SESAR JOINT UNDERTAKING

Demonstrating RPAS integration in the European aviation system

A summary of SESAR drone demonstration project results

founding members

EUROPEAN UNION EUROCONTROL

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Foreword

By Florian Guillermet, Executive Director, SESAR Joint Undertaking

Over ten years ago drones or remotely-piloted aircraft systems (RPAS) were not part of the SESAR Definition Phase as it was impossible to predict at that time the exponential growth of these unmanned aircraft. Over time, however, it became clear that if safe, non-segregated, unmanned operations were ever to become commonplace, it would be essential for the SESAR Joint Undertaking (JU) to adapt its research and innovation to developments in this field. It would also require the partnership to show leadership in the air traffic management (ATM) domain, taking advantage of the comprehensive SESAR membership to ensure a coordinated approach to European drone integration.

In line with the European Commission's "Roadmap for the integration of civil RPAS into the European aviation system", in 2013, the SESAR Joint Undertaking launched its first RPAS activity, the co-funding of nine demonstration projects. Bringing partners together from across ATM and Europe, the projects aimed to fly RPAS in non-segregated airspace in order to test what was possible within the current regulatory environment using existing technology. This brochure provides an aggregated summary of the results from these projects.

As expected, the demonstrations collectively highlighted several technical, operational, safety and security matters that need to be addressed in relation to, among others, RPAS detect and avoid (D&A) capabilities, the impact of varying aircraft performance, as well as communications and spectrum.

Building on these demonstration activities and taking input from a wide range of aviation stakeholders, the SESAR JU has since defined how drone research should be conducted in SESAR 2020 in accordance with the 2015 European ATM Master Plan, which captures the research of these aircraft for the first time.

Several activities have been identified and incorporated into the SESAR research project definitions, focusing on the integration of RPAS with manned aviation within managed airspace. While clearly not the whole story, this approach addresses the first steps in the European Commission's Roadmap.

Looking towards the future, 7 million consumer leisure RPAS are expected to be operating across Europe and a fleet of 400 000 is expected to be used for commercial and government missions by 2050. With knowledge of this forecasted growth, the SESAR JU is committed to continuing its research efforts on integrating drones, including civil RPAS, into European airspace.

About SESAR

SESAR is the technological pillar of the Single European Sky, which defines, develops and deploys solutions to modernise air traffic management in Europe.

SESAR JOINT UNDERTAKING

A unique public-private partnership, in place since 2007, uniting:

- 2 founding members: EU and Eurocontrol
- 19 industry members
- 100+ companies from across air traffic management
- 60+ universities, research centres and SMEs
- 3,000 experts from aviation and ATM

OUR ACTIVITIES

Since its establishment, the SESAR JU and members have taken ATM research 'out of the lab' onto real systems and into real-life air traffic operations across Europe and internationally.

- 350 research projects
- 350 validation exercises
- 30,000 flight trials
- More than 90 industrial prototypes

WHAT WE HAVE DELIVERED

60+

60+ new or improved operational procedures and technologies (SESAR Solutions)

Drones, UAV, UAS, OPV, RPAS — what is the difference?

Unmanned aerial systems (UAS), of which the unmanned aerial vehicle (UAV) is the airborne component, comprise two fundamental types: remotely-piloted aircraft systems (RPAS), a class of UAS which has a 'pilot' operating the remotely-piloted aircraft (RPA) from a ground-control station (GCS); and UAS with no remote pilot, or autonomous air vehicles. The term 'drone', essentially a layman's term, refers to all types of UAS.

The demonstration projects described in this brochure looked at the integration of categories of aircraft within the RPAS family, and are therefore referred to as RPAS throughout.

Why are RPAS applications needed?

RPAS are opening up a promising new chapter in the history of aviation. Because they can fly close to the ground and obstacles, these unmanned systems are able to work in all sorts of hazardous conditions that would be dangerous for traditional manned aircraft or human intervention.

By 2050, it is estimated that there will be some 7 million consumer leisure RPAS in operation across Europe, including a fleet of 400 000 RPAS offering important services across the agricultural, energy, e-commerce as well as public sectors. With an estimated value of EUR 15 billion annually, this market represents a huge potential for Europe and its global competitiveness.

All of this is great news for Europe, its citizens and economy. However, the integration of these new vehicles is not without some challenges.

How is Europe addressing their integration into civil airspace?

The drone market is growing fast and evolving with many different types of aircraft, each with their own specific characteristics. However, Europe is already well on the way to identifying the needs and requirements for integrating these unmanned aircraft systems into the European aviation and ATM environment.

In 2012, experts in the field were called upon by the European Commission to develop a European roadmap for the integration of civil RPAS which was officially launched in June 2013. It identifies a step-by-step approach for the safe integration of RPAS into the non-segregated ATM environment in Europe as of 2016.

The SESAR Joint Undertaking, along with many other aviation stakeholders, is contributing to this roadmap by researching the procedures and technologies needed to ensure the safe and seamless integration of RPAS with manned aircraft operations.

SESAR RPAS demonstrations — results at a glance

In 2013, the SESAR Joint Undertaking launched nine SESAR demonstration projects to see how RPAS could be safely operated within non-segregated airspace using existing technologies. Over a period of two years, these projects brought together operators, manufacturers, ANSPs and regulatory authorities to explore RPAS integration in real operational environments and to identify potential operational, technological and regulatory gaps.

The main aim of the demonstration projects was to see what level of RPAS operations was possible within the current regulatory and operating environment, using current technology. These demonstrations aimed to highlight areas where additional research and development were needed, as well as providing valuable insight into the practical challenges of flying this new and potentially disruptive technology.

Overall, apart from the different performance characteristics of some RPAS types, these projects perceived no significant difference in the behaviour of RPAS compared to small general aviation aircraft, when operating in the air traffic control (ATC) environment. However, on the basis of the findings captured at that time the projects identified several technical, operational, safety and security matters. These need to be addressed before integration could be considered:

1. A harmonised and well-established civil **regulation and certification** system by the required certification authorities;

2. **Policies and procedures** on how ATC should interact with RPAS to ensure efficient operations and to meet safety-level requirements;

3. A **detect & avoid (D&A) capability and compliance** with European aircraft equipage requirements;

4. Reliable **command and control (C2)** links should be developed together with contingency procedures in case of failure and implemented in a protected spectrum band; and

5. Specific **training and licensing for RPAS pilots**.

The main conclusions and recommendations from the nine projects are as follows:

Regulation and certification

Demonstrations are a very effective mechanism to increase stakeholders' awareness and to gain the trust and buy-in of aviation authorities. However, the current process for obtaining the necessary approval from the authorities is rather burdensome and time-consuming. One recommendation would be to define national-specific RPAS test flight zones with simplified procedures to obtain flight permits. To ensure legal compliance, an initial package for small RPAS could be defined, comprising a simple and efficient navigation system, a permanent positon reporting system and geo-fencing capabilities. Coordination between civil-military aviation authorities, capitalising on the military experience, would reduce research efforts and facilitate the maturation of the regulatory framework.

For test areas, segregation is a prerequisite until a suitable D&A system is available and accepted by the authorities. The use of temporary segregated airspace, such as danger areas, is not sustainable for routine operations, since this approach does not meet the principles of equivalence and transparency.

Another important challenge is insuring these systems since insurance rates are currently significantly higher than manned aviation and may hamper the business case for RPAS operations. As RPAS operations become more common and the safety and security risks identified are addressed, there is an expectation that the cost of insurance should significantly diminish.

Air traffic control and airspace procedures

The projects showed that while RPAS can be operated much like conventional aircraft from an ATC perspective, their variety in size and performance require the definition of new RPAS-specific procedures, for example for integration into the arrival sequencing at an airport.

To increase awareness and support their integration, RPAS flight plans should be shared with all the operational stakeholders involved (air traffic control units as well as airport authorities where relevant) before and during mission execution, using standardised data formats and exchanges, as done for manned flights.

RPAS missions are likely to vary widely in nature, so research is required into the best method of defining mission profiles to enable the smooth management and execution of each mission. Specific procedures should cover the launch and recovery methods for aerodromes and different procedures depending on the RPAS typology for emergency and/or non-nominal conditions. Existing separation standards may also need to be reviewed and potentially altered even though it is recommended to maintain standard ICAO separation minima.

Regarding aerodrome access, RPAS-operating characteristics should be compatible with the aerodrome in question in order to maintain runway capacity at realistic levels. High-performance RPAS operations could be integrated into busier medium-sized airports, while lower performance RPAS could be operated from aerodromes with lower traffic levels or with traffic operating at similar speeds. Alternatively, it may be possible to maintain airport throughput using new RPAS-specific procedures which do not interfere with conventional operations at the airport.

Projects also recommended that emergency recovery areas within the airspace are identified, predefined and introduced in aeronautical charts; and that radar systems capabilities are adapted to take into account RPAS specifications and missions to help the controllers safely perform their separation duties.

Detect and avoid (D&A) capabilities

A detect and avoid (D&A) system is essential for the integration of RPAS in non-segregated airspace, specifically in uncontrolled airspace. Research into this important topic is essential to cover both collision avoidance and traffic avoidance. Recommendations for the implementation of D&A cover the following:

- Relying on Automatic dependent surveillance-broadcast (ADS-B) data only may be sufficient in cases where all aircraft are equipped with these systems, and where the underlying ATM operating environment allows for it. Additional primary radar data can be used to provide increased traffic information in cases where not all systems are cooperative;
- There is a need for appropriate electro-optical technology (e.g. high definition cameras and communication architecture) to secure the use of procedures currently dependent on the human eye, such as the 'line-up behind and hold' procedure and the 'see and avoid' capability;
- Future work to define and standardise a D&A automatic capability for RPAS is considered the key for real integration of RPAS in ATM.

Spectrum, command and control (C2) requirements, datalink

Contingency procedures for radio failure, C2 loss, Global Navigation Satellite System (GNSS) failure, and emergency landing should be investigated and possibly standardised at the ICAO level.

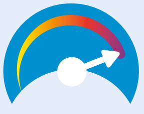
To allow for the loss of control links between the pilot and the RPAS, backup communications should be considered, possibly based upon a ground or mobile telecommunications infrastructure. It is also recommended to produce procedures to handle these types of incidents, and to train the RPAS team and the pilot in command on those procedures associated with emergency at the operational site, specifically on:

- Expected reaction time;
- Expected communication and responses between the involved actors; and
- The method of providing back-up communications in the event of a communication link failure.

The lack of available spectrum and frequencies for civil operations use was also identified as an issue by the demonstration projects. They noted that the need to exploit different existing link technologies or the development new RPAS-specific links (e.g. C-band) in order to allow the use of larger RPAS. Additional research, in particular electromagnetic compatibility studies, are required to understand the level of C2 frequency needed for flying more than one RPA at the same time in the same conditions.

Remote pilots

Suitable qualifications for RPAS pilots are needed in order to execute live unmanned flights in non-segregated airspace. The qualification and licensing requirements for RPAS pilots should be researched including pilot/controller phraseology to include additional terminology to reflect unique RPAS conditions, such as the loss of C2 link and the concept of lost link routes. Further work is required to assess the feasibility of piloting two RPAS at the same time in a crowded environment.

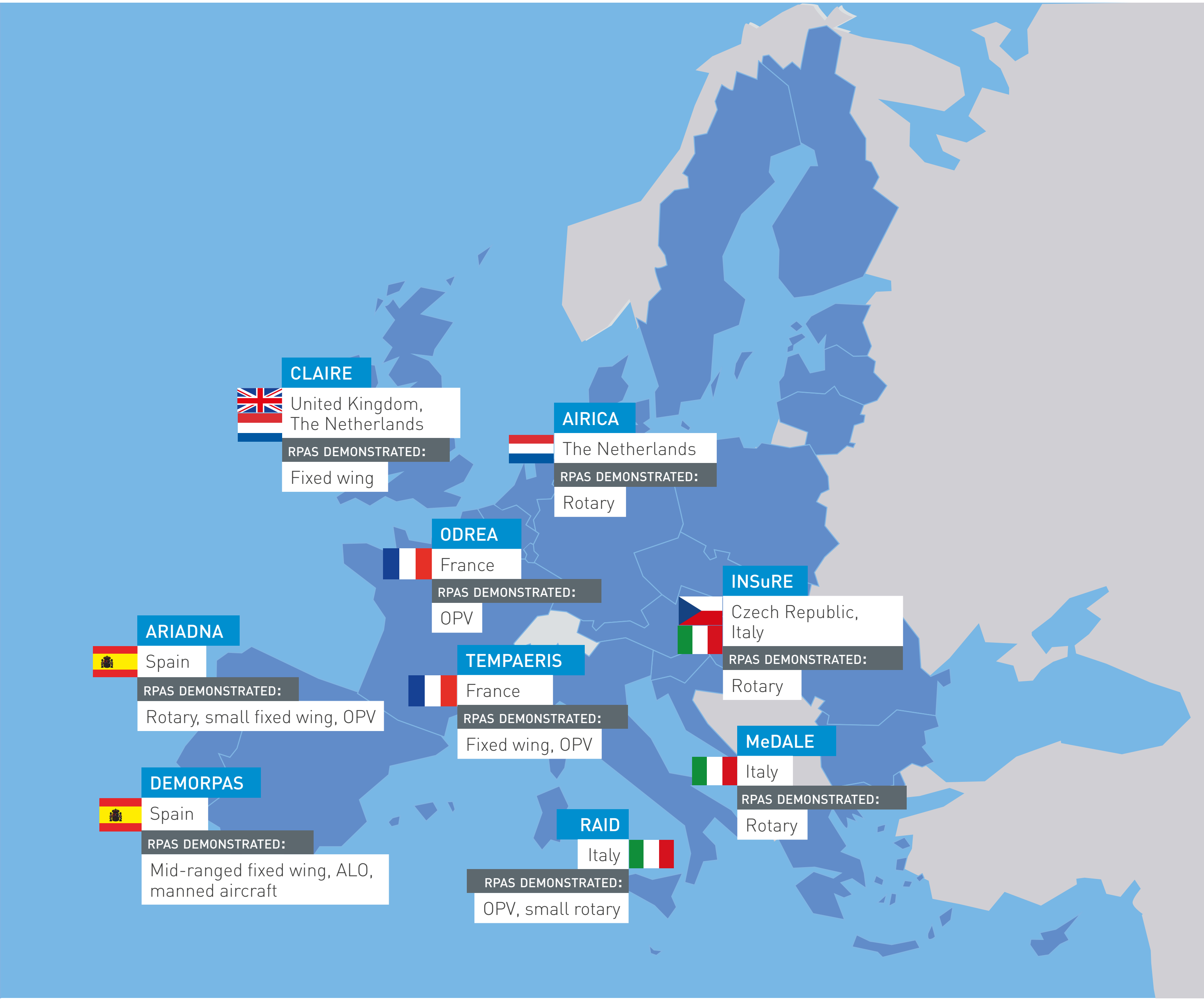


Air vehicle performance

The different performance characteristics of RPAS including lower airspeeds and different climb/descent/turn profiles is a factor which needs to be taken into account through adapted procedures and associated mitigations. The practice of blocking out large altitude bands of airspace for a manned aircraft to enable RPAS to climb or descend could result in non-optimised trajectories for other airspace users. Standardised methods must be established on how to share RPAS performance characteristics and mission information with the Network Manager and controllers.

Sometimes specific performance (like the ability to do steeper descents) can be of benefit so RPAS do not necessarily need to follow all the area navigation (RNAV) trajectories for manned aircraft; specific new RPAS procedures could be designed to take advantage of these different operating characteristics.

Project overview by country



AIRICA

ATM Innovative RPAS Integration for Coastguard Applications

Consortium
Netherlands Aerospace Centre (NLR) (coordinator), Netherlands Coastguard, Royal Netherlands Air Force and Schiebel

Location
The Netherlands

Website
www.airica.eu

Summary
The main objective of the AIRICA project was the performance of a realistic coastguard search and rescue (SAR) mission in non-segregated airspace. The demonstration involved beyond visual line of sight (BVLOS) flights and ensured separation with real intruder aircraft using a transponder interrogation and an automatic dependent surveillance — broadcast (ADS–B) receiver detect and avoid (D&A) functionality. The project also assessed the feasibility of implementing an enhanced state-of-the-art communication with air traffic control (ATC).

The Netherlands Aerospace Centre (NLR) conducted the flight campaigns in collaboration with Schiebel, the Netherlands Coast Guard, and the Royal Netherlands Air Force. Schiebel provided the unmanned helicopter — a CAMCOPTER® S-100. The Coast Guard provided a DO228 aircraft which acted as the 'intruder', while the Royal Netherlands Air Force provided as 'intruder' an Alouette III helicopter, as well as ATC services. A flight test campaign was performed at the Netherlands RPAS Test Centre (NRTC) in Marknesse, while the demonstration flight campaign itself was carried out from De Kooy Airfield in Den Helder, the Netherlands.

Although the project clearly demonstrated that it is feasible to perform D&A functionality based on transponder Interrogation and ADS-B receiver signals, it is recommended to extend the system with non-cooperative sensors.

ARIADNA

Activities on RPAS Integration Assistance and Demonstration for operations in Non-segregated Airspace

Consortium
Indra Sistemas S.A. (coordinator), Centro de Referencia de Investigación, Desarollo e Innovación ATM (CRIDA), ENAIRE, FADA-CATEC

Location
Spain

Summary

The project performed flight demonstrations at the ATLAS experimental test centre in Jaen, Spain using three different types of aircraft: a rotary wing RPA (<25 kg), fixed wing RPA (15 kg) and a MRI-general aviation manned aircraft.

A first exercise validated the design and use of a satellite-based augmentation system (SBAS) procedure for rotary wing RPAS. Specifically the exercise assessed the acceptable accuracy values for the RPAS following the procedure, as well the availability, integrity and continuity of the satellite signal during the operation.

Meanwhile, a second exercise validated concepts for a ground-based situational awareness system (GBSAS) with the use of ADS–B and air traffic control radar data to increase the remote pilot situational awareness of the surrounding traffic. In addition, the exercise demonstrated that even very small RPAS can be equipped with ADS-B technology and therefore be 'seen' by other manned and unmanned aircraft.

CLAIRE

CiviL Airspace Integration of RPAS in Europe

Consortium
Thales UK Limited (coordinator), NATS (En Route) Plc, Netherlands Aerospace Centre (NLR)

Location
United Kingdom, the Netherlands

Summary
The principal aim of the project was to identify the key issues associated with operating RPAS in non-segregated airspace. A three-strand approach was used, based on an incremental series of exercises, each led by one of the partners. Each focused on a specific 'exercise', which provided invaluable demonstration and communication outputs. NLR led the simulation work covering operations of RPAS in and around airports while NATS led a similar activity addressing the en-route airspace integration of RPAS. Using the Watchkeeper platform, Thales was responsible for the integration of an RPAS into the airspace with the intention of 'pushing the boundaries' and providing opportunity to actually fly an RPAS in non-segregated airspace. This was successfully achieved in September 2015 after important work had been completed to address key issues including:

- Compatibility of RPAS equipment;
- Airspace access and ATC interaction;
- Contingency management;
- Insurance arrangements;
- Regulatory approval; and
- Pilot licensing.

This exercise represented an 'aviation first' as the aircraft operated within the existing airways structure with controller oversight and without recourse to an on-board safety pilot.

DEMORPAS

Demonstration Activities for Integration of RPAS in SESAR

Consortium
Ingeniería de Sistemas para la Defensa de España (ISDEFE) (coordinator), CRIDA, ENAIRE, FADA-CATEC and Instituto Nacional de Técnica Aeroespacial (INTA)

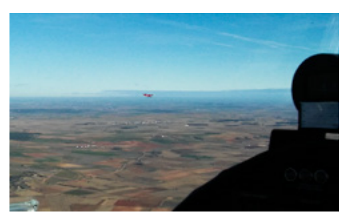
Location
Spain

Summary

The DEMORPAS project performed two flight campaigns in which live flight trials took place based at the Matacán airbase in Spain. Air traffic services were provided in emulated non-segregated airspace with surrounding traffic. Bringing together a multidisciplinary team, two INTA platforms were used in the flight trials, namely a close to mid-range fixed wing RPAS (light observation aircraft -ALO) and a manned aircraft (STEMME S-15).

During the first campaign, the ALO performed live flight trials, following air traffic control (ATC) instructions for all the flight phases. The RPAS was controlled by controllers from different ATC units (ground, approach and en-route), who transferred control from one to the other and communicated by radio to the remote pilot and controllers. Specific RPAS emergency procedures were also carried out during the campaign, such as datalink loss, to identify differences with manned aircraft procedures from an ATC perspective.

The second campaign involved a simultaneous flight of both ALO and STEMME S-15 in the same airspace. A conflict between both aircraft was simulated, together with some RPAS emergencies. The conflict was detected and resolved by the controllers in accordance with pre-defined procedures specifically designed for the flight.



INSuRE

Integration into Non-Segregated ATM

Consortium
Ingegneria Dei Sistemi S.p.A. (IDS) (coordinator), Air Navigation Services of the Czech Republic (ANS CR) and Sistemi Dinamici S.p.A. (SD)

Location
Czech Republic, Italy

Website
www.insure-project.eu

Summary
The INSuRE flight trials were the first RPAS flights to take place in the airspace of Taranto-Grottaglie in Italy. In preparation for the flights, an intensive real-time simulation campaign was conducted using IDS facilities and simulation platforms in Pisa. The SD-150 HERO from Sistemi Dinamici, a rotary wing RPAS with <150 kg maximum take-off weight (MTOW), was used during the trials.

The overall aim of the project was to demonstrate the safe integration of RPAS in airport surface operations prior to take-off and landing. With the demonstration campaign, the project consortium were able to test all aspects of integration from controlling procedures and verification of integrity of the control link (C2) for communicating between the RPAS pilot and controllers.

The campaign also demonstrated the safe execution of RPAS flights using a D&A capability compatible with existing operating procedures, while identifying alternative RPAS surveillance, communications and navigation solutions.

MeDALE

Mediterranean ATM Live Exercise

Consortium
Leonardo Finmeccanica (coordinator), ENAV, Nimbus and Thales Alenia Space Italia (TASI)

Location
Italy

Summary

The objectives of MedALE project were to verify and demonstrate the validity and limits of combined RPAS operations in civil airspace, taking into account different types of RPAS. To reach its objectives, the project took a stepped approach with two complementary phases. First, a networked simulation was performed which evaluated the set-up of necessary operational procedures for managing different RPAS categories, flying at the same time in the same civil airspace and operating beyond the line of sight. Three different flight simulators were used during this phase of the project: a medium altitude long endurance (MALE) RPAS (Finmeccanica Alenia Aermacchi Sky-Y), a tactical RPAS (Finmeccanica Selex Falco) and a mini RPAS (Nimbus C-Fly). Located respectively in Turin, Ronchi dei Legionari and Lombardore, these simulators were networked and operated using the same simulation scenario based on the ATC environment of Sardinia.

For purpose of the simulation, the Sky-Y was modified to integrate the SATCOM datalink provided by TASI as well as an ASD-B simulator capable of interacting with the simulation scenario, which involved the NATO Modelling and Simulation Center of Excellence of Rome, and civil and military controllers. The ENAV ATC personnel, located at the military ground radar station in

Grazzanise and at the Naples-Capodichino civil airport, conducted this live demonstration with the controllers simulating the use of normal civil airspace procedures to manage the Sky-Y RPAS. The instructions for route and altitude changes aimed to simulate the typical interaction with normal air traffic, preventing conflict situations. In addition, some emergency procedures, such as C2 loss and loss of engine power, were also tested. For the MedALE flight trial, the Leonardo-Finmeccanica Aircraft Division Sky-Y RPAS was configured to support the interaction between the pilot at the ground station and the civil air traffic controllers, aiming to demonstrate the possibility of managing a RPAS in nominal and emergency conditions.

ODREA

Operational Demonstration of RPAS in European Airspace

Consortium
Rockwell Collins France (coordinator), DSNA,
Ecole Nationale de l'Aviation Civile (ENAC), Sagem

Location
France

Website
www.odrea.org

Summary
The project conducted fast-time simulations at DSNA/DTI in Toulouse, as well as real-time simulations distributed between Toulouse-Blagnac (air traffic controllers and pseudo-pilots) and Pontoise (real remote pilot stations (RPS) and remote pilots). Flight demonstrations were also performed in Toulouse-Blagnac terminal manoeuvring area (TMA), between Muret-Lherm general aviation aerodrome and Toulouse-Blagnac international airport. A temporary restricted area was activated during the D&A exercises.

The main objectives of these exercises were to define and validate tailored departure, transit and arrival trajectories for the two aerodromes, taking into account both the flight performance of the RPA and the environmental constraints of the TMA. The exercises also allowed for the definition and testing of a procedure to deal with C2 loss of control to support standardisation activities in this area. Ultimately, these exercises sought to demonstrate the capability to integrate an RPA into the managed traffic of a mid-size commercial airport and a general aviation aerodrome.

The RPAS used in the project was Sagem's fully qualified one-tonne class Patroller™. It was equipped with a D&A suite, and configured in optionally piloted vehicle (OPV) mode during the demonstration flights, i.e. with a safety pilot on-board but remotely operated from the RPS, for the sake of safety. This allowed the project to assess the performance of the D&A suite when faced with cooperative and non-cooperative traffic.

RAID

RPAS ATM Integration Demonstration

Consortium
Centro Italiano di Ricerche Aerospaziali ScpA (C.I.R.A. ScpA) (coordinator), Deep Blue SRL, Nextant S.p.A, Nimbus SRL, University of Malta, Malta Air Traffic Services (MATS)

Location
Italy

Website
raid-sjuproject.eu

Summary

The project conducted 50 real-time simulations involving both controllers and remote pilots, and making use of a distributed simulation testbed composed of a remote pilot station and the RPAS real-time simulator, located at CIRA, and the controller simulation facility at MATS. A total of 12 live trials, each lasting 30 minutes, were also carried out in Italy, in an area located close to both the Capua Airport and to the CIRA premises.

The project used the FLARE vehicle from the CIRA Flight Laboratory for Aeronautical Research, which is a TECNAM P92 Echo-S aircraft operated as an OPV and equivalent to a MALE RPAS vehicle. A second small rotorcraft RPAS, manufactured by NIMBUS, was also used in the demonstrations.

A new RPAS human machine interface (HMI) developed taking into account RPAS pilots user requirements was also used.

Specifically, the project aimed to quantify and demonstrate the level of maturity, limitations and compatibility with current infrastructures and procedures for D&A and for C2 loss. The project sought also to assess the impact of RPAS integration into unsegregated airspace on safety, the RPAS pilot, controllers and ATM procedures and operations. In addition the project aimed to identify similarities between the RPAS and manned aircraft operations in the area of ATM, as well as specificities to RPAS operations in terms of constraints and new ATM and technological requirements.

TEMPAERIS

Testing Emergency Procedures in Approach and En Route Integration Simulation

Consortium
DSNA (coordinator), Airbus ProSky, Cassidian SAS, ENAC and STERIA

Location
France

Website
www.tempaeris.org

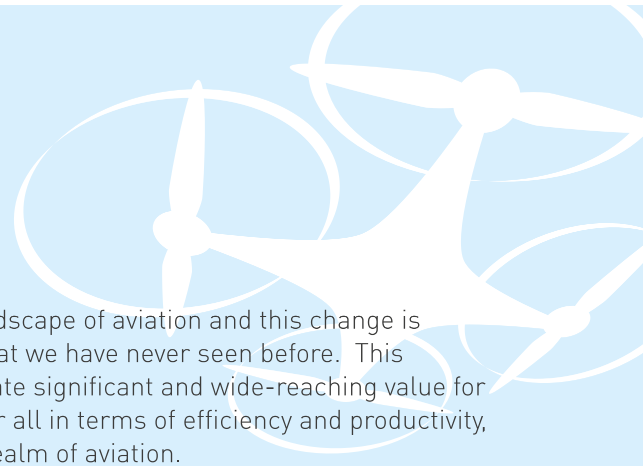
Summary
The objective of the project was to investigate the impact of RPAS integration into non-segregated airspace in a mid-traffic density environment. More specifically, the project focused on emergency procedures for RPAS, the impact on the traffic safety and regularity, as well as on controller workload.

Trials using real flights were carried out at the Bordeaux-Mérignac airport, a regional airport that handles annually 4.38 million passengers and approximatively 70 000 aircraft movements with a mixture of IFR, VFR and military traffic. The trials dealt with the approach phase of air traffic control operations, assessing the impact of integrating slow-flying RPAS (between 70 and 90 kt) into a non-homogeneous traffic. The trials also assessed the impact of RPAS non-nominal modes (communication failure, command and control failure) on ATC performance.

Meanwhile, real-time simulations were carried out in the terminal manoeuvring/lower en-route airspace, in order to address a broader spectrum of situations. The simulations included a reference scenario with no RPAS and two RPAS scenarios: a 'nominal RPAS' scenario and another one with non-nominal situations ('return home').

These scenarios consisted in simulations lasting approximately 40 minutes and displaying 3 to 4 flights with different types of RPAS. These RPAS had different approach speeds and some of them using SATCOM, thus enabling the impact of communication latency to be explored.

Conclusions



RPAS are clearly changing the landscape of aviation and this change is happening at a speed and scale that we have never seen before. This market has the potential to generate significant and wide-reaching value for Europe. It means opportunities for all in terms of efficiency and productivity, stretching to sectors beyond the realm of aviation.

With the update of the European ATM Master Plan in 2015, the integration of RPAS is a new priority for SESAR and therefore the Single European Sky. As a consequence from 2016, the SESAR JU is investing resources in SESAR 2020 to continue research in this fast-moving domain. In the SESAR 2020 Industrial Research programme, RPAS become a new class of airspace user in all concepts so that RPAS issues can be studied alongside those for manned aviation.

Specific solutions will be produced for RPAS collision avoidance, surface management and integration with IFR traffic. In addition, the SESAR JU has launched an Exploratory Research Programme to address VLL RPAS in order to stimulate innovation and development, and future-proof our skies for the safe integration of RPAS alongside existing conventional aircraft.

Glossary

ADS–B	Automatic dependent surveillance – broadcast
ATC	Air traffic control
ATM	Air traffic management
BVLOS	Beyond visual line of sight
CIRA	Centro Italiano di Ricerche Aerospaziali ScpA
CRIDA	Centro de Referencia de Investigación, Desarrollo e Innovación ATM
C2	Command and control
D&A or DAA	Detect and avoid
ENAC	Ecole Nationale de l'Aviation Civile
E-VLOS	Extended visual line of sight
GBSAS	Ground-based situational awareness system
GCS	Ground-control station
GNSS	Global Navigation Satellite System
HMI	Human machine interface
ICAO	International Civil Aviation Organization
IDS	Ingegneria Dei Sistemi S.p.A.
INTA	Instituto Nacional de Técnica Aeroespacial
ISDEFE	Ingeniería de Sistemas para la Defensa de España
MALE	Medium altitude long endurance
MATS	Malta Air Traffic Services
MTOW	Maximum take-off weight
NATO	North Atlantic Treaty Organization
NLR	Netherlands Aerospace Centre
NRTC	Netherlands RPAS Test Centre
OPV	Optionally piloted vehicle
RNAV	Area navigation
RPAS	Remotely piloted aircraft system
RPIC	Remote pilot in command
RPS	Remote pilot station

SAR	Search and rescue
SATCOM	Satellite communications
SBAS	Satellite-based augmentation system
SESAR JU	SESAR Joint Undertaking
SID	Standard instrument departure
SWaP	Size, weight and power
TASI	Thales Alenia Space Italia
TCAS	Traffic alert and collision avoidance system
TMA	Terminal manoeuvring area
UAS	Unmanned aerial system
UAV	Unmanned aerial vehicle
VLL	Very low-level
VLOS	Visual line of sight

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