



SMART WINE PRODUCTION USE CASE

Deploy an IoT system, based on 150 actuator/sensor nodes, to monitor and collect the data coming from 5 vineyards and cellars to perform data analysis and decision making to improve the vine yield and wine production

FABRICE DUBOURDIEU
DENIS DUBOURDIEU DOMAINS



OUTLOOK

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- Context
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- IoT System Overview
 - Device/Edge Domain : Sensors and Gateway/MiddleWare
 - Cloud Domain : Data Analysis
 - Application Domain : User Interface
- Conclusions



DENIS DUBOURDIEU DOMAINES

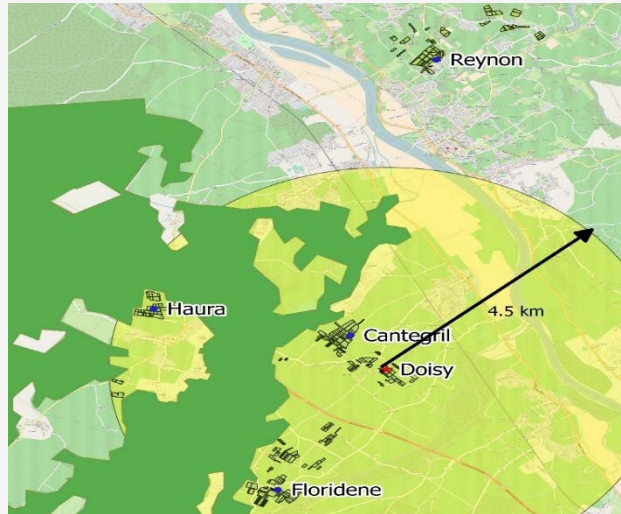
— *Vignerons à Bordeaux depuis 1794* —

- Family estate Bordeaux wine producer
 - 5 different estates 125 ha of vineyard
 - 4 wineries
- 14 different wines (Red, Dry White, Noble Sweet)
 - Staff about 45 (full time equivalent)
 - Sales : ~5 M€; ~0.5M bottles

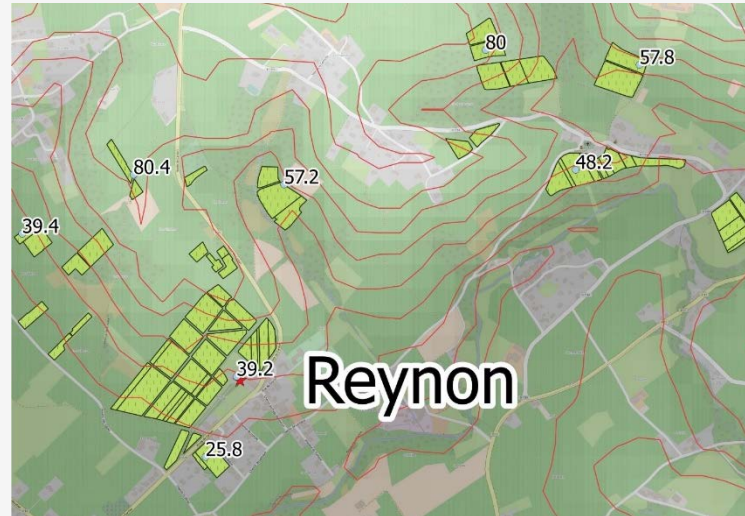
OUR ESTATES

- Château Doisy-Daëne à Barsac Grand Cru Classé 1855
- Château Cantegril à Barsac
- Clos Floridene à Pujols s/ Ciron (Graves)
- Château Haura à Illats (Graves)
- Château Reynon à Beguey (Cadillac Côtes Bordeaux)
- More information : www.denisdubourdieu.com

TOPOLOGY AND GEOGRAPHICAL DISTRIBUTION OF THE 5 DOMAINS



The forest in the area of the IOT application



The Reynon vineyard with some elevation points

CONTEXT

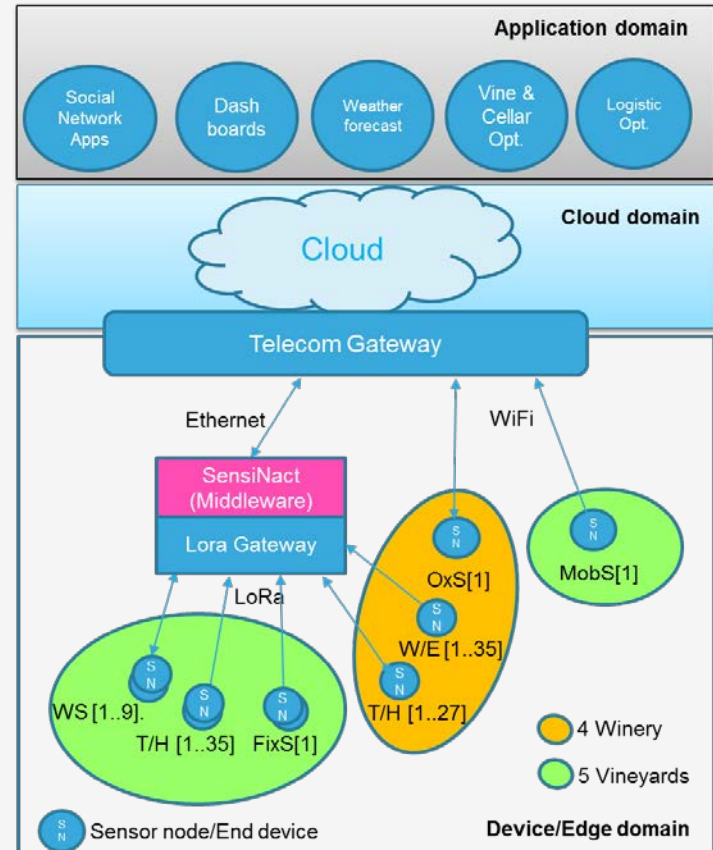
- Manage a **large number of sites and data** with few staff is hard. New tools are required to facilitate this management.
- **Optimize wine production**, preserving its quality, is fundamental to keep competitiveness.
- **Optimal management of resources** (man-power, equipment, phytosanitary products, water, electricity, etc.) is a key economic factor for small and middle winegrowers.
- We are member of an ISO14001 certified organization

OBJECTIVES

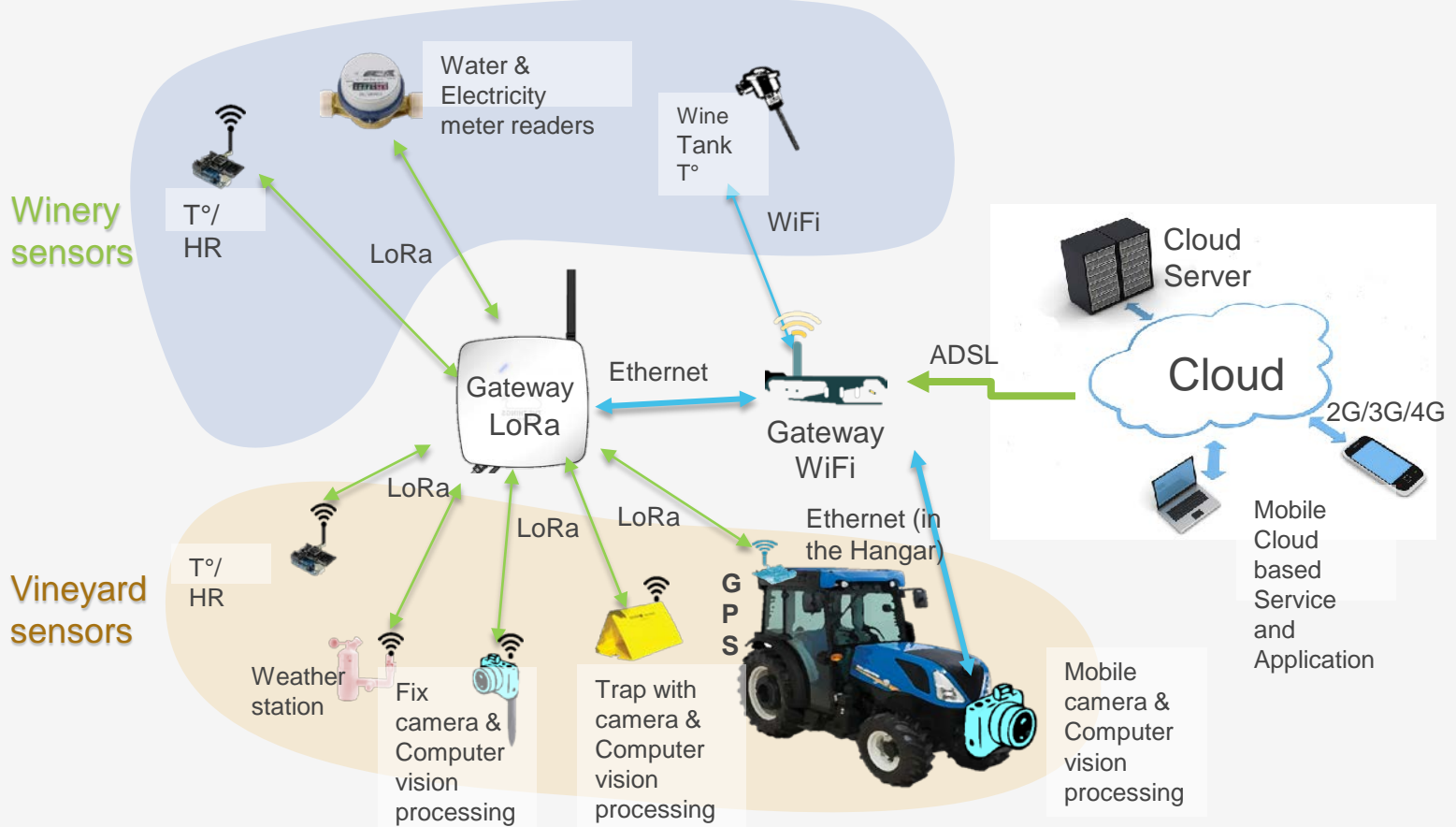
- **Improve vine and wine production** by defining, and implementing an IoT system able to gather the data, coming from different vineyards and cellars, to perform data analysis, system and risk management, and decision making.
- **Provide** to middle and small winegrowers and producers **new tools to optimize resources** (manpower, fertilizers, materials, electricity, water, etc.) and preserve the environment by reducing the use of pesticides, carbon print, etc.
- Deploy a cost effective precision viticulture management and a global vineyard control system in order to **increase competitiveness**.
- **Optimize** the use of inputs in wine-making by controlling **all environmental factors affecting the process** (temperatures, humidity, oxygen, etc.).

SMART WINE PRODUCTION IOT SYSTEM OVERVIEW

- **Device/Edge Domain**
 - ✓ Sensors to monitor weather, vineyard and winery conditions.
 - ✓ Middleware for data gathering.
- **Cloud Domain**
 - ✓ Perform data analysis on : weather conditions, vineyard phenological stages and resources.
 - ✓ Use analysis results to improve vine yield, wine quality and optimize resources.
- **Applications Domain**
 - ✓ Facilitate decision making by monitoring and controlling the vineyards and cellars at anytime and anywhere.
 - ✓ Optimize resource allocation and use.



EDGE DOMAIN : SENSORS



WEATHER AND WINERY: SENSORS

- Sensors for monitoring weather conditions: distributed in 5 vineyards of 125 hectares, with a density of at least 1 device every 2.5 hectare.
 - ✓ 9 Weather stations sensing Temperature, Hygrometry, Barometric pressure, Wind speed and direction, Solar radiation, Rainfall.
 - ✓ 35 sensors for Temperature and Hygrometry
- Sensors for monitoring winery conditions.
 - ✓ 27 sensors for Temperature and Hygrometry.
 - ✓ 26 Water meter readers.
 - ✓ 9 Electricity meter readers.



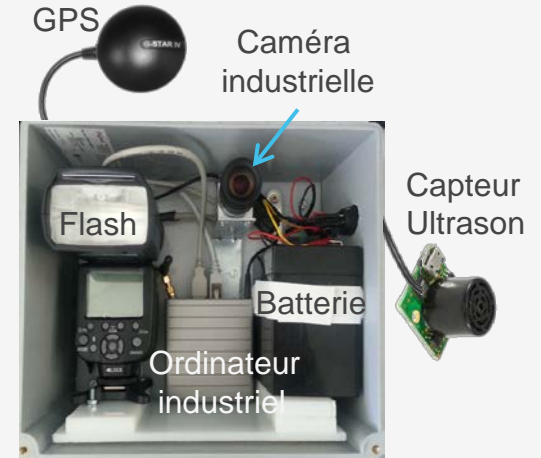
PHENOLOGICAL STAGES: FIXED SENSORS

- Fixed sensors monitor, night after night, the evolution of the vine.
 - ✓ Specific camera and lighting for visible and near Infra Red images of the vine. On board processing reduces drastically the data length sent to the gateway.
 - ✓ Low spatial density but high temporal density.
- Data collected:
 - ✓ Phenological stages.
 - ✓ Disease symptoms.
- Low cost technologies for large distribution in the vineyard.
- A variation of this sensor exists for counting bugs in traps.



PHENOLOGICAL STAGES: MOBILE SENSORS

- Mobile sensors are mounted on tractors.
- They acquire images every meter along the tractor track with a dedicated camera.
- Images are stored on board all along the trip and transferred to gateway via WiFi once in the hangar.
- Data collected:
 - Phenological stages.
 - Vine vigor estimation.
 - Yield prediction.
- Data with high spatial density and low time density are then acquire.



EDGE : CONNECTIVITY

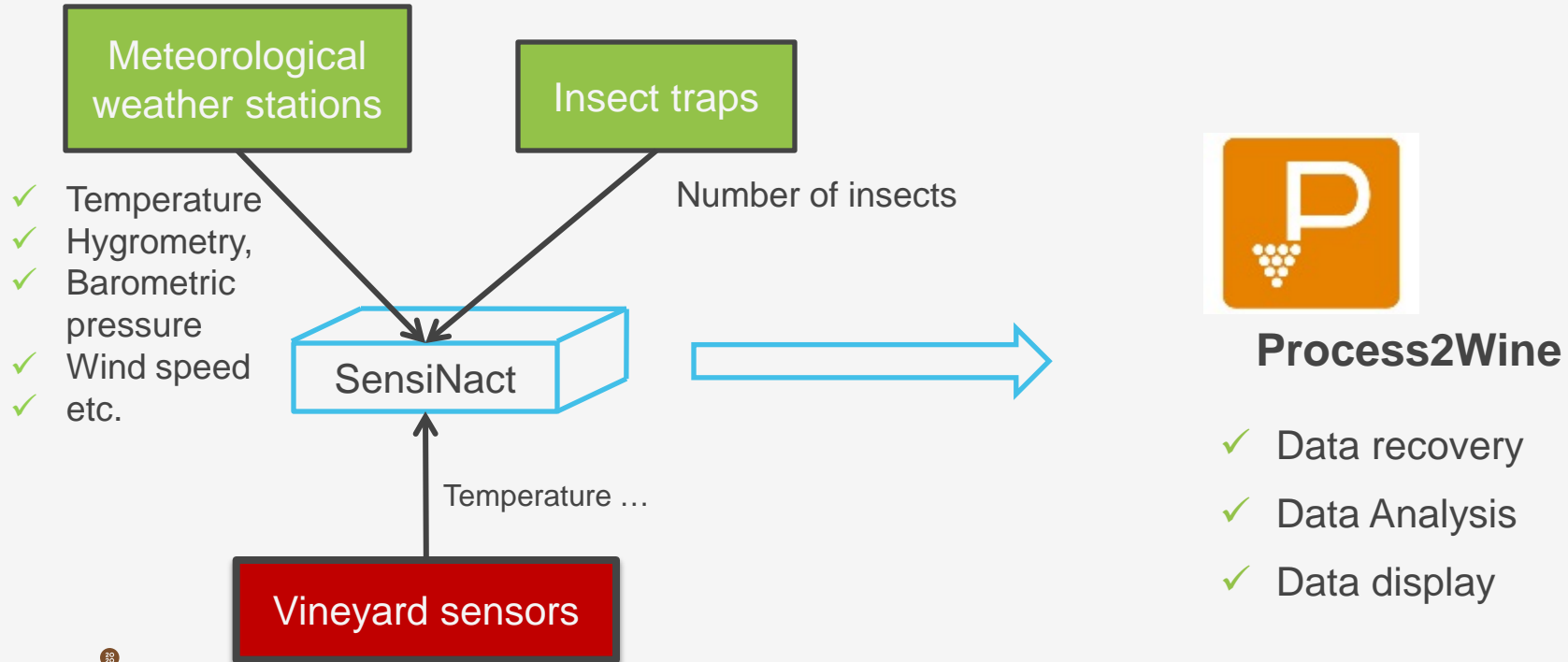
- LoraWAN Sensor Network
 - ✓ Operates in EU863-870 ISM (Industrial, scientific and medical) unlicensed band
 - ✓ Long Range communication till 15 kms in suburban areas
 - ✓ Star-of-starts topology
 - ✓ Low Power – high battery lifetime(3-5 years minimum required)
 - ✓ Low bit rate from 27 kb/s to 50 kb/s according to the transmission mode
 - ✓ Low cost transceiver
 - ✓ Private Network without the involvement of mobile network operators
 - ✓ Application (transmission of around 250 sensed data every 15') complaint with maximum duty cycle (key constraint for networks operation in unlicensed bands).

EDGE : GATEWAY & MIDDLEWARE

- Gateway
 - ✓ End devices/sensors send data to gateway over single wireless hop.
 - ✓ Gateway (nodes) relay messages between end devices and a central network server
 - ✓ Gateways are connected to the network server through a non-LoRaWAN network (e.g. IP over cellular or Ethernet).
 - ✓ Communication is bidirectional, although uplink communication from end devices to the network server is strongly favored.
- Middleware
 - ✓ **SensiNact** allows to gather the data coming from the LoRaWAN Network and send them to the Cloud for data analysis.

CLOUD : DATA ANALYTICS

- Data recovery from a sensor network



CLOUD : DATA ANALYTICS

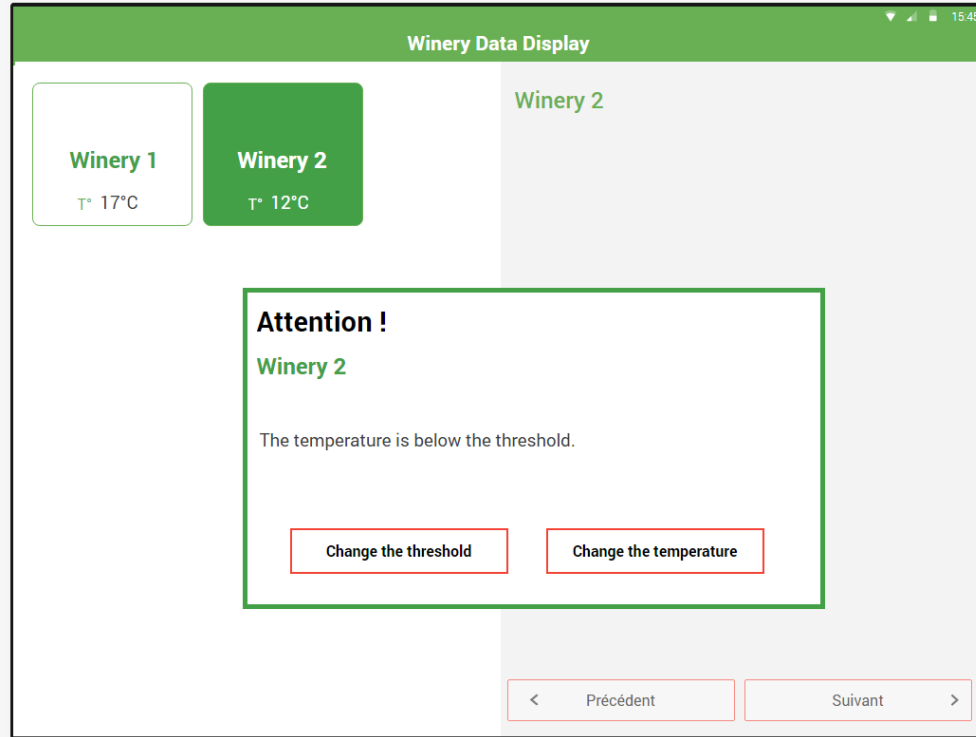


CLOUD : DATA ANALYTICS

- Phenological data analysis:
 - Phenological stage detection: bud breaks, flowering, fruit set, veraison...
 - Disease symptoms: redness or yellowing of leaves, rotting.
- Vigor estimation:
 - estimated using vegetation indices or leaves porosity (summer), shoots length and diameter (winter)
- Yield prediction:
 - inference from the number of visible berries on each image.
- Combining data from fixed and mobile sensors to take advantage of high temporal density and high spatial density

APPLICATION : USER INTERFACE

- Winery data display and alert system



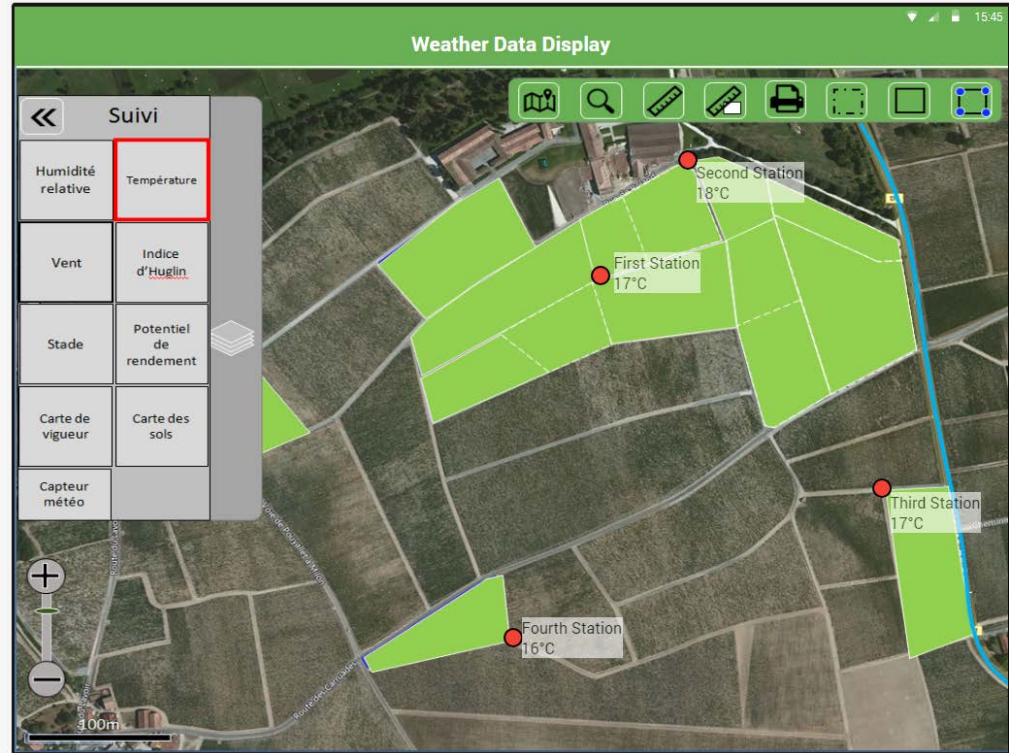
APPLICATION : USER INTERFACE

- Weather data display
- Service Provider

Weather data \updownarrow Climate model maps



- ✓ Temperature,
- ✓ Relative humidity,
- ✓ Wind map,
- ✓ Phenological stage,
- ✓ Sunshine,
- ✓ Strength map...



CONCLUSIONS

- Developments on going to adapt all sensors to LoRaWAN connectivity
- Trials done to validate LoRaWAN communications
 - ✓ Very good solution for winery considering long distance and walls thickness.
 - ✓ Very good solution to gather data from vineyards of several kms.
- New features introduced thanks to the Smart wine production IoT system
 - ✓ Real time reporting.
 - ✓ Monitoring (temperature, density during vinification...).
 - ✓ Precision Viticulture Techniques.

PARTNERS



Denis Dubourdieu Domaines

Wine grower and Wine
Producer



VINIDEA

Innovation brokering and
dissemination to wineries



Process2Wine

IT provider for a Smarter
Viticulture



ISVEA

Analytical, consulting and
R&D services to Wine
industry.



Bordeaux INP

Signal and Image
Processing Research lab



CEA

Worldwide, leading,
Applied Research center



life.augmented

STMicroelectronics

Semiconductor company
leader in IoT components.