



The **SPADE** project: A multi-purpose physical-cyber Agri-forest drones ecosystem for governance and environmental observation

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 @Spade_EUproject
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INTRODUCTION

Rationale:

Risks related to drone operations

- Cyber-security breaches
- physical safety and security hazards
- risks of human errors

Regulations concerning drones are new

Emergence of new operations, applications and services

Technological architecture is complex



INTRODUCTION

Our Project

SPADE aims to develop an intelligent ecosystem to address the multiple purposes concept in the light of deploying unmanned aerial vehicles (UAVs) to promote sustainable digital services for the benefit of a large scope of end users in sectors of crop production, forestry, and livestock. This includes individual UAV usability, UAV type of applicability, UAV governance models availability and UAV generated data trustworthiness.



Start Date

1 September 2022



End Date

31 August 2026



INTRODUCTION

The consortium

21 partners

- 9 European countries (Spain, Greece, Norway, Denmark, Germany, France, Portugal, Finland, Slovakia)
- 1 associated – UK

Multidisciplinary consortium

universities, research institutes, small and medium-sized enterprises (SMEs), highly recognised consulting companies and 2 cooperatives



INTRODUCTION

SPECIFIC OBJECTIVES



Learning and engaging others in learning about the various impacts and risks of drones as multi-purpose vehicles on the "Farm-to-fork" ecosystems



Develop cost-effective drones and sensors for multipurpose applications



Develop an open-source, open-access ecosystem which allows the collection, processing and distribution of data from and to multiple stakeholders



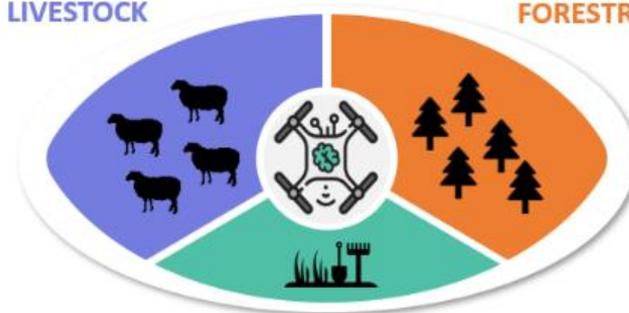
Pilot deployment of the SPADE ecosystem in 3 pilots and further applications through an open call for optimally integrating its components and optimizing its use



Making the innovation known, used, socially robust and anchored for long term in agriculture and forestry

LIVESTOCK

FORESTRY



CROPPING

PILOTS



Forestry Pilot

A case study in Southern Norway in forestry inventory, forest harvest and other forest operations



Open-field Pilot

The open-field case study in Spain on potato crops and fruit farming in terraced crops, focusing on crop scouting, disease detection, monitoring and other operations

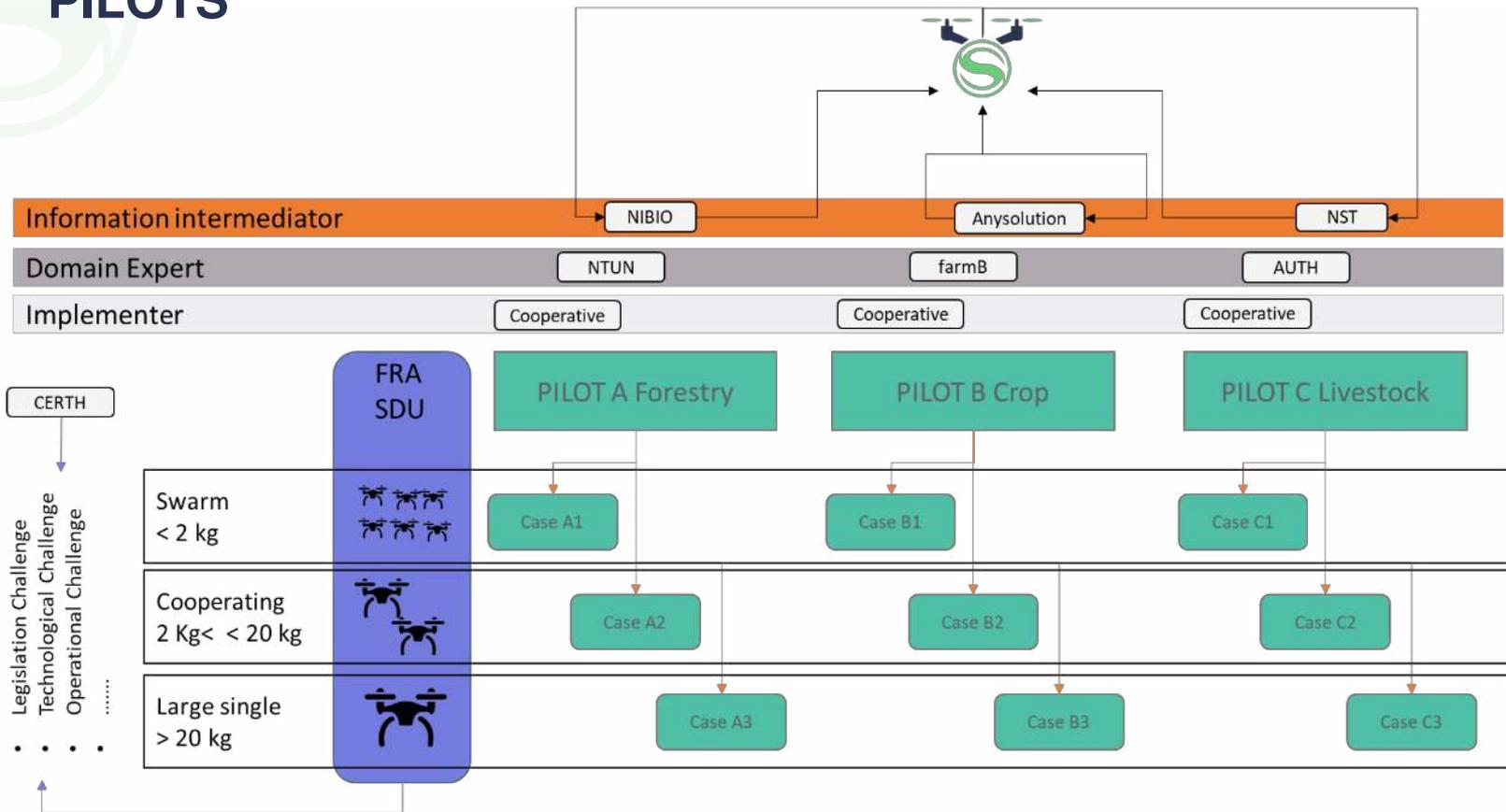


Livestock Pilot

Pilot on the Greek island Lesvos with 3 use cases that aims to promote and improve breeding via grazing & health monitoring of sheep flocks

The pilots will utilise 3 use cases in terms of drones' operation and size: swarm small sized drones, cooperating medium sized drones and large operations drones.

PILOTS



Forestry pilot - Norway

Norway

Use Cases:

Swarm for inventory

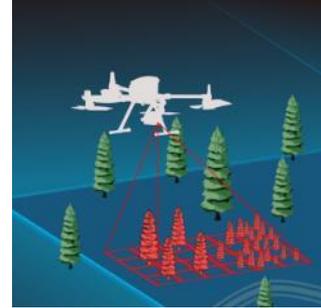
One larger drone: with lidar scanner flying above forest. Small drones flying between trees

Collaborating - Planting drone

Drone making inventory of the forest and locating the areas for planting

ML solution for detection of the seedling desired positions

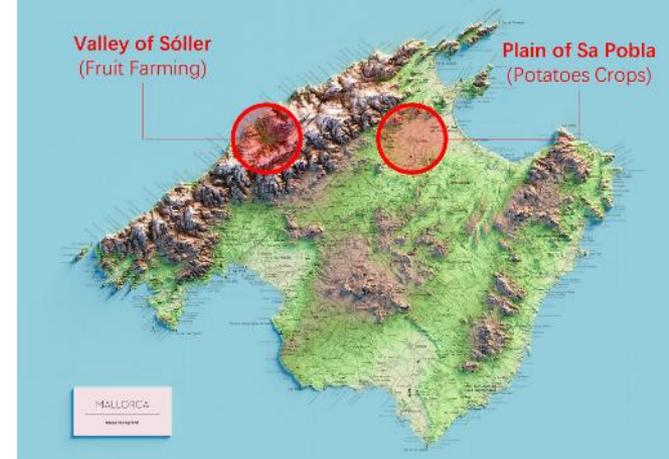
Large drone: for lifting tree logs



Open field pilot - Spain

Mallorca – Balearics

Use cases in potato fields, olive and citrus orchards
(terraced crops)



Open field pilot - Spain

EXPECTED USE

- Early detection of **pests and diseases**
- **Crop scouting** for vegetative state of the plants (detection of areas with fertilizer and/or watering problems)
- **Yield prediction**
- **Crop monitoring and decision-support**
- High **precision irrigation and spraying done by drones**
- Characterization of soil variability to **plan future crops**

CHALLENGES

- Very low level of digitalization in the agricultural sector in the Balearic Islands
- Use of drones limited by several regulatory restrictions, such as:
 - Fruit farming use case located in protected area (*Serra Tramuntana* – UNESCO site)
 - Spraying (of any type) not allowed at regional level (Balearic Islands)
 - Not allowed to fly drones over 10kg at national level (Spain)

NEEDS

- Regulatory changes are required at regional/national level to be able to test the large drones and spraying applications
- Categorization of spraying applications should be promoted (not the same spraying of phytosanotary products and spraying of water for irrigation, or insects for biocontrol of plagues and diseases)
- Administrative burden to fly drones (especially in restricted/controlled areas) should be made easier for farmers in order to ensure a wide adoption of drones in agriculture

Livestock pilot - Greece

Lesvos Island

Use cases to be evaluated in situ:

- Detection & counting. (Edge Computing tools using ML)
- Real-time tracking of herds. (Edge Computing tools using ML)
- Grazing land search: Landscape conditions detection and identification of grazing areas, Thresholding targeted area for virtual fencing. (Edge Computing tools using ML combined with NDVI grazing zone maps)

Sensors

- Drones equipped with: thermal, RGB, multispectral
- edge computing devices
- wearable IOT sensors, GPS tracking, accelerometer
- NST dashboard developed for SPADE



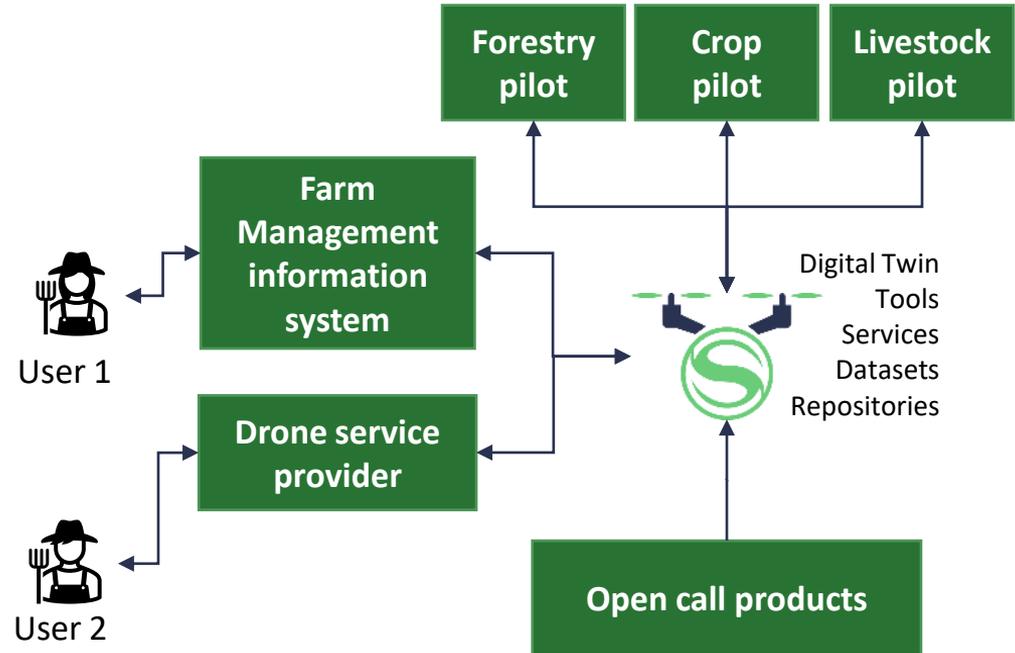
The SPADE ecosystem

SPADE platform

- Distributed architecture
- Cybersecurity, Connectivity and Interoperability
- Digital twin support
- Drone data marketplace
 - Data processing and distribution
- Services marketplace

Large scale demonstration and impact

- Pilots in Forestry, Crop and Livestock
 - 3 use cases – swarm, cooperative and large operative for applications
- Open calls
- Virtual representation via digital twin method
- Open source
- Standardisation



Policy aspects

Operational

- **Regulations on flight** altitudes and flight paths to prevent interference with commercial aircraft and ensure safety.
- **Geofencing regulations** to prevent drones from **entering restricted areas**, such as airports or protected wildlife zones.
- **Licensing requirements** for drone operators, including **training, certification**, and knowledge of relevant regulations.

Data

- **Privacy guidelines** to address concerns related to aerial surveillance and **data collection**.
- Encryption and **data security standards** to **protect sensitive information** collected by drones.
- **Data ownership** and sharing policies to ensure appropriate use of collected data and **protect farmers' and landowners' rights**.
- **Standards for drone performance** and accuracy in **data collection** to ensure reliable and high-quality results.
- **Guidelines for collaboration** and data sharing among drone operators, research institutions, and government agencies.

Environment & Ethics

- **Environmental impact** assessment guidelines to minimize disruption to wildlife habitats and **sensitive ecosystems**.
- **Noise pollution** regulations for drones to mitigate **disturbances to wildlife** and nearby communities.
- **Ethical guidelines** for using drones in **wildlife research and conservation** to minimize stress on animals.

Technical

- **Standards for drone maintenance** and inspection to ensure safe and **reliable operation**.
- **Battery disposal** and recycling policies to manage the **environmental impact of drone batteries**.
- **Insurance requirements** for drone operators to **cover liability** and potential damages.
- **Guidelines for public engagement** and consultation to address **community concerns** and promote transparency.

High Level Architecture and digital twins

Standardisation

IoT & Edge Landscape Report

Gap Analysis Report

IoT Impact Beyond 5G Report

Computing Continuum Report

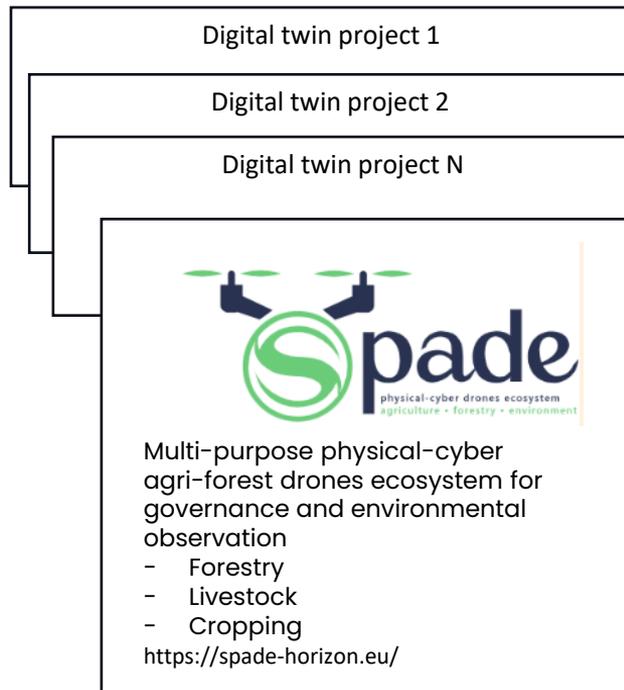
Ontology Landscape Report

Guidance on integration of IoT/Edge in
Data Spaces

Landscape of EU funded projects

(High Level Architectures and Digital Twins)

(Report on continuum)



Digital Twin Reference
Architecture

ISO/IEC 30188

Security and Privacy of
Digital Twins

ISO/IEC 27568

Systems of systems UAS
(Unmanned Aircraft Systems
Reference Architecture

ISO/IEC 22080, ISO/IEC
27115

Antonio Kung (TRIALOG)
Asbjorn Hovsto (HAFENSTROM)



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physical-cyber drones ecosystem

agriculture • forestry • environment