Establishing New Foundations for the Use of Remotely Piloted Aircraft Systems for Civil Applications

Overview and Motivation

Remotely Piloted Aircraft Systems (RPAS), also called drones, can offer many new services and applications. These go beyond traditional aviation and include the promise to perform existing services in a more affordable and environmentally friendly way. The European aviation community is currently exchanging views on how, and under which conditions, RPAS can be allowed to fly.

RPAS have a potential for a wide range of civil applications that would benefit European citizens and industry. As a result, the demand to operate RPAS over long ranges is drastically increasing. However, the regulation regarding the use of RPAS in civil airspace is not yet ready to enable operations beyond visual line of sight (BVLOS).

The SkyOpener project is funded by the European Union through the European GNSS Agency (GSA) in the framework of the Horizon 2020 program. SkyOpener's goal is to test the use of RPAS for civilian applications and to contribute to the roadmap for the integration of civil RPAS into non-segregated airspace. In this context, the use of EGNOS and Galileo is a major opportunity to provide enhanced navigation services in terms of integrity and positioning accuracy.

EGNOS is the first pan-European satellite navigation system. It augments the American GPS satellite navigation system and makes it suitable for safety critical applications such as flying aircraft or navigating ships through narrow channels. Sometimes called the 'European GPS', Galileo provides accurate positioning and timing information using data from its 18 satellites.

SkyOpener will test a system and operational processes aimed at reducing all categories of risks associated with RPAS. The system will allow Air Navigation Service Providers (ANSPs) to monitor RPAS operations taking place in the very low level (VLL) airspace, which is below 500 ft above ground level (AGL). This is done by implementing an Unmanned Traffic Management (UTM) system that interacts with Air Traffic Management (ATM).

The project will also demonstrate two applications, where drones are not yet deployed, due to regulatory constraints. The first is surveillance of linear infrastructure, such as corridor mapping, for powerlines, railways, pipelines. The second is mapping airport area obstacles in the framework of the e-TOD (electronic-Terrain Obstacle Database) standard.

Objectives

The detailed objectives of the SkyOpener project consist of the following:

a) Improvement of reliability and security of navigation systems used on RPAS. SkyOpener will test GALILEO signals as a complement to GPS to show improvement of reliability of the overall navigation. This will improve the positioning robustness and accuracy and mitigate against the risk of GPS signal loss and collision.

b) Integration of Satellite Communication to increase the reliability of the RPAS communication systems. Radio communication systems on board RPAS usually provide 80-90% availability. SatCom systems provide much better availability, typically 99%. SkyOpener is testing a system that will significantly enhance the reliability and the availability of the CNPC (Control of Non-Payload Communication). It will combine radio and satellite link systems with hot redundancy, thus increasing availability up to 99.9%.

c) Testing an ATM system dedicated to RPA VLL operations with interactive surveillance features - UAV Traffic Management (UTM). SkyOpener is testing a surveillance system dedicated to RPAS operations at VLL. The ANSP will receive data from the RPAS to show the aircraft's position in real time.

d) Improvement of information processing and presentation on RPAS to reduce the risk of human error. SkyOpener is testing the user interface at the level of the Remote Pilot in the RPAS, developing a more user-friendly interface for the pilot.

e) Testing the RPAS mission payload and software package for e-TOD services and linear surveillance operations beyond line of sight. SkyOpener is testing an integrated mission payload that includes remote sensing (LiDAR), high definition cameras and direct geo-referencing with satellite navigation. The goal is to provide accurate information about obstacles within the e-TOD (Electronic Terrain and Obstacle data) services geographical boundaries, as well as objects (trees, temporary structures, etc.)

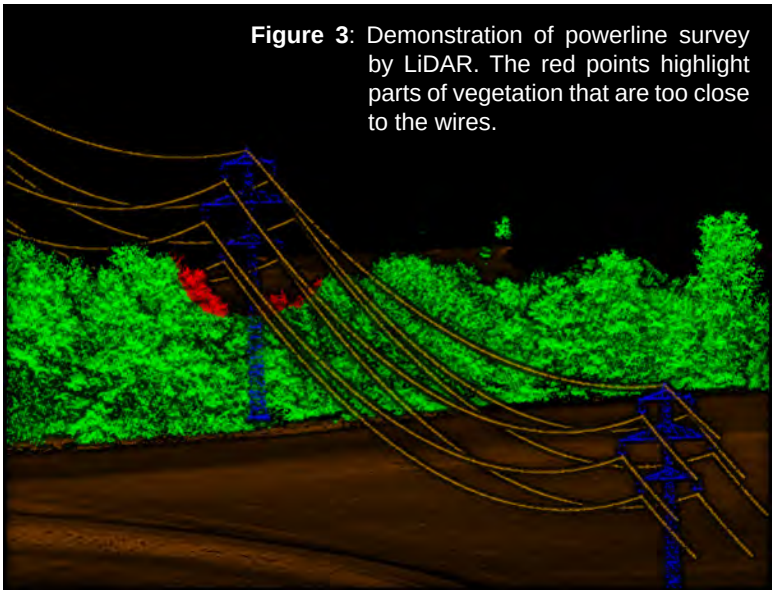


Figure 3: Demonstration of powerline survey by LiDAR. The red points highlight parts of vegetation that are too close to the wires.

that intrude into linear infrastructure corridors, and emergency or post-emergency surveys (landslides, flooding, collapse, short-circuits, etc.) of critical infrastructure.

Methods and Project Status

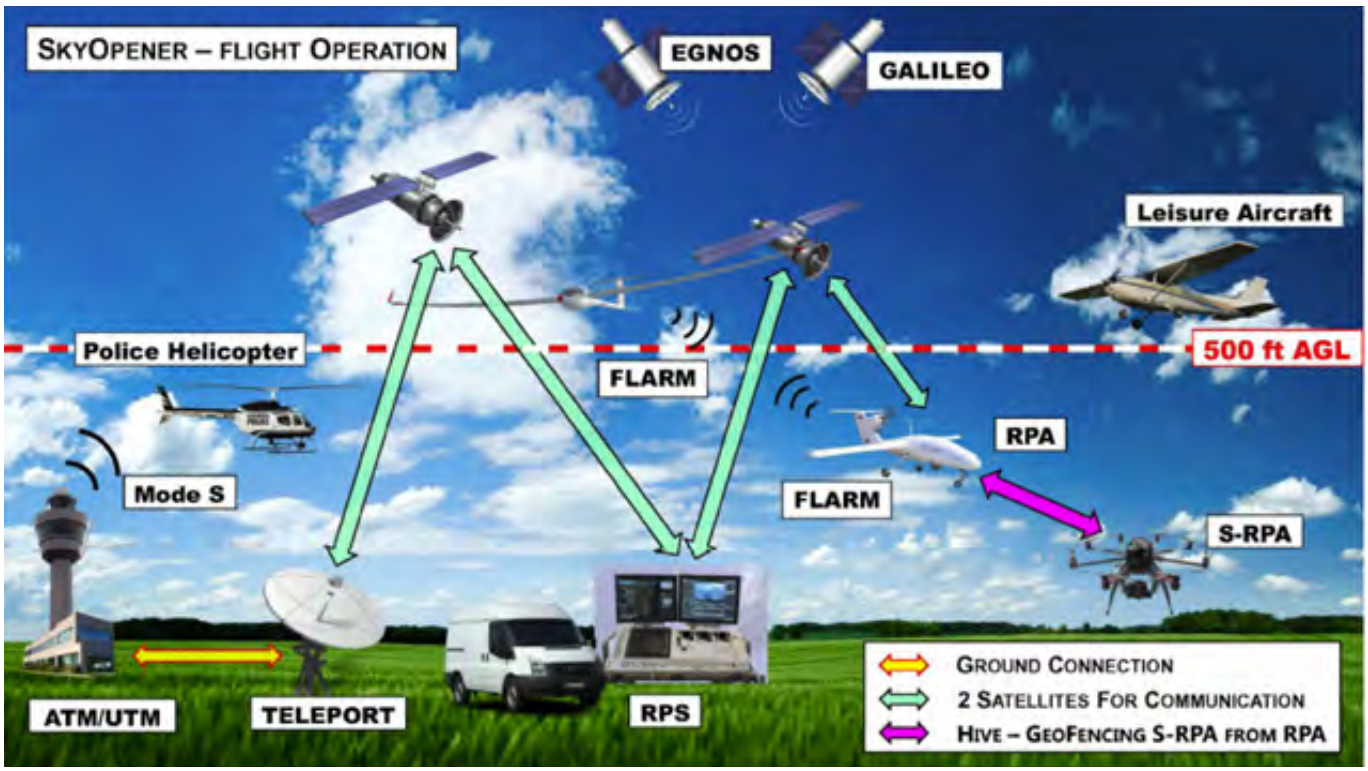
Components of the system have been developed and tested. These include:

- The redundant command & control communication and data relay, based principally on satellite communication (L- and Ka-band frequencies) and mobile communication (LTE);
- The mission computer system, managing interactions between RPAS and ground station, autopilot, payload control and storage, real-time alarms management, and communications systems;
- The ground station, featuring a user-friendly interface to manage all phases of the mission, from mission planning, authorization requests, geofencing planning, to flight-time control, telemetry, data exchange, emergency handling, and finally mission data download;
- The UTM system, allowing interoperability with existing ATM environment, and public access for drone operators;
- An operating system for commercial drones, managing a variety of aircrafts and integrating aerial data into design, engineering, asset management and decision workflows;
- The mission data exploitation chain, based on workflows (tested on real-world data in equal or very similar conditions as required in operation) for LiDAR data, as well as visible-spectrum and infrared images, to obtain products according to end-users requirements.

The project has just finalized the components test review and is now proceeding with the integration of the system. This will be completed by April 2018. This phase will be immediately followed by field demonstration activity in Switzerland. This will be organized in collaboration with end-users, notably Group-E, the Swiss national energy transport network manager, and Skyguide, the national air-traffic control authority.

Results, Lessons Learned, Challenges

By designing, implementing and testing components, SkyOpener has already given initial proof of the feasibility of RPAS use for long-range survey missions in conditions that can guarantee safety of the drone itself, of population and objects on the ground, and of other manned or unmanned aircraft. Valuable data



exploitation chains have already been successfully demonstrated, in particular regarding linear infrastructure survey and monitoring, and airport area obstacle mapping.

The number and density of RPAS operations in non-segregated airspace is anticipated to increase. SkyOpener holds the promise of being an enabling asset for ANSPs and UTM service suppliers by developing elements required to operate RPAS in the “Specific” operational category, as described in European Aviation Safety Agency (EASA) Notice of Proposed Amendment (NPA) 1705-05 A & B.

Dissemination of project results will contribute to regulation drafting, in particular the overall concept defined in the “RPAS ATM Concept of Operations” published by EUROCONTROL. Specifically, it will contribute to very low level airspace operations where RPAS must seamlessly integrate with manned aircraft operating under Visual Flight Rules (VFR) under specific conditions. These are prescribed by the National Aviation Authorities (NAA) and can vary from State to State, e.g. police helicopters, military aircraft, balloons, gliders, training aircraft, fire-fighting aircraft, and ultra-light aircraft. However, RPAS operating in this airspace do not have to confirm to either Instrument Flight Rules (IFR) or Visual Flight Rules (VFR), as set in International Civil Aviation Organization (ICAO) Annex 2.

Moreover, the conclusions of the SkyOpener project will contribute to the work of the SESAR Joint Undertaking (JU), as indicated in the recently published U-Space Blueprint that sets out the vision for the U-Space. U-Space aims at enabling complex drone operations with a high degree of automation to take place in all types of operational environments, particularly in an urban context. When fully deployed, a wide range of drone missions, that are currently being restricted, will be possible thanks to a sustainable and robust European ecosystem that is globally interoperable.

These results were obtained under reasonable cost constraints, so that future long-range civil RPAS operations will compete strongly with manned-aircraft-based operations. The main reasons are the reduction in costs and simplified logistics, as well as enhanced quality and detail of data, thanks to the possibility of flying low, closer to the survey targets. New applications for aerial survey and direct intervention (e.g. in maintenance, delivery, etc.), will be made possible in areas where large aircraft cannot fly.

The main challenge remaining is linked to guaranteeing safety and the regulatory risk. Regulation authorities need to require very demanding proof of safety. This involves technological development such as demonstrated in SkyOpener, but also extensive testing, the creation of the required standards and certification norms and processes. Another challenge is the regulating activity.

Another challenge is the regulating activity: large-scale commercial operation of long-range drones will only be possible after an EU directive is issued, hopefully soon.