

# SESAR INNOVATION PIPELINE

Air traffic management research and innovation

2022 Highlights





## About SESAR 3 JU

The SESAR 3 Joint Undertaking is an institutionalised European partnership between private and public sector partners set up to accelerate through research and innovation the delivery of the Digital European Sky. It is harnessing, developing and accelerating the take-up of the most cutting-edge technological solutions to manage conventional aircraft, drones, air taxis and vehicles flying at higher altitudes.

The SESAR 3 JU partnership brings together the EU, Eurocontrol, and more than 50 organisations covering the entire aviation value chain, from airports, airspace users of all categories, air navigation service providers, drone operators and service providers, the manufacturing industry and scientific community.

The partnership also works closely with the regulatory and standardisation bodies, notably EASA and Eurocae, as well as key stakeholders, such professional staff organisations, the space and military communities and global partners.

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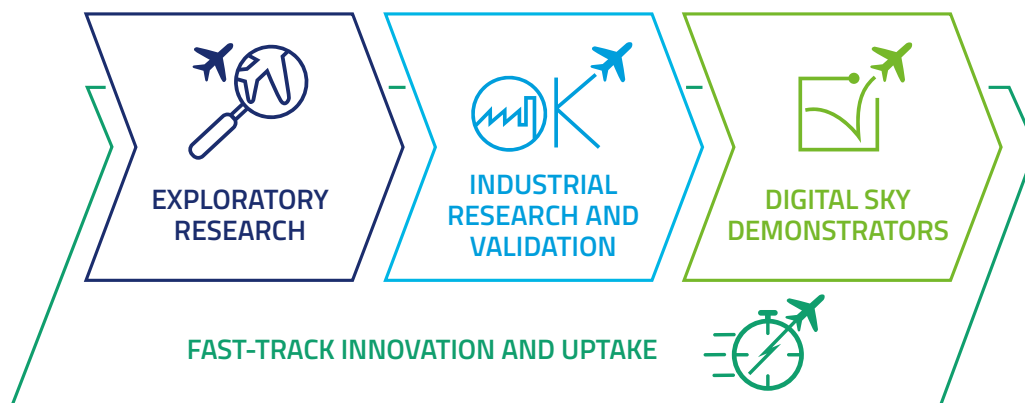
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## About the SESAR Innovation Pipeline

The Digital European Sky leverages the latest digital technologies (“SESAR Solutions”) to increase the levels of automation, cyber-secure data sharing and connectivity in air traffic management, as well as to enable the virtualisation of its infrastructure and air traffic service provision in all types of airspace, including for very-low and high-altitude operations. In doing so, these technologies enable the system to become more scalable and agile, while building resilience to disruptions, changes in traffic demand and diversity of air vehicles. These attributes are all key to future proofing the system in a smart and sustainable way.

To deliver the Digital European Sky, the SESAR research and innovation programme is designed as an innovation pipeline, made up of exploratory research, industrial research and validation, fast-track innovation and uptake, and very large-scale demonstrations/demonstrators, where ideas are transformed into tangible solutions.

The research takes place in over 50 test beds across Europe (simulation platforms, on-board commercial flights, dedicated airport testbeds and air traffic control centres), which validate concepts and candidate solutions. The testing is not limited to a specific location, but can be used to test multiple environments irrespective of the location where the physical validation is held.

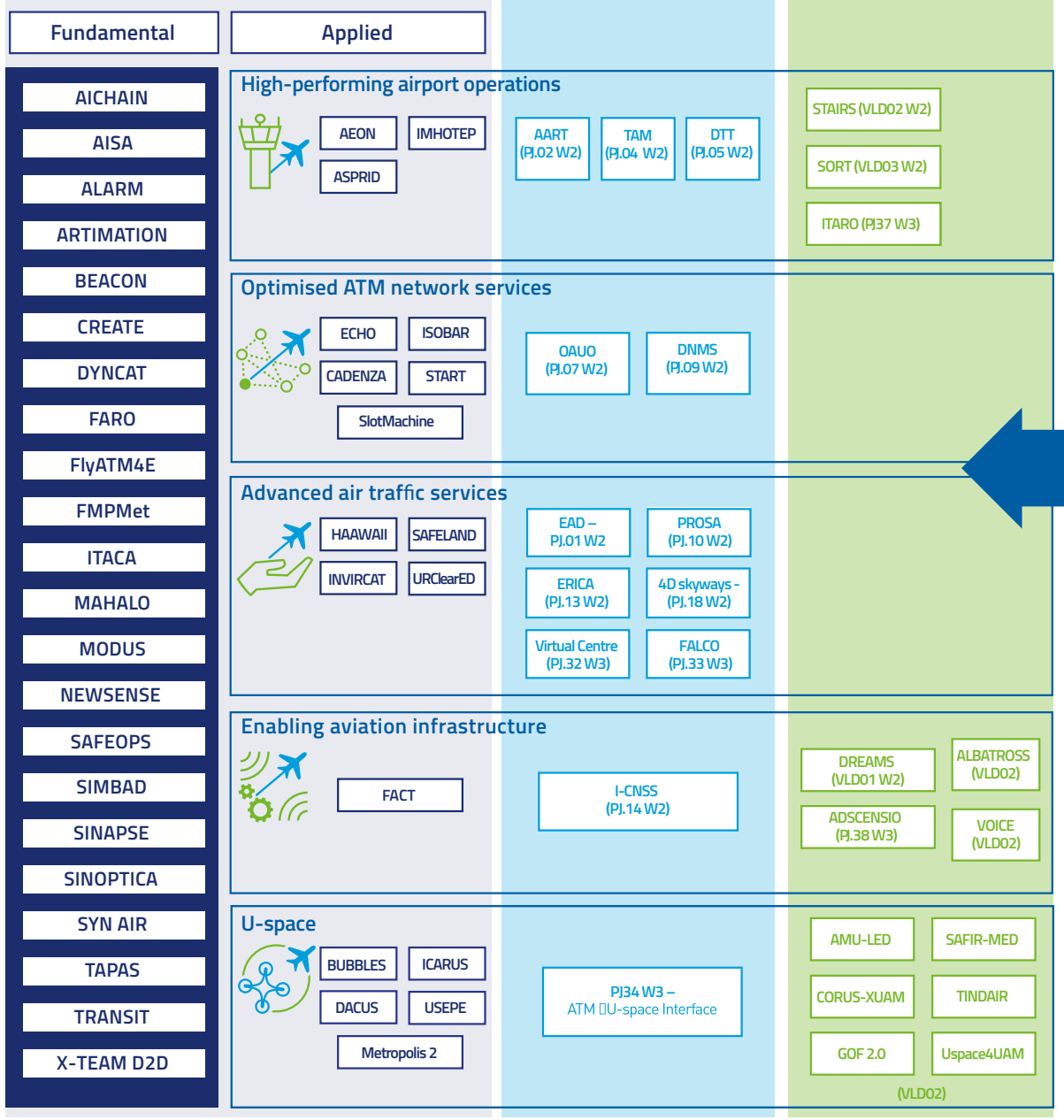


## Snapshot of SESAR 2020 project portfolio

In 2022, the research and innovation programme was composed of 70 projects developing concepts solutions in the areas of high-performing airport operations, optimised network operations; advanced air traffic services, enabling infrastructure and U-space. A total of 45 projects completed their activities by the end of year, mainly in the area of exploratory research (see pages 10-25 for more details) and

U-space (see pages 46-52 for more details). Further work continued on the remaining industrial research projects, delivering a new series of solutions ready for industrialisation (see pages 25-38 for more details), while demonstrations continued to showcase the benefits of these solutions when rolled out at scale (see pages 39-45 for more details).

# SESAR 2020 at a glance



**Transversal activities**

- Engage knowledge transfer network
- NOSTROMO
- Master Plan – Pj20
- Content integration – Pj19

Timeframe  
1 January - 31 December 2022\*

\* The following projects closed at the end of 2022: Engage; VLD1-W2 DREAMS; VLD2-W2 STAIRS; HAAWAI; FMPMet; USEPE; SlotMachine; SAFELAND; CREATE; X-TEAM D2D; Modus; IMHOTEP; FlyATM4E; ALARM; ISOBAR; SINAPSE; ASPRID; TAPAS; SINOPTICA; URClearED; NOSTROMO; FARO; AISA; AEON; SafeOPS; Metropolis 2; MAHALO; BEACON; START; BUBBLES; TRANSIT; INVIRCAT; CADENZA; ITACA; DYNCAT; DACUS; NewSense; SYN AIR; AICHAIN; ARTIMATION; SIMBAD; ICARUS; FACT; U-space4UAM; TINDAIR; GOF2.0

## Ready to deliver!



**On 5 May, the SESAR 3 JU gathered in Brussels its founding members, staff, as well as representatives from the European institutions and key stakeholders to mark the launch of the new partnership. Although officially established in December 2021, this was the first occasion for all 55 organisations making up the partnership, including the EU (represented by the Commission) and Eurocontrol, to come together in person. The gathering was a moment to connect and reflect upon the ambitious goal of making Europe's aviation infrastructure fit for the digital age, while offering quick wins to contribute towards the sector's net zero ambitions.**

Addressing the event by video link, Karima Delli, Member of the European Parliament and Chair of its Committee on Transport and Tourism said: *"The transport sector, and aviation in particular, faces enormous challenges in meeting the imperative to achieve a net-zero carbon future and the fit for 55 goals. We need to drastically speed up efforts to make aviation sustainable and SESAR 3 Joint Undertaking, with its leading role in research development and air transport management, will play a prominent part in finding the right solutions to decarbonise the aviation sector."*

The new partnership comes at a crucial moment for the aviation sector, noted Henrik Hololei, Director General for Mobility and Transport, European Commission: *"As the sector recovers from the impact of the pandemic, the imperative to accelerate its transition to a sustainable and digital future is stronger than ever. The renewed and enlarged SESAR 3 JU partnership, which brings on board many new partners, will have a central role in bringing to market the technologies and innovative solutions that will reduce emissions, improve safety, enhance Europe's global competitiveness, and make the Digital European Sky a reality!"*

Rosalinde van der Vlies, Director of the Clean Planet Directorate, Directorate-General for Research and Innovation, said: *"The partnership's multiannual work programme seeks to deliver the technological solutions needed to achieve the modernisation and digitalisation of air traffic management (ATM) in Europe and to achieve the Single European Sky. In collaboration with the complementary initiatives of Clean Aviation, Clean Hydrogen and BATT4EU Horizon Europe partnerships, the European Commission is paving the way to a climate-neutral air transportation system delivering on the European Green Deal objectives."*

## Andreas Boschen begins mandate as SESAR 3 JU Executive Director



On 1 July, Andreas Boschen officially started his mandate as Executive Director of the SESAR 3 JU. During his time at the European Commission, Boschen has been actively shaping policy and following legislation on aviation, more specifically the Single European Sky, developing implementing rules, managing the Single Sky committee and coordinating relations with Eurocontrol and third countries.

Over the last eight years, he has been managing EU financial support to the deployment of SESAR solutions via the Connecting Europe Facility. This combined knowledge of policy, regulation and sector priorities, as well as programme and project implementation, will be key as the partnership seeks to accelerate between now and 2030 the delivery of an inclusive, resilient and sustainable Digital European Sky.

*“We need to provide solutions to make air traffic management in Europe environmentally sustainable and fit for the future. This is the vision of the Digital European Sky; I look forward to working with our members and partners to making it a reality,”* said Boschen.

## New States’ Representatives Group to maximise impact of SESAR research and innovation

**The need for coordination with Member States to is the rationale behind the establishment of the SESAR 3 JU States’ Representatives Group, which aims to capture synergies between European and national-level initiatives to accelerate the roll-out of the Digital European Sky vision.**

Meeting for the first time in February, the SESAR 3 JU States Representatives Group is composed of EU Member States and associated countries to Horizon Europe represented by national ministries or authorities responsible for innovation and/or aviation in their respective States. Chaired by Anne-Marie Ragnarsson, Swedish Transport Agency, the Group will have an advisory role, providing opinions, recommendations or proposals to the SESAR 3 JU Governing Board on the strategic orientation of the JU, as well its progress towards and compliance with the objectives and targets set out in the partnership’s work programme.

Meeting at least twice a year, the Group will also aim to ensure strong links are maintained between the JU’s activities, national programmes addressing science and transport, Horizon Europe and relevant policy initiatives, such as the Single European Sky.

Speaking on the occasion of the first meeting of the Group, Ms Ragnarsson said: *“With the establishment of the States’ Representative Group, Member States now have a seat at the SESAR research and innovation table, allowing them to become more engaged and take an active part in the SESAR 3 JU’s priorities, planning and activities. I also see great promise with the SESAR 3 JU becoming more deployment-oriented, which will of course require bringing innovators closer together with regulators – something which the Group will help facilitate.”*

[www.sesarju.eu/governance](http://www.sesarju.eu/governance)

## Digital European Sky programme gets started

### SESAR 3 JU multi-annual work programme published



In March, the SESAR 3 JU published its multi-annual work programme, covering the research and activities foreseen between now and 2031. Adopted by the SESAR 3 JU Governing Board, the work programme provides a comprehensive view of the policy context for the innovation programme, as well as activities needed to deliver the Digital European Sky, according to the timeframe of the European ATM Master Plan.

[www.sesarju.eu/publications](http://www.sesarju.eu/publications)

### Call launched under Horizon Europe

In April, the SESAR 3 JU published two open calls addressing exploratory research, industrial projects, and activities to fast track innovative solutions within the framework of its Digital European Sky research and innovation programme. The calls cover a wide range of topics aimed at making air traffic management in Europe smarter and more sustainable.

The selected call topics are part of the research and innovation priorities outlined in the SESAR 3 JU's multi-annual work programme and in the more recently published bi-annual work programme. They cover a wide range of areas that are needed in order to deliver the Digital European Sky, according to the timeframe of the European ATM Master Plan.

The exploratory research call (HORIZON-SESAR-2022-DES-ER-01) aims at fostering new and innovative ideas to transform air traffic management in Europe, as well as encouraging coordinated exchange of knowledge

and stimulating the future ATM skilled workforce. It is composed of three work areas, namely "fundamental science and outreach", "application-oriented research" and "knowledge transfer network".










The industrial research call (HORIZON-SESAR-2022-DES-IR-01) is composed of six work areas, addressing ATM Master planning and performance management, emissions reduction, automation, domain airspace management, artificial intelligence, among others. Novel activities are also sought to fast-track innovation and uptake of solutions addressing U-space (integration of drones, urban air mobility, multimodality and the aviation green deal).

### Calls under Connecting Europe Facility

In September, the European Climate, Infrastructure and Environment Executive Agency (CINEA) launched a second call under the Connecting Europe Facility, containing provisions for a series of SESAR JU Digital European Sky Demonstrators in the areas of automation and virtualisation. The demonstrators, when selected, are expected to be launched in 2023 and to run until 2026. See page 44 for more details.

In November, five new Digital Sky Demonstrators officially kicked off. With combined funding to the tune of EUR 45 million from the Connecting Europe Facility between now and 2025, the selected projects aim to accelerate the market uptake of SESAR Solutions for greener aviation and urban air mobility. See pages 41-43 for more details.



Digital European Sky at a glance					
FLAGSHPIS	EXPLORATORY RESEARCH	INDUSTRIAL RESEARCH AND VALIDATION	FAST TRACK INNOVATION AND UPTAKE	DIGITAL SKY DEMONSTRATORS	
 Connected and automated ATM	Fundamental ASTAIR HYPERSOLVER	Applications-oriented CODA SMARTS	FCDI MIAR FCA	Call topic (September 2022) CEF-T-2022-SIMOBGEN-SESAR-DSDA-WORKS	
 Air-ground integration and autonomy		SOLO NETWORK TBO	ECHO 2 IRINA		
 Capacity-on-demand and dynamic airspace	HUCAN	ISLAND	IFAV3 FASTNet KAIROS		
 U-space and urban air mobility	ImAFUSA MUSE	AI4HyDrop	EUREKA ENSURE SAFIR-Ready	OperA SPATIO	U-ELCOMÉ BURDI EALU-AER
 Virtualisation and cyber-secure data sharing	SEC-AIRSPACE		VITACY CNS DSP	Call topic (September 2022) CEF-T-2022-SIMOBGEN-SESAR-DSDA-WORKS	
 Multimodality and passenger experience	MAIA	MultiModX	SIGN-AIR		
 Aviation green deal	AEROPLANE E-CONTRAIL	Green-GEAR	CICONIA CONCERTO GEESE	DYN-MARS GALAAD	ECHOES HERON
 Artificial Intelligence for aviation	SynthAIR TRUSTY	ASTRA	JARVIS	DARWIN	
 Civil/military interoperability and coordination		MITRANO	HARMONIC		
Knowledge transfer	Engage 2	Transversal	AMPLE3	PEARL	

NOTE: It should be noted that the projects listed for exploratory research, industrial research and fast-track to innovation and market uptake were announced in February 2023 as a result of a call launched in 2022.



## London City Airport wins 2022 SESAR 3 JU-ACI Europe Digital Transformation Award



In June, London City Airport received the SESAR JU-ACI Europe Digital Transformation Award. The airport was recognised at the 18th Annual ACI EUROPE Best Airport Awards during the 32nd ACI EUROPE Annual Congress & Assembly, which took place in Rome on 23 June.

London City is the third airport to be awarded the prize, which celebrates airports that have successfully embraced digitalisation, adopting innovative technologies and procedures to improve the safety, capacity, efficiency and environmental footprint of its airside operations.

The judges recognised London City as a pioneer for deploying digital remote tower, a SESAR solution. In 2021, the airport became the first international airport in the world to be fully controlled by a remote digital air traffic control (ATC) tower. Implemented by NATS and Saab, in collaboration with the UK's CAA, airlines and local communities, the 50-metre tower enables traffic to be managed by controllers 115 kms away at NATS' air traffic control centre in Swanwick, Hampshire using an 'enhanced reality' view supplied by the tower. Moving from a traditional visual control room to a remote ATC centre also gave London City Airport multiple benefits in safety, resilience, security and cost efficiency.

More about remote towers: [www.sesarju.eu/projects/DTT](http://www.sesarju.eu/projects/DTT)

## Droniq wins 'Future Skies' award at European Startup Prize for Mobility ceremony

In May, Droniq received the 'Future Skies' special award during a ceremony of the European Startup Prize for Mobility (EUSP) in Paris, organised under the auspices of the French Presidency of the EU. The company was recognised for its innovative work on integrating unmanned air systems (UAS) into European airspace. The 'Future Skies' prize recognised Droniq for generating creative solutions for smarter and more sustainable flying.

The EUSP is an EU-funded acceleration and investment Programme for sustainable mobility startups. It was created in 2017 by Karima Delli, Chairwoman of the European Parliament's Committee on Transport and Tourism. Established in collaboration with the European Parliament, European Commission, European Investment Bank, EIT InnoEnergy, GSA, SESAR 3 JU, Europe's Rail and together with major mobility corporations and tech giants, this public-private initiative aims to support and scale up smart and sustainable mobility startups all across Europe.

## Myriad of SESAR 3 JU innovations on show at World ATM Congress 2022



Close to 8,000 delegates gathered at the airspace management industry's annual global meeting in Madrid from 21-22 June for World ATM Congress 2022 where SESAR 3 JU participated in the Europe for Aviation stand and theatre. SESAR 3 JU experts led industry panels addressing performance improvements and showcased research and innovation aimed at delivering the Digital European Sky.

## SESAR 3 JU annual conference: making Europe's airspace fit for the digital age

In October, industry leaders gathered alongside EU policy makers to discuss the aviation sector's digitalisation efforts at the first annual conference of the SESAR 3 JU. Held in Brussels, the conference featured panel discussions on the digitalisation of Europe's aviation sector – alongside the Digital European Sky Marketplace showcasing some of the latest SESAR innovations.

The urgency to address climate change was a running theme throughout the day. "Citizens want mobility, and for that we need aviation... but people also want to fly in a green spirit, so they want to limit their impact on the environment," said Andreas Boschen, Executive Director at SESAR 3 JU. "I think we are on track [delivering solutions], but external disruptions will make it more challenging."

These disruptions mean that we need to do more to make sure that the [ATM] framework is more resilient and flexible, more adaptable to all of these uncertainties, said Rachel Smit, a member of Transport Commissioner Adina Vălean's cabinet.

Digitalisation of the aviation ecosystem was discussed in a second morning panel, where speakers stressed the opportunity to boost ATM's performance and unlock the potential to reduce the sector's CO<sub>2</sub> emissions.

Air traffic controllers are enablers for getting solutions deployed quicker into a workable future operational environment. We should ensure their involvement at all stages of innovation and implementation. This was the key message from Marc



Baumgartner representing the International Federation of Air Traffic Controllers' Associations (IFATCA).

Industry players reiterated the added-value of the SESAR 3 JU. If we only manage to achieve the SESAR flagship programmes for a digital sky that would already "be magic", according to Dirk Hoke, Chief Executive Officer at Volocopter – a new member of the SESAR 3 JU, but which has been active in recent years in several large-scale demonstrations. If we can implement and accelerate these projects, he added, "My wish-list is covered!"

A standards and regulatory framework conducive to digital transformation was explored by speakers in the final panel discussion. There was common agreement for the need to embed standards and regulatory work much earlier within the innovation lifecycle, something which the SESAR 3 JU will seek to do.



## SESAR 3 JU and EUROCONTROL reinforce collaboration

**In December, the SESAR 3 JU and founding member, EUROCONTROL, signed an administrative agreement setting out EUROCONTROL's renewed role in and commitment to the partnership and the Digital European Sky research and innovation programme. The agreement was signed by Andreas Boschen, Executive Director of the SESAR 3 JU and Eamonn Brennan, Director General, EUROCONTROL, on the occasion of the SESAR 3 JU's Governing Board.**

As founding member of the SESAR 3 JU, EUROCONTROL has supported SESAR research and innovation since 2007, playing a leading role in developing and delivering new or improved technologies and procedures to make European air traffic management smarter and more sustainable. With the establishment of the SESAR 3 JU in November 2021, EUROCONTROL expects to commit up to EUR 500 million in in-kind contributions and additional activities, as well as providing programmatic, administrative and back-office support, including the provision of office space for the partnership's headquarters in Brussels.

Specifically, the agreement reflects the obligations set out in the European Council Regulation (Article 157 and Article 158) establishing the SESAR 3 JU. It states that EUROCONTROL will carry out development and validation activities in support of the SESAR 3 JU work programme, as well as provide advice

on European ATM developments, in particular on the future airspace architecture. The agreement also has provisions for programme management support, in addition to back-office arrangements covering information technology, communications and logistics support. This includes the provision of office space for the headquarters of SESAR 3 JU in Brussels. Both parties also signed an administrative arrangement on data protection with the temporary approval by the European Data Protection Supervisor.

*"We are delighted to have the renewed commitment and support of EUROCONTROL for the SESAR 3 JU partnership and our research and innovation work programme. We look forward to working closely with EUROCONTROL in collaboration with other founding members and partners in order to deliver an inclusive, resilient and sustainable Digital European Sky,"* said Andreas Boschen, Executive Director, SESAR 3 Joint Undertaking.

*"It gives me great pleasure to inaugurate the brand new offices of SESAR 3 JU at our premises as part of the agreements we signed today. These reconfirm our commitment to the SESAR programme, and express our full support to research and innovation activities in Europe. Our cooperation is a hugely important step forwards towards delivering sustainable, innovative and digital solutions. Bringing all the key actors in the aviation value chain together, under one roof, for the benefit of European aviation is a core goal of EUROCONTROL and in that regard we're proud to host the SESAR 3 JU at our Brussels HQ,"* said Eamonn Brennan, Director General of EUROCONTROL

## SESAR 3 JU joins Alliance for Zero-Emission Aviation



**In December, the SESAR 3 JU joined the European Commission's Alliance for Zero-Emission Aviation.**

Launched in June 2022 by European Commissioner Thierry Breton, the Alliance aims to prepare the aviation ecosystem for the entry into service of hydrogen- and electric-powered aircraft, to ensure that air transport contributes to Europe's 2050 climate neutrality objective.

The SESAR JU joins organisations from across the aviation community, from aircraft manufacturers, airlines, airports, energy companies, fuel providers, standardisation and certification agencies, passenger and environmental interest groups and regulators. Together they aim to examine the current challenges facing the entry-into-service of these aircraft.

In particular, the members of the Alliance will focus on issues such as the fuel and infrastructure requirements of hydrogen and electric aircraft at airports, standardisation and certification, and the implications for airlines and air traffic management.



# SESAR EXPLORATORY RESEARCH

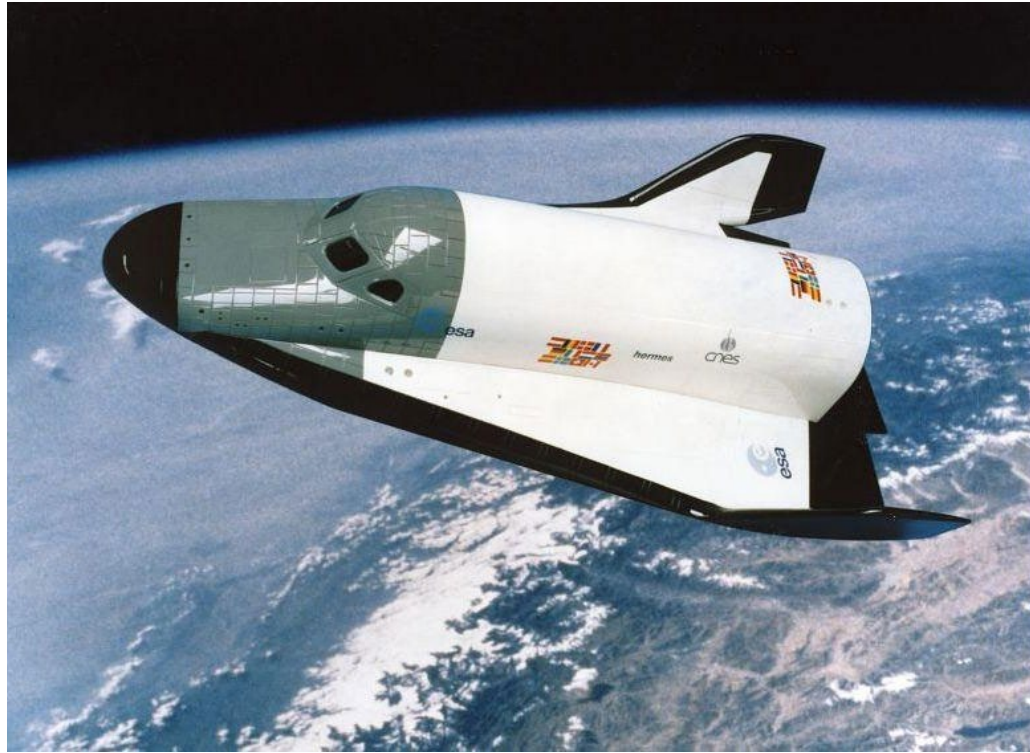
## Exploring the boundaries of ATM research

### Making space for new high altitude entrants

**A growing number of vehicles use higher airspace – the region between the airspace normally used by aircraft and the beginning of space – to deliver a range of commercial services including surveillance, broadband connectivity, supersonic and hypersonic travel, trans-atmospheric and suborbital vehicles, and military users. The mix of uncrewed, piloted, fast and slow-movers requires a robust operational framework to ensure safe operations.**

The ECHO project carried out a comprehensive demand analysis and developed a basic concept of operations (ConOps) for higher airspace to enable safe, efficient and scalable operations above the flight levels where conventional air traffic operates. The ConOps helps to identify future infrastructure needs and will allow business values in the order of billions per year to take shape. Particular attention must be given to scarce resources already managed in a cooperative manner. The ECHO project is instrumental in developing a global performance-based framework for higher airspace, and unleashing the great potential of this new frontier for flight. (e.g. frequencies, transponder codes), as well as elements that are necessary for safety reasons (e.g. capabilities to monitor and mishap debris) and necessary capabilities for communications, navigation and surveillance.

As demand is expected to evolve over time, the ConOps addresses short-, medium- and long-term time frames; importantly addressing today's



operations as well as of vehicles and activities still to be developed. The project also paves the way for the economic development of innovative and commercial concepts using the higher airspace environment including system wide information management and trajectory-based operations.

The ConOps provides the foundation for the development of a higher airspace regulatory framework by the European Union Aviation Safety Agency (EASA) and continued research into industry requirements. It represents a significant step forward towards achieving international approvals and opening up a burgeoning sector across Europe.

<https://higherairspace.eu/>

*This project received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 892928.*

## A new dawn for weather-resilient air traffic management

Bad weather can play havoc with the best-laid plans. This is especially true in air traffic management, where poor meteorological conditions are the cause of an estimated 20 % of all traffic delays in Europe. Performing better during adverse weather relies on timely and accurate forecasts, which is easier said than done given how quickly the conditions can evolve. Closing the gap on the uncertainty brought about by weather has been a focus of a number of SESAR research and innovation projects over the last two years.

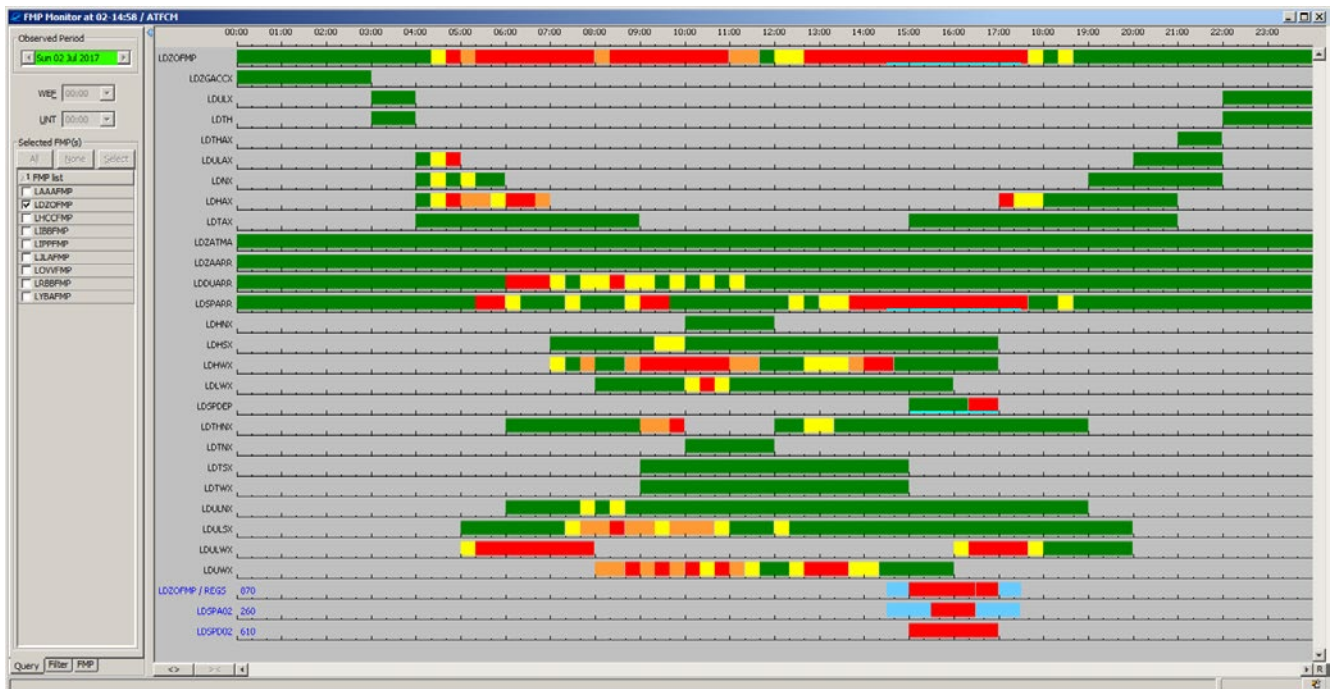
## Integrating meteorological uncertainty into flow management

Delays come about because bad weather makes air traffic difficult to predict and complex to manage, resulting in reduced airspace capacity. *“It is quite challenging, mainly because forecasting adverse weather is very difficult, even for short lead times. Furthermore, the accuracy of the weather prediction rapidly degrades with the forecasting horizon. Quantifying the weather forecast uncertainty is the main difficulty, and its analysis requires a probabilistic approach,”* explains Alfonso Valenzuela, one of the principal researchers in the SESAR project, FMP-MET.

The project looked at how to best integrate MET forecast uncertainty information into the decision-making process for flow management positions (FMP), an operational position that monitors the level of traffic in airspace sectors and coordinates flow measures when an excess of demand over capacity is detected. The research team developed a probabilistic methodology to forecast traffic congestion and traffic complexity

to be used in conjunction with the tools currently employed by FMPs. An innovative feature of the FMP-Met tool is its ability to provide the FMP with an intuitive and interpretable probabilistic assessment of the impact of convective weather on the traffic, up to 8 hours in advance, to allow better-informed decision making. The next steps in this research should lead to the development of a prototype tool, in close collaboration with FMPs, implementing the FMP-Met concept.

Of course, predicting the weather is an important part of network forecasting and performance. The ISOBAR project prototyped a storm forecaster tailored to air traffic management and a user-driven mitigation plan that takes into account flow constraints and network effects. The set of weather management boosters includes a neural network that integrates convective prediction into a structured airspace map, together with a set of AI modules, such as AI-based hotspot detection and adaptive mitigation measures, to support decision-making by the human operator. The project also developed an operational and technical



roadmap for the integration of ancillaries into the Network Manager platform by defining interfaces, and functional and performance requirements.

*"The project results are expected to improve convective weather forecasts, anticipate the detection of demand - capacity imbalances in the network and provide optimal mitigation solutions. This means better situational awareness of the operating environment, which at end of the day, means better decision-making and performance all around,"* says Marta Sánchez Cidoncha, ISOBAR project coordinator.

FMP-MET: <https://fmp-met.com>

ISOBAR: <https://isobar-project.eu/>

## Sounding the alarm on natural hazards

**Bad weather is not just a nuisance for air traffic, it can also be hazardous. "Serious damage can be caused to aircraft if smoke, dust or even sea salt are ingested by engines, due to both the erosion and corrosion they cause, and possible obstructions, or because they affect in-flight combustion,"** explains Manuel Soler, ALARM project

**coordinator. "Volcanic ash and gases, such as sulphur dioxide, are also important hazards, causing abrasions to windscreens, corrosion to engines, and different damage to aircraft systems and instruments, while electromagnetic radiation from the sun can interfere with aircraft communication systems,"** he adds.

The ALARM project developed a system that monitors and gives early warnings about natural events that pose a risk to aviation, but also considers the environmental impact of these events as a further hazard. The early warning system prototype can be integrated into ATM systems as an application programming interface (API) providing nowcasting (up to 2 hours) and short-term forecasting (up to 6 hours) of SO2 plumes at a regional scale and of severe thunderstorms at a local scale (airport). It also provides forecasting and medium-term forecasting (up to 48 hours) of climatic hotspots at a European scale. The requirements of all these products have been included in the system-wide information management (SWIM) yellow profile to facilitate data exchange.

ALARM: <https://alarm-project.eu/>

## Managing bad weather around airports



**Today, especially at larger airports, controllers use air traffic control support systems to help them organise and guide arriving and departing traffic. However, these systems do not yet have the capability to use weather measurements or forecasts to calculate flight routes around, for example, thunderstorms. "If extreme weather areas occur, the pilots decide on which side and at what distance they will fly around them. Controllers then have to calculate manually separation infringements with other aircraft,"** explains Antonio Parodi, coordinator of the SINOPTICA project.

The project developed a module for an extended arrival manager (Extended AMAN) system that uses current weather information and forecasts to plan the approaching traffic around the developing weather at an early stage. It is integrated directly into the working position of approach controllers and works seamlessly with existing systems. In case a severe weather area blocks the route, the AMAN calculates new approach routes around the dangerous areas with new arrival times and new positions in the landing sequence. The controllers responsible get advisories where and for how long the aircraft have to leave the standard approach routes and at which target times they will be at the main



waypoints of the route. Additionally, the systems allow controllers to visualise the predicted and animated severe weather areas.

SINOPTICA: <http://sinoptica-project.eu/>

## Climate impact and weather

Weather and climate change are inextricably linked, which is what prompted the CREATE project to assess the impact of ATM operations on the climate, while also improving resilience to weather phenomena in a changing climate. "The changing global climate increases the future severity and frequency of disruptive weather phenomena. This deteriorates the reliability of ATM network planning and increases potentially the delays within air traffic operations," says Angelo Ricco, CREATE project coordinator.

The project developed a climate and weather-aware concept of operations (ConOps) encompassing a multi-aircraft

four-dimensional (in space and time) trajectory optimisation framework. It also built an environmental scoring module (ESM) to evaluate the "greenness" of aircraft trajectories. This considers CO<sub>2</sub>, non-CO<sub>2</sub> emissions and contrail probability formation during the en-route phase of flight, in addition to NO<sub>x</sub> and particulate matter emissions (related to the impact on air quality) during the approach and departure phase. The algorithmic approach is fast enough to be easily implemented at different stages of the trajectory lifecycle; for example helping to resolve hotspots in the network due to weather hazards, or air quality sensitive regions, taking into account evolving traffic.

Non-CO<sub>2</sub> emissions are also assessed in the FlyATM4E project; the climate impact of such emissions is strongly dependent on weather and varies considerably according to atmospheric conditions, such as air temperature and altitude. "Non-CO<sub>2</sub> effects, such as contrail cirrus clouds (ice crystals that form behind an

aircraft) and NO<sub>x</sub>-induced changes of ozone and methane, upset the radiative balance of the atmosphere. They can cause both warming and cooling effects and, unlike CO<sub>2</sub>, do not follow a linear pattern but contribute to both positive and negative effective radiative forcing (ERF)," explains Sigrun Matthes, coordinator of the FlyATM4E project. The project modelled these climate impact metrics in multiple environments with a focus on intra-European flights, and explored the feasibility of a concept for aircraft avoiding the more sensitive areas, otherwise known as "big hits". Their modelling found that in most cases it should be possible to apply effective re-routing strategies to support eco-efficient routes and climate-optimised aircraft trajectories.

CREATE: <https://create-project.eu/>

FlyATM4E: <https://flyatm4e.eu/>

Discover the full portfolio of projects addressing meteorology: <https://www.sesarju.eu>



## Safe landings

**Advances in automation technology could mean that one day only one pilot is needed in the cockpit of commercial aircraft. SAFELAND investigated the feasibility of this move to single-pilot operations and what needs to be done to ensure the safety of such operations.**

**What are single pilot operations and are these already a reality?**

Under current EU regulations, at least two pilots must be present within the cockpit of commercial flights. But new advances in technologies open up the possibility to certify single pilot operations (SPO), either for certain portions of the journey, such as when cruising, or for the whole flight once the technology is mature. The introduction of greater levels of automation in the

cockpit would therefore allow the pilot to focus on more strategic and safety-critical tasks.

**What happens if the pilot becomes incapacitated during a flight?**

A key requirement for the implementation of SPO will be preserving the safety levels as in current multi-pilot operations, and addressing risks such as in-flight pilot incapacitation. These safety requirements are at the core of the operational concept developed by SAFELAND, which supported a single-piloted aircraft during the flight and landing in case the single pilot on board becomes incapacitated at any point.

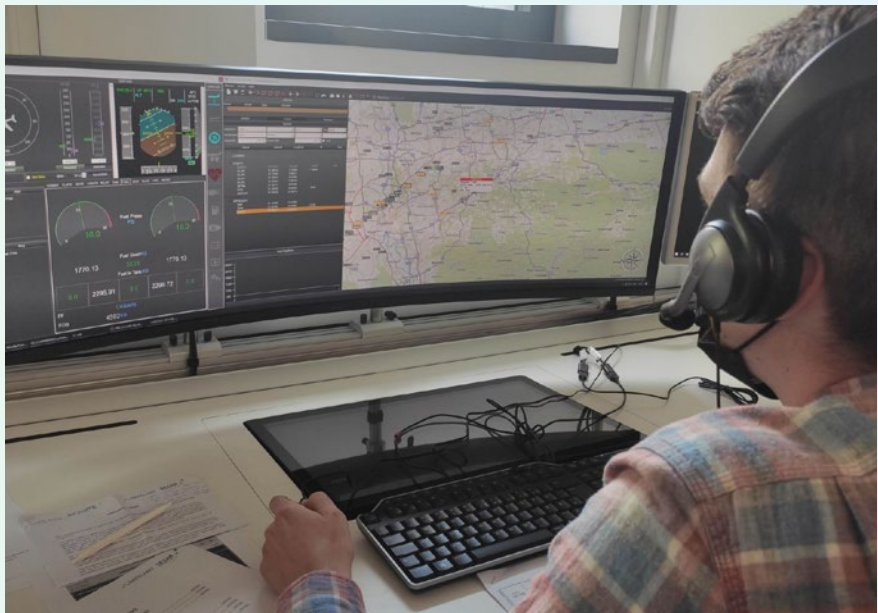
**What were the outcomes of the SAFELAND project?**

The SAFELAND project developed a concept predicated on the interaction of a ground-based operator working from a remote ground station position with on-board automation and air traffic controllers. The concept includes the description of the foreseen operational processes and procedures allowing the transition from single-piloted aircraft to remotely piloted aircraft (RPA) in case of incapacitation, together with an analysis of any technical, legal, and regulatory implications.

**What changes will be needed in the cockpit/on the ground?**

The SAFELAND concept assumes that the single-piloted aircraft is equipped with more sophisticated automation than the current CS-25 certified aircraft (e.g., onboard pilot health monitoring system, reliable and sufficient command and control - C2 - data link, and an advanced system capable of autonomously land the aircraft).

In addition, the concept envisages remote pilots operating from the ground to monitor single-piloted aircraft, to support the single pilots upon request and, if necessary, to intervene and take over control of the aircraft.



Furthermore, no significant changes to the tasks and responsibilities of air traffic control (ATC) and the airline operations control centre (AOCC) are foreseen in the SAFELAND concept, since the incapacitated aircraft will be handled following standard emergency procedures.

**How could the results of your project be used by the authorities, ANSPs (Air Navigation Service Providers), end-users?**

The results of the project could support the rulemaking process by the authorities, in particular those regulations related to the rules of the air, operations, aircrew and "ground crew" competencies (e.g., training, assessment, etc.), functions and responsibilities of people involved (i.e., pilot in command, air traffic controller (ATCO), remote operators in the ground station). Several other regulations currently in force may also need to be updated, incorporating provisions for SPO and remote operators. The results may also boost new competences for ATCOs, to better address the SPO and relationship with the remote operators in the ground station.

**What benefits do you hope your project will bring?**

The concept is still relatively low in maturity. The goal was to explore the feasibility of a high-level operational concept, evaluating the acceptability of roles and distribution of responsibilities between ground station operators, air traffic controller, and automation, and identifying the most efficient use of resources to compensate for incapacitation. The results, complemented by regulatory and legal analyses as well as preliminary safety and cyber-security assessments, will represent significant progress in the advancement of research into SPO.

<https://safeland-project.eu/>

*This project received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 890599*



## Explainable artificial intelligence – why it matters for air traffic management

**Artificial intelligence (AI) holds great promise for enabling Europe to sustainably manage growing air traffic and an increasingly complex airspace. But to unleash its full potential requires making AI applications explainable and with that trustworthy, says Mobyen Uddin Ahmed, Associate Professor in Artificial Intelligence/Computer Science at Mälardalen University, Sweden, and project coordinator of ARTIMATION.**

**What is meant by a black box? Why does AI have to be explainable?**

“Black Box” refers to a system whose inputs and outputs are known, but its internal mechanism is unknown to humans. How does the decision making system work? Why did the AI take that specific decision? Take Apple’s SIRI or Google’s Alexa; we can request them to play random songs, without knowing how those songs were chosen. Knowing how music choices are made is no big deal,

but the same cannot be said for decision making in air traffic management (ATM), a safety critical industry. Nowadays, ATM operators do not know “why” or “how” a certain decision has been taken, which lowers their trust in the system. Making AI “explainable” is therefore a critical step to improving trust and reliability in the interaction between humans and AI.

**How difficult is it to introduce AI/ML into ATM?**

In ATM, there are many experts with years of in-depth operational experience in dealing with complex scenarios. ARTIMATION is looking at how to transfer that experience and knowledge into the system and to collect quality data in order to train the AI algorithms. We are also looking at predicting how the AI will go on learning, adapting itself to a changing world, with various inputs. Lifelong machine learning with human-centred AI is in fact one of the core elements of the project.

**How could the results of your project be used by the authorities, air navigation service providers or end users?**

ARTIMATION explored AI explainability in two tools: a conflict detection and

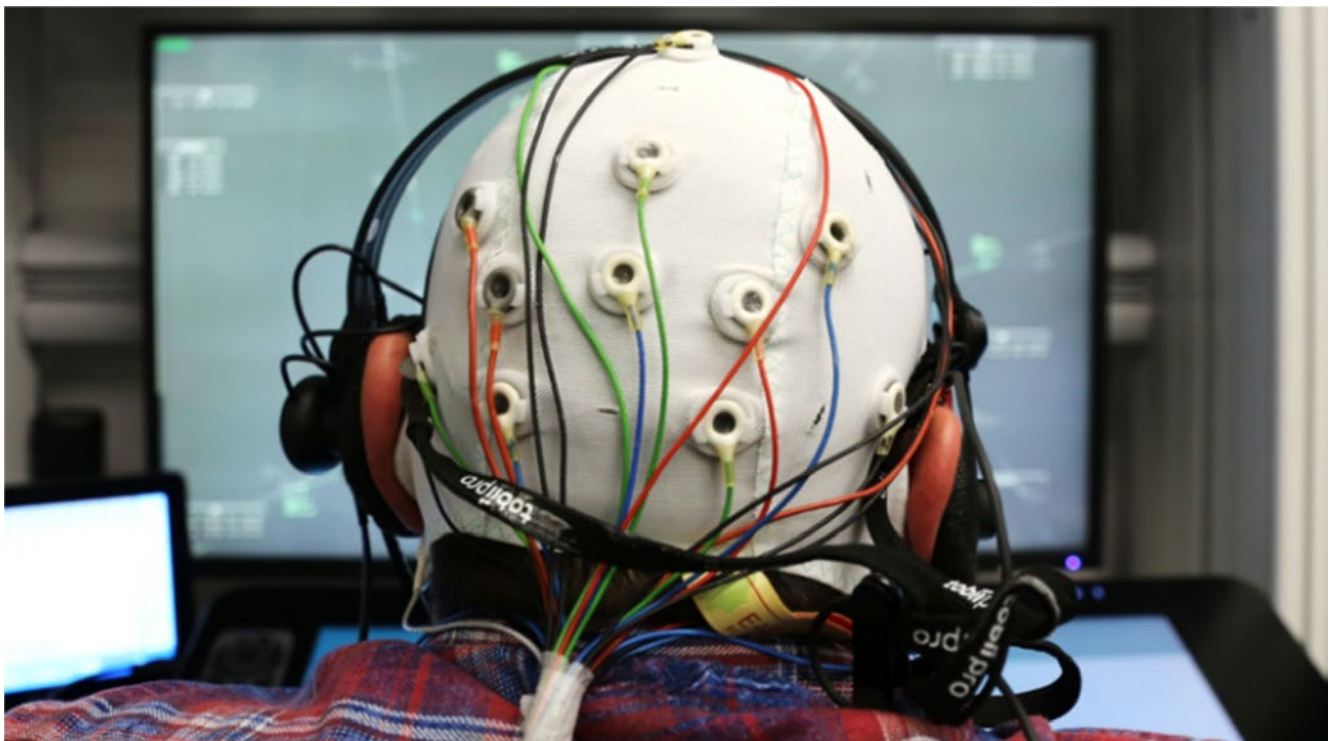
resolution tool and a delay propagation tool. Both tools will be useful to better understand the next steps in the ATM field to increase the use of automation to support controllers, ANSPs and generic end users in their activities. Within the project we will also draw up guidelines to support XAI feasibility in different application and further detail knowledge on explainability.

**What benefits do you hope your project will bring?**

A more understandable AI will help improve safety and system performance, adapting the use to the context. As the complexity of ATM systems will grow in the future, there is a growing need for improving the system, aiming at optimisation that will lead to an improvement of the overall sector performance.

[www.artimation.eu](http://www.artimation.eu)

*This project received funding from the SESAR Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 894238*





## CORDIS publishes results pack on SESAR AI projects

Artificial intelligence offers applications that can learn autonomously and advise on complex problems across various industries. ATM is no exception. In October, CORDIS, the EU's primary platform for disseminating research result, published a Results Pack highlighting recent advances made by 15 exploratory projects supported by EU funding through the SESAR 3 Joint Undertaking. The projects featured address all phases of flight from strategic and pre-tactical planning to tactical operations themselves.

## SESAR 3 JU Scientific Committee kicks off

The first physical meeting of the SESAR 3 Joint Undertaking's newly composed Scientific Committee took place in December in Budapest, following the SESAR Innovation Days. Elected for a period of four years, the Committee will provide independent scientific advice to the SESAR 3 JU and its governance on all aspects of the Digital European Sky research and innovation programme, with a particular focus on early technological concepts.



Chaired by Tatjana Bolic, University of Westminster, the Committee is composed of nine highly regarded academics from across Europe, and the ATM and aviation research domains. Collectively, they represent a significant mass of scientific expertise with a wealth of knowledge of the SESAR research and innovation landscape.

- Dr. Rosa Maria Arnaldo Valdes, Universidad Politécnic de Madrid
- Dr. Sara Bagassi, Università di Bologna
- Dr. Juan Besada, Universidad Politécnic de Madrid
- Dr. Tatjana Bolic, University of Westminster
- Dr. Daniel Delahaye, Ecole Nationale de l'Aviation Civile
- Dr. Peter Hecker, Technical University of Braunschweig
- Dr. Efstathios Malakis, Hellenic Civil Aviation Authority
- Dr. Fedja Netjasov, Faculty of Transport and Traffic Engineering
- Dr. Rita Somogyi, Asura Technologies

The Committee is one of the three governance bodies of the SESAR 3 JU, making recommendations directly to the Governing Board and consulting on matters of scientific significance for programme. Specifically, the Committee is tasked with advising the SESAR 3

JU's about the scientific priorities to be addressed in the partnership's work programme, including the scope of calls for proposals and members' annual activities plan. In addition, the Committee aims to champion knowledge exchange, applying the principles of open science and open data.

*"The Scientific Committee is critical to ensuring that the Digital European Sky research and innovation programme and results are technically and scientifically sound. In particular, we will count on the support of the committee members in looking beyond our current horizon and formulating the vision for future ATM research,"* said Andreas Boschen, Executive Director, SESAR 3 Joint Undertaking.

*"I am honoured to serve as a Chair of the new Scientific Committee. Air transport is an integral part of our society. As such, the improvements in the ATM need to be fit for purpose, taking in account the latest societal changes and technological advances. I believe that the Scientific Committee can help guide ATM research to continue integrating societal needs and scientific developments, improving the time to implementation,"* said Tatjana Bolic, Chair of the SESAR 3 JU Scientific Committee.

## SESAR Innovation Days showcase aviation's commitment to a smart and sustainable future

In December, after a two-year hiatus, 400 of Europe's leading researchers in the ATM and aviation domains gathered in Budapest for the SESAR Innovation Days to take stock and exchange on a wide variety of topics, from artificial intelligence and energy-efficient flying to meteorology and drone traffic management. Results stemming from the showcased research have the potential to push the boundaries of ATM, making it smarter and more sustainable in the coming years, the participants heard.

Now in its twelfth edition, the SESAR Innovation Days, a flagship event in the aviation research calendar, showcased some of the breakthrough concepts from the SESAR 3 JU's exploratory research portfolio, as well as novel outcomes from the broader ATM research community.

Altogether, the conference featured some 37 posters and 51 papers, covering data-driven methods for safety and resilience prediction, climate-optimised trajectories, drone traffic management, airport operations, among other research areas. Special plenary sessions looked at the important topics of U-space, the enabling framework for drone integration, the environment and artificial intelligence.

Much of the research presented during the conference stems from the 41 exploratory research projects and the SESAR knowledge transfer network,



Engage, which ran from 2020 to 2022, bringing together academic and industry partners, such as universities, SMEs, research centres, airlines, manufacturers, and air navigation service providers



from across the European Union and EU Associated Countries.

Fittingly, the conference closed with the SESAR Young Scientist Award ceremony, celebrating the next generation of aviation and ATM researchers in two categories, students and PhD. The top prize among the students went to Marie-Christine Nevir, Technische Universität Dresden, who developed and initially validated a new workload model for sector-less airspace (i.e. flight centric air traffic control). The jury praised Nevir for the very high level of innovation demonstrated in her work for tackling controller organisation in light of this this relatively new operational concept.

Omar Garcia Crespillo, German Aerospace Center (DLR) & Swiss Federal Institute of Technology Lausanne (EPFL), received first prize in the PhD category for his work on Global Navigation Satellite System (GNSS)/Inertial Navigation System (INS) Kalman filter integrity monitoring with uncertain time-correlated error processes. The jury praised him for a very well structured and written thesis, which demonstrated excellent scientific rigour and innovation in terms of the simulation approaches

It was announced that the next SESAR Innovation Days will take place in Seville, Spain, from 27 to 30 November 2023.

[www.sesarju.eu/sesarinnovationdays](http://www.sesarju.eu/sesarinnovationdays)



## List of exploratory research projects (2020-2022)

**ARTIMATION** – Transparent artificial intelligence and automation to air traffic management systems

ARTIMATION aimed to investigate AI methods in predicting air transportation traffic and optimizing traffic flows based on explainable artificial intelligence (XAI) to address the challenge related to transparency of automated system in the ATM domain. ARTIMATION aimed to provide a proof-of-concept of transparent AI models that includes visualisation, explanation and generalisation to ensure safe and reliable decision support.

Web: [www.sesarju.eu/projects/artimation](http://www.sesarju.eu/projects/artimation)

**AISA** - AI situational awareness foundation for advancing automation

To implement advanced automation, AI and human need to be able to share situational awareness. Therefore, AISA project explored the effect of, and opportunities for, distributed human-machine situational awareness in en-route ATC operations. The project developed an intelligent situationally-aware system by combining machine learning with reasoning engine.

Web: [aisa-project.eu/](http://aisa-project.eu/)

**MAHALO** - Modern ATM via human/ automation learning optimisation

To answer the question if automation should match human behaviour or be understandable to humans, MAHALO developed an individually-tuned ML system to solve ATC conflicts and couple this to an enhanced en-route CD&R display. Insights will be used to define a framework to guide design of future AI systems.

Web: [mahaloproject.eu](http://mahaloproject.eu)

**TAPAS** -Towards an automated and explainable ATM system

TAPAS explored highly automated AI-based scenarios through analysis and experimental activities applying explainable artificial intelligence (XAI) and visual analytics, in order to derive general principles of transparency which pave the way for the application of AI technologies in ATM environments, enabling higher levels of automation.

Web: <https://tapas-atm.eu/>

**AICHAIN** – A platform for privacy-preserving federated machine learning using block chain to enable operational Improvements in ATM

AICHAIN proposed an innovative digital information management concept combining federated machine learning (FedML) and blockchain technologies. This enables the cyber-secured exploitation of large private data sets by a privacy-preserving federated learning architecture in which neither the training data nor the training model need to be exposed.

Web: [www.aichain-h2020.eu/](http://www.aichain-h2020.eu/)

**CREATE** - Innovative operations and climate and weather models to improve ATM resilience and reduce impacts

Air operations largely use weather information to make the air traffic flow safe, continuous and efficient. As climate changes are ongoing, available information on the weather on short and longer notice are increasing and technology is being improved. CREATE aimed to achieve innovative procedures in ATM to reduce climate and environmental impact, while becoming more resilient to weather phenomena.

Web: <https://create-project.eu/>

<b>DYNCAT</b> - Dynamic configuration adjustment in the TMA	DYNCAT aimed to enable more environmentally friendly and more predictable flight profiles in the TMA, namely on approach, by supporting the pilots in configuration management. The project is analysing the existing aircraft in operation and air traffic control procedures and propose improvements to on-board and ground procedures. The project identified the necessary technological and regulatory changes for improved airborne procedures and assess the environmental potential of improved operations. Web: <a href="http://www.sesarju.eu/projects/DYNCAT">www.sesarju.eu/projects/DYNCAT</a>
<b>FlyATM4E</b> - Flying ATM for the benefit of environment and climate	FlyATM4E expanded approved climate-assessment methods and optimization of aircraft trajectories to identify promising mitigation options suitable to solve the task of reducing overall climate impact of aircraft operations. The project is assessing the feasibility of a concept for environmental assessment of ATM operations working towards environmental optimisation of air traffic operations. Web: <a href="http://flyatm4e.eu/">flyatm4e.eu/</a>
<b>FMPMet</b> - Meteorological uncertainty management for flow management positions	FMPMet integrated meteorological forecast uncertainty information into the decision-making process for flow management position (FMP). The tools provides the FMP with an intuitive and interpretable probabilistic assessment of the impact of convective weather on the operations, up to 8 hours in advance. Web: <a href="http://fmp-met.com">fmp-met.com</a>
<b>SINOPTICA</b> - Satellite-borne and in-situ observations to predict the initiation of convection for ATM	SINOPTICA explored the potential of assimilating remote sensing, GNSS-derived datasets and in situ weather stations data into very high-resolution, very short-range numerical weather forecasts to provide improved prediction of extreme weather events to the benefit of ATM operations. Web: <a href="http://sinoptica-project.eu/">http://sinoptica-project.eu/</a>
<b>ALARM</b> - Multi-hazard monitoring and early warning system	ALARM developed a prototype global multi-hazard monitoring and early warning system (EWS). A global multi-hazard monitoring means near-real time and continuous global Earth observations from satellite, with the objective to generate prompt alerts of natural hazards affecting ATM and to provide information for enhancing situational awareness and providing resilience in crisis. Web: <a href="http://www.sesarju.eu/projects/ALARM">www.sesarju.eu/projects/ALARM</a>
<b>FARO</b> - Safety and resilience guidelines for aviation	FARO aimed to bring new insights about safety and resilience in ATM, with four objectives: to exploit existing safety knowledge, to quantify the impact of increasing automation on ATM safety, to analyse the impact of increasing automation on ATM resilience, and to provide design guidelines and identify future research needs. Web: <a href="http://faro-h2020.eu/">faro-h2020.eu/</a>
<b>BEACON</b> - Behavioural economics for ATM concepts	BEACON studied the feasibility of extending user- driven prioritisation process (UDPP) to allow multi-prioritisation processes in the airspace and exchange of slots between airlines. It built two models: a strategic model and a detailed tactical simulator To properly capture the agents' behaviours, BEACON made use of behavioural economics. Web: <a href="http://www.sesarju.eu/projects/beacon">www.sesarju.eu/projects/beacon</a>

**ITACA** - Incentivising technology adoption for accelerating change in ATM

ITACA aimed to accelerate the development, adoption and deployment of new technologies in ATM. ITACA developed a new set of methodologies and tools enabling the rigorous and comprehensive assessment of policies and regulations aimed at amplifying the uptake of new technologies within ATM.

Web: <https://www.itaca-h2020.eu/>

**SafeOPS** - From prediction to decision support - strengthening safe and scalable ATM services through automated risk analytics based on operational data from aviation stakeholders

Maintaining safety and cost-efficiency of air transport operations while increasing the capacity will push the next generation of ATM systems towards digitalisation. In the mid-term, a digitalised system in the human operated ATM environment will be capable of delivering reliable predictive analytics based on automated information processing. SafeOPS aimed to support these future services by investigating the use of big data analytics together with new risk assessment methodologies.

Web: [www.sesarju.eu/projects/SafeOPS](http://www.sesarju.eu/projects/SafeOPS)

**SIMBAD** - Combining simulation models and big data analytics for ATM performance analysis

SIMBAD developed and evaluated a set of machine learning approaches aimed at providing state-of-the-art ATM microsimulation models with the level of reliability, tractability and interpretability required to effectively support performance evaluation at ECAC level. The project demonstrated and evaluated the newly developed methods and tools through a set of case studies.

Web: [www.sesarju.eu/projects/SIMBAD](http://www.sesarju.eu/projects/SIMBAD)

**Modus** - Modelling and assessing the role of air transport in an integrated, intermodal transport system

Modus analysed the performance of the overall transport system by considering the entire door-to-door journey holistically. The project identified (future) drivers for passenger demand and supply and assesses the impact on airside and landside processes and capacities. Based on these analyses, potential solutions to meet high-level European transport objectives were proposed.

Web: [modus-project.eu/](http://modus-project.eu/)

**TRANSIT** - Travel Information management for seamless intermodal transport

TRANSIT developed a set of multimodal key performance indicators (KPIs), mobility data analysis methods and transport simulation tools, allowing the evaluation of the impact of innovative intermodal transport solutions on the quality, efficiency and resilience of the door-to-door passenger journey.

Web: [www.transit-h2020.eu/](http://www.transit-h2020.eu/)

**X-TEAM D2D** - Extended ATM for door2door travel

X-TEAM D2D defined, developed and initially validated a concept of operations for the seamless integration of ATM and air transport into an overall intermodal network, including other available transportation means (surface, water), to enable the door-to-door connectivity, in up to 4 hours, between any location in Europe.

Web: [xteamd2d.eu/](http://xteamd2d.eu/)

**SYN AIR** - Synergies between transport modes and air transportation

SYNAIR developed common goals for transport service providers, which will justify data sharing while facilitating the user to execute a seamless D2D journey. SYN AIR aimed to generate customer door-to-door journeys and analysed how those journeys can be facilitated through improved planning and operations activities powered by data sharing.

Web: [www.sesarju.eu/projects/synair](http://www.sesarju.eu/projects/synair)

**NewSense** - Evaluation of 5G network and mmwave radar sensors to enhance surveillance of the airport surface

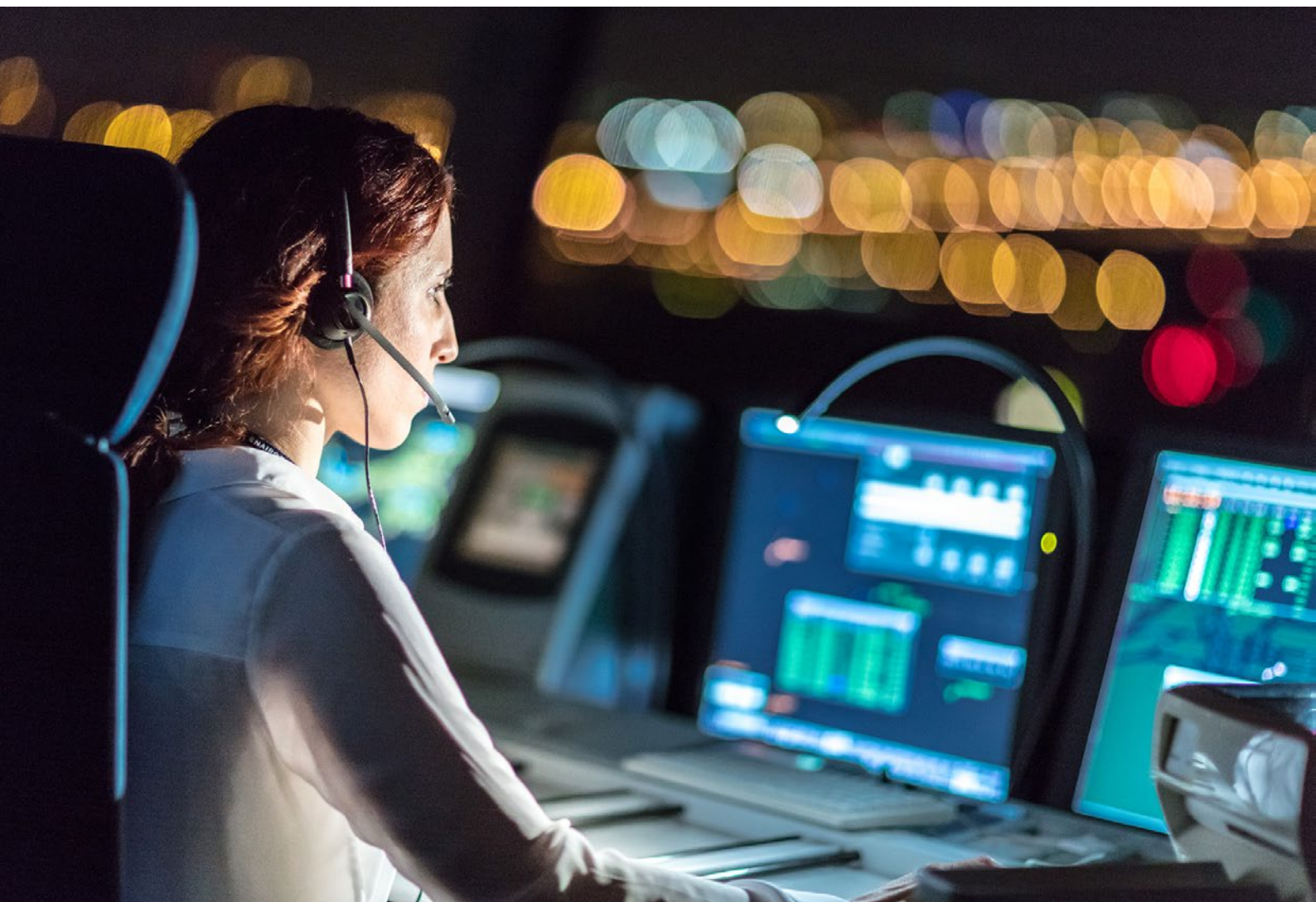
NewSense aimed to improve safety and efficiency of operations primarily in secondary airports with innovative low-cost surface surveillance solutions, based on 5G cellular networks for the long term, and msafmWave radar for the medium term, allowing the implementation of affordable advanced-surface movement guidance and control systems (A-SMGCS).

Web: [www.sesarju.eu/projects/NewSense](http://www.sesarju.eu/projects/NewSense)

**SINAPSE** - Software defined networking architecture augmented with artificial intelligence to improve aeronautical communications performance, security and efficiency

SINAPSE proposed an intelligent and secured aeronautical datalink communications network architecture design, based on the software defined networking (SDN) architecture model augmented with artificial intelligence (AI) to predict and prevent safety services outages, to optimise available network resources and to implement cybersecurity functions protecting the network against digital attacks.

Web: [5.196.117.230/sinapse/](http://5.196.117.230/sinapse/)





**AEON** - Advanced Engine Off Navigation

AEON defined a concept of operations focusing on engine-off taxiing techniques, and a set of dedicated tools to support the operators. The project defined how to determine, in real time, efficient and conflict-free routing plans for autonomous and non-autonomous aircraft taxiing from gates to the corresponding runways and the other way around.

Web: <https://www.aeon-project.eu/>

**ASPRID** - Airport system protection from intruding drones

ASPRID developed a service-oriented operational concept and system architecture to protect airport operations from unwanted drones. To do so, the project analysed aircraft and airport (runway and ground) operations to pinpoint possible vulnerabilities. With this, the project identified possible technologies, procedures and regulations that could help better safeguard against drone incursions and/or can help them recover from any disruptions as quickly and as efficiently as possible. In doing so, the project proposed a more integrated and coordinated approach to handling drone incursions.

Web: <https://www.asprid.eu/>

**IMHOTEP** - Integrated multimodal airport operations for efficient passenger flow management

IMHOTEP developed a concept of operations and a set of data analysis methods, predictive models and decision support tools that allow information sharing, common situational awareness and real-time collaborative decision-making between airports and ground transport stakeholders.

Web: [www.imhotep-h2020.eu/](http://www.imhotep-h2020.eu/)

**HAAWAII** - Highly automated air traffic controller workstations with artificial intelligence integration

HAAWAII research and developed a reliable, error resilient and adaptable solution to automatically transcribe voice commands issued by both air-traffic controllers and pilots, and to perform proof-of-concept trials in challenging environments. Also, the objectively estimated controllers' workload utilising digitised voice recordings of the complex London TMA was assessed.

Web: [www.hawaii.de](http://www.hawaii.de)

**CADENZA** - Advanced capacity and demand management for European network performance optimisation

CADENZA developed a detailed trajectory broker concept for the European network, incorporating advanced demand-capacity balancing mechanisms. The trajectory broker will balance capacity and demand through a coordinated capacity provision process and collaborative trajectory management (including a novel trajectory charging scheme). Significant improvements in cost-efficiency and delay are expected.

Web: <https://cadenza-project.eu/>

**ECHO** - European concept of operations for higher airspace operations

ECHO delivered a comprehensive demand analysis and innovative and feasible concept of operations enabling near term and future higher airspace operations in a safe and orderly manner. The higher airspace including the operators forms a new, almost legacy free environment enabling an expeditions uptake of innovations or extrapolated SESAR solutions.

Web: <https://higherairspace.eu/>

**ISOBAR** - Artificial intelligence solutions to meteo-based DCB imbalances for network operations planning

ISOBAR aimed at the provision of a service- and AI-based network operations plan, by integrating enhanced convective weather forecasts for predicting imbalances between capacity and demand and exploiting AI to select mitigation measures at local and network level in a collaborative ATFCM operations paradigm.

Web: [isobar-project.eu/](http://isobar-project.eu/)

<p><b>START</b> - A stable and resilient ATM by integrating robust airline operations into the network</p>	<p>START developed, implemented, and validated optimisation algorithms for robust airline operations that result in stable and resilient ATM performance even in disturbed scenarios. The main focus of the project is the optimisation of conventional traffic situations while considering disruptive weather events such as thunderstorms.</p> <p>Web: <a href="http://start-atm.com">start-atm.com</a></p>
<p><b>FACT</b> - Future all aviation CNS technology</p>	<p>FACT aimed to increase safety, security, efficiency, and robustness of future air traffic environment through development of integrated CNS functional architecture supporting the use of common performance based approach, addressing needs of large spectrum of airspace users across varied operational environments.</p> <p>Web: <a href="http://www.sesarju.eu/projects/FACT">www.sesarju.eu/projects/FACT</a></p>
<p><b>NOSTROMO</b> - Next-generation open-source tools for ATM performance modelling and optimisation</p>	<p>The ATM system is composed of elements that interact with each other generating a number of properties characteristic of complex adaptive systems. NOSTROMO developed new approaches to ATM performance modelling able to reconcile model transparency, computational tractability and ease of use with the necessary sophistication required for a realistic representation of the ATM system.</p> <p>Web: <a href="http://www.sesarju.eu/projects/NOSTROMO">www.sesarju.eu/projects/NOSTROMO</a></p>
<p><b>SlotMachine</b> - A privacy-preserving marketplace for slot management</p>	<p>Until now, ATFM slots have only been subject to intra-airline swaps, used by airlines to prioritize expensive flights and thus minimise overall costs. Airlines want to keep the cost structure of their flights confidential, as they fear a competitive disadvantage when disclosed. This desire for confidentiality has hampered slot swapping between different airlines. SlotMachine employed blockchain technology and secure multi-party computation to extend the existing UDPP solution with the possibility to keep private the participating airlines' confidential information, such as the cost structure of flights.</p> <p>Web: <a href="http://www.sesarju.eu/projects/SlotMachine">www.sesarju.eu/projects/SlotMachine</a></p>
<p><b>INVIRCAT</b> - IFR RPAS control in airports and TMA</p>	<p>INVIRCAT created a concept of operations for remotely piloted aircraft systems in the terminal manoeuvring area of airports, assessing it through simulations and draft a set of recommendations for rulemakers and standardisation bodies.</p> <p>Web: <a href="http://www.invircat.eu/">www.invircat.eu/</a></p>
<p><b>SAFELAND</b> – Safe landing through enhanced ground support</p>	<p>SAFELAND aimed to support flight and landing of aircraft operated by a single pilot, in case of partial or total incapacitation of the pilot. SAFELAND focused on the ground side, specifically on the role ATM could have in managing the transition from a single pilot operated flight to a status with reduced or absent contribution of the onboard pilot to landing.</p> <p>Web: <a href="http://safeland-project.eu/">safeland-project.eu/</a></p>
<p><b>URClearED</b> - A unified integrated remain well clear concept in airspace D-G class</p>	<p>URClearED supported current study activities on the RWC functionalities by defining and analysing operational scenarios, which allow to assess requirements and assumptions made in current standards and applicable documents, and then paving the way to future industrial level activities on such system.</p> <p>Web: <a href="http://www.urcleared.eu">www.urcleared.eu</a></p>



# DELIVERING SESAR SOLUTIONS

## Industrial research & validation

### **SESAR 3 JU delivers new solutions for market take-up**

**At the end of 2022, SESAR 3 JU members and partners delivered a new series of solutions ready for industrialisation by aviation stakeholders as part of the drive to make Europe's aviation infrastructure fit for the digital age.**

The latest delivery (Release 12) includes a total of 15 solutions aimed at improving airport operations and air traffic services, while boosting the performance of the overall aviation network.

Now ready for market uptake, the solutions are the result of rigorous research and innovation work conducted over the past three years by aviation stakeholders across Europe within the context of the SESAR 2020 industrial research programme. Coming to a close in 2022 the programme is expected to deliver a total of 75 new solutions to boost the performance of Europe's

air traffic management (ATM), making it smarter and more sustainable. Altogether, close to 150 solutions have got the green light since the start of SESAR, with many now in or part of deployment plans.

At the same time, new industrial research projects will get underway in 2023 within the SESAR 3 JU's Digital European Sky programme, with a view to developing more innovative solutions in line with the priorities outlined in the European Master Plan, the roadmap for the modernisation of ATM.



**sesar**  
JOINT UNDERTAKING

# 15 new SESAR Solutions ready for industrialisation



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	<b>High-Performing Airport Operations</b>	<b>Second runway aiming points (SRAP)</b> <i>(SJU reference: PJ,02-W2-14.2)</i>
		<b>Increased second glide slope (ISGS)</b> <i>(SJU reference: PJ,02-W2-14.3)</i>
		<b>Increased glide slope to a second runway aiming point (IGS-to-SRAP)</b> <i>(SJU reference: PJ,02-W2-14.5)</i>
		<b>Full guidance assistance to mobiles using ‘follow-the-greens’ procedures based on airfield ground lighting (aprons/taxiways/runways)</b> <i>(SJU reference: PJ,02-W2-21.4)</i>
		<b>Connected regional airports</b> <i>(SJU reference: PJ,04-W2-28.1)</i>
	<b>Advanced air traffic services</b>	<b>IFR RPAS accommodation in Airspace Class A to C</b> <i>(SJU reference: PJ,13-W2-115)</i>
	<b>Optimised ATM network services</b>	<b>Initial 4D Mission Trajectory development with integrated DMA types 1 and 2 supported by automation and dynamic civil-military CDM</b> <i>(SJU reference: PJ,07-W2-40)</i>
	<b>Enabling aviation Infrastructure</b>	<b>GBAS - GAST D extended scope</b> <i>(SJU reference: PJ,14-W2-79a)</i>
		<b>FCI services</b> <i>(SJU reference: PJ,14-W2-77)</i>
		<b>Multi sensor data fusion surveillance</b> <i>(SJU reference: PJ,14-W2-84a)</i>
		<b>Multi Remote Tower Surveillance module</b> <i>(SJU reference: PJ,14-W2-84b)</i>
		<b>Secured surveillance systems (single and composite systems)</b> <i>(SJU reference: PJ,14-W2-84c)</i>
		<b>Phase overlay for ADS-B</b> <i>(SJU reference: PJ,14-W2-84d)</i>
		<b>Surveillance performance monitoring tool for cooperative sensors</b> <i>(SJU reference: PJ,14-W2-84e)</i>
		<b>Surveillance Performance Monitoring – end-to-end</b> <i>(SJU reference: PJ,14-W2-84f)</i>
<b>SWIM TI Green profile for G/G Civil Military Information Sharing</b> <i>(SJU reference: PJ,14-W2-101)</i>		

Check out the SESAR Solutions Catalogue (2021) <https://www.sesarju.eu/catalogue>

## An A-C in integrating remotely-piloted aircraft systems

**Is it a bird? Is it a plane? No, it's a remotely piloted aircraft system or RPAS! Ermanno Girardelli, Leonardo, is coordinator of ERICA, a SESAR research and innovation project dedicated to integrating these aircraft into non-segregated airspace alongside commercial manned traffic. In this Q&A, he explains how RPAS can make a difference to citizens' lives and what the SESAR project is doing to enable these aircraft to take off.**

### What are remotely-piloted aircraft?

"Remotely-piloted aircraft" (RPA) is a specific set of unmanned aircraft, which is remotely operated by a pilot in a control station, hence the term "Remotely-piloted aircraft System" (RPAS). These differ to "autonomous aircraft systems", since the latter have some level of autonomy.

### What kind of services do RPAS provide citizens and businesses?

RPAS are especially useful for repetitive tasks or situations where a human pilot might be put at risk. Situations could include floods, where a continuous monitoring of the situation is needed; or an accident at a chemical plant, where pollutants have been released into the atmosphere, making it too dangerous to fly overhead.

RPAS can also be useful in the everyday life of citizens for the transport of both small packages and bulk cargo, and for monitoring linear infrastructures, such as pipelines, power lines and railways tracks, among other applications. They are also very useful for emergencies, such as search and rescue or the delivery of medication or defibrillators.



### Why is it challenging to integrate RPAS into the airspace? Why can't they be treated like a plane or a helicopter?

Managing RPAS traffic is challenging for controllers for a number of reasons. For a start, many RPAS fly significantly slower than conventional jet airliners. Added to that is the latency in communication that may occur between the operator on the ground and the platform in the air with the possibility of a command and control link loss. RPAS may also require special mission patterns and the smallest ones could be impacted by weather such as strong winds, often far more significantly than other conventional aircraft. For instance, in the unlikely event that the control link fails, the RPA flies a pre-established trajectory while air traffic control manages other aircraft. This needs specific defined contingency procedures to maintain the safety of surrounding aircraft and the population on ground. Of course, the main difference between an RPAS and a manned aircraft is the fact that there is no pilot on board, so important functions usually performed by an on board pilot must be performed by new systems, such as Detect and Avoid (DAA) surrounding traffic when an RPAS flight is in zones where it is the pilot's responsibility for keeping clear of other aircraft and obstacles.

### What is the rationale of ERICA? What are its main objectives?

ERICA focussed on the integration of RPAS in normal, everyday, aircraft traffic. The project aims to identify the minimal changes needed to existing systems and procedures in order to enable RPAS integration in the current air traffic for controlled airspace classes A-C under IFR (instrument flight rules). It is also looking at the introduction of on-board DAA systems to allow aircraft to react to unforeseen situations almost instantaneously, but in a manner that does not compromise the safety of surrounding traffic.

The project is carrying out its research in two parallel steps, covering two different phases. The first phase is accommodating the demand for RPAS in the short-to-medium term, establishing harmonised procedures across low-to-medium density and low-to-medium complexity European airspace; this accommodation phase builds on current technologies and procedures. The second phase addresses the full integration of civil and military RPAS, in the longer term, enabling their deployment in a cooperative environment in full integration with the manned aviation; this integration phase will require new technologies and an evolution in the wider ATM system.

**What is novel about the project’s approach? How are you building on past results?**

Integrating RPAS into the current air traffic is a massive job involving many European research initiatives, including ERICA, which is addressing a specific airspace (Classes A-C) and category of RPAS (medium altitude long endurance – MALE - with fixed wings). For instance, the project is validating a DAA solution building on the results of previous initiatives, in which the DAA systems ACAS-Xu and “European Detect And Avoidance System” (EUDAAS) were defined and developed. Similarly, the project is taking advantage of the work of previous SESAR projects, e.g. PJ10-W1 PROSA, on RPAS integration, and PJ.11-W1 CAPITO on collision

avoidance, exploiting the lessons learned of air-ground industries, air navigation service providers, network manager and academic-research community.

**Can you describe the testing/validation that you are doing?**

We tested the interoperability of RPAS that are equipped with the DAA system with all other categories of aircraft. We are also tested the proposed adjusted ATM procedures in simulated and real environments where RPAS can fly in unsegregated airspace.

**How could the results of your project be used by the authorities, ANSPs, Network, end users?**

Regarding the work on DAA, the results of the project will help to define

requirements for, and assess the safety performance and operational acceptability of both the ACAS-Xu and the EUDAAS systems.

We also expect that our work will provide a sound basis for designing the procedures and regulations together with technologies and functions necessary for RPAS integration. Given the high level of acceptance by all stakeholders involved, we believe that this will pave the way to European-wide implementation.

[www.sesarju.eu/projects/ERICA](http://www.sesarju.eu/projects/ERICA)

*This project received funding from the SESAR Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 874474*



## SESAR partners validate speech recognition tech for tower controllers

**SESAR 3 JU member, DLR together with air traffic controllers from AustroControl and Oro Navigacija recently validated an assistant-based speech recognition system to support controllers working in future multiple remote tower centres. The validations are part of the project “Digital Technologies for Tower” (PJ05-W2-97 DTT), which is developing new technologies for airport towers, particularly in the area of remotely controlling multiple airports and innovative human-machine interfaces.**

Flight strips are an essential tool for tower air traffic controllers. DLR’s prototypic electronic flight strip display shows the most relevant information for every flight at each of the three airports in different bays.

The developed assistant-based speech recognition system first transforms the controller speech into a sequence of words. Afterwards, relevant air traffic control (ATC) concepts such as call sign, command types and values are automatically extracted from the sequence of words. Such ATC concepts are displayed and highlighted in the flight strip system without the need for the controller to manually insert information with an electronic pen. The aim is to keep the workload and situational awareness of controllers at an optimal level at all times.

The assistant-based speech recognition system uses machine learning algorithms to automatically adapt the acoustic, language, command prediction and command extraction models to new environments. Furthermore, it uses contextual knowledge from radar data, flight plan data, and meteorological data to reduce command recognition error rates.

The three-week validation was carried out from 14 February to 3 March 2022 with ten air traffic controllers from Austria and Lithuania in the TowerLab of DLR’s Institute of Flight Guidance in Braunschweig. Working in a multiple remote tower setup they remotely controlled three simulated airports in two scenarios: one with the developed speech recognition support and a second scenario for comparison without such support. During and after the simulation scenarios, researchers gathered data about the command recognition, workload, situation awareness, and system usability.

The trials showed that the automatic extraction of ATC commands supports and relieves controllers in their work.

[www.remote-tower.eu](http://www.remote-tower.eu)

*This project received funding from the SESAR Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 874470*



**SPEECH RECOGNITION ATCO**

**Speech Recognition for ATC Towers**

**“CLEARED FOR TAKEOFF”**

## Keeping regional airports connected

**In May, SESAR 3 JU partners conducted tests at Landvetter Airport in Gothenburg, Sweden, on a solution to allow for more effective collaborative decision making (CDM) between airport stakeholders and more efficient airside operations. This low-cost solution for regional airports is expected to help increase the predictability of traffic across the European air traffic network.**

Airports can be integrated into the air traffic management network by departure planning information (DPI) messages to the Network Manager (NM). On the one hand, large airports can implement airport collaborative decision making (A-CDM), which improves the information exchange with the network manager by sharing the status and time estimates of their outbound flights. On the other hand, smaller airports can implement the advanced ATC tower concept, allowing them to send a DPI message to the network manager operations centre (NMOC) when an aircraft leaves the blocks. Many regional airports are not ready to invest in the full A-CDM suite but are interested in sharing more than what is offered by the advanced ATC tower concept with the Network Manager Operations Centre.

The solution validated at Landvetter Airport aims at improving the efficiency of the turnaround process at regional airports by sharing information about key milestones associated with each flight. The milestones are generated in a quasi-automatic manner and offer a full set of departure planning information (DPI) messages to the Network Manager Operations Centre. By sharing accurate estimates of take-off times for flights is expected to bring network performance benefits as a result of enhanced traffic predictability and reduced need for sector capacity 'buffers'. In doing so, the



solution provides regional airports with an affordable means of meeting the Network Manager accuracy criteria.

The validation exercise was based on the A-CDM / airport operations plan (AOP) Indra solution, aiming at validating the capabilities of a Regional Network Integrated (RNI) tool module.

During the exercise, three working positions were used, each one with a configured interface according to its role, in order to enable tower controllers, ground handlers and airport operators to perform their own tasks.

The different stakeholders supervised how the system was monitoring the operations and providing calculated target off-block times (TOBTs) and target take off times (TTOTs) based on the disruptions detected during the turnaround.

The participants were extremely positive regarding the usefulness of flight information for both arrivals and departures that they were provided with

and also that EUROCONTROL NM are now analysing the data quality contained in the different DPI messages compared to actual operations.

The validation was carried out together with EUROCONTROL, Swedavia, LFV and Menzies.

[www.sesarju.eu/projects/TAM2](http://www.sesarju.eu/projects/TAM2)

*This project received funding from the SESAR Joint Undertaking within the framework of the European Union's Horizon 2020 research and innovation programme under grant agreement No 874472.*



## SESAR partners propose solution to optimise traffic in busy airspace

**SESAR research partners fine-tuned a tool to optimise arrivals and departures in high density and complex airspace. The tool works in near real time to calculate periods of peak demand on particular routes and proposes solutions to share out the traffic and improve the environmental efficiency through optimised climb and descent profiles.**

The research was carried out by UK air navigation service provider, NATS, and Indra, who ran a simulation to assess the systemised airspace management prototype (SYSMAN) and air traffic control procedures within systemised airspace around London (extended terminal manoeuvring area - E-TMA) for arrival and departure procedures, as part of work on the SESAR industrial research project, Enhanced Arrivals and Departures and the SESAR Solution PJ.01-W2-08B.

SYSMAN aims to enhance significantly how air traffic controllers identify and act upon imbalances of demand and

capacity simulated airspace. The tool continuously monitors the predicted demand/flow rates for defined Fixpoints, route-segments, or sectors, identifying over-demand periods across given timeframes. When demand on either inbound or outbound flows is predicted to exceed specified limits, the user can look at options to balance demand across routes, or can ask the tool for automatic system suggestions.

The route balancing strategy considers the level of demand on secondary routes – e.g. inbound and outbound flows to adjacent airports – to suggest use of an alternative standard instrument departure (SID) or standard instrument arrival (STAR) routes for particular aircraft, or alternative cruise routes for overflights. This option, which takes advantage of the systemised airspace and performance-based navigation route structures (e.g. offload / parallel arrival and departure routes), aims at a system-wide optimisation of the flows, and a more consistent and manageable delivery of the departure streams into the en-route airspace.

The arrival scenario focused on the eastern sectors of London E-TMA, looking for bunching and capacity issues

both on the entry and merge points/ stacks, with the route options based on the current airspace structure.

The departure scenario focused on the western sectors, identifying issues on several of the departure routes, and used a more experimental systemised structure, with four parallel routes covering E-TMA airspace.

The validation platform made use of a prototype based on iACM System (Indra Airspace Capacity Manager), which was fed with simulated Network Manager traffic data for the pre-tactical phase, and included a connection with Indra's next-generation air traffic management system iTEC (interoperability Through European Collaboration) for an improved simulation of the tactical phase, and simulated Heathrow AMAN (arrival manager) messaging.

[www.sesarju.eu/projects/EAD2](http://www.sesarju.eu/projects/EAD2)

*The solution is part of the Enhanced Arrivals and Departure project, which received funding from the SESAR Joint Undertaking within the framework of the European Union's Horizon 2020 research and innovation programme (872085).*





## Controllers give thumbs-up to more accurate trajectory data

**Controllers participating in a recent SESAR validation campaign in Geneva have responded enthusiastically to the introduction of technology that will allow them to have a more accurate view of air traffic. Led by Skyguide and skysoft-ATM in cooperation with Airbus Defence and Space, the real-time simulations were conducted within the context of the SESAR Horizon 2020 4DSkyways project addressing trajectory-based operations (TBO).**

The validation, which took place mid May, focused on the use of automatic dependent surveillance – contract (ADS-C) reports to improve ground trajectory prediction and conflicts detection and resolution tools, and the use of new controller-pilot data link communications (CPDLC) ATN-B2 messages for complex and in advance clearances.

### ADS-C and extended project profile (EPP)

With ADS-C technology becoming available, aircraft have the capability to downlink and share their predicted trajectory (extended project profile, speed

schedule) from the flight management system (FMS) to the ground system tools. This data is very valuable since it offers an accurate picture in real time of the aircraft's intentions and performance (lateral & vertical profiles). The data is fed into controller support tools, allowing controllers greater situation awareness, and the ability to better detect and resolve possible trajectory conflicts.

### CPDLC ATN-B2 messages

Controller-pilot data link communications, CPDLC, allow for a fast exchange of text messages via data link between air traffic controllers and pilots. The advantages to this form of communication over traditional voice communications are manifold: it reduces the risk of misunderstandings and allows controllers to deal with requests simultaneously. The new CPDLC standard ATN-B2 coupled with the capability of autoloading function in the FMS allows for the transmission complex and in advance clearances to the flight crew. This permits in particular to use points with latitudinal and longitudinal coordinates in designing trajectories, which facilitate optimum trajectories, therefore flight efficiency.

### Advanced automation

CPDLC and ADS-C open up the possibility on increasing the automation of the

air traffic management system. In this respect, SESAR partners have developed automation tools, such as trajectory visualisation on the human-machine interface, electronic coordination (inter-centre/inter-sector trajectory negotiation), graphical trajectory design tools, systems proposals, automated CPDLC message generation, monitoring aids (e.g. discrepancy detection and solving, conformance monitoring), conflicts detection and resolution tools.

### Validation campaign

The objectives of the validation exercises were:

- To assess the use of the ADS-C EPP data associated to CPDLC ATN-B2 capabilities to enrich ground trajectory prediction and therefore conflicts detection and resolution tools. Also, to test new functionalities and automation linked to complex clearances transmitted by datalink.
- To optimise air traffic control performance and task-sharing between executive and planning controllers thanks to better anticipation and advance clearances capabilities.

The results gained from the questionnaires and discussions among participants suggest that controllers found the use of downlinked ADS-C EPP in the ground system and the CPDLC ATN-B2 capabilities bring a lot of benefit in managing traffic, better anticipation thanks to improved trajectory prediction, inter-centre electronic coordination and clearances in advance. This also allows a better distribution of tasks between Executive and Planning Controllers. Controllers were very enthusiastic about the foreseen benefits of these new technologies.

[www.sesarju.eu/projects/4DSkyways](http://www.sesarju.eu/projects/4DSkyways)

*This project received funding from the SESAR3 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 8723*

## Can automatic speech recognition reduce aviation's fuel consumption?

**In 2022, SESAR 3 JU members and partners investigated the impact that automatic speech recognition (ASR) can have on flight efficiency and safety in air traffic management. The validation took place within the context of the SESAR industrial project, PROSA.**

ASR takes audio signals and transforms them into text, for example for visualisation on the controller's display. The technology integrates artificial intelligence (AI) and machine learning algorithms to consider text predictions based on surveillance data; creating ATM commands based on existing air traffic control concepts; and a combination of both to provide further applications for the controller working position (CWP).

Led by SESAR 3 JU member, DLR, the validation involved 10 air traffic controllers from Austro Control supported by two safety experts from Integra recently validated the influence of automatic speech recognition on flight efficiency and ATM safety in DLR's ATMOS simulation environment.

The validation also saw the participation of DLR experts of the ATM simulator and speech recognition and understanding (ASRU), one subject matter expert from Austro Control, one observer from SESAR 3 Joint Undertaking.

The trials were conducted within the context of the PROSA project, which is developing a dedicated ASR solution, and the HAAWAI project, which provided expertise ASR architecture and improved transcription and annotation rules.

Each controller took part in in four different simulation runs either with a medium or a high (42 arrivals per hour) traffic scenario. Both scenarios were conducted once with



ASRU support and once without it. To avoid sequence effects, five controllers started with ASRU support while other five started without it (so called baseline runs).

DLR is evaluating the effect of ASRU on the flown trajectory length, which correlates of course with kerosene consumption. In baseline runs the controllers entered all spoken commands manually into the aircraft radar labels, i.e. they entered heading, speed, flight level and altitude values as well as cleared waypoints, transitions and descent rates. In simulation runs where ASRU was active, these inputs were done automatically, only required correcting actions when ASRU did not recognize a clearance correctly. It can be already stated now, that the number of necessary inputs was reduced by a factor between 8 and 12 with ASRU support.

The ASRU can also mean enhanced safety since the time saved on inputs can be used to focus on safety-critical tasks. When it becomes necessary, the ATCO can use this additional time for taking care of emergency flights, for coordinating with

other sectors or simply for improving the performance by giving the right clearance at the "perfect" time.

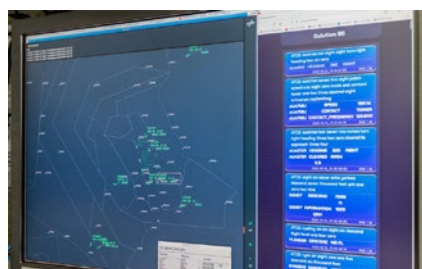
These safety buffers were not only claimed, but measured by a secondary task, which the controllers performed in addition to controlling the traffic.

From observations (without detailed evaluation) it can be assumed that the command recognition rate was above 90%. Detailed evaluation of ASRU performance is in progress and will be reported later. Safety experts from Integra, on behalf of air navigation services of the Czech Republic, are currently evaluating, if the remarkable performance of ASRU could also have negative effects on safety due to over trust in the system. The solution in this case is the integration of ASRU output with the downlinked settings from the aircraft, so that an additional safety net is available.

The benefit of the presented ASRU solution is that controllers can concentrate on his/her main task, monitoring and sequencing aircraft and can avoid the tedious work of maintaining the radar label contents!

[www.sesarju.eu/projects/PROSA2](http://www.sesarju.eu/projects/PROSA2)

*This project received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 874463*



**SESAR makes progress on virtual centre technologies**

**In 2022, SESAR research partners successfully completed a series of tests on virtual centres and the delegation of air traffic management service provision. The tests were conducted as part of SESAR project PJ.10-W2 PROSA (Solution 93) and PJ.32-W3 Virtual centres, under the lead of German air navigation service provider, DFS Deutsche Flugsicherung, and compliant with the standard of EUROCAE WG-122.**

Virtual centres sees the unbundling of the services that make up air traffic control such as flight data, radar and weather information and decoupling these services from the physical location of the control centre and the controller working position (CWP). In doing so, air navigation service providers can delegate services and resources to deal more flexibly with traffic fluctuations, virtually allocating controllers and resources where and when needed, and scaling capacity up or down according to demand.

**Multiple cross-border validation (PJ.10-W2-93 and PJ32-W3-VC – EXE3)**

Skyguide & Skysoft-ATM together with their partners (DSNA, DFS, NATS, INDRA and FREQUENTIS) have successfully developed and validated a virtual centre platform, composed of several ADSPs and ATSUs where all the data exchanged were managed through a central broker based in Vienna, at FREQUENTIS premises. The aim was to demonstration interoperability between ATSUs and ADSPs irrespective of the vendors of the systems installed at the premises. By combining different virtual centre architectures and different operational use cases (e.g., delegation by night

and in contingency situations), a total of 10 different delegation use cases were developed covering the following operational scenarios.

Despite some instabilities observed in the network (VPN connections over public internet were used), the exercise partners were able to play all the planned use cases. The performances of the CWPs and ADSPs in exchanging data through the broker were rated from excellent to acceptable. In certain CWPs, the feeling was similar to being in a true OPS room, in front of an operational system.

**Italian validation (PJ.10-W2-93 EXE4 and PJ32-W3-VC – EXE 1.5)**

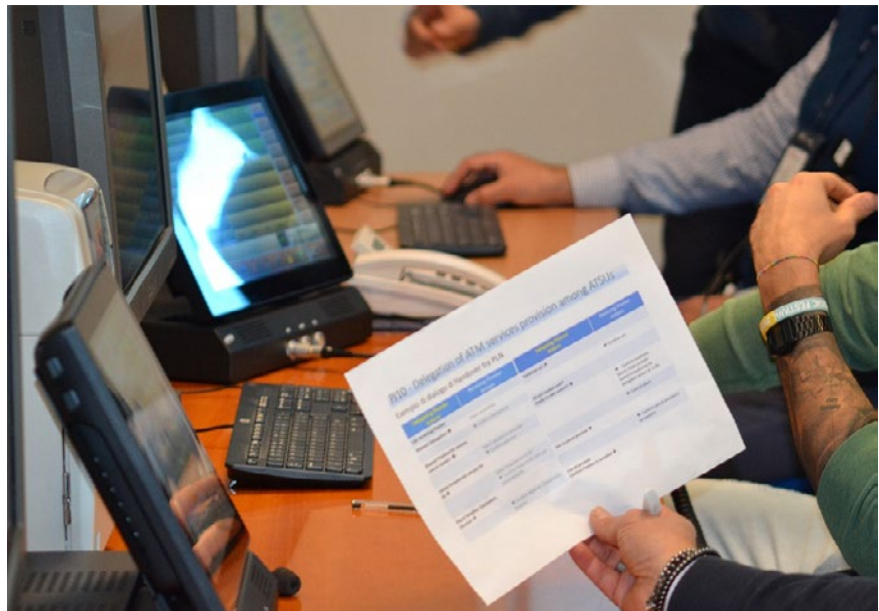
The Italian validation was carried out at ENAV National Test Facility in Rome using Coflight Cloud Services, the LEONARDO Controller Working Position and SITTI Voice Control Distribution systems. They involved the delegation of ATM services provision among ATSUs and contingency use-cases involving an ADSP and two different air ATSUs (Rome and Brindisi Area Control Centres) and focused on the coordination of both

air traffic flow capacity management (ATFCM) with the local traffic load management Tool from the partner IDS AirNav, and civil-military operations.

Specifically, the exercises combine architectures and tested different traffic load conditions ranging from medium to high density in a total of 15 different delegation and contingency use-cases scenarios, including night time operations, on-demand and service provision between civil military operations. Overall, the validations demonstrated the feasibility and added value of the solution.

**Danish-Swedish validation (PJ.10-W2-93 and PJ32-W3-VC – EXE5)**

A newly developed TopSky ATC platform that was deployed in Copenhagen, Malmoe and Paris, and focused on ATS delegation across national boundaries in support of workload distribution. The exercise mainly looked at the operational aspects, human acceptability and feasibility in relation to ATS delegation. In the scenario, an increase in traffic occurred in Copenhagen airspace, triggering a delegation request to



Malmö, to reduce the workload for the Copenhagen controllers. The operational procedures developed in PJ.10-W2 PROSA Solution 93 were applied during the delegation process and ATS delegation was performed across the boundary, both to an idle (not used) controller working position (CWP), as well as to a CWP already managing traffic. Several different sector configurations / delegation scenarios were tested. The exercise provided useful information about safety, human performance and

operational concept, as well as platform development possibilities.

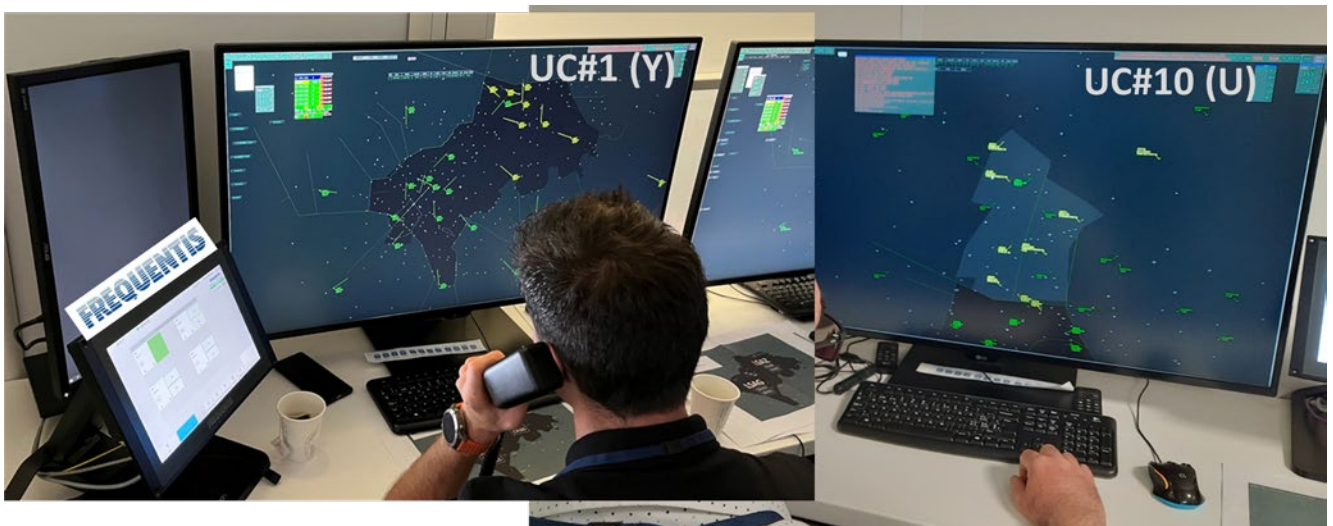
Even though some delay was detected in data transmission during the exercise, while using public internet for the data transfer, the stability of the platform was a major contributor to the successful outcome. The overall concept of ATS delegation was perceived as acceptable from a human performance perspective, even if some adaptation might take place in both systems and procedures to

mature the concept further. No critical safety issues were identified during the exercise.

[www.sesarju.eu/projects/PROSA2](http://www.sesarju.eu/projects/PROSA2)

[www.sesarju.eu/projects/VC](http://www.sesarju.eu/projects/VC)

*These projects has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreements No 101017587 and No 874463*



## Overview of industrial research projects

**AART** - Airport airside and runway throughput

(PJ.02 W2)

To improve the efficiency and resilience of arrival and departure operations at capacity constrained airports and access to secondary airports, the project addresses human, technical, procedural and performance aspects in the following areas: Advanced geometric GNSS based procedures in the TMA; separation evolution of separation minima for increased runway throughput improved access to secondary airports digital evolution of integrated surface management; and safety support tools for avoiding runway excursions.

Web: [www.sesarju.eu/projects/aart](http://www.sesarju.eu/projects/aart)

**TAM** - Total airport management

(PJ.04 W2)

European airports need to become more operationally efficient. To this end, the project is developing concepts, tools and procedures to increase the predictability and resilience of airport operations, improving the punctuality of flights in a safe and environmentally sustainable manner. The aim is to improve airport/network integration for large and medium/regional airports, improve airport airside/landside integration, and reduce the impact of meteorological aspects on airport operations. The project is also investigating how environmental aspects can be better monitored and managed in day-to-day airport operations.

Web: [www.sesarju.eu/projects/TAM2](http://www.sesarju.eu/projects/TAM2)

**DTT** - Digital technologies for tower

(PJ.05 W2)

The project aims works on two different topics: multiple remote tower and remote tower centre; and new human machine interaction (HMI) modes for airport tower. The solutions developed by the project are expected to positively contribute to safety and increase situation awareness and controllers' productivity.

Web: [www.sesarju.eu/projects/DTT](http://www.sesarju.eu/projects/DTT)

**CI** - Content integration, performance management and business case development

(PJ.19 - W2)

This project assesses the performance of the SESAR Solutions compared with the performance ambitions set out in the European ATM Master Plan. This is done in close collaboration and coordination with all SESAR 2020 projects through a continuous, rolling and iterative content integration process.

**AMPLE** - Master planning

(PJ.20 - W2)

The project brings together the SESAR community, ensuring the broad ATM representativeness required from air navigation service providers, airports, airborne and ground industry and Network Manager, in order to maintain the European ATM Master Plan, the roadmap on ATM modernisation.

**EAD** - Enhanced arrivals and departures

(PJ.01 - W2)

The project is developing concepts, tools and procedures to optimise terminal manoeuvring areas (TMAs) in a safe, cost-efficient and environmentally sustainable manner. This will be achieved by taking advantage of the latest technological developments from both an airborne and a ground-system perspective and through the secure sharing of data. The needs of all airspace users are being addressed including rotorcraft. The aim is to exploit the environmental benefits achieved from continuous climb operations (CCO), continuous descent operations (CDO) and improved arrival sequencing. A focus is to minimise delays and improve resilience and predictability for high-density/complex TMAs.

Web: [www.sesarju.eu/projects/EAD](http://www.sesarju.eu/projects/EAD)

**PROSA** - Separation management and controller tools (PJ.10 W2)

The project is validating a series of separation management and controller tools aimed at boosting the performance of the air traffic system across all key areas. The project will focus on three solutions: flight-centric ATC and improved distribution of separation; delegation of airspace amongst air traffic service units (ATSU); HMI interaction modes for ATC centres.

Web: [www.sesarju.eu/projects/PROSA2](http://www.sesarju.eu/projects/PROSA2)

**ERICA** - Enable RPAS insertion in controlled airspace

(PJ.13 W2)

The project is developing and validating the key operational and technological enablers that are necessary to ensure the integration of remotely-piloted aircraft systems (RPAS) into non-segregated airspace. These include a detect and avoid (DAA) system for IFR RPAS operating in airspace A to C for collision avoidance and a framework for allowing routine access and operations by RPAS.

Web: [www.sesarju.eu/projects/ERICA](http://www.sesarju.eu/projects/ERICA)

**4D Skyways** - Improving trajectory management for European air transport

(PJ.18 W2)

The project builds on research outcomes on trajectory management to enable a move towards trajectory-based operations (TBO). The focus is now on improving the ground trajectory prediction and separation management/ monitoring tools by using aircraft trajectory data, more precise weather data, improved algorithms and machine-learning techniques. The project is exploring new automation techniques that can support trajectory exchanges (big data, machine learning, voice recognition, etc) and define a common trajectory service as an alternative architecture for trajectory exchanges between ground ATM actors compared to the current fragmented approach.

Web: [www.sesarju.eu/projects/4DSkyways](http://www.sesarju.eu/projects/4DSkyways)

**VC** - Virtual centre

(PJ.32 W3)

Traditionally, ANSPs host a monolithic ATM system in each air traffic system unit (ATSU) with very few information services and infrastructure elements being shared between the different centres. In the virtual centre approach, the controller working positions are decoupled and may even be geographically separated from the ATM information services that they consume, and these ATM information services may be shared between different ATSUs or even between ANSPs. The project is further investigating the air traffic flow and capacity management (ATFCM) aspects of such airspace delegation among ATSUs.

[www.sesarju.eu/projects/VC](http://www.sesarju.eu/projects/VC)

**FALCO** - Flexible ATCO endorsement & LDACS complement (PJ.33 W3)

The project is investigating and validating technologies and procedures, enabling a more flexible and efficient re-organisation and endorsement of air traffic controllers (ATCOs), based on traffic complexity, sector classes and the level of skills, experience and training a controller has received on a specific class of working environment and supporting system. The project is also working on replacing analogue voice communication with a capability supported by I-band digital aeronautical communication system (LDACS) in order to improve air-ground connectivity.

[www.sesarju.eu/projects/FALCO](http://www.sesarju.eu/projects/FALCO)

**I-CNSS** - Integrated CNSS (PJ.14 W2)

The project is developing the future technologies coming from the communication, navigation and surveillance (CNS) domains in order to support and manage operational services, like the 4D trajectory management, in the future ATM system. Performance requirements for CNS systems are becoming increasingly complex and demanding and must be considered as part of an integrated and holistic system of systems and a unified concept of operations, where possible.

Web: [www.sesarju.eu/projects/ICNSS](http://www.sesarju.eu/projects/ICNSS)

**OAUO** - Optimised airspace users operations

(PJ.07 W2)

The project aims at defining and validating improved airspace user processes and tools in order to optimise ATM Network operations. The project is developing a collaborative framework managing delay constraints on arrivals; and mission trajectory management with integrated dynamic mobile Areas (DMA) Type 1 and Type 2. It is also looking at developing requirements and validating procedures and workflows for flight/wing operations centre to enable collaborative decision making between stakeholders throughout the flight trajectory. Other areas of focus include integrating airspace user (AU) priorities and preferences in airport and Network processes; making use of automation in collaborative decision making and coordination; better interoperability between AU and the NM operations.

Web: [www.sesarju.eu/projects/OAUO2](http://www.sesarju.eu/projects/OAUO2)

**DNMS** - Digital network management services

(PJ.09 W2)

The project focuses on improving the network traffic prediction for all stakeholders involved in demand capacity balancing, dynamic airspace configurations, integrated network management and ATC planning and collaborative network performance management. This project is structured around three solutions: dynamic airspace configurations (DAC); enhanced network traffic prediction and shared complexity representation; and a prediction algorithm to anticipate the performance degradation in identified areas within the network.

Web: [www.sesarju.eu/projects/DNMS](http://www.sesarju.eu/projects/DNMS)

**AURA** - ATM U-space interface

(PJ.34 W3)

The project aims to identify the requirements for U-space information exchange with ATM through system-wide information management and will validate a set of selected U-space services, developing the service definition for the SWIM candidate services. It will also provide inputs for the current regulatory and standardisation initiatives regarding U-space with a high involvement of external stakeholders.

Web: [www.sesarju.eu/projects/aura](http://www.sesarju.eu/projects/aura)







# DEMONSTRATING SESAR

## Very large-scale demonstrations

### Performance monitoring for optimised climb operations

**Air traffic conflicts can be prevented by applying altitude constraints to deconflict aircraft ahead of time so that when they reach a crossing point they are vertically separated. This reduces the number of tactical interventions by air traffic control and enables uninterrupted and more efficient climb and descent profiles. In order to make these new procedures possible, pilots need to be well aware of the constraints and monitor their climb and descent performance so these altitude constraints can be met.**

The Integrated TMA, Airport and Runway Operations (ITARO - PJ.37) project demonstrated several solutions in the airport environment that improve efficiency both operationally as well as environmentally.

As part of the project, NLR conducted a pilot-in-the-loop evaluation to determine what kind of additional information on the cockpit displays can help improve the situational awareness with respect to altitude constraints. This evaluation is a demonstration of advanced climb and descent operations where departure and arrival routes are deconflicted with the use of altitude constraints at route crossings.

The pilot-in-the-loop evaluation was conducted in NLR's APERO cockpit simulator. APERO is a fixed-base flight simulator that can be configured to simulate a wide range of aircraft types. Its flexible software enables easy and quick implementation of new cockpit systems and applications.

The newly developed climb performance monitor indications assist the pilot with timely identification and notification of not meeting the altitude constraint. Air traffic control should then be informed

by the pilot as soon as possible to avoid a potential traffic conflict.

NLR implemented four different experimental indications on the primary flight display that provide the pilot with information on the current climb performance with respect to the next altitude constraint. During the experiment the pilots were asked to evaluate the different experimental indications and determine which indication provides the most situational awareness of the altitude constraints and the current climb performance.

The general conclusion from the piloted evaluation is that additional information on the climb performance with respect to the next altitude constraint does increase the situational awareness. This helps the pilot to timely identify that an altitude constraint might not be met. Each type of indication provides specific benefits and the pilots did not concur on what the most useful indication is. However, they did agree that a dedicated indication for the required climb performance monitoring purpose on the primary flight displays is very useful.

All feedback from the pilots will be used to derive a new type of indication that combines the best features of all four indications evaluated in this experiment.

[www.sesarju.eu/projects/ITARO](http://www.sesarju.eu/projects/ITARO)

*This project has received funding from the SESAR 3 Joint Undertaking (JU) under grant agreement No 101017622.*



**SESAR partners move ahead with sustainable taxiing tests at Schiphol**

**SESAR partners, led by SESAR 3 JU founding member Schiphol, have started follow-up testing on more sustainable methods for taxiing. The tests are part of the work undertaken by SESAR’s flagship very-large demonstration, ALBATROSS, and its successor, the Digital European Sky Demonstrator, HERON.**

Taking place at the airport, the trials involved a KLM aircraft moving to and from a platform near the Zwanenburgbaan runway with its engines switched off. This way of taxiing can significantly reduce fuel consumption and therefore CO2, nitrogen and ultrafine particle emissions.

Taxibots will be deployed at the airport over the next year and a half. The Taxibots will take selected aircraft to a location further away from the gate and en route to the runway to start their engines there. Further operational testing will include pushbacks and towing empty aircraft.



The aim is to test, introduce and scale up new procedures for sustainable taxiing to and from the Polderbaan, among other locations, from mid-2024.

Schiphol aims to have sustainable taxiing operation at the airport by 2030, and is working towards this goal in collaboration the Dutch air navigation service provider, The Netherlands (LVNL), KLM, Transavia, Corendon Dutch Airlines, TUIfly and ground handling companies dnata, Swissport, Viggo, KLM Ground Services

and TaxiBot provider Smart Airport Systems. The Ministry of Infrastructure and Water Management is supporting the initiative, in addition to the SESAR 3 Joint Undertaking.

*ALBATROSS has received funding from the SESAR Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101017678*

*HERON is co-funded by the European Union under grant agreement No 101079472*



**World premiere at Frankfurt Airport: satellite-based precision landings possible even in bad weather**

**In July, DFS, the German air navigation service provider, started the use of the GBAS precision landing system for poor weather conditions at Frankfurt Airport. This is the first system of its kind in the world.**

DFS has been operating digital precision landing systems, known as Ground Based Augmentation Systems (GBAS), at Bremen Airport since 2012 and at Frankfurt Airport since 2014. GBAS is the term

used to describe navigation by satellite, but combined with a ground-based supplementary, or augmentation, system. Only this combination gives the accuracy required for precision landings.

So far, the system has been used for landings under good visibility. Since 14 July 2022, aircraft can now approach Frankfurt Airport using GBAS even in poor weather conditions. Such weather conditions are known as meteorological category II, or CAT II, i.e. a cloud base of 30 metres and a minimum visibility of 300 metres.

**Full runway capacity available – even in bad weather**

GBAS thus joins the established instrument landing system (ILS) in the ranks of approach aids for all-weather

operations. The decisive advantage is the system's digital signals, which are not disrupted by preceding aircraft. With the conventional instrument landing system, separation has to be large between the landing aircraft because of the possible problems caused by poor weather conditions. GBAS, on the other hand, allows approaches with almost normal separation. In bad weather, almost the full capacity of the runways can thus be utilised and delays avoided.

The prerequisite for use is that aircraft are equipped with the technology. Even if

just 30 percent of aircraft have the new system on board, noticeable capacity advantages can be expected, as shown by simulations conducted in advance.

The first landing using the new procedure was made by Lufthansa flight LH273 from Milan Linate with an Airbus A319.

The new GBAS CAT II approach procedures were realised within the framework of the SESAR DREAMS project funded by the European Union. In the pan-European SESAR projects, air navigation service providers, airlines,

airports and other technology partners jointly develop concepts for the air traffic of the future. This expert group has pioneered the use of the new GBAS landing system for all-weather operations worldwide.

[www.sesarju.eu/projects/DREAMSVLD](http://www.sesarju.eu/projects/DREAMSVLD)

*This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 874469*

## Green deal and U-space Digital Sky Demonstrators officially get going

**In November, five Digital Sky Demonstrators officially kicked off. With combined funding to the tune of EUR 45 million from the Connecting Europe Facility between now and 2025, the selected projects aim to accelerate the market uptake of SESAR Solutions for greener aviation and urban air mobility.**

The projects were selected following a call issued in September 2021 by the European Climate, Infrastructure and Environment Executive Agency (CINEA) under the Connecting Europe Facility. The demonstrators are a key tool to support the SESAR JUs vision of delivering the Digital European Sky, matching the ambitions of the 'European Green Deal' and the 'Europe fit for the digital age' initiatives. The two SESAR-related topics covered by the call, 'U-space and urban air mobility' and 'aviation Green Deal', were selected from among nine flagships outlined in the work programme of the new SESAR 3 Joint Undertaking.

The Digital Sky Demonstrators will take place in live operational environments and will put to the test (on a very large scale) the technological solutions necessary to deliver the Digital European



Sky. The demonstrators are part of an innovation pipeline designed by the SESAR Joint Undertaking to bridge the gap between applied/industrial research and industrialisation, and to accelerate market uptake. Critical to their success will be the involvement of early movers, as well as a strong and close connection with relevant standardisation and regulatory activities and bodies.

### Aviation Green Deal

The objective of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement, requires accelerating the shift to smarter

and more sustainable mobility. This implies the need for aviation to intensify its efforts to reduce emissions. To this end, a set of operational measures to improve the fuel efficiency of flights will have to be put in place with the aim of enabling aircraft to fly their optimum fuel-efficient 4D trajectory. At the same time, to ensure sustainable air traffic growth, it will be necessary to speed up the modernisation of the infrastructure in order to offer more capability and capacity, making it more resilient to future traffic demand and adaptable through more flexible air traffic management procedures. Furthermore, reducing the impact of aircraft noise and improving air quality will remain a priority around airports.

## AVIATION GREEN DEAL

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Project name	Description	Duration (months)	Coordinator
<b>ECHOES</b> (Extended Communications in vHf Over Enhanced Satellite segment)	<p>Aims to demonstrate how satellite-based VHF voice and data communications, as well as ADS-B surveillance can improve ATM services and have positive environmental impact in remote and oceanic regions. ECHOES will launch two new satellites to provide new operational services aimed at:</p> <ul style="list-style-type: none"> <li>▪ Increased efficiency: reducing separation, flying more efficient routes and increasing punctuality.</li> <li>▪ Reinforced safety: monitoring every flight and connecting aircraft permanently.</li> <li>▪ Reduced CO<sub>2</sub> footprint: enabling more efficient routes and increasing the predictability of flights.</li> <li>▪ Flexible route planning: allowing users to fly preferred and more flexible efficient routes.</li> <li>▪ Readiness: No changes will be required by services in existing installations, avionics or controllers and pilots procedures.</li> <li>▪ Standardisation: support the development of standardisation for satellite-based communication, navigation and surveillance systems.</li> </ul>	36	Startical
<b>HERON</b> (Highly Efficient Green Operations)	<p>Aims to mitigate CO<sub>2</sub> emissions from air transport through the development of more efficient aircraft and air traffic control operations enabled by:</p> <p>Improved technology, such as equipping aircraft with more advanced continuous descent approach flight management system (FMS) functionalities, increased glide slope capabilities;</p> <p>More efficient aircraft operations targeting gate-to-gate optimisation through green approaches (efficient procedure designs), green taxiing, trajectory planning improvements and integrated 4D for green trajectories (ADS-C);</p> <p>Infrastructure improvements, including ADS common services and new controller supporting tools;</p> <p>Harmonised performance benefit assessments and ambitious standardisation and regulation supporting efficient operations.</p> <p>The demonstration will bring together mainline aircraft operators, airports, air navigation service providers, who will carry out some 1,000 flights across Europe.</p>	36	Airbus

## U-SPACE AND URBAN AIR MOBILITY

To unlock the potential of the drone economy and enable urban air mobility (UAM) on a wide scale, a new air traffic management framework for low-altitude operations needs to be put in place. Known as U-space, the framework foresees a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. As such, U-space is an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and all types of environment - even the most congested - while addressing an appropriate interface with manned aviation and air traffic control.

Project name	Description	Duration (months)	Coordinator
<b>U-ELCOME</b> (U-space European COMmon dEpLoyment)	<p>Aims to facilitate the market uptake of U-space services (U1 and U2) through a set of demonstrations in various operational environments and locations across Europe (Spain, Italy and France). The demonstration activities will also address the interface with the air traffic management system to ensure safe and fair access to airspace for all airspace users.</p> <p>The U-ELCOME will aim to develop a scalable U-space architecture enabling the required level of information exchange and coordination among U-space service providers (USSPs) and between USSPs and ATM using interoperable standards, allowing for automated drone traffic management and situational awareness among all U-space stakeholders.</p> <p><a href="#">More about the project</a></p>	36	Eurocontrol
<b>BURDI</b> (BeNe U-space Reference Design Implementation)	<p>Aims to demonstrate the feasibility of managing dense and complex unmanned aircraft systems (UAS) operations in controlled, uncontrolled and urban air mobility environments. Multiple domains will be considered, such as the delivery of goods, inspections, support to medical as well as security operations. The trials will take place around the Belgian cities of Antwerp, Liège and Brussels close to international airports, an active maritime port and the border with The Netherlands. The project aims to ensure that solutions to be deployed are economically sustainable and socially acceptable and of benefit to the general public. Ultimately, the project aims to become a reference for best practices, standardisation, harmonisation and/or interoperability, fostering operational deployment of U-space airspace across Europe</p> <p><a href="#">More about the project</a></p>	33	skeyes
<b>EALU-AER</b> Enhanced Automation for U-space/ATM integration	<p>Aims to demonstrate U-space architecture operations (U1 and U2 services) and the integration with ATM, leveraging world-class drone traffic management technology solutions. These solutions include a UAS platform (WebUAS), a backhaul network (ARINC Ground Network), communications and surveillance equipment, and advanced three-dimensional phased array radar (Skyler). The project builds on previous research and seeks to enable higher automation for future U3 and U4 services. The project will focus on five use cases of urban air mobility that capture the operational requirements, vehicle dynamics, and technology demonstrations associated with the projected near-term UAM services market, such as local inspection, light-freight, long-distance logistics, air-taxi operations, hence spanning short to long range distances.</p> <p>The partners involved aim to integrate the U-space system into the Future Mobility Campus Ireland's (FMCI) vertiport operations site and associated facilities.</p> <p><a href="#">Read the press release</a></p>	36	Future Mobility Campus Ireland

## Second call launched for SESAR 3 JU Digital Sky Demonstrators

**In September, the European Climate, Infrastructure and Environment Executive Agency (CINEA) launched a call under the Connecting Europe Facility, containing provisions for a series of SESAR JU Digital European Sky Demonstrators in the areas of automation and virtualisation. The demonstrators are a key tool to support the SESAR JU’s vision of delivering the Digital European Sky, matching the ambitions of “sustainable and smart mobility” and “Europe fit for the digital age” initiatives. The demonstrators, when selected, are expected to be launched in 2023 and to run until 2026.**

The two SESAR-related topics covered by the call, “gradual transition towards

higher levels of automation” and “virtual centres and ATM data service providers (ADSPs)”, were selected from among nine flagships outlined in SESAR 3 Joint undertaking’s multiannual work programme:

**Gradual transition to higher levels of automation (CEF-T-2022-SIMOBGEN-SESAR-DSDA-WORKS):** Europe’s ATM infrastructure operates with low levels of automation support and data exchange, leading to rigidity, lack of scalability and resilience, and an inability to exploit emerging digital technologies, including in support of new airspace users. The future architecture of the European sky requires increased automation in air traffic control and an infrastructure commensurate with the performance required by each airspace user type and environment, including those in the transition areas between Europe and neighbouring ICAO regions, which may have specific regulations and challenges.

**Virtual centres and ATM data service providers (ADSPs) (CEF-T-2022-SIMOBGEN-SESAR-DSDU-WORKS):**

A lack of flexibility in the sector configuration capabilities at pan-European level. This is caused by the close coupling of ATM service provision to the ATS systems and operational procedures, preventing air traffic from making use of cloud-based data service provision. A more flexible use of external data services, considering data properties and access rights, would allow the infrastructure to be rationalised, reducing the related costs. It will enable data- sharing, foster a more dynamic airspace management and ATM service provision, allowing air traffic service units (ATSU) to improve capacity in portions of airspace where traffic demand exceeds the available capacity. It furthermore offers options for the contingency of operations and the resilience of ATM service provision.

## Overview of SESAR 2020 very large-scale demonstrations

**STAIRS** - Surface Traffic Alerts Improve Runway Safety

(VLD2-W2)

Closed

While safety has improved thanks to airport surface management systems, these systems do not fully resolve the risk of runway incursions and are not envisaged to be deployed at smaller airports. And although traffic collision avoidance systems (TCAS) has been in use since 1981, there is currently no aircraft system to prevent runway collisions. SESAR JU members and partners have developed a solution making use of ADS-B technology to provide on-board surface alerts (PJ.03b-05 ‘Traffic alerts for pilots for airport operations’). This demonstration assessed the performance of this solution in real operational environments, in particular the absence of nuisance alerts, paving the way towards the deployment of the solution’s or future ADS-B applications and standards.

Web: [www.sesarju.eu/projects/STAIRS](http://www.sesarju.eu/projects/STAIRS)

**ITARO** - Integrated TMA, airport & runway operations

(PJ.37 W3)

The project plans to demonstrate on a larger scale several solutions in the airport environment, which research has shown can bring efficiencies, both operationally and environmentally. These include procedures to enable more efficient and integrated runway throughput and terminal operations; a collaborative framework for managing delay constraints on arrivals; and improved arrival and departure operations.

Web: [www.sesarju.eu/projects/itaro](http://www.sesarju.eu/projects/itaro)

**SORT** - Safely Optimised Runway Throughput

(VLD3-W2)

The project is testing solutions delivered such as optimised separation delivery on final approach (PJ.02-01-01); wake turbulence separations (for arrivals) based on static aircraft characteristics (PJ.02-01-04); reduction of wake turbulence risk considering acceleration of wake vortex decay in ground proximity (PJ.02-01-07); minimum pair separations based on required surveillance performance (PJ.02-03); trajectory based integrated runway sequence (PJ.02-08-01); and increased runway throughput based on local ROT characterisation (ROCAT) (PJ.02-08-03).

Demonstrations are taking place at London Heathrow, Vienna and Stockholm Arlanda.

Web: [www.sesarju.eu/projects/sort](http://www.sesarju.eu/projects/sort)

**DREAMS**- Demonstration of runway enhancements made with satellite navigation

(VLD01 W2)

Closed

This project sought to mitigate the climate impact of aviation through the development of meaningful and sustainable activities including efficient airport operations using GNSS technology and improved aircraft noise assessments.

Web: [www.sesarju.eu/projects/DREAMSVLD](http://www.sesarju.eu/projects/DREAMSVLD)

**ADSCENSIO ADS-C** enables and supports improved ATM operations

(PJ.38 W3)

Building on the results of DIGITS, this project aims to demonstrate the efficiency and robustness of a technological infrastructure to support datalink communications between the aircraft and various ground consumers for real-time transmission of four-dimensional trajectory data. The aim is to support the industrial implementation of the use of automatic dependent surveillance-contract extended projected profile (ADS-C-EPP) data downlinked from aircraft – the target is for 45% of all flights in Europe to have the capacity to share trajectory.

Web: [www.sesarju.eu/projects/ADSCENSIO](http://www.sesarju.eu/projects/ADSCENSIO)

**ALBATROSS** -The most energy efficient flying bird (VLD02)

ALBATROSS aims to support the transition towards greener and more sustainable aviation. Taking holistic approach, the project addresses all flight phases and demonstrate the complementary between airborne and ground solutions, such as alternative aircraft fuel, technologies for better air-ground connectivity, artificial intelligence and big data, and highly collaborative ATM procedures.

Web: [www.sesarju.eu/projects/ALBATROSS](http://www.sesarju.eu/projects/ALBATROSS)

**VOICE** - Reduced separations and improved efficiency based on Vhf cOmmunIcations over LEO satEllites (VLD02)

The project is demonstrating the benefits of using satellite-based VHF systems for voice and datalink air traffic services in remote and oceanic airspace where currently there is no coverage, especially in reducing separation without compromising on safety. Project partners are performing demonstration activities in oceanic areas to demonstrate the viability of space-based infrastructure as the backbone for current terrestrial airspace. They will also perform cross-border operations to illustrate the feasibility of using these technologies across national borders.

Web: [www.sesarju.eu/projects/voice](http://www.sesarju.eu/projects/voice)



# ENABLING THE SAFE AND SECURE INTEGRATION OF DRONES

## U-space

### Initial results of SESAR U-space demos now available!

**In June, the SESAR 3 JU published the initial results from its U-space very large-scale demonstrations on the safe and secure integration of drones.**

The publication presents the initial results from seven research and innovation projects, namely one industrial research project and six very large-scale demonstrations:

- AURA ATM: U-space interface (Industrial research, PJ.34)
- CORUS-XUAM: Concept of operations for European U-space services – extension to urban air mobility
- AMU-Led: Air mobility urban large experimental demonstrations
- GOF2.0: Gulf of Finland 2.0 – Integrated urban airspace
- TINDAIR: Tactical instrumental deconfliction and inflight resolution
- SAFIR-Med: Safe and flexible integration of advanced U-space services for medical air mobility
- USPACE4UAM: Bridging the gap between development and deployment of U-space services to enable the safe introduction of UAM in Europe

From 2020 to 2022, these projects carried out tests and trialed solutions aimed at showing the readiness of U-space to manage a broad range of drone operations and related applications, and their interaction with manned aviation.

[www.sesarju.eu/publications](http://www.sesarju.eu/publications)

### Marking a new “aura” in air mobility

**In November, partners in the SESAR U-space AURA project completed a series of tests on two solutions aimed at enabling interactions between systems managing drone and conventional air traffic (ATM).**

Coordinated by Indra, the AURA (PJ.34) project aims to integrate the management of the very low-level airspace (VLL) or U-space as it is also known, with traditional air traffic management systems. The goal is to enable seamless operations between U-space and ATM.

Two validations took place in Madrid at Indra’s premises.

The first exercise assessed different interactions between U-space and ATM systems in a mid to long-term scenario, where there is a high volume of U-space operations. Under these new air traffic conditions, several ATM-U-space interface functionalities and services have to be developed further. For this reason, one of Indra’s exercises focused on validating the expected interactions between U-space services and ATM to enable dynamic drone flight plan modifications in case of non-nominal conditions, such as unmanned aerial systems (UAS) flying within a no-fly area after having applied a dynamic airspace reconfiguration. The drone was performing a runway inspection when a manned aircraft requested clearance for an emergency landing. The air traffic controller performed a Dynamic

Airspace Reconfiguration, forbidding UAS operations in the requested runway while enabling a U-space corridor allowing the drone to safely exit the conflicting area and ending its mission. Once the runway was cleared, air traffic controller gave clearance for a safe manned emergency landing. Everything went as expected!

What about the other exercise? A certain portion of airspace was delegated to UAS operations so that several commercial missions could be performed. These included a police drone mission, which was delegated to a particular area in which no other drones could operate. These operations were taking place in very low level (VLL) far from controlled airspace. Thanks to the “smart filtering” functionality, only UAS traffic information was shared with the ATM system, particularly to alert of a helicopter flying near the police drone mission or when a non-cooperative drone was entering into the police U-space area of operation.

In both exercises several innovative services and functionalities of the ATM-U-space interface were successfully tested, such as: dynamic airspace reconfiguration, “smart filtering” or dynamic flight plan modification. These were in addition to standard U-space functionalities like flight plan authorisation, geofencing or non-conformance monitoring were tested during this validation.

[www.sesarju.eu/projects/aura](http://www.sesarju.eu/projects/aura)

*This project has received funding from the SESAR Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101017521*



## Europe's first-ever beyond visual line of sight drone flight takes off in Belgium

**At the end of June, partners in SESAR's SAFIR-Med project got the green light from the Belgian civil aviation authority to operate a beyond visual line of sight (BVLOS) flight over a populated area between two hospitals in Antwerp. The flight is fully compliant with EASA's specific operations risk assessment (SORA) and unmanned aircraft system (UAS) regulations.**

BVLOS capabilities mean that flights can be flown beyond the visual range, enabling drones to cover far greater

distances and opening up the possibility of a wide variety of applications. In the case of the SAFIR-Med project, the focus is on urgent medical deliveries. These are coordinated through a command and control centre system (C2C), which has interfaces with a U-space services provider (USSP).

The flight, which took place on 22 June, was given authorisation to take off by the civil aviation authorities who validated the project's processes and technologies in three areas:

Combined mitigations to reduce the risk for people on the ground and in the air;

Risk mitigation based on the SABCA designed X-8 multicopter with an

integrated parachute, fully compliant with the flight test requirements specified in the ASTM F3322-18 Standard Specification;

Robust ground organisation, emergency response plan (ERP).

With this first authorisation, project partners are now planning a series of demos in the cities of Maastricht, Aachen, Hasselt, Heerlen and Liège.

[www.safir-med.eu](http://www.safir-med.eu)

*The project has received funding from the European Union's H2020 research and innovation programme under grant agreement No. 101017701*



## Cargo drone conducts final CORUS-XUAM test flights

Partners in the SESAR CORUS-XUAM very large-scale demonstration ran their final flight tests using a cargo drone from Volocopter and testing deconfliction between crewed and uncrewed aircraft. Taking place in Germany at DLR's National Experimental Test Centre for Unmanned Aircraft Systems at Magdeburg-Cochstedt Airport, the tests simulated two research scenarios for urban areas in London and Frankfurt/Main for the first time. The multi-national research team composed of DFS Deutsche Flugsicherung GmbH, DLR, Droniq, NATS, and Volocopter presented their flight tests to the invited guests at an open day on 30 November 2022.

Drones and drone technology will change our everyday lives. They may soon be more visible in the skies, ranging from delivery drones to air taxis. But in order for drone flights to become a part of everyday life in the coming decades, clearly defined regulations, flight corridors, and safe air traffic management (ATM) for new airspace users are needed. After all, conventional air traffic and future uncrewed aircraft must operate smoothly and reliably side by side in a safe manner. Flight tests are essential for designing and testing realistic unmanned aircraft system traffic management (UTM) for uncrewed air transport. To this end, a series of large-scale demonstrations (VLDs) have taken place throughout the year within the framework of the EU project CORUS-XUAM.

The VoloDrone is being developed by Volocopter to deliver up to 200 kilograms of cargo in an all electric flight at a distance of up to 40 kilometres. The flight tests in Cochstedt simulated with this drone an air taxi scenario for the connection between the city centre and the major airports within the metropolitan regions of London and Frankfurt/Main. It focused on the digital



communication interface for ATM/UTM, including contingency management in the event of unforeseen conflict scenarios, and potential routing and air traffic management solutions. In the scenarios, the flight request, flight planning and flight execution from takeoff to landing were remotely piloted/automated. Up until now, air traffic management in conventional air traffic has been largely based on VHF radio communication between pilots and air traffic controllers. In the future, the operation of a large number of uncrewed aircraft will require a digital and highly-automated system that complements traditional air traffic control systems.

To achieve this, the U-space concept is currently being developed throughout Europe. In the future, drone flights are to operate in U-space airspace – from takeoff, flight, and landing. The flight test demonstration at the Cochstedt drone test site showed how the VoloDrone flies scaled-down versions of the flight routes under research. For the Frankfurt scenario, this was the simulated route between Frankfurt Messe and Frankfurt Airport. For the London scenario, this was a potential route between London City Airport and London Heathrow Airport. Suitable locations for vertiports, takeoff and landing sites for future air taxis were determined for both scenarios. The flight tests focused particularly on the testing of deconfliction manoeuvres and procedures. Exemplary here are prioritized Emergency Medical

Services (EMS) aircraft that are given priority: this was clearly demonstrated in the flight tests with an ADAC EMS helicopter in the 'Frankfurt scenario', where the VoloDrone automatically adjusted its flight path to avoid the EMS helicopter. In the 'London scenario', the research teams tested how reducing the speed of the VoloDrone could be used to maintain separation with commercial air traffic, or to give more time to carry out ground operations at the destination vertiport in preparation for arrival.

Overall, the flight tests in Cochstedt are part of a whole series of demonstration tests within the framework of the EU project CORUS-XUAM. Prior to this, large-scale demonstrations took place in Spain, Italy, France, Sweden and Belgium to gain experience with the integration of uncrewed aerial NATS Internal vehicles alongside existing air traffic in various urban areas. The results will be incorporated into the further development of the European U-space Operations Concept (CONOPS). Well-established standards and regulations for uncrewed air traffic are urgently needed so that the industry can unfold its great predicted development potential.

<https://corus-xuam.eu/>

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

## Successful drone test flights in Austria and Estonia for GOF 2.0

The SESAR GOF 2.0 very large-scale demonstration is developing solutions for the safe and sustainable integration of unmanned aerial vehicles and air taxi operations in urban airspace. In September, a series of tests took place in Austria and Estonia, the findings of which marked another important milestone in the development of U-space.

Fifteen partners from both the scientific community and the drone and aviation industry have been working together in the project GOF 2.0 to enable safe, orderly, and efficient control of unmanned aerial systems in a manned aviation environment. Interoperability is at the forefront, enabling secure (data) communication between airborne and ground-based systems. This creates a “system of systems” that combines classic air traffic management and new and improved drone-specific services.



The basis for an economical and scalable use of this new type of airborne mobility technology is the further integration of airport and port infrastructure, public transport, and logistics centres. In all use cases, the focus is on increasing efficiency compared to ground-based technologies and supporting a seamless transport chain between urban areas and the airports while taking into account the highest safety requirements.

St. Georgen am Ybbsfeld Airport – not far from Amstetten / Lower Austria – was chosen for the Austrian validation. In this trial, among other things, automated parcel delivery at low-altitude and its safe interaction with air taxi flights and

conventional air traffic were extensively tested as an example of a realistic use case.

Meanwhile, in Estonia, trial flights took place in Viimsi to test systems and technical solutions developed for the management of unmanned air traffic in urban environments and for supporting drone flight in controlled and uncontrolled airspace.

In addition to flexibility, the technical solutions developed allow unmanned aviation to be integrated with conventional aviation, and the positions of drones can also be shared in real time. For example, this means that if a medical helicopter and a package delivery drone want to reach the same building at the same time, the new system makes it possible to automatically postpone the delivery drone’s flight by something like 20 minutes until the medical helicopter has left the area.

The GOF 2.0 consortium consists of: Estonian Air Navigation Services (EANS), Dimetor, Airbus Urban Mobility GmbH, Aviamaps, CAFA Tech, DroneRadar, EHang, Fintraffic ANS, Frequentis, PCSS Poznańskie Centrum Superkomputerowo-Sieciowe, Polish Air Navigation Services Agency, Robots.Expert, Threed Systems, Unmanned Life, Vaisala.

<https://gof2.eu/>

*This project has received funding from the SESAR 3 Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101017689*





## Poland demonstrates air mobility solutions for cities throughout the EU

**At the end of August, Rzeszów, southern Poland, played host to a demonstration of drone solutions that will be used by public services in cities across the European Union. Partners in the USpace4UAM project presented their research and real-life applications that will ultimately support the development of an enabling framework for urban air mobility (UAM) for the EU.**

The USpace4UAM project is part of a portfolio of projects funded by the EU body, the SESAR 3 Joint Undertaking, to develop a technological framework for the safe and secure integration of drones in Europe’s airspace (commonly referred to as U-space). Drone flights over Poland therefore contribute to the development of EU-wide regulations and systems that will allow in the coming years to increase the number of flights by aircraft

- including drones - in the EU skies, while improving safety.

The result of many months of work on the project were presented in the last days of August at the so-called DemoDay in Rzeszów – the conference part was held in the Urban Lab centre, and the practical part in the Air Park Village area. The event was held under the patronage of the mayor of the city of Rzeszów, which emphasises the importance of such projects from the point of view of the needs of municipal services. Among the guests and speakers were experts from the aviation and technology sectors, as well as representatives of public and emergency services and the city of Rzeszów.

Test flights over Poland were carried out for three scenarios of the use of autonomous drones in public service in cities: to provide emergency services with aerial monitoring from accident sites, to take a series of ortho- and photogrammetric photos for the needs of public institutions and to transport AED defibrillators. The key element of the demonstration was the integration within

the U-space Service Provider architecture designed by Altitude Angel, one of the USpace4UAM consortium members, that enables safe and efficient drone operations by supporting the operator in flight planning, automating flight approval process and supervising ongoing flights. The project is being implemented in Poland, the Czech Republic, Germany, Austria, Spain and the UK. The Polish partner of the consortium is the Rzeszów-based company Dronehub, which operates flights in Rzeszów under the USpace4UAM project.

In addition to Dronehub and Honeywell, the USpace4UAM consortium included Air Navigation Services of the Czech Republic, Altitude Angel, Austro Control, CATEC, CRIDA, DLR, ENAIRE, Lilium, TECNALIA, UpVision and Vertical Aerospace.

[www.sesarju.eu/projects/USpace4UAM](http://www.sesarju.eu/projects/USpace4UAM)

*This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017643*

## SESAR innovation paving the way towards drone services market

**Urban air mobility, emergency medical deliveries and aerial infrastructure inspections were just some of the everyday uses for drones showcased during EU Drone Days, a two-day conference co-organised by the European Commission and the SESAR 3 Joint Undertaking (SESAR 3 JU). The conference highlighted the important role that innovation is playing in building a competitive, safe and sustainable drone services market in Europe, with up to EUR 35 million in EU-SESAR funding available in 2023 to fast-track the uptake of future SESAR U-space innovations.**

Gathering some 450 stakeholders from the drone industry and European institutions, EU Drone Days was a backdrop for the launch by the European Commission's Drone Strategy 2.0, an initiative, which aims to foster the development of new sustainable drone services and transport solutions. U-space

is the ecosystem under development, based on research by the SESAR 3 JU, which will allow drones to operate at scale. Through presentations and a dedicated exhibition, the conference showcased the latest results from SESAR 3 JU's project portfolio that are developing digital and automated technological solutions that will make U-space a reality.

Between 2020 and 2022, these projects carried out tests and trialed solutions at close to 70 locations around Europe showing the readiness of U-space services to manage a broad range of drone operations and related applications, and their interaction with manned aviation. These range from parcel deliveries between urban areas, medical emergencies and police interventions, as well as air taxi trials in controlled airspace around airports. An important output of the research programme was an updated and consolidated concept of operations for U-space, now including urban air mobility (UAM).

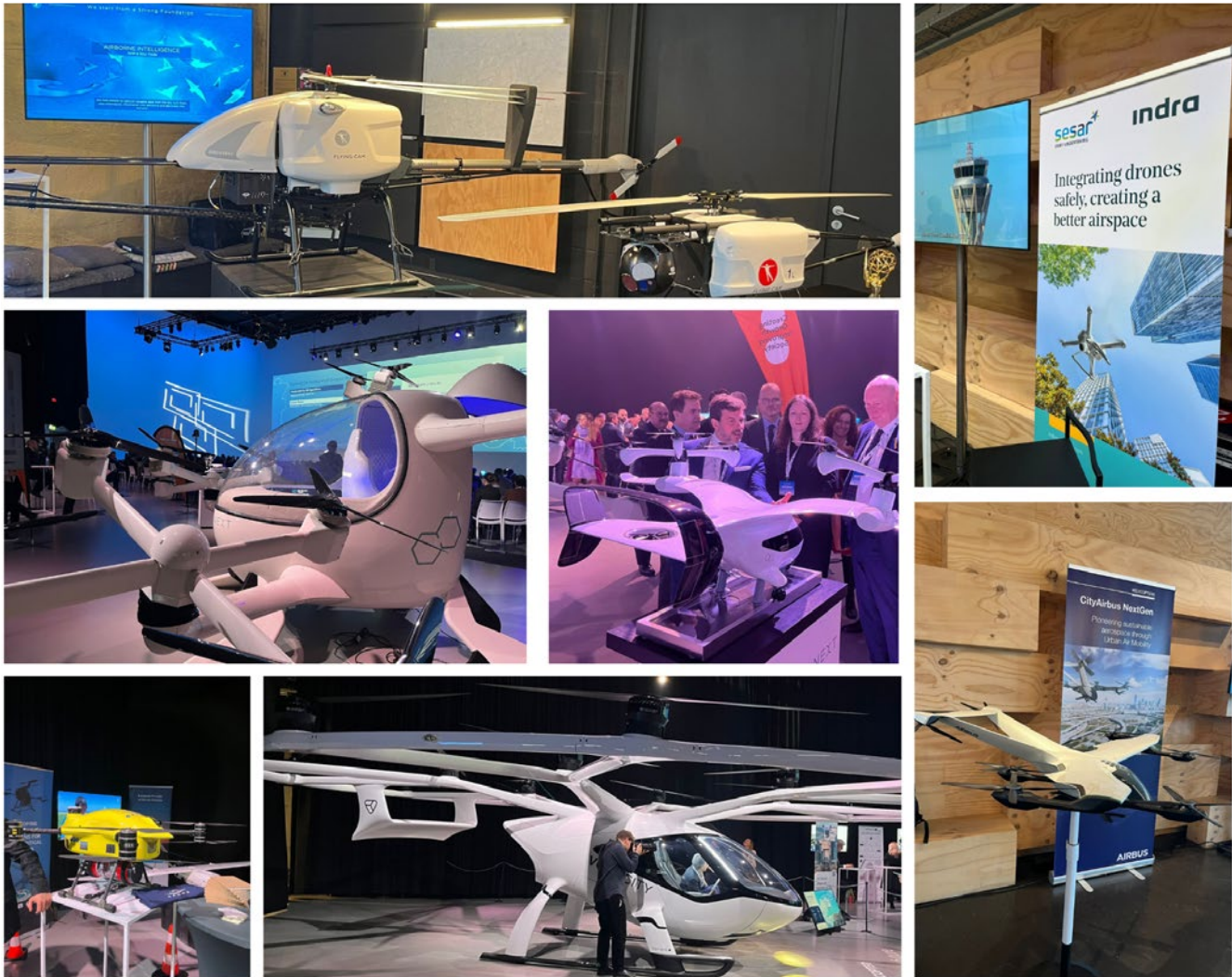
*"The vision set out by today's Drone Strategy 2.0 is clear: by 2030 drones will be part of our everyday lives, offering EU citizens and*



*businesses a wide range of commercial and public services. The digital solutions stemming from SESAR 3 JU's programme are concrete building blocks for the U-space and will help us achieve this ambitious vision. They will help scale up the implementation of urban air mobility and build a safe and sustainable EU drone services market that would serve as a best practice for the rest of the world,"* said Henrik Hololei, Director-General for Mobility and Transport at the European Commission and Chair of SESAR 3 JU's Governing Board.



## U-space showcase



In addition to projects showcasing their results, the conference discussed the role that strong collaboration has played delivering tangible solutions for U-space. The projects brought together a wide range of actors from traditional aviation, start-ups, research institutes, universities, drone operators, service providers, airports, local and city authorities, law enforcement agencies, military stakeholders and civil aviation authorities. The SESAR 3 JU also worked closely with the European Union Aviation Safety Agency (EASA) and EUROCAE, the European aviation

industry standards developing body, and is supporting wider standardisation work by the International Civil Aviation Organisation (ICAO), in particular through ICAO's UAS advisory Group.

*"Collaboration is key to successful innovation. We have seen that in the U-space demonstrations, which took place over real cities, with civic authorities, emergency services, air traffic control and airports, all providing us with valuable insights and helping to deliver solutions that make sense and bring maximum benefits. Thanks to this collaborative spirit, we are*

*beginning to see U-space implementations across Europe,"* said Andreas Boschen, Executive Director of the SESAR 3 JU.

Indeed, the deployment of U-space is taking place progressively across Europe based on increasing availability of blocks of services and enabling technologies, the conference heard. The European regulatory framework and the first U-space regulations, adopted

by the European Commission in 2021, enters into force in January 2023 and will promote a harmonised approach to U-space deployment across Europe.

Citizens' confidence and acceptance will be critical to the further development of the drone services market, which speakers highlighted throughout the conference.

*"Europe must become a pioneer and trendsetter in the international drone market. For this, we need a comprehensive and non-discriminatory framework. A fully functioning European drone ecosystem can only be effective if users, regulators, and the public are involved. We need to seek dialogue with citizens to address barriers and concerns about drone safety,"* said Jan-Christoph Oetjen, Member of the European Parliament.

## Overview of U-space projects (2020-2022)

**BUBBLES** - Defining the building basic blocks for a U-space separation management service

BUBBLES developed the concept of a U-space advanced (U3) 'separation management service'. It is developing algorithms to compute the collision risk of UAS (Unmanned aircraft systems), allowing to define separation minima and methods, so that a safety level stated in terms of overall probability of collision can be defined and maintained.

Web: <https://bubbles-project.eu/>

**DACUS** - Demand and capacity optimisation in U-space

DACUS developed a service-oriented demand and capacity balancing (DCB) process for drone traffic management. This overall objective responds to an operational and technical need in European drone operations for a tangible solution integrating the functionalities of the SESAR U-space services for drone traffic management (DTM) to produce timely, efficient and safe decisions.

Web: <https://dacus-research.eu/>

**ICARUS** - Integrated common altitude reference system for U-space

ICARUS developed an innovative solution to the challenge of the common altitude reference inside very low-level (VLL) airspace with the definition of a new U-space service and its validation in a real operational environment.

Web: [www.u-spaceicarus.eu/](http://www.u-spaceicarus.eu/)

**Metropolis 2** - A unified approach to airspace design and separation management for U-space

Metropolis 2 provided the fundamentals for concrete solutions for U-space U3/ U4 services that are needed to enable high density urban aerial operations, with a unified approach to the following U-space services: strategic deconfliction, tactical deconfliction, and dynamic capacity management.

Web: [www.sesarju.eu/projects/Metropolis2](http://www.sesarju.eu/projects/Metropolis2)

**USEPE** - U-space separation in Europe

USEPE researched drones' separation methods in high demanding environments, such as cities, and on the use of machine learning algorithms to automate the safe separation and deconfliction of drones, while maintaining airspace capacity in different environments. The research took into account both the strategic and tactical flight phases.

Web: [www.sesarju.eu/projects/USEPE](http://www.sesarju.eu/projects/USEPE)

<p><b>AMU-LED</b> - Air mobility urban large experimental demonstrations</p>	<p>The project developed a detailed concept of operations and define urban air missions followed by simulations and a large-scale real flight demonstration campaign to verify and validate the concepts. The project allowed UAM stakeholders to specify various use cases applicable to logistics and urban transport of passengers, design or integrate UAM environment, test the UAS ground and airborne platforms and finally, assess safety, security, sustainability and public acceptance.</p> <p>Web: <a href="https://amuledproject.eu/">https://amuledproject.eu/</a></p>
<p><b>CORUS-XUAM</b> – Concept of operations for European U-space service – extension for urban air mobility</p>	<p>CORUS-XUAM demonstrated how U-space services and solutions could support integrated urban air mobility (UAM) flight operations, allowing eVTOLs/UAS and other airspace users (unmanned and manned) to operate safely, securely, sustainably and efficiently in a controlled and fully integrated airspace, without undue impact on operations currently managed by ATM. The project also updated the concept for operations, taking into account the latest U-space developments.</p> <p>Web: <a href="https://corus-xuam.eu/">https://corus-xuam.eu/</a></p>
<p><b>GOF 2.0</b> - Integrated urban airspace very large-scale demonstration</p>	<p>The project demonstrated operational validity of serving combined UAS, eVTOL and manned operations in a unified, dense urban airspace using current ATM and U-space services and systems. Both ATM and U-space communities depend extensively on the provision of timely, relevant, accurate and quality-assured digital information to collaborate and make informed decisions.</p> <p>Web: <a href="http://www.sesarju.eu/projects/GOF2">www.sesarju.eu/projects/GOF2</a></p>
<p><b>SAFIR-MED</b> – Safe and flexible integration in advanced U-space and flexible services focusing on medical air mobility</p>	<p>The project combined five unmanned UAV platforms (passenger eVTOL, hydrogen fuel cell VTOL, AED medical drone, X8 medical transport) with manned aviation in real-life demonstrations validating technology and the maximum number of U-space services in real urban environments. The results are expected to help refine the current U-space architecture principles and create measurable indicators for the inclusion on UAM smart city transport roadmaps, supporting standardisation and safety.</p> <p>Web: <a href="https://www.safir-med.eu">https://www.safir-med.eu</a></p>
<p><b>TINDAIR</b> - Tactical instrumental deconfliction and in flight resolution</p>	<p>The project demonstrated and refined the safety, performance, standardisation and regulatory requirements to enable UAM with specific focus on U-space U3 services identified in the U-space Blueprint and refined by CORUS, and, unlock new and enhanced applications and mission types in high density and high complexity areas.</p> <p>Web: <a href="https://tindair.eu/">https://tindair.eu/</a></p>
<p><b>U-space4UAM</b> - U-space for UAM</p>	<p>The project carried a series of multi-national demonstrations, both with drones and UAM, covering different use cases, including mixed operations, to derive critical enablers for a wide set of UAM service applications that can be applied all over Europe.</p> <p>Web: <a href="http://www.sesarju.eu/projects/U-space4UAM">www.sesarju.eu/projects/U-space4UAM</a></p>



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