

ENAIRe's participation in innovation projects

Objectives and benefits

Digital European Sky
(SESAR Research and Development)

2025, September



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Background

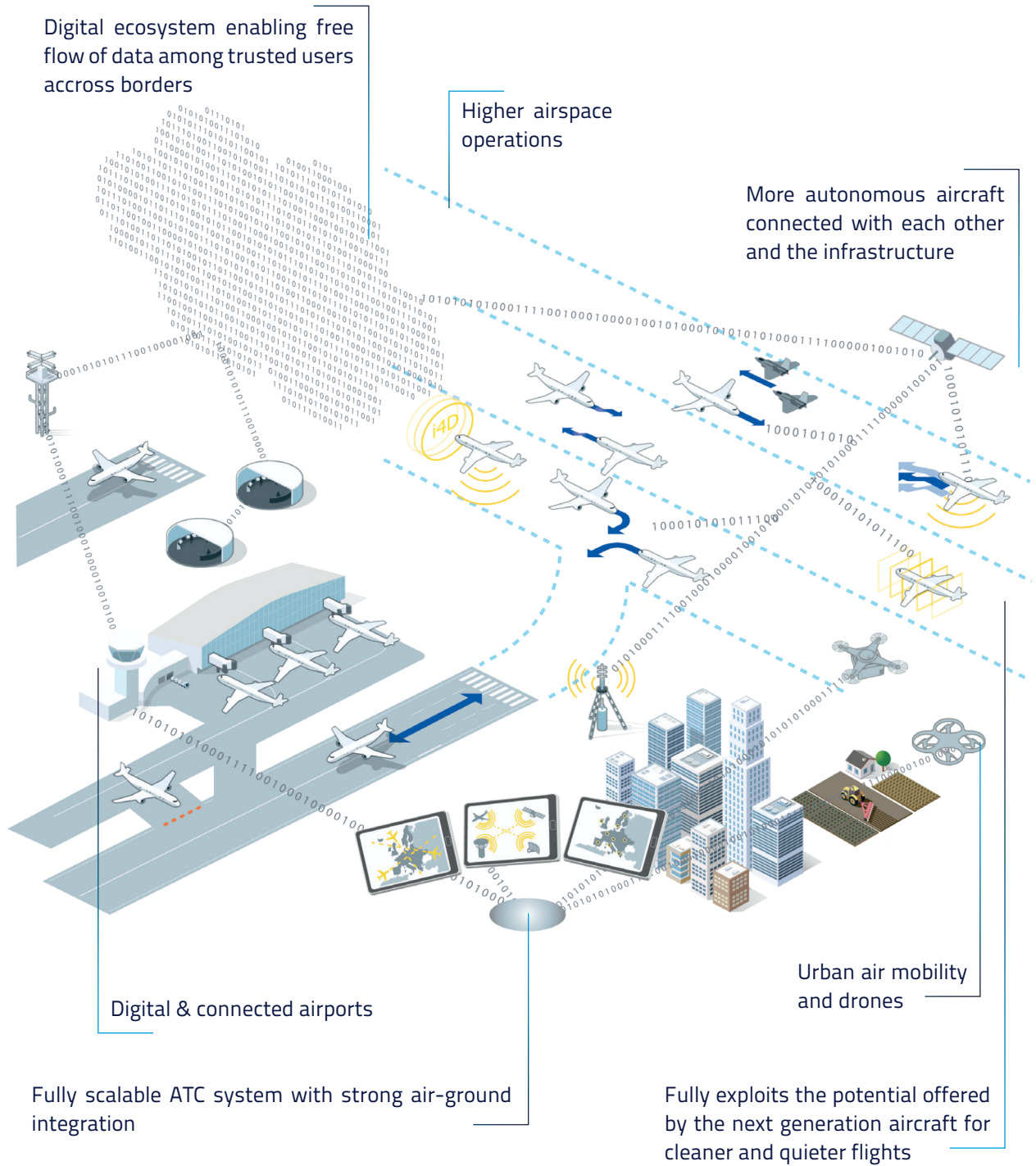
ENAIRe has been actively present in the SESAR project since its creation, proactively participating and investing its resources and efforts for the correct and homogeneous implementation of the project. For this reason, it has been since the beginning an active member of the SESAR Joint Undertaking (SESAR JU), participating in the development of IR (Industrial Research) and Exploratory Research (ER) R&D Projects and in demonstration activities within the framework of the SESAR 1, SESAR 2020 programmes, and continuing with the European Digital Sky (DES) programme, with the inclusion of new concepts of automation, artificial intelligence, use of quantum technology, multimodality, full integration of drones and suborbital flight operations.

Since its inception, ENAIRe has participated in 77 Projects in SESAR 1, 33 Projects in SESAR 2020 and is participating in different DES projects, with the aim of implementing these technologies in the future, when they are mature and validated.

The SESAR programme was first proposed in 2017, and then further detailed in 2019, in the European ATM Master Plan 2020 edition, in a commonly agreed roadmap by stakeholders from across the aviation community. The Digital European Sky leverages the latest digital technologies to transform Europe's aviation infrastructure enabling it to handle the future growth and diversity of air traffic safely and efficiently, while minimising environmental impact.

This transformation centres on technologies that can increase the levels of automation, cyber-secure data sharing and connectivity in air traffic management (ATM), as well as the virtualisation of its infrastructure and air traffic service provision in all types of airspace, including very low and high-altitude operations.

In doing so, these technologies enable the system to become more modular and agile, while building resilience to disruptions, traffic growth and diversity of air vehicles.



Fully exploits the potential offered by the next generation aircraft for cleaner and quieter flights

To bring the maximum benefits, the digital transformation will be holistic and passenger-centric, covering air travel door-to-door and involving everyone that plays a role in that experience, from the airports, airlines, and air navigation service providers, to the regulatory, standardisation and safety bodies.

As it is stated in the Vision of the newly ATM Master plan Edition 2025, the evolution towards a fully operational Digital European Sky, is achieved throughout **four phases**:



Unlike the previous SESAR 2020 programme, in SESAR3 or Digital European Sky (DES) the calls are open, so the submitted proposals compete and are evaluated by the SJU (and also CINEA in the case of the Digital Sky Demonstrators (DSDs)).

This is why ENAIRE's great success in these first DES calls becomes even more relevant since we participate in a total of 21 IR1 (Industrial Research) projects of the 27 finally awarded, in addition to one ER1 (Exploratory Research) project. In a second call, ENAIRE was granted another 4 ER2 projects.

In the field of demonstrator projects or DSDs, ENAIRE has continued its participation in the 3 DSD1a projects that began in 2022, to which we must add another 2 projects awarded in the DSD1b call. These projects will allow the concepts developed in early maturity phases of the innovation cycle to be tested and will serve as a starting point for industrialisation.

The following principles will underpin the demonstrators/DSDs:

- **For early movers.** The demonstrator network will be continental in scale and will act as a global showcase of European leadership, establishing an initial critical mass of early movers on breakthrough innovations.
- **People.** The digital European sky will encourage a shift away from a traditional product centric strategy to one that focuses on the end-user, stimulating entrepreneurship, a risk-taking culture and creating buy-in from operational staff.

- **Focus.** The demonstrators will focus on the breakthrough innovations that can bring the greatest benefits, attract the best innovators, and connect local and regional ecosystems.
- **Standards & certification.** To keep pace with technological advances, the demonstrator network will closely involve the relevant authorities and bodies to develop the next generation standards that are responsive to policy needs, agile, open, and joined up.
- **Regulation.** A key added value of the network should be to facilitate interactions between breakthrough innovators, early movers, and regulators to help develop regulatory frameworks that allow the benefits of digital technologies to be fully realised.
- **Aviation green deal.** Europe should be the world's most environmentally friendly continent to fly. One of the flagship initiatives of the demonstrator network will be oriented towards accelerating market uptake of solutions enabling "perfect flights" from an emissions perspective, eliminating unnecessary ATC interventions that would result in a degradation of the optimum trajectory and generate extra emissions. This flagship will also facilitate the integration of the next generation of aircraft that will be cleaner and quieter.

The goal is to achieve a “digital European sky” by 2045, with accompanying improvements in air traffic services as well as the inclusion of operations at very low altitudes and high altitudes.

	A	B	C	D
			Defragmentation of European skies through virtualisation	Digital European Sky making Europe the most efficient and environmentally friendly sky to fly in the world
Trajectory optimisation			Transition to TBO phase 2	Transition to TBO phase 3
Data volumes			Transition towards high performance of air-ground connectivity (multilink)	Large volumes of data flow in a effective and secured manner across trusted users
Automation			Higher levels of automation support	For certain phases of flight, the system is fully automated and able to handle both nominal and non-nominal situations
Dynamic airspace			Virtualisation and dynamic airspace configuration	Capacity adjustments are implemented in real time and ensure an optimal and cost-efficient use of resources any moment across the network (airspace, data, infrastructure and human-machine teaming)
Human roles			Human centric	Human-machine teaming
New service delivery model and supporting regulatory framework				

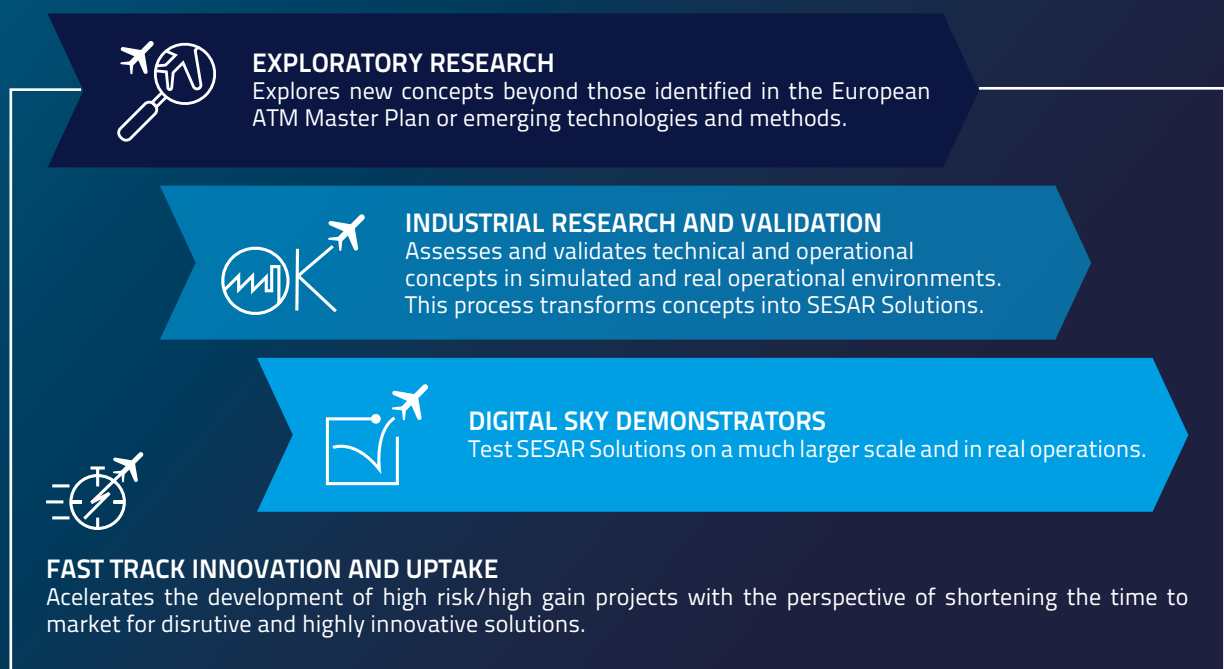
Mitigation CO ₂ impact	-1%	-7,5%
Mitigation total impact (incl. non CO ₂)	No	Yes
Integration zero-emission aircraft	Limited	Yes, full. All types
Minimum share of supply of sustainable aviation fuel (SAF)	Increasing to 20% by 2035	Increasing to 42% by 2045 and to 70% by 2050

ENAIRe's contribution to the European Digital Sky

Since its inception, ENAIRe is member of the SESAR Joint Undertaking (SESAR JU), public-private partnership in charge of the management of the Research and Development in ATM, currently focusing on the Digital European Sky (DES) programme and following the ambitions declared in the European ATM Master Plan 2025 edition, approved by the SESAR JU Governing Board in December 2024.

The bulk of ENAIRe's current participation in the DES programme is within the first call of industrialisation projects or Industrial Research 1 (IR1) and in the demonstration projects.

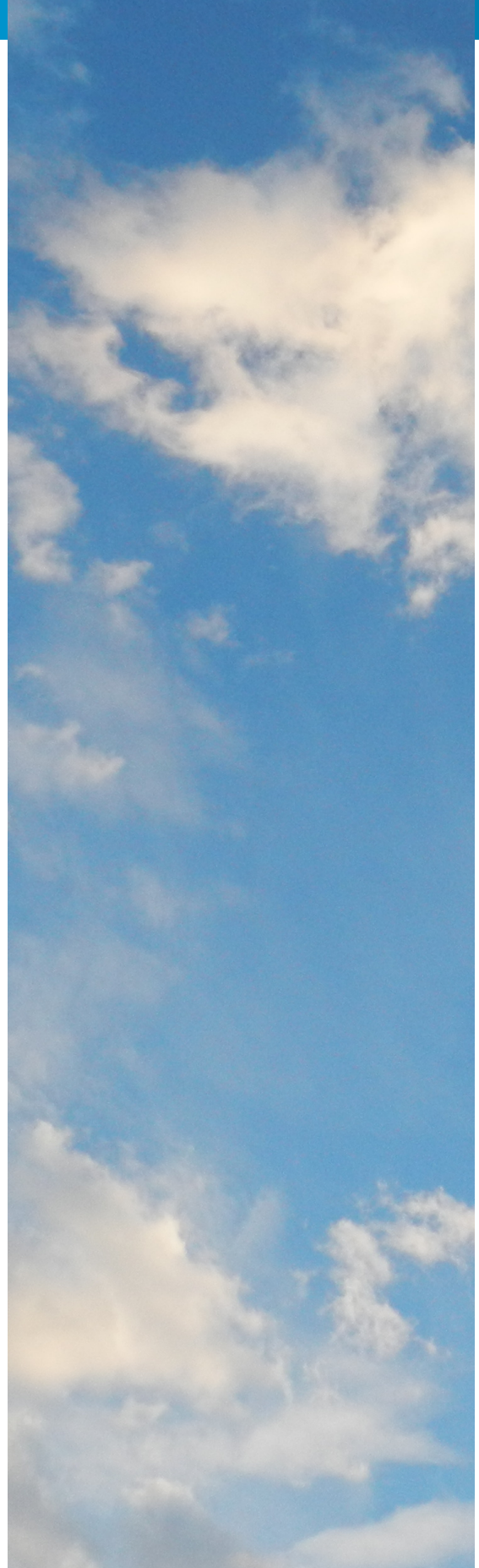
ENAIRe's level of participation in Industrial Research projects is more than remarkable since we contributed to 21 projects of the 27 total projects awarded in this call, and we are also the leaders of two of them. The IR1 projects began between June and September 2023 and have a duration of 3 years, with the year 2025 being the year in which most of the validation exercises are expected.



In 2023, ENAIRE has begun its participation in the first call for Exploratory Research projects of the DES programme, which correspond to the most initial phase of innovation and allows the identification of innovative ideas that may be beneficial in the future. After the good experience of participating in Exploratory Research projects at SESAR 2020, ENAIRE continues its involvement in projects of this type that are the basis of innovation, mainly supporting CRIDA in providing technical and operational expertise related to Air Traffic Management and U-Space.

ENAIRE has continued its journey in the 3 demonstrator projects of the DES programme that started in 2022. With the demonstrator or DSD projects, what is sought is to reach the maximum level of maturity of the innovation cycle, demonstrating that the concept is ready for its implementation and evidence is obtained of the benefits previously investigated in the Industrial Research and Exploratory Research phases.

To achieve this level of maturity, certification and standardization tasks take special importance, which is why coordination is maintained with agencies such as AESA (Spanish Aviation Safety Agency), EASA (European Aviation Safety Agency) or EUROCAE (European Organization for Civil Aviation)



Digital Sky Demonstrators (DSD)

ENAIRE contributes in two different DSD calls:

- The first DSD call in which ENAIRE participates is the DSD1a call, whose projects started in 2022 (ECHOES in March, while HERON and U-ELCOM in November) and will extend its duration until Q4 2025.
- The second call with ENAIRE contribution is DSD1b, where ENAIRE participates in two projects, DEVICE and ESMA, which cover three years from January 2024, finalising in June 2027.



ESMA

European Sky Multilink ATN

The ESMA project addresses the need to increase the level of automation in air traffic management (ATM). Its objective is to present the operation of a multilink communications infrastructure, focusing on satellite data link (SATCOM Datalink) together with VHF data link (VDL) Mode 2.



How will ENAIRE contribute?

ENAIRE provides its CNS infrastructure and expertise to validate this technology.

Objectives / Expected Benefits:

- Operation of a dual-link communication service, aimed at the seamless link transition between Satcom (Iris) and VDLm2.
- To perform a multilink demonstration involving the transition between ATN/OSI and ATN/IPS protocols. This demonstration will show the compatibility of OSI-based aircraft, OSI based ground station and IPS ground station together with the goal of developing further the FCI (Future Communication Infrastructure).



ECHOES

Extended Communications in vHf Over Enhanced Satellite segment

The general objective of ECHOES is to demonstrate the technical feasibility of a solution based on satellite technology for VHF voice and data communications in areas where VHF communications are currently not available due to lack of infrastructure (oceanic and remote areas). In addition to this, the possibility of using ADS-B based on this satellite technology will also be tested.

Objectives / Expected Benefits:

To demonstrate the feasibility of space-based solution for very high frequency (VHF) communications (voice and datalink) in air traffic management.

To investigate some key functionalities such as on-board processing of data in the satellite or simultaneous transmission and reception of VHF communications.

To contribute to the regulatory and standardisation of the space-based VHF technology based on the analysis of end-to-end system performances.

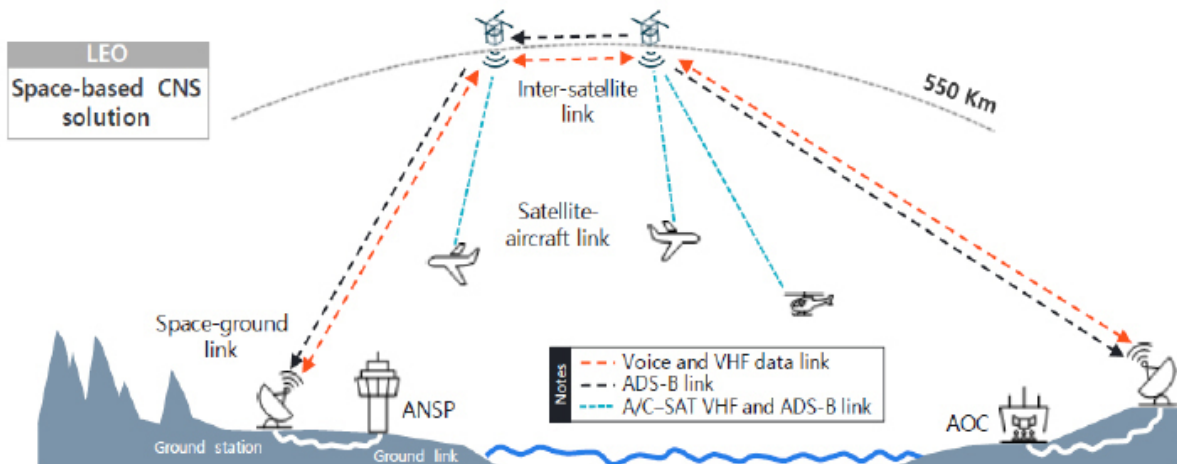
To achieve these objectives, ENAIRE contributes in the following Use Cases:

- Use of satellite-based VHF voice/data communications and satellite-based ADS-B as a means of contingency/delegation
- Initial assessment of separation minima reduction for increased airspace capacity in oceanic regions.
- Airlines applications: VHF AOC message transmission for flight analysis, fleet management and ADS-B as source for GADSS.
- Initial assessment of utilisation of User Preferred Routes (UPR) in oceanic regions.



ECHOES

Extended Communications in vHf Over Enhanced Satellite segment



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Assessment of **separation minima reduction** for increased airspace capacity in oceanic regions



Permanent contrails prevention on the South Atlantic corridor



VHF AOC message transmission for flight analysis and fleet management



Assessment of utilisation of **User Preferred Routes (UPR)** and other applications (GADSS) in oceanic regions



Use of satellite-based VHF voice/ data comms and ADS-B as a means of **contingency/delegation**

How will ENAIRE contribute?



ENAIRE provides its CNS infrastructure and its ATM expertise to validate this technology.

ENAIRE is the leader of the Safety Assurance work package as well as the Demonstration Plan deliverable.

These use cases are covered by several exercises whose geographical scope is set in the South Atlantic corridor, including Southwest European oceanic airspace, particularly, in FIR Santa Maria Oceanic, FIR Canarias (under ENAIRE responsibility), FIR Sal Oceanic, FIR Dakar Oceanic and FIR Atlantic.



HERON

Highly Efficient Green Operations

[OUTCOMES ↗](#)

The HERON project aims to promote the deployment of a set of measures to mitigate CO2 emissions from air transport through the development of sustainable activities that include more efficient air operations both in the air and on the ground.

Among the mitigating measures, advanced technologies can be found in on-board equipment and, also, from the ANSP point of view, new approach procedures will be developed, and air-ground coordination of Trajectory Based Operations (TBO) will be demonstrated in the planning and execution phases.

Objectives / Expected Benefits:

- **OPTIMISED APPROACHES:** Linked to the operational flight demonstration of green approaches, including Continuous Descent Operations (CDO), optimised approach spacing management integrating wind aloft, and increased second glideslope (ISGS) solutions.
- **IMPROVED TRAJECTORY PLANNING:** Improves the management of trajectory through the implementation of solutions at EUROCONTROL/ Network Manager (NM) and local levels, allowing AUs to file more efficient trajectories according to the available ATM improvements.
- **ADS-C COMMON SERVICES:** Aims to develop further, from the current TRL6 up to TRL7/8, the ADS-C common service and all its components.
- **INTEGRATED 4D FOR GREEN TRAJECTORIES:** Demonstrating the operational and environmental benefits of the integration of Automatic Dependent Surveillance – Contract (ADS-C) data into ATM and ATC systems and procedures.
- **GREEN SURFACE OPERATIONS MANAGEMENT:** Aiming to demonstrate operational aspects of available green (and smart) technologies to increase sustainability while optimising operations at medium and large European airports.

How will ENAIRE contribute?



ENAIRE provides its CNS infrastructure and expertise to validate this technology.



DEVICE

DElegation through Virtual Centres

The DEVICE project will industrialise an early version of the iTEC SkyNex platform, consolidating the virtual centre and delegation technologies necessary to realise the planned European Airspace Architecture Study (AAS), which is the document that sets the guidelines to be achieved in the architecture of European airspace in the future.

The results are expected to pave the way towards greater interoperability and automation, ultimately improving the resilience of the entire EU ATM system.



How will ENAIRE contribute?

ENAIRE is the Project Coordinator.

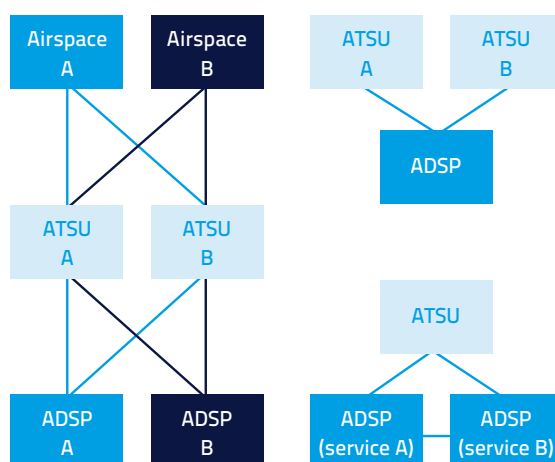
ENAIRE provides its infrastructure and ATM expertise to validate the Virtual Centre concept.

ENAIRE leads the "Y Architecture" work package and is responsible of demonstrations:

- "Y Architecture" between Madrid and Sevilla
- "D Architecture" between Madrid and Barcelona
- "Triangle Architecture" with NAV Portugal.

Objectives / Expected Benefits:

- To demonstrate the new air traffic service (ATS) operating model based on the delegation of ATS using virtual centres (VC), and the increased efficiency and resilience of the ATS thanks to better use of resources across Air Traffic Service Units (ATSU) borders.
- To demonstrate the ATS operating model based on the air traffic management (ATM) data service providers (ADSPs) concept outlined in the airspace architecture study and later complemented by a European Commission study.
- To demonstrate the feasibility of delivering cross border services even through different platforms (iTEC SkyNex and COOPANS).



U-ELCOMe

U-space European COMMon dEpLoyment

The U-ELCOMe project aims to fully implement U-space's U1 and U2 services in the market through a set of tests and demonstrations in various operating environments 15 European locations distributed in Spain, Italy and France.

These two mentioned services are characterised by the following:

- **U1 Service:** Initial and basic U-space services. It allows both registration and electronic identification of drones.
- **Phase U2:** Initial U-space services for flight management. This includes the creation of a flight planning system, permit approval, tracking and conventional interaction with air control (ATC).



How will ENAIRe contribute?

ENAIRe provides its operational and U-Space expertise in the concept definition as well as in the analysis of results.

ENAIRe leads the Spanish Cluster that will perform several demonstrations in 8 regions through live trials in Spanish Airspace.

Objectives / Expected Benefits:

- To target the fully scalable market uptake of U1 and U2 U-space services including the interface with the Air Traffic Management.
- To ensure safe and fair access for all airspace users.
- To facilitate implementation of research results between research and implementation.
- To contribute to the consolidation of standardisation and regulatory requirements.



Locations

France: Bréty LF-R333, Saint Quentin Yvelines (5 sites).

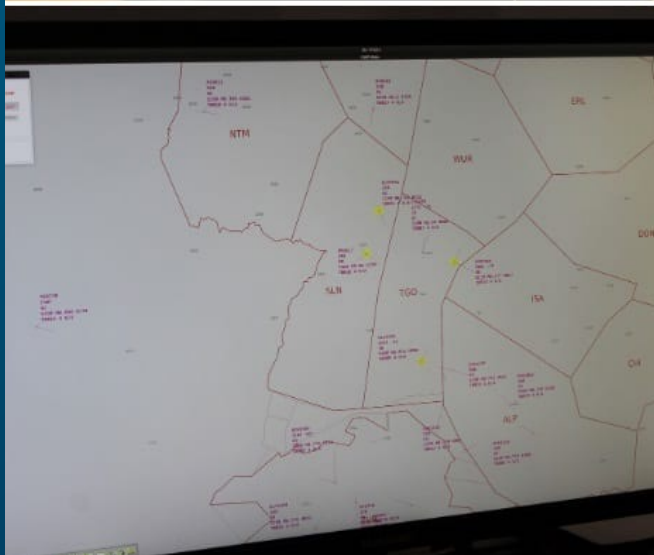
Spain: Navarra, Catalonia Region, Madrid, Seville & Jaén, Zaragoza, Fuerteventura (Canary Islands), A Coruña, Valencia.

Italy: Milan, Venice, Rome, Naples.

Industrial Research (IR)

ENAIRe participates in 19 Industrial Research projects, in addition to the two transversal projects. IR projects started from April 2023 to September 2023 and

have a total duration of 36 months, until Q3 2026. Main core of ENAIRe activities is foreseen in Q4 2025, where several validation exercises will be performed.





ATC TBO I

4D Trajectory automation integration in support of TBO

The ATC-TBO project proposes to validate the TBO (Trajectory Based Operations) concept in the tactical phase for en-route and TMA operations.

Trajectory-based operations (TBO) is the glue between the ATM components during tactical planning and flight operations by synchronising the view of the trajectory between different actors and ensuring consistency between the trajectory and/or generic constraints that originate from the various ATM components and the various regions that shape this trajectory.

To achieve the goal of validating the concept, the ATC-TBO project It will be supported by **3 solutions**:

- Improvement in automation for sector planning and separation management.
- Improved ground-air trajectory synchronisation.
- Advanced separation management through CPDLC and Datalink.

Objectives / Expected Benefits:

Building on SESAR 2020 4DSkyways, the project aims to:

- Focus on value by validating performance benefits for environment, operational efficiency, capacity, cost efficiency, safety, and security.
- Engage with our key stakeholders – especially flight crew and air traffic controllers – to ensure that our TBO solutions are operationally acceptable, and they are fully involved in aspects that might impact their work including advanced automation.
- Promote a collaborative working environment – a partnership between operational and industry partners – that delivers useful and accessible deliverables.

How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results. ENAIRE leads a validation exercise that will prove the resolution of very likely conflicts within the planning separation

management function, considering the Trajectory Predictors Figures of Merit and contributes in another one to validate the optimised flight profiles using automated clearances.





MITRANO

Mission Trajectory in ATC and Network Management Operations

The MITRANO project validates the integration of military-type trajectory management within the ATC, as well as coordination in civil-military decision making at the network level. This project includes advanced design principles for military access to airspace, type 3 Dynamic Mobile Areas (DMA), and also provides a technological solution for the protection of surveillance data.

Type 3 Dynamic Mobile Areas are portions of airspace around moving aircraft that may be temporarily restricted for civil traffic in order to satisfy military needs. This new concept allows reducing the volume of restricted airspace not used by civil traffic, thus achieving an increase in capacity.

Objectives / Expected Benefits:

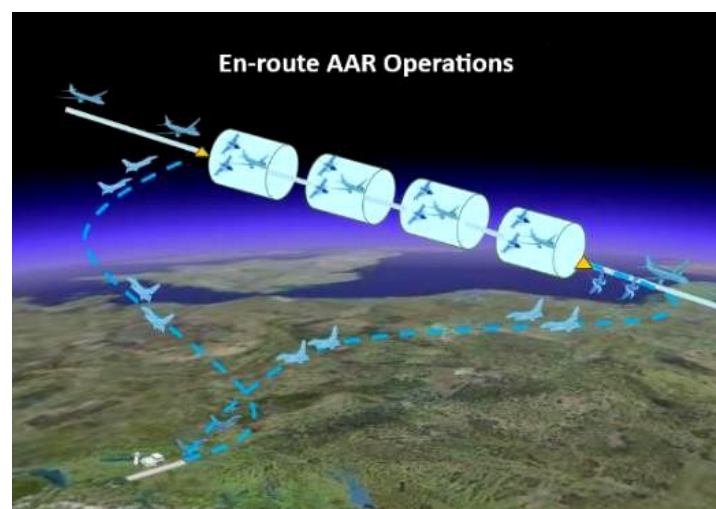
- To investigate new operating methods, services and tools to integrate mission trajectory data into the network level ATM execution phase.
- To develop the Advanced Flexible Use of Airspace concept (AFUA), specifically the use of dynamic mobile areas (DMAs) of type 3 as fully integrated into the mission trajectory management process – from planning to execution.
- To improve existing cybersecurity features.



How will ENAIRe contribute?

ENAIRe provides its operational and ATM expertise in the concept definition as well as in the analysis of results for DMA solution. In ADS-B phase overlay solution, ENAIRe contributes with its expert CNS staff.

ENAIRe leads a validation exercise concerning to the management of Mission Trajectory with DMA type 3, from planning to execution.



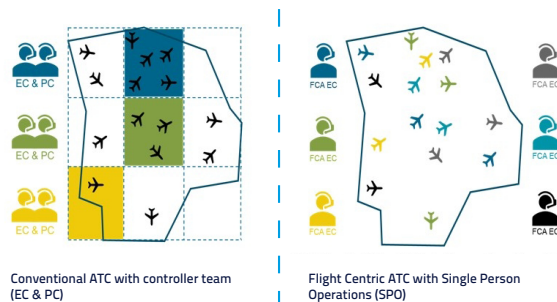


FCA

Flight Centric ATC

The project aims to validate the concept of Flight Centric ATC (FCA) for areas of medium air traffic density, which represents a change in ATC services as we know them today.

With this new concept, the controller will no longer be responsible for the separation of aircraft within a sector of airspace but will be in charge of a number of aircraft throughout an entire air segment. This means that more than one air traffic controller can be working in the same airspace and allows traffic to be distributed more equitably and avoid loss of productivity in underloaded sectors.



Objectives / Expected Benefits:

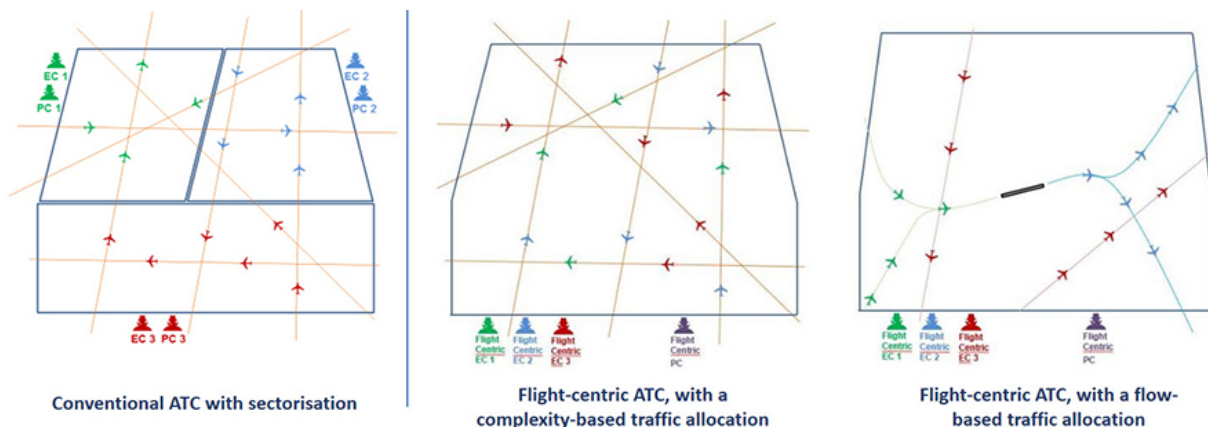
The candidate solution is expected to increase of controller productivity owing to a better balance of the demand and increase flight efficiency by removing the sectors entry/exit conditions, as well as enhance safety and capacity, and improve environmental performance.

How will ENAIRE contribute?



ENAIRES provides its operational and ATM expertise in the concept definition as well as in the analysis of results. Is the leader of the Final SPR-INTEROP/OSED deliverable.

ENAIRES leads a validation exercise that will simulate upper airspace of Madrid ACC to investigate manual allocation of flights to FCA and the interaction of FCA with DCB procedures.



FCDI

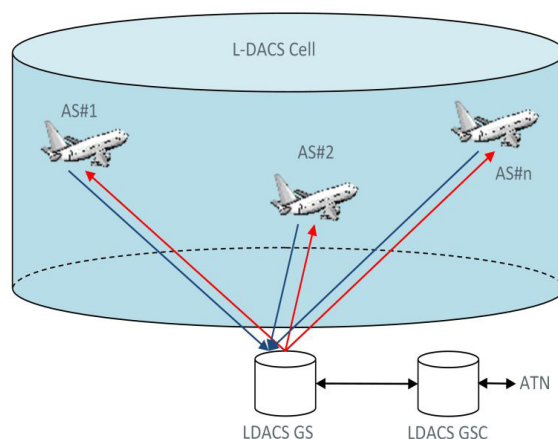
Future Connectivity and Digital Infrastructure

The FCDI project aims to develop future CNS technologies in order to support the ATM System that is to come, and which will include, among other innovations, 4D Trajectory Management. Having a CNS system prepared for the future of CNS implies that the performance requirements of CNS systems are increasingly complex and demanding, being considered as part of an integrated and holistic system of systems.

Objectives / Expected Benefits:

- **Collaborative Cyber Security Framework for CNS:** to elevate trust and safety - The main objective is to provide effective and long-term defence against cyber security attacks to future hyperconnected and automated aeronautical CNS environment.
- **Hyper Connected ATM precursor:** to pave the way for the best use of safety aeronautical and broadband cabin communication links - The main ambition of this solution is to show the feasibility to use cabin non-safety air-ground links as a complement to aeronautical safety links, to support safety and regularity of flight communications.
- **FCI Services and IPS Enhancements:** to enhance the FCI Mobility & Multilink for a safer and more interoperable Aviation – The Future Communication Infrastructure (FCI) is a critical enabler for long - term viability of many operational concepts developed in SESAR.

- **FCI Terrestrial Data Links – LDACS:** to provide secure, high throughput communication capability and voice, with embedded navigation capability – The main objectives of this Solution are to increase the maturity level of the LDACS Airborne Enabler, through the development of LDACS avionic prototypes and validate the integration of LDACS with the current Open Systems Interconnection (OSI) based Services environment.



How will ENAIRE contribute?

ENAIRE provides its CNS infrastructure and expertise to validate this technology.

MIAR

(Multilink ConOPS) LDACS

The project aims to demonstrate that LDACS (L-band Digital Aeronautical Communications System) can support CNS services on aircraft. LDACS is a new air-to-ground communications standard that enables IP-based broadband data communications. The project will focus on flight testing using LDACS-based CNS services to provide optimised separation between aircraft in real time.

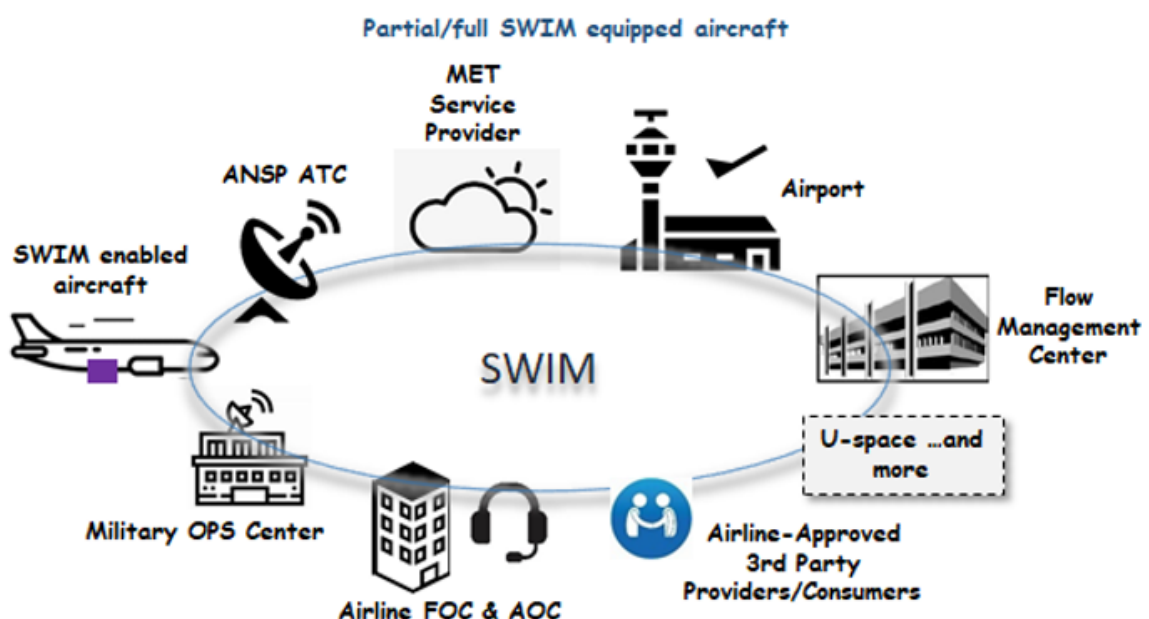


How will ENAIRE contribute?

ENAIRE provides its CNS infrastructure and expertise to validate this technology.

Objectives / Expected Benefits:

- To ensure that the business case for deploying the LDACS infrastructure in the real world remains robust and positive for stakeholders in support for the acceleration for the adoption of LDACS.
- MIAR will demonstrate several complementary navigation technologies such as e-DME, terrain-based navigation and radar-based navigation as well as the navigation function in LDACS.
- In the area of communication and surveillance, the project will validate air-to-ground SWIM (System-Wide Information Management) solutions.





iSNAP

iTEC SkyNex ATC Platform

The objective of this project is to develop the architecture of the iTEC platform so that it is compatible with the virtual centre concept. The evolution of the platform will provide improved security, resilience and scalability of the ATM network, enabling more flexible provision of ATM services.

The concept of virtual centre refers to the decoupling the data services required for ATM systems (such as flight data, radar and weather information), from the physical location of the controller's workplace. This will allow greater flexibility when organising ATC operations and, therefore, more cost-effective service delivery.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

ENAIRE leads a validation exercise on the delegation of airspace using Virtual Centre D-Architecture.

Objectives / Expected Benefits:

- Modernise applications to ensure flexibility on their development and evolution and facilitate their life cycle agility.
- Focus on "Virtualisation" and "ATM data as services", to allow a more flexible provision of ATM Services.
- Implement the key concepts stated in the Airspace Architecture Study.
- Remove technical debt / obsolescence at all layers.
- Leverage on the benefits of modern IT infrastructure and platforms (cyber-resilience & on-demand capacity).





VITACY

Virtual center with Triangle Architecture and Cyber-resilience

The project will advance the virtual centre concept by developing "triangular architecture." Virtual centres allow the decoupling of data services required for ATM systems (such as flight data, radar, and weather information) from the physical location of the controller's workplace.

With this type of architecture for virtual centres, the replacement of data centres as we currently know them could be achieved by new specific ADSP (ATM Data Service Provider) data providers more oriented to functionality, which allows, among others, new business opportunities.

Objectives / Expected Benefits:

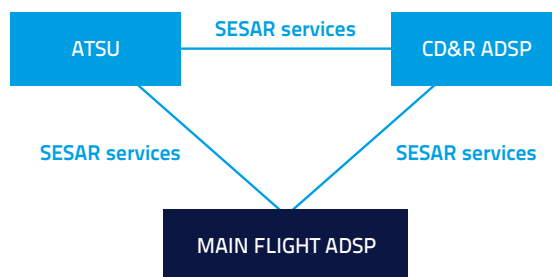
- Continue researching in the ATM virtual centre technology field, by developing the "triangle architecture", a powerful type of architecture based on disaggregating services currently offered by a main ADSP (Aeronautical Data Service Providers) into new specific functionality oriented ADSPs.
- Develop cyber-resilience tools focused on virtual centre environment to monitor attacks and display alerts if detected.



How will ENAIRe contribute?

ENAIRe provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

In addition, ENAIRe supports the technical verification for Virtual Centres with triangle architecture.



IFAV 3

Increased flexibility of ATCO validations

This project aims to enable a more flexible deployment of ATCOs across sectors. Due to current regulations and practices, the deployment of air controllers in an airspace is limited by the so-called unit rating, for which controllers must receive extensive training on local procedures and circumstances.

The fact of being able to have a flexible deployment of ATCOs based on the possibility of having a flexible unit enablement will allow optimisation of control resources. All of this will help the ATM to be more resilient and reactive to unforeseen events, changes in traffic demand or staff shortages.

Objectives / Expected Benefits:

- Increasing flexibility in the deployment of air traffic controllers to sectors
- Increasing safety
- Increasing cost efficiency of air traffic control service provision
- Increasing resilience against staff shortages
- Reducing the stress levels during worktime thanks to more flexible schedules, trainings, and duties
- Fostering standards to lower the probability of "human error" during operations.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

ENAIRE is the leader of the Validation Plan as well as the Validation Report.

ENAIRE leads several validations exercises to prove the IFAV concept.



ECHO 2

European Concept for Higher Altitude Phase 2

Towards the inte-gration between Air Traffic Management and Higher Altitude Operations

The main objective of this project is the modernisation and adaptation of the European ATM system that allows the integration of the so-called high-altitude operations or Higher Airspace Operations (HAO). These types of operations occur above flight level FL550, that is, operations above 17,000 meters, while flights usually take place around 10,000 meters.

It is expected that part of the increase in these high-altitude operations will come from new actors with a variety of operational characteristics, such as, for example, high-altitude drones, making the aforementioned modernisation of the system necessary.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

Objectives / Expected Benefits:

- **Commercial Space Operations:** Involves private companies launching and managing satellites and spacecraft for various services and exploration.
- **High Altitude Platform Systems:** Stratospheric systems used for telecommunications, surveillance, and environmental monitoring, capable of staying airborne for extended periods, from weeks to months.
- **Supersonic and Hypersonic Aircraft:** Advanced planes designed to travel faster than the speed of sound, with hypersonic ones reaching speeds over five times that, allowing for rapid global travel and prolonged high-speed flight.
- **Suborbital Operations:** Vehicles and flights that ascend beyond Earth's atmosphere or reach just under orbital velocity, enabling brief journeys into space without achieving orbit, often used for research and rapid point-to-point travel.



SOLO

Single Pilot Line Operations

The SOLO project aims to advance research for commercial passenger aircraft operations that propose single-pilot operations, which are planned for the next decade.

ENAIRE will participate in the validation of the concept from the ATC point of view, trying to analyse and evaluate the possible impact of this type of operations on ATC tools and procedures.

Objectives / Expected Benefits:

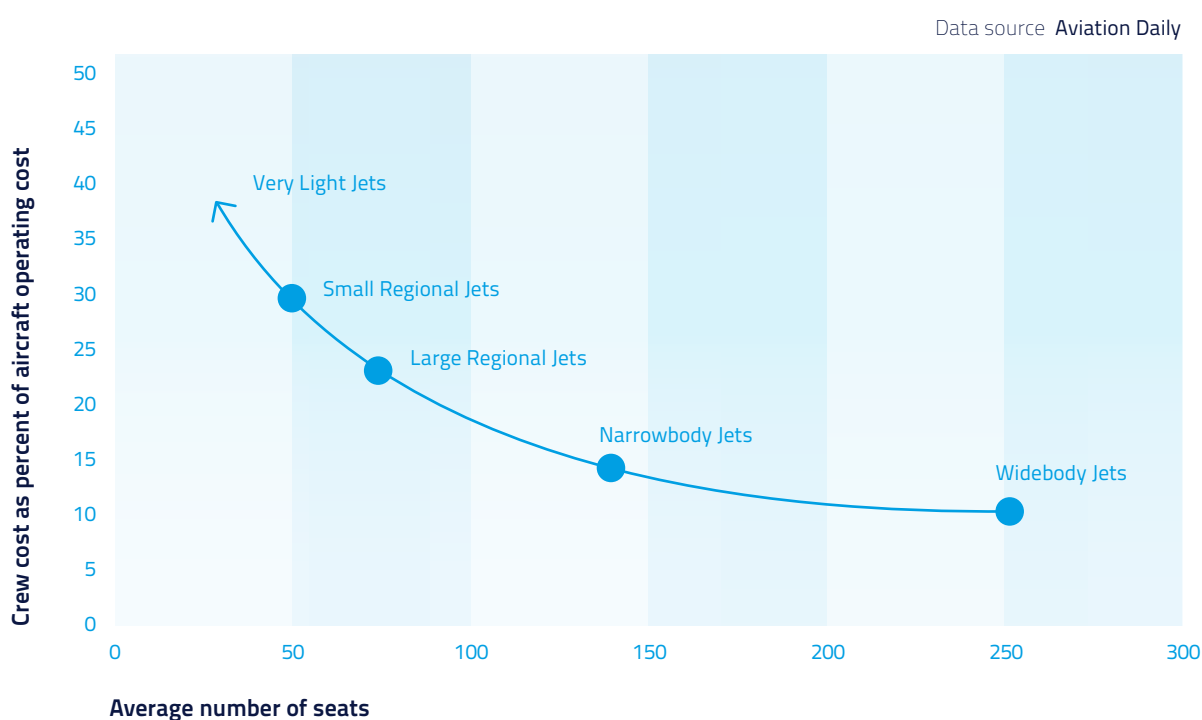
- To feed standardisation and regulatory developments on SPO.
- Introduction of greater levels of automation in the cockpit would therefore allow the pilot to focus on more strategic and safety-critical tasks.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

ENAIRE leads a Real-Time Simulation which connect Cockpit domain to ATC operators of multiple sectors, in order to validate part of the Normal, Abnormal and Emergency Situations.



SPATIO

U-Space Separation

[SPATIO WEB](#)

Management

Project lead by ENAIRE/CRIDA

SPATIO is investigating U-Space services that address separation between unmanned aerial vehicles. In particular, conflict resolution services will be analysed, as well as the relationship between separation and capacity in U-space airspace, such as, for example, the relationship with the dynamic capacity management service.



How will ENAIRE contribute?

ENAIRE is the Project Coordinator and provides its operational and U-Space expertise in the concept definition as well as in the analysis of results.

ENAIRE is the leader of the following deliverables:

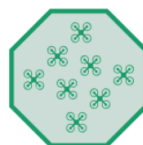
- Solution 1 Validation Plan
- Solution 1 Final SPR-INTEROP/ OSED

ENAIRE is the leader of the validation exercise that covers the Dynamic Capacity Management.

Objectives / Expected Benefits:

- Provides benefits to main users of U-space Service Providers (operators and pilots) in terms of access and equity by using fairness rules, mission efficiency and capacity by optimising the airspace with the SCD (Strategic Conflict Detection) and SCR (Strategic Conflict Resolution) services.
- Benefits citizens and society by balancing the capacity based on environmental and safety aspects with the collision risk, environmental and social impact models developed.
- Considers a multi-U-space Service Provider (USSP) environment, where several concurrent separators operate in uncontrolled airspace, to enhance safety and capacity for a given airspace compared to a U-space airspace where only strategic services are available.

OBJECTIVE 1



Strategic Conflict Resolution service

OBJECTIVE 2



Tactical Conflict Resolution service

OBJECTIVE 3



Classification of U-space airspace

OBJECTIVE 4



Ensuring safe U-space operations

ENSURE

ATM-U-space Interface and Airspace Reconfiguration Service

The ENSURE project aims to perfect and complete the common interface between the ATM, which is responsible for aircraft operations, and the U-Space concept, which does the same with drones or unmanned aircraft. Guaranteeing an interoperable and effective interface between conventional and unmanned traffic and air traffic control is essential to be able to integrate drone operations within the airspace and for both types of operations (aircraft and drones) to coexist in the same system.

In addition to this, the project includes a second solution to develop a dynamic airspace configuration service (that is, being able to modify the configuration of the sectors) that allows maintaining traffic segregation and avoiding proximity between manned and unmanned aircraft within of the airspace designated as U-Space.

Objectives / Expected Benefits:

- Enhance situational awareness of manned and unmanned traffic for both ATM and U-space stakeholders, enabling the safe and efficient integration of manned aircraft and drones within controlled airspace. Define the responsibilities of the Air Traffic Controllers and DAR Managers, accounting for the impact on human performance, to ensure the operations are managed safely and efficiently.



How will ENAIRe contribute?

ENAIRe leads Dynamic Airspace Reconfiguration activities (under Solution 2)

ENAIRe provides its operational and U-Space expertise in the concept definition as well as in the analysis of results.

ENAIRe is the leader of the following deliverables:

- Contextual note for Solution 2
- Validation Report for Solution 2

ENAIRe leads a validation exercise related to Dynamic Airspace Reconfiguration supporting UAM operations. In addition to this, ENAIRe will perform some live trials to prove the concept.



EUREKA

European Key solutions for vertiports and UAM

The EUREKA project aims to allow the accommodation of urban air mobility or Urban Air Mobility (UAM) in all types of airspace but being especially focused on operations at vertiports. The UAM will allow the use of small, highly automated aircraft to transport passengers or cargo in urban and suburban areas, with vertiports being the urban infrastructure for the arrival and departure of these aircraft.



How will ENAIRE contribute?

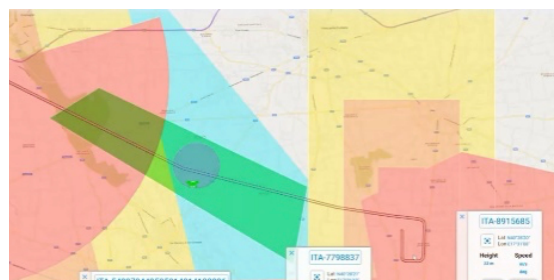
ENAIRE provides its operational and U-Space expertise in the concept definition as well as in the analysis of results. Is the leader of the Validation Plan and Validation Report for Solution 2

ENAIRE is the leader a validation exercise for the vertiport traffic management and a live trial for real eVTOL landing at vertiport in an airport environment.

Objectives / Expected Benefits:

Developing standardisation and regulation recommendations for the following scenarios:

- Arrival/departure to/from vertiports, encompassing route and trajectory planning.
- Vertiport collaborative traffic management, optimising resource utilisation and capacity allocation.
- Vertiport disruption and emergency management, ensuring preparedness for unforeseen circumstances.
- Vertiport Network Flow, Capacity & Operational Management, enabling efficient coordination and operations across the vertiport network.



OperA

Operate Anywhere

This project addresses the joint development and validation of UAM (Urban Air Mobility) technologies and operations necessary in a real European environment. This will assist the market in the necessary technological development, while providing a significant amount of knowledge that will be necessary to ensure a safe introduction of the new UAM vehicles in all types of airspace.

Objectives / Expected Benefits:

- Enable safe and efficient operations in all types of airspace (controlled, uncontrolled and U-space) and conditions by validating 3 different complex IAM - piloted air taxi and unmanned cargo - operations in real-life ATM conditions including contingency and non-nominal situations.
- Stimulate the uptake of new sustainable Innovative Air Mobility services by addressing Air/Ground integration and the critical transition steps from piloted towards automated flights for 5 key autonomy-enabling technologies.
- Ensure environmental sustainability compared to the next best transport alternative, and enhance it, by optimising flight routing for minimum noise footprint and aircraft energy utilisation.
- Accelerate the deployment of IAM (Piloted Air Taxi and Unmanned Cargo) by addressing necessary standardisation, regulation, and roadmaps.



How will ENAIRE contribute?

ENAIRE provides its operational and U-Space expertise in the concept definition as well as in the analysis of results.



IRINA

IFR RPAS Integration

The project aims to validate the integration of RPAS in class A airspace (the most restrictive of all, since only instrument or IFR flights can fly) up to class C (IFR and VFR operations are allowed, although the latter only receive flight information and not control as if the IFR does).

Managing RPAS traffic is challenging for controllers, as RPAS fly much slower than conventional aircraft and suffer latency or even loss of communications with the ground.

In addition to this, precise investigations will also be carried out for the accommodation of RPAS in class D to G airspace, where the role of ATC personnel is increasingly diminishing.

Objectives / Expected Benefits:

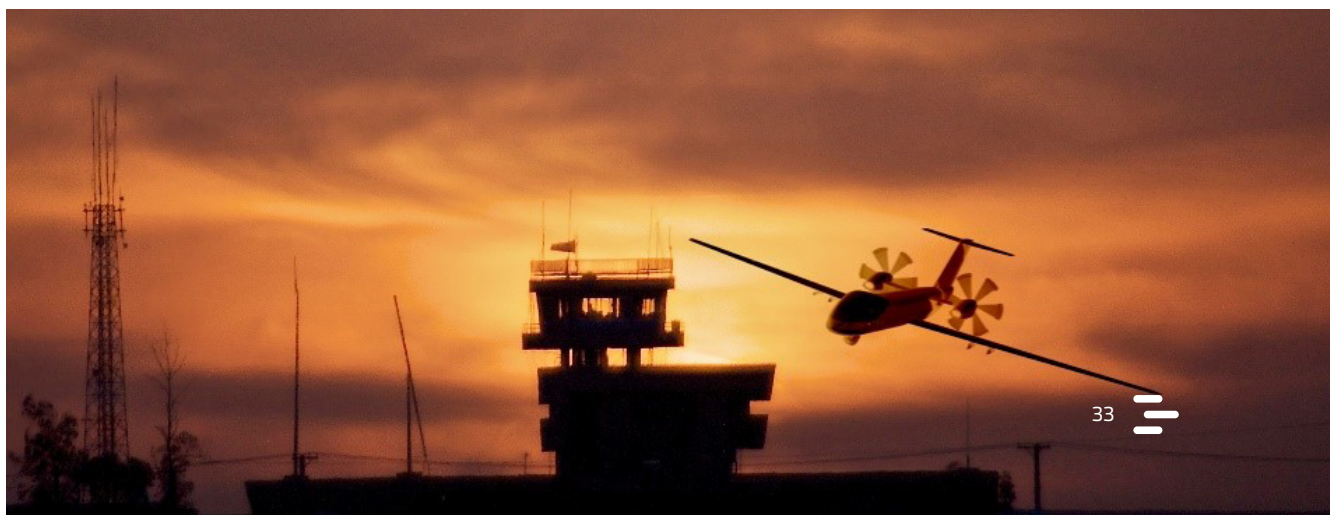
- The IRINA project focuses on the Detect and Avoid function that enables RPAS to avoid collisions, especially when operating in airspace classes where all traffic is not flying under ATC guidance and leverage this technology in a way that enables everyone to safely use the same airspace.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results. Is the leader of the literature review.

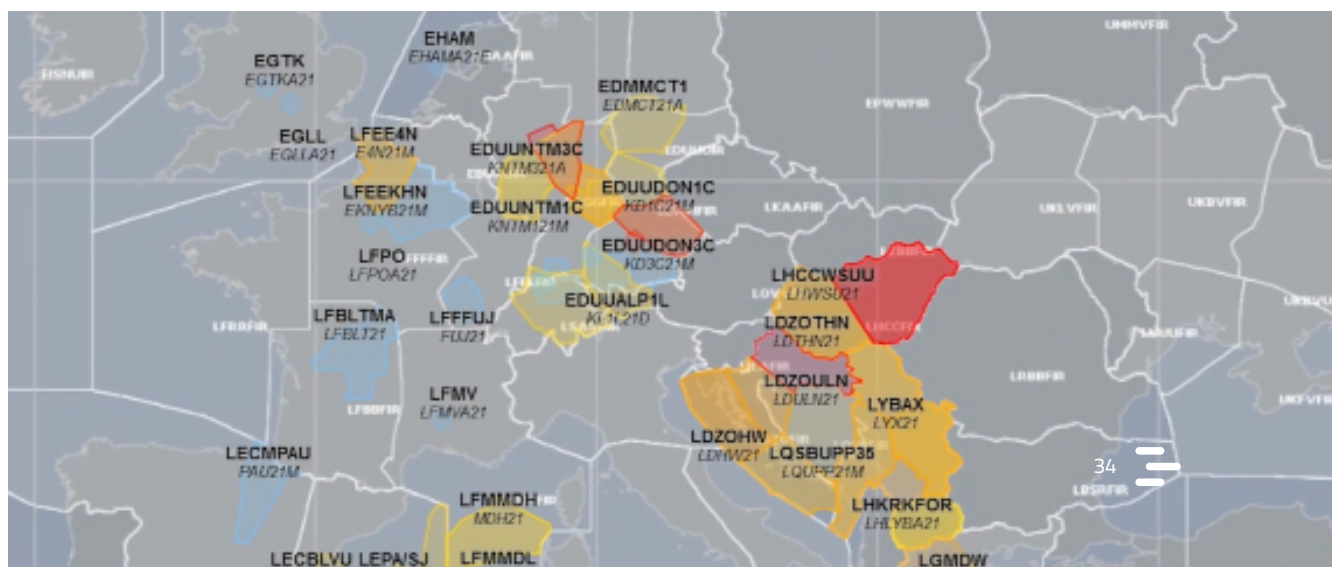
ENAIRE leads a Real-Time Simulation that will cover the adaptation of ground-based safety nets.



Intelligent suite for local and network demand and capacity balance

Objectives / Expected Benefits:

-



ENAIRe leads the Digital Capacity solution. Provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

- Standardisation and Regulation
- Validation Report for Digital Capacity solution
- CBA for Digital Capacity solution
- Contextual Note for Digital Capacity solution

ENAIRe leads a validation exercise for automated Airspace Capacity Assessment and performance enhancement.

HARMONIC

Harmonised network through smart technology and Collaboration

This project completes the development of the Demand and Capacity Balancing (DCB) operating concept in those areas where improvements would make the application of the operating concept more efficient.

DCB processes make it possible to minimise interruptions and optimise operations through powerful and accurate forecasts of air traffic demand, balancing demand with capacity.

Objectives / Expected Benefits:

- **Enhance collaboration and communication:** Promote improved collaboration and communication between local and network-level actors to support the implementation of the new Flow Concept of Operations (CONOPS).
- **Optimise demand-capacity balancing:** Implement solutions to automate demand management processes, optimise capacity utilisation and enable more effective decision-making.
- **Improve dynamic airspace configurations:** Enhance certain aspects of the dynamic airspace configurations concept to better manage airspace capacity. Provide supporting tools to allow humans to work efficiently in a complex and dynamic environment.

- **Validate multi-constraint reconciliation:** Elevate DCB to a new level with tools that allow stakeholders to express their business needs while ensuring correct capacity utilisation.
- **Validate tools for civil-military collaboration:** Test and validate a set of tools designed to improve collaboration between civil and military entities, ensuring flexible and cooperative capacity provision.

How will ENAIRE contribute?



ENAIRE leads the Dynamic Airspace Configuration solution. Provides its operational and ATM expertise in the concept definition as well as in the analysis of results. Is the leader of the following deliverables:

- Standardisation and Regulation
- Validation Plan and Validation Report for Dynamic Airspace Configuration solution
- Technical Specification for Dynamic Airspace Configuration solution

ENAIRE leads several validation exercises to prove the concept of Dynamic Airspace Configuration.



KAIROS

AI-based weather prediction

KAIROS will improve the quality of weather information using artificial intelligence. By producing accurate digital weather forecasts over longer timeframes, aviation stakeholders (ATC, airports, airlines, etc.) will be better positioned to mitigate the impact of weather conditions on their operations.

Operational benefits will be achieved thanks to the integration of real-time meteorological information obtained through Artificial Intelligence with decision-making support tools and platforms.

Objectives / Expected Benefits:

- Apply artificial intelligence algorithms on available forecast and observation weather data to improve the prediction of several weather phenomena impacting aviation (convective weather, high altitude ice clouds, clear air turbulence, and low visibility)

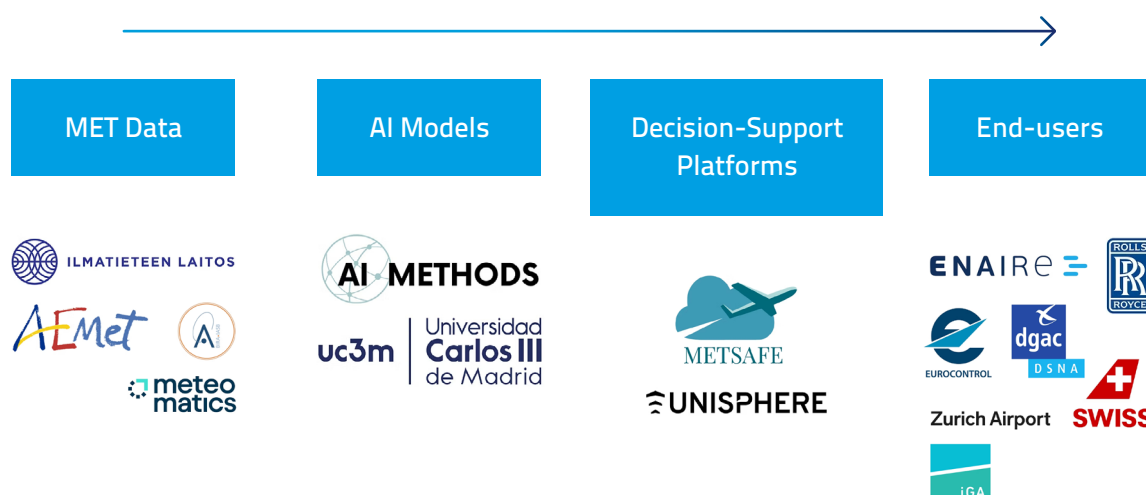
- To assess the potential impact of improved weather information on aviation operations, the AI-based forecast will be integrated with decision support tools and platforms currently used by aviation stakeholders across the airspace system.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

ENAIRE is the leader of the Validation Plan and Validation Report deliverables.





JARVIS

Just a Rather Very Intelligent System

The JARVIS project aims to develop and validate digital assistants based on Artificial Intelligence that support on-board systems, ATC systems and, also, in the airport environment.

From the ATC point of view, it will be focused on increasing the automation of control towers, trying to mainly improve environmental aspects, as well as airspace capacity management.

Objectives / Expected Benefits:

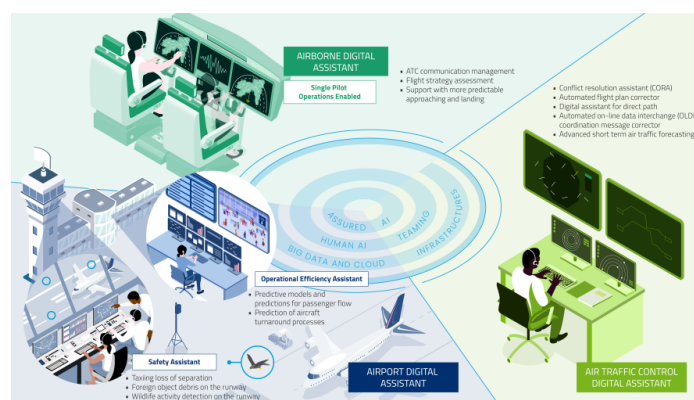
- Aims at developing and validating three ATM solutions: an Airborne Digital Assistant, an Air Traffic Control Digital Assistant, and an Airport Digital Assistant.
- Airborne Digital Assistant directly enables reduced crew and single pilot operations while maintaining or improving current safety levels.
- ATC-Digital Assistant aims at improved human-AI teaming to improve performance, operational efficiency, environment and maintain safety levels.
- AI-enabled Airport Digital Assistant will provide an alert system, helping to take appropriate mitigation actions and achieve a more predictable airport operations plan



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results. ENAIRE leads several validation exercises to prove the following concepts:

- Digital assistant for Direct Path Recommendation
- Automated OLDI Coordination Message Corrector



JARVIS Concept Image



Exploratory Research (ER)

ENAIRe participates in the two ER calls launched:

- In the first ER call (ER1) ENAIRe contributes to the project SMARTS, which started in September and will extend its technical activities until August 2025, having an additional 6 months for dissemination activities.
- The second ER call with ENAIRe contribution is ER2, where ENAIRe participates in four projects: ORCI, SATERA, U-AGREE and CORUS Five. These projects which cover two years from September 2024, finalising in August 2026. As in ER1, these projects will have an additional 6-months period for dissemination activities.





SMARTS

Smart sectors. AI focus for Dynamic configuration of airspace

The main objective of SMARTS is to ensure that the airspace design and configuration process is carried out in the most efficient way possible so that the maximum potential of the airspace can be exploited.

To achieve this goal, the project will take into consideration the characteristics of the environment (at the level of complexity, capacity estimation, sectors...) and the requirements of the actors involved, both at the local level and at the network level.



How will ENAIRE contribute?

ENAIRE provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

[SMARTS METHODOLOGY](#) ↗

Objectives / Expected Benefits:

- Take full advantage of the airspace potential using sectors' shapes that are suited for optimal workload distribution across a configuration, increasing the resiliency of sectors and sector configuration plans.
- Improve the demand capacity balancing using machine learning to enhance traffic prediction at the 8–24-hour range, and to determine/ compute the sectors' configuration providing the required capacity.
- Provide fine-tuned solutions to real-time operation exploring different traffic scenarios, based on traffic predictions constructed from flows.
- Being able to automatically determine the optimum level of airspace usage, measured in terms of capacity, using artificial intelligence techniques.
- Explore the use of machine learning and more in general artificial intelligence for demand capacity balancing, paving the way for its widespread usage.





ORCI

Optimised Runway Centreline Interception

The project will explore innovative AI-based solutions to help increase runway throughput using advanced automation support tools in the TMA domain. Specifically, the objective is to provide key information to controllers in final approach sectors, to support informed decisions on when to issue vectoring instructions to aircraft for optimal spacing between consecutive arrivals during medium, high, very high-density, and increasingly complex TMA airspace operations. The project will work on an AI model to optimise delivery of vectoring instructions, leading to enhanced capacity, efficiency, environmental performance, and overall improvements to arrival air traffic management.

The ORCI research will investigate a new artificial intelligence (AI) based decision support tool (DST) that can help to enhance ATCO performance in the TMA approach phase, even as traffic demand and complexity becomes very high. This will be achieved by providing ATCO with key information (e.g. "what" distance between consecutive arrivals would be achieved at the ILS localiser interception point "if" the ATCO started vectoring instruction phraseology "right now") in support of trajectory management.

Objectives / Expected Benefits:

- The project will develop an AI model that is trained using radar surveillance data and ATC voice communications between pilots and controllers.
- ORCI aims to lower the workload on ATCOs, enabling them to manage traffic more efficiently, and focus on critical decision-making, ultimately contributing to an optimal arrival stream at the airport.



How will ENAIRES contribute?

ENAIRES provides its operational and ATM expertise in the concept definition as well as in the analysis of results.



SATERA

Space-based composite Ads-b and multilateration system validation through scalable simulations

SATERA addresses the concept of a space-based composite ADS-B + E-MLAT system using ADS-B and MLAT receiving stations on board small satellites on low Earth orbits.

SATERA aims to design and validate a GNSS independent ATC surveillance system enabling the definition of integrity parameters for space-based ADS-B data improving the Air Traffic Security and Safety.

SATERA aims to be a key enabler to optimise air operations, mainly for long-haul flights over oceanic or uninhabited areas, allowing the reduction of greenhouse gas emissions, the increase of airspace capacity, safety, and security

Objectives / Expected Benefits:

- SATERA aims to enhance European airspace sovereignty by fostering the provision of critical ATM services by European companies, enhancing the European industrial leadership on the ATC using satellites and boosting the deployment of space-based ADS-B in Europe.



How will ENAIRES contribute?

ENAIRES provides its operational and ATM expertise in the concept definition as well as in the analysis of results.

SATERA OBJECTIVES [➤](#)

SO1

Formulate the concept of operations of a reliable space-based surveillance system to provide composite ADS-B + E-MLAT surveillance from a constellation of small satellites in LEO orbits.

SO2

Develop an integrity estimator for the entire space-based ADS-B system.

SO3

Design and validate receiver system architecture models capable of receiving ADS-B messages and measuring, at least, the following combinations of parameters: TDOA+DFOA, TDOA+AoA, DFOA+AoA and TDOA+AoA+DFOA.

SO4

Develop a communication network architecture integrating the inter satellite link (ISL), the downlink (DL), and the ground subnetworks (GSN).

SO5

Develop and validate a communication network simulator capable of emulating the real-time traffic produced by up to a maximum of 225 aircraft.

U-AGREE

U-space Air and Ground Risk modEls Enhancement

The U-AGREE project aims to develop an integrated risk model for unmanned aircraft systems (UAS) operations, to prevent negative impacts on safety, security, privacy, and the environment. This model is intended to implement the SORA methodology, which is mandated by the EU Regulation for conducting drone operations in the Specific category.

To achieve its objectives, U-AGREE will follow these key steps:

1. Identifying realistic scenarios where UAS operations take place and all potential hazards these operations may pose to safety, security, privacy, and the environment.
2. Assessing metrics and thresholds, in collaboration with relevant stakeholders such as civil aviation authorities and common information service providers, to measure risks associated with identified hazards.
3. Developing mathematical models that connect hazards to their effects, define mitigation barriers and quantify the effectiveness of these barriers in reducing risk.
4. Evaluating the model's applicability and effectiveness by integrating the risk model into the scenarios identified earlier in the project.

This approach ensures that U-AGREE delivers a robust framework for safe, secure, and sustainable UAS operations while supporting compliance with EU regulations.

Objectives / Expected Benefits:

- These models will also reflect the possibility of multi-dimensional harmful effects on safety, security, privacy and the environment posed by drone operations. The U-space services will also be included as risk mitigators.

How will ENAIRE contribute?



ENAIRE provides its operational and U-Space expertise in the concept definition as well as in the analysis of results.



CORUS FIVE

Development of the extended U-space Concept of Operations CORUS V5.0

The project aims to extend the scope of the existing U-space ConOps version 4.0 into extended geographical scope (e.g., above VLL and eVTOL operations in the vicinity of airports, CTR, cities, and low altitude helicopter operations). It will make provision for functionalities and U3/U4 services supporting U-space integration and suggest SESAR Solutions, flight rules and airspace structure as elements of the ConOps.

CORUS five will also raise relevant concerns, such as liability and quality of digital terrain models, common altitude reference systems and issues of convergence between Mean Sea Level (MSL) vs Above Ground Level (AGL) altitude references. The ultimate objective is to publish the fifth edition of the U-space Concept of Operations that supports safe, green and acceptable operations of crewed and uncrewed aircraft.



How will ENAIRe contribute?

ENAIRe provides its operational and U-Space expertise in the concept definition as well as in the analysis of results.

Objectives / Expected Benefits:

- **New type of aircraft (eVTOL)**

A number of companies are developing electrically powered aircraft capable of vertical take-off or landing, referred to as eVTOL.

- **Airspace Management Systems**

Small UAS are difficult to safely mix with manned aircraft. Work is going on to solve this, including in CORUS five, but today the simplest way to have safe operation is to keep small UAS apart from manned aircraft in separate airspaces.

- **Sustainable and Interoperable Operations**

U-space is an enabler for sustainable operations. Many UAS are powered by electricity, leading to a lower carbon footprint as electricity generation becomes less reliant on fossil fuels.

- **New Regulatory Framework**

The CORUS five project will look forward to the next round of regulation which will aim to increase the capacity of U-space while maintaining the same level of safety, security and social acceptance.

[MORE INFO](#) ➤

Transversal Projects



AMPLE3

SESAR 3 ATM Master Planning and Monitoring

This is one of the transversal projects of the DES Programme and allows supporting SESAR 3 JU in the monitoring and reporting of the activities carried out within the programme, both at the industrialisation level and at the implementation level. This monitoring of the progress of the projects also allows for updating the so-called European ATM Master Plan, which functions as a roadmap for the Single Sky.

Objectives / Expected Benefits:

- To bring together contributions from SESAR 2020 members, ensuring the broad ATM representativeness required from air navigation service providers, airports, airborne and ground industry and network manager; all having a keen interest in future ATM evolution.
- To provide content integration services to support the SESAR programme management to deliver a coherent set of SESAR Solutions aligned at content level with the direction and ambitions set by the Strategic Research and Innovation Agenda and the European ATM Master Plan.

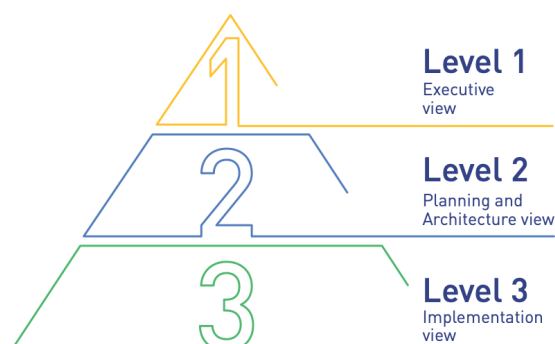


How will ENAIRE contribute?

ENAIRE leads the Optimised Deployment performance impact work package.

ENAIRE provides its ATM expertise as well as its experience in previous ATM Master Plan projects.

European ATM Master Plan Levels



[EUROPEAN ATM MASTER PLAN](#) ↗

PEARL

Performance Estimation, Assessment, Reporting and simulation

Project lead by ENAIRE/CRIDA

This is the second of the programme's transversal projects and is focused on the project performance management process and the analysis of the improvements and benefits that the different projects that are developed in it bring to the programme. To carry out this analysis, it is necessary to map the evaluations of the different R&D&i projects with respect to the roadmap set out at the European level in the European ATM Master Plan.

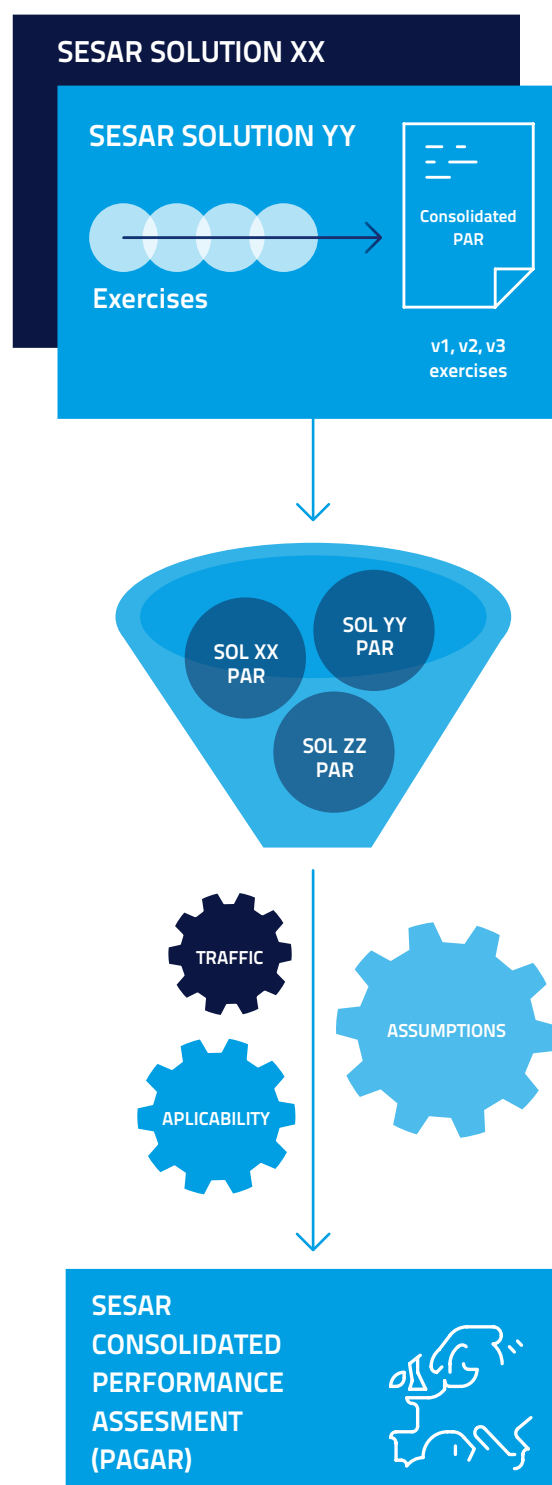
Objectives / Expected Benefits:

- To assess every solution and research outcome and how they contribute to meeting the overall performance ambitions of the European ATM Master Plan.
- To maintain the SESAR Performance Framework and related material, as well as provide support to project maturity gates.



How will ENAIRE contribute?

ENAIRE is the Project Coordinator. Provides its ATM and performance expertise.





Digital European Sky
(SESAR Research and Development)

