



CORUS-XUAM: TACKLING URBAN AIR MOBILITY AIRSPACE INTEGRATION CHALLENGES

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Abstract

Over the last century, the development of the aviation industry has fundamentally changed the way we live, work, and travel, and aviation has not stopped innovating during this time. In the last few years, new types of aircraft have started to be developed, including Unmanned Aircraft Systems (UAS or drones) and Urban Air Mobility (UAM) aircraft. With the development of these new aircraft types, aviation is once again taking a significant step forward. UAM refers to an ecosystem that enables on-demand, highly automated, passenger or cargo-carrying air transport services, with particular reference to the urban and sub-urban environments, where aviation is often highly regulated today. The UAM industry's vision involves new vehicle designs, new system technologies, the development of new airspace management constructs, new operational procedures and shared services to enable an innovative type of transport network.

The CORUS-XUAM research project demonstrated how U-space services and solutions could support integrated UAM flight operations, allowing air taxis, drones and other airspace users (unmanned and manned) to operate safely, securely, sustainably and efficiently in a controlled and fully integrated airspace, without undue impact on operations currently managed by air traffic management (ATM). The project was undertaken by the consortium that delivered the SESAR JU-funded CORUS U-space Concept of Operations (ConOps) in 2019, extended by the addition of UAM expertise.

CORUS-XUAM activities started with updating of the U-space ConOps, addressing the integration of UAM and drone operations into the airspace, as well as identifying new U-space-phase U3 and U4 services. The project's activities then continued with the preparation and execution of six challenging Very Large Scale Demonstration (VLD) campaigns in Belgium, France, Germany/UK, Italy, Spain, and Sweden.

These VLD activities were the core of the CORUS-XUAM project. They demonstrated integrated UAM, drone and manned aircraft operations, through advanced forms of interaction using digital data exchange, supported by integrated and advanced U-space services in urban, sub-urban, and inter-city scenarios, as well as in and near ATM-controlled airspaces and airports. The VLDs focused on different types of mission, such as passenger transport, logistics, delivery, emergency response and surveillance, using different U-space deployment architectures and state-of-the-art technologies. They considered coordination between ATC (Air Traffic Control) and U-space, including interaction with air-traffic controllers and pilots. The VLDs combined flights by air taxis with other traffic and operations in the control zones (CTR) of major airports. Vertiport procedures, separation, and data services were also demonstrated.

In the specific this paper provides information about the Very Large Demonstration executed in Italy.

The Italian demonstration, focused on guidelines for safe depot-to-depot operations between two logistics centres within a suburban area. Flight tests, with involvement of a fast UAM vehicle and other drones for operations, took place at Grottaglie-Taranto civil airport in the framework of Grottaglie Airport Test Bed, allowing the involvement of an ATM component and the demonstration of coordination and interoperability between ATM and U-space for the management of UAM cargo traffic. This VLD addressed the UAM-tailored performance

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framework developed in CORUS-XUAM, including safety, access and equity, cyber security and human performance, measured through human-in-the-loop assessment, such as ATCOs and pilots and analysis of data collected during the demonstration.

In detail the scenario, was composed by three different macro area located in Apulia Region (South-East of Italy):

- Grottaglie-Taranto Civil Airport
- Manduria Airfield
- Urban Area: Hospital

The type of operation was identified as a medical cargo transportation. The demonstration saw the participation and involvement of different actors, vehicles, systems and facilities and was composed by the following phases:

Phase 1: UAM medical cargo operation in U-space with other UAS

Phase 2: BVLOS (Beyond Visual Line Of Sight) small cargo operation from suburban to urban area

Phase 3: Management of emergency from ATM in U-space: HEMS flight with high priority

In detail the demo was composed by the following steps:

- A cargo (e.g. medical goods) arrived at Taranto-Grottaglie Civil airport.
- The medical content was loaded on a Pipistrel (PVS) Large Fixed Wing Cargo UAS/RPAS placed in an area close to the airport.
- The PVS aircraft started the mission and flew in U-space through a dedicated UAM corridor in VLL (Very low level Airspace) which ended in an area (logistic center) close to Manduria.
- During the flight other drone operations (photogrammetry, precision agriculture) were performed and managed in the U-space.
- Once the PVS a/c landed on the airfield, the medical load was divided into several smaller loads.
- One of these was loaded on a Techno Sky UAS and transported to final destination (Manduria city area near hospital) through a specific BVLOS operation of 7km.
- Before the return flight to Grottaglie Airport of the PVS (before take-off), an emergency occurred (an HEMS flight started in controlled airspace and executed operation in U-space). The emergency was managed at all levels.
- A commercial Drone Detection system was also used for detection of non-cooperative drones and related information were integrated into d-flight USSP (U-space Service Provider) platform.
- The following U-space services were used and applied during the demo: Network identification service, geoawareness, traffic information, flight authorization

The Italian demonstration confirmed that the U-space services tested are largely ready for emergency transport services and operations with drones in peri-urban and urban areas, regardless of the size of the drones used (UAM cargo drone vs small drone if appropriately authorized for operations).

The demonstration has also allowed to further investigate the U-space services and to collect valuable feedback for the subsequent industrialization phase. The experience in ATM and U-space acquired will contribute significantly to the definition of the European UAM operating concept, demonstrating its applicability in the Italian context and ensuring its correspondence with national interests and business strategies. The main results of CORUS-XUAM were used to consolidate the ConOps at the end of the project. The project also involved extensive consultation and communication initiatives involving authorities, U-space stakeholders and end-users.

Innovative ATM/U-space services and the development of smart, automated, interoperable, and sustainable traffic management solutions are the key enablers for achieving the high level of integration needed to make urban air mobility a reality. These challenging objectives can only be achieved through an evolutionary development process ensuring the definition and timely deployment of appropriate, advanced and interoperable ATM/U-space infrastructure, technology, and traffic management capabilities, providing advanced services that fit with expected types of operation and levels of demand.

The CORUS-XUAM project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101017682.

Keywords: UAM, AAM, U-space, drone, mobility

1. Introduction: the CORUS XUAM Project

Over the last century, the development of the aviation industry has fundamentally changed the way we live, work, and travel. During this long time, aviation has never ceased to innovate. New types of aircraft are now appearing, including Unmanned Aircraft Systems (UAS or drones) and Urban Air Mobility (UAM) aircraft. The latter may be electric Vertical Take-off and Landing (eVTOL), electric Conventional Take-off and Landing (eCTOL), and some are Personal Air Vehicles (PAV). With the development of these new aircraft types, aviation is once again taking a significant step forward. Since Fritz Lang's 1927 film *Metropolis* showed aircraft flying between buildings, people have dreamed of using air travel to improve transport in cities. UAM is the realization of that dream, enabled by advances in technology that among other things reduce the noise and size of aircraft. UAM has the potential to revolutionize the way people and packages move in and around cities by enabling point-to-point flights, by-passing ground congestion and shortening journey times. More specifically, the term UAM refers to an ecosystem that enables on demand, highly automated, passenger or cargo-carrying air transport services with particular reference to the urban and sub-urban environments[1], where aviation is often highly regulated today. The UAM industry vision involves new vehicle designs, new system technologies, the development of new airspace management constructs, new operational procedures and shared services to enable an innovative type of transport network.

Today, over four billion people, or more than half the world's population, live in cities and by 2050, with the urban population more than doubling its current size, nearly 7 of 10 people in the world will live urbanized lives. They are at the centre of economic activity, with more than 80% of global GDP generated in cities, according to the World Bank[1]. Commuting to work has become a significant time sink for millions of people around the world. In London, the average driver spends 227 hours a year stuck in traffic, travelling at speeds of just 11 km/h and urban traffic congestion will probably get worse in the near future[2][3].

The challenge is on for better, more sustainable transport technologies and models to improve commute times and accelerate the transport of goods across town.

A growing number of players, led by aerospace, automobile, and technology companies, are working on UAM solutions and eVTOL technologies to enable runway-independent operations, with very high degrees of automation, up to and including fully self-piloted aircraft. Most operators envisage a significant number of simultaneous operations around metropolitan areas at altitudes up to 5000 feet and speeds up to 150 knots. These aircraft will typically carry cargo or 1-4 passengers on short trips (e.g. less than 100 km.)[4].

There are a number of related R&D projects around the world working towards this goal, some already experimenting with aerial prototypes or full-scale eVTOL demonstrators. Similar to the helicopter, this new breed of aircraft is somewhere between commercial airplanes and remotely controlled UAS, configured to carry large payloads and people. The first generation of full-scale demonstrators are already flying today and initial commercial flights are possible within the next 3-5 years. Meaningful innovation fueled by a significant amount of capital investment in eVTOL prototypes and UAM services development is opening a new frontier for mobility services[5].

The UAM industry has significant potential for growth - it has been estimated that by 2035 around 23,000 UAM/eVTOL will be serving a global market worth US\$74 billion. Of course, progress is never a straight line, especially in technology, regulatory and industry transformations as significant as introducing a new transport system. Consequently, forecasts of the size of the global market for eVTOLs and related UAM services by 2030 vary widely: MarketsandMarkets puts the figure at \$15 billion while Morgan Stanley projects a total addressable market of \$322 billion.^{10,11} Another American forecast expects that 4,000 eVTOLs will operate 55,000 urban airtaxi flights each day across the United States[7].

As with any mass market, the demand for eVTOL services - both cargo and human transport - will increase as the price becomes competitive against ground-based transport options, and as

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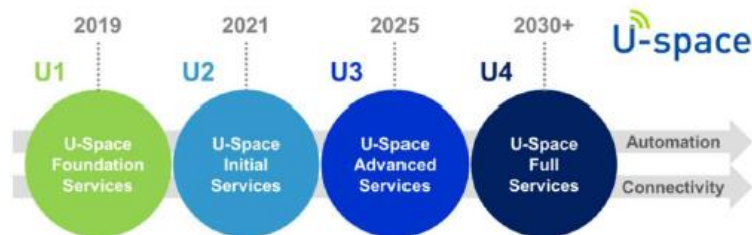
consumers gain confidence that UAM services are safe. If this happens, the worldwide commercialization of eVTOLs could be a reality within 5 to 10 years. Ultimately, UAM will become part of the smart-city infrastructure and service network that spans an array of requirements from advanced air traffic management, purpose-built charging stations, pollution-monitoring systems, vehicle-to-vehicle communications, and data-ownership. Of course, for this to happen, eVTOL/UAM operations and services must be as safe, quiet, environmentally sustainable, convenient, and as efficient as or even more so than ground-based mobility options.

Another step towards UAM is the commercialization of small, lightweight, pilotless UAS or drones used for delivering packages. Pioneers in drone delivery are competing to disrupt the last-mile logistics market[10]. One promising early sub-market is the drone delivery of medical and essential supplies to remote locations and in an urban environment. The commercialization of drone delivery is making progress because of the evolution of the relevant regulations and the systematic integration of UAS operations with approved boundaries into the U-space ecosystem.

Opening the sky to these new classes of airspace user is a political and economic imperative for the EU. The European UAM market is projected to be the fastest growing one in the period 2023-20309. EU countries such as Germany and France are investing heavily in the development and procurement of advanced eVTOL systems for commercial operations.

However, these novel operational characteristics prevent immediate deployment of full-scale UAM operations since existing airspace procedures, regulations, standards, policies, and structures do not accommodate the operations envisaged. Most UAM investors propose limited scale operations initially, some even proposing to begin with pilots in the aircraft much like current helicopter operations, until the necessary constructs exist. Many expect an evolution that eventually enables high-density self-piloted operations.

Current operations take place under an initial regulatory framework conceived for UAS and the European Union's (EU) U-space concept. UAM operations, which are expected to start around 2023-2025, will require the definition of a well-defined concept of operations, procedures and a more specific regulatory framework. This will enable new services and allow the integration of air and ground transport to offer smarter and more efficient mobility.



Innovative U-space services and the development of smart, automated, interoperable, and sustainable traffic management solutions will be key enablers for achieving this high level of integration. U-space will also need to address a variety of constraints to meet the requirements of "priority aviation" such as security or emergency service helicopters. It is, therefore, obvious that the most critical success factor for U-space UAM operations will be the ability to identify solutions that allow UAS, UAM/eVTOL and all the other airspace users (unmanned and manned) to operate safely, securely, sustainably and efficiently in a controlled and fully integrated airspace, without undue impact on operations currently managed by ATM.

These challenging objectives can only be achieved through an evolutionary development process ensuring the definition and timely deployment of appropriate, advanced and interoperable U-space infrastructure, technology, and traffic management capabilities, providing advanced services that fit with expected types of operation and levels of demand.

A U-space Concept of Operations (ConOps) for UAM is central to this evolution. This ConOps must be accepted by the U-space stakeholder community and enable the safe integration of UAM and UAS above VLL, into airspace managed by U-space and Air Traffic Control and alongside manned aviation. Additionally, since UAM represents one of the most demanding use cases for U-space

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services and capabilities, an extensive set of demonstrations and validation exercises of the proposed solutions are necessary before deployment. To meet this challenge, a balanced group representing the most innovative research arms of the ATM, UAS and UAM industries have formed the CORUS-XUAM consortium. The CORUS-XUAM Very Large Demonstration (VLD) project extended the U-space ConOps defined by the CORUS project to enable the safe and efficient integration of UAM operations. Through the planning, preparation and execution of six demonstration campaigns in six different European locations, the project consortium demonstrated integrated operations of both unmanned and manned aircraft and advanced forms of interaction through digital information and data exchange. These included the provision of integrated and advanced U-space services in urban, sub-urban, and inter-city scenarios as well as in and near airspaces and airports currently managed by ATM.

The project also explored how to ensure a proper interface with ATM/ANS (Air Navigation Services) with a particular focus on airport scenarios, as well as with all relevant airspace operations.

2. Very Large Scale Demonstration (VLD) Scope

2.1 Very Large-scale Demonstration Purpose

The SESAR JU defines U-space as “an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and **all types of environment** - even the most congested -...” This encompasses Urban Air Mobility, which is indeed the target of CORUS-XUAM. To frame the scope, EASA is defining Urban Air Mobility as “an air transportation system for passengers and cargo in and around **urban environments** [19], and specifically mentions sub-urban environments in its reports. The notion of environment, as a subset of urban scope, is relevant for the deployment of U-space in support of UAM, influencing aspects such as functionalities of the services, level of required performance, types of operations supported or airspace structuring. Requirements resulting from the execution of demonstrations in each (sub) environment might be different.

In this sense, and with a view of better addressing the diverse use cases, CORUS-XUAM VLD addressed the following UAM environments, also depicted in below:

- **Urban environment**, defined as an area either within the urban centre or a dense urban cluster of a city;
- **Sub-urban (residential) environment**, defined as an areas within a semi-dense urban cluster or a peri-urban cell [20] used mainly for residential purposes;
- **Sub-urban (industrial) environment**, defined as an area within a semi-dense urban cluster or a peri-urban cell used mainly for industrial activities;
- **Sub-urban (intercity) environment**, defined as a succession of semi-dense urban clusters and peri-urban cells linking two close cities.

In addition to the defined environments, controlled airspace within urban and sub-urban areas corresponds to areas belonging to any of the above environments within airspace managed by ATC.

From the point of view of operational environments, the scope of CORUS-XUAM was:

- Mixed operations/missions in urban and suburban environments and in an airport environment, including at least:
 - Seamless door-to-door transport of people (air taxis), including UAM flight between different cities (inter-city scenario);
 - Seamless door-to-door transport of goods (logistics services);
 - Depot-to-depot transport of goods (logistics services);
 - Visual and data acquisition and aerial works, and in particular:
 - UAM for emergency operations;
 - Surveillance of people, traffics flows and infrastructure.

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- Involvement of a dedicated vertiport placed in a city.

Moreover, CORUS-XUAM VLD targeted the following operational and technical aspects:

- o Seamless transition between different UTM systems;
- o Seamless coexistence of different USSP;
- o Automated flight and flight planning management;
- o Ad-hoc weather information provision;
- o Mission planning and approval process;
- o Collaboration and interface between ATM/ATC and USSP/U-space;
- o Use of eVTOL and fixed-wing UAM solutions;
- o Use of UAM of different performances and power supplies (electric/fuel);
- o Involvement of small drones for specific missions in a mixed environment (UAM/UAS).

The project CORUS-XUAM was articulated around six exercises, performed in seven different European locations:

- Belgium;
- Germany/UK;
- Italy;
- Spain;
- Sweden;
- France.

The aim was to cover the main aspects of the safe integration of a variety of UAM missions, enabled by U-space solutions.

Several and different stakeholders were involved in the exercises:

- Different ANSPs;
- Different USSPs;
- Airport operators;
- UAM and UAS operators/pilots;
- UAM manufacturers;
- Involvement of smart-cities, municipalities and regions (e.g. Paris Region, Linköping and Norrköping, Helsinki, Catalonia/Castelldefels, Bari/Taranto, Antwerp, Bruchsal, Toulouse Metropole).

3. The Italian Very Large Scale Demonstration

3.1 Exercise description and scope

The Italian demonstration, focused on guidelines for safe depot-to-depot operations between two logistics centers within a suburban area. Flight tests, with involvement of a fast UAM vehicle and other drones for specific operations, took place at Grottaglie-Taranto civil experimental airport, allowing the involvement of an ATM component and the demonstration of coordination and interoperability between ATM and U-space for the management of UAM cargo traffic. This VLD addressed the UAM-tailored performance framework developed in CORUS-XUAM, including safety, access and equity, and human performance, measured through human-in-the-loop assessment, such as ATCOs and pilots and analysis of data collected during the demonstration.

In detail the scenario, was composed by three different macro area located in Apulia Region (South-East of Italy):

- Grottaglie-Taranto Civil Airport
- Manduria Airfield
- Urban Area: Hospital

The type of operation was identified as a medical cargo transportation. The Figure-1 provides an overview of locations.

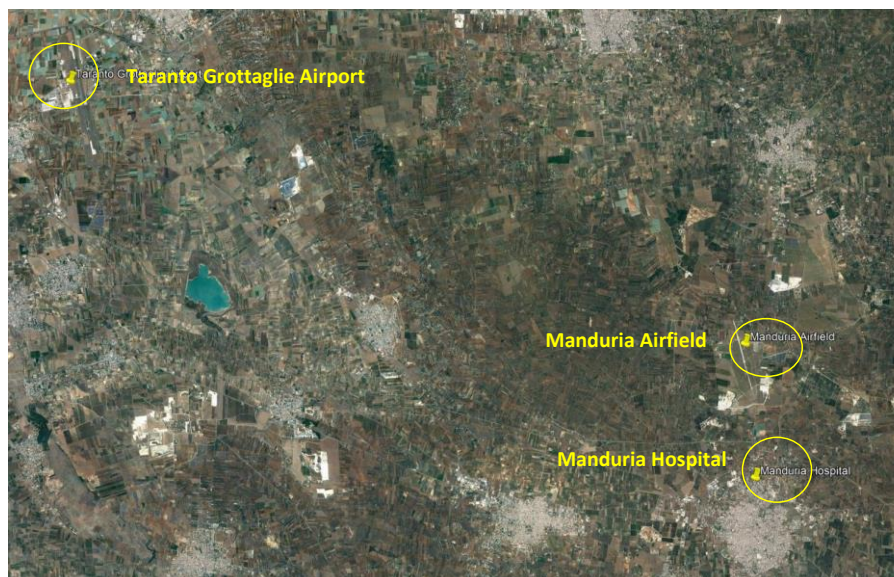


Figure 1: Italian exercise locations

3.2 Stakeholder's expectations and Key Performance Areas addressed by the exercise

The following table provides a summary of Stakeholders involved in the exercise with information about their involvement, interests and Key Performance Areas addressed:

Stakeholder	Involvement	Why it matters to stakeholder	Key Performance Areas
ANSP	ANSP is involved in strategic phase for activities related ATM (controlled airspace) and manned a/c operations in u-space (e.g. HEMS	Integration of UAM operations in U-space need a coordination between ATM and UTM in terms of services. It is requested to demonstrate that	Human Performance , Safety, Access and Equity, Global Interoperability

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Stakeholder	Involvement	Why it matters to stakeholder	Key Performance Areas
	flights, VFR) through FISO. In addition Taranto Grottaglie civil airport is involved and is the "starting" location for demo activities related to PVS Fixed wing cargo RPAS/UAM so ATC/TWR-GND controllers will be involved	operations in U-space don't have negative impact on current safety level of controlled airspace. Possible impact on Human performance needs also matters ATCO on their duties.	
USSP	USSP is involved in provision of U-space services to related users in U-space.	Maintain or increase the safety levels related introduction of UAM traffic in U-space. Provide access and equity to a new type of airspace users (U-space users such as UAM/UAS operators).	Safety, Access and Equity
Drone Pilot/Operator	Will be involved for specific operation in LOS and BVLOS (last cargo delivery, aerial photography, precision agriculture) which are part of WP8 Italian demo scenario	Ensure the operational feasibility and acceptability of flying drones in U-space. Ensure the utilisation of U-space services	Human Performance, Safety, Access and Equity, Efficiency, Cost Effectiveness
UAM Pilot/Operator	Will be involved in transportation of cargo (medical) from Taranto Grottaglie Airport to Manduria Airfield placed in suburban area.	Ensure the operational feasibility and acceptability of flying UAM in U-space. Ensure the utilisation of dedicated U-space services for UAM	Human Performance, Safety, Access and Equity, Efficiency, Cost Effectiveness
Airfield/Vertiport operator	Will be involved in management of ground operations and coordination related to Manduria Airfield	Ensure an equitable usage of Airfield/vertiport by UAM/drone users. Ensure the access to airfield/ vertiport of UAM/drone users	Access and Equity, Cost Effectiveness

4. Exercise Platform / Tool and Demonstration Technique

The following picture (Figure-2) provides a schematic view of architecture of Italian Demo exercise. The main elements reported have been described in the sections of this chapter.

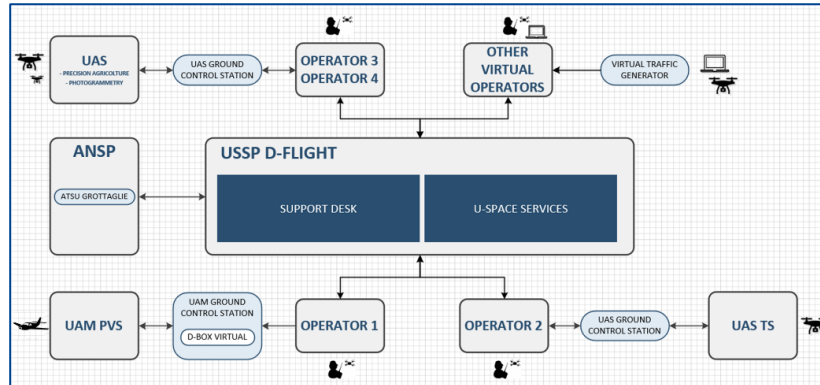


Figure 2: Exercise Architecture

In addition to the elements already described, the diagram provides blocks related the following actors/system involved in the demo:

- Support Desk (D-FLIGHT): is a human actor that acts as a bridge between UAS operator and ANSP and provides coordination and exchange of information needed for specific services (e.g. emergency management, activation/de-activation of u-space volumes). He also provides coordination for management of HEMS flight originated in ATM with operation in U-space as described in the “phase3” of this demo.
- Other virtual operators: are the UAS generated and managed by virtual traffic generator of d-flight. This element generates virtual tracks of different commercial UAS taking in consideration their performances.

4.1 Pipistrel Vertical Solution UAM Fixed Wing Cargo RPAS

Pipistrel UAM fixed wing cargo is an optionally piloted aircraft whose design is based on the Pipistrel model Virus SW 600 D. Pipistrel UAM is a two-seat aircraft of composite construction. The aircraft is arranged as a high wing mono-plane with cantilevered wings, T-tail empennage and tricycle landing gear. It is equipped with a 73,5 kW Rotax 912 iS Series engine. The cabin incorporates side-by-side seating and two large gull-wing doors. The flight control system, which consists of various levers, pedals, bell cranks and pushrods, is designed in a way to ensure full flight control from the left seat only. A centrally-located quadrant incorporates two levers for throttle and propeller pitch control. The elevator trim is commanded via a lever located between the two seats which also features the trim position indication. Pipistrel fixed-wing UAM features an AFCS with full ATOL (automatic take-off and landing) capability. The AFCS rack (flight control computers, actuators, switches and circuit breakers, etc...) is installed behind the seats, occupying the space that is normally dedicated to the baggage compartment. The AFCS has the capability to command the aircraft in all flight phases, from take-off to landing including taxi and automatic go-around and automatic management of emergency contingencies. It therefore has authority on multiple axes: pitch, roll, yaw, pitch trim, flaps, airbrakes, thrust, wheel brakes and nose-wheel steering. Thrust is managed by controlling throttle and propeller RPM separately.

The AFCS also has the capability to receive manual remote inputs from a Ground Control Station (GCS). The “remote” pilot uses a joystick to control the aircraft’s three axis and a dedicated device with two levers for commanding throttle and propeller RPM. In order to function, the AFCS requires a set of

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data which is provided by dedicated equipment and sensors installed on the aircraft:

- INS/AHRS/GNSS receiver for inertial and satellite-derived position, attitude, angular rates, accelerations
- Radar altimeter to measure Height above ground
- Datalink which transmits and receives data to and from the GCS
- Magnetometer, for magnetic heading measurement
- Air Data Computer to process air data from pressure inputs from pitot-static system
- Engine Control Unit, Provide engine monitoring data to avionics and AFCS

Next Figure-3 provides an overview of system:



Figure 3: PVS Remote Piloted Aircraft + Remote Pilot Station

4.2 Techno Sky UAS

The UAS used for last mile delivery used by UAS Operator Techno sky was the PPL 612 PLUS EVO XL in Figure-4. The PPL 612 Plus EVO XL is a UAS configured as hexarotor with MTOM less than 25 Kg that obtained the Project's Certification issued by ENAC (Italian civil Aviation Authority).



Figure 4: Techno Sky UAS

Technical Specs	
MTOM	15 kg
Wingspan/max dimension	1.6 m
Wind resistance	12.5 m/s
Cruise speed	12.5 m/s
C2	2.4 GHz
Range	4000 m
Endurance	15 min
Takeoff	Manual (RC) or automatic

Table 1:UAS Technical Specifications

4.3 USSP platform: D-flight

D-flight is a ENAV Group company and pursues the development and provision of services for the management of Unmanned Aerial Systems (UAS) and related activities. ENAV, with D-flight, is at the forefront for the construction of the U-space in Italy, and for this reason, D-flight aims to be recognized as the reference Italian U-Space Service Provider (USSP).

D-flight platform (Figure-5), makes available to users actually the following U-space Services:

- **U-space foundation services (U1):** e-registration, e-identification and geofencing.
- **U-space initial services (U2):** support for the management of drone operations: flight planning, flight approval, location, dynamic airspace information and procedural interfaces with air traffic control.



Figure 5: D-flight platform

Here are listed the main capabilities and U-space services provided by the platform:

UAS Operator registration

The user can login on the D-flight portal and be registered as UAS operator sending the required documentation. The accreditation allows access to the geo-awareness service, among the most important features: Visualization and interrogation of the Aeronautical Maps with the regulated areas for the UAS flight; The visualization and interrogation of temporary restricted areas of airspace (e.g NOTAM); Navigating the map with normal WebGIS tools and advanced layers (e.g Population Density Map, Land Use).

Identification

The service allows the authority or private citizen (with exclusive reference to their data) to know some information about the vehicle, its operator and its owner, through the D-flight platform.

The "QR Code UAS Operator" is an alphanumeric code that allows to uniquely identify a UAS operator. The UAS operator is required to print and apply his UAS Operator QR Code on equipment in its possession, before using them in flight. The identification service is valid in all EU countries that have implemented the interoperability of the national UAS Operator registers.

Declaration

D-flight platform allows the user to carry out operations in a specific category, in accordance with the standard scenarios defined by the Authority (see ENAC guideline), through the declaration service

on the portal.

Drone Operation Plan (DOP)

The Drone Operation Plan (DOP) service allows to view the area of operation and verify the compatibility between the air rules and the operations planned by other Operators in the same area and in the same time period.

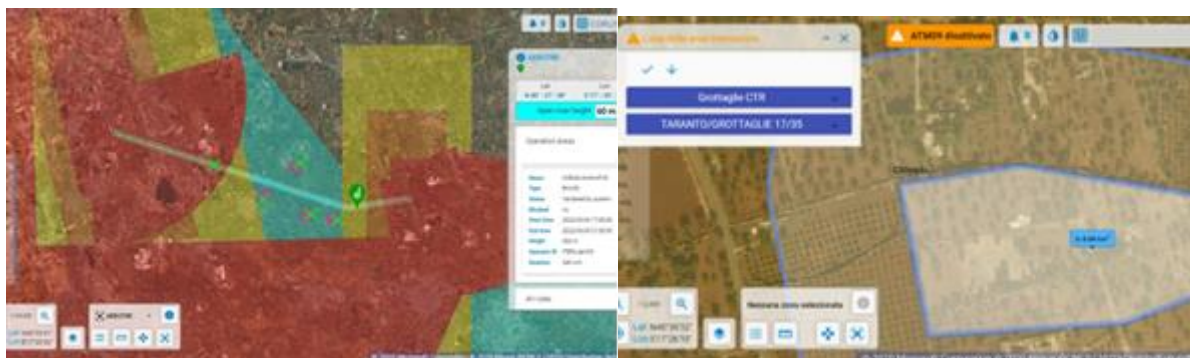


Figure 6: Drone Operation Plan

The service "Drone Operation Plan" (DOP) in Figure-6 is mandatory for the UAS Operator operating on the basis of ENAC authorization in BVLOS. For other types of UAS operations, the service is not mandatory, but its use constitutes an important contribution to the situation awareness in relation to the airspace affected by the activity.

Drone Operation Area (DOA)

The service Drone Operation Area (in figure below) for VLOS mission in the OPEN category has a double value: 1. allows the Operator to quickly check the compatibility of a flight area VLOS with limitations in the use of airspace; 2 makes available to all registered users with active subscription, the "missions" in progress, displayed anonymously on the map of the D-flight portal. Only upon activation, the Drone Operation Area will become visible on the map to all D-flight users logged into the portal. It is possible to have only one Drone Operation Area active or saved at a time. The service is not mandatory, but it constitutes an important contribution to the situation awareness in relation to the airspace affected by the activity.

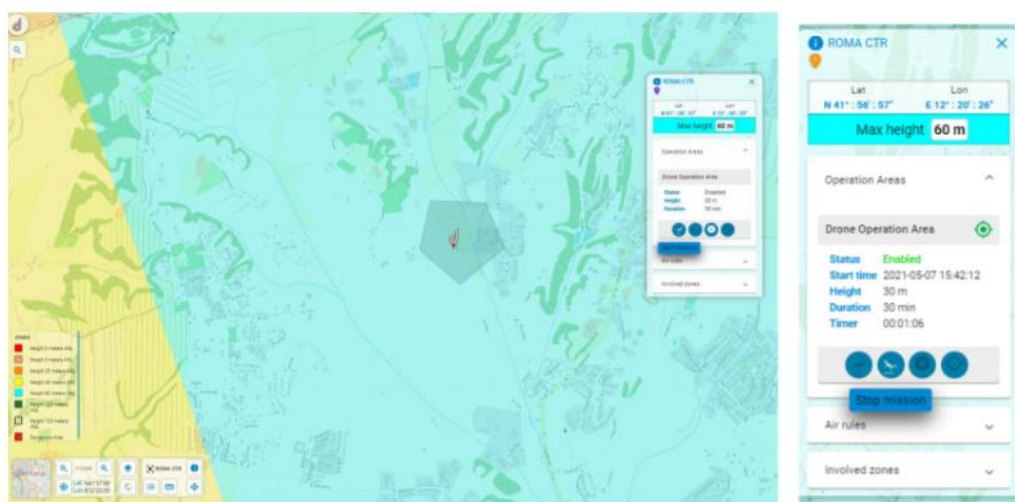


Figure 7: Drone Operation Area

Network Identification Service

Tracking

The service allows the user to share their position with D-flight. The position will be shared on the

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map, in pseudo-anonymous form with all other users logged in to the portal in relation to the area of interest, with a view to situation awareness. The development of the Network Identification Service will allow the progressive improvement of the situation awareness in relation to the airspace affected by UAS activity.

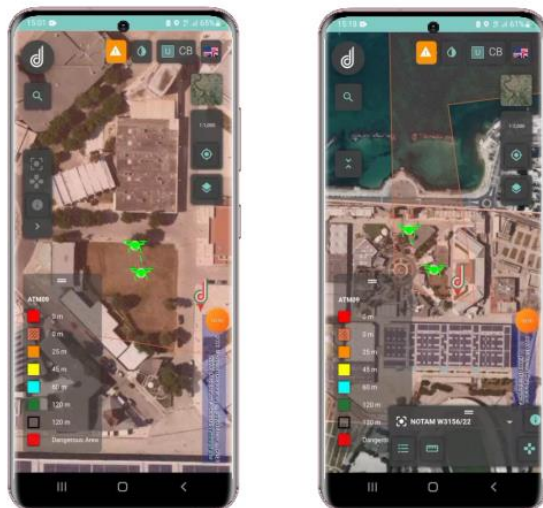


Figure 8: Tracking

The position will show the following information:

- drone license plate or user ID;
- coordinates (Lat / Lon) of the drone's position;
- mission Status;
- duration of Mission;
- start / end date;
- height;

The drone track is represented by a dashed line (Figure-8) and is also highlighted with the following colors:

- green, red, orange or gray, depending on the "status" of the planned mission:
- green track: no anomaly;
- red track: the position is within a no-fly area (i.e. No Fly Zone);
- orange track: the position is outside the planned area;
- grey track: data transmission error.

Operators of UAS vehicles who intend to use the promoted services, always in full compliance with the GDPR on Privacy, will contribute to the creation of an overall picture of the low-altitude traffic situation represented by D-flight in the form of **Traffic Information Service (TIS)**. In line with the concept of electronic conspicuity, introduced by the U-space regulatory package recently adopted by the European parliament, the services already active and recommended by ENAC (Ente Nazionale Aviazione Civile) for Drone Operation Area (DOA) for operations in the Open category will contribute to the completion of geographical awareness, Drone Operation Plan (DOP), already mandatory for operations beyond the visual field in the Specific or Certified category, as well as the traces of manned vehicles visible by the ADS-B cooperative surveillance networks.

Advanced GIS Services

On D-flight, in addition to the basic Geo Awareness service, other value-added GIS services are available.

Maps

'Aerial' - The map showing the orthophotos: geometrically correct and geo-referenced aerial photographs, so that the scale of representation of the photograph is uniform. The map can be considered equivalent to a geographical map;

'Road' - The map that displays vectorial images of roads, buildings and geography in a graphic manner. The map can be considered equivalent to a political map.

'Aerial Street' - The Aerial map that highlights the streets and main landmarks for easy identification of places through satellite images (in addition to the openstreetmap, already available on D-flight).

The 'Aerial', 'Road', 'Aerial Street', 'Dark' Maps include Google Bing data and will allow Operators to analyze in more detail the area of operations.

Layers

'Land use' - which includes information relating to the environment on some priority issues for the European Union (air, water, soil, land cover, coastal erosion, biotopes, etc.) Figure-9_1. The 'Land use' layer includes the data provided by the CORINE 2018 project (a European program launched in 1985 by the European Commission) and will allow Operators to carry out a preliminary analysis of the ground risk for the preparation of the SORA.

'Census' - which includes information on the number of inhabitants by census section (Figure-9_2). The 'Census' layer includes the ISTAT data from the 2011 census and will allow Operators to carry out a preliminary analysis of the ground risk for the preparation of the SORA.

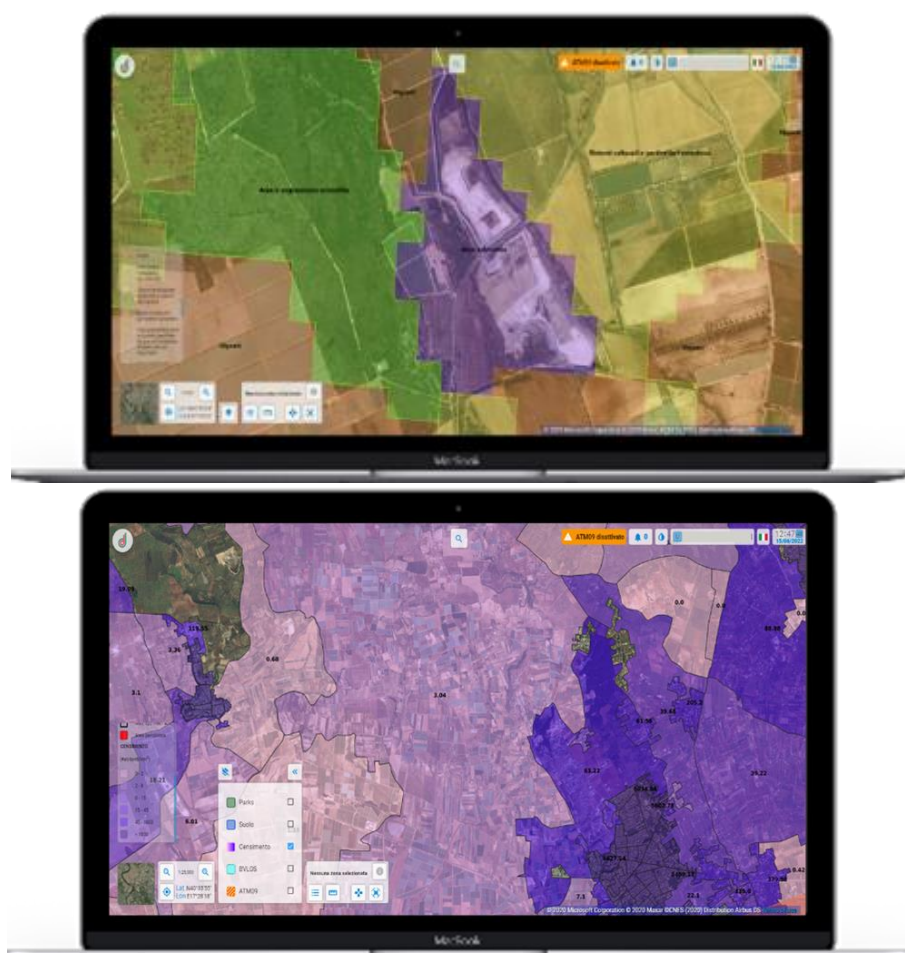


Figure 9: Population density layer

GNSS Monitoring

This service allows users to view on the map an indication of any malfunction status of the GNSS signal. If the GNSS signal is corrupted (e.g. due to problems on a GNSS satellite / interference due to significant ionospheric phenomena) an Alert (red traffic light) or a Warning (yellow traffic light) relating to the signal status in the selected map region. Finally, in the event of an alarm, by clicking on the detail expansion arrow it is possible to consult the following values on the GNSS signal:

- Minimum HDOP: index of the quality of the satellite arrangement in the horizontal reference condition;
- Minimum VDOP: index of the quality of the satellite arrangement in the vertical reference condition;
- Minimum elevation: the minimum elevation in degrees between the satellites visible in the reference condition (useful for evaluating the width of the local horizon, or the degree of visibility of the drone);
- Hor error: the estimate of the error in meters in the horizontal reference condition;
- Error Up: the estimate of the error in meters in the vertical reference condition;
- HPL: maximum horizontal error in meters estimated by EGNOS in the reference condition;
- VPL: maximum vertical error in meters estimated by EGNOS in the reference condition.

4.4 Pollicino UTM BOX

The UTM Box Pollicino™ is a drone tracker based on LPWAN LTE technology, which implements remote identification service over the internet network (Figure-10). It is the first Remote Identification device conforming to the “Manifesto” for the development of U-space services in Italy. Actually, the tracker is ready for EU Regulation 2021/664.

The Family of the Pollicino encompasses the basic Pollicino UTM Box, but also the new UTM Boxes with additional features, actually under development.

The basic Pollicino Tracker can be easily configured to work with different USSPs. In the default configuration the tracking service is linked to D-flight USSP by the exploitation of d-Flight ICD for connectivity. The new versions of the Box handle also the possibility of multiple USSPs connectivity, through an UAS Operator configuration portal.



Figure 10: Basic Pollicino UTM Box for Tracking service

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Dimension (WxHxD)	62x47x18 mm
Weight	40 grams
Battery life	up to 6 hours
Recharge	Micro USB connector
Data transmission frequency	1.5 seconds
Frequency bands (Italy)	B3 (1800 MHz) e B20 (800 MHz)
4 Led indicators	NET, TX (Data transmission), STATUS, CHARGING
Network connection	NB-IoT, LTE CAT-M

Table 2: Pollicino basic technical specification

The UTM Box was used for tracking of UAM and all drones of demonstration

4.5 Taranto-Grottaglie airport

Italy has identified a whole equipped and operative airport to support the development of UAS and U-space technologies and AAM/UAM services: the Taranto-Grottaglie airport “Marcello Arlotta” (ICAO CODE: LIBG). In January 2015, ENAV, the Italian air navigation service provider, designed three restricted areas (totaling about 370km²) where drone products, operations and services can be tested and demonstrated. Since then, the DTA (Distretto Tecnologico Aerospaziale) has devised an impressive development strategy leveraging this airport infrastructure to increase regional and national capacity in UAS development, applications and services. Preliminary results of these initiatives is the deployment of an ICT environment on March 2020 that will host a UAS flight operation simulation environment (the simulation environment is development by Leonardo, Telespazio and Vitrociset) and the realization of a flight test campaign for the ECARO project where a UAS VTOL MOTOW=150Kg was used to demonstrate capability of the UAS to fly a satellite based approach procedure. The involvement of other companies and authorities (ENAC, ENAV, Telespazio, ESA/ASI Spaziale Italiana, Aeroporti di Puglia, the Italian AirForce, CIRA), through project and agreements with DTA, having common aims and research goals that can synergistically operate within the Grottaglie Airport Test Bed allows to create a cradle of industrial development in the Grottaglie airport. In the figure-11 below, the segregable air space are highlighted. It must be considered also that other air spaces can be segregated after the achievement of a UAS flight authorization from ENAC (Italian CAA).

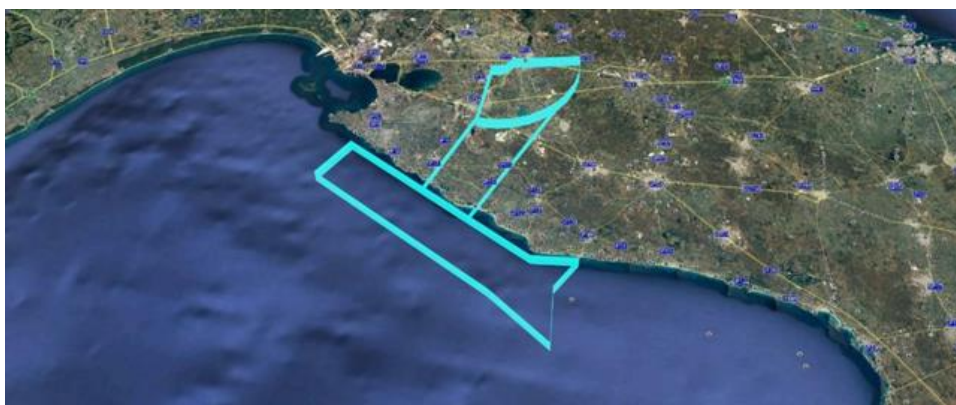


Figure 11: Restrictable areas for UAS operations, as designed by ENAV

The Grottaglie airport is fully operative and classified as CAT 1. Currently the traffic is created by:

1. training and institutional flights of Italian Navy and of Financial Police (both are based near to the airport and use separate runway),
2. cargo services related to the Leonardo plant next to the airport (2 flight a week),
3. other private flights.

At the standard equipment as for the airport classification, through previous initiatives a system

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monitoring GNSS interference is deployed and active (upon request).

Lastly, several hangars are available to host UAS while DTA has a laboratory in the Technical building where, if required, office work can be realized.

4.6 Aerotre aerodrome

The second aerodrome identified for the operation is AEROTRE airfield. This airfield is currently exploited mainly by the aeroclub Accademia Voli Imperiali, whose activity is aimed at flight school and aeronautic awareness diffusing. The aeroclub has a fleet of about 11 aircrafts.

The airfield spanning about 130.000 m², has a grass runway and taxiway, a helipad, an area for aircraft park and 4 hangars to park aircrafts. The runway is long about 350 m.

It must be considered that the Aerotre airfield is out of the R315 air space.

4.7 Manduria hospital

Last demonstration site is the hospital 'Marianna Giannuzzi', that is located in the peri-urban area of Manduria as showed in Figure-12. The hospital is very near to a railway and on its opposite side a quite large green area is available between populated areas. The canal is larger than 100m and can be exploited to mitigate UAS flight operations. In the neighborhoods of the hospital there are some park areas that can be potentially exploited to equip a temporary landing areas.

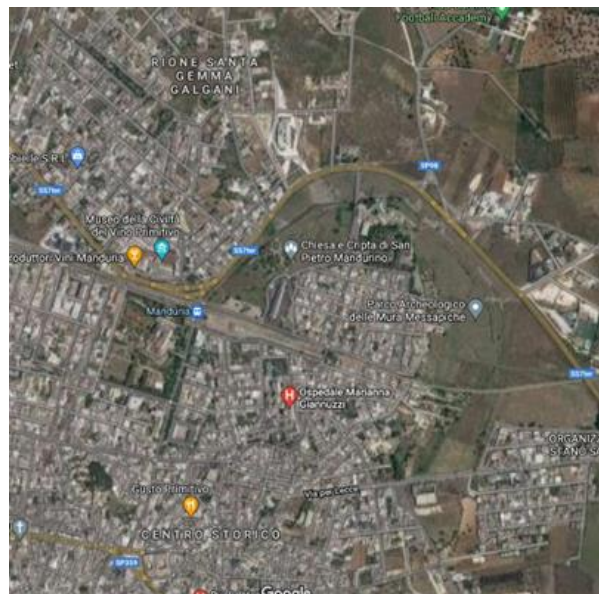


Figure 12: Manduria Hospital

5. Validation Scenario

The Demonstration scenario is represented by a Medical cargo transportation in U-space with UAM CTOL RPAS and UAS multicopter.

5.1 Operational scenario summary

The scenario of the Italian exercise consisted in the transport of goods (e.g. medical supplies) from the civil / experimental airport of Taranto Grottaglie, located in Puglia, to the hospital of the city of Manduria, including a stopover at an airfield near the city. The operations covered mainly rural and suburban environments in controlled airspace. Specifically, the demonstration was made of these different steps:

Demo steps (Concept)
A cargo (e.g. medical goods) arrived at Taranto Grottaglie Civil airport.
The medical content was loaded on a Pipistrel (PVS) Large Fixed Wing Cargo UAS/RPAS placed in an area close to the airport.
The PVS/RPAS started the mission and flight in U-space through a dedicated UAM corridor in VLL which ended in an area (logistic center) close to Manduria.
During the flight other drones specific operations (photogrammetry, precision agriculture) were performed and managed in the U-space.
Once the PVS/RPAS landed in the airfield, the medical load was divided into several smaller loads.
One of these, was loaded on a Techno Sky UAS and transported to final destination (Manduria city hospital) through a specific BVLOS operation.
Before the return flight to Grottaglie of the PVS/UAM (before take-off), an emergency occurred (an HEMS (Helicopter Emergency Medical Service) flight started in controlled airspace that executed operation in U-space. The emergency was managed at all levels.

The Figure 13 below provides an overview of Operational scenario

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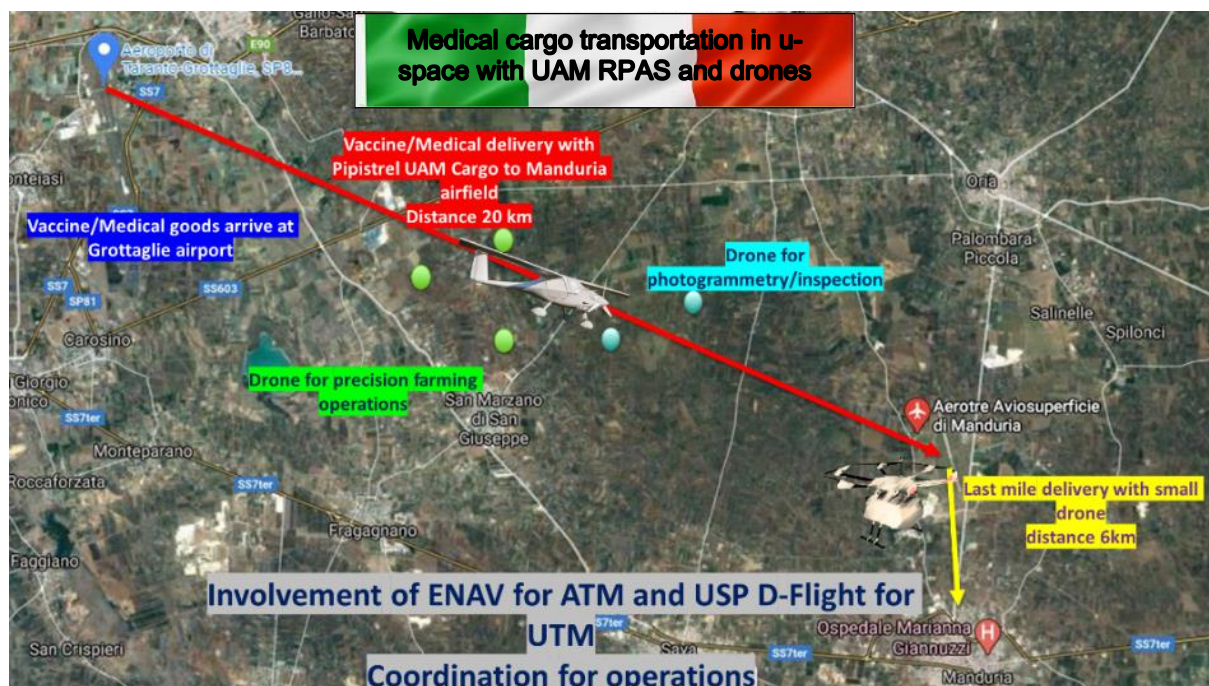


Figure 13: Operational scenario overview

The scenario phases are the following:

Phase 1: UAM medical cargo operation in U-space with other UAS

Pipistrel, an UAM operator, planned to fly a Fixed wing cargo a/c to carry a vaccine/medical cargo from Taranto Grottaglie civil airport to Manduria airfield located at 20km away. The pilot on board was equipped with a device for exchange of u-space service with d-flight. The PVS vehicle (Figure-14) and related operator were registered and the UAM operation information were available to USSP (U-space Service Provider) (D-Flight) and to ATM/ANSP (ENAV).



Figure 14: PVS Aircraft used for UAM cargo operation

The PVS operator prepared the UAM flight plan/mission by selecting the dedicated UAM corridor to be used¹. The request was submitted to USSP, which determined if the 4D trajectory was conflict-free and checked other resources (e.g., availability of airfields). At the same time, in the same way as a real case, the USSP managed also the other Flight Authorizations and related requested missions of other

¹ UAM corridors are published in AIP and selectable by UAM operator through USSP web-portal interface

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UAS present near the corridor selected for the PVS and performed an assessment of conflict-free status. In fact, during the demo, other specific operations (inspection, precision agriculture) were foreseen in the same area (plus simulated traffic).

Since the PVS was registered, the system automatically linked the elements described in the registry with elements of the flight request, in which full details of the airworthiness of the same, and its procedures in contingency situations, were described. For example, this information could include designated safe landing areas or details of the equipment and capabilities of the PVS. USSP provided flight planning assistance services and services providing the expected density of traffic in the mission area. The ANSP accepted the flight authorization, and the USSP sent the acceptance of the flight authorization request to the PVS Operator. The pre-flight information (e.g., NOTAM, weather info, other UAS planned operations in the area) was prepared and made available by USSP to PVS Operator, who received, reviewed the briefing, and accepted the flight. USSP recorded the acceptance and published the info to the other interested stakeholders who were an active part of U-space. The strategic de-confliction and Procedural Interface with ATC service assured the Situational Awareness in the U-space volume. At this point, the PVS pilot performed the pre-flight checklist and started the flight. The PVS performed the take-off from a dedicated surface in the ATZ. The procedures/flight paths used for take-off and landing from/on this dedicated area to PVS were strategically de-conflicted and did not interfere with the Airport procedures (e.g., SID/STAR, final approach path, initial take-off, etc., used by other AUs). The area could be considered a U-space airspace portion in ATZ.

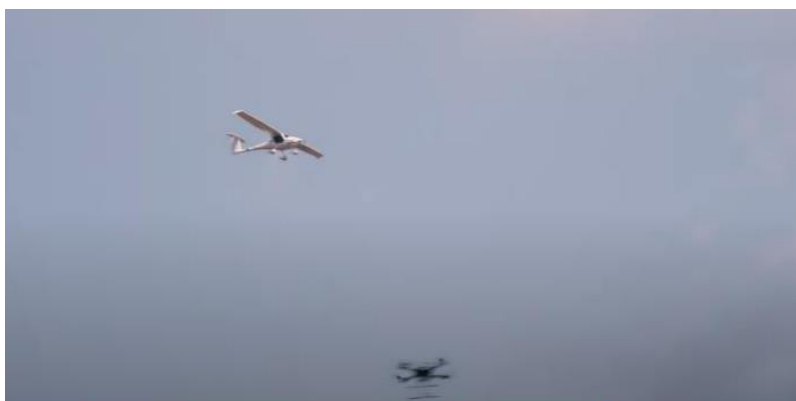


Figure 15: PVS fixed wing cargo and other UAS flying at same time

The UAM flight was tracked by the USSP, that elaborated the flight information, and provided traffic information to all interested stakeholders (ANSP, FIC, UAS pilots, UAM pilots manned aviation). The same tracking process was applied to all other UAS that gather the Flight Authorization (e.g. other UAS involved in the demo), in fact the USSP detected all other drones (with the Drone Detecting System), produced the system tracks, created and provided the traffic information to all interested users/stakeholders. Figure-15 shows the PVS and UAS flying at same time, the Figure-16 the others UAS involved in the operations. The USSP in addition performed the monitoring of the alignment of U-space users involved flights with related plans and, in case of non-conformance, provided the related warnings.

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Figure 16: Other UAS involved in operations

The PVS pilot transited from the cruise phase, via the arrival path, to the landing one at the reserved airfield, according to the flight plan, still tracked by USSP. After the landing and taxi phase, the PVS went to the stand/hangar and turned off the engine. The operation/flight plan was considered closed, and tracking was over. USSP recorded the closure of the flight. The medical cargo was unloaded (Figure-17). The PVS/RPAS pilot performed the post-flight checks, filled out the report, and sent it to USSP, which saved the data and fed systems with the flight data to build and provide statistics to the PVS UAM operator.



Figure 17: Landing of PVS UAM cargo aircraft on Manduria and transfer of medical parcel delivery to Techno Sky UAS pilot

Phase 2: BVLOS small cargo operation from suburban to urban area

Once the PVS vehicle landed in the Manduria airfield, the medical cargo was split into different small packages: one of them was loaded on Techno Sky drone for the last mile delivery from the airfield to Manduria Hospital (Figure-18). For this operation the UAS operator and drone were registered on the USSP platform and once SORA was provided, the operation was authorized. It consisted of a 6km BVLOS operation from a substantially rural area to an urban environment in controlled airspace, so it could not use any standard scenarios or pre-defined risk assessment. During this specific flight no criticalities and/ or abnormal situations were foreseen, as everything happened according to standard procedures, Figure-19 shows the track of the UAS during BVLOS operation.

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Figure 18: Techno Sky UAS used for BVLOS last mile delivery operation

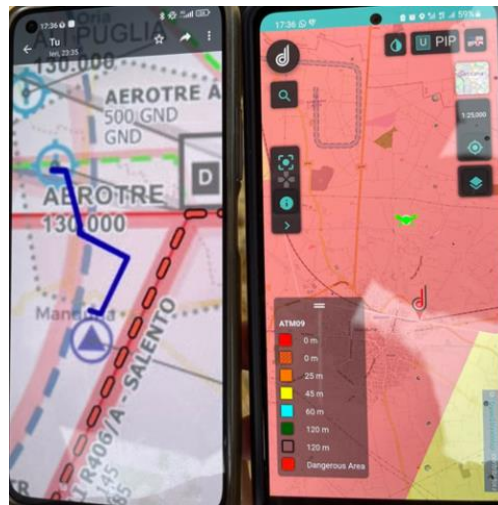


Figure 19: Tracking of UAS along BVLOS operation (from d-flight mobile app)

Phase 3: Management of emergency from ATM in U-space: HEMS flight with high priority

Once its purpose had been achieved, the PVS vehicle was ready to return to the airport of origin. Before starting the flight again, an emergency was generated in the affected area, identified by the ANSP. The emergency was related to a high priority HEMS flight operation originated in Taranto Grottaglie Airport (Figure-20) and executed in U-space in VLL. The HEMS operation (simulated) was managed through a LOA between ANSP and Company (HEMS), the flight was from the airport to the city hospital and didn't need an FP submission. At this point, ANSP notified the emergency to the d-flight USSP Operational Support Desk (a human actor that acted as a bridge between ATM and UTM in Figure-21) together with the information for the activation of Dynamic Airspace Reconfiguration (DAR), useful to manage and continue the operation. Figure-22 provides an overview of different airspaces.



Figure 20: Taranto Grottaglie ATC Tower in communication with d-flight Operational Support Desk

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Figure 21: d-flight Operational support Desk

USSP acknowledged awareness of the emergency, transmitted emergency notifications and DAR information to all interested U-space users (e.g., UAS, UAM pilots). UAS pilots in the interested U-space volumes received the warning and performed actions according to the Emergency Response Plan (in the case of a demo, during this phase, precision agriculture and photogrammetry UAS pilots landed the drones). In the meantime, the PVS pilot received information from USSP. The USSP monitored the traffic situation during the emergency continuously and provided traffic updates to interested users/stakeholders. When the HEMS operation ended, ANSP provided notification to the USSP support desk so that the DAR was deactivated. PVS UAM could start the flight. USSP recorded the end of the flight and provided updates to interested users. UAS pilots in the interested area received information and resumed their own navigation according to the mission plan.



Figure 22: Volumes of operation

The UAM corridor

The PVS UAM vehicle operation was entirely performed within a corridor (UAM corridor) strategically defined to connect Grottaglie airport and Manduria airfield. The characteristics of UAM corridor are reported below and in Figure-23:

- target cruise altitude 1000ft AGL
- lateral corridor width $\pm 250\text{m}$
- vertical corridor width $\pm 100\text{m}$.

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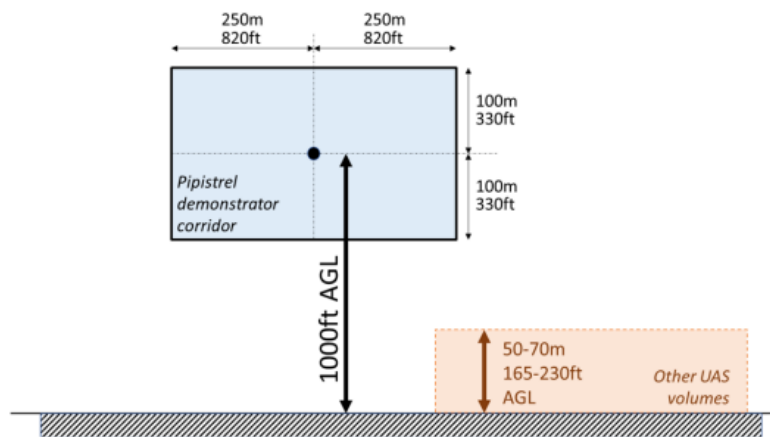


Figure 23: UAM corridor specifications

Within this corridor no other traffic was planned to fly during the demonstrations.

5.2 Operating method

For this specific demonstration different phases were executed with a specific focus on UAM operation, in detail:

- **Strategic:** any general activities related to the management of UAM and independently to the single flight. They are encompassing registration, publication of UAM Corridor, operational authorization of UAM, etc.
- **Preflight:** Any activity related to the preparation of the flight prior to departure, including vehicle pre-flight checks, vehicle charging, flight planning, boarding passengers and/or cargo.
- **Departure:** the period in which the UAM vehicle physically departs from the location A (Vertiport, stand, runway, airfield, etc.) up to the point at which it reaches cruise altitude. Departure includes taxi, take-off and initial climb.
- **En route:** The point at which the vehicle reaches cruise altitude up to the point at which it begins the approach to the destination location/point (Vertiport, stand, runway, airfield, etc.)
- **Approach:** the period between the UAM vehicle aligning with the optimal track to the assigned destination and reaching the decision point (or decision altitude/flight). Descent is expected to occur within this phase. The UAM pilot will elect to either continue or land or climb to a safe maneuvering altitude (executing a missed approach).
- **Landing:** the point at which the decision is made to continue to the destination from the decision point (or decision altitude/height) until the UAM vehicle lands.
- **Post flight:** the period after the UAM vehicle stops moving, the flight closes and securing the vehicle commence. Post flight activities typically includes de-boarding passengers and/or cargo and vehicle servicing activities.

6. Demonstration Exercise Technique

The demonstration technique chosen for this exercise is a live operational trial (Demo). This technique is suitable to achieve the demonstration objectives due to fully representative nature of the exercise. The demo provides the participation of human actors (ATCOs, USSP operator, Remote Pilots), vehicles (UAM RPAS Cargo, other UAS), and real systems (ATM/UTM)- and facilities (Taranto Grottaglie civil airport, Manduria airfield, civil hospital)

6.1 Analysis Specification

Data collection methods

Throughout the demonstration, data were collected from participants using a range of qualitative and quantitative techniques. Controllers, remote pilots and other actors involved had the opportunity to provide in-depth feedback once the measured runs have concluded. The individual methods to be used are as follows:

Quantitative data collection:

Logged data will form the basis of the performance assessment against relevant KPAs measured. Instantaneous Self-Assessment (ISA) will support the assessment of participant workload for UAM+UAS pilots and ATCOs.

The core sections of the Post-Run Questionnaire (PRQ) (to be completed by each participant after every measured run) consisted of industry standard human performance scales, which generated numerical data on a range of human performance aspects. These included:

- SHAPE Teamwork Questionnaire (STQ);
- Situational Awareness for SHAPE (SASHA);
- NASA Task Load Index (TLX);
- SHAPE Automation Trust Index (SATI).

Qualitative data collection:

Questionnaires provided most participant subjective data for this exercise:

- The PRQ included questions based on specific events experienced during the simulation such as safety or platform issues.
- The PSQ collected participants' comments on the concept, its limitations, and recommendations.

Observations were recorded by the validation team and assessment experts during measured runs to capture events or comments made by participants that was valuable to support other data.

Debrief sessions will allow the participants to discuss their opinions and experiences at the close of each day of runs. The output supported the findings of the PRQ and PSQ for the results

Analysis method

The analysis considered both objective and subjective information. The subjective information were processed to obtain an estimate of the acceptability of tested solutions. This supplied answers to outstanding HP and SAF issues related to the concept.

Regarding the qualitative data collected by observations, questionnaires, and debriefings, they were analyzed using operational and Human Factors knowledge. Data from questionnaires were analyzed through the answers reflecting ad hoc scales to check the level of agreement or disagreement of the involved actors with the submitted questions. Deterministic analysis was mainly conducted on the data recorded during the demonstration. The objective information was used as supplementary to the subjective information, especially in relation to the workload and situational awareness. Quantitative

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data were collected by extraction from the demo system log. The measures were employed to assess the exercise evaluation criteria (demo objectives).

Quantitative and qualitative measurements, referring to subjective or objective indications, were collected by means of the following data collection methods as showed in Table-3.

Data Collection Methods	Qualitative	Quantitative	Objective	Subjective	KPA
Over the shoulder Observations	√		√		Human Performance, Safety
Questionnaires	√	√		√	Human Performance, Safety, Operational Efficiency, Global Interoperability
Debriefings	√			√	Human Performance, Safety, Operational Efficiency, Global Interoperability
System Data Log		√	√		Global interoperability, Safety, Operational Efficiency, Capacity

Table 3: Data collection method

6.2 Exercise Planning and management

Activities:

WP8 Demo exercise planned the following tasks that were performed in the preparatory, execution and post- execution phases of the demonstration.

Preparatory activities

1. Obtaining of permission to fly and authorizations
2. Confirmation of the demo design, including scenarios, use cases, objectives and data collection methods.
3. Preparation of the Fixed Wing Cargo UAM RPAS, test of the systems and pre-flight checklist.
4. Preparation of Drone for BVLOS last mile cargo delivery operation, test of the systems and pre-flight checklist.
5. Preparation of simulated drone traffic (generated by drone traffic simulator).
6. Test of e-Identification and tracking of involved vehicles.
7. Preparation and set up of involved facilities (Airport/Airfield).
8. Development of exercise materials, including questionnaires, training resources, observation and debrief sheets and run records.
9. Data log testing to ensure that data is recorded correctly by the systems.
10. Acceptance testing and approval of the systems involved, with the resolution of any issues prior to the exercise.

Execution activities

1. Participant briefings to enable familiarization with all aspects of the demo, including the systems, scenarios, operational environment, and experimental process.
2. Execution of planned use cases (flight of involved vehicles, coordination of actors involved and execution of their tasks/duties).
3. Measured runs that will act as the validation exercise itself. These will be executed after each demo run.
4. Collection of all data types, both during measured runs and following completion of all scheduled runs.
5. Post flight execution checklists.

Post-execution activities

1. Processing of all data collected from various sources to enable analysis to be performed.
2. Analysis of the consolidated demo data, using appropriate methods to reveal trends and key findings.
3. Production of the demo report to set out results against exercise success criteria and expected performance benefits.

7. Results

The results of this study are organized and reported in two primary categories: per Demonstration Objective and per U-space Services.

By organizing the results in these two categories, the study offers a clear and structured presentation of the findings, facilitating a thorough understanding of both the overarching demonstration goals and the specific contributions of individual U-space services.

7.1 Analysis of Exercise Results per Demonstration objective

This section presents the outcomes as they relate to the specific objectives defined for the demonstration. Each objective was evaluated based on a set of predefined success criteria, encompassing both qualitative and quantitative measures. The analysis highlights the extent to which each objective was achieved, offering insights into the effectiveness and efficiency of the tested solutions. Detailed findings include statistical data, participant feedback, and observational notes that collectively inform the overall performance against each objective. Each Objectives is formatted in the following ID EXE3-CX-OBJ-XXX, where EX3 identifies the Italian Exercise, CX stands for Corus Xuam and XXX is a progressive number. The same approach is applied for Success Criteria.

EX3-CX-OBJ-001 :To demonstrate the operational acceptability, i.e. the impact of roles, tasks and procedures under U-space services on end users

SUCCESS CRITERIA

- **EX3-CX-SCR-01.01** The tasks, roles and procedures defined by the U-space services concept bring benefits, in terms of situational awareness and workload, to the UAM pilot/operator (individually and at team level) in nominal (and emergency) situations.
- **EX3-CX-SCR-01.02** The tasks, roles and procedures defined by the U-space services concept bring benefits, in terms of situational awareness and workload, to the drone pilot/operator (individually and at team level) in nominal (and emergency) situations.
- **EX3-CX-SCR-01.03** The tasks, roles and procedures defined by the U-space services concept bring benefits, in terms of situational awareness and workload, to the ATCO (individually and at team level) in nominal (and emergency) situations

Findings on Workload

The evaluation of the mental **Workload** was performed by means of the Bedford Scale with the aim of identifying the actor's spare mental capacity while completing a task. The scale encompasses a hierarchical decision tree that guides all the involved actors through a ten-point rating scale (1 lowest-10 highest), where each point is accompanied by a descriptor of the associated level of workload. For

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the interpretation of the results, scores in the range of 1-3 are considered as satisfactory workload, 4-6 represent tolerable but not satisfactory workload, responses above 6 require further investigation (the workload was not tolerable, but it was possible to complete the task) and 9-10 are considered as unacceptable (it was not possible to complete the task).

The following questionnaire (Figure-24) was used:

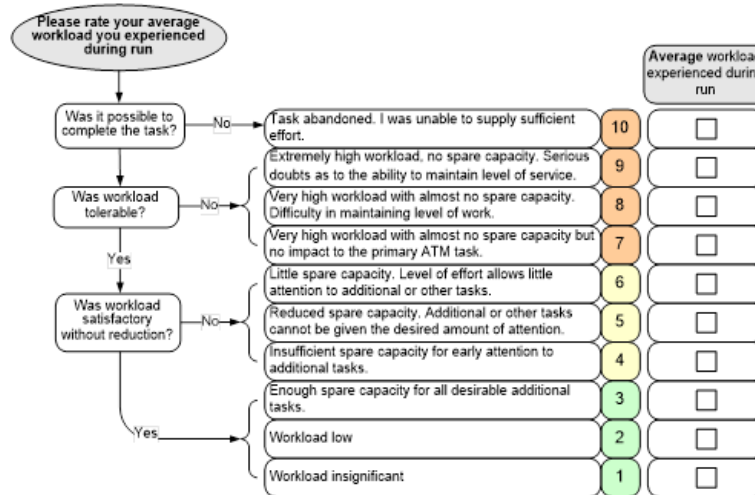


Figure 24 Bedford Workload Scale

The feedback have been grouped per actor involved (UAM pilot/operator, drone pilot/operator, ATCO) in accordance with the aforementioned success criteria related to EX3-CX-OBJ-01 objective.

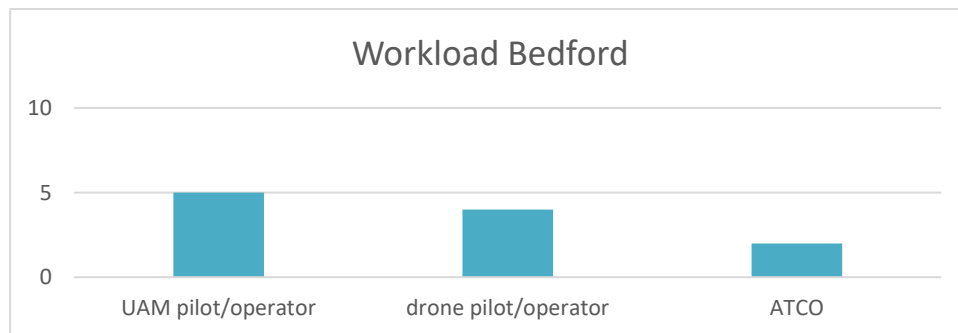


Figure 25 Workload Bedford

The Figure-25 above describes Workload results for the different actors involved in the demonstration. The ATCO acting at the Tower controller position perceived a low workload (2). The ATCO was able to perform his/her task without problems also considering the limited number of targets in the controlled area but nevertheless he/she suggested to improve silent coordination to keep controllers' workload low. Instead Drone pilots/operators and UAM pilots/operators perceived respectively an Insufficient spare capacity for early attention to additional tasks (4) and a Reduced spare capacity. Additional or other tasks cannot be given the desired amount of attention (5) workload level. The results are justified

because drone / UAM pilots have encountered some issue related to the coverage of 4G signal in suburban areas. In fact The 4G coverage was good near the city centre, not good in sub-urban and rural area, so several times the tracking for both "Pollicino (UTM box hook on device)" and d-flight app was lost.

Findings on Situational Awareness

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Situational awareness represents the perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future. During the exercise this indicator was assessed through China Lakes Scale questionnaires and debriefing. Results are supported by charts elaborated with data coming from Post Demo Questionnaires.

The China Lakes Scale indicates the perceived level of SA of the actors after demonstration days. The scale encompasses a hierarchical decision tree that guides through a ten-point rating scale, where each point is accompanied by a descriptor of the associated level of SA.

The following questionnaire (Figure-26) and rating scale were used for this demonstration:

Please rate Situational Awareness (SA) you experienced during the run

Was it possible to perform the task?

Yes

Was your level of SA acceptable?

Yes

Was your level of SA satisfactory?

Yes

SA experienced during the run

My SA with respect to the task was far too low. I could not perform the task because I did not possess the necessary information.	1	☐
My SA with respect to the task was very low. I was unaware of almost all of the information required to perform the task effectively.	2	☐
My SA with respect to the task was low. I was unaware of most of the information required to perform the task effectively.	3	☐
My SA with respect to the task was low. I was unaware of about half of the information required to perform the task effectively.	4	☐
My SA with respect to the task was reduced. I was unaware of some of the important information required to perform the task effectively.	5	☐
My SA with respect to the task was insufficient. I was not aware of all the information required to perform the task effectively.	6	☐
My SA with respect to the task was not complete. I was able to perform the task, but not satisfactorily.	7	☐
My SA with respect to the task was good. I was able to perform the task well most of the time.	8	☐
My SA with respect to the task was very good. I was able to perform the task well all of the time.	9	☐
My SA with respect to the task was excellent. I was able to perform the task extremely well all of the time.	10	☐

Figure 26 China Lakes questions and rating scale

Figure-27 below show on the vertical axis the China Lakes ten rating scale while on the horizontal axis the different actors involved (UAM pilot/operator, drone pilot/operator, ATCO). The figures show the average SA results obtained throughout the demo days.

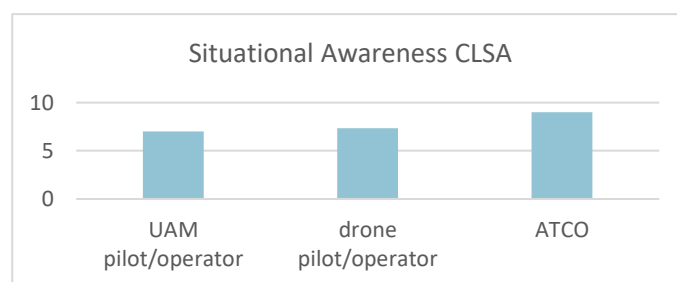


Figure 27 CLSA Situational Awareness

The rating score on situational awareness perceived by ATCO was *very good* (9) because he/she was provided with all information needed to work. Drone pilots/operators and UAM pilots/operators rating score on SA was between *My SA was not complete* (7) and *My SA was good* (8). Despite the positive evaluation, drone / UAM pilots have encountered some issue related to traffic information services: in some cases, not all drones were displayed due to connection issues and coverage of 4G.

- **EX3-CX-SCR-01.04** Coordination among actors involved is granted without timely or performance (capacity, efficiency and safety) degradation of operations

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To assess the coordination among all the actors involved in the demonstration, ad hoc post flight and post demo questions were submitted to them to get feedback according to a frequency scale ranging from 1 “Never” to 5 “Always”. Answers will help to decide if the communications and the exchange of data between the actors has been clear, fast, safe and efficient. Questionnaire answers were complemented with the over-the-shoulder observations and debriefings.

Question concerning this topic is reported below and has been submitted to ATCO, drone pilots/operator and Support Desk:

- **WERE DATA EXCHANGE AND INTEROPERABILITY BETWEEN INVOLVED ACTORS CONDUCTED IN A FAST AND SAFE WAY?**

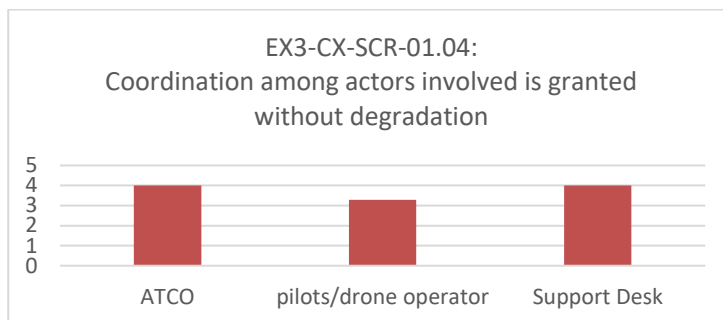


Figure 28 EX3-CX-SCR-01.04

ATCO and Support Desk scored an Often (4) while drone pilots/operator scored a rate between Sometimes (3) and Often (4) as showed in Figure-28. The lower rating score is justified by the numerous issues encountered relating to 4G coverage; in some places without coverage, the backup communication took place via phone. 4G coverage turned out to be a big issue especially in many areas outside the city where the connection network is not good, therefore, all the actors proposed to find an alternative method to 4G. For Tracking the integration with surveillance data of ANSP (for a/c equipped with mode S transponder) and ADS-B out or other means for e-conspicuity will represent an important enhancement.

EX3-CX-OBJ-02 To demonstrate that UAM fixed wing cargo certified missions/ operations in the U-space can be carried out safely

SUCCESS CRITERIA

- **EX3-CX-SCR-02.01** All planned operations are conducted, within acceptable level of safety

EX3-CX-OBJ-03 To demonstrate that specific BVLOS drone cargo missions/operations in the U-space can be carried out safely

SUCCESS CRITERIA

- **EX3-CX-SCR-03.01** All planned operations are conducted, within acceptable level of safety.

EX3-CX-OBJ-04 Demonstrate the usage of dedicated corridor in U-space for certified UAM cargo operation in sub-urban area.

SUCCESS CRITERIA

- **EX3-CX-SCR-04.01** All planned operations are conducted, within required level of safety.

In order to assess that the procedures aimed at the integration of all U-space users can be managed efficiently from a safety and operational point of view, ad hoc questions have been formulated in post flight and post demo questionnaires. The questions reported below were submitted to all the involved actors in order to collect their feedback according to an agreement scale ranging from 1 “Strongly disagree” to 5 “Strongly agree”.

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- **THE INTEGRATION OF PVS/RPAS IN THE VLL IS FEASIBLE WITHIN ACCEPTABLE LEVEL OF SAFETY.** (UAM-drone pilots/operator)
- **DID YOU CONSIDER ALL THE PROCEDURES RELATED TO U-SPACE USERS INTEGRATION ACCEPTABLE AND MANAGEABLE BY AN OPERATIONAL POINT OF VIEW?** (ATCO)
- **IN THIS FLIGHT I WAS ALWAYS AWARE OF THE STATUS OF A SPECIFIC DRONE.** (Support Desk)

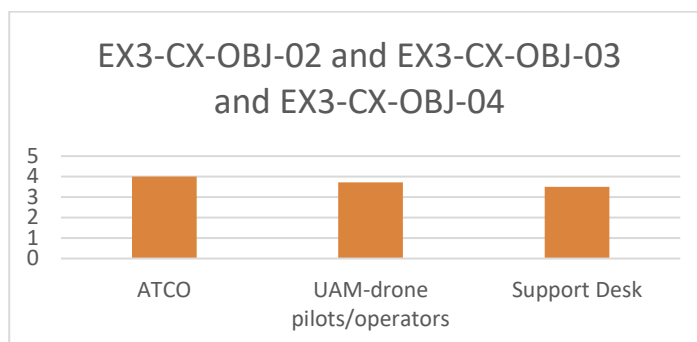


Figure 29 EX3-CX-OBJ-02 and EX3-CX-OBJ-03 and EX3-CX-OBJ-04 Results

All the involved actors gave a score between undecided (3) and agree (4) regarding the evaluation of the safe integration of U-space users in the VLL airspace (Figure-29). Authorization, strategic separation, tracking, weather/meteo services allow the predictability of routes and operations in u-space.

Strategic separation service from USSP and use of dedicated corridor for UAM vehicle and dedicated volumes for small UAS operation worked properly. Punctual meteo information provided to operators, in particular to small UAS operators are an add on value in order to execute the mission in an efficient and safe way.

All the involved actors gave positive feedback on evaluation of the safe integration of U-space users in the VLL airspace. Some doubts that have affected the evaluation are more related to issue regarding the u-space services information exchange in areas not covered by 4G signal.

EXE3-CX-OBJ-005 : Demonstrate data exchange and interoperability between USSP, UAM RPAS CARGO, other drones and ATM during nominal and non-nominal (emergency) situations.

SUCCESS CRITERIA

- **EX3-CX-SCR-05.01** The information provided (in terms of quality of data) by the technical systems supports the end users' performance in achieving their tasks

The assessment of the information provided in terms of quality of data by the technical systems during the demonstration is given on a five-point frequency scale ranging from 1 to 5, corresponding to answers from "Never" to "Always". As shown in the figure-30 below, and confirmed in the debriefing, the actors response that the information provided (in terms of quality of data) by the technical systems "sometimes" supports the end users' performance in achieving their tasks.

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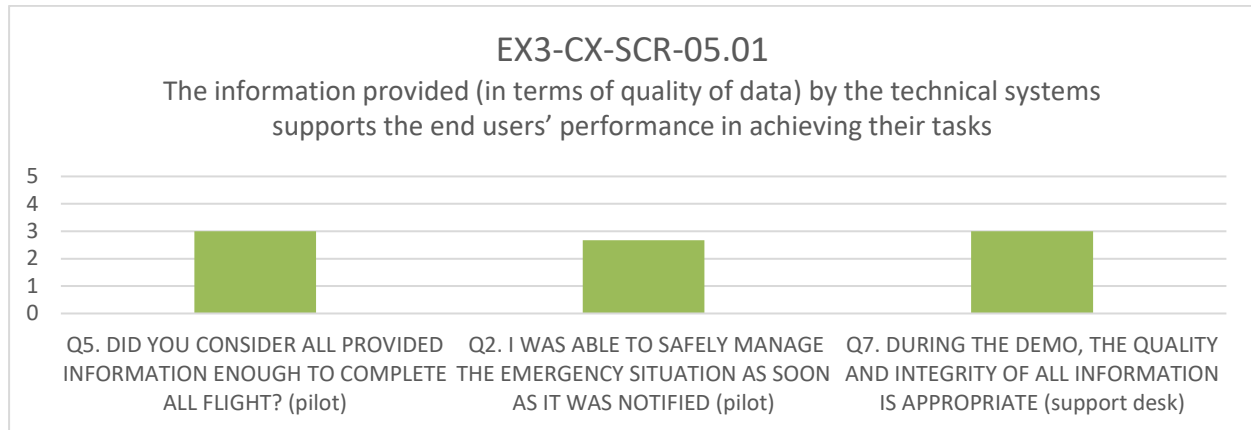


Figure 30 EX3-CX-SCR-05.01

For each question the actor's response is "sometimes". In fact, the information provided in terms of quality of data by the technical systems needed some refinements from both pilot and support desk side. In addition, during the debriefing, it was reported that the pilot gains confidence by knowing that he/she is being tracked and he/she can be more focused on the mission (the same is true in the ATC field, if the pilot knows he/she is being tracked by the radar he/she is calmer and focuses better on the mission). In order to provide an overall overview to perform their tasks, it is important to provide information on the U-Space and try to create a suitable aeronautical culture for the role of pilot / operator.

- **EX3-CX-SCR-05.02** The information provided (in terms of HMI) by the technical systems supports the end users' performance in achieving their tasks

The same results are reported for success criteria EX3-CX-SCR-05.02. Also in this case in order to evaluate the information provided in terms of HMI by the technical systems several questions (five-point frequency scale ranging from 1 to 5) on information in terms of HMI to Support Desk were submitted.

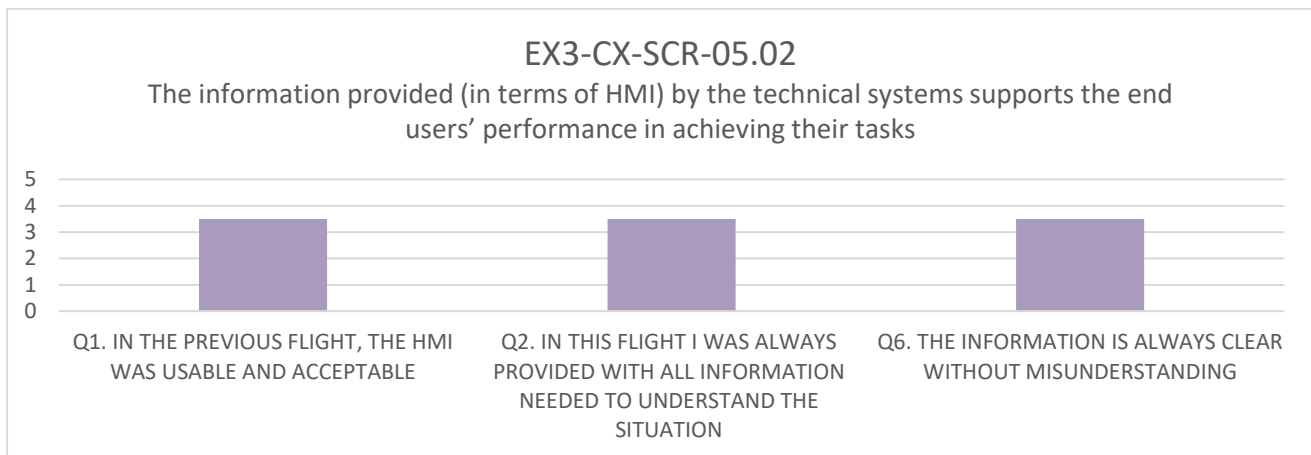


Figure 31 EX3-CX-SCR-05.02

As reported in the chart above (Figure-31), for each question the score of response is between "Sometimes" (3) and "Often" (4). It was justified by several feedback and recommendations gathered during the debriefing. First of all, the involved Support Desk proposed to modify all icons and labels because they were very similar to each other. Currently, the HMI platform increases the workload of operators/pilots. In order to avoid these issues, it was recommended ad hoc training for pilots and operators. No-fly-zone activation was good, but all involved actors proposed to change color code (not blinking green when just created but immediately blinking red).

EXE3-CX-OBJ-007 and EXE3-CX-OBJ-008

EX3-CX-OBJ-07 To demonstrate the successful management of priority/ emergency originated in ATM (e.g., HEMS flight originated in ATM with operation in U-space)

SUCCESS CRITERIA

- **EX3-CX-SCR-07.01** During the management of this kind of emergency/priority the acceptable level of safety is maintained

EX3-CX-OBJ-08 To demonstrate the management of emergency related to certified UAM cargo flight (e.g. non-conformance) originated in U-space.

SUCCESS CRITERIA

- **EX3-CX-SCR-08.01** During the management of this kind of emergency/priority the acceptable level of safety is maintained

Concerning the objectives EX3-CX-OBJ-07 and EX3-CX-OBJ-08, these were developed together as they deal with the level of safety of emergency/priority maintained during the mission. In the chart below, several questions have been grouped, they have been submitted to the Support Desk and Pilot involved in the demonstration through five-point frequency scale ranging from 1 to 5, corresponding to answers from “Never” to “Always”. The score obtained is very high (4,5/5), pay attention on the first column, the response is in line with the overall results as showed in Figure-32.

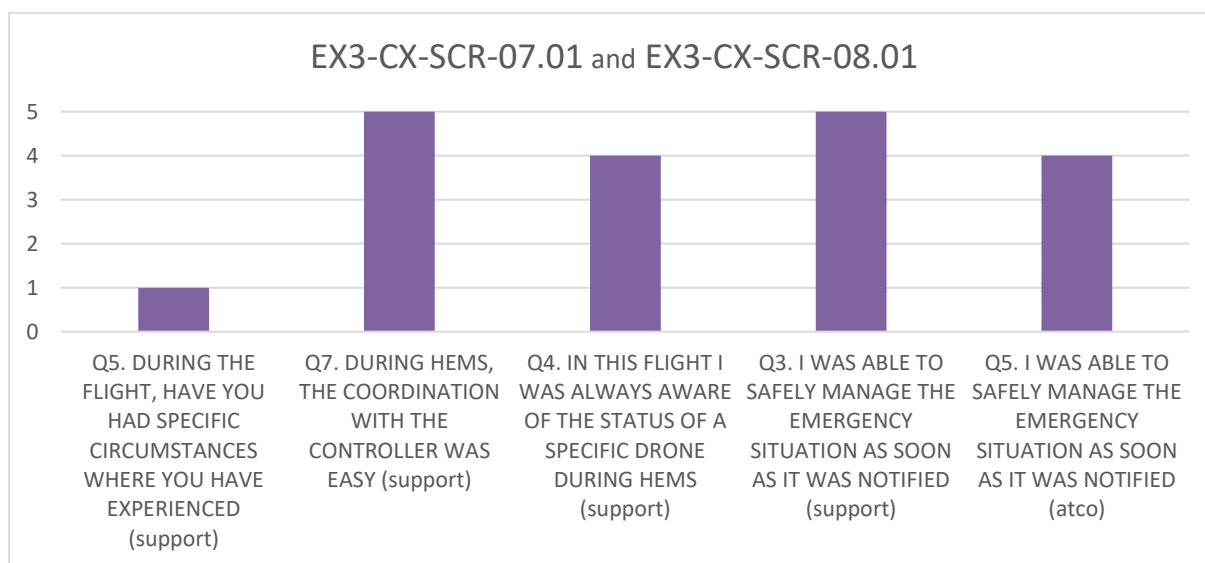


Figure 32 EX3-CX-SCR-07.01 and EX3-CX-SCR-08.01

During the HEMS all involved actors affirmed that the coordination with the controllers was easy, the Support Desk was always aware of the status of specific drone and both Support Desk and Controllers were able to safely manage the emergency situation.

The application of DAR and coordination between ATM and u-space through a dedicated service was useful to accommodate the priority operation .

Remote pilots recommended to modify the sound of the alert in order to make it more invasive and “strong”.

EXE3-CX-OBJ-009: Demonstrate that different U-space users of different categories (open, specific, certified) and manned aircraft can cohabits in a safe way during nominal operations

SUCCESS CRITERIA

- **EX3-CX-SCR-09.01** During the management of this nominal operations the acceptable level of safety is maintained

Overall, the involved actors considered that the different U-space users of different categories (open, specific, certified) were acceptable, and the level of safety was maintained at an acceptable level although some possible safety-related events occurred especially related to technical systems supports. This is confirmed by the chart below. Note that, results were gathered using different scales: Q3, Q4 (Support Desk) and Q4 ATCOs five-point frequency scale ranging from 1 to 5, corresponding to answers from “Never” to “Always”; while Q3 ATCOs was evaluated by agreement scale ranging from 1 to 5, corresponding to answers from “strongly disagree” to “strongly agree”.

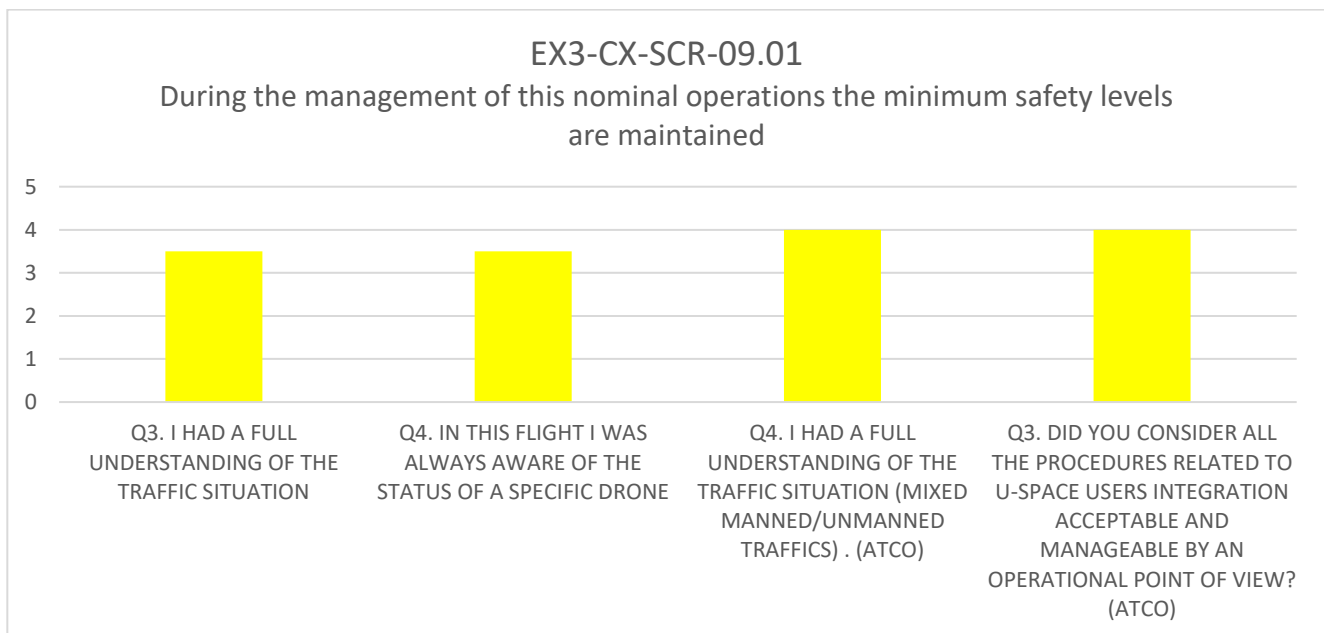


Figure 33 EX3-CX-SCR-09.01

As graph in Figure-33 above, concerning Support Desk, he/she often had a fully awareness of traffic situation and consequently he/she was aware of the specific status of the drone. ATCOs, furthermore confirmed that all procedures related to U-Space users was acceptable and manageable by operational point of view.

7.2 Analysis of Exercise Results per U-space Services

In this section, the results are detailed according to the U-space services framework. U-space services are critical for the safe and efficient integration of drones into airspace, and the results provide an evaluation of each service's functionality and performance during the demonstration. The analysis covers various aspects such as service reliability, user satisfaction, and operational feasibility. Both subjective and objective data are used to assess the services, including system logs, user questionnaires, and expert debriefings, providing a comprehensive understanding of each service's contribution to the demonstration's success.

A series of ad hoc questions that were formulated to assess the efficiency and quality of the U-space services addressed by the demonstration are reported below. The questions were answered respecting two different scales: a frequency scale from 1 “Never” to 5 “Always” and an agreement scale from 1 “Strongly disagree” to 5 “Strongly Agree”.

Tracking and position reporting service

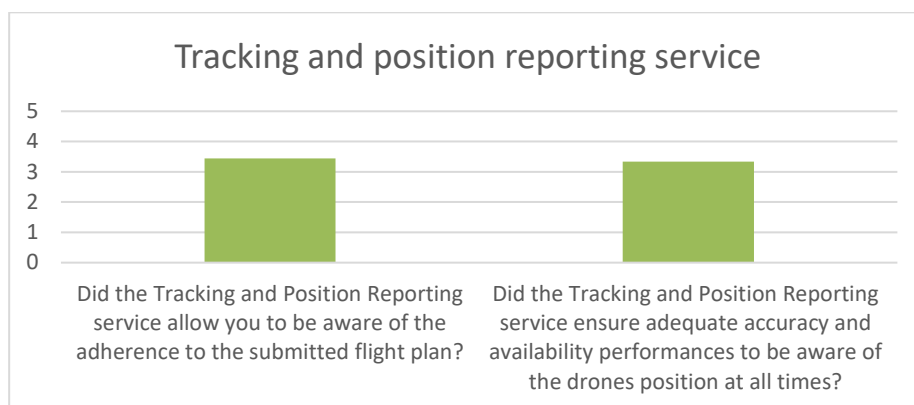


Figure 34 Tracking and position reporting service

The rating score is between *Sometimes* (3) and *Often* (4) in the frequency scale as showed in Figure-34. The score is justified by some inefficiencies that did not allow the UAM vehicle to be tracked in all phases of the mission; furthermore, there sometimes was a latency between the track and the effective position due to bad connection and 4g coverage and it produced a buffering on the platform display. The 4G coverage was good near the city center, not good in sub-urban and rural area, several times we lost the tracking for both "Pollicino (UTM box hook on device)" and d-flight app. For Tracking the integration with surveillance data of ANSP (for a/c equipped with mode S transponder) and ADS-B out or other means for e-conspicuity will represent an important enhancement. Figure-35 shows the tracking of PVS in the corridor

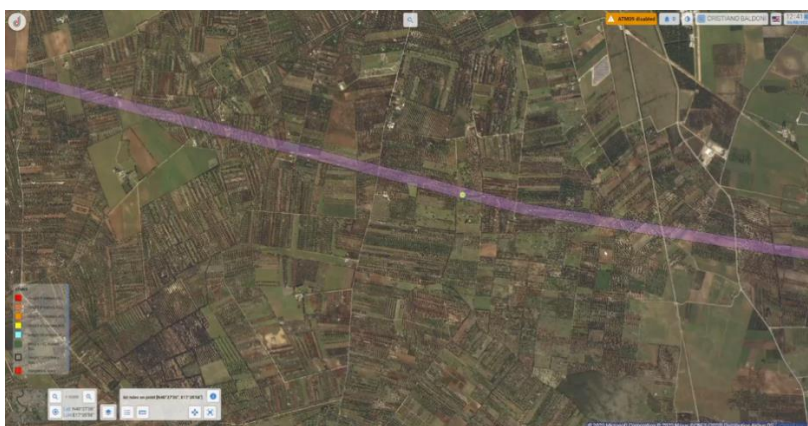


Figure 35: Track of the PVS UAM cargo in the corridor

Emergency management service

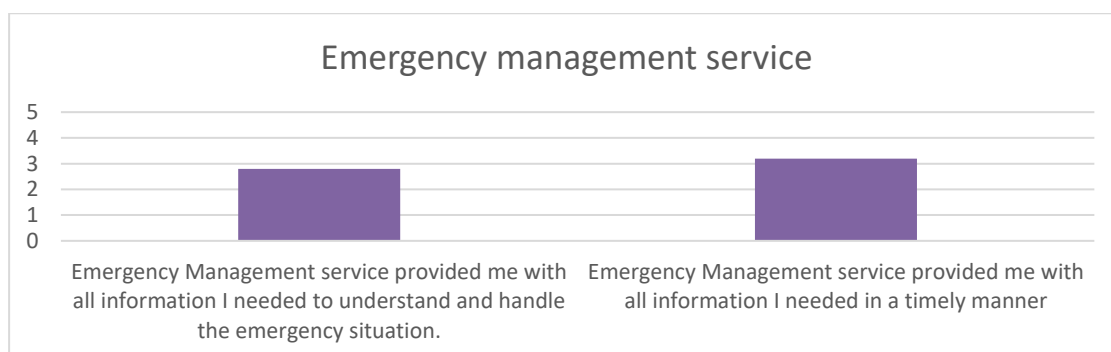


Figure 36 Emergency management service

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The rating score is around *Sometimes* (3) in the frequency scale.

Emergency management worked properly as showed in Figure-36. During the management of HEMS operation, originated in ATM and executed in u-space volume, the U-space users received the warning message(Figure-37) and the trigger of apply the emergency response plan (land all), until the end of operation. The DAR was applied in a procedural way through the use of d-flight support desk, an human actor that acts as "bridge" between ATM and u-space. The procedures adopted and working method worked properly

The evaluation was affected by some issues related to bad connection and 4G coverage. In many points there was no 4G coverage and therefore this limited the functionality of the platform and the ability to receive notification in a timely and efficient manner by end-users. In addition from feedback collected by the u-space users (drone pilots), enhancement of HMI are recommended. In particular more emphasis to the warning messages need to be done in order to enhance the visualization on their GCS/device.

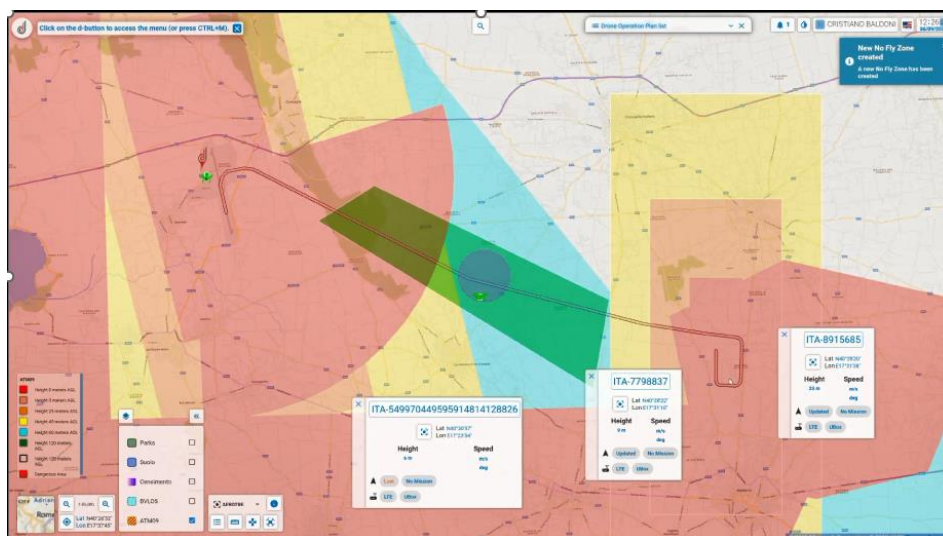


Figure 37: display of DAR area

Strategic Conflict Resolution service

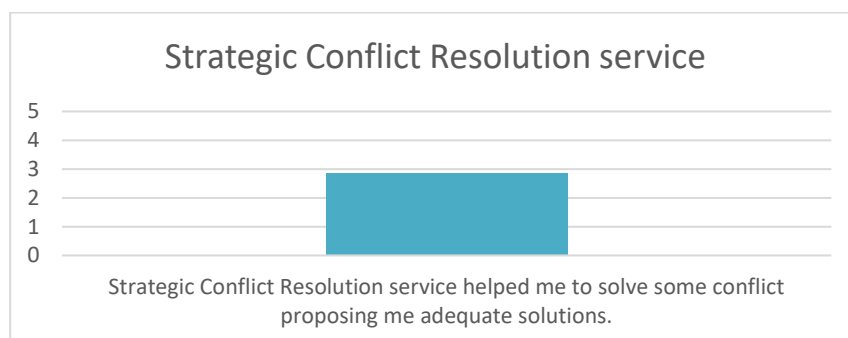
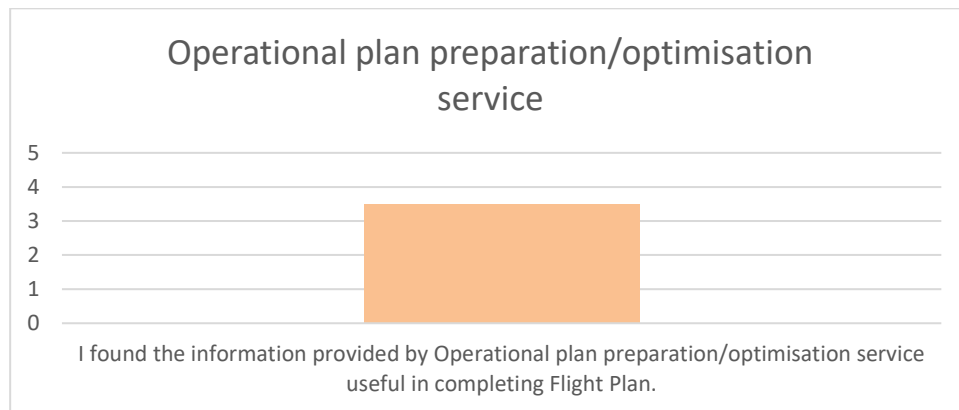


Figure 38 Strategic Conflict Resolution service

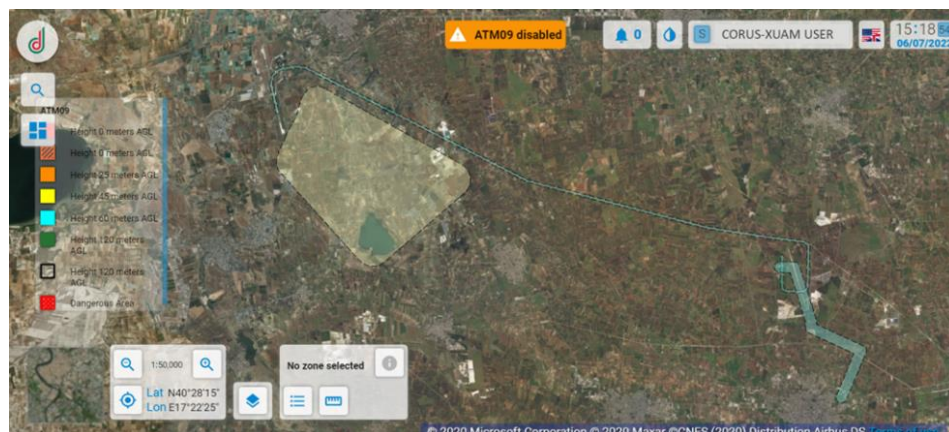
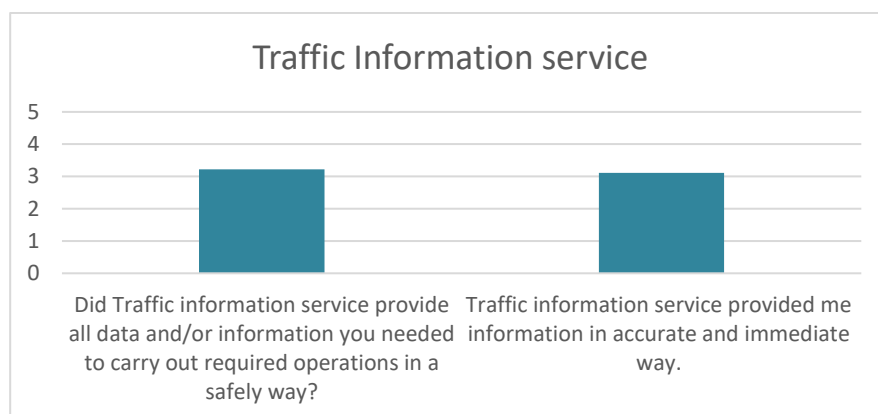
The rating score is just below *Undecided* (3) in the agreement scale, as showed in Figure-38. All flights were strategically deconflicted, no conflicts have been detected during the executions of flights.

Many actors involved (remote pilots) suggested to simplify the interface with platform and make it clearer and more intuitive; they proposed an improvement of icons and labels dedicated to information of this service.

Operational plan preparation/optimization service*Figure 39: Operational plan preparation/optimisation service*

The rating score is between Undecided (3) and Agree (4) in the agreement scale (Figure-39). Service worked properly. The information provided by the service were sufficient. Figure-40 shows an example of Drone Operation Plan.

End-users proposed improvement to the platform interface in such a way as to make it easily accessible.

*Figure 40: Drone Operational Plan (DOP)***Traffic Information service***Figure 41 Traffic Information service*

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The rating score is between Sometimes (3) and Often (4) in the agreement scale (Figure-41). Service worked properly in areas covered by 4G. On some occasions, the traffic data was not updated in real time due to a buffering in the tracks related to a bad 4G signal. Improvement to the HMI of platform have been collected and proposed by the end-users, in particular to check the altitude of a specific target they had to click on it on the interface. The suggestion is to display the altitude data without clicking on the target Figure-42 shows the layout of Drone Operation Area

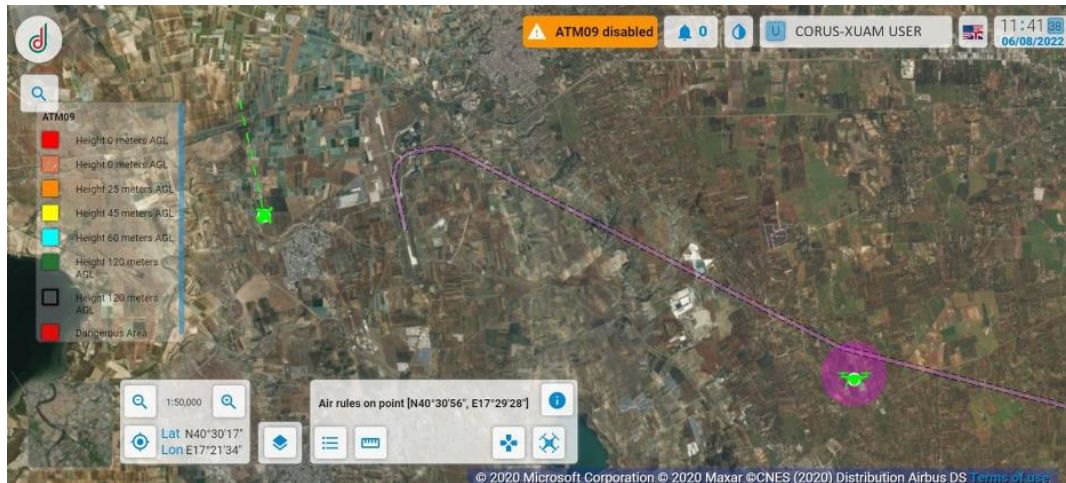


Figure 42: Drone Operation Area

Procedural Interface with ATC service

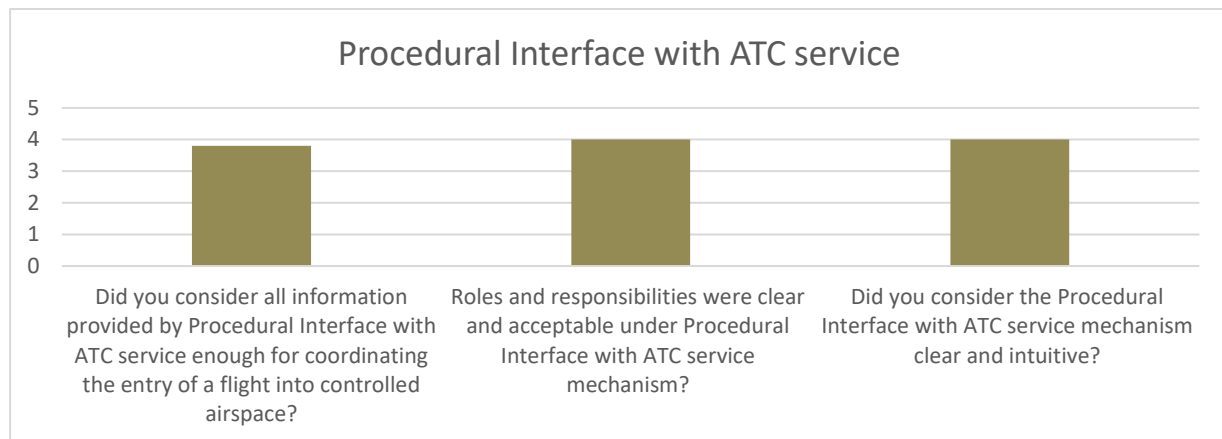


Figure 43 Procedural Interface with ATC service

The score obtained is around Often (4) in the frequency scale. All the pilots found this service useful, clear and efficient (Figure-43).

Population Density Map service

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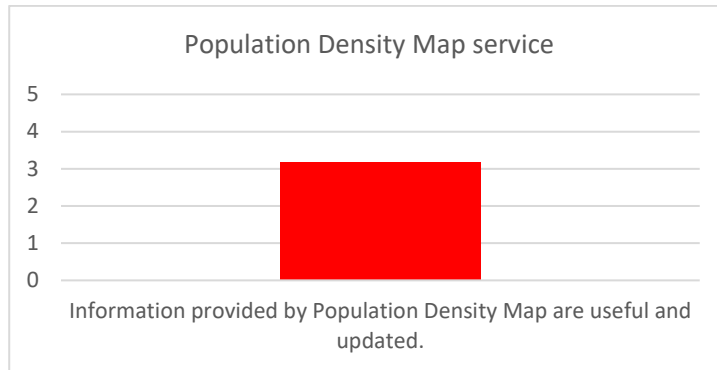


Figure 44 Population Density Map service

The rating score is between Undecided (3) and Agree (4) in the agreement scale (Figure-44). The service worked properly and was useful for the calculation of ground risk in particular during the preparation of SORA for the specific BVLOS cargo operation executed by the UAS operator Techno Sky. Figure-45 shows the graphical interface of Population map layer

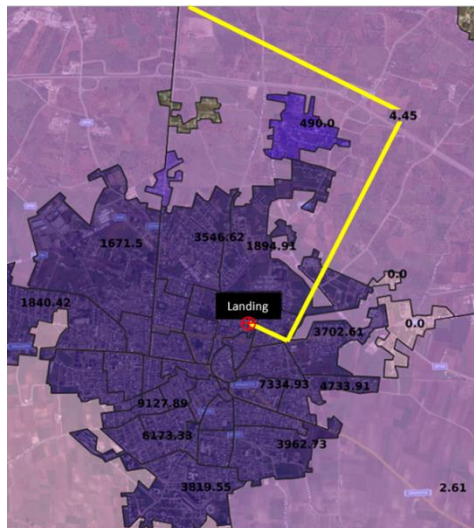


Figure 45: Population map layer

Monitoring service

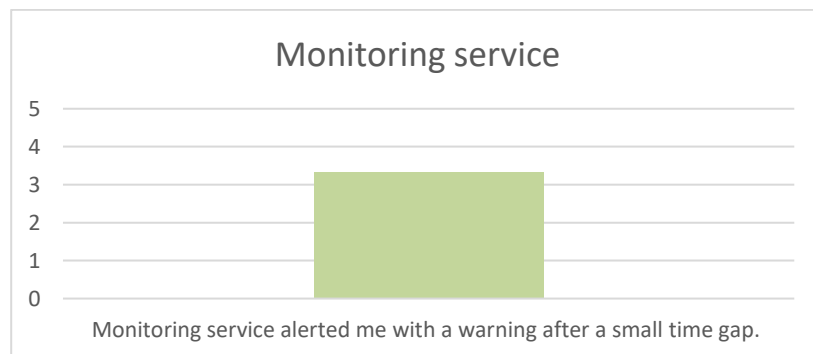


Figure 46 Monitoring service

The rating score is between Sometimes (3) and Often (4) in frequency scale (Figure-46). No deviation were collected during the demo execution. Off-line tests of functionality were executed successfully

7.3 Unexpected Behaviors/Results

The 4G coverage was good near the city center, not good in sub-urban and rural area, several times the tracking for both “Pollicino (hook on device)” and d-flight app was lost. For Tracking it is recommended the integration with surveillance data of ANSP (for a/c equipped with mode S transponder) and ADS-B out is an important enhancement

7.4 Confidence in Results of Demonstration Exercise

Limitations and impact on the level of Significance

All the flights were performed under adequate flight conditions. The declared operations were carried out at times of low probability of passers-by and vehicles circulating in the surrounding area, thus avoiding interference from people and/or fixed/mobile objects. And since the trials were performed under a controlled environment, there was no room for malicious behaviors from any airspace user. Thanks to the good planning and coordination between actors involved (ANSP, USSP, UAS operators/Pilots) no blocking issues were experienced.

The level of significance is proportional to the scope of Live Trials and number of flights executed.

Quality of Demonstration Exercise Results

The results have been derived from data obtained by means of questionnaires and integrated with comments provided by all the actors involved (operational experts and validation experts) through several debriefing sessions performed. This kind of analysis allowed to verify the consistency and confidence of data collected providing a good quality of demonstration results. Actors involved in the demonstration are highly experienced and contributed in a decisive manner to debriefing sessions and discussions, by offering interesting insights and consistent advice. Their subjective feedback provided deep reflection on the concept under assessment.

Significance of Demonstration Exercise Results

For all that said above, demonstration results gathered by means of questionnaires can be considered as statistically relevant for the specific demonstration objectives. Results regarding the Human Performance and Safety can be considered well representative of the operational concept under investigation also thanks to the cross-check evidence from direct over the shoulder observations taken during the demo. Indeed, post flight debriefing discussion with controllers and the final post demonstration evaluation helped a lot to unambiguously understand actors’ feedback and better weight the “qualitative” performance indicators in case of uncertainty.

8. Conclusions

The following paragraphs summarize the conclusions provided by the Italian demonstration activities on the following aspects:

- The achieved maturity level of the services/capabilities,
- The performance assessment per KPA.

With the summarized results, our conclusion is that CORUS-XUAM demonstration objectives can be considered as achieved.

8.1 Conclusions on maturity of the services/capabilities

According with results obtained and data collected, the following conclusions have been derived:

- The maturity reached by the addressed U-space services is at a satisfactory level although it has not been able to test their maximum performance due to issues related to bad internet connection and 4G reliability.
- Many of the proposed services were considered very useful by end users but they certainly could be improved. Regarding this, many feedback collected from the involved actors are constructive for the improvement of both the USSP platform and the services implemented.
- Some improvements have been identified for enhancement of USSP platform. In fact, although the platform received a good evaluation, many end users agreed that some display of information could be simplified and made more intuitive, especially to facilitate their task in emergency situations with tight deadlines.
- Regarding provided information, drone pilots did not have to search for them and, accordingly, they were able to prioritize tasks. Furthermore, the information provided by USSP platform enhance the situational awareness level thanks to the visualization of the drones traffic.
- Emergency management worked properly. During the management of HEMS operation, originated in ATM and executed in u-space volume, all the users performed their tasks as expected. The DAR was applied in a procedural way through the use of d-flight support desk, an human actor that acts as "bridge" between ATM and u-space. The procedures adopted and working method worked properly. Despite this In many points there was no 4G coverage and therefore this limited the functionality of the platform and the ability to receive notification in a timely and efficient manner by end-users.
- Procedures for coordination (ATM/UTM) and management of emergency/priority flight originated in controlled airspace and executed in u-space with DAR proved to be valid and efficient.
- Authorization process and services worked properly and assured equitable access to u-space users. During the demo also priority usage of u-space volumes (for management of HEMS operation) were tested successfully. Strategic separation service from USSP and use of dedicated corridor for UAM vehicle and dedicated volumes for small UAS operation worked properly. This aspect was tested having in contemporary open and specific UAS operations and UAM flights in the same U-space airspace. The Strategic management service and authorization process was used in support of this aspect
- The u-space volume tested in the demo allowed the flight of one big UAM vehicle +4 small drones at same time. The feedback related to management of operation were good.

8.2 Conclusions on maturity of performance

Qualitative data allowed to assess very important results. According to the feedback provided by all the involved actors, demo leads to the conclusion that:

- According to ATCO perspective, workload levels during the Demonstration activities were acceptable and he/she was able to accomplish his/her tasks within average tolerable levels of attention and effort. The UAM/drone pilot/operator perceived a higher WL level due to some issue related to bad 4G coverage in suburban areas. In the urban environment the coverage of 4G was good and no negative impact on workload was assessed. The overall workload mainly stayed at acceptable levels.
- All the involved actors experienced positive level of individual situational awareness. The SA rating score perceived by ATCO was very good. A slight decrease in UAM/drone pilot/operator SA was perceived due to some problems with 4G signal. In the urban environment the coverage of 4G was good and no negative impact on SA was assessed. Visual and audio alerts improvements have been suggested in case of emergency for increase of SA.
- There was positive response and acceptance of D-Flight Platform and U-Space services provided. Some HMI improvements have been identified.
- For each mission, the risks were safely mitigated by: On-drone capabilities, U-space services, ATSU services. In this context, it has been demonstrated that U-Space can provide a contribution in terms of safety both at ground and air level. Regarding the conduction of all the planned operations in both nominal and emergency case, although they were conducted within acceptable level of safety, the evaluation was affected by the occurrence of some technical problems related to the 4G coverage that have not allowed the continuous traceability of some flights.
- During the landing phase of BVLOS small cargo delivery, near the city hospital, the C2 link between RPS (located at departure area, 7km distant from landing site) was lost and the system automatically switched on 4G/LTE performing an Autoland. This kind of redundancy of c2 link was very useful and increase the safety levels.
- No problems related to the primary security criteria emerged at any time during the demonstration. Data security was not affected by any threats and no vulnerabilities of the assets involved were attacked.

9. Recommendations

From experiences of demo activities performed in the frame of WP8 many recommendations were collected:

- The strategic phase is fundamental and represents a «column» for safe coordinated and efficient UAM operations (e.g. use of DOA/DOP, mission plan, authorisation, NOTAM etc.)
- The 4G coverage was good near the city center, not good in sub-urban and rural area, several times the tracking for both “Pollicino (hook on device)” and d-flight app was lost. For Tracking it is recommended the integration with surveillance data of ANSP (for a/c equipped with mode S transponder) and ADS-B out is an important enhancement
- Weather information/service is a key element for the last mile delivery with small drone in BVLOS. In particular precise meteo information (micro weather) on departure/landing site and during the cruise phase of the operation are strongly recommended. Recommendation : meteo info coming from Meteo Service provider/USSP/ or dedicated meteo station installed on departure/landing site/platforms for routine operations (e.g. medical transportation between 2 hospitals or 2 logistic hubs
- Spread information and communication about what is u-space and all related information among pilots associations, drone associations is a must
- It is recommended a simplification of whole SORA process a/o automation (or for some steps) and reduction of «burocracy» will facilitate operations
- Many HMI improvement on USSP app/system (from pilots/operators) were collected. The general recommendation is to have an “user-friendly”. interface
- The procedures were respected but pilots were unable to track the transponder mode S from D-flight. D-flight must necessarily track the transponder mode S because everyone is able to keep it on board.
- It is important to provide information on the U-Space and try to create a suitable aeronautical culture for the role of pilot/operator.
- All actors strongly recommended ad hoc training for pilots and operators, in order to improve the familiarization with the concept proposed and platform.
- In order to avoid misunderstanding or off-line issues, all users suggested and recommended an alternative type of alert (e.g. sms).
- In addition, from BVLOS operator side, it was recommended to have a different DOA configuration: users recommended to find a fair relationship between drones’ shapes and dimension and DOA maximum size.

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