

SESAR INNOVATION PIPELINE

*Air traffic management
research & innovation
2019 highlights*



EXPLORING THE
BOUNDARIES OF
ATM RESEARCH

DELIVERING
SESAR
SOLUTIONS

DEMONSTRATING
SESAR
SOLUTIONS

ENABLING
SAFE AND
SECURE
INTEGRATION
OF DRONES



About the SESAR Joint Undertaking

SESAR is the technological pillar of the EU's Single European Sky policy and a key enabler of the EU Aviation Strategy. SESAR defines, develops and deploys technologies to transform air traffic management in Europe.

The SESAR Joint Undertaking (SESAR JU) is the public-private partnership set up to define and deliver technological solutions to make this transformation a reality. It works with all actors in the aviation value chain to agree on the research and development priorities, as well as technology roll-out plans, which are documented in the European ATM Master Plan - a collaboratively-agreed roadmap for ATM modernisation.

Founded by the European Union and Eurocontrol, the SESAR JU has 19 members, who together with their partners and affiliate associations represent over 100 companies working in Europe and beyond. The SESAR JU also works closely with staff associations, regulators, airport operators, airspace users, the military and the scientific community.

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SESAR 2020 AND THE INNOVATION PIPELINE

This brochure provides highlights of some of the SESAR research and development (R&D) activities that took place over the course of 2019 as well as what is coming in 2020.

SESAR 2020 is a European research and innovation programme, which aims to transform air traffic management into a more modular, scalable, automated, interoperable system that takes advantage of advances in digital and virtualisation technologies.

The programme builds on its predecessor, SESAR 1, to deliver high-performing operational and technological solutions for uptake by the aviation industry.

Guided by the European ATM Master Plan, SESAR 2020 focuses on developing solutions in several key areas:



High-performing airport operations, including total airport management, remote towers, runway throughput capabilities, navigation and routing tools, airport safety alerts for controller and pilots



Advanced air traffic services, including time-based separation and European wake vortex re-categorisation (RECAT-EU), better sequencing of traffic, automation support tools, integration of all vehicles



Optimised network operations, including dynamic collaborative tools to manage ATC airspace configuration (sectors), and civil-military collaboration for greater predictability and management of operations and airspace use



Enabling infrastructure, including CNS integration to facilitate economies of scale and seamless service delivery; and system-wide information management governance, architecture and technology solutions and services for information exchange



Drone integration, covering technologies and service solutions to support complex drone operations with a high degree of automation in all types of airspace, including urban areas

The research is categorised into three strands: exploratory research, industrial research and validation and very large-scale demonstrations. These strands have been designed as an innovation pipeline through which ideas are transformed into tangible solutions for industrialisation.

EXPLORATORY RESEARCH

Explores new concepts beyond those identified in the European ATM Master Plan or emerging technologies and methods: The knowledge acquired can be transferred into the SESAR industrial and demonstration activities.

INDUSTRIAL RESEARCH & VALIDATION

Assesses and validates technical and operational concepts in simulated and real operational environments according to a key performance area. This process transforms concepts into SESAR Solutions.

VERY LARGE SCALE DEMONSTRATIONS

Test SESAR Solutions on a much larger scale and in real operations to prove their applicability and encourage the early take-up of solutions

Accelerating the pace of change in air traffic management

The pace of innovation in air traffic management is picking up, according to an analysis made by the SESAR Joint Undertaking. An assessment of the SESAR 2020 research and development (R&D) programme, using established key performance indicators, shows that the time it takes to deliver mature SESAR Solutions has been reduced by approximately 40% between the first phase of R&D (SESAR 1) and SESAR 2020.

The analysis points to several factors that have led to this acceleration since the previous R&D programme finished in 2016, notably a clearer scoping of Solutions and establishing an integrated approach to Solutions development and validation.

The assessment also took a look at the SESAR Innovation Pipeline as a mechanism to transform concepts into tangible Solutions, going from exploratory research to industrial research and demonstrations.

Indicators suggest that this Pipeline is proving effective; with the results from 50% of SESAR's first batch of exploratory projects (14 out of 28 projects) now being fed into the second wave of SESAR 2020 industrial research, which is due to get started by end of 2019. This transfer of results is providing a fresh injection into the programme of technologies such as augmented reality and artificial intelligence, including big data.

At the same time a total of 27 Solutions delivered by the SESAR 1 programme are part of very-large scale demonstrations, allowing stakeholders to see how the Solutions work in real operational environments and encouraging swift uptake by industry.

The assessment also indicated that over 90% of the R&D priorities outlined in European ATM Master Plan (2015 edition) are covered by SESAR 2020.

A YEAR OF STRATEGIC PLANNING

2019 saw the publication of a number of key strategic documents, setting out the vision, strategies and roadmaps for delivering smarter, more seamless, sustainable and safer air transport.

European ATM Master Plan

Updated every three to four years through an extensive consultation process involving all industry and institutional stakeholders, the European air traffic management (ATM) Master Plan sets the direction for developing, delivering and deploying the technologies and standards needed to transform Europe's aviation infrastructure enabling it to handle the future growth and diversity of air traffic safely and efficiently, while minimising environmental impact. The Plan also reflects the recommendations made by Wise Person's Group as well as a joint declaration by industry on the need to implement a digital European sky. The plan is also instrumental for ensuring global harmonisation and interoperability, in support of the Global Air Navigation Plan (GANP) of the International Civil Aviation Organization (ICAO).



Airspace Architecture Study and Transition Plan

The study proposes a new approach to Europe’s airspace architecture that leverages modern technologies and decouples service provision from local infrastructure. It also sees a progressive increase in the levels of automation, cyber-secure data sharing and connectivity. With this proposal, airspace configuration and design would be optimised from a European network point of view, connecting airports and taking due consideration of major traffic flows across Europe. Data services will be made available to trusted users feeding advanced air traffic control tools, allowing operational harmonisation and increasing the level of performance of air traffic controls centres across Europe. Meanwhile, the Transition Plan sets out three key operational and technical measures that need to be put in place in the short term (2020 to 2025) in order to set in motion the transformation changes outlined in the Airspace Architecture Study. These changes are integrated into the Master Plan.



Towards a digital European sky

In November, members of the SESAR JU came together at a workshop in Amsterdam to discuss the research needed in order to deliver smarter, more sustainable and safer aviation.



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The workshop, organised and moderated by NLR and DLR, used the “World Café” method to stimulate lively discussions among the 50 participants on the challenges facing aviation especially relating to capacity and sustainability, as well as the research priorities that have been identified in the Master Plan

In small groups, the participants dived deeper, defining concrete activities associated with each research priority. The outcomes of the workshop are providing the basis for a future innovation portfolio as detailed in the digital European sky, which was published at the end of December. The blueprint also sets out the mechanisms and partnership model needed in order to deliver the digital European sky.



**SESAR innovation recognised
in 2019 ATM
Magazine Awards**

SESAR projects and partners were among the winners of the ATM Awards 2019, each judged to be outstanding performers spearheading innovation and leading the industry to ever greater performance. The awards attracted entries from across the global air transport industry, highlighting major innovation and projects that stand to enhance airspace capacity, safety and environmental sustainability.

SESAR innovation was recognised in five of the six awards categories:

Service provision: The ATEAM Network Collaborative Management (NCM), bringing together Lufthansa Group with Ryanair, Air France, British Airways and easyJet, received third prize in this category for its collaborative work with other stakeholders to reduce network inefficiencies in air traffic flow capacity management.



Enabling technology: SESAR member, skyguide, won first prize in this category for its work on shifting to service oriented architecture, a pre-requisite for system-wide information management and the implementation of the virtual centre concept and related business models.

Environment: xStream, a large-scale demonstration led by DSNA and involving NATS, skyguide, Eurocontrol and DFS, received first prize in this category for delivering ready-to-use operational cross-border arrival management solutions following trials in Paris, Zurich, Frankfurt, leading to the first implementation at London Gatwick in October 2019. This category also recognised steps taken to implement the SESAR solution free route by the Borealis Alliance, allowing airlines to fly more direct routes, reducing fuel burn and emissions.

Research and innovation: SESAR innovations picked up all three prizes in this category. Thales with COOPANS, DFS, DSNA, Enaire, Enav, Eurocontrol, Frequentis, Hungarocontrol, Indra, Leonardo, LPS SR, NATS, SINTEF, skyguide, ANS CR, received first prize for demonstrating the virtual centre concept, and the decoupling data service provision from air traffic service provision. Meanwhile, second place went to partners in the DIGITS large-scale demonstration (Airbus with Air France, British Airway, EasyJet, Iberia, Novair, Wizz Air, Eurocontrol, DFS, NATS, Enav, Indra, Airtel, Thales, Leonardo, Honeywell, COOPANS) for successfully trialling the exchange of trajectory data, making traffic flows more fluid and aircraft speed easier to manage. Finally, third prize went to the GAINS large-scale demonstration for showing how solutions developed for scheduled airlines can be adapted for use by general aviation. The project

was coordinated by Helios with AOPA UK, Pildo Labs, Funke Avionics and Trig Avionics.

Runway and terminal area: Second place in this category went to Austro Control with DLR for developing 'plate lines' to accelerate the decay of wake vortices by around 30 %. The partners estimate that optimised separations could reduce average delays per flight, which in turn would result in reduced fuel burn in the TMA and greater throughput. An annual assessment had already indicated that a potential reduction of tactical delay for pairwise dynamic separations could be in the order of over EUR 1 million for a large airport.

*Exploring the boundaries
of ATM research:*

SESAR exploratory research

Through its exploratory research, the SESAR JU looks beyond the current R&D and what is already identified in the European ATM Master Plan. The aim is to investigate new ideas, concepts, and technologies, but also challenge pre-conceived notions about air traffic management and the aviation value chain.

The SESAR exploratory research activities are overseen by a scientific committee, established in 2017, bringing together independent and highly-regarded academics from across Europe and the aviation research domain, as well as observers from the European Commission, Eurocontrol and the SESAR Programme Committee.

Progress made on third wave of exploratory research projects

Over the course of 2019, work continued in a third wave of exploratory research projects aimed at fostering new ideas and knowledge transfer in air traffic management (ATM) in Europe.

Satellite signal jamming, improved airport surface movements using existing surveillance technologies and models to improve traffic predictability are just some of the topics that the selected projects have addressed.

The projects bring together universities, start-ups, manufacturers, service providers from across Europe (i.e. Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, Portugal, Republic of Serbia, Spain, The Netherlands, and the UK) as well as Eurocontrol and EASA.

The results from the projects will be published in the second quarter of 2020.



The project is building a modelling framework to better understand and model how architectural and design choices influence the ATM system and its behaviours, and vice versa how the expected ATM overall performances drive the design choices.

<http://www.evoatm-project.eu/>



The project (Enhanced situational awareness through video integration with ADS-B surveillance infrastructure on airports) is making use of technical progress in CCTV cameras, light detection and ranging (LIDAR) technology and image processing techniques, and is taking advantage of reduced equipment costs, to provide regional and local airports safe and affordable surface movements surveillance capabilities.



The project proposes strategic models to predict the volume, flexibility and complexity of traffic demand taking into account both individual flights and network infrastructure (i.e. sectors and airports). The aim is to enable early flight information sharing in order to identify potential network bottlenecks and the degree of flexibility of all flights. At the tactical level, the extent to which strategically assessed pre-departure and en-route flight flexibility mitigates actual network congestion, is being evaluated.

<https://adapt-h2020.eu/>

	<p>Global Navigation Satellite System (GNSS), such as the Galileo constellation, will become the primary means of aircraft navigation in the mid to long term. However, GNSS signals are vulnerable to threats, especially to jamming and spoofing, which may cause the total loss of navigation. The project is researching multiple measures that could be deployed on most aircraft to manage these threats, either on their own or in a collaborative fashion with other aircraft.</p> <p>http://gateman.gmv.com/</p>
	<p>The project aims to maximise the effectiveness of capacity management processes in trajectory-based operations taking full advantage of available trajectory information. Specifically, the projects is investigating the integration of demand and capacity, and flight centric solutions.</p> <p>www.cotton-er.eu</p>
	<p>The project aims to increase safety, reliability and interoperability of general aviation/rotorcraft (GA/R) operations both with commercial aviation and with emerging drones operations. These aspects are foreseen as critical elements to secure and improve airspace access for GA/R users in future airspace environment and improve operational safety of their operations.</p> <p>https://aerospace.honeywell.com/en/pages/emphasis-project</p>
	<p>The project is developing novel tools to evaluate ATM systems coupling under future deployment scenarios. The aim is to provide ATM system designers with insight into the impact of deploying solutions in different manners, e.g., harmonised vs. local/independent deployment, and information on the criticality of elements in the system and how this might vary between different stakeholders.</p> <p>https://domino-eu.com/</p>

The activities also include Engage, a knowledge transfer network to encourage collaborative research on future and emerging innovative ideas, expertise on ATM. The network is stimulating the transfer of exploratory research results towards ATM application-oriented research. The network has established a knowledge hub, in which members across the research community are continuously involved (see next page).

The network has completed its second year, maintaining a two-fold focus on inspiring new researchers, and helping to facilitate the transfer of results from fundamental and applied research into industrial research. In 2019, a successful summer school was held, and ten PhDs plus ten catalyst-fund projects were launched. The thematic workshops matured into their second season, with more to follow in 2020, along with a second Call for project funding, and the next summer school in Luxembourg. All events are free to attend, with grants to support student travel available, as training and synergies are explored with the SESAR Digital Academy (see page 10).

<https://engagektn.com/>



NEXT PHASE OF EXPLORATORY RESEARCH

In April, the SESAR JU launched an open call for exploratory projects with a total of EUR 38.5 million from the EU's Horizon 2020 budget.

The selected projects will address a wide variety of topics:

- ▶ Digitalisation and automation principles for ATM
- ▶ Cognitive support
- ▶ Complexity and data science for ATM Performance
- ▶ Digital Information management
- ▶ Environment and meteorology for ATM
- ▶ Safety and resilience
- ▶ Accelerating change in ATM
- ▶ Behavioural economics in ATM
- ▶ Legal and regulatory challenges of higher levels of automation
- ▶ ATM role in intermodal transport
- ▶ CNS for ATM
- ▶ Automation of airport operations
- ▶ Innovation in airport operation
- ▶ Meteorology at airports
- ▶ Increased levels of automation for the ATM network
- ▶ Innovation in network management
- ▶ Network capacity Increase from fully dynamic airspace
- ▶ Automation and CWP
- ▶ Enabling performance by innovation in air traffic services
- ▶ ADSB-in applications
- ▶ Long-term evolution of air/ground synchronisation
- ▶ Digital evolution of separation minima in en-route and TMA
- ▶ Increased capacity for high density operations by evolution of controller/Pilot communication
- ▶ Innovation in CNS to enable digitalised operations
- ▶ Measuring and managing ATM performance
- ▶ ATM Validation for a digitalised ATM
- ▶ Future ATM Architecture
- ▶ Control of IFR RPAS in the TMA
- ▶ Remain Well Clear for IFR RPAS Integration in class D-G airspace
- ▶ RPAS for manned flight contingency management
- ▶ U-space

The projects will kick off in the first half of 2020.



Launch of SESAR Digital Academy

2019 saw the launch of the SESAR Digital Academy - a learning initiative supporting Europe's future aviation and ATM workforce. The mission is to nurture Europe's brightest minds and advance learning, scientific excellence and innovation in aviation and ATM. The Academy aims to promote student mobility and a whole spectrum of learning opportunities, from fundamental research to industry-focussed applied research, and to enhance the knowledge, skills and employability of aviation professionals.

The SESAR Digital Academy seeks to bring together under one umbrella access to SESAR exploratory research activities and outreach relating to education and training, as well as professional learning opportunities offered by research centres, universities, industry partners and other entities within the ATM/aviation domain.

The mission and vision of the SESAR Digital Academy are complementary to those of existing aviation/aeronautics interest groups, associations and networks at European level. The academy will seek to identify synergies and potential for collaboration as part of its plan of activities.

The Academy's **mission** is guided by the following set of values:

- ▶ Promoting the sharing of knowledge, ideas skills and expertise on air traffic management and aviation research across academia and industry, both within Europe and beyond;
- ▶ Nurturing the professional development of the future aviation workforce by creating learning and knowledge exchange opportunities;
- ▶ Advancing scientific excellence and know-how in ATM and aviation research, encouraging research across disciplines on the most promising ideas and concepts;
- ▶ Promoting equal opportunities in ATM and aviation research and more broadly the industry, recognising diversity and inclusion as key to the competitiveness of the industry.

Participants and beneficiaries

The digital academy is an open initiative with a wide range of participants and beneficiaries:

- ▶ Students and academia
- ▶ Research institutes
- ▶ Industry
- ▶ Standardisation, regulatory and safety authorities

Contact

Want to contact us ? Drop us an email at info@sesaracademy.eu

YOUNG TALENT CELEBRATED AT 2019 SESAR INNOVATION DAYS

Airspace design, the integration of drones, machine learning and automation were just some of the research themes of the 2019 SESAR Innovation Days (SIDS), which took place between 2-5 December in Athens. Bringing together over 400 participants, the event celebrated in particular young talent in aviation with the awarding of the Young Scientist Award and the Digital Sky Challenge.

SESAR Innovation Days

Hosted by the National Centre of Scientific Research (NCSR) "Demokritos", the 2019 SESAR Innovation Days showcased results from European exploratory research on ATM. Main highlights of the event included:

- 38 papers on a wide variety of topics including: airport operations, network flow management, complexity and data science, human factor, modelling and simulation techniques, machine learning, decision support tools, drones, meteorology, conflict detection, airspace architecture and design.
- 21 posters presenting research on a variety of themes, including blockchain technologies for drones, safety net solutions, data-driven predictability tools, detection and tracking technologies for airport surface management, etc.

The event also featured a panel with experts, who discussed the move towards advanced levels of automation in the ATM



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system. While there was a common consensus on the need for increasing levels of automation to cope with the traffic, the experts highlighted several areas needing particular attention, such as the human factor, change management, cyber resilience, certification and societal acceptance of the use of automated systems in a safety-critical industry such as ATM/aviation.

Attracting young talent was also a recurring theme at the conference.

In a dedicated panel, representatives from European and International aviation/ATM noted that bringing new blood into research and innovation will make or break the aviation/ATM industry. They underlined the need for the ATM research community to become more open and embrace other disciplines to enrich its knowledge and expertise.

Engage, the SESAR JU's network for knowledge transfer, is supporting this effort through a wide range of activities, which Andrew Cook from Westminster University presented at the SIDs. These include summer schools, thematic challenge workshops, catalyst funding and grants to support the participation of younger researchers at industry/academic events.

This is very much aligned with the SESAR digital academy, an initiative that the SESAR JU is working on to attract young talent with a skillset matching the needs of the future ATM system.

Proof of the current pool of talent was during the SESAR Young Scientist Award ceremony, which featured presentations from the three short-listed scientists. In third place, Leonid SEDOV, Linköping University, was recognised for his research on capacity estimations and route planning for the management of dense drone traffic in very low level (VLL) uncontrolled airspace. Javier Alberto Perez Castan from Universidad Politécnica de Madrid was awarded the second place for his research into continuous climb operations in high-density scenarios to reduce the capacity and safety impact of traffic around airports.

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Finally, the top award went to Junzi Sun, Delft University of Technology, for his novel scientific approaches to modelling different aspects of aircraft performance. Rooted in the philosophy of open data and open models, the results of this research provide a framework that enables more transparency and comparability for future ATM research.

The conference closed with the announcement that the next SESAR Innovations Days will take place in Budapest from 8-10 December.

www.sesarinnovationdays.eu

Digital Sky Challenge

SESAR Innovation Days was a perfect backdrop to organise the Digital Sky Challenge, an innovation sprint of 48 hours where 12 competing teams from across Europe were asked to come up with solutions addressing safety, environment and a better passenger experience. Taking place at Athens Airport, the Challenge aimed to see what could be achieved by harnessing big data and AI technologies for aviation.

Co-organised by Athens Airport, ACI Europe and the SESAR JU with 23 other partners, over the two-day the teams developed their solutions from several data sources, which they first pitched to 19 mentors and then to a jury made up of



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aviation experts. The winners were announced at an awards ceremony held in the Stavros Niarchos Foundation:

Passenger experience challenge winner: Innov'ATM developed an innovative app to track passengers with their consent, so that airlines, airports and air traffic control know where they are.

Safety challenge winner: With no prior background, JBM successfully developed from scratch a safety-net in 48 hours capable of analysing distances between aircraft in order to alert of potential incidents. JBM also received two special recognition prizes from Honeywell and Airbus.

Environment challenge winner: The Eco-Travellers (from Sopra Steria) developed a tool to allow passengers select the best and most green mobility option, integrating multiple modes of transport. The tool took into account existing systems and offsetting schemes.

www.digitalskychallenge.eu



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Delivering SESAR Solutions

Industrial research & validation

SESAR Solutions refer to new or improved operational procedures or technologies that aim to contribute to the modernisation of the European and global ATM system.

To deliver solutions ready for pre-industrialisation, the SESAR JU and its members have built a process, known as the release process, whereby solutions are tested or validated in real operational environments, including direct airport interfaces. The Solutions are validated according to key performance areas such as safety, cost and operational efficiency, capacity and the environment.

SESAR JU and its members have taken research and innovation out of the lab and connected it with the real world. Validations take place in simulation platforms, on board commercial flights, dedicated airport testbeds and air traffic control centres. Exercises are not limited to a specific location, but can be used to test multiple environments irrespective of the location where the physical validation is held.

First wave of SESAR 2020 comes to a close

In 2019, the first wave of SESAR 2020 industrial research programme came to a close, delivering a number of solutions (as part of Release 9) to the necessary level of maturity to make them available for pre-industrialisation (Technology readiness level 6 or V3).

	Trajectory based Integrated Runway Sequence (SJU reference: PJ.02-08-01)	
	Enhanced visual operations (SJU reference: PJ.03a-04)	
	Traffic alerts for pilots for airport operations (SJU reference: PJ.03b-05)	
	Enhanced rotorcraft operations in the TMA (SJU reference: PJ.01-06)	
	Optimised traffic management to enable free routing in high complexity and very high complexity environments (SJU reference: PJ.06-01)	
	High productivity controller team organisation in en-route (including e-TMA) (SJU reference: PJ.10-01a1)	
	Integrated tactical and medium conflict detection & resolution (CD&R) services and conformance Monitoring tools for en-route and TMA , formerly known as improved performance in the provision of separation (SJU reference: PJ.10-02a1)	

	<p>Enhanced airborne collision avoidance for commercial air transport normal operations - ACAS Xa European acceptability framework (SJU reference: PJ.11-A1)</p>	
	<p>AeroMACs integrated with ATN, digital voice and multilink (SJU reference: PJ.14-02-06)</p>	
	<p>RNP1 reversion based on DME-DME, formerly known as alternative position, navigation and timing (A-PNT) (SJU reference: PJ.14-03-04)</p>	
	<p>Sub-regional demand capacity balancing common service (SJU reference: PJ.15-01)</p>	
	<p>E-AMAN (delay sharing) common service (SJU reference: PJ.15-02)</p>	
	<p>Aeronautical data common service, formerly known as static aeronautical data common service (SJU reference: PJ.15-10)</p>	
	<p>Aeronautical digital map common service (SJU reference: PJ.15-11)</p>	
	<p>Enabling rationalisation of infrastructure using virtual centre based technology, formerly known as work station, service interface definition and virtual centre (SJU reference: PJ.16-03)</p>	
	<p>Multi touch input (MTI) (SJU reference: PJ.16-04-01)</p>	
	<p>eFPL supporting SBT transition to RBT (SJU reference: PJ.18-02c)</p>	
	<p>Reactive flight delay criticality indicator (FDCI) as part of AU processes for trajectory definition (SJU reference: PJ.07-01-01)</p>	
	<p>Enhanced computer-assisted slot allocation (ECASA) (SJU reference: PJ.09-03-01) and AOP/NOP departure information integrated in eFPL (SJU reference: PJ.09-03-02) in support of collaborative network management</p>	

The closure of the first wave of activities has resulted in a prioritisation of the remaining candidate solutions, focusing on those that will bring the expected benefits and that will reach V3 maturity by the end of the SESAR 2020 programme. This means that work has discontinued on a number of solutions.

At the same time, a total of 15 projects (12 focusing on industrial research and three very large-scale demonstrations) will continue work in the second wave of the programme with a view to delivering a further 50 solutions.

Read about these solutions in the 2019 SESAR Solutions Catalogue

Here are activities undertaken in 2019 on some of these solutions:

SESAR solution to enhance safety of mixed air traffic in Europe

Rotorcraft and general aviation fly at different speeds and altitude to commercial traffic, making the management of the traffic more complex. Flight trials conducted by SESAR members are showing how advanced approach and departure procedures can enable more efficient mixed air traffic operations, especially in adverse weather conditions.

Conducted between October and December 2018, the flight trials demonstrated a candidate solution (PJ.01-06) to allow rotorcraft to fly advanced point-in-space procedures, such as radius curves legs. These pave the way for simultaneous non-interfering operations by rotorcraft at busy airports and important emergency operations in mountainous areas. The procedures also help to reduce the noise of approaches in populated areas, and for rotorcraft to operate close to airports without coming into conflict with fixed-wing traffic or requiring runway slots.

Bringing together SESAR partners, DLR, Thales and Airbus Helicopters, the flight

trial at Braunschweig ran for over 10 hours with pilots flying a helicopter equipped with synthetic vision systems, a head mounted display (HMD - helmet), coupled to the current helicopter flight mission system (FMS), and further hardware equipment necessary for generating the symbology for both HMD- and head-down displays. Separately at Airbus Helicopters facilities in Donauwoerth, flight trials with curved and steep approaches were performed with a 4-axis autopilot coupling to achieve a high degree of automation and thereby significant crew workload reduction in approach and departure phases.

During these trials, the pilots assessed and validated the benefits of integrating such vision systems and advanced

autopilot modes to support the pilots and by this, increase the safety and reliability of rotorcraft operations. The pilots also evaluated the benefit of having satellite-based (SBAS) navigation for advanced point-in-space RNP 0.3/LPV approaches and departures to and from the final approach and take-off area.

As part of the flight trials, the partners organised open days in June and October allowing a broader range of ATM stakeholders from Europe and further afield to see first-hand the technology and procedures in real-time simulations.

www.sesarju.eu/projects/ead

[SJU reference: PJ.01-06]



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2019 SESAR Solutions Catalogue

The third edition of the SESAR Solution Catalogue provides a holistic view of the status of SESAR R&D in 2019 and offering solutions to some of the pressing challenges facing European aviation today. The publication covers the results of the first R&D programme (SESAR 1); more than 60 solutions, many of which are in the process of deployment at local and European levels. It also presents details of the ongoing R&D (candidate solutions) as we reach midway in the current programme, SESAR 2020. Finally, the catalogue gives a flavour of some of the promising results coming out of the SESAR's dedicated exploratory research programme.

Download the catalogue: <https://www.sesarju.eu/solutionscatalogue>



Taking virtual centres to the next level

In October, SESAR members and partners showcased progress made on the virtual centre, a solution identified in the Airspace Architecture Study as a critical element for optimising Europe’s airspace.

Today, ATM in Europe mostly consists of country-based systems and processes, which require customised systems and solutions at each ATM provider. This has led inevitably to a lack of interoperability and higher costs of air navigation services across Europe and an inefficient usage of resources.

The virtual centre refers to the decoupling air traffic management (ATM) data services, such as flight data, radar, and weather information, from the physical controller working position (CWP). The aim is to enable greater flexibility when it comes to organising air traffic control operations and, in doing so, seamless and more cost-efficient service provision to airlines and other airspace users.



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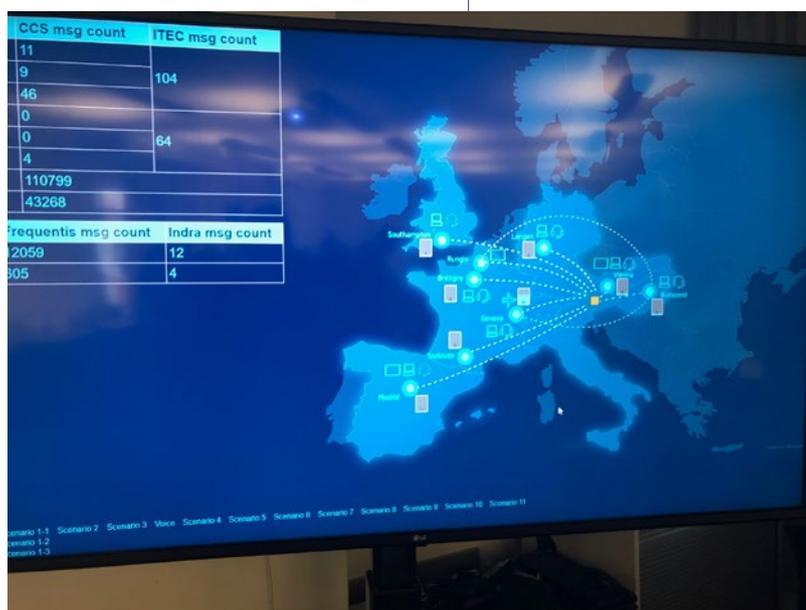
Over 100 participants attended a live demonstration of the solution, which took place at the premises of Frequentis, one of the partners involved in virtual centres. There they witnessed seven air navigation service providers (ANSPs) transferring airspace and flights between one another. The demonstration showcased some of the benefits that full delegation and optimisation of sectors across Europe can provide, namely increased increased

cost efficiency with the rationalisation and standardisation of systems and services and increased flexibility made possible through workload balancing, but also increased operational flexibility and better service continuity.

The demonstrations follow extensive research and validation conducted within the framework of the virtual centre project (PJ.16.03) by SESAR JU members and partners, namely COOPANS, DFS, DSNA, Enaire, ENAV, Eurocontrol, Frequentis, HungaroControl, Indra, Leonardo, LPS SR, NATS, SINTEF, Skyguide, Thales (lead partner), and Air Navigation Services of the Czech Republic.

www.sesarju.eu/projects/cwphmi

[SJU reference: PJ.16-03]



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Validating multiple remote towers

In 2019, several open days were held in Sweden, Norway, Germany and Hungary to present the results from validations of the multiple remote tower concept. The open days, which were organised within the context of the SESAR PJ.05 project, allowed participants to see first-hand how the concept works in real operational environments.

Remote towers are already a reality for leading air navigation service providers (ANSP) across the world. This operating concept is at the forefront of ATM service provision, however the potential of this technology continues to be explored by SESAR partners with regards multi-remote towers, a concept where an air traffic controller could provide services to multiple aerodromes.

For the Hungarian validation exercise, camera systems were installed at the

three airports involved in the project that provided live video streams which were displayed on a monitor wall. In addition to the video stream, controllers were supported by live radar information, and could listen to live radio communication and get relevant flight information. The Hungarian validation simulated traffic for three Hungarian airports (i.e. Budapest Airport, Pápa Military Airbase, and Debrecen Airport) and looked at how a single air traffic controller could control these airports simultaneously in a multi-remote tower module (MRTM).

The validations were carried out by DLR, responsible for project coordination within SESAR, Frequentis as the technology partner, and HungaroControl as the experienced ANSP to implement this experimental concept into daily operations.

Meanwhile in Sweden, an open day hosted by SESAR member Saab (NATMIG) presented the results of two different SESAR trials on multiple remote towers coordinated by COOPANS (LFV). In the first

exercise, one air traffic controller handled two airports simultaneously. The second exercise showed how three airports were simultaneously handled by one air traffic controller. A follow-up close out event gave participants the chance to visit the brand new remote tower control (RTC) Stockholm from which in the near future several Swedish airports will be controlled.

Two further open days took place in Germany, organised respectively by DFS and Frequentis, and AT-One (DLR), B4 (ON) and Frequentis, looking at the flexible allocation of aerodromes between multiple modules.

Finally, in Norway, Indra successfully validated multiple remote tower operations with Norwegian air navigation service provider (ANSP) Avinor, showing the possibility to manage multiple airports from one single integrated screen.

www.remote-tower.eu/

[SJU reference: PJ.05-02]

SESAR R&D shows how solutions can help airlines lower costs of delay by 40% in capacity constrained situations

Everyone hates it when their flight is delayed, not least airlines which have to deal with missed connections, disrupted fleet and crew schedules, night-time curfews, fuel, maintenance slots and aircraft repositioning. All these knock-on disruptions generate extra costs for airlines which in turn put pressure on ticket prices and their overall long-term sustainability.

Being able to have more control over selecting which delayed flights to prioritise based on business needs is a big advantage for airlines and other actors, which is where the user driven prioritisation process, or UDPP for short,

comes in. Part of the SESAR PJ.07 project, UDPP is a solution that helps airlines prioritise their delayed flights. Under development since 2012, some UDPP features have already been deployed such as enhanced slot swapping, while others have achieved different maturity levels.

Two core UDPP functionalities, fleet delay reordering and selective flight protection, were validated in early 2019; the latest feature to be successfully simulated is 'the Margins'. The feature enables airlines to input this time across all their flights caught in a heavy delay and, in addition to estimated departure time which is already submitted to Network, create a 'margin of manoeuvre'. This in turn can be used to reorder and prioritise flights to best suit the needs of each airline when foreseen capacity reductions have been identified.

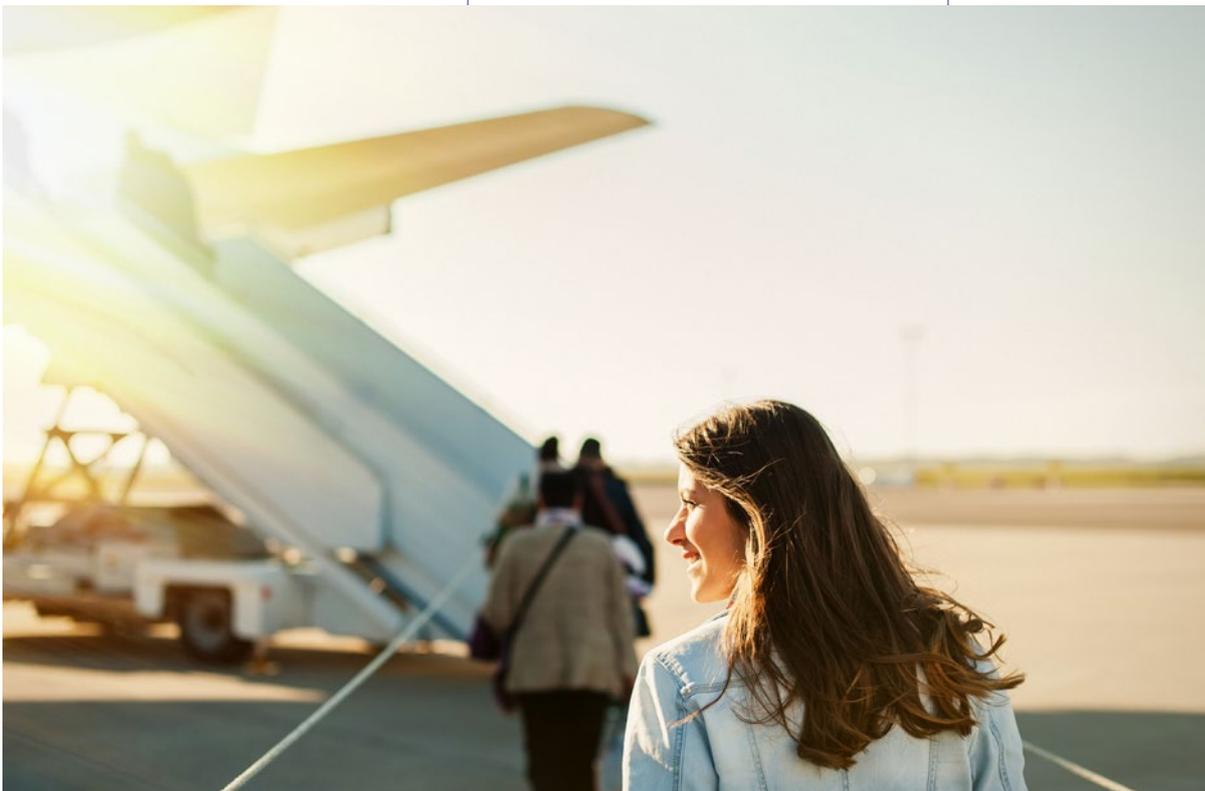
The margins were successfully tested in a recent validation exercise, led by Eurocontrol and involving operational

experts from airlines (Air France, Air Baltic, Lufthansa Group/Swiss, HOP!, Transavia and El Al) and IATA. The exercise revealed that by offering airlines an additional set of information, they could optimise the position for a set of delayed flights within their margins, reducing the number of missed passenger connections, and lowering the cost of delay by 40% in a capacity-constrained situation.

As part of the SESAR research programme, the next steps will be, starting in 2020, to validate UDPP together with several ATM processes for arrivals at a number of airports in Europe until the UDPP solution has been judged mature and ready to be implemented into operations.

www.sesarju.eu/projects/oaou

[SJU reference: PJ.07-02]



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New alert system to offer enhanced runway safety

SESAR members completed a series of flight testing of a system which looks set to improve safety for pilots, passengers and other aircraft on airport runways. The system is one of several solutions in the pipeline as part of the SAFE (PJ03b), a project that brings together air navigation service providers, manufacturers, airport operators, research institutes from across Europe and Eurocontrol.

Traditionally, pilots rely on their line of sight and instructions from air traffic control to avoid collisions. Developed within the framework of SESAR by members Honeywell, Airbus, Dassault and Eurocontrol, the solution “traffic alerts for pilots for airport operations” - a software-based system - provides early warning to aircrews, empowering

pilots to make quicker decisions and avoid runway incursions. Specifically the system analyses aircraft position data and calculates factors, such as time to collision, through specialised algorithms to alert pilots of surrounding aircraft. The system provides timely surface traffic indications and warnings to the flight crew. These include visual awareness on the airport moving map display in the cockpit as well as an audio alarm. The pilot receives a text message showing time to collision, colour-coded image, and aural message.

The solution is designed to require minimal changes to existing avionics and uses automatic dependent surveillance-broadcast (ADS-B), a globally mandated technology upgrade due by 2020, to make installation of the solution quick and simple. The solution is equally applicable to commercial aircraft and business aircraft. Its success depends on

the performance and quality reception of broadcast ADS-B aircraft data and compliance with the relevant standards.

The work covers two implementation options for the runway: one which provides a warning, plus a second which adds cautions and indications. A third option provides alerts, cautions, and indications on the taxiways. The solution was delivered for industrialisation and deployment by the end of 2019.

www.sesarju.eu/projects/safe

[SJU reference: PJ.3b-05]

Demonstrating SESAR

Very large-scale demonstrations

Very-large scale demonstrations offer a critical mass of proof of the performance benefits that SESAR Solutions can deliver to the aviation community. The demonstrations include trials involving live traffic and so typically take place in close-to-operational environments. These demonstrations are the result of open calls, so are capable of bringing a much broader range of stakeholders, among which airspace users and other aviation end-users. The fact that so many stakeholders are eager to participate is proving invaluable for accelerating the operational acceptance and the subsequent industrialisation of SESAR Solutions. In other words: “seeing is believing.”

In 2019, significant progress was made by these demonstrations to prove the operational benefits offered by SESAR Solutions. Discover examples of these projects on the following pages.

Real-time planning for the airports – European research for more punctual and efficient airport operations

Nice, Hamburg and Budapest. Three European airports with very distinct operational characteristics and challenges. But over the last three years, these three airports have acted as demonstrator sites

in the Integrated Airport Operations project to showcase the potential of technological solutions designed to support the tasks of tower and apron controllers as a means of ensuring greater efficiency:

Digital ‘taxiing manager’

The first solution – automated assistance to controllers for surface movement planning and routing – comprises a route-planning tool that makes automated planning of

aircraft routing available to apron and ground controllers. The system calculates ideal taxi routes for each aircraft, which it then proposes to the controllers, although the operator can change them at any time.

No congestion at departure

The second solution – pre-departure sequencing supported by route planning – builds on the optimised taxi routes and is intended to ensure that engines are started at the latest possible moment – thereby minimising the environmental impact.

Enhanced safety nets

The third solution – airport safety nets for controllers – draws on available information to enable new ‘safety nets’ at airports. These new safety nets can alert air traffic controllers when traffic deviates from air traffic control (ATC) instructions or procedures, enabling prompt reactions.

The IAO team (DLR, DSNA, HungaroControl, Indra and SINTEF) implemented the solutions at three different airports to see how they could



© IAO

be broadly applied despite significantly different local characteristics. Over the course of the project, the participating partners installed the infrastructure for on-site testing and connected the demonstrators to the operational airport systems. Doing so enabled access to live data from flight operations, such as the current traffic situation and the associated flight plans allowing for a very close-to-operational environment. All exercises were performed with local air traffic controllers as realistically as possible. Controllers were therefore able to provide their immediate impressions, feedback and assessments.

The three solutions are among the ATM sub-functionalities outlined in the European Union's Pilot Common Project (PCP), a European regulation binding the EU Member States and their operational stakeholders, including a number of airports, to deploy in a synchronised and timely manner the most essential SESAR operational improvements.

www.iao-project.eu

New SESAR research project aims to make aircraft movements on the airport surface safer and more efficient

Launched in 2019, the Airspace User supporting Demonstration of Integrated Airport Operations (AUDIO) aims to improve safety, efficiency and predictability of flights by increasing the flight crew's situational awareness while the aircraft is taxiing. Cockpit crews currently have access to information such as the digital layout of airports or a graphical representation of their own position through what is called the Electronic Flight Bag (EFB) System. AUDIO proposes to provide additional data, traditionally available to controllers only. In a real-life demonstration at Hamburg airport, AUDIO will demonstrate the viability of an innovative advanced and connected moving map application, developed under a previous EU-funded project. The application provides the cockpit with local airport data such as the on-ground traffic situation and planned taxi routes.

www.sesarju.eu/projects/AUDIO



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Towards more predictable air traffic

Initial four-dimensional trajectory management (i4D) supports the move towards trajectory-based operations and more predictable air traffic. With i4D, trajectory predictions are computed by the aircraft's flight management system (FMS) and shared among all operational stakeholders. The concept relies on datalink to downlink the FMS predictions, as well as uplink ATC constraints and clearances, which are auto-loaded in the FMS to keep trajectory predictions up-to-date.

SESAR has been instrumental in advancing i4D, with numerous validation exercises, culminating in live trials demonstration in February 2012 and March 2014, which tested avionics and ATC system prototypes developed by Airbus, Honeywell, Thales, MUAC and Noracon. In May 2014, EUROCAE and RTCA jointly developed and published i4D supporting standards, enabling partners to move ahead with i4D industrialisation. In December 2018, the first certification was granted by EASA and FAA to the Airbus A320, which have since

been delivered to EasyJet – further aircraft certifications are in the pipeline for delivery to Air France, British Airways, Iberia, Novair, Wizzair.

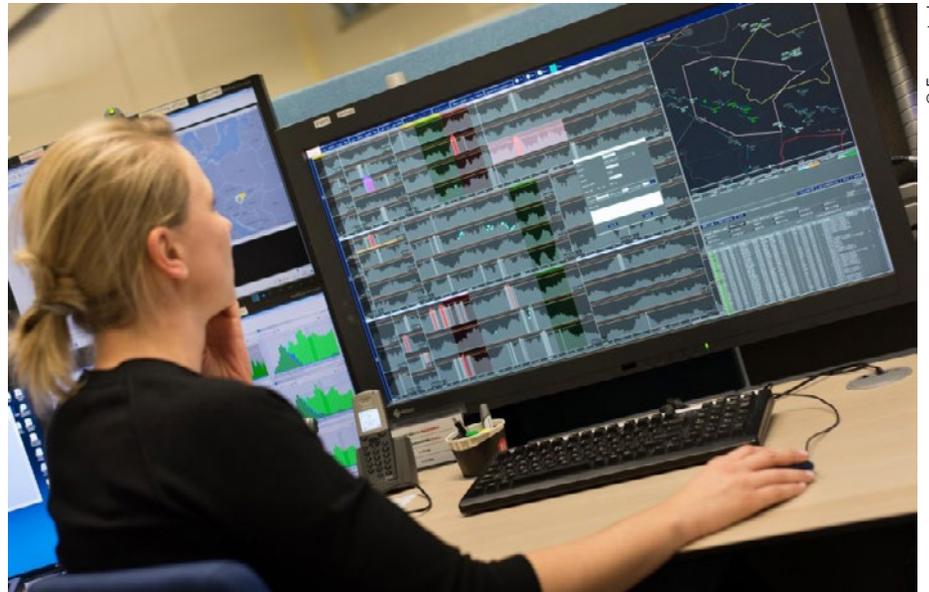
These aircraft took part in 'DIGITS' - a large-scale SESAR project demonstrating how sharing trajectory data with air traffic control can improve the predictability of air traffic. In 2019, aircraft operated by the abovementioned airlines started exchanging Automatic Dependent Surveillance – Contract (ADS-C) data with air traffic controllers at Eurocontrol's Maastricht Upper Area Control Centre (MUAC). Using ADS-C technology, aircraft log on to the MUAC system and automatically downlink flight management system information, which can be displayed on the controllers' screens.

In particular, the flight management system downlinks the extended projected profile (EPP), which consists of up to 128 waypoints in four dimensions, and therefore, provides valuable data to the controllers about the aircraft's intent. Should it differ from the flight plan available to the air traffic controllers, they will receive a warning. Further information such as the top of descent is made available to the controllers too, so that continuous descent operations can be initiated more optimally. ADS-C has the potential to increase safety and ensure more efficient air traffic management service provision.

The partners are evaluating the technology's potential in improving ground trajectory predictions and enhancing a range of applications – from conflict detection to demand and capacity balancing.

DIGITS provides a stepping stone for the Pilot Common Project (PCP AF-6), which mandates i4D deployment by European ANSPs in 2025, with 45% of the European flights equipped by 2026.

www.sesarju.eu/projects/digits



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Research addresses air traffic delays and congestion

Ahead of the summer traffic, SESAR JU members and partners demonstrated how local demand and capacity balancing (DCB) solutions can improve predictability and punctuality of air traffic in the overall network.

The SESAR JU large-scale demonstration brought together flow management staff from two Spanish air traffic control centres, as well as engineers and experts from Enaire and Eurocontrol's Network Manager. Together they sought to demonstrate how the use of local DCB short-term ATFCM measures (STAM) solutions can help to decrease the number of flights affected by measures to balance traffic demand with capacity and any knock-on delays. Specifically, the partners also aimed to demonstrate how these solutions can help to identify on-time imminent complex air traffic situations, declare hotspots where necessary, and select the most appropriate measure to address the situation while minimising any impact on

the overall network and airlines' flight plans.

The demonstration focussed on two scenarios: the electronic coordination between the Network Manager and local flow manager to reduce congestion by imposing short-term ground delays (mandatory cherry picking); and the electronic coordination of computer-assisted-slot-allocation (CASA) for specific traffic flows in the network.

The results from the demonstrations showed that the solutions can have a positive impact on the reduction of regulations imposed on flights and delays in the network, with an average decrease of delay per regulated flight of 9,6%, while a decrease in total delay of 31%.

www.sesarju.eu/projects/ncm

Delivering cross-border solutions to optimise air traffic arrival flows

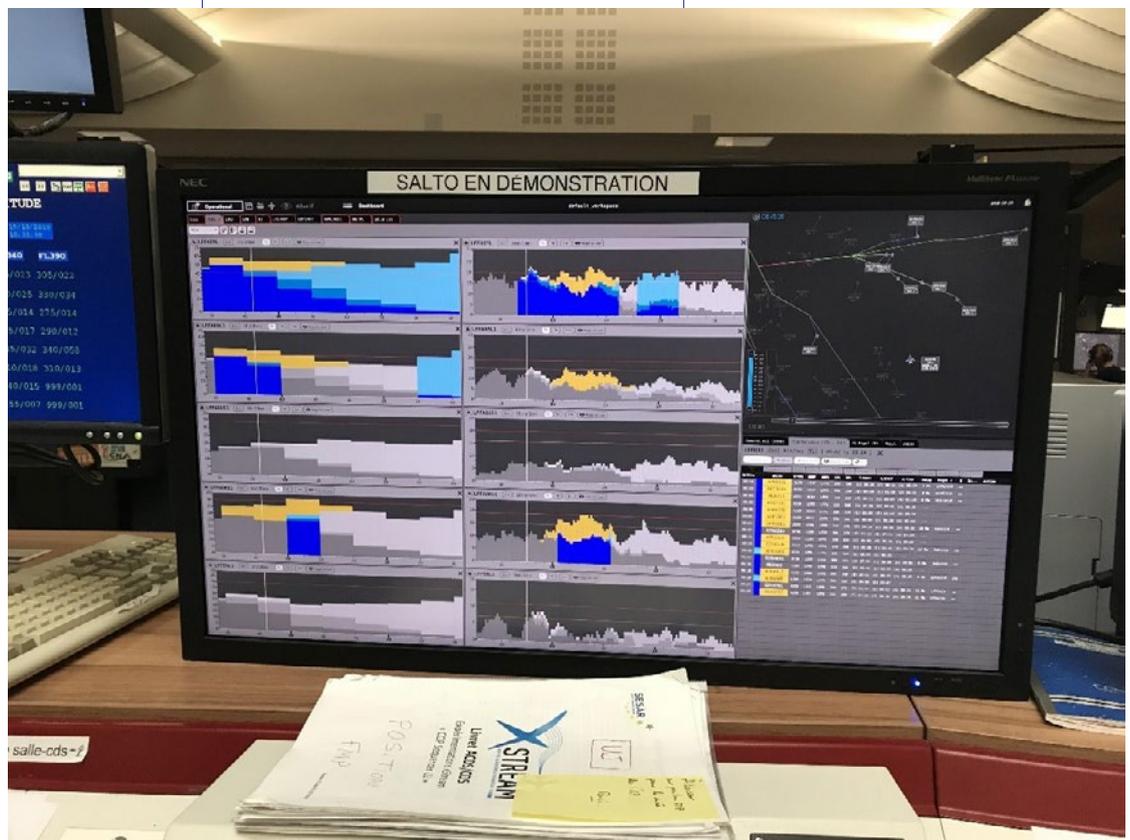
DSNA, NATS, skyguide, DFS and their partners in the xStream project completed live trials from Summer 2017 to Summer 2019, demonstrating the operation benefits of extended arrival management (E-AMAN) and target time of arrival (TTA).

The successful results of xStream are providing the basis for synchronised deployment by the SESAR Deployment Manager: 24 European major airports will operate extended arrival management procedures by 1st January 2024 in order to improve flight efficiency and predictability at airports, in TMA, in Extended TMA and in en-route. Amongst

them, ten major airports are located in FABEC airspace and four in UK airspace.

In 2019, final xStream trials were conducted in Frankfurt, London, Paris and Zurich and explored a large set of solutions. Through these trials, AMAN horizons were extended from 200 NM to more than 350 NM, with a wide participation of surrounding Upper Area Control centres (UAC) such as Maastricht, Reims, Paris, Swanwick, Prestwick, Shannon, Karlsruhe, Zurich, Geneva and Milan. Extended AMAN operations were demonstrated for the first time on a highly congested single runway at London-Gatwick. The absorption of arrival delay during the en-route phase led to a reduction of fuel consumption by up to 30 kg per flight, representing 90 kg of CO2 emissions and has now been permanently implemented.

From March to October 2019, additional live trials were performed in Frankfurt and Paris to further explore the benefits of optimising target times of arrival (TTA) procedures at congested airports. Using web service-based platforms, DSNA (resp. DFS) was able to automatically coordinate TTA requests with Network Manager (resp. flight crews from participating airlines) in order to optimise air traffic flows into arrival constraints. This new process was experimented on ATFM regulations in Paris, and with airborne flights landing at Frankfurt airport just after the morning opening of the airport. By better matching traffic demand with local constraints, delays could be reduced in Paris by 5% without impact on safety management by controllers. Results in Frankfurt show the potential of better flight efficiency



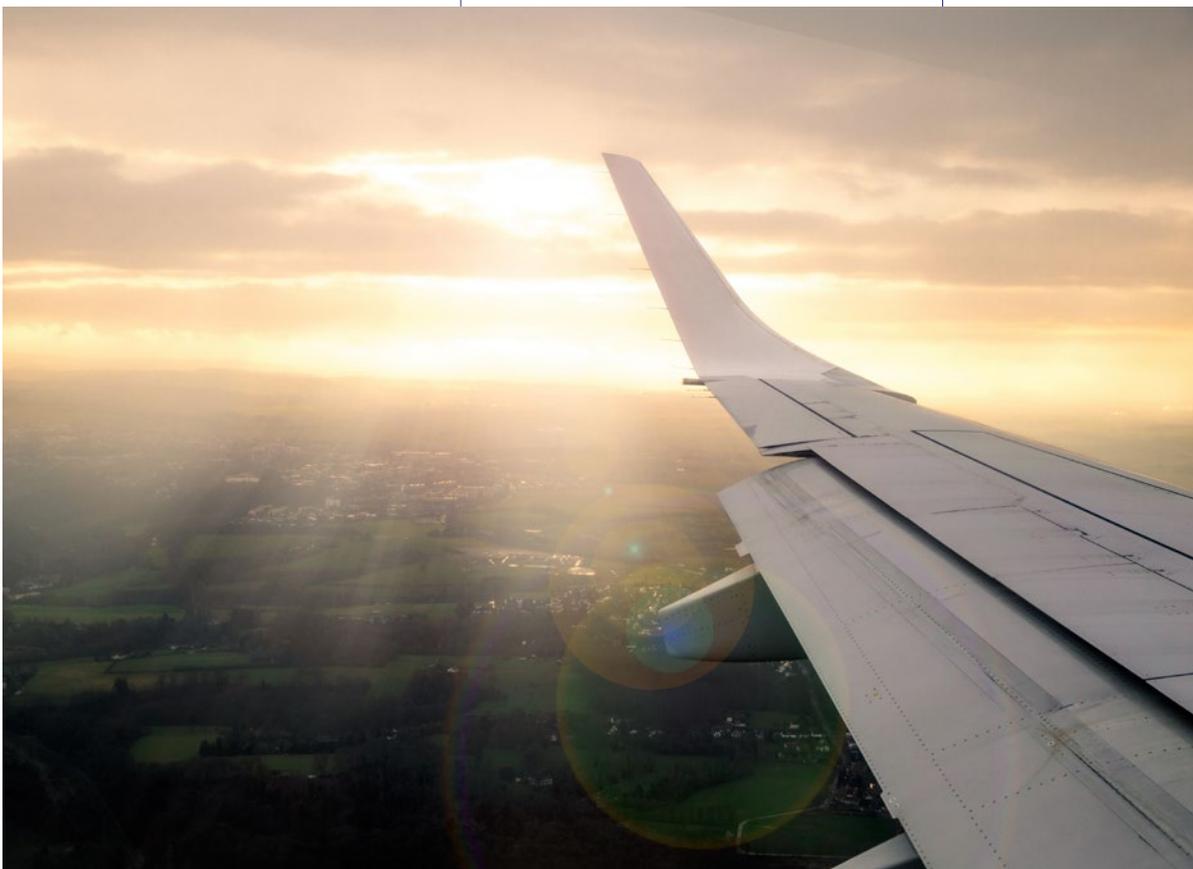
with a slight reduction of track miles flown in the Terminal Area (TMA).

Finally, two trials were conducted in Zurich and Paris to address the integration of airspace user priorities in the arrival planning process. Indeed, a few minutes gained by a flight can be sufficient to ensure connections for dozens of passengers. In Paris, the AFLEX (Arrival Flexibility) concept allows an airspace user to express its priorities (i.e. swap requests between

two arrivals) to the DSNA web portal in real-time, which will then be integrated by Paris FMP in its arrival planning strategy. In Zurich, a shadow-mode trial was performed using the new UDPP collaborative prototype in order to integrate airspace users' preferences during arrival capacity constrained situations. The two concepts are complementary to each other and should be further developed.

E-AMAN operations between London-Gatwick and Maastricht UAC were implemented immediately after the trials and other partners are already working towards partial or full E-AMAN implementation starting in 2020.

www.sesarju.eu/projects/xstream



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Enabling the safe and secure integration of drones

U-space

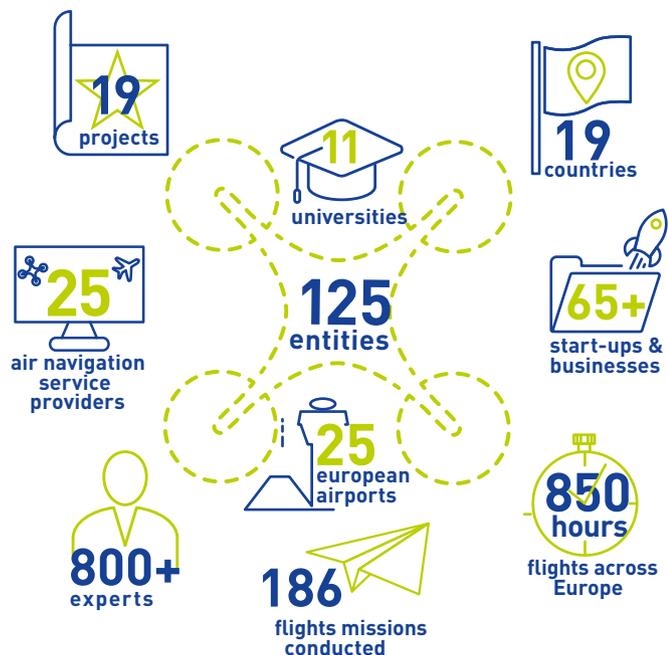
Research and innovation is underway in SESAR to ensure that the increase of drone traffic in Europe's skies can be managed safely, in particular in relation to commercial air transport. Much of it is done within the framework of U-space, an initiative by the European Commission to ensure the safe and secure integration of drones across Europe. The aim of U-space is to put in place 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 a large numbers of drones, with an initial look at very low-level (VLL) operations. The services and technologies are categorised as: foundation services (U1), initial services (U2), advanced services (U3) and full services (U4).

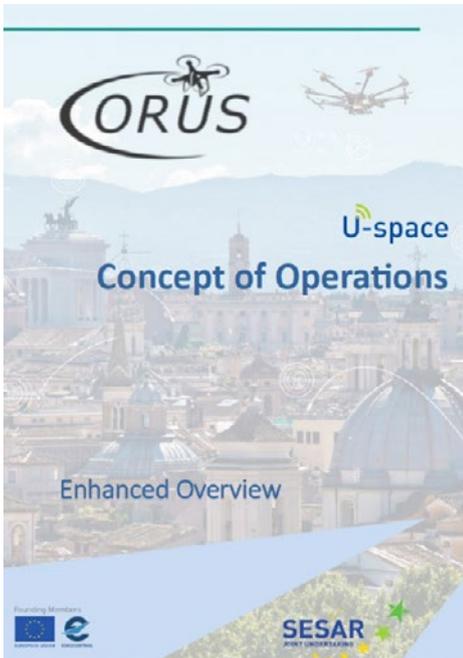
In this context, in 2019 the SESAR JU partners completed work in a series of U-space projects addressing everything from the concept of operations for drone operations, critical communications, surveillance and tracking, and information management to aircraft systems, ground-based technologies, cyber-resilience and geo-fencing. Progress was also made by several large-scale demonstrations to showcase already matured U-space services and technologies for visual line of sight (VLOS) and BVLOS drone flights. The scope covers operations in rural and urban areas, in the vicinity of airports, in uncontrolled and controlled airspace, and in mixed environments with manned aviation. Projects for example, examined how to handle VLL operations where general aviation, commercial aviation and drones share the airspace.

The preliminary results from these projects show that progress was made on the building blocks of U-space, with project partners already reporting plans to start work now in their respective countries to deploy some elements of U-space. At the same time, the

projects also identified important gaps in terms of the performance of certain technologies or where more research is needed, especially in the area of urban air mobility operations and the interface with manned aviation.

U-SPACE RESEARCH & INNOVATION IN NUMBERS





U-space concept of operations published

A harmonised approach to integrating drones into very low-level airspace is vital if the rapidly growing drone industry is to fulfil its economic and social potential. Gathering experts from aviation, research and academia, guided by a 21-member stakeholder advisory board, the Concept of Operation for European UTM Systems (CORUS) project has completed work on a concept for operations (CONOPS) for U-space, namely uncontrolled very low-level airspace, and in and around controlled and/or protected airspace such as airfields. It proposes an initial U-space architecture with a detailed definition of the airspace types to be used for very low-level drone operations and the services in them, so that operations are safe and efficient. It balances the needs of the drone sector with those of society as a whole.

The document describes an initial architecture that identifies the airspace types, services and technical development

necessary for implementation of the CONOPS, quantifying the levels of safety and performance required. It includes use-cases for nominal scenarios such as contingencies and emergencies; and proposes a method to assess the safety of service provision (MEDUSA). Finally, it proposes solutions for easing social acceptance of drones by examining aspects including safety, privacy, noise and other societal issues.

Broad acceptance of the CONOPS has been essential to its success, with interested parties invited to join the “U-space Community Network” (UCN) that grew to over 500 members during the course of the two-year project. These UCN members received information about the progress of the project, were invited to attend the workshops, and provided input on a number of questions to guide the project’s work. Well over a thousand written comments were received on the three drafts. CORUS also communicated and cooperated with more than 70 organisations involved in other related projects looking at specific drone and U-space technologies.

The CONOPS is an initial, though detailed and widely accepted, step towards the safe interaction of drones with all different types of airspace users.

www.sesarju.eu/projects/corus

Safe drone operations require reliable tracking and monitoring

Reducing the risk of conflict between airspace users becomes more important as more drones enter the airspace. The Clear Air Situation for uaS (CLASS) project examined the potential of ground-based technologies to monitor and separate drone traffic in an unmanned aerial traffic management system (UTMS) in real-time. The consortium fused surveillance data obtained using a drone identifier and tracker, and holographic radar, to feed a real-time unmanned air traffic management (UTM) display.

CLASS tested tracking and display of cooperative and non-cooperative drones in six operational scenarios, ranging from an out-of-control leisure drone, conflicts with emergency operations, and incursions by rogue drones. Various scenarios were carried out by project partners to benchmark the surveillance and data fusion technology and achieve the lowest rates of false alarms. The functionalities provide the basis for a real-time centralised UTMS which can be used





by all stakeholders, from drone operators to air navigation service providers and authorities. The functionalities were also designed to support advanced services such as geo-fencing (where the drone pilot is warned automatically if he trespasses into an unauthorised zone), geo-gaging (where the drone pilot is warned that he is leaving a pre-defined zone), conflict detection and resolution.

As a result of the demonstrations, CLASS was able to deliver the functional and technical requirements for tracking, monitoring and tactical deconfliction. CLASS also found variations in the performance of tracking technology and recommended the drawing up of standards for different U-space services. Further research is recommended to scale up the operational scenarios to simulate surveillance in denser environments, initially involving tens of drones.

www.sesarju.eu/projects/class

Urban air mobility demonstrated at Helsinki Airport

In August, partners in the SESAR JU Gulf of Finland (GOF) U-space project successfully completed a series of piloted air taxi flight trials at the Helsinki International Airport. The flight trials demonstrated the feasibility of connecting conventional ATM and UTM or U-space systems to enable urban air mobility.

During the trials, the piloted taxi was fully connected with air traffic control at the airport, as well as two U-space service providers working in the same geographical area, with data exchanges taking place in real time between the systems.

The flight trials are one of seven demonstrations that the 19 members of the GOF project have undertaken to demonstrate that safe and integrated drone operations are possible, building upon established and existing systems in an open and interoperable environments.

Together the partners have pooled their expertise to develop interoperable and data-sharing solutions which are aligned with the overall U-space architecture. In addition to air traffic management, large-scale drone use will rely on scalable radio communication systems (e.g. mobile networks) and weather information, which have also been trialled in the project.

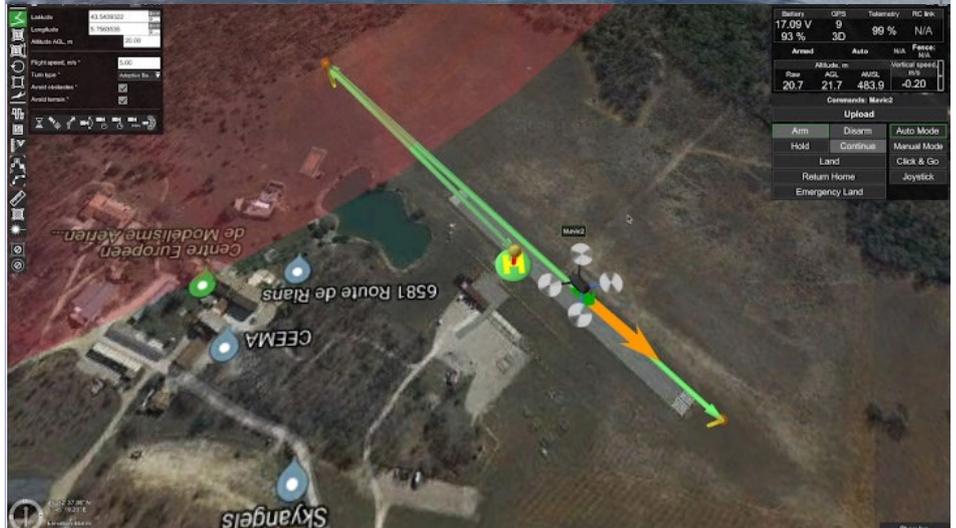
www.sesarju.eu/node/3203

Geofencing for safe and autonomous flight in Europe

To prevent drones straying into protected areas, for example around critical infrastructure such as power plants or airports, geofencing and geo-caging technology is used to contain drone operations. Geofencing solutions prevent drones from entering forbidden areas and geo-caging does not allow drones to fly beyond a set boundary. Both measures are critical to keeping complex low-altitude airspace safe for all by ensuring drones avoid any designated no-fly zones and adhere to rules put in place by EU member states.

The GEOSAFE research set out to establish state-of-the-art geofencing solutions regarding U-space regulation and to propose improvements and recommendations for future geofencing system definition. The project was based on a one-year long flight-test campaign which assessed a number of commercially-available geofencing solutions in order to propose improved geofencing systems for tomorrow and technological improvements for drones. The research included 280 flight tests in France, Germany and Latvia, which tested representative situations that a drone will face in urban and rural areas. They covered a range of missions including agricultural operations, inspections, emergency events and deliveries.

The project concluded most drones meet the requirements for pre-tactical geofencing and demonstrated that existing technology is ready for initial U-space services even though no one solution is aligned with regulations in different countries. Solutions are also available to support tactical geofencing necessary to deliver advanced U-space services despite the lack of standardisation. However, technology capable of supporting



dynamic geofencing is not sufficiently mature to meet full U-space service levels, although this is expected to develop rapidly in the near term, not least because dynamic geofencing is a key function for unmanned vehicles operating beyond the visual line of sight.

The results are helping to inform the European Commission of best practices for integrating drones into European airspace.

www.sesarju.eu/projects/geosafe

Solving big challenges in small packets - Meeting U-space information needs

Many of the differences between ATM and UTM have to do with scale. Drone information services will be significantly more detailed, diverse and dynamic than those used by aircraft today. Safety critical information, for instance, will be needed at a much higher fidelity than in today's solutions, and will include geospatial information services to ensure surface clearance, local weather information to calculate drone trajectory uncertainties and non-conventional navigation sources (such as signals of opportunity and vision-based navigation)

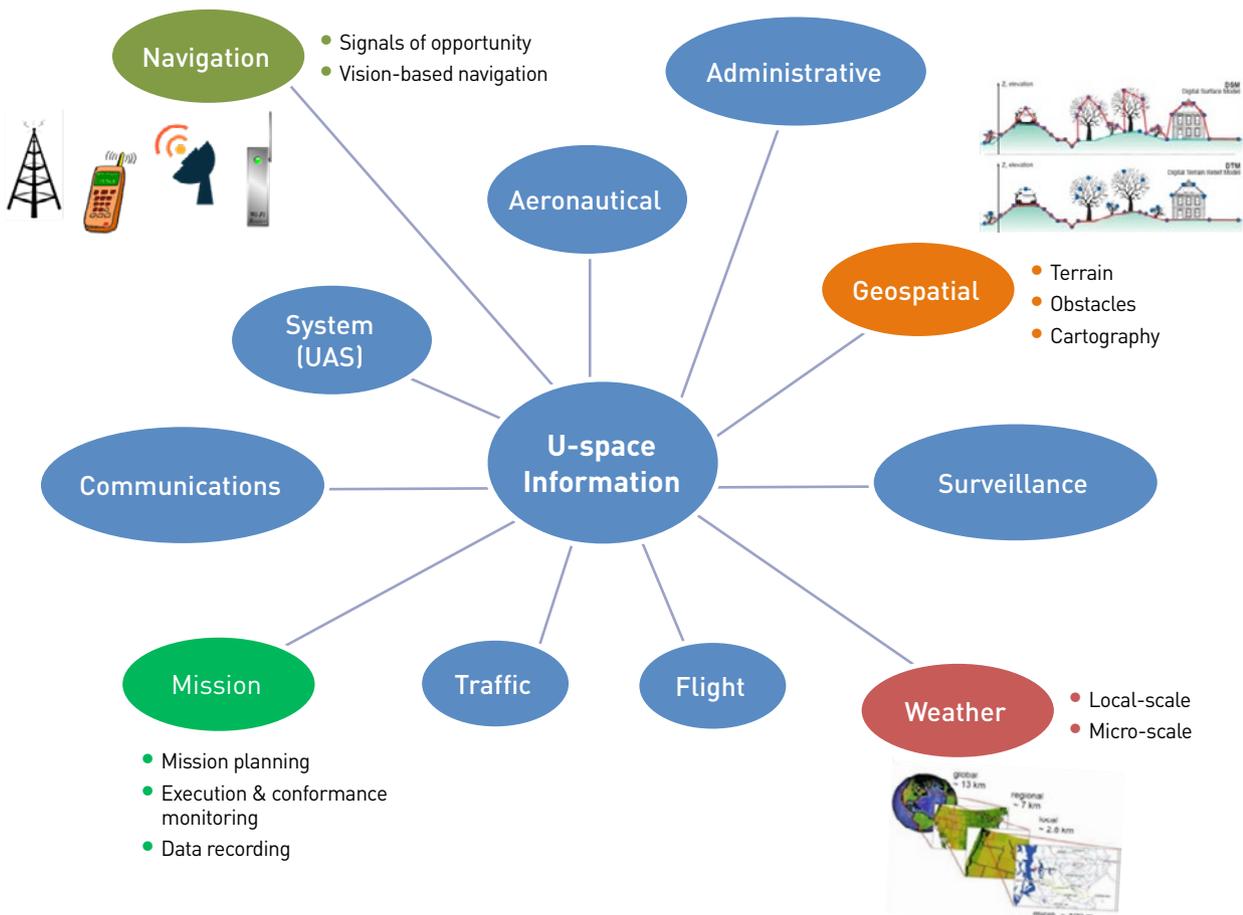
to allow for more precise navigation on a local scale. Services of this level of fidelity will require the movement and provision of massive amounts of data to wide array of users spread out over a large geographical area.

Partners in the Impetus project looked at what information is needed and how it will be used by drones in very low-level airspace, researchers proposed an information management architecture based around microservices. This contrasts with legacy monolithic applications, which are centralised, uniformly packaged and single-language-based programmes that quickly reach overwhelming complexity as they grow to meet consumer demand. Microservice-based applications avoid

this issue as the entire application is split into small, independent but highly interconnected services.

The framework of the Impetus solution is based on a federated architecture with a layered distribution of responsibilities. It is made up of a central actor that provides a single point of truth of the airspace situation, an intermediate interface composed of multiple U-space service providers, and an external layer for the end users (drone operators). The Impetus platform supports testing of various U-space services.

www.sesarju.eu/projects/impetus



Putting U-space services to the test in operational scenarios

In 2019, partners in the PODIUM large-scale demonstration brought to a close two years of intensive validation and trials at five operational sites in Denmark, France and the Netherlands. The project tested the performance of pre-flight and in-flight services using different scenarios ranging from airport locations to beyond visual line of sight. The results are being used to draw up recommendations on future deployment, regulations and standards.

Today, drone operators need to perform a number of manual processes before they can fly. All this takes extra time and effort which can affect the commercial viability of drone operations. PODIUM has helped to reduce the risks inherent to the operational and industrial deployment of U-space by demonstrating a web-based UTM system – including an open cloud-based solution and a secure gateway solution - using tracking systems based on ADS-B 1090 MHz, UNB- L-Band, and GSM networks.

PODIUM concluded that there is a very strong demand from all stakeholders for U-space solutions that can ease the burden of obtaining flight authorisations

for drone flights, and that increased situational awareness enables safety and efficiency benefits during flight execution. It found U-space services for the pre-flight phase almost ready for deployment, but concluded that significant action is needed to ensure that U-space services can really take off in the flight execution phase. In particular, PODIUM made recommendations relating to tracking, the human machine interface for drone pilots, and the access to trustworthy data – with implications for standardisation and regulation, and further research and development.

www.sesarju.eu/projects/podium



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Coming next in 2020

U-space brochure out now!

Get the preliminary results from the 19 completed U-space research projects. The brochure provides the conclusions from the projects, detailing the technologies and services addresses, as well as the types of missions and categories of airspace addressed.

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Sustainability, capacity and urban air mobility - focus of SESAR demonstrator call

The SESAR JU has launched an open call for very-large scale demonstration projects within the framework of the SESAR 2020 research and innovation programme. The call covers a wide range of topics aimed at boosting the performance of aviation in Europe, with a focus on sustainability, capacity and urban air mobility. A total of EUR 19.5 million is earmarked for the research from the EU's Horizon 2020 budget.

Read about the call:
www.sesarju.eu



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MG-01-19-780-EN-N

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