5 services of Drones for increased airports and waterways safety and security

D8.5 Pilots' Events 1 Reports

Document Summary Information

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Contributions from	Carlos del Río, George Nikolouzos, George Bogdos, Joanna Makuchowska		

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Project Summary

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Participant No.	Participant Organisation Name	Short	Type	Country
1(coord.)	Airbus Defence & Space	ADS	IND	FR
2	Future Intelligence Ltd.	FINT	SME	EL
3	Ecole Nationale de l'Aviation Civile	ENAC	RTO	FR
4	Air Force Institute of Technology	ITWL	RTO	PL
5	Vicomtech	VICOM	RTO	ES
6	Hellenic Mediterranean University	HMU	ACAD	EL
7	Ferrovial Corporacion SA	FERRO	USER	ES
8	Greek Water Airports	GWA	SME/USER	EL
9	AirMap Deutschland GmbH	AIRMAP	SME	DE
10	Eurocontrol	EUROC	USER	BE

Executive Summary

The main objective of the 5D-AeroSafe project is to automate basic operations in airports and waterdromes, originally performed by humans, by utilizing Unmanned Aerial Vehicles (UAVs), commonly known as drones. In this respect, operations that required extensive planning and synchronization, will be performed faster, safer, and possibly more accurately. Nonetheless, this endeavour requires deep understanding of the requirements, the possible implications, and the existing legislation. To achieve this, the 5D-AeroSafe project has envisioned a series of trials, workshops and pilots, engaging end-users, the User Advisory Board, and other experts in the field, to obtain their feedback, based on their expertise, and integrate it in the design and development procedure, thus employing a highly agile methodology, towards the creation of an ecosystem that will accurately and effectively meet all the possible requirements, and address all possible shortcomings. To this end, this purpose of this deliverable, which is part of T8.4 effort, is to report the outcomes of the first pilot

and second workshop that took place on November 18th, 2021. During this event we presented accurate simulations of all the envisioned operations and conducted a very fruitful conversation within the consortium and the invitees, where very insightful information was exchanged through a structured Q&A procedure.

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Glossary of terms and abbreviations used

Abbreviation / Term	Description
UAV	Unmanned Aerial Vehicle
UAB	User Advisory Board
Navaids	Navigation Aids
DOA	Description of the Action
PAPI lights	Precision Approach Path Indicator lights
GWA	Greek Water Airports
GGCS	Generic Ground Control Station
UTM	Unmanned Aircraft System Traffic Management
AvDay	Aviation Day is defined the time 30min before Sun rise until 30min after Sun set
EASA	European Union Aviation Safety Agency
ASD	Airside Safety Department
VLOS	Visual Line of Sight
BVLOS	Beyond Visual Line of Sight
ATC	Air traffic control
ATSEP	Air Traffic Safety Electronics Personnel
AGL	Airfield Ground Lightning
ATCO	Air Traffic Control Officer
DMO	Drone Mission Operator
ATM	Air Traffic Management
CTR	Control Zone
CTA	Control Area
TMA	Terminal Manoeuvring Area
DGPS	Differential Ground Positioning System
VOR	Very high frequency omni-directional range
FOD	Foreign Object Debris

1 Introduction

The goal of the 5D-AeroSafe project is to automate common airport and waterdromes' operations, formerly performed by with manned aircrafts, by utilising UAVs, commonly referred as drones. This will allow for more flexible management and planning of operations, minimize the operations' duration and eliminate the possible

risk inevitably imposed by performing operations utilising manned aircrafts. Drone operations within airports is an emerging trend. Nevertheless, the legislation and regulatory frameworks are still incomplete, and undergo continuous developments and updates. Therefore, it is a rather tedious task to review and keep up with the latest updates of these frameworks. To this end, the 5D-AeroSafe project has envisioned a series of pilot, trial and workshop events, where several diverse stakeholders, such as the 5D-AeroSafe consortium, end-users, the User Advisory Board (UAB), and several other experts in the field of aviation, will be invited to participate and provide their feedback by participating in structured Q&A procedures and open discussion panels.

Following Workshop 1, which took place on September 4th, 2020, Pilot 1, along with the Workshop 2 took place on September 18th, 2021. During this two-fold event the responsible partners presented detailed simulations of the respective operations, i.e., runway and taxiway inspections, waterway operations and inspections, and Navaids inspections and calibrations. The presentations were followed by a structured Q&A procedure, where interesting and on-point questions were posed by the invitees. Finally, a very fruitful and insightful discussion was triggered between the consortium, the UAB and other experts.

The purpose of this document (D8.5), which is the first of a three-fold series of deliverables (D8.5-M21, D8.6-M24, D8.7-M34), is to present the content of Pilot 1 and the accompanying Workshop 2 event, along with the exchanged information and the derived outcomes, stemming from the Q&A and the open discussion that took place during these events. This three-fold series of deliverables is part of T8.2 effort, where HMU is the responsible partner.

The rest of this document is structured as follows, Section 2 presents the pilots' (Pilot 1, Pilot2a, Pilot 2b, and Pilot 3) envisioned timeline and context, within the 5D-AeroSafe project. Section 3 presents the content and outcomes of Pilot1 and workshop 2events. Section 4 and Section 5 present the references and any other complementary material (e.g., Pilot 1 agenda) respectively.

2 Pilots' Timeline

The 1st Pilot demonstrated the validation of the RPAS flight procedures using a simulated environment, based on the Paparazzi opensource simulation platform, provided from ENAC for 5D AeroSafe. The event took place online using Microsoft Teams and a workshop was organized for participants using the Slido[1] Q&A web-based platform. A physical meeting was not possible during the time of the 1st Pilot, due to Covid-19 restrictions and according to the public health organization guidelines.

The pilots 2a and 2b will demonstrate the validation of Visual Analytics and AI algorithms modules under development at WP4. They will showcase potential risks that the 5D AeroSafe project has to consider during the relevant inspections. The visual analytics modules will be utilised in inspections that will focus on the sea conditions (height and frequency of waves) and debris detection for waterway inspections, pavement monitoring and lighting condition or runway/taxiway inspections as well as FOD identification. These pilots will take place during 2022 at some of the available trials sites.

Finally, pilot 3 will take place at a relevant airport environment to showcase the full 5D-AeroSafe potentials, as a complete solution. The validation will focus on the RPAS integration, the miniaturized transceiver, the communications links, the APIs for integration with legacy systems and the coexistence of Unmanned Air Vehicles (UAV) with Manned Air Vehicles in a non-segregated airspace. Moreover, this pilot will demonstrate the feasibility of maintaining all EASA safety protocols and levels.

2.1 Pilot Use Cases

For all the envisioned pilots three inclusive use cases have been designed, to showcase and validate the developed functionalities for all possible scenarios. This subsection presents some of the organizational, tactical, and technological details for each use case. Each use case, depending on the technological approach and required expertise, has been assigned to different partners to coordinate and deliver, namely Ferrovial, GWA, and FINT.

2.1.1 UC1: Inspections at airports – Taxiway/Runway inspection

Concerning airports' operations, the following inspections have been envisioned:

- L1 runway inspection
- L2 taxiway inspection
- Runway FOD inspection
- Terminal rooftop inspection
- Perimeter control

Although all of the inspections are being further analysed at project level, the focus for Pilot 1 has been on the L2 taxiway inspection, due to the easiness of implementation, added value and recurrence. All of them have been considered to take place at London-Heathrow airport, part of Ferrovial's portfolio. Nonetheless, they are easily replicable in order to be deployed at other places.

An overview of the current process was provided, as it is important to make sure this kind of operations, although disruptive in some angles, fit well with inspections' requirements and reporting needs. The Airside Safety Department is responsible for ensuring compliance with the certification requirements, laid down by the European Union Aviation Safety Agency (EASA). A three-tier inspection regime is used on the movement

1 https://www.sli.do/

area and associated airfield ground lighting systems (AGL). Level 2 inspection is carried out each day under the 'Taxiway Monitoring System' as shown in Figure 1. This involves a slow speed driving or walking inspection of a particular area of taxiway. The whole taxiway system is inspected to a Level 2 standard over a 32-day period. Inspectors will raise maintenance requests via the Engineering Help Centre or flag areas for monitoring. Results from these inspections are used to inform preventative or minor maintenance requirements and wider decisions on capital asset replacement programmes.

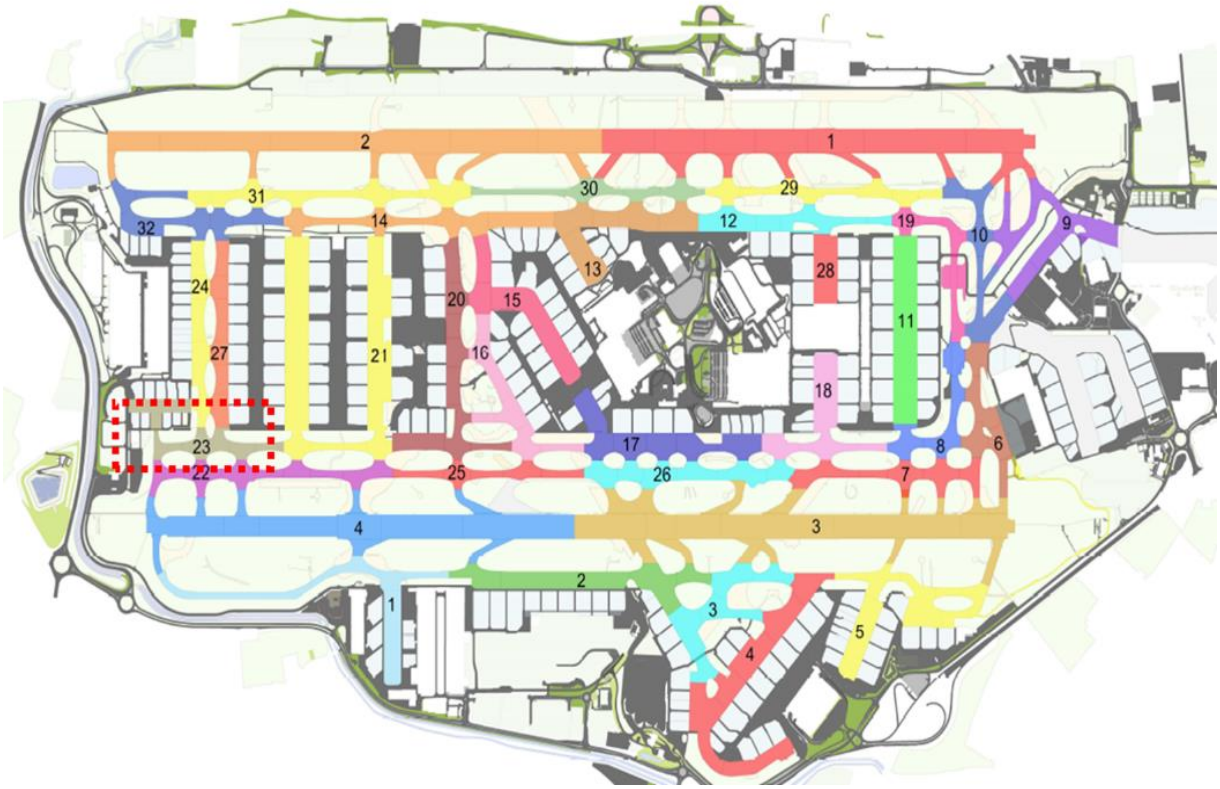

Figure 1 L2 Inspection Areas

As part of a Level 2 inspection of an area, the ASD will deploy drones equipped with visual cameras to carry out the inspection. The pavement inspection takes place during daytime, and the lighting inspection takes place during night-time. The mission is carried out within Visual Line of Sight (VLOS) and by a quad-copter drone equipped with an RGB camera for the inspection. Furthermore, the mission is carried out at a height of 5m, which has been deemed adequate for the input that the visual analytics module needs. This inspection requires coordination with Air Traffic Control (ATC) and the other stakeholders of the airport. The flight plan for the mission is made available to the Air Traffic Control Officer (ATCO) through U-space services, and the Drone Mission Operator (DMO) is in constant link with Air Traffic Management (ATM) through VHF radio. For this inspection, the collision avoidance with aircrafts is ensured by the closure of the area to inspect.

These are the scheduled operations. The pavement inspection operation takes place during daylight, at around 8 am. The lighting inspection takes place during night-time, either before 5 am or after 6 pm.

Type of operation	Area of operation	Flight plan	Type of drone	Payload	Category of operation
VLOS	Airport environment - taxiways (CTR)	Route along the taxiway 5m AGL	Quad rotor (Atrax type)	Visual camera	Specific (STS 1)

Figure 2 Screenshot of the simulation

A simulation video as shown in screenshot, in Figure 2, was shared with participants and the operation using a single drone at area 23 was detailed by the speaker. The whole flight takes 12 minutes and 30 seconds to perform the operation. The actual duration of the visual inspection of this specific area takes 11 minutes and 30 seconds. For this area, the drone is deployed near some service buildings in the surroundings of checkpoint 19, enabling an easy access to and exit from the airfield if the operation needs to be cancelled.

For the sake of the simulation, area 23 was selected. It is comprised by the taxiway that connects stands 519 to 527, taxiway Y and links 53 and 51.

Non-nominal situations were shared as well. This could be represented by, but are not limited to:

- Loss of communications link
- Loss of DGPS

- Flight plan divergence detected
- Out of contingency buffer
- ATC requests interruption

For them, emergency landing sites are defined.

Finally, the speaker provided an overview of the expected results, in terms of surface condition checks and lighting condition checks.

2.1.2 UC2: Inspections at water airports – Waterways inspection

Within the context of WP2 we have defined a number of deferent use cases associated with Waterdromes surveillance, but "the waterway inspection" was chosen due to easiness of implementation, importance, added value, recurrence and competing solutions.

It is a pre-scheduled mission, and in most cases, it should be conducted more than 6- or 8-times during aviation day (AvDay), as it is mandatory to check operational waterway(s) every morning and 15 min before each seaplane arrival.

The purpose of the inspection is to verify that waterway(s) is/are safe for operations and there are no floating obstacles such as logs, boxes, big oil or fuel cans, branches, bulky debris or junk etc along the waterway or its vicinity that can cause damage to a seaplane during its movement. The whole procedure is performed by boat and lasts more than 30 min.

The Simulation revealed that the use of UAVs not only eliminates the risk of human exposure to rough weather conditions as well the boat expenses, but it reduces the duration of the inspection to almost one-third.

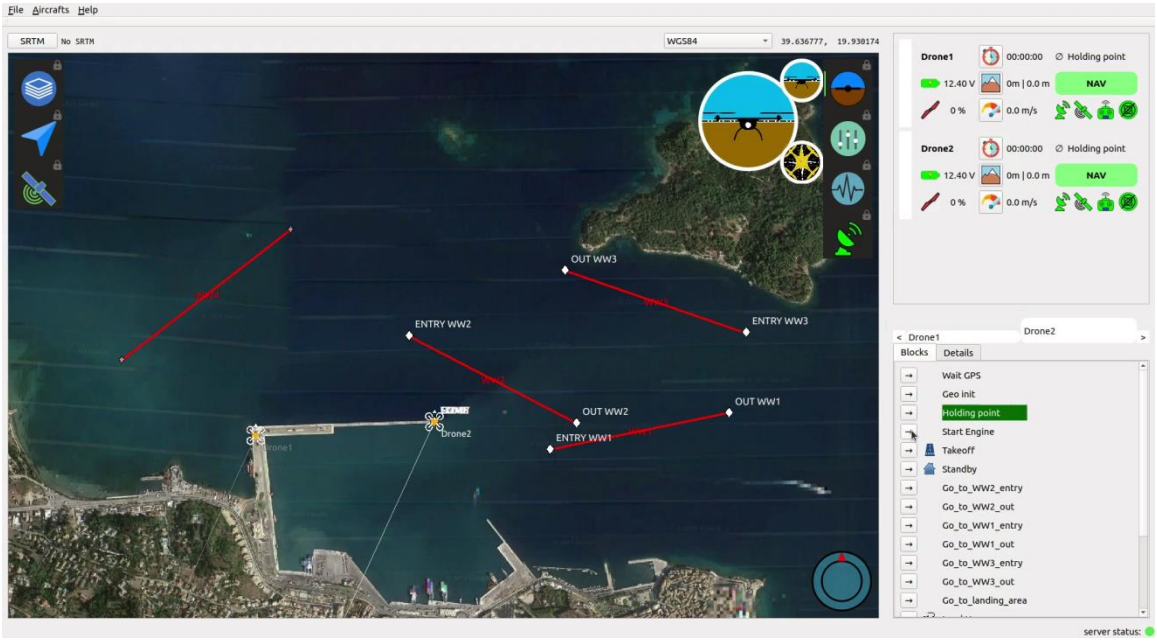

Figure 3 Waterdromes Operations

Two drones take off from two different points, heading to two deferent areas as depicted in Figure 3. The first drone inspects waterway No4 (o5/23) on the left side of the screen at all its length and returns to its initial point after 8 min, covering 2,5 Km. The second drone on the right side of the screen inspects waterway No2 (11/29) at all its length, then waterway No1 (08/26) at all its length and then waterway No3 (13/31) at all its length too, and finally returns to its initial point after 14 min covering 4 Km.

2.1.3 UC3: Navaids inspections: Extended ground test of a VOR

Three different use cases have been defined that are associated with the Navaids inspection but the "extended ground test" or "long-range ground test" was chosen due to easiness of implementation, importance, added value, recurrence and competing solutions. It is a pre-scheduled mission, to follow a VOR ground test, as a safety measure to verify and enhance ground measurements taken by Air Traffic Safety Electronics Personnel (ATSEP) during scheduled periodic preventive maintenance.

The missions showcase the capability of 5D-AeroSafe to provide a safety view on the drone missions in a busy, safety-critical CTR area. Once drone inspections show significant correlation with platform's mission, they will become a routine. The benefit of the mission is that ATSEP can create a quite automated procedure of measurements and a routine check that can be used in cases that the space around a VOR has changed significantly, and nearby obstacles need to be evaluated.

The simulation revealed that the use of UAVs not only minimizes the duration of the inspection to 30 minutes but could also significantly reduce the cost of a typical flight inspection.

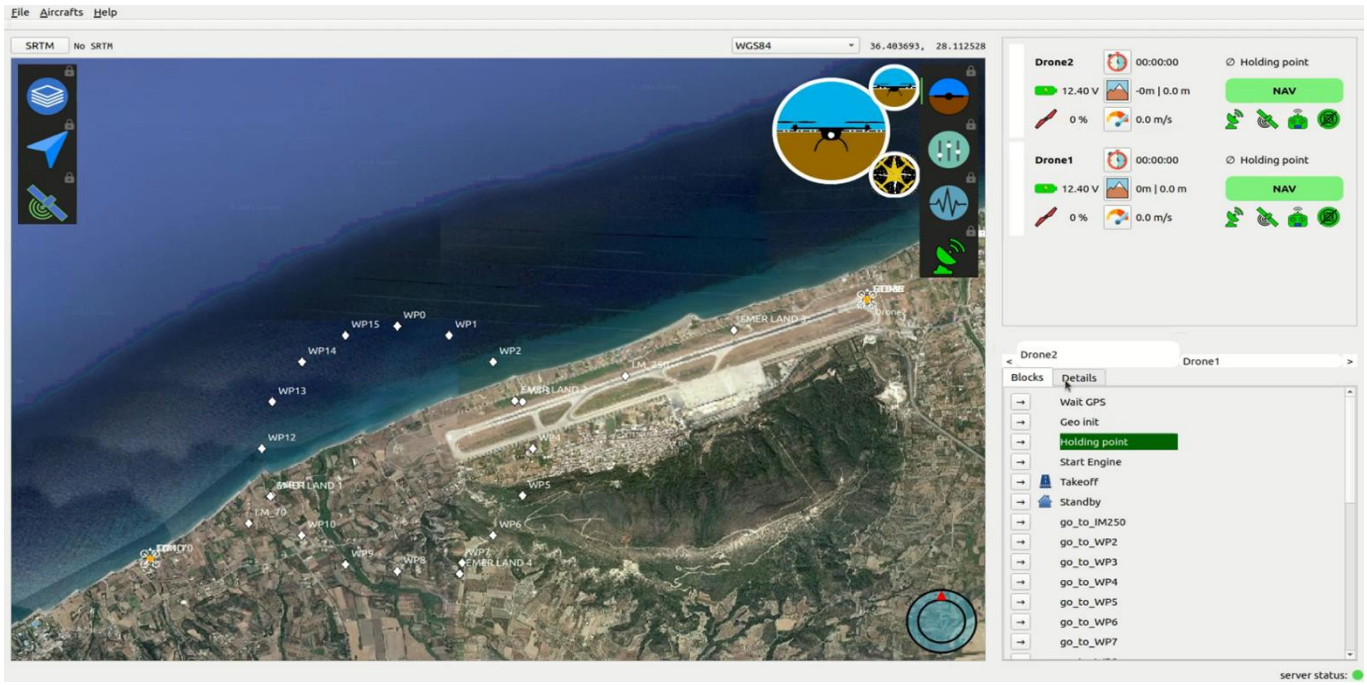

Figure 4 Navaids Inspection

The ATSEPs deploy 2 drones from suitable positions marked in Figure 4, close to the VOR terminal. During a joint 30-minute flight, each drone checks half orbit of a 1000m radius and 1000m axial performance in 2 or 3 critical radials for the operations. During the drone's flight, the measurements must be taken at various points in space to validate accuracy of Navaids signals. At the end of the mission, the mission manager notifies the Tower Control for the completion of the mission through the UTM centre.

3 Pilot 1 Events

The 1st Pilot was held on December 14th, 2021 and it was separated in 2 sub-events. A main event that the 5D AeroSafe was demonstrated, and a workshop that was held after the main event. During the demonstration of the project all participants were given access to Slido, an application for adding questions, and all questions were discussed in the workshop, which followed the main event. A screenshot of the main event and the workshop is depicted in Figure 5 and Figure 6 respectively.

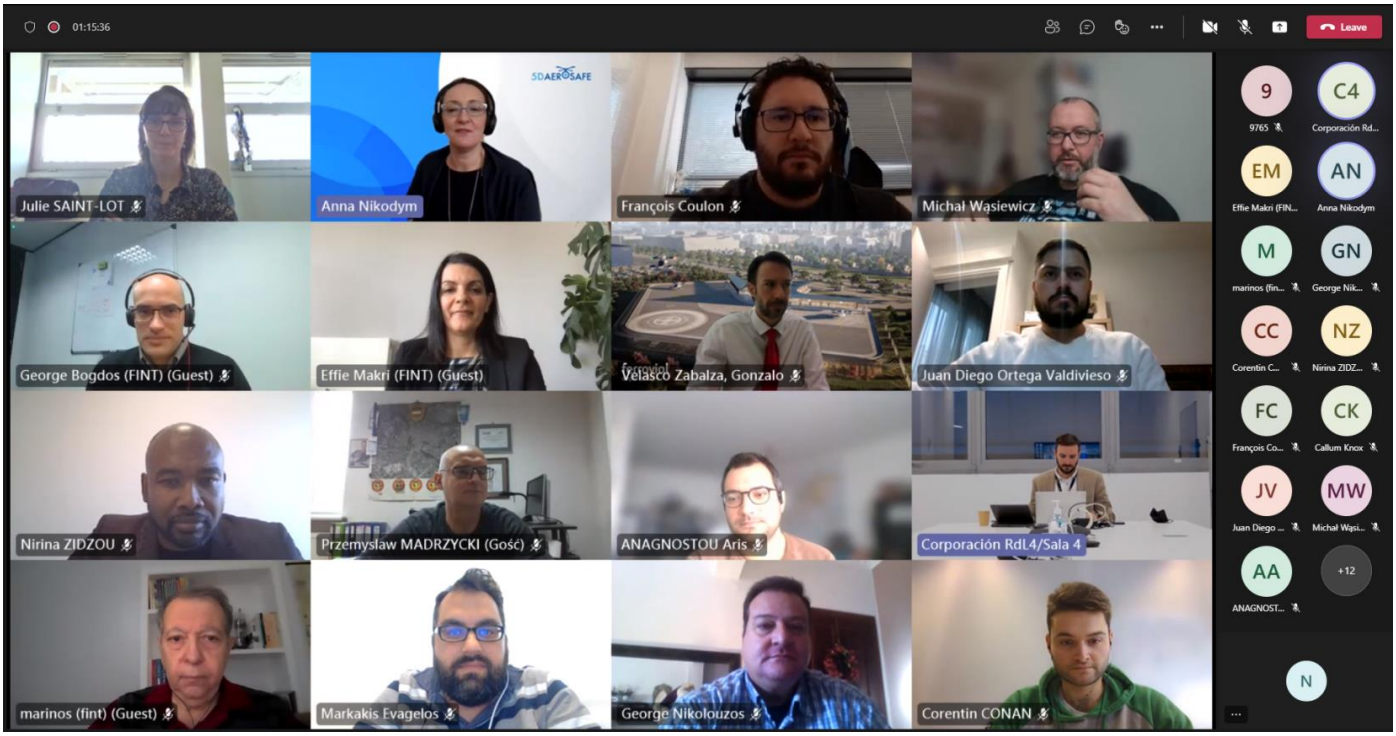

Figure 5 Pilot Main Event

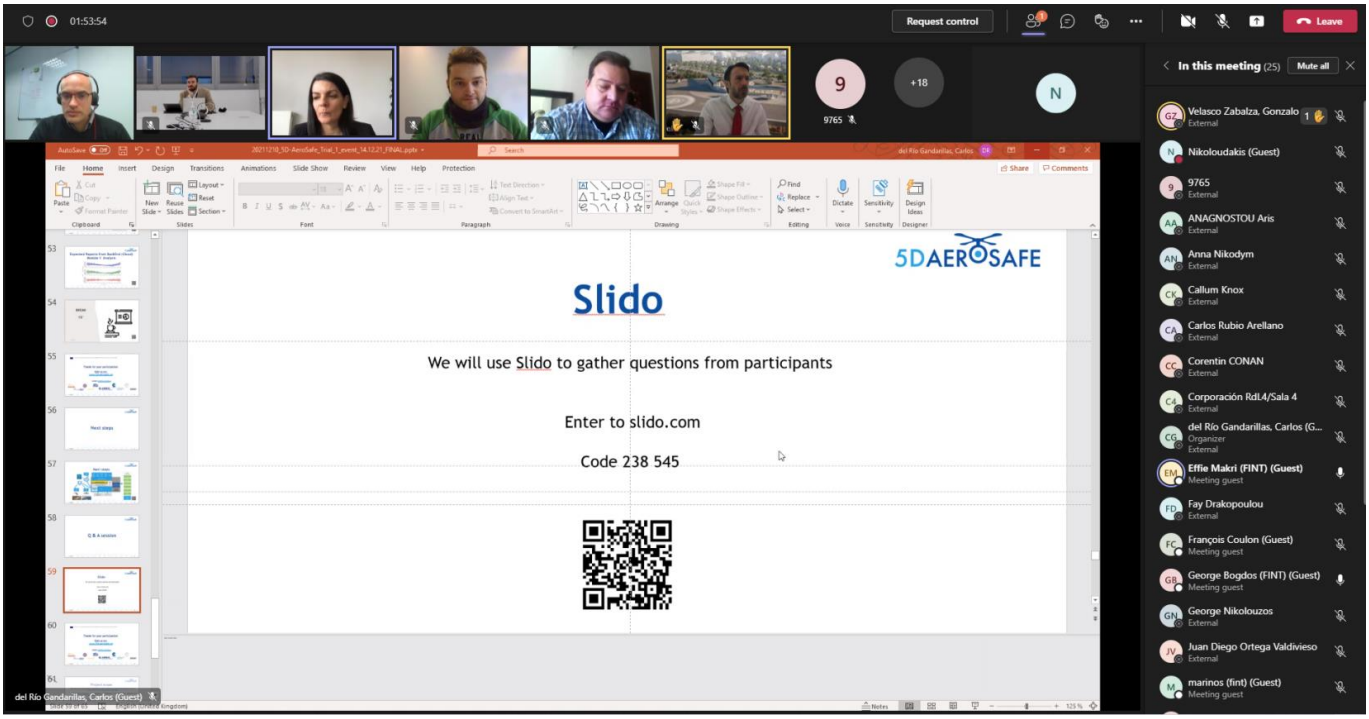

Figure 6 Workshop Event

3.1 Main Event

The main event was initiated by Ms. Effie Makri from FINT, technical managers of the project, who welcomed the participants and presented the vision of the project. The presenter described the various roles of 5D AeroSafe and the overall concept of this project. A screenshot of the main event introduction is shown in Figure 7.

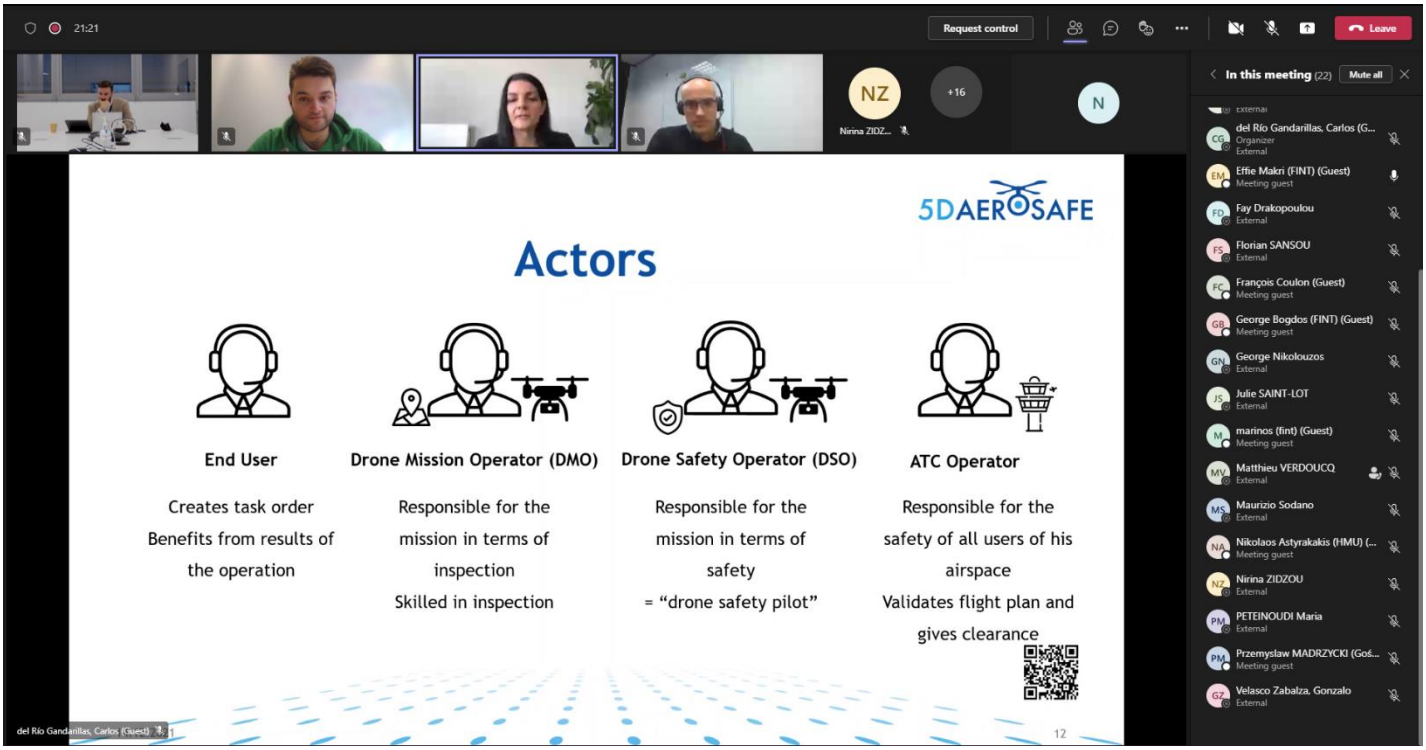

Figure 7 Introduction by Ms. Effie Makri

The next speaker was Mr. Carlos del Rio from Ferrovial, who presented the scope of 5D-AeroSafe project trials and the WP6 purpose, scope, objectives, and planned pilots, as depicted in Figure 8.

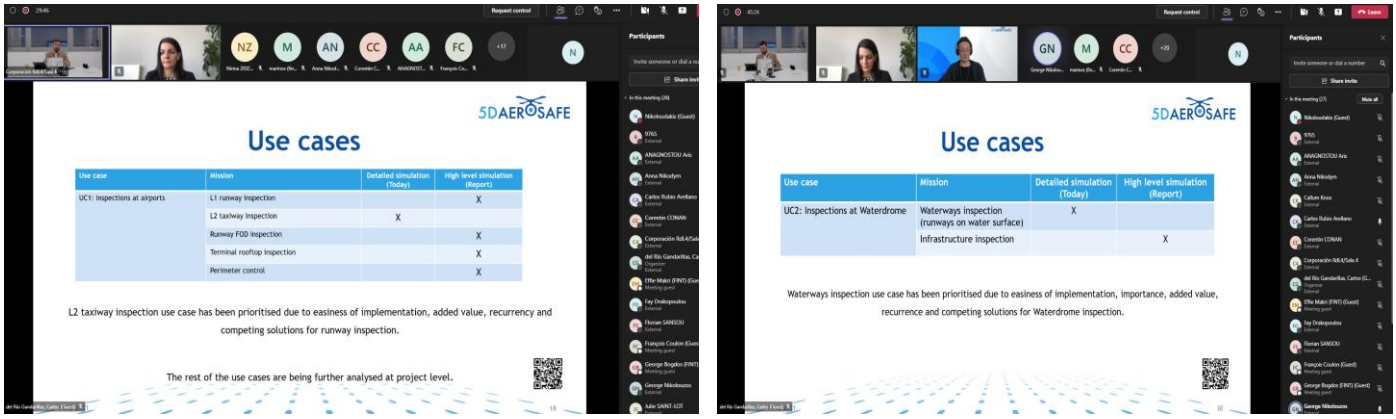

Figure 8 Carlos del Rio 1st Presentation

The next speaker was Corentin Conan from ENAC, who explained the common regulations' framework that must be followed from all use cases, and presented the order creation, the order validation, the flight plan selection/load and the flight plan validation procedures as shown in Figure 9.

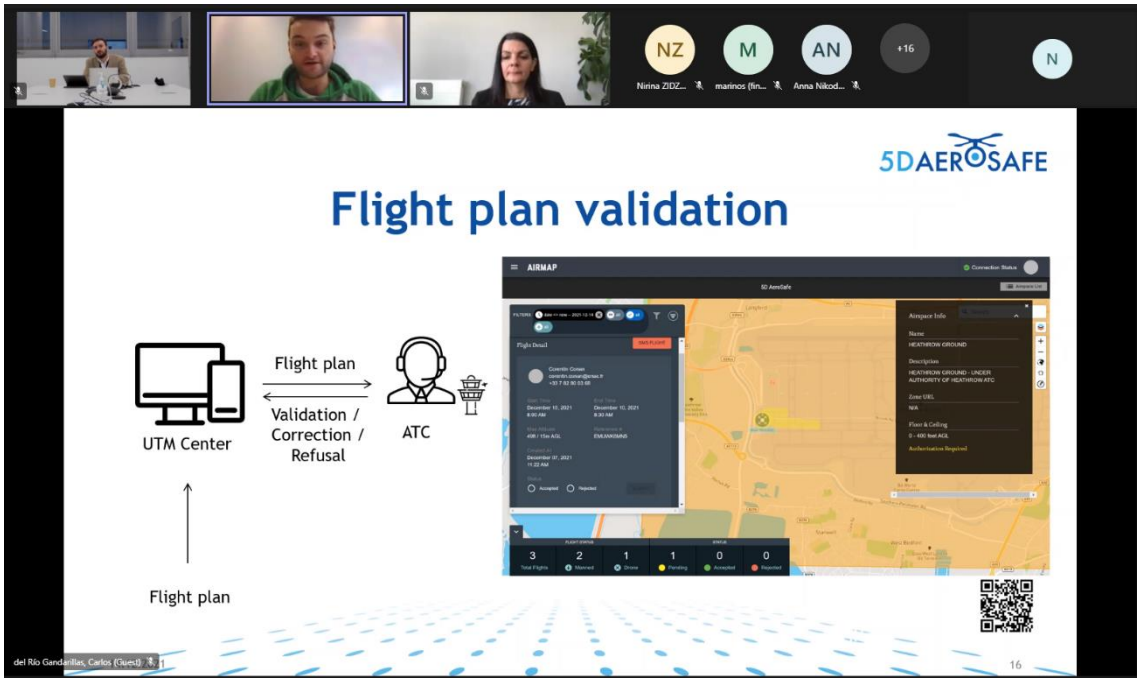

Figure 9 Corentin Conan Presentation

Later, Mr Carlos del Rio described the airports use case: overview, current inspection procedures, drone-based inspections, simulation insights and expected results.

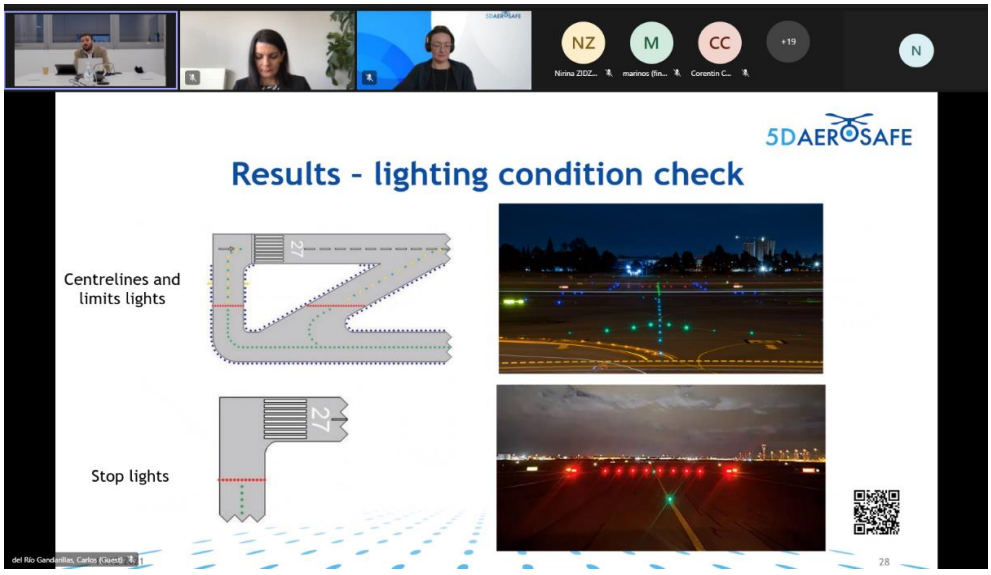

Figure 10 Carlos Del Rio 2nd Presentation

The next presentation, Figure 11, was performed by Mr. George Nikolouzos from GWA, concerning waterways' inspections and operations. As an expert in waterway operations, the presenter described the advantages and

the help that 5D-AeroSafe offers to the Port Authorities, GWA, and the safety of waterdromes. A simulation was presented after the talk, to showcase accordingly the use case of waterway inspection.

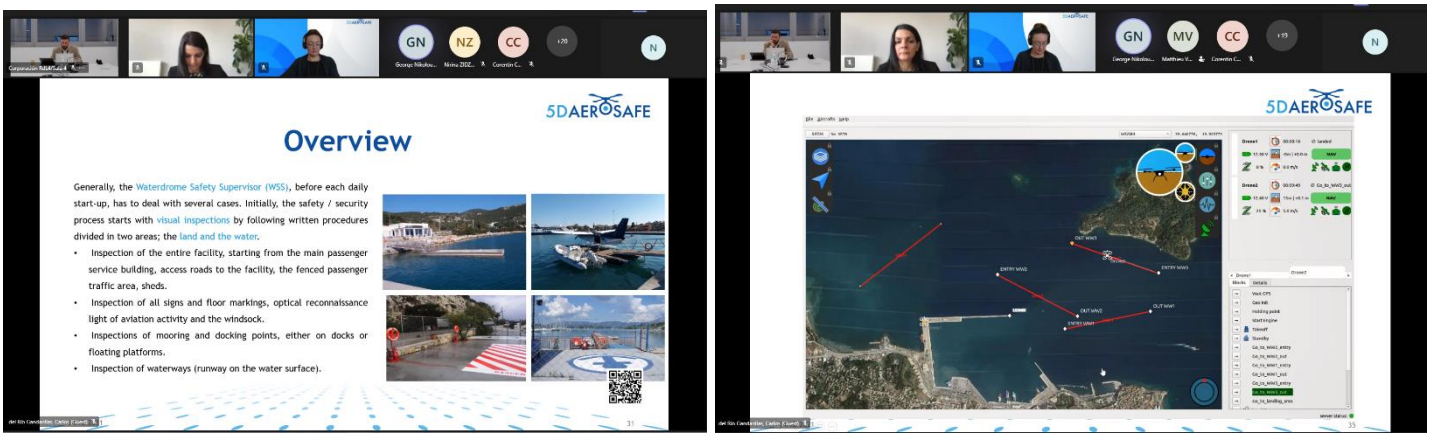

Figure 11 George Nikolouzos Talk (Waterdromes' Inspections)

Finally, the last use case concerning Navaids' inspections and calibration was presented by Mr. Marinos Kardaris from FINT, in Figure 12, who analysed the current inspection and calibration process in comparison to the inspection performed by a drone. A simulation was also performed for Navaids' inspection that depicted an enormous improvement in inspection speed and results.

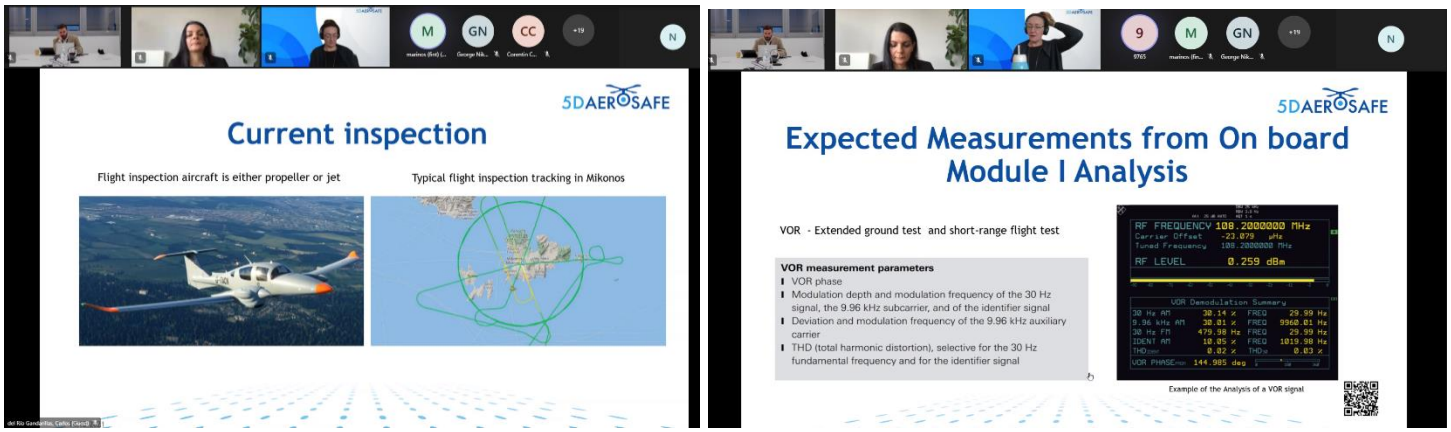

Figure 12 Navaids Inspection Presentation

A final discussion was held by partners for the use cases, the expected results and the non-nominal situations as shown in Figure 13, along with potential solutions. Mr. George Bogdos from FINT added some final comments, presented the future actions and plans of 5D-AeroSafe, and discussed about the next pilot expectations. Additionally, a high-level developer/development discussion was held with topics concerning the drone payloads, the GGCS, the UTM and other 5D-AeroSafe components.

Figure 13 Expectations and Other Situations Presentation

3.2 Workshop

Figure 14 Slido QR code for questions

During the main event some questions were asked from the participants, through the Slido platform depicted in Figure 14. After this event, a workshop was held to answer all questions and an open intuitive discussion was held among partners and participants. The questions that were asked in this workshop and during the presentation were:

1. Are the current waterway inspections by boat impeded by the various sea states?
    - George Nikolouzos answered:
        - First of all, the operator must own a boat, in order to inspect the waterways.
        - The seaplane operation should not take place with waves over 2 meters. The 2 meters waves are when there is a hurricane or a thunderstorm. That's why we have choose to create the water, airports and water rates on in the vicinity of ports, which are affected less by the winds.
        - Normally seaplanes are operated between no winds or three to four Beaufort scale of winds.
        - It is hard for officers coming out to inspect waterway to find objects in the period of heavy rain and especially autumn.

2. Does the Paparazzi Simulator take under consideration the drone take-off and landing concerning altitude?
    - Corentin Conan answered:

        - In the properties of the simulator and the models, users need to know the altitude of the take-off and landing point and the height of all other waypoints. Also, the altitude is calculated according to the altitude of the take off point.
    - George Bogdos answered:
        - It all depends on the use case and the drone of operation, for example fixed wing and quad rotor drone has different needs, concerning properties.
    - A little discussion was held between partners comparing fixed wing and multi-rotor drones and the final outcome was the same, that it all depends on the use case, even though the multi-rotor drones provide many advantages comparing to the fixed wing drones.

3. Where and who can review the collected data? And can the data be reviewed in real time?
    - George Bogdos answered:
        - The data can be reviewed in a real time. This is what we need and want to achieve. It's the actual pain that we wanted to solve here. We want to provide this data to a flexible cloud platform, do the analytics and through the application that we described before provide that data to the dashboard applications, that related users can actually see the results of an operation.
        - It all depends on the actual actors that Mr. Corentin has provided very briefly in previous discussions
4. Gonzalo Velasco asked a question: What does the project envisage to achieve in the short term? We have been running trials in the last years and the problem is that it takes several hours for the algorithms to process images, so are you targeting real time inspection?
    - George Bogdos answered:
        - This is actually what we tend to do, yes, so this is exactly what you mentioned at the beginning, it's a kind of a real time.
        - This information will go directly to the cloud where we will have this capacity in order to to to do it and do it as quickly as possible. Our goal is to do it in a real time mode and have some results in the next 30 minutes
5. Can third party developers take part in the 5D Aero safe procedure or consume any data generated within the project?
    - Partners answered that the 5D-AeroSafe will provide an example of 3 main use cases and applications utilizing the 5D-AeroSafe data.
    - Additionally, the partners announced that there will be an API Toolbox for integration of third-party applications and consume of 5D-AeroSafe data.

Some last comments were added by partners and the workshop finished with acknowledgements by Ms. Effie Makri and participants.

The list of participants is shown provided below:

5D-AeroSafe Partners

- Carlos del Rio Gandarillas (Ferrovial)
- Effie Makri (FINT)
- George Bogdos (FINT)
- Corentin CONAN (ENAC)
- Anna Nikodym-Bilska (ITWL)
- Fay Drakopoulou (GWA)
- Marinos Kardaris (FINT)
- Przemyslaw Madrzycki (ITWL)
- Anagnostou Aris (EUROCONTROL)
- François Coulon (ENAC)
- George Nikolouzos (GWA)
- Nikolaos Astyrakakis (HMU)
- Markakis Evagelos (HMU)

- Yannis Nikoloudakis (HMU)
- Juan Diego Ortega Valdivieso (Vicomtech)
- Michał Wąsiewicz (ITWL)

Guests

- Florian Sansou (ENAC)
- Julie Saint-Lot (ENAC)
- Gonzalo Velasco (Ferrovial Airports)
- Martinavarro Edgar (ENAIRE)
- Callum Knox (Labirynth project)
- Nirina ZIDZOU (ENAC)
- Maria Peteinoudi (European Defence Agency)
- Maurizio Sodano (Asprid Project)
- Matthieu Verdoucq (ENAC)
- Víctor Sánchez Aguero (IMDEA Networks Institute)
- Carlos Rubio Arellano (innCome I+D+i)
- Jose Soler(Ferrovial)

4 Appendix 1

4.1 Pilot 1 Event Agenda

WORKSHOP AGENDA/ Tuesday, December 14th, 2021. Online.

10:00 - 10:10 **Welcome and intro to the project**

Speaker: Ms. Effie Makri, FINT, GR

10:10 - 10:15 **WP6 and trials overview**

Speaker: Mr. Carlos del Río, Ferrovial, ES

10:15 - 10:20 **Common framework for use cases**

Speaker: Mr. Corentin Conan, ENAC, FR

10:20 - 11:05 **Use cases presentation**
Moderator: Ms. Effie Makri, FINT, GR
Speaker: UC1: Inspections at airports – Taxiway inspection
Mr. Carlos del Río, Ferrovial, ES
Speaker: UC2: Inspections at water airports – Waterways inspection
Mr. George Nikolouzos, GWA, GR
Speaker: UC3: Navaids inspections: Extended ground test of a VOR
Mr. Marinos Kardaris, FINT, GR

11:05-11:20 **Coffee break**

11:20 - 11:25 Next steps for 5D-AeroSafe
Speaker: Mr. George Bogdos, FINT, GR
11:25 - 11:55 Q&A session using Slido
Moderator: Ms. Effie Makri, FINT, GR
11:55 - 12:00 Closing Remarks and Workshop Summary
Speaker: Ms. Effie Makri, FINT, GR