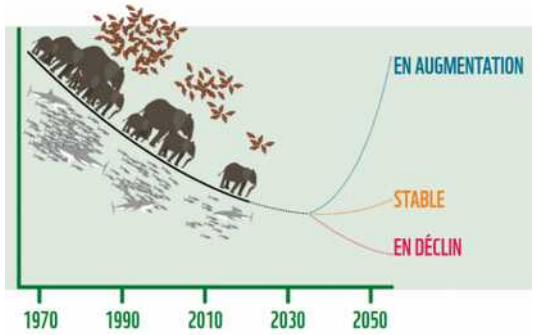
Plan

- Présentation du projet
- Partenaires, Acteurs et Objectifs
- Work Package 3
- Une infrastructure de communication large échelle
- Dernières rencontres au Jardin du Lautaret (Mai 2024)
- Conclusions, Attentes, Actions à venir …

Innovative sensor networks to understand the Planet Habitability

Anthropocene: proposed geological **epoch dating** from the commencement of significant **human impact** on Earth's geology and ecosystems





Biodiversity collapse of 68% since 1970. WWF 2020

Terra Forma project will help to understand the **Planet Habitability**

4 key challenges for Planet Hab.

Water ressources

Chemical pressure

Soil capital

Biodiversity habitats

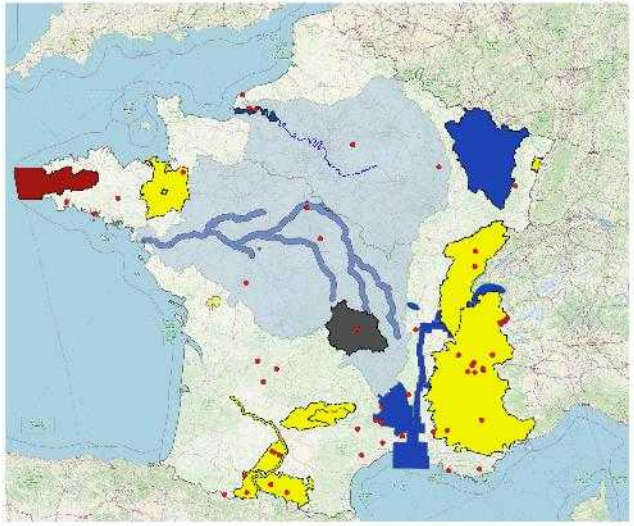
To understand

Innovative sensor networks deployed at environmental **observation sites**

Development of:
- Smart sensors
- **Communication infrastructures**
- Social infrastructure[1]

[1] TF must be connected to the society to produce the needed social change for better social ecosystems more resilient and sustainable

Interdisciplinary instrumented observation sites



- Currently on the French metropolitan territory :
  - OZCAR: 21 observatories > 60 instrumented sites
  - RZA: 14+1 “work areas” > 80 instrumented sites

 New instruments required to better study the complex biotic-abiotic interactions at a relevant sca

- Program of Terra Forma:
  - Step 1: Co-deployment on 3 pilot sites
  - Step 2: implementation on 12 additional sites
  - Step 3: dissemination of the developed tools

OZCAR: Observatory of the Critical Zone

RZA: “Work areas” network

Some keys figures of Terra Forma project

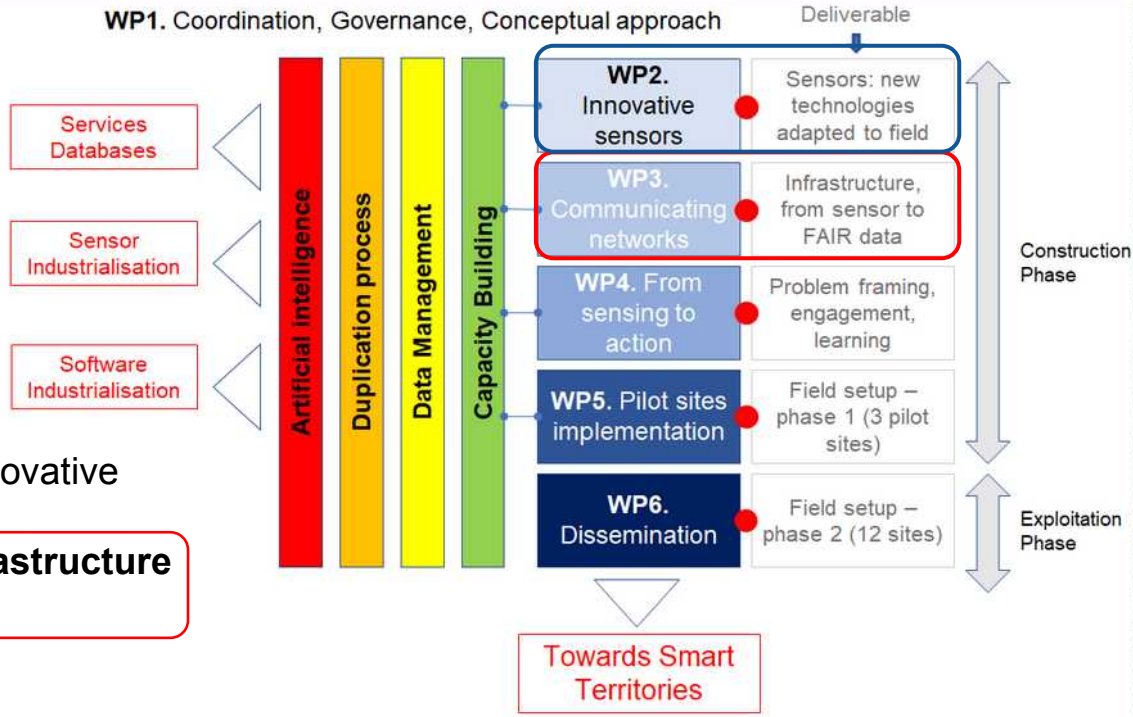
Terra Forma project is:

- Collaboration of **42 Laboratories**

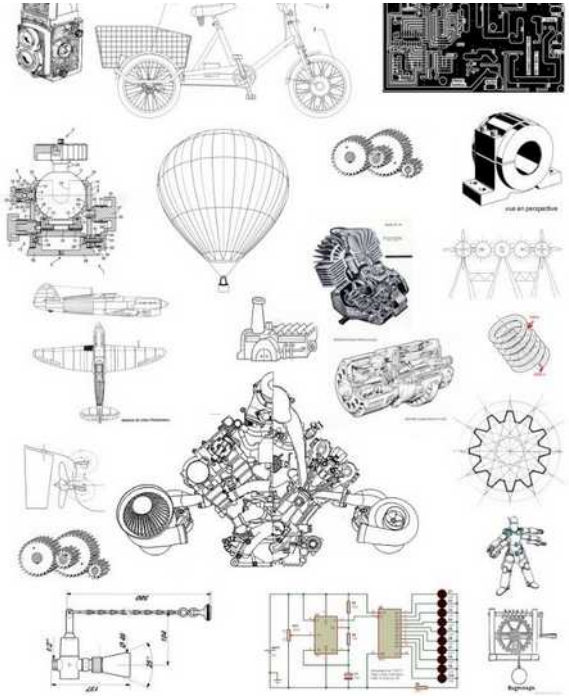
from11 Universities, 11 Institutes of Research

- Budget of **9.6M€**
- From 2022 to 2029
- 6 work packages

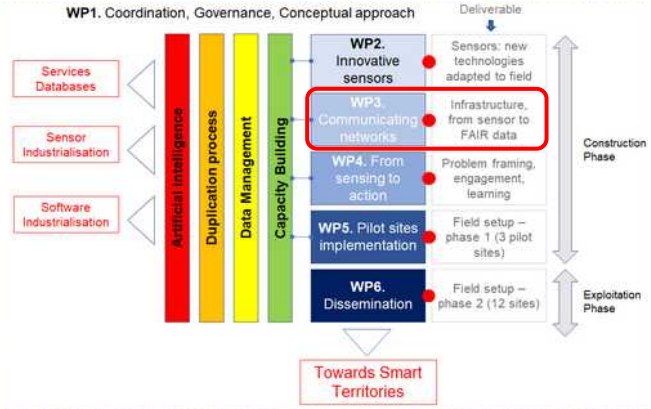
Organization of the project



- **WP2** dedicated to the development of innovative **sensors** adapted to field
- **WP3** dedicated to the building of the **infrastructure** to collect, transmit and manage the data



https://artsvisuels2012.wordpress.com/2012/01/25/machine-infernal/



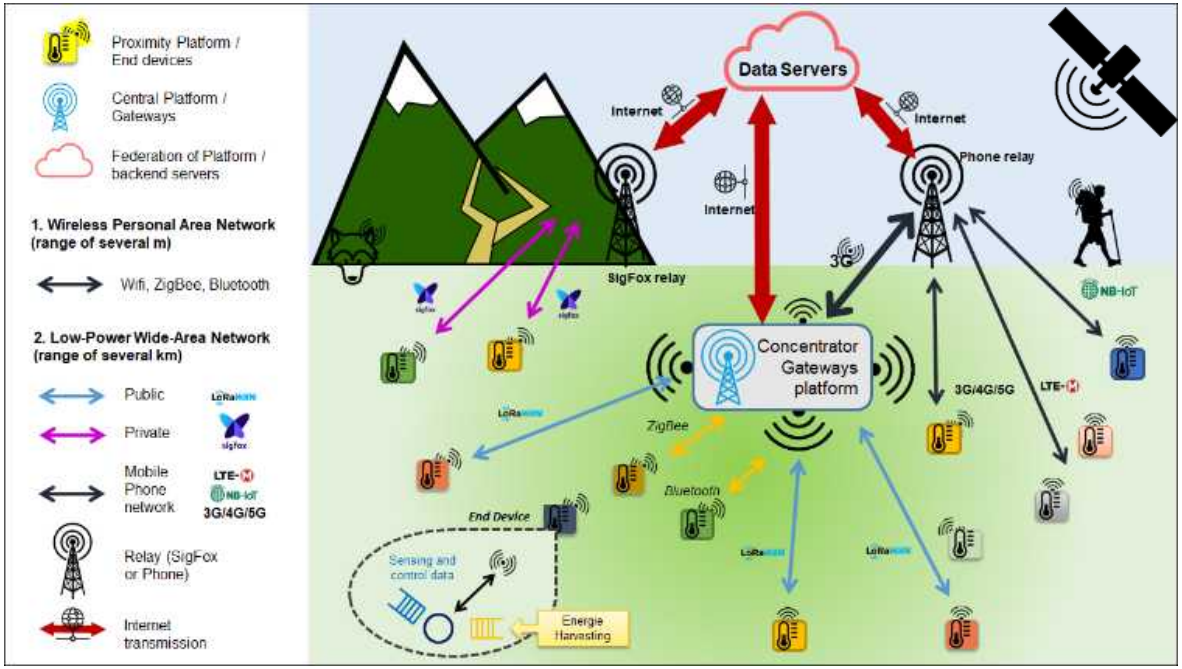
What should we develop in WP3 ?

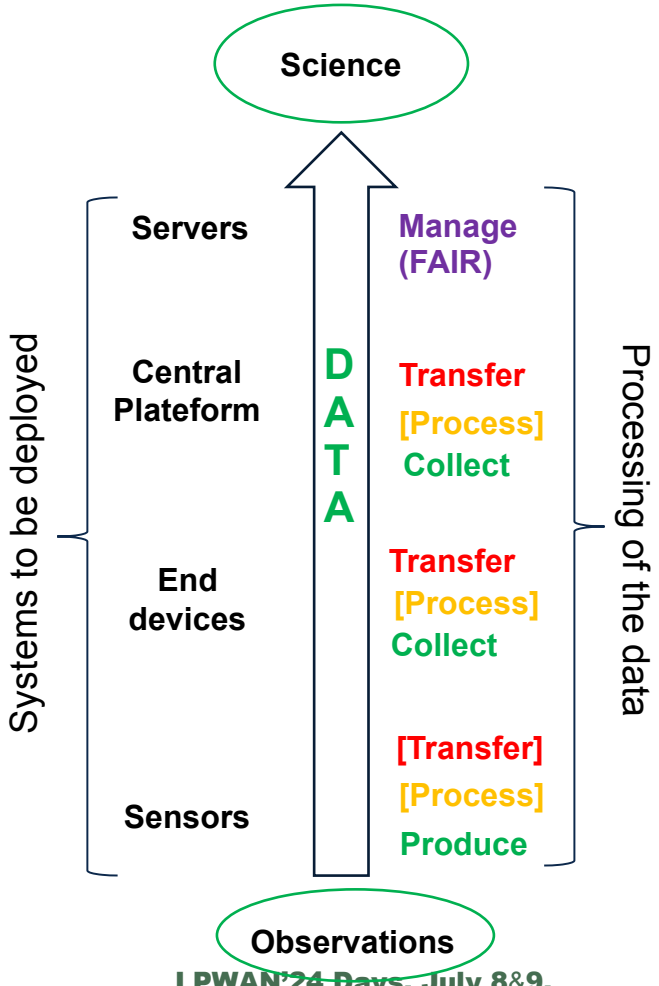
« From sensors to Cloud »

From Field Measurements to Science
From Sensors to Cloud

WP3

Dense and scalable networks of heterogeneous sensors

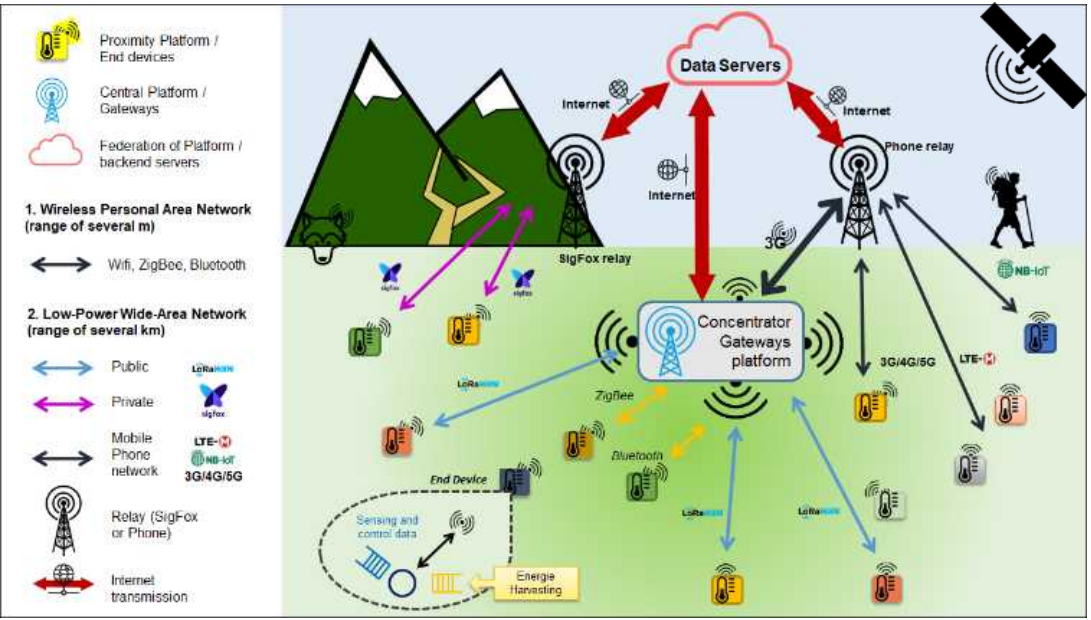




From Field Measurements to Science
From Sensors to Cloud

WP3

Dense and scalable networks of <u>heterogeneous</u> sensors



Requirements:

- Deployment of relevant communication technologies to meet the **needs** and **constraints** of **each sensor** and each **location** (WPAN, LPWAN)
- Multi-protocol **central platform** to aggregate data
- **Energy harvesting** when needed and possible
- **Scalable** infrastructure

A wide variety of sensors, technologies, use-cases … to be addressed !

(the challenge of the data management not presented here)

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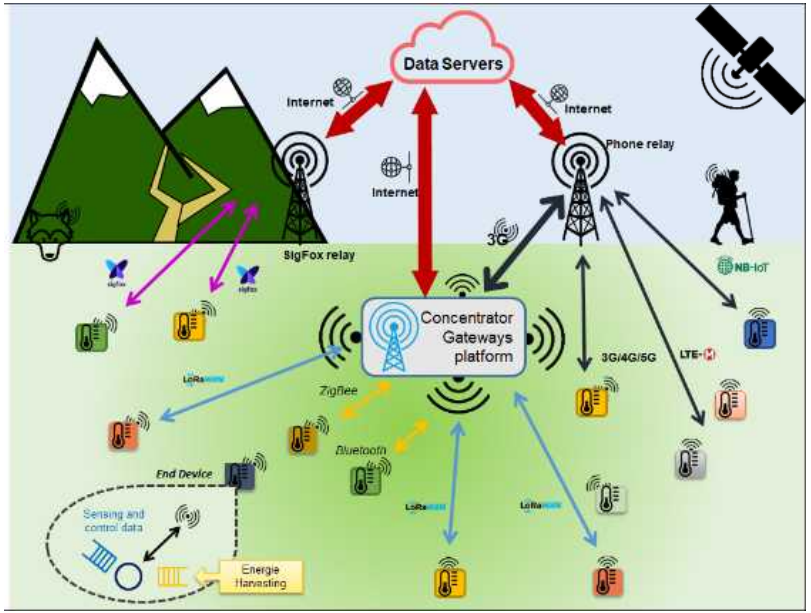
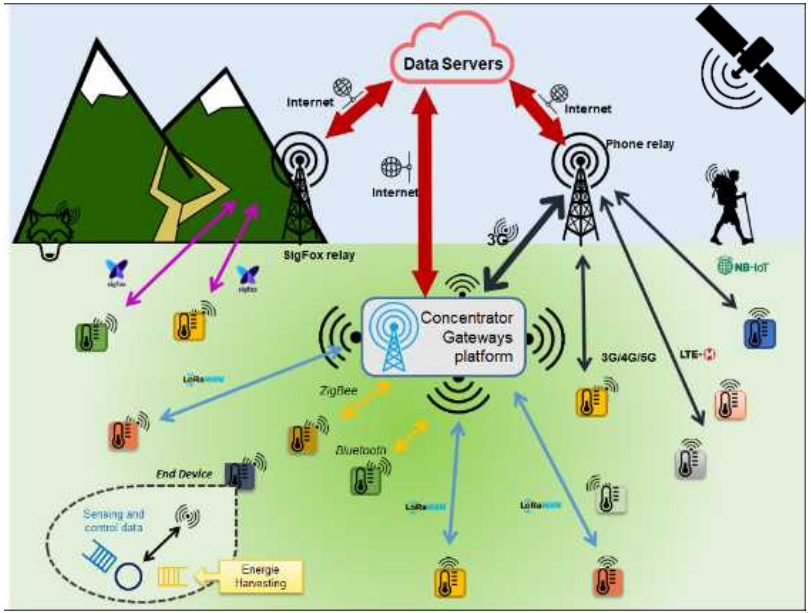
From Field Measurements to Science
From Sensors to Cloud



Key challenges (1):

- **Collect all the data** (or almost) produced by sensors
  - suitable hardware (wired or wireless interfaces)
  - suitable software (specific drivers)
- **Transfer data** whatever the **location** of the sensor
- **Ensure a high Quality of Service**
- **Limit the maintenance needs**: autonomy > 6 months
  - Limit the transmission time
  - Implement energy harvesting systems
  - Design reliable systems
- **Process data** as soon as possible (only relevant data)

From Field Measurements to Science
From Sensors to Cloud



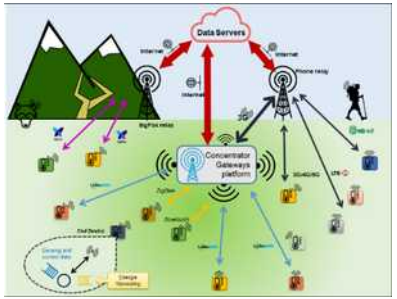
Key challenges (2):

- **Low cost** (considering the time of life of systems)
  - **High durability** (repairability)
  - **Upgradability** (new needs, new techno…)
- **Socially** approved
- **Accessibility of the systems**
  - DIY
  - easy to use, tutorial, tech. assistance, …
- **Low environmental impact** (small, light, discrete, recyclable…)

Tradeoffs to be made !!

major part of the budget dedicated to manufacturing

TF meeting @St-Jacut in 2022



Who will the « designers » ?

N.B.: Not “builders” because major part of the budget dedicated to manufacturing

Project teams involved in WP3

Terra Forma gathers variety of complementary expertise

BEYLOT André-Luc
SARRAMIA David
DONSEZ Didier
PIERRE Guillaume
KACIMI Rahim
ROYER Laurent
FREICHEY Matthieu
LE GENTIL Mickael
AMAROUCHE Nadir
CHARADE Olivier
SENTIEYES Olivier
VANDAELE Richard
THIEBOLT Francois

N.B.: Close links with education

Université de Grenoble-Alpes (UGA)
LIG-CNRS laboratory

Skills:

- **LpWAN technologies** (IoT satellite, LoRa, …)
- **RTK over LoRaWAN**
- AI – Tiny ML
- Programming/use of large number of end devices

Cubesat mission

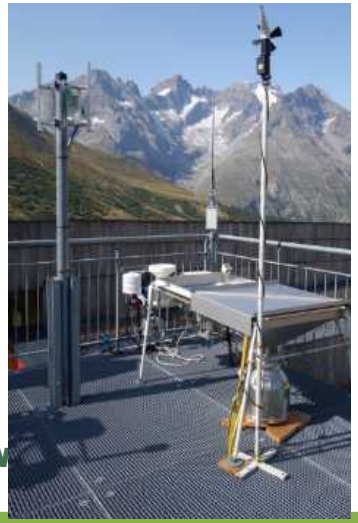
Developments & Experimentations

- ThingSat project
- Counting/recognition of animals – IA for birdsong
- Air Quality Station

WildCount:Recognizing and counting the presence of humans and animals

Air quality station

Station LORA station in Alpes



Connected groundhog cage

OpenCollar (LR1110)

LPW

Université de Rennes 1
IRISA laboratory

Skills:

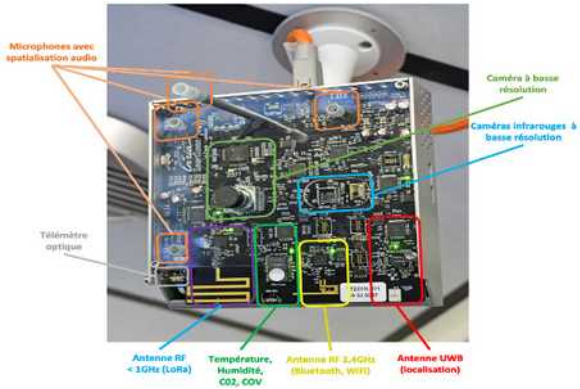
- **LPWAN** nodes
  - Adaptive architectures and protocols
- Energy **harvesting** and **management**
  - Model-based and model-free managers (Fuzzyman, RLman)
- **Wake-up** radio
- Radio-Frequency security
- **Fog** computing

The FogGuru hardware platform

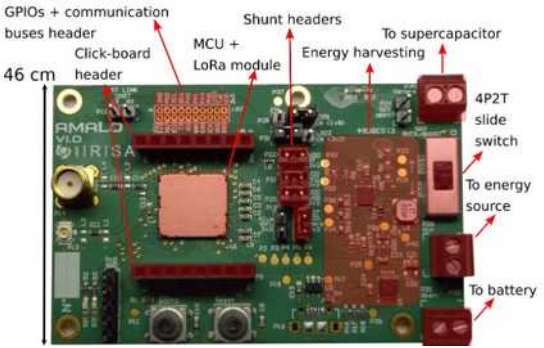
Developments & Experimentations

- Fog computing platform (FogGuru)
- Autonomous LoRa sensor board (AMALO) with power harvesting, energy storage and management
- Multi-sensors network (SmartSense)

PowWow : energy autonomous nodes



SmartSense : multi-sensors network

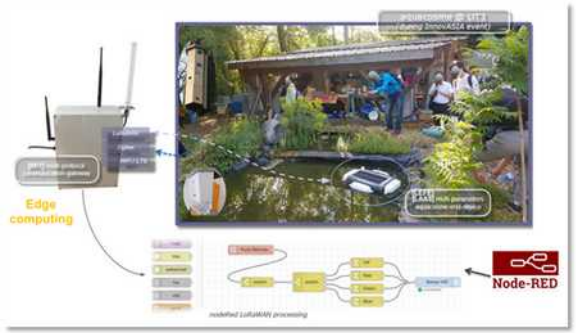


AMALO: adaptative LoRa nodes

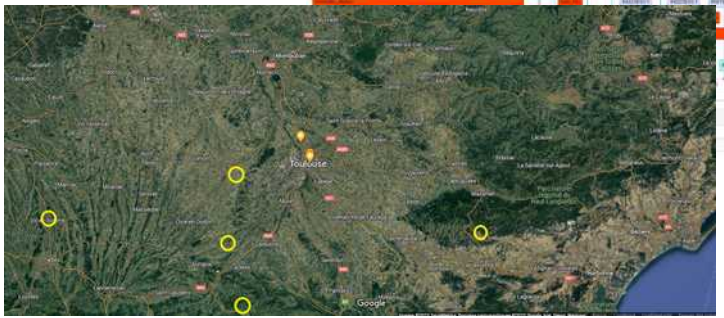
Univ. Toulouse 3, Toulouse INP, IRIT-CNRS

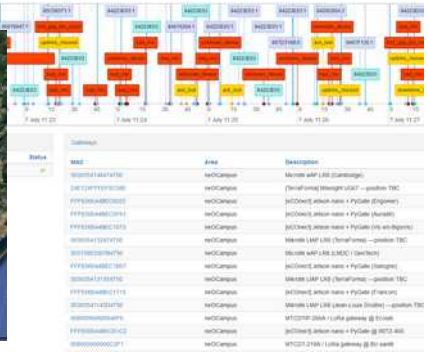
Skills:

- **WPAN, LPWAN** technologies
- **Multi-RAT** IoT gateways



Dashboard





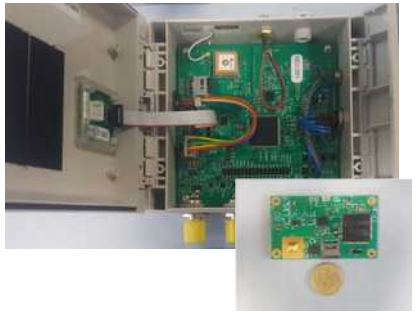
Université de Clermont Auvergne (UCA)
LPC-CNRS laboratory

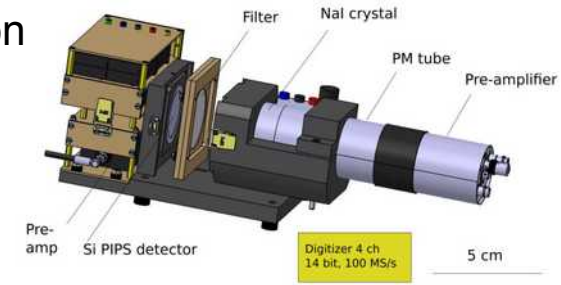
- **Skills:**

- **LoRaWAN private networks** in highly constrained environments
- LoRaWAN generic node (SoLo)
- **Radioactivity** measurement
- **Data Management (CEBA)**
- Management of large collaboration project (HEP programs)

Developments

SoLo and mini-SoLo





Radon **A**nalysis on **V**olcanoes with **I**n-situ **O**bservations of short-**L**ived **I**sotopes (RAVIOLI)

Experimentations

- 6 sites in Auvergne (lake, rivers, agr. field, pasture, …)

- Volcanos: Etna, Masaya, Soufrière

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Division Technique (DT) of INSU-CNRS

Skills:

- Technical staff of about 40 p.
- Design and deployment of instruments for **hostil environments**
- Management of **public tenders** for devices duplication process
- Management of instrument stock

Developments & Experimentations

- Design, test and the french seismologic and geodesic network (RESIF) system; management of contracting for production

From prototype …

… to industrial system

3ème Rencontre TERRA FORMA
Jardin du Lautaret 28-30 Mai 2024

Biologistes, Hydrologues, Géologues, Physiciens, Electroniciens, Créatifs (SHS), Agents PNE et Informaticiens (RSD + Data)

Rappel : LoRaWAN

Nœuds

Passerelle(s) ou gateway

Serveur LoRaWAN
LNS

Ex:

THE THINGS NETWORK
ChirpStack
Live Objects
acklio

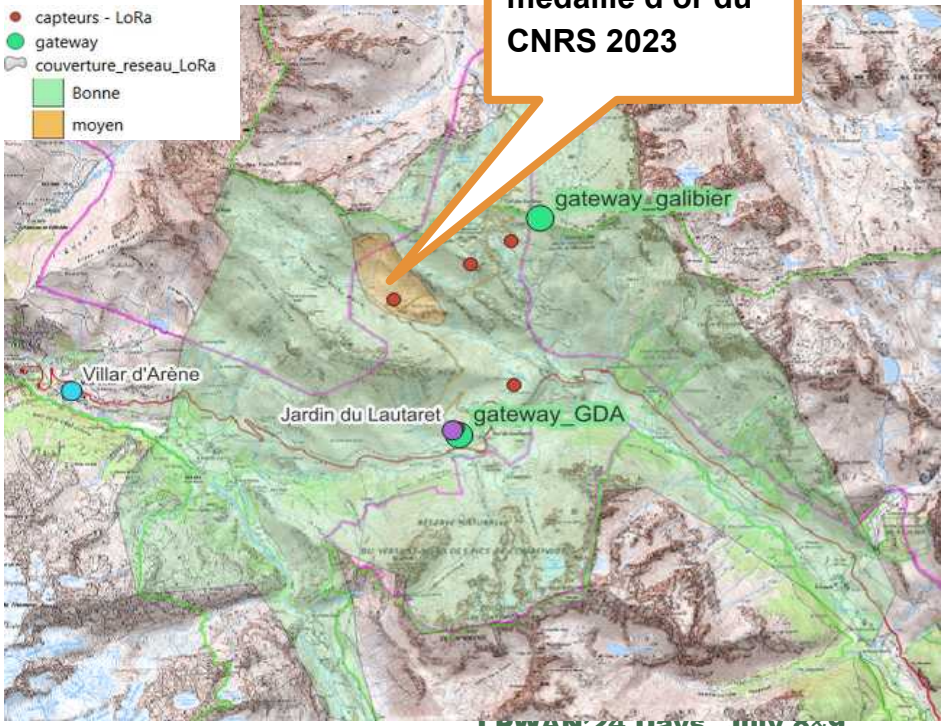
Serveur(s) application

Objectifs des rencontres TF LoRaWAN @ Jardin du Lautaret 28-30 Mai 2024

- **(Un des) Objectif de TERRA FORMA**

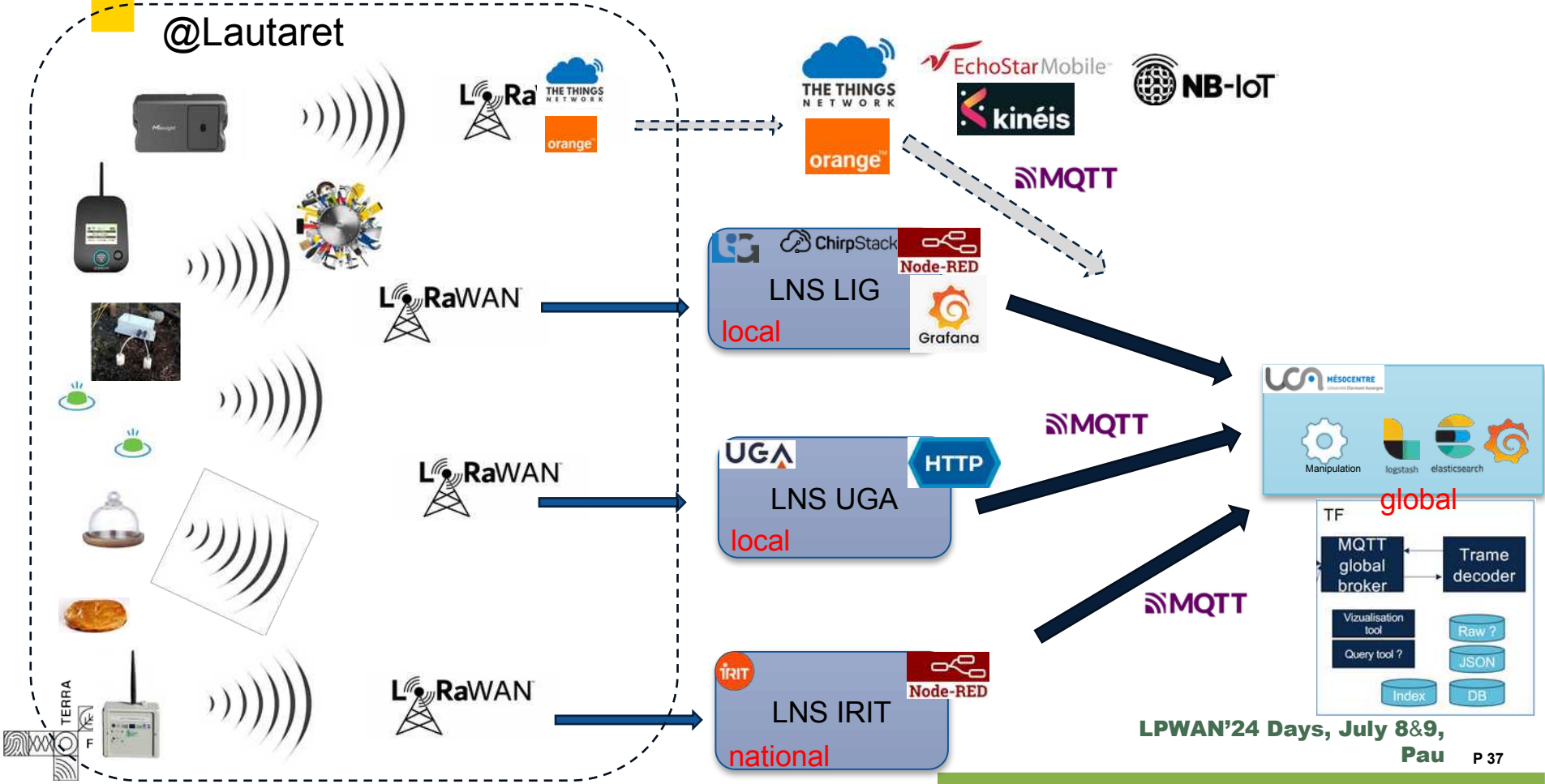
- **Fournir une infra « plug-and-play » de collecte de données de capteurs LoRaWAN (entre autres)**
  - Déploiement **simple** et **standardisé** de capteurs LoRaWAN quel que soit le site TF
    - Grâce à un serveur **LNS TF national** (démonstrateur @IRIT)
    - Modèle inspirant : service communautaire TTN
    - Viser une « grande » **qualité de service** !
  - Possibilité d'utiliser LNS « locaux » et opérés
    - => agrégation des flux de données sur **serveur global** (démonstrateur @UCA)

Infrastructure LoRaWAN @ Lautaret

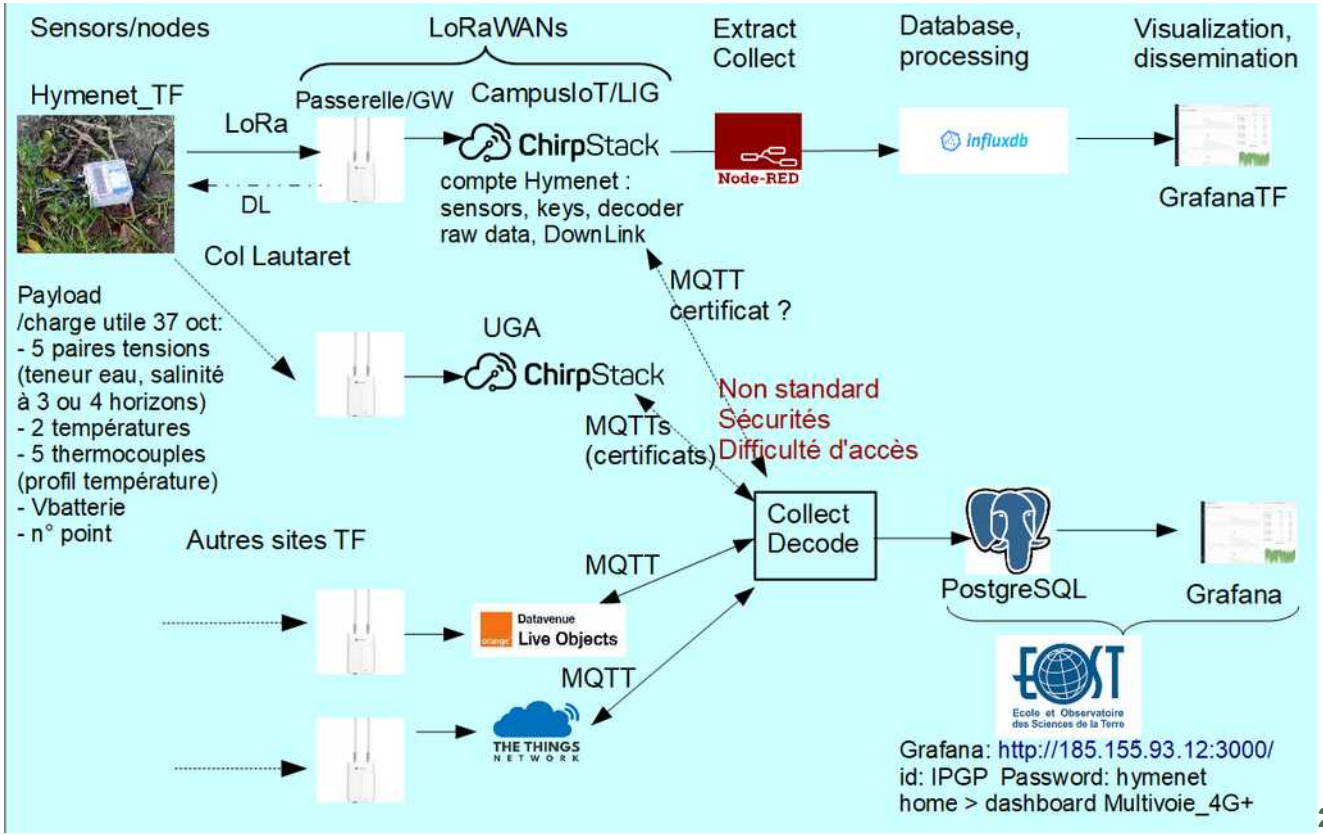


Sandra Lavorel, médaille d'or du CNRS 2023

Expérimentation d'un serveur dit Global pour les données dites « chaudes »



Expérimentation de l'infrastructure LoRaWAN locale @Lautaret



Testeur Terrain (aka FTD) multi-technologies multi-réseaux

https://gricad-gitlab.univ-grenoble-alpes.fr/thingsat/public/-/blob/master/balloons/2024-05-24/README.md#media

Endpoints sentinels : évolution de la couverture réseau

https://github.com/CampusIoT/RIOT-wyres

https://github.com/i2hm/micro_climate_station/tree/main/kicad/rak3172_board

Conclusion

Aujourd'hui LoRaWAN SubGHz

Demain NB-IoT, IoT satellitaire, 5G, LoRa Relay, Mesh (DECT NR+), LR-FHSS, mioty, …

Il y aura presque toujours un tuyau adapté à la remontée des données métier (eRECA)

Terrain d'expérimentation "extrême" à échelles réelles et source de data set pour la communauté ResCom

Coopération avec SLICES FR

Laboratoires impliqués : CARRTEL, CEBC, CEFE, Centre de Géosciences, CERFE, CESBIO, Chrono-environnement, CRAL, CReSTIC, DT-INSU, Dynafor, ECOBIO, ECOLAB, EVS, GET, GR, GSMA, HABITER UR, IGE, IM2NP, IPAG, IPGP, IRISA, IRIT, ISM, ISTO, LAAS, LCA, LECA, LEMAR, LHYGES, LIG, LIRMM, LMGE, LPC, LRGP, LIS, RiverLy, SAS, Subatech.

Tutelles et partenaires non académiques : CNRS :INSU, INEE, INSIS, IN2P3, INP, INS2I, INSHS, INSB.**Autres organismes de recherche** : IRD, INRAE, IPGP. **Ecole d'ingénieur** : Mines ParisTech. **Universités** : Grenoble, Savoie-Mont-Blanc, Toulouse et Toulouse INP, Rennes, Clermont-Auvergne, Montpellier, Reims, Toulon, Franche Comté, Orléans, Strasbourg, Aix Marseille.**EPIC**: INERIS. **PME**: Extralab

Soutiens: CNES, OFB, BRGM, Agence de l'eau Loire Bretagne, Réseau RECOTOX, l'observatoire du sol vivant, Institut Carnot Eau & Environnement, Groupes Régionaux des experts du climat, Régions, Office régionales de la biodiversité, Fondation François Sommer

Remerciement aux autrices du livre TERRA FORMA qui nous ont laissé l'emprunt de leur titre.

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