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

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Agenda

- The SPADE project
- Description
- Objectives
- SPADE pilots
- SPADE ecosystem
- Open research
- Next steps

THE SPADE PROJECT

MULTI-PURPOSE PHYSICAL-CYBER AGRI-FOREST DRONES ECOSYSTEM FOR GOVERNANCE AND ENVIRONMENTAL OBSERVATION

Funded by the European Union

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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

Why SPADE?

Variety of risks related to drone operations

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

Regulations concerning drones are still new

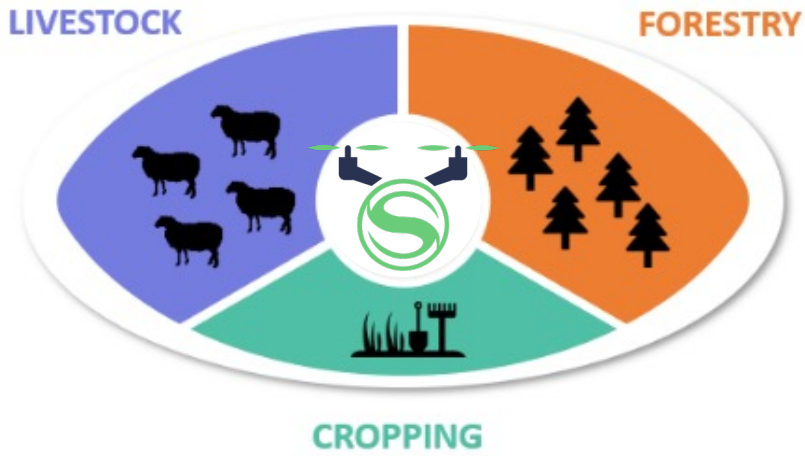
New operations, applications and services built on drones' capabilities are emerging

The technological architecture is getting more complex

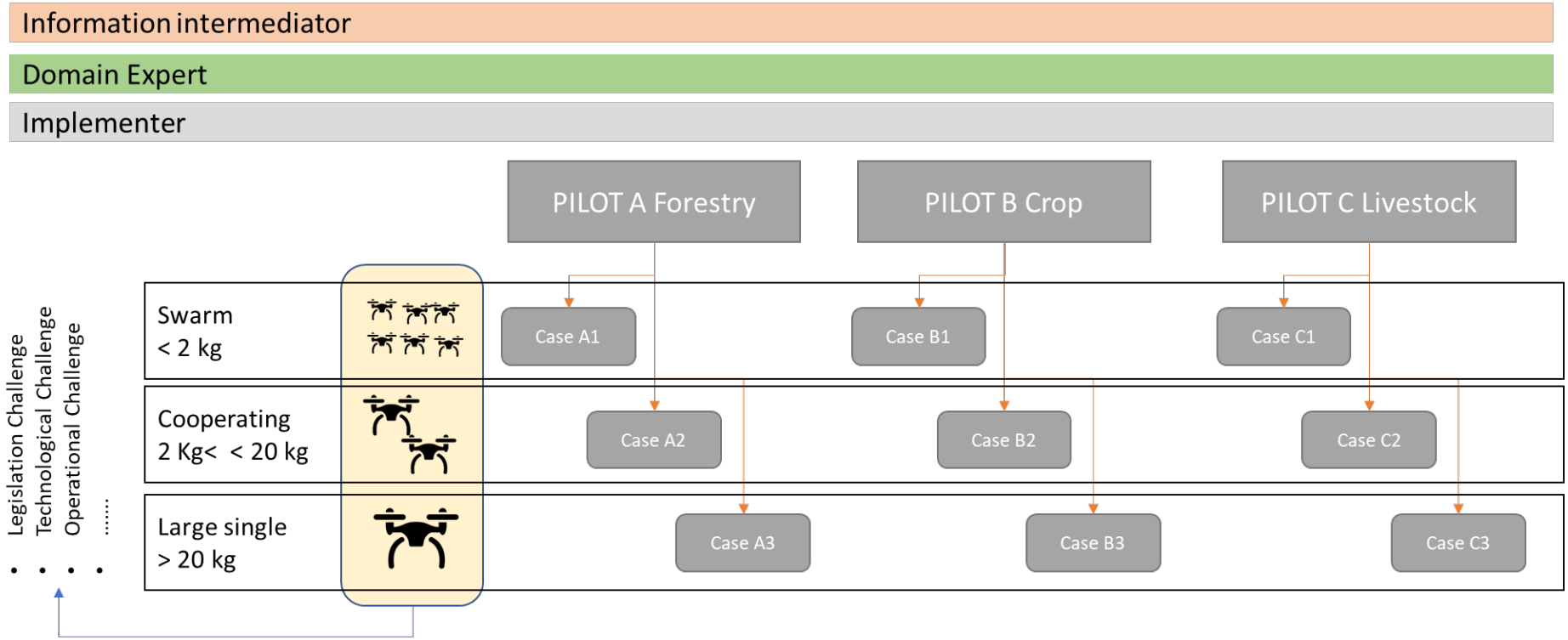
The objectives

develop an intelligent ecosystem

- to address the multiple purposes concept of deploying Unmanned Aerial Vehicles (UAVs)
- to promote sustainable digital services in the sectors of forestry, cropping and livestock farming



The pilots


Information intermediator
Domain Expert
Implementer
PILOT A Forestry
PILOT B Crop
PILOT C Livestock
Swarm
< 2 kg
Cooperating
2 Kg< < 20 kg
Large single
> 20 kg
Case A1
Case B1
Case C1
Case A2
Case B2
Case C2
Case A3
Case B3
Case C3
Legislation Challenge
Technological Challenge
Operational Challenge
.....

Forestry pilot

Swarm	Cooperating	Large single (actions)
Goal: improved forest inventory	**Goal:** improved performance of forest harvesters	**Goal:** replacing manual labour and wheel machines with drones for higher efficiency and lower environmental impact
Technical solution: flying through the forest with AI-enabled drone swarm	**Technical solution:** Tethered drone from roof of harvester will support operator, monitor environmental performance and ensure connectivity in remote areas with low connectivity	**Solution:** Cargo drone will be used to move heavy objects (harvested logs) from the forest
Beyond state of art: under-canopy flying with swarm compared to current single drone above canopy flights	**Beyond state of art:** Tethered drones are applied for military purposes but have never been used in forestry	**Beyond state of art:** Cargo drones have not previously been used in the forestry sector
Risk: flying multiple drones and colliding with people, line of sight	**Risk:** continuous flying drone above machines and people needs to be addressed	**Risk:** flying very heavy drones in areas with forest workers and machines cause safety, health and regulatory risks.

Crop production pilot

Swarm	Cooperating	Large single (actions)
Goal: Improved pest control and crop monitoring	**Goal**: Improved pest control in olive orchards, improved potato crop monitoring	**Goal**: replacing manual labour or heavy ground vehicles in agriculture operations (e.g., spraying)
Technical solution: flying over crop fields and orchards with AI-enabled drone swarm	**Technical solution**: cooperative under-/above-canopy flight for pest detection in olive trees. Potentially, tethered drone for crop monitoring	**Technical solution**: heavy
Beyond state of art: in orchards, swarm orchestration for simultaneous data gathering in several tree rows	**Beyond state of art**: cooperative image acquisition in orchards, tethered drone usage in crop monitoring, integration with digital twin/SPADE platform	**Beyond state of art**: integration of heavy drone mission and operations with SPADE's digital twin
Risk: flying multiple drones and colliding with people, line of sight.	**Risk**: safety risk	**Risk**: those related to heavy drones. When spraying is considered, potential health and environmental risks related to the chemicals used.

Crop production pilot

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

- Plant health monitoring
- Zone mapping
- Zone-based applications
- Sprayer applications
- Selective harvesting
- Disease detection
- Weed detection

Livestock pilot

Swarm	Cooperating	Large single (actions)
Goal: Improved Livestock Monitoring	**Goal:** improved performance of Livestock monitoring, employing Livestock health status monitoring.	**Goal:** To substitute manual labour and ground vehicles with UAVs for flexibility, higher efficiency and lower environmental impact (e.g., Spraying).
Technical solution: flying over detected sheep flocks with AI-enabled drone swarm	**Technical solution:** Tethered drone from roof of shepherds' vehicles will support operator, monitor environmental conditions and ensure connectivity in remote areas with low connectivity.	**Technical solution:** Drone payload will be used to carry spraying equipment to deal with disease carrying insects.
Beyond state of art: determine array of sensors via structured deployment of UAVs in swarm formations. Thus, defining virtual sensor combinations.	**Beyond state of art:** Tethered drones are applied for military purposes but have never been used in Livestock.	**Beyond state of art:** Spraying drones have never been used for Health control in Livestock.
Risk: flying multiple drones and colliding with people, line of sight	**Risk:** continuous flying drone above machines and people needs to be addressed	**Risk:** flying very heavy drones in areas with Livestock may raise safety, animal behaviour and regulatory risks that will be measured during SPADE evaluation stages

Livestock pilot

Wearables on animals
- Support tracking in the absence of drones.
- Provide behavior status

Beacon to UAVs incidents of importance or urgency
Collaborate with drones in the livestock health care scenarios

Initial trial
- Scenes included small herds of sheep and goats.
- Height reached max 150 meters.
- Infrared was tested.
- Second test with mixed populations herds + horses

Sensors
wearable IOT sensors, GPS tracking, accelerometer, NST dashboard developed for SPADE

Results
- Sheep did not seem to bother by the presence of the drone even at small height (<6 meters).
- Significant amount of data recorded
- Used for edge computing ML.

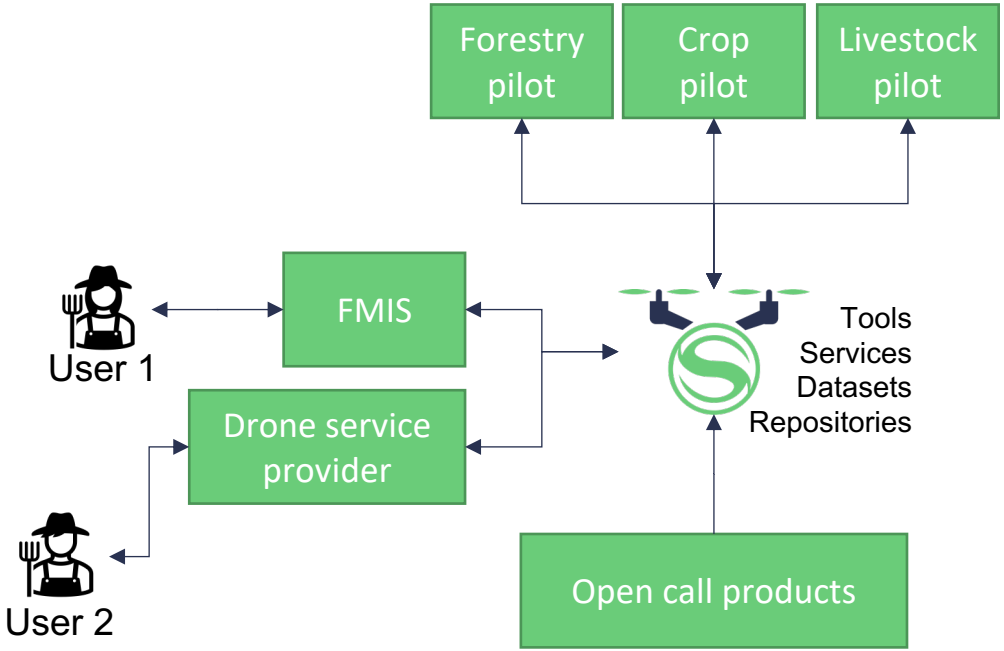
The SPADE ecosystem

SPADE platform

- Distributed architecture
- Support interoperability, interconnectivity
- Drone data marketplace
  - Data processing and distribution
- Services marketplace

Large scale demonstration

- Pilots
- Open calls



The SPADE open research

Open data

- Repositories
- Codes

Open tools

- Services

Open access publications

- Scientific publications
- Popular press and other publications

Project results

- Public documents

Open platform

- External service providers
- External data providers

Next steps

- Finalisation of the system architecture
- System development
- Pilots requirements definition
- Use cases launch and interaction with system
- Open calls launch
  - 2 open calls – various topics

Disseminate the final results at the end of SPADE project


Spade
physical-cyber drones ecosystem
agriculture • forestry • environment