SMARTER AIRPORTS, STRONGER EUROPE

DELIVERING AVIATION TRANSFORMATION

sesar
JOINT UNDERTAKING

ACI EUROPE
AIRPORTS COUNCIL INTERNATIONAL

Contents

About SESAR Joint Undertaking

The SESAR Joint Undertaking is an institutionalised European partnership between public-private members, 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 safely and efficiently manage conventional aircraft, drones, air taxis and vehicles flying at higher altitudes. With the Digital European Sky comes the promise of making Europe's airspace the most efficient and environmentally friendly sky to fly in the world. The SESAR JU partnership brings together the EU, EUROCONTROL, and more than 50 organisations covering the entire aviation ecosystem, 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 as professional staff organisations, the space and military communities and global partners.

www.sesarju.eu

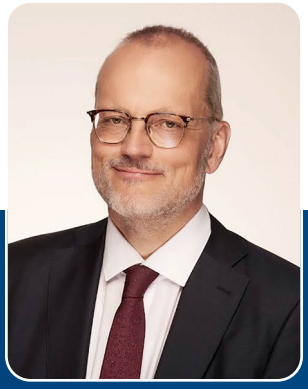
About ACI EUROPE

ACI EUROPE is the European region of Airports Council International (ACI), the only worldwide professional association of airport operators.

ACI EUROPE represents over 500 airports in 55 countries. Our members facilitate over 95% of commercial air traffic in Europe. Airports and air connectivity support 14 million jobs, generating €851 billion in European economic activity (5% of GDP). In response to the Climate Emergency, in June 2019 our members committed to achieving Net Zero carbon emissions for operations under their control by 2050, without offsetting.

www.aci-europe.org

Forewords



Andreas Boschen

Executive Director of the SESAR Joint Undertaking

Airports are more than gateways for passengers and goods. They are critical nodes in a wider air traffic management (ATM) network, bringing together airlines, air navigation service providers (ANSPs), the Network Manager and many other stakeholders to deliver safe, efficient, and seamless journeys. As aviation evolves, airports face increasing complexity: growing demand, tighter operational constraints, rising expectations from passengers and communities, and the need to reduce environmental impact.

Meeting these challenges requires innovation across the entire aviation ecosystem. It requires better use of data, closer collaboration between stakeholders, and solutions that enable the network to operate as one. This is the ambition of the SESAR Joint Undertaking (SESAR JU), which unites the entire Air Traffic Management community to define, develop, and deliver innovative solutions that enable a more connected, digital, and sustainable European network – the Digital European Sky.

Today, 12 airport operators are members of the SESAR JU, while many more airports participate in SESAR research and innovation activities. Through these collaborations, solutions are tested in real operational environments, ensuring that they can deliver value across Europe's diverse airport landscape. Some of these airports are featured in this publication, sharing their experiences of how SESAR innovation is helping to transform their operations, making them smarter, more seamless, and sustainable.

Smarter, through the use of real-time data sharing, digital platforms, and artificial intelligence to support better decisions and more efficient operations.

More seamless, by enabling airports to become integrated mobility hubs, connecting air travel with other modes of transport, and supporting a smoother passenger journey from door to door.

More sustainable, by improving the efficiency of airport and airspace operations, reducing fuel burn, emissions and noise while making better use of existing capacity.

Together, these stories clearly demonstrate that the future of airports depends on a connected ecosystem where innovation delivers greater resilience, competitiveness, and sustainability across Europe.

Enjoy the read!

Olivier Jankovec

ACI EUROPE Director General

As demand for air connectivity continues to grow, the need for the SESAR Joint Undertaking's research and development has never been more important.

Every day, airports are balancing growing passenger demand, limited possibility to expand capacity, increasingly complex operations, and ambitious sustainability goals, all whilst operating as part of an interconnected aviation network. Meeting these challenges is particularly tricky as the aviation sector is entering a profound transition in which traffic growth alone can no longer guarantee financial viability. Digitalisation, integrated operations, and closer stakeholder collaboration are therefore essential for the future of European aviation.

SESAR innovations are delivering tangible benefits now – not only for airport operations by squeezing every last drop of capacity out of our constrained infrastructure, but for passengers too. This means more predictable journeys, fewer delays and smoother connections, and a reduction in unnecessary fuel burn and emissions – realising SESAR's aim of making Europe the most efficient and environmentally friendly sky to fly in the world by 2045.

The stories in this guide show how that future is already taking shape. Through real airport case studies, they demonstrate how SESAR projects are delivering practical results today, and how they will continue doing so in the future. Whilst each airport's journey is unique, they all share a common ambition: embracing innovation to improve performance, strengthen collaboration, and enhance the passenger experience. They also remind us that meaningful innovation is never achieved in isolation. It depends on partnerships, shared expertise, and a collective commitment to turn bold new ideas into operational reality. This is where SESAR truly delivers.

I hope the experiences shared on these pages will inspire others to explore the many innovations that SESAR offers. As the examples in this guide clearly demonstrate, SESAR is delivering benefits that reach the entire aviation network – and beyond. In doing so, it also demonstrates the value of coordinated European action – where collaboration, innovation, and public-private investment combine to deliver lasting benefits for airports, communities, businesses, and European citizens alike. That is a powerful case not only for what SESAR has achieved already, but for what it can continue to contribute in the years ahead.

Introduction

Welcome to Smarter Airports, Stronger Europe: Delivering Aviation Transformation

Every airport faces the same challenge: how do you handle more passengers, cut emissions and improve resilience without building more infrastructure?

Across Europe, airports are already finding answers. Working with partners through the SESAR Joint Undertaking, they are using digital technologies, artificial intelligence and new ways of collaborating to transform the way aviation operates.

This publication tells those stories.

It showcases how research and innovation are helping airports gain visibility on their operations and increase efficiency by connecting to the wider network, which ultimately delivers benefits for passengers, communities, and the European economy[1].

For airports, these stories provide practical examples of how other airports are solving real operational challenges. The aim is not simply to showcase innovation, but to inspire others to adopt solutions that are already proving their value.

For policymakers, the stories highlight the importance of Europe's innovation community in driving real change in a crucial sector for the continent's connectivity, cohesion and competitiveness. These stories show the value of cross-border and cross-sector collaboration and how technological advances translate into practical benefits for citizens, businesses, and regions.

SESAR innovation supporting Europe's competitiveness

The innovations featured in this publication are part of a wider European effort to build a more resilient, competitive and sustainable aviation sector. Through SESAR, Europe's aviation community is developing and deploying "made in Europe" technologies and solutions that strengthen connectivity, improve performance, and support the transition towards the Digital European Sky. In this way, innovation in areas such as smart airport operations contributes not only to better aviation, but also to Europe's wider competitiveness and resilience.

Discover how SESAR innovation supports Europe's competitiveness and resilience

SCAN ME

https://www.sesarju.eu/node/5282

1. These innovations contribute to the vision set out in the European ATM Master Plan (https://www.sesarju.eu/masterplan), supporting the transition towards a more digital, connected, resilient and sustainable Air Traffic Management system.

Delivering solutions for smart, seamless and sustainable airport operations

The stories in this publication explore different ways in which innovation is helping airports become more connected, efficient and sustainable - from making better use of data and improving collaboration, to creating more seamless passenger journeys and reducing the environmental footprint of airport operations. They are grouped around three themes: smart, seamless and sustainable.

SMART

Smart solutions feature a range of digital, data sharing, and advanced decision-support tools that are helping airport stakeholders make the best possible decisions in real time. By improving collaboration and predictability, these solutions contribute to more efficient airport operations and stronger performance across the wider ATM network.

SEAMLESS

Seamless solutions focus on improving the passenger experience. Airports are no longer just points of departure and arrival – they are becoming integrated mobility hubs, where passenger journeys extend far beyond the terminal. These solutions are helping to create a door-to-door journey for passengers that is planned, booked, and managed as one, no matter the mode of transport.

SUSTAINABLE

Sustainability is at the forefront of airport operations, with innovation playing an important role in reducing the sector's environmental footprint. The solutions presented in this section aim to make every movement on the ground and in the air as efficient as possible, reducing unnecessary fuel burn, emissions and other environmental impacts.

The people and airports behind the innovation

Each story presented within this publication is a standalone tale of how a team of cross-sector researchers and practitioners has combined their experiences, skills, and knowledge to help make European aviation safer, more efficient, and sustainable. They all strive to bring benefits not only for those working in the industry, but those who pass through it, such as passengers and local residents.

The projects featured are co-funded within the framework of Horizon Europe, and in some cases, the Connecting Europe Facility. Due to the scale of activity undertaken through SESAR, this publication showcases a representative selection of SESAR innovations rather than an exhaustive overview.

→ Discover the full portfolio of SESAR projects and solutions

SCAN ME

http://sesarju.eu/projects/portal

Putting smart airports on the map

The airports featured in this publication represent a selection of SESAR innovation taking place across Europe, demonstrating how airports of all sizes are delivering smarter, more seamless and more sustainable operations.

Automated taxiing support
Amsterdam
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Connecting regional airports to the Network Manager
Eindhoven
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Quiet and efficient aircraft landings
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Tracking and reducing environmental impact
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Planning arrivals earlier
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Optimising airport capacity with AI
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Connecting journeys across transport modes
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Preparing airports for new mobility
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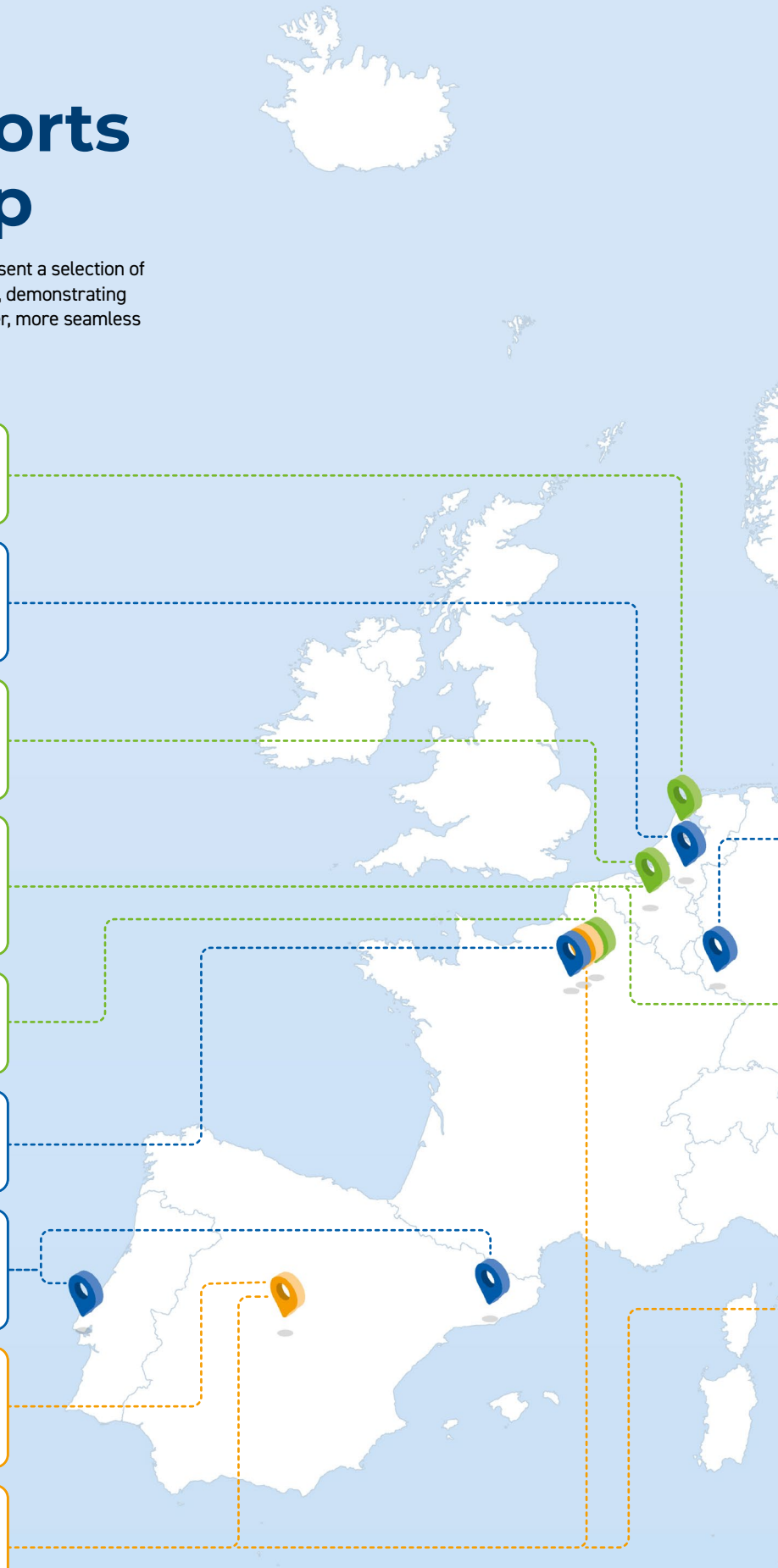

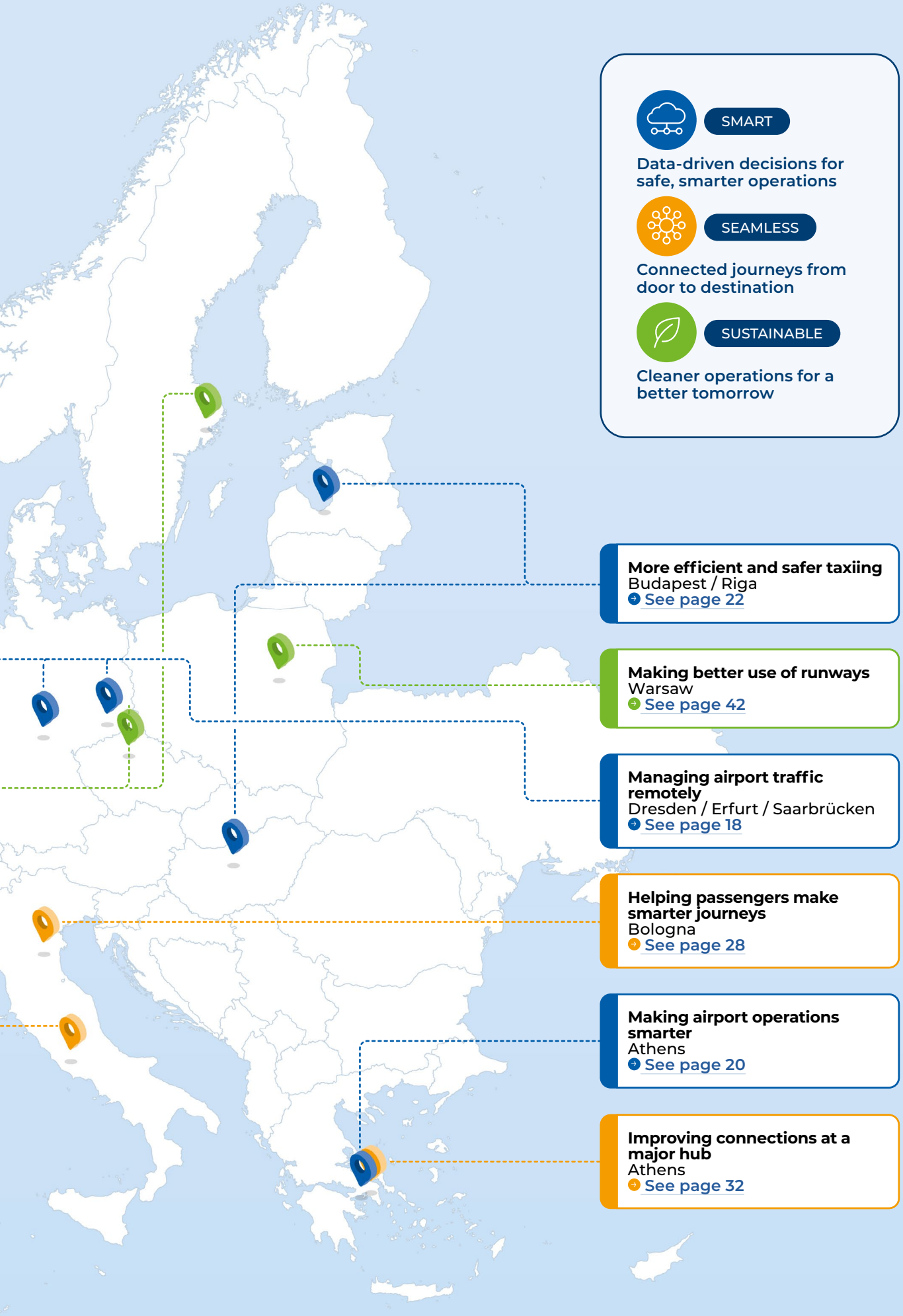

SMART

Data-driven decisions for safe, smarter operations

SEAMLESS

Connected journeys from door to destination

SUSTAINABLE

Cleaner operations for a better tomorrow

More efficient and safer taxiing
Budapest / Riga
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Helping passengers make smarter journeys
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Making airport operations smarter
Athens
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Improving connections at a major hub
Athens
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Smart, seamless and sustainable – the digital transformation at a glance

From smarter journeys to more sustainable operations, SESAR innovation is transforming every stage of the passenger journey and airport ecosystem. Together, SESAR projects are delivering smarter, more connected, and more sustainable airports.


CATERING
SMART
Data-driven decisions for safe, smarter operations
SEAMLESS
Connected journeys from door to destination
SUSTAINABLE
Cleaner operations for a better tomorrow

SMART

Europe’s airports are handling more passengers, more flights and greater operational complexity than ever before. SESAR helps airports work smarter by enabling better coordination, faster decision-making, and more connected operations. The result is airports that can respond more effectively to change, improve day-to-day performance and make the best use of existing infrastructure.

SMART

Plugging the data gap: How AI is helping Europe's regional airports to better connect to the aviation network

Many regional airports have historically lacked the digital infrastructure to share real-time operational information with the wider network. AI-supported tools are now helping these airports provide better data – improving predictability and supporting more efficient network operations.

Europe's aviation network has long operated in an environment where only the largest players are fully visible.

At major airports, every aircraft movement is tracked, digitalised, and instantly shared with the Network Manager operated by EUROCONTROL. This helps to increase predictability and ensure the most efficient experience for passengers and pilots. However, it is estimated that the Network Manager only receives accurate departure information for around 50% of overall air traffic.

Due to the required upfront investment, small and regional airports have traditionally lacked the same scale of digital infrastructure found at larger airports, limiting their ability to provide automated operational information. As such, this category of airports represents 83% of all airports not providing this information to the Network Manager.

This means at a regional airport like Eindhoven, key milestones during an aircraft's time on the ground have previously been inputted manually by airport staff. However, manual data can be prone to lags and inaccuracy, leading to lower visibility for the Network Manager, which is trying to optimise a congested European sky.

If an aircraft is delayed on the tarmac, operational stakeholders elsewhere in the network often do not find out until the slot has already been missed, causing a ripple effect of reactionary delays across the continent – which can impact passengers in several locations. Now, change is on the horizon thanks to a new smart solution.

"The main goal is to get the regional airports within Europe more connected to the Network Manager," said **Lennard Albarda, Product Owner of Airport & Passenger Systems at Eindhoven Airport**.

Collaboration for better data provision

At Eindhoven Airport, teams had been exploring ways to improve their turnaround monitoring and provide better data to the Network Manager.

Discussions with EUROCONTROL enabled them to coordinate these efforts alongside a series of other regional airports, all working to address the same challenge through PEACOCK – a SESAR JU Digital Sky Demonstrator. The initiative brings together airports, the wider industry, and the Network Manager to show how digital technologies can improve information sharing and strengthen the integration of regional airports into the European Air Traffic Management (ATM) network.

TAKEAWAYS

- **Data scarcity has historically limited the integration of Europe's regional airports into the Network Manager at EUROCONTROL.**
- **AI tools have reduced the workload of airport staff and increased data availability.**
- **More accurate data allows slots to be planned with greater precision, improving efficiency for passengers and pilots.**

The core idea was simple: to put regional airports in a position to automatically contribute highly accurate status updates about their aircraft turnarounds, so that the Network Manager gets a continuous flow of timely, high-quality data.

With twenty regional airports collaborating in the project, the collective impact could deliver more efficient operations for airports, airlines, and Air Navigation Service Providers (ANSPs), while improving journeys for passengers across Europe through enhanced reliability and predictability of operations.

AI model learns by looking

Eindhoven tested quasi-automatic surveillance turnaround tools with the aim of removing the human data-logging burden on its staff. To do this, the airport trialled a cost-effective 'lite' Airport Operations Centre, driven by smart software.

High-definition AI-enabled cameras were installed to observe aircraft stands and fed live video into an artificial intelligence model. Instead of staff pausing their work to log events by hand, the AI automatically detects all turnaround processes – such as the arrival of fuel trucks, the opening of catering doors, and baggage loading.

By analysing these events in real-time and then learning from data of past flights, the system has begun to shed light on the sequence of ground handling operations, automatically calculating reliable estimates of when the plane will be ready to depart – helping to make better predictions for aircraft slot management. More data means more information from which to make better informed decisions.

Automated data interfaces were created to share this ground intelligence with the Network Manager at EUROCONTROL. The moment the AI system updates a flight's turnaround schedule, that data is pushed instantly.

"If we start sharing this information with the Network Manager, they will receive pieces of new information that will allow them to reoptimise the European network and better allocate more efficient slots to aircraft," explained Albarda.

Involving staff vital for widespread acceptance

One important part of the project was involving staff in the development and deployment of the new AI technologies, with the tool designed to supplement their work rather than take over. Letting staff know how the AI system works and letting them be part of implementation discussions was a way to do this. *"If everybody sees how the benefits will result in better operations then they are more willing to adopt it,"* said Albarda.

> *If more airports contributed to sharing data with the Network Manager, the effect would be even bigger – because if we gather more data and more insights to optimise, then that optimisation will automatically be more effective.*

This widespread stakeholder buy-in has also seen another change which has come as a surprise to Albarda. Now that the technology is better understood, staff are proactively coming back to the team responsible for the project with ideas on how to improve and add new operations into the solution's remit.

Efficiency gains at the heart of success

By moving turnaround monitoring from manual processes to automated data flows, PEACOCK has been able to prove that smaller hubs can also provide accurate departure estimates and important data to support the wider European network. As a Digital Sky Demonstrator – putting to the test the technological solutions necessary to deliver the Digital European Sky – the PEACOCK project is part of an innovation pipeline designed to bridge the gap between research and industrialisation, accelerating market uptake.

The trials demonstrated that a regional airport's smaller size can be an operational benefit. With shorter lines of communication and fewer bureaucratic hurdles, Eindhoven was able to run rapid proof-of-concept testing cycles that brought the 'Lite APOC' ecosystem to life in record time.

This improved connection with the Network Manager has had positive impacts at Eindhoven Airport. For passengers, this means fewer unexpected delays. For airlines, it means their aircraft are allocated highly efficient slots. For the wider aviation network, the benefits extend well beyond the airport, with more efficient traffic flows, greater airspace capacity, fewer holding patterns and taxi queues, leading to lower fuel burn, emissions in the air and on the ground.

"If more airports contributed to sharing data with the Network Manager, the effect would be even bigger – because if we gather more data and more insights to optimise, then that optimisation will automatically be more effective," concluded Albarda.

FACT BOX

Eindhoven Airport provides an important node of regional connectivity in the Netherlands and beyond. Data is now able to improve the efficiency of the airport's operations.

Discover the PEACOCK project

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www.sesarju.eu/projects/PEACOCK

SMART

Offering a smart way to improve airport arrival efficiency and enhance safety

Air Traffic Management is getting smarter. Introducing a highly accurate, explainable AI tool to the final approach sector could deliver a scalable blueprint for quieter, cleaner, and more efficient airport arrivals.

TAKEAWAYS

- **Optimising aircraft spacing can increase the landing rates at busy airports.**
- **AI-enabled support can help air traffic controllers to increase arrival throughput by up to 12% without compromising safety.**
- **The AI model can be adapted to different forms of arrival management methods, providing potential benefits for all airports across Europe.**

When aircraft approach an airport, air traffic controllers must ensure that pilots follow the correct spacing for their aircraft – at least 2.5 nautical miles – to land safely. This is critical not only for safety, but also for maintaining runway capacity and reducing delays.

"The challenge is that these air traffic controllers have to do the final integration in the extension of the localiser with a lot of cognitive effort," said **José-Manuel Risquez, Senior ATM-IA Expert at Ineco**. *"90% of the success of that final spacing is dependent on the skills, ability, mood, or simply how tired you are – because it's based on cognitive effort,"* Risquez added.

Introduction of AI to ease efforts

SESAR JU research partners explored whether an AI model could support air traffic controllers. The ORCI project aims to investigate a new AI-based decision-support tool that can help to enhance performance by providing air traffic controllers with real-time information to help them manage aircraft paths more effectively. The system shows the likely spacing between arriving aircraft if they issue a specific instruction at that moment, helping them make better decisions.

Such a model is compliant with the EU regulatory framework that includes the EU AI Act, EASA rulemaking activities, and ATM standards, that require that AI-based solutions are trustworthy. This includes explainability, so that operators can understand outcomes and proposals.

"The chosen model gave us the best results and also explained why we are seeing certain predictions," said **Rita Bañón, a Technical Engineer at Ineco**.

With the model's format decided, the researchers set about training it to an operational level. *"We started with three-month data of Summer, which is where there is the highest volume of traffic. Then, we started filtering with the*

> *It is something that I think would be very easy to implement without major changes to any Air Navigation Service Provider's technology, and it's not doing anything beyond what the controller does every day. It just helps them in making the decision to achieve what they do every day more easily.*

procedures that they were using," said Bañón.

Barcelona and Lisbon offered different operational environments

There is no one-size-fits-all solution to final approaches. Among the different final approach sequencing methods currently in use, the researchers evaluated Trombone and Point Merge, two of the most widely implemented methods for managing traffic during the final approach phase.

In a Trombone system, aircraft follow an extended routing before being turned back towards the runway. A small error in deciding when to issue that turn can translate into a much larger spacing error by the time the aircraft reaches final approach. *"If you make a mistake, it doubles [in impact],"* said **Ian Crook, Managing Director of ISA Software**.

By contrast, in a Point Merge System, aircraft follow a curved sequencing, before turning towards a common merge point. Because every aircraft has the same remaining distance to the runway after the turn, controllers can manage spacing more consistently.

The Barcelona Airport environment was simulated to test the Trombone system, while Lisbon Airport was chosen to test the Point Merge system. The airports integrated the impact of different weather systems and assessed how these would affect operations. Lisbon, in particular, was a strong use case for this.

"In Lisbon, they very often face a lot of strong front winds, so it affects the runway throughput because the same spacing with a lot of wind effect can decrease runway throughput at the airport," said Risquez.

Model showed efficiency and environmental success

After training the model, the teams were able to run a series of simulations. The scenarios compared controller performance with and without AI assistance, assessing whether the tool could improve aircraft spacing accuracy and arrival efficiency. *"When they were running the scenarios with the assistance of the tool, compared to when they're running without the assistance of the tool, the target spacing accuracy improved by 40% to 55-57% in different scenarios,"* explained Crook.

The simulations showed that landing rates were increased for both airports by between 4-12% - around one to three extra aircraft per hour. While results varied between the two airports because of their different runway configurations and operating environments, the results helped to prove the tool's potential. It was not just in throughput that results were positive.

"There were similar improvements in both the productivity of the air traffic controllers – they could do more in less time and handle more aircraft – and the typical distances flown were lower throughout, which equals less fuel burn and less emissions," said Crook.

If made operational, the AI model could help airports to accommodate more traffic without building new infrastructure or changing existing work procedures. *"It is something that I think would be very easy to implement without major changes to any Air Navigation Service Provider's technology, and it's not doing anything beyond what the controller does every day. It just helps them in making the decision to achieve what they do every day more easily,"* added Crook.

Developed and validated through the SESAR ORCI project with operational experts from Barcelona and Lisbon, the approach demonstrates the potential of explainable AI to support future ATM operations. *"We are in a better position to adopt these technologies than before, because people are now more receptive to them,"* Risquez concluded.

FACT BOX

Barcelona and Lisbon Airports are busy airports, so they were the perfect places to test a new AI model that could help air traffic controllers to maximise arrival efficiency by up to three extra aircraft an hour.

Discover the ORCI project

SCAN ME

www.sesarju.eu/projects/ORCI

SMART

Beyond the glass: How digital remote control towers are changing the operations of Europe's airports

For airports with lower traffic volumes, traditional control tower infrastructure can be costly to maintain. Digital remote towers provide a flexible and resilient way to deliver air traffic services using innovative digital technologies.

TAKEAWAYS

- **Digital remote towers allow controllers to manage airport operations from centralised locations (not physically at the airport) while maintaining the same high safety standards.**
- **Sharing technology and expertise across airports can improve flexibility and make better use of available resources.**
- **Reliable digital connections and real-time information are enabling more resilient and scalable ATM operations.**

Control towers remain essential to the safe and efficient movement of aircraft. Some of Europe's airports with infrequent flights are looking for ways to optimise this expensive yet essential infrastructure: one solution that has been developed and deployed is digital remote control towers.

"For regional airports which have to bear the costs of air traffic control, this is going to be a gamechanger," said **Holger van de Sand, Head of Regulatory Affairs for Remote and Virtual Tower Operations at DFS Deutsche Flugsicherung in Leipzig**.

From conceptual blueprint to the control room

DFS has been responsible for the control tower operations at Saarbrücken airport since 2018 and at Erfurt since 2022. The airports saw fewer than ten commercial flights a day – and then infrastructure issues forced a change. *"The conventional tower at Saarbrücken Airport was so old that it had to be rebuilt or reconstructed. The costs for that were so high that we decided to go a different way,"* explained van de Sand.

The small number of flights also created a unique staffing issue, with a small workforce needed, but flexibility being difficult to build in. *"It's a problem from the social side as you only have a few air traffic controllers, normally working alone at the conventional tower,"* said van de Sand.

"We decided that the biggest advantage is to have more people in one room, cross-qualified. If you have a remote tower system, you may combine several airports in one Remote Tower Centre (RTC)," he added.

How the digital towers work

Remote digital control towers very closely mirror the setup of a physical control tower, but there is one key difference.

"You replace the out-of-the-window view with a visual presentation system," said van de Sand. This

synthetic overlay changes how controllers interact with their environment. The visual presentation system is made up of several different sensors which are displayed across a series of screens. In Leipzig, the screens are smaller and placed one metre away from the operator – a preference that staff signalled when working on the development.

The sensors always include live cameras from the runway location. Other tools that can be integrated include infrared sensors, ambient noise from the airport, radio frequencies, telecommunications channels, and radar. This helps to accurately monitor weather conditions, ensure effective communication with ground staff and that safety procedures are followed.

This is transmitted live from the airport to the remote control tower by independent telecommunications

> *For regional airports which have to bear the costs of air traffic control, this is going to be a gamechanger.*

lines hosted by separate operators. In the case of Leipzig, four independent channels are transmitted through two different telecoms providers. Dynamic routing ensures that data is pulled from whichever line boasts the lowest latency at any given moment, ensuring the digital panorama remains as close as possible to real-time. Having multiple systems helps to build a contingency into procedures, so that systems do not collapse in case of major disruption, enhancing resilience.

"You have to be very careful about the reliability of the technique and about the contingency measures when it comes to a failure of the system, and we spend a lot of time creating the contingency concept of what to do if a part of the system fails," said van de Sand.

"But it helps us to be more resilient against any influence and it's a contingency measure to make sure that at least one line is always available to transfer the data," added van de Sand.

Standardisation and the multi-airport advantage

Digital remote towers have offered other benefits, particularly on a staffing level. *"You have a unique technical solution that works for several airports. You don't have to support individual technical solutions at each airport differently. The only differences may be the airport technical systems, like the airport lighting system or such,"* he said.

This standardisation means that operators can work for different airports seamlessly when needed within the remote centre, provided that they have the correct licensing. One of the biggest markers of success for the DFS team in Leipzig has been this seamless nature of the transition. *"For the pilots and the airlines, it's more or less hidden that the service is provided from an RTC instead of the conventional tower. Normally, the pilots are really surprised to realise that there is no longer anyone controlling from the physical tower,"* explained van de Sand.

As for improvements, higher resolution displays and expansion to other airports are next – with Dresden Airport soon to become part of operations, and temporary use at another major airport which will soon repair its physical tower.

The German experience demonstrates how digital remote towers can help modernise airport operations, improving flexibility, resilience, and the efficient use of ATM resources across Europe.

Digital remote tower technology, advanced through SESAR research and innovation, is already implemented in several countries, including Germany, Sweden, Norway, and Hungary, with centralised centres managing several airports.

This technology is expected to be adopted further across Europe, helping to reduce infrastructure and operational costs, maintain the viability of smaller airports, improve safety and resilience, and provide greater flexibility in allocating resources across the network.

FACT BOX

Saarbrücken, Erfurt and Dresden airports are among the European airports exploring digital remote tower operations. At Saarbrücken and Erfurt, lower traffic volumes and ageing infrastructure prompted a move towards remote tower services, with operations now at the remote tower centre in Leipzig managed by DFS, Germany's Air Navigation Service Provider.

Discover the digital remote towers solution

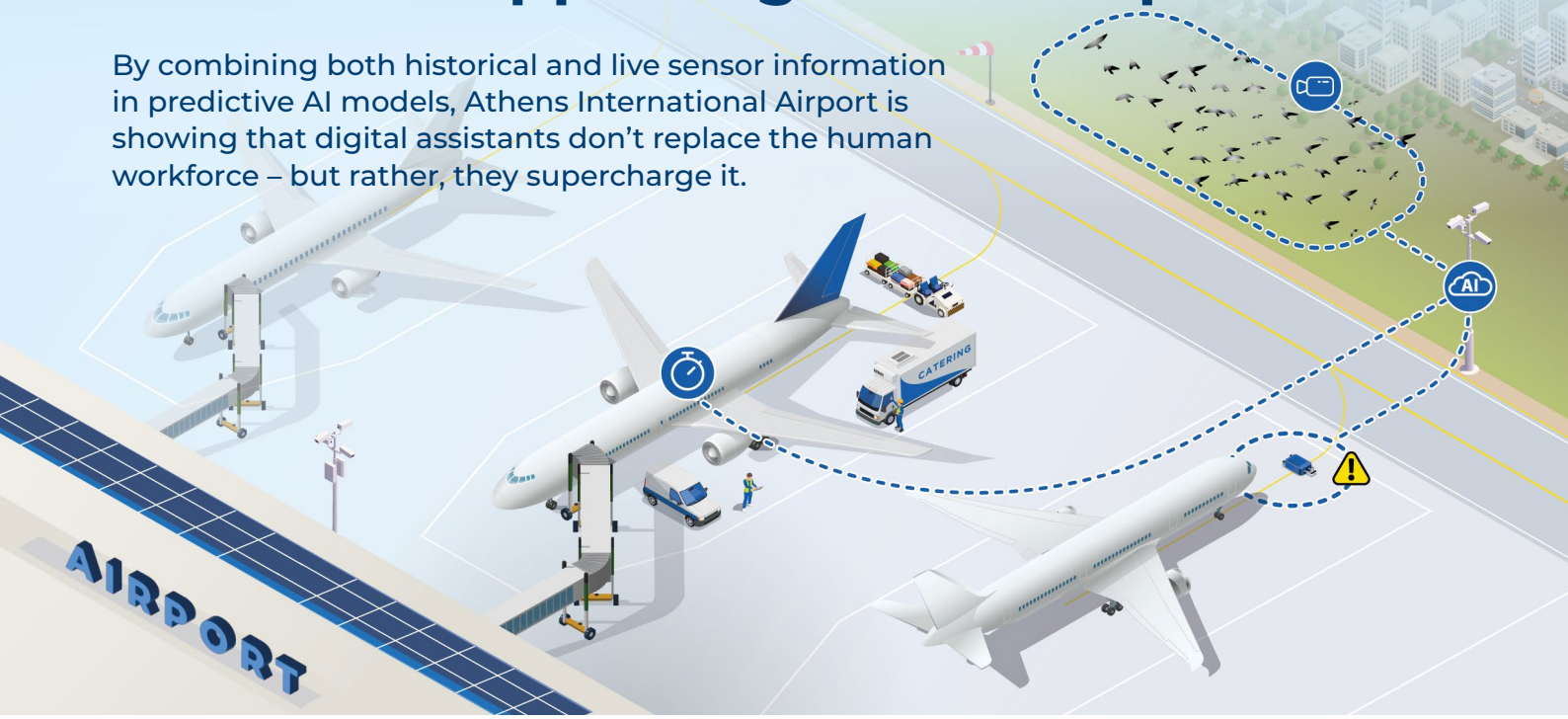
SCAN ME

www.sesarju.eu/sesar-solutions/multiple-remote-tower-and-remote-tower-centre

SMART

From safety to passenger flows: how AI is supporting smarter operations

By combining both historical and live sensor information in predictive AI models, Athens International Airport is showing that digital assistants don't replace the human workforce – but rather, they supercharge it.



TAKEAWAYS

- **AI-powered assistants can help to integrate multiple data sources to support faster and better operational decisions.**
- **AI tools improve safety operations by detecting foreign objects, wildlife activity and potential vehicle incursions.**
- **Predictive models can improve turnaround processes, reduce waiting times, and better manage passenger flows.**

Safety and security sit at the heart of airport operations, but as traffic volumes increase, operational efficiency continues to grow in importance.

Through the SESAR JU JARVIS project, the team at Athens International Airport explored how an airport digital assistant (AP-DA) could combine different data sources to support decision-making across a whole range of airport operations.

"The JARVIS AP-DA is an advanced digital assistant that optimises airport operations, touching on both safety functionalities and operational throughput – both airside and landside," said **Nikolaos Iosif, Manager of Operational Compliance and Transformation at Athens International Airport**.

The aim was to launch one digital assistant covering both safety and efficiency, but the potential benefits and quantity of data available forced a rethink.

"You cannot have one solution which deals at the same time with safety and efficiency, so we committed at first to one solution in the beginning – and we delivered four solutions," said Iosif.

> *The JARVIS AP-DA is an advanced digital assistant that optimises airport operations, touching on both safety functionalities and operational throughput – both airside and landside.*

Safety first

At Athens Airport, two digital assistants are responsible for safety, enabled by AI. *"It detects foreign objects and wildlife activity in the runway environment, as well as taxiway incursions for avoiding risks of collisions,"* explained Iosif.

Keeping foreign objects and wildlife off the airfield is crucial to airport operations. A dropped suitcase or a flock of birds in the wrong place at the wrong time can bring operations to a standstill. This was the duty of several staff teams from security to ground handling and was a labour-intensive job in which human errors could happen, according to Iosif.

Integrating AI was a way to improve this process. The team in Athens set up a link between the AI model and the airport's range of sensors like cameras, so that the model could access live data. These tools, alongside chunks of historic data, were then used to train the JARVIS AP-DA model to spot foreign objects. *"We used part of our taxiway, and we started throwing things like cones, suitcases and screwdrivers at certain areas so that the algorithms coming out of the detection from the camera could process and give us some results,"* said Iosif. The AI was able to spot and issue alerts for objects and birds in daylight scenarios.

The second safety-focused AP-DA model was designed to address the risk of taxiway incursion using AI. At some spots on an airfield, taxiways and service roads cross, if timed incorrectly, this can cause a serious collision. The AP-DA model was linked to Athens' sensors to perform live monitoring of the airfield. By enabling the AI to learn about different types of vehicles, it alerted the relevant safety teams to potential collisions and close calls.

The digital assistant was tested in a shadow environment with project partner Indra. It stopped several potential taxiway incursions and ensured that interruptions were avoided. However, darkness and bad lighting posed a problem.

Both assistants for safety are now planned to continue, with more developments needed before they become fully operational. A series of small radars is set to be placed on top of cameras to fix the shortcomings and cover low-light conditions.

Efficiency wins improve passenger experience

Making passenger flows and aircraft turnaround smoother were the key drivers of the other two AP-DA models. *"It will ensure more predictable aircraft turnaround times and passenger flows,"* said Iosif.

Predicting turnaround times is something that teams had been working on for a number of years, but the team believed that predictive AI algorithms based on historical data could improve this process.

> *[The JARVIS AP-DA] will ensure more predictable aircraft turnaround times and passenger flows.*

"What we wanted to do, based on the available pool of data like the experiences of previous turnarounds of similar aircraft, at the same area of the airport, at that period of the month, at that time of the day with similar weather conditions, was to predict the expected time of completion of the whole turnaround process," explained Iosif. Like the PEACOCK project, JARVIS focuses on turnaround. However, while PEACOCK monitors turnarounds in real time and generates predictions, JARVIS estimates turnaround time before the movement takes place, based on historical data of similar movements.

This approach drove the process – and it paid off. The digital assistant was marked as ready for deployment following successful tests, which proved that it increased operational efficiency and predictability for airport teams.

With turnaround time now shortened, attention shifted to streamlining passenger processes. Predictive AI models were used for real-time passenger monitoring data to help with the calculation of operational timestamps.

However, passenger-side data remains a challenge, as the most reliable information currently available to airports is linked to passengers passing through automated boarding pass controls, explained Iosif. This limited visibility makes it more difficult to predict passenger movements and optimise processes.

The team fed this data into the digital assistant's AI model and enhanced it with live data feeds from sensors within the airport. This enabled the team to make predictions of passenger flows through the airport and also to trigger alerts to the airport centre when predictions exceeded predefined thresholds, enabling them to modify their plans.

FACT BOX

Athens International Airport is Greece's largest airport and a major gateway for international travel. Its operations team spotted an opportunity to use AI to support safety monitoring, aircraft turnaround and passenger flows.

Discover the JARVIS project

SCAN ME

www.sesarju.eu/projects/JARVIS

SMART

Green means go: a smart and safe way to manage airport ground movements

Moving aircraft safely around airports is a complex endeavour, particularly when visibility is poor. Automated lighting systems are helping pilots and controllers reduce errors, ease workloads, and keep operations moving.

TAKEAWAYS

- **'Follow the greens' lighting systems can help move aircraft safely around airports and overcome the difficulties posed by low visibility conditions.**
- **Mapping routes with the system helps to reduce radio congestion and strain for air traffic controllers.**
- **'Follow the greens' stops pilots taking wrong turns or mistaking runways and taxiways, reducing the risk of accidental collisions on the apron.**

Before an aircraft takes off or after it lands, it must navigate one of the busiest parts of an airport: the ground environment. Hundreds of aircraft and vehicles may be moving between runways, gates, and service areas, requiring constant coordination between pilots and controllers.

To ensure safe navigation on an airfield, aircraft and vehicles have long relied on clear radio instructions from controllers, utilising individual navigation devices to follow these on an airport map. During busy periods or poor visibility, this can increase workload for controllers, create delays, and increase the risk of navigation errors.

SESAR research partners developed the 'follow the greens' procedure, supported by automated lighting and digital surface management tools, to make aircraft movements on the ground safer and more efficient.

Keeping aircraft moving safely in low visibility

Many factors can impact the ability of an aircraft to safely navigate an airfield. Poor visibility means that line of sight is reduced, and air traffic controllers may have to take a more hands-on approach, providing taxi instructions in stages and asking aircraft to stop while they reassess the situation and monitor potential conflicts.

"If the visibility is bad and there are several aircraft taxiing at the same time, the controller has to give instructions for just part of the way," said **Hans Christian Erstad, a Systems Engineer at Indra**, one of the research partners. *"Even if an aircraft was cleared to taxi all the way to the runway, air traffic controllers might have to instruct the aircraft to stop somewhere in case of the risk of a conflict, so the controller must have constant awareness at all times,"* added Erstad.

> *Pilots liked the [Follow the greens] solution as it is simple, safe, and intuitive.*

This increases controller workload and can reduce the number of aircraft that can safely move around the airport at any one time, particularly when operating at unfamiliar airports or during disrupted conditions. Taking a wrong turn can create delays and require controllers to reorganise traffic flows.

For pilots, navigating a busy airport environment can be challenging too. Operating at several airports, often daily, pilots can easily make mistakes in their own ground navigation, something which Erstad said is their *"nightmare." "There are incidents where they take the wrong turn. It delays the traffic because the aircraft that turned wrong is then stuck in the wrong roads, and the air traffic controller has to find a solution,"* he added.

Bringing 'follow the greens' into the digital age

The idea behind 'follow the greens' is not new. First explored decades ago, the concept uses a simple principle: guiding aircraft along their assigned route through a sequence of green lights that indicate where they can safely move. However, advances in automation, sensors, and digital systems are now enabling the concept to be applied in a much more intelligent way.

By connecting individual lights with real-time operational data, the system can support controllers in planning routes, monitoring aircraft movements and identifying potential conflicts, while giving pilots clearer guidance during taxi operations. *"It requires an advanced lighting system that can turn on each light individually,"* explained Erstad.

When an aircraft is ready to depart, an air traffic controller designs a safe and effective route which is then communicated to the system. The controller then instructs the pilot to 'follow the greens'. *"To do this, you need to have an interface and know exactly how all the lamps are identified or numbered,"* said Erstad.

When an aircraft receives push-back clearance, lights are automatically switched on ahead of the aircraft to guide its way. Sensors detect when the aircraft has passed and automatically switch off the lights again. Data, such as scheduling and arrival times, help to run a series of predictions. Live feeds assessing any delays and positions also inform the system to automatically detect any potential conflicts at taxi and runway intersections. Scheduling and standby data also help to determine the priority of aircraft.

"It's based on standby updates and departure slots, and typically departures have priority over arrivals," explained Erstad.

Pushback slots and air traffic clearance determine this order, and planes with later departure slots tend to be kept behind.

"Today, air traffic controllers are monitoring the situation, looking at the time and making decisions about the priority – but when you have this information, it is not very difficult to automate this sequencing process. The information is typically something that the airport provides itself," he added.

Workload reduced for air traffic controllers

Through SESAR, simulations were made of Budapest Airport operations, where HungaroControl, Hungary's Air Navigation Service Provider, tested how the 'follow the greens' solution performs, replicating different weather conditions, time periods, and other real-life scenarios.

"The performance improvement was that the controller workload was lower," said Erstad.

The results showed reduced workload for air traffic controllers, increased efficiency in taxi operations, and fewer navigation errors for pilots. *"Pilots liked the solution as it is simple, safe, and intuitive,"* commented Erstad.

A 'follow the greens' system is now installed at Riga Airport in Latvia, where it allows aircraft to taxi more quickly and safely in low visibility conditions.

FACT BOX

Tested in a simulated Budapest Airport environment and now deployed at Riga Airport, 'follow the greens' technology uses automated lighting to guide aircraft safely during taxi operations, particularly in low-visibility conditions – enhancing safety for all stakeholders.

Discover the 'follow the greens' solution

SCAN ME

www.sesarju.eu/sesar-solutions/guidance-assistance-through-airfield-ground-lighting

SMART

Joined-up performance: How airports are better connecting people, data, and decisions

Data alone cannot improve an airport's performance. By connecting operational data across stakeholders and turning it into actionable insights, digital solutions are helping airports improve situational awareness, coordinate operations more efficiently, and build resilience across the wider network.

TAKEAWAYS

- **Groupe ADP successfully unified its airside and landside Airport Operations Centres into a single Total Airport Management entity at Paris-Charles de Gaulle in September 2025.**
- **The approach integrates data from the airports with external partners such as infrastructure maintenance, wildlife management, ground handling, and fire and rescue services to create more efficient operations.**
- **Baggage processes are one key area of improvement – with passengers experiencing quicker turnaround times as a result.**

Every airport depends on hundreds of people making thousands of decisions each day. Airlines, baggage handlers, security teams, firefighters, air traffic controllers and maintenance crews all play their part. *"The difficulty is to bring everyone together and to work towards operational excellence,"* said **Olivier Delain, R&D Unit Manager at Groupe ADP**.

Breaking down silos

Total Airport Management (TAM) is designed to bring all these teams together through a single Airport Operations Centre. After successfully introducing the concept at Paris-Orly in 2019, Groupe ADP expanded it to Paris-Charles de Gaulle, where separate airside and landside control centres were merged into one in September 2025. *"Since Paris-Charles de Gaulle is a very big airport, we had difficulties in grouping together all operational aspects into an Airport Operations Centre: until 2025, we had two Airport Operations Centres. One was dedicated to airside operations, one was dedicated to landside operations, and they cooperated together. Since 3 September 2025, they have been grouped into a single entity,"* said Delain.

Under the TAM approach, the Airport Operations Centre triggers several key improvements: establishing clear accountability across processes, shifting from reacting to anticipating and planning, better collaboration between teams, and instilling a culture of continuous enhancements.

Supplying operation centres with reliable data

These improvements depend on access to reliable, timely data. Without it, processes risk being less effective and staff are forced to spend more time resolving operational issues. However, stakeholders can sometimes be resistant to sharing potentially sensitive data: stakeholder buy-in is often the hardest part of APOC implementation; occasionally harder than establishing the technology itself. This is where the SESAR FASTNet project comes in: showcasing how Total Airport Management brings significant benefits across all stakeholders. *"FASTNet was born from our airport operator staff saying that a lot of data is not reliable enough,"* said Delain.

"In FASTNet, we aimed to improve data in the strategic phase, up to several months in advance, the

planning phase (D-7, D-1), and the tactical phase (day of operations)," explained Delain.

Predictive planning at Paris-Orly

The FASTNet project aims to make use of advances in data technologies to help fully integrate airport operations into the network – taking an individual Airport Operations Plan (AOP) and aligning it with the overall Network Operations Plan (NOP), improving predictive planning for both the airport and network. As a result, FASTNet identified several processes where better prediction and planning could support airport operations at Paris-Orly, the smaller of Groupe ADP's two airports. The project used historical and real-time operational data to develop machine-learning models capable of forecasting demand for resources such as baggage handling, security, and passenger processing. The first step was securing reliable and safe access to this potentially sensitive data. *"We asked [participating] airlines, Air France and Transavia, at Paris-Orly to provide us with data – like bookings – as soon as they have it, and also any flight schedule updates,"* said Delain.

Crucially, FASTNet also leverages direct pre-coordination data from daily discussions between origin and destination airports – a process established alongside SESAR research partners. By sharing real-time schedules on the day of operations, airports can anticipate and resolve traffic bottlenecks locally. This approach allows hubs to adjust specific flights together, fixing delays before they need to be escalated to the Network Manager, managed by EUROCONTROL.

> *By combining this information, we could better plan the number of bags per flight, for instance, and be able to calibrate the check-in process, security, and border control.*

This data was then combined with the airport's existing data, such as historic passenger levels and staff numbers, from which the FASTNet solution was able to generate more accurate forecasts to better support TAM processes around staffing and guide work processes. *"By combining this information, we could better plan the number of bags per flight, for instance, and be able to calibrate the check-in process, security, and border control,"* explained Delain.

This additional data improves experiences and wait times for passengers by allowing staff in the operations centre to be better prepared.

Halving predictive errors

Trials of the FASTNet solutions were held in a test environment at Paris-Orly Airport, with the results compared to live operations. According to Delain, the results were *"really very good,"* and proved that the level of error was reduced. The tests showed benefits in a range of areas including overall efficiency of the airport's processes, human performance across different levels of Orly's operations, and financial savings in staffing costs.

But one area which particularly stood out for Delain was in baggage processes, something which will always be welcomed by passengers. *"For the bags per flight, we could reduce the dissimilarity by more than 50% between the current method and what we have today,"* he said.

Jumping industrial hurdles

Following the successful trials, the solution developed under FASTNet has gained the seal of technological readiness approval: now, Delain wants to explore how to industrialise it at both Paris-Charles de Gaulle and Paris-Orly. The first step is continuing to improve the tool so that it remains reliable and the machine learning at its heart can become even more effective. This requires continued and assured access to more data in order to learn.

Helping to build harmonised skies

Throughout the project, the improvement of airport processes has been front of mind – and being able to develop the FASTNet solution for more than one partner is the kind of collaboration encouraged by SESAR.

"SESAR is absolutely fundamental for research in Europe. Each airport developed their own tool, but now we are building something together," said Delain.

This standardisation means that money is saved for airports, who can leverage existing technologies tested in real environments, leading to consistent operations across Europe. For this reason, the solutions developed under SESAR are of paramount importance, according to Delain.

"SESAR, for me, is the best vehicle towards research and development in Europe," he concluded.

FACT BOX

Paris-Orly and Paris-Charles de Gaulle airports, both operated by Groupe ADP, had separate Airport Operations Centres and processes, making coordination across complex airport activities more challenging. But a Total Airport Management (TAM) approach is bringing together operational teams, processes, and data to support more coordinated decision-making and drive passenger improvements.

Discover the FASTNet project

SCAN ME

www.sesarju.eu/projects/FASTnet

SEAMLESS

SESAR is helping create a more connected travel experience by bringing together air, rail and other transport modes into one seamless journey. The result is travel that is easier to plan, easier to navigate, and better connected from door to destination.

SEAMLESS

Connecting the dots: Why multimodality is the next frontier for Europe's regional airports

By helping air, rail and local transport operators share information more effectively, Bologna Airport is making onward journeys smoother for passengers, while improving efficiency and supporting more sustainable travel.

TAKEAWAYS

- **Connecting transport services can make journeys beyond the airport smoother and more predictable.**
- **Shared information helps operators coordinate better and respond faster to disruption.**
- **Multimodal solutions can support more sustainable travel choices for passengers.**

Plane journeys are typically just one part of the equation when it comes to a passenger's travel from door-to-door. While transport to and from airports often makes up a significant part of the overall journey, in a new country or city, passengers may require additional support on other transportation services.

At Bologna Airport, the mobility team is working to simplify travel connections through the Travel Wise project, an air-rail synergy project between the SESAR Joint Undertaking and Europe's Rail Joint Undertaking. In doing so, they are seeking to offer their travellers a seamless and smooth experience for their onward journey – and improve the coordination between transport operators in the process.

Breaking down transport silos

Bologna is located in the centre of Italy, and its train station serves as a vital connection for high-speed rail travel across the country.

With the airport less than seven kilometres from the main station and connected by both bus and monorail, many passengers choose to use the city as a connection point, making it a perfect environment for testing new approaches to multimodal travel.

But until recently, each transport operator ran on its own timetables with different solutions and costs to passengers. Staff at the airport spotted a chance to improve this passenger experience, and to reduce the impact of delays and other issues on passengers.

"We saw an opportunity to share data between airlines and rail and monorail operators and to use cameras and other devices to monitor crowds and queues. This meant we could have historical and real-time data to share between different operators and analyse the best moment to add another shuttle and capacity to

the system," explained **Barbara Melotti, the Mobility Manager at Bologna Airport and partner in Travel Wise**.

> *We are sharing real data with passengers, so they can see waiting times and which are the alternative means of transport.*

How the digital twin was created

At the heart of the solution is a 'digital twin', known as the intermodal common situational awareness (I-CSA) tool. It brings together information from different transport operators to create a shared view of what is happening across the airport's transport network, and provides suggestions to connecting transport operators on how best to structure their timetables. It can also guide passengers towards the quickest mode of transport using a WebApp. Live and future weather forecasts also help to spot any potential disruptions.

A collaborative way of working

Initial tests have shown how better information sharing can increase efficiency for travel operators. Before Travel Wise, airport staff relied largely on phone calls to alert transport operators about delays or request additional capacity. Now, real-time data sharing via the new digital twin tool allows these decisions to be coordinated automatically. *"You can pass from a siloed way of transport to a more coordinated form of transport, and be more sustainable,"* said Melotti.

This collaboration has also led to a new agreement put in place between regional transport operators, making it easier for passengers to book multimodal journeys. As part of the agreement, Bologna Airport Station was created as a dedicated destination within the rail ticketing system. *"We supported an agreement between Trenitalia [Italy's train operator] and Marconi Express [the local monorail operator] so it's possible to buy combined tickets to Bologna Airport station,"* explained Melotti. Over 60,000 combined tickets have been sold since the agreement came into force in February 2025.

Streamlined experience for passengers

For passengers, the streamlined service means that they can experience smoother journeys to and from the airport. The team has already witnessed shorter monorail queues after the project implementation. *"We are sharing real data with passengers, so they can see waiting times and which are the alternative means of transport,"* said Melotti.

The system also helps passengers cope with disruption. If a train or connecting service is delayed, they can receive updated travel information and, in some cases, contingency support to help them complete their journey to the airport with less stress. *"The passenger can insert their itinerary into a WebApp – stating 'I have a train and then a monorail and then this flight.' The app can send a message to passengers in case of delays, but also can send the same message to the airport, and the airport can send passengers a QR code to open a fast-track lane at the security,"* explained Melotti.

Next steps for Bologna

At Bologna, the team hopes that this is just the beginning of their multimodal mission. The next step is to extend the system to involve more transport operators, creating an even more connected door-to-door journey for passengers. The team also hopes that the data will be integrated into other apps and form part of airline plans, so passengers can book trips all the way through to their final destination, well beyond the airport.

FACT BOX

Bologna Airport is located less than seven kilometres from the city's main railway station, which provides high-speed rail connections across Italy. Its combination of airport, rail, bus, and monorail links makes it an ideal environment for testing new approaches to door-to-door travel.

"We want to offer real-time information to passengers on screens that show – for example – when you arrive in an airport, you can take the monorail, that it takes seven minutes, costs X amount and shows the CO_2 consumption," concluded **Dora Ramazzotti, Corporate Secretary and Member of the Sustainability Committee at Bologna Airport**.

Discover the Travel Wise project

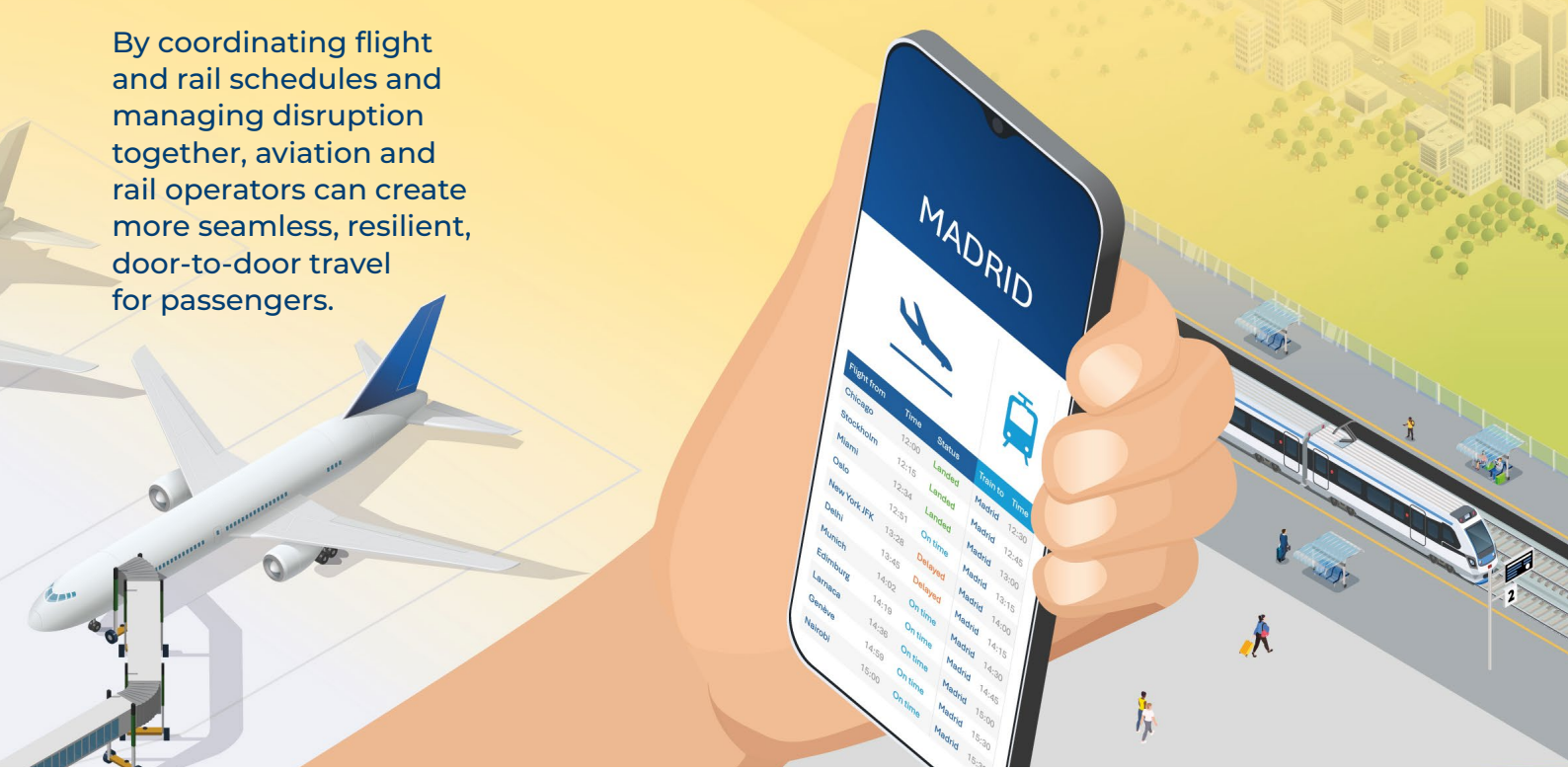
SCAN ME

www.sesarju.eu/projects/Travel%20Wise

SEAMLESS

Bringing aviation and rail together to create seamless passenger journeys

By coordinating flight and rail schedules and managing disruption together, aviation and rail operators can create more seamless, resilient, door-to-door travel for passengers.



TAKEAWAYS

- **Better coordination between aviation and rail can make multimodal journeys faster, more predictable, and more resilient.**
- **Timetable adjustments of just 20 minutes and shared disruption management can deliver significant benefits, with trials showing how passenger journey times can be reduced by almost 20% and delays by roughly 50%.**
- **Digital tools and shared data can help operators plan connections and respond more effectively when disruption occurs.**

For many passengers, a flight is only one part of the journey. Reaching an airport, and continuing onwards to their final destination, often requires combining different transport modes. Yet aviation and rail services have traditionally been planned separately.

The SESAR JU MultiModX project aimed to bring operators from each sector together to create a passenger-first approach to multimodal travel.

"This is central to Europe's wider climate and mobility goals, particularly reducing short-haul flights while improving regional connectivity and door-to-door travel," said **Lucía Menéndez-Pidal, a Researcher and Aviation Engineer at Nommon Solutions and Technologies and a member of the MultiModX Research Team**.

A fragmented journey experience

When booking multimodal journeys, the process is often fragmented. Booking experiences are siloed by mode of transport, information can be inconsistent across platforms, schedules are typically not coordinated, and disruption management tends to stop at the border of each transport mode.

"If something goes wrong, travellers can easily end up stranded without clear support or responsibility," commented Menéndez-Pidal. SESAR JU research partners set out to explore how digital solutions and closer operational integration could make multimodal journeys work better in practice.

A three-pronged approach

To do this, the project focused on three areas. First, researchers

> *Improving multimodal travel is not only about building new rail lines or airports. Better coordination of existing services can already deliver major gains in reliability, travel time and passenger convenience.*

analysed the passenger experience across the full journey to identify where connections could be improved.

Second, they explored how better coordination of flight and rail schedules – including minor timetable adjustments – could create better connections between modes of transport, reduce transfer times, and increase the number of successful multimodal journeys for passengers.

Third, they examined how operators could work together during disruption, simulating different scenarios (such as airport closures and rail disruptions), challenging operators to coordinate their responses across modes of transport.

"The three models form a complete cycle: measuring performance, improving the network, and managing disruption when things go wrong. The project demonstrated that seamless multimodal travel is not just a policy ambition – but something that can be operationally planned, tested, and scaled using shared data," said Menéndez-Pidal.

Bringing these elements together, the project created a way to stress test different multimodal scenarios and identify bottlenecks, compare solutions, and make data-backed decisions based on real door-to-door passenger journeys.

Fostering a collaborative mindset to disruption management

Delays, airport closures, rail disruptions, technical failures and industrial action are daily challenges for the whole transportation sector. Traditionally, each operator has focused on managing disruption within its own network, making it difficult to coordinate responses across different modes of transport. Part of the project's goal was to foster a collaborative mindset, helping to build trust in each other and in the system. *"MultiModX continuously evaluates what is happening across both the air and rail networks and then calculates the best possible alternatives for affected passengers,"* explained Menéndez-Pidal.

Passengers: the main winners from increased collaboration

The tests carried out in Spain showed that relatively small timetable adjustments could deliver significant improvements for passengers, and that optimisation could create more attractive multimodal itineraries. *"The number of successful connecting passengers increased by more than 7%, while many multimodal journeys became substantially faster,"* said Menéndez-Pidal.

In one example, better timetable co-ordination reduced the journey between Navarra and A Coruña by 185 minutes. Schedule adjustments – most of which were around just 20 minutes – demonstrated how small changes can have a major impact on connectivity.

Better coordination also helped during disruption. When working together to overcome disruptions, the number of passengers left stranded was reduced by 17%, while overall journey times were reduced by almost 20% and delays decreased by roughly 50%.

"Improving multimodal travel is not only about building new rail lines or airports. Better coordination of existing services can already deliver major gains in reliability, travel time and passenger convenience," commented Menéndez-Pidal.

For airports, integrating rail as part of the wider transport network could also help extend their regional reach and provide passengers with more alternatives.

"The willingness to collaborate is growing, but Europe still needs stronger connections – technically, operationally and commercially – to truly make air and rail work as one system," added Menéndez-Pidal.

FACT BOX

Spain became a test environment for researchers and industry partners from the aviation and rail sectors to explore how better coordination could enhance multimodal journeys for both passengers and operators.

Discover the MultiModX project

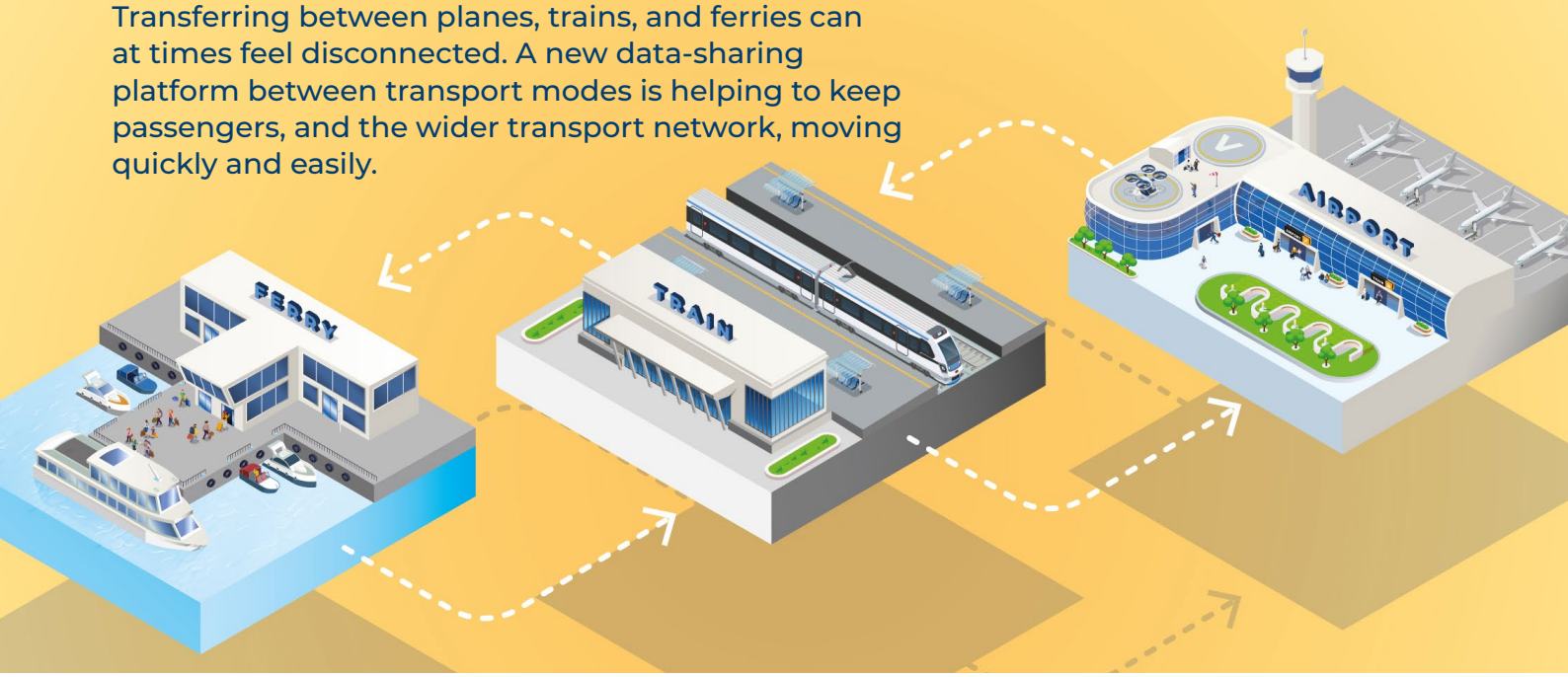
SCAN ME

www.sesarju.eu/projects/MultiModX

SEAMLESS

Connecting air, rail, and sea: How data sharing is creating door-to-door travel

Transferring between planes, trains, and ferries can at times feel disconnected. A new data-sharing platform between transport modes is helping to keep passengers, and the wider transport network, moving quickly and easily.



TAKEAWAYS

- **For decades, aviation, rail, and maritime travel have operated independently, making it difficult to manage disruptions across different stages of a passenger's journey.**
- **Greek transit operators spotted a way to improve passenger experience through a collaborative, real-time data-sharing platform.**
- **By creating a shared situational awareness across air, rail, and sea, Athens is laying down the groundwork for a stress-free door-to-door travel experience.**

Congested airport runways have consequences beyond aviation. When passengers continue their journey by rail or ferry, if an arriving aircraft is delayed, it can start a stressful countdown towards a missed train or onward ferry.

Traditionally, various transport sectors have operated largely independently, managing their networks with little visibility of what is happening across the wider journey. But a new platform developed by SESAR JU research partners is helping to address this challenge – bringing together operators from across Europe's transport sectors to share data and better coordinate efforts to improve passenger journeys.

Managing seasonal peaks across the Aegean

In Greece, the city of Athens provides a valuable environment for testing multimodal coordination. *"Every year, millions of visitors arrive through Athens International Airport and continue their journeys to the Greek islands via ferry services or throughout mainland Greece using rail,"* said **Nikos Papagiannopoulos, Head of Digital and Innovation Services at Athens International Airport**.

During peak tourist periods in the summer months, passenger volumes increase significantly across the city's transport infrastructure, making it more challenging to maintain smooth connections and efficient resource allocation.

Creating a shared view of the journey

Having a complete picture of what is happening across different transport modes has long been a challenge. Operational data is managed separately by each operator, with network and transport managers having to rely on phone and email to troubleshoot and stay updated.

The SESAR research partners spotted a way to streamline this through the creation of a shared data platform. *"At its core, the platform acts as a trusted data-sharing and collaboration environment that allows transport stakeholders to exchange relevant operational information in a secure and interoperable manner. It integrates data from aviation, rail, and maritime systems, normalises different data sources, and transforms them into actionable insights,"* explained Papagiannopoulos.

> *The ultimate vision is a seamless door-to-door travel experience. Passengers will benefit from better communication throughout their journey, greater visibility of their travel status, and a more coordinated transport experience across air, rail, and maritime services.*

System designed to supplement existing infrastructure

Rather than replacing sector-specific systems already used by operators, the multimodal solution developed in the Travel Wise project is designed to connect them. This enables better information sharing, co-ordinates responses to disruptions, and facilitates collaborative decision-making between operators. *"This creates a shared understanding of what is happening across the broader travel ecosystem and enables stakeholders to act collectively, rather than independently,"* said Papagiannopoulos.

The platform combines operational and passenger-related information, including schedules, transport status updates, passenger flows and connection times. One area that this information has proven to be useful is managing delays. This new, shared data approach means that if a train bound for the airport is suddenly delayed, the impact is no longer visible only to the rail operator. Other stakeholders are now in the loop, allowing them to make more informed decisions. *"Airlines, airport operators, and other partners can better understand the potential impact on passenger flows and prepare appropriate mitigation measures,"* explained Papagiannopoulos.

Efficiency wins on show

Testing is ongoing, but the initial results show several benefits for the operators. *"Early work has shown that richer visibility into passenger movements and transport conditions enables more informed decisions regarding resource allocation and operational planning,"* said Papagiannopoulos.

As this visibility improves, operators can better anticipate congestion patterns, optimise resource utilisation – like staffing levels at particular bottlenecks – and proactively manage passenger journeys across the whole transport ecosystem.

"The ultimate vision is a seamless door-to-door travel experience. Passengers will benefit from better communication throughout their journey, greater visibility of their travel status, and a more coordinated transport experience across air, rail, and maritime services," explained Papagiannopoulos.

European framework helps to bring together transport methods

Bringing together operators from different transport networks can be a challenge, with each already having to deal with their own sector-specific issues. But developing such a solution as part of a widescale European project was something which Papagiannopoulos said made this easier. *"The partnership between Europe's Rail and SESAR sends a strong signal that future mobility should be planned and managed as an interconnected ecosystem, rather than as separate transport modes,"* he concluded.

FACT BOX

Athens International Airport connects millions of passengers with onward train and ferry journeys across Greece, including rail links to mainland destinations or high-volume seasonal ferry routes to the Aegean islands. Travel Wise is making these connections more seamless.

Discover the Travel Wise project

SCAN ME

www.sesarju.eu/projects/Travel%20wise

SEAMLESS

Air taxis and drones: Preparing for the next era of air mobility

As drones and other vertical take-off vehicles move closer to everyday operations, airports, Air Traffic Management stakeholders, and new operators are working together to define how these services can be safely integrated.

TAKEAWAYS

- **From medical deliveries to future passenger services, new air mobility will depend on close coordination between airports, Air Traffic Management stakeholders and operators.**
- **New roles and digital services could help manage future networks of advanced air mobility operations.**
- **Vertiports, specially designated infrastructure for these vehicles, could support new cargo and logistics operations alongside existing airport operations.**

As drones and other vertical take-off and landing aircraft move closer to wider adoption in Europe, they could open the door to new services – from medical assistance and cargo transport to air taxis. To unlock these, some airports are exploring the use of vertiports, designed to provide designated grounds for efficient cargo and logistics operations. Vertiports provide take-off, landing, and parking areas for vertical take-off and landing air vehicles such as drones – but must be safely integrated into existing Air Traffic Management procedures and flows.

"The positioning of vertiports is a hugely important thing, because we're trying to make this newer mobility seamless," said **Sara McNamee Freire, an R&D and Regulatory Compliance Specialist at UrbanV air mobility**.

Seamless integration of operations central to success

SESAR JU partners in the EUREKA project demonstrated how vertiport operations can be integrated into airport operations and the wider airspace system. Live trials in Italy, France and Spain explored how flight procedures, traffic management, and network coordination can safely accommodate new types of air vehicles, alongside conventional aircraft.

> *There's a huge interest in the medical world in [air mobility solutions] becoming a reality, so this is probably going to be the starting point.*

At a test site near Rome Fiumicino Airport, researchers validated how autonomous drone operations could function safely in close proximity to one of Europe's busiest airports. *"We tested the interaction of drone related systems alongside the traditional airport systems and how it could work airspace-wise – to find out if there would be any interference in having these flights so close to the runways,"* said McNamee Freire.

The demonstrations focused not only on individual drone flights, but on how vertiports, operators, airports and air navigation services can work together as a connected operational ecosystem. This cooperation will be essential if new air mobility services are to scale safely.

"We need to place vertiports in a strategic location where you can still have the other transport hubs nearby, or you're very close to the destination that you want to travel to," explained McNamee Freire.

Rome Fiumicino Airport was selected due to Italy's enabling regulatory landscape. *"We used the regulatory sandbox, a framework that exists in Italy, to provide a separated space in order to test experimental flights with drones, and different electric technologies from vertiports, inside the space of the airport,"* highlighted McNamee Freire.

Integration with airport systems helps overcome safety concerns

Safety was at the heart of the demonstrations. By connecting vertiports with existing airport systems, the project showed how new drone operations could be safely managed alongside conventional air traffic. Air traffic controllers were involved in the trials to assess how information from new drone operations could be integrated into existing procedures and support safe decision-making.

Reliable data on drone positions, planned flights, and operational conditions helps build confidence among aviation stakeholders and will be a key requirement as new air mobility services develop.

Coordinating future vertiport networks

As the number of vertiports increases in the future, coordinating operations across multiple locations will become an important-to-solve challenge. With that in mind, the EUREKA project explored the introduction of a new role: the Network Vertiport Manager.

"The Network Vertiport Manager is the manager of the entire network. In our use case, it allocates the slots, provides the information inside the network like the weather and slot availability: these are the two services that we have addressed in our project at this stage," explained **Marika Lombardi, R&D and Compliance Manager at UrbanV air mobility**.

This new role would coordinate operations across a network of vertiports to ensure that individual vertiports do not operate in isolation – and optimise airspace use.

During the tests, the importance of this role came to the fore and provided immediate results. *"We saw there was an improvement in the capacity and the efficiency of the operations,"* said McNamee Freire.

Access to reliable information, including local weather conditions, will also be essential for smaller drones and electric aircraft – which can be particularly sensitive to factors such as wind and precipitation.

"The weather service is fundamental for these smaller drones and electric aircraft because the impact that micro weather has on each of these aircraft is very big. Even with small gusts of wind, or different states of precipitation in the different areas inside a regional or urban network, the impact is really huge," explained McNamee Freire.

Medical deliveries and future passenger services on the horizon

With the demonstrations validating the operational concept, attention is now turning to how vertiports can support existing airport infrastructure and wider mobility networks. In the short term, medical and cargo operations are seen as some of the most promising applications – due to the flexibility and speed with which advanced air mobility could operate.

"In the context of the city of Rome, probably some of the first networks will be for medical services between hospitals. This is one of the main cargo service that is being explored," said McNamee Freire. *"There's a huge interest in the medical world in [air mobility solutions] becoming a reality, so this is probably going to be the starting point,"* she added.

In the longer term, the same infrastructure could support passenger services including electric vertical take-off and landing (eVTOL) such as air taxis. *"For drones it could be a step forward for the development of commercial operations, and can be the starting point for eVTOL operations inside the network,"* said Lombardi.

Expert insights help achieve acceptance

A key strength of the project was bringing together airports, regulators, Air Navigation Service Providers, and technology developers to test solutions in a real operational environment. That collaborative approach helps build confidence that future air mobility can be integrated safely into Europe's aviation network.

"It helps us understand the acceptability of these new technologies inside the traditional aviation world and how we can shape it in order to make it publicly acceptable," explained McNamee Freire.

FACT BOX

Trials in Italy, France and Spain have explored how Air Traffic Management can be adapted to accommodate the operations of vertiports – new sites designed for the use of vertical take-off and landing air vehicles.

Discover the EUREKA project

SCAN ME

www.sesarju.eu/projects/EUREKA

SUSTAINABLE

The most sustainable flight is one that avoids unnecessary delays, waiting and inefficiency. SESAR helps airports and air traffic partners work together more effectively, reducing unnecessary fuel burn and emissions through smarter operations. By making every journey more efficient, airports can deliver environmental benefits today while supporting aviation's long-term path to climate neutrality.

SUSTAINABLE

Taxibots help cut ground emissions at one of Europe's largest airports

With airports on the quest to cut emissions across their operations, automated taxiing tools are helping to make pushback procedures more efficient and more sustainable.

TAKEAWAYS

- **Aircraft spend only a small part of their journey taxiing, but this has a relatively high fuel burn compared to when the aircraft is cruising – creating opportunities for emissions savings.**
- **Taxibots are helping to reduce these emissions by towing aircraft for part of their journey between the gate and runway.**
- **Tests at Schiphol showed potential fuel and CO_2 savings for airlines, with one airline reporting savings of between 95kg of fuel and 299kg of CO_2 per flight.**

Moving an aircraft from a gate to a runway may seem routine, but as airports seek sustainability improvements, even these short journeys have become an area for efficiency gains – due to the multiplier effect of optimising the huge numbers of taxied aircraft each day. Taxiing is one of the least efficient phases for aircraft operations, during which engines run at very low thrust, burning a disproportionate amount of fuel.

As a result, research partners in the SESAR JU AEON and ASTAIR projects explored alternative automated taxi support to help reduce fuel consumption and emissions during aircraft ground movements.

Exploring smarter ways to taxi

"We considered every technique that could reduce fuel consumption. It started with basic techniques that are already operational, called single-engine taxiing, as an aircraft on the ground does not need all engines just to taxi," explained **Mathieu Cousy, a Research Engineer at the French National School of Civil Aviation (ENAC), and AEON/ASTAIR Coordinator**.

Researchers then explored whether taxibots – specialised vehicles that tow aircraft while allowing an aircraft's engines to remain switched off for this part of the journey – could provide a further opportunity to reduce fuel burn.

By using live data feeds, research partners developed an automated taxiing system that could provide stakeholders with information 20 to 30 minutes in advance of taxiing – creating a quicker turnaround at gates, meaning less idle time for waiting aircraft burning fuel.

"With automation, turnaround operations are easier to put in place because it's easier to compute the best time to push the aircraft back, the best position to get into the right lane, and to smooth out everything," said Cousy.

The team at ENAC tested these scenarios at their simulation

facilities in France. They found that automated taxiing boosted efficiency of aircraft movements in most operational situations, while still allowing human intervention when unexpected events occurred.

> *With automation, turnaround operations are easier to put in place because it's easier to compute the best time to push the aircraft back, the best position to get into the right lane, and to smooth out everything.*

The simulations also highlighted sustainability wins with the small taxi vehicles running as hybrid vehicles, producing fewer emissions compared with conventional taxi procedures.

"We had an algorithm which was really efficient to manage the different taxi routes and speeds for every vehicle on the ground," said Cousy. *"Then, it was a starting point for EUROCONTROL and other entities (that are more operational) to produce their own sustainable taxiing concept of operation,"* he added.

Schiphol strides ahead

Live demonstrations with taxibots were put in place at Amsterdam's Schiphol Airport as part of HERON; one of SESAR's Digital Sky Demonstrators. The airport selected runway 36L (the Polderbaan) as a suitable test location because of its distance from the terminal area. *"It is the furthest away from the terminal buildings, 12 to 15 minutes taxi time. That could save a lot of fuel used for taxiing to that runway if you use the Taxi tow vehicle instead,"* said **Erik Derogee, a Senior Solutions Lead for SESAR at Amsterdam Airport Schiphol**.

Initial trials involved flights operated by KLM and Corendon. They found reductions in fuel burn and emissions compared to standard taxi procedures, offering potential benefits for both the environment and airlines' operating costs. Since the tests, the airline EasyJet has also signed up to join the automated taxi procedures at Schiphol. The airline believes the procedure will help them save 95kg of fuel and 299kg of CO_2 per flight.

Supporting people alongside automation

Automation does not remove the need for people: pilots from participating airlines have received training on how to work with the taxibots. For ground staff, their tasks remain largely the same as the vehicles are similar to existing tugs used for push-back, but there are several smaller procedural differences such as communication with the pilot.

"Just in front of the runway, they have a special area where they can disconnect. And then the taxi tow driver will start driving the taxi tow again because they have to remove it in front of the aircraft," said Derogee.

One current limitation is vehicle availability. A taxibot round trip can typically take 45 minutes with the vehicles taking service roads back for their next project, but Derogee expects this capacity challenge to lessen as more vehicles become available.

Upgrades to existing procedures

Following the adoption of the automated taxiing procedure, Schiphol acquired a fleet of hybrid and diesel vehicles and expects further sustainability gains with the introduction of electric taxibots.

"The first fully electric taxi came in recently. So that means that there are no engines running on an aircraft to the runway, but also the towing vehicle is also electric, so there are no particles coming from that vehicle," said Derogee. *"We intend to buy new ones in the near future,"* he added.

Future plans include expanding the procedure to more runways and more airlines. SESAR partners are also working on more standardised approaches to managing fleets of taxi vehicles, which could support its adoption at other airports.

FACT BOX

Amsterdam Airport Schiphol is one of Europe's largest and busiest airports, with six runways and over 1,300 daily flights. Taxibots are helping the airport to reduce aircraft fuel burn and cut its local emissions during taxi operations.

Discover the AEON project

SCAN ME

www.sesarju.eu/projects/AEON

Discover the ASTAIR project

SCAN ME

www.sesarju.eu/projects/ASTAIR

SUSTAINABLE

Steeper slopes, quieter skies: How later descents can lower noise pollution

Noise pollution remains one of aviation's most persistent environmental challenges, but trials at Brussels Airport have demonstrated how shifting to a slightly steeper landing approach can help reduce noise for communities on the ground.

TAKEAWAYS

- Slightly increasing an aircraft's angle of descent can reduce noise pollution in lower altitude.
- At Brussels Airport, introducing a steeper angle of descent has reduced sound energy by up to 37%.
- The approach builds on procedures that many pilots are already familiar with, making wider deployment easier.

Noise pollution is one of the toughest challenges facing airports and their operational environments. While aircraft manufacturers continue to develop quieter aircraft, airports, airlines, and Air Navigation Service Providers are also exploring how changes to flight procedures can reduce noise today. By initiating aircraft landings at a steeper angle, aircraft remain at a higher altitude for a longer time and also fly at lower speeds – reducing noise impact for surrounding residents.

As a partner in the SESAR JU HERON Digital Sky Demonstrator, Brussels Airport worked with its partners to demonstrate the benefits of steeper descents and encourage their large-scale deployment. *"The airport has an impact on people living in the neighbourhood and the local environment. On the one hand, we create prosperity and well-being, on the other, our activities can also cause nuisance. By focusing on noise reduction and clean air, we want to find a good balance between air traffic and a good quality of life,"* said **Erik Watzeels, SESAR Development Manager at Brussels Airport**.

Geographical realities drive innovation

Located around 12 kilometres from the city centre, Brussels Airport is surrounded by several strategic sites and densely populated neighbourhoods. This proximity means that managing the impact of its operations is an important priority for the airport.

As part of this effort, the airport is exploring how changing the glide slope for approaching aircraft could reduce noise for people living nearby. A glide slope is the vertical path an aircraft follows during its final approach to landing. It provides precise vertical guidance to ensure that a plane descends safely without hitting obstacles and arrives at the

runway's touchdown zone in the correct position, at the correct angle and at the correct speed.

Traditionally, aircraft approach airports using a standard glide slope of around 3°. By increasing this angle, aircraft can remain higher for longer before descending more steeply towards the runway. This means less time spent flying at lower altitudes over surrounding communities, reducing the impact of noise on the ground. *"The concept of an increased second glide slope... can reduce the amount of noise at ground level near the final approach segment, as well as fuel burn and CO_2 emissions,"* commented Watzeels.

> *Through the SESAR framework, we had the opportunity to deepen and extend this collaboration also to other stakeholders, in order to achieve our ambitions in reducing the impact on people living in the neighbourhood and on the local environment.*

Trialling increased glide slopes

Brussels Airport decided to put the theory to the test over two trial periods. In the first trial phase between October 2024 and February 2025, aircraft increased the glide slope to 3.2° on two of the airport's runways. A second trial period between March and May 2025 increased the angle to 3.5° on a single runway. Noise levels were monitored by sensors across the airport and in nearby areas.

"To reduce the impact on the airport capacity due to the operational flight demonstrations, it was deliberately decided to only execute the operational flight demonstrations during off-peak moments," explained Watzeels.

As confidence grew, the number of flight trials was increased, while certain precautions were taken, such as avoiding tests in snowy weather to limit risks. The team found that steeper approaches could deliver a measurable reduction in noise for communities around the airport.

"The noise reduction compared to the standard 3.0° approaches was more significant for approaches with a 3.5° glide slope, up to 2dB, than for a 3.2° glide slope, up to 1dB," said Watzeels. This represents a decrease in sound energy of between 21 and 37%.

The results support the wider deployment of steeper approaches, with Brussels Airport's experience contributing to efforts to encourage uptake across Europe.

Behind the scenes and next steps

The tests meant several operational changes needed to be made. The airport installed new glide slope indicator lights, also known as precision approach path indicators, on the other sides of their selected runways, so that aircraft could be informed of the correct approach to take.

The airport also worked closely with its Air Navigation Service Provider and other operational partners to create new flight procedures for the new angles, something which the SESAR framework was able to facilitate.

"Through the SESAR framework, we had the opportunity to deepen and extend this collaboration also to other stakeholders, in order to achieve our ambitions in reducing the impact on people living in the neighbourhood and on the local environment," commented Watzeels.

For pilots involved in the demonstrations, no extra training was needed, since many are already used to navigating steeper glide slopes in operation at other airports in Europe. For instance, large-scale demonstrations of steeper approaches recently took place across several German airports including Frankfurt, Düsseldorf, Berlin, Nürnberg, Stuttgart and Hamburg, resulting in more efficient flight paths and significant CO_2 savings across these airports.

Following the conclusion of the trials, Brussels Airport is continuing to assess how steeper approaches could be used more widely, including whether they should apply to all flights or only during certain periods.

"Studies are ongoing to see whether we go for a steeper slope on the runways or only during certain periods of time. We also need to take into account the traffic mix, so whether aircraft are capable of flying the new glide slope. If you miss part of the aircraft fleet, then you restrict yourself in the operational benefits," concluded Watzeels.

FACT BOX

Brussels Airport is located just 12 kilometres from the city centre, making aircraft noise an important issue for surrounding communities. Its proximity to residential areas makes it an ideal location to trial new ways of reducing aircraft noise.

Discover the HERON project

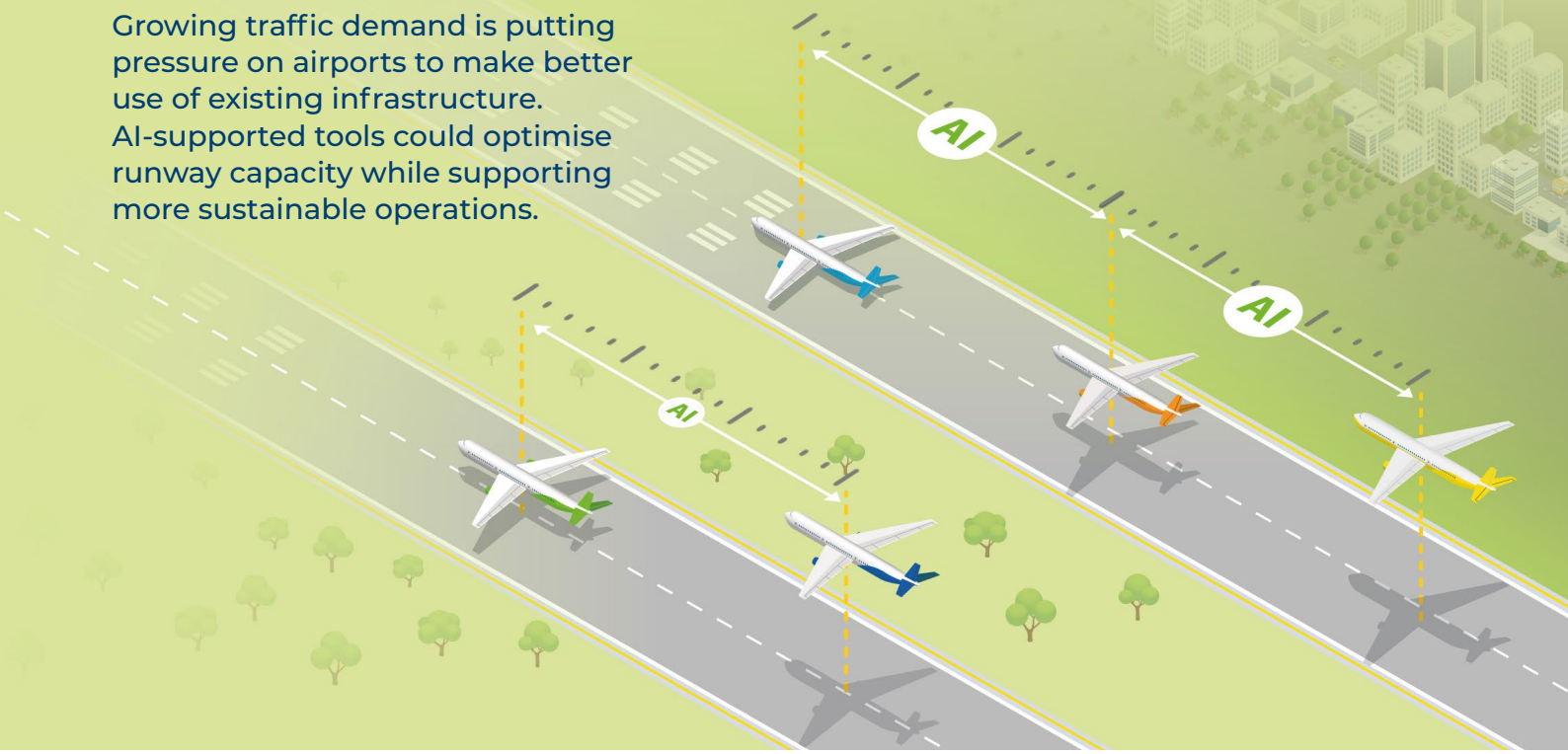
SCAN ME

www.sesarju.eu/projects/HERON

SUSTAINABLE

How AI is helping air traffic controllers to unlock more runway capacity

Growing traffic demand is putting pressure on airports to make better use of existing infrastructure. AI-supported tools could optimise runway capacity while supporting more sustainable operations.



TAKEAWAYS

- **Increased air traffic means that more aircraft seek to land each day, but this puts additional pressure on airport resources.**
- **AI is helping air traffic controllers to safely reduce the distance between arriving aircraft to increase landing rates.**
- **With the tool now used at several sites across Europe, it is hoped more airports will be able to unlock additional capacity.**

Air traffic continues to grow to new levels of demand, placing greater pressure on already busy airports. This increased traffic leaves airport operators seeking the most effective way to increase the number of aircraft landing per hour.

"The demand of traffic is there – so we need to find ways to accommodate that traffic level as efficiently as possible," said **Frédéric Rooseleer, a Safety Engineer at EUROCONTROL working in the SESAR eORD tool**.

Meeting demand through smarter runway management

SESAR partners set out to address two specific performance objectives. *"The first was to find ways to increase runway throughput and runway capacity. The second was the environmental aspects, which can be obtained through direct or indirect improvements,"* explained Rooseleer.

Increasing aircraft capacity does not necessarily mean building additional physical infrastructure. *"If we are able to increase runway capacity, we are also able to accommodate traffic with existing infrastructure,"* said Rooseleer.

Runway capacity is directly linked to the minimum separation distance that air traffic controllers must apply between arrival aircraft. According to EUROCONTROL, this can vary anywhere between 2.5 and 6 nautical miles.

"These minimum arrival separations were developed historically as static separations, applied to a limited number of aircraft categories or groups," explained Rooseleer.

Currently, air traffic controllers monitor these distances using radar, considering external factors like wind speed and aircraft performance. A degree of caution is built into these procedures,

resulting in greater gaps being left between arrival aircraft for safety – reducing landing rates.

To address this, the partners turned to the enhanced Optimised Runway Delivery (eORD) solution, which supports controllers in calculating the most optimal separation. *"The approach controller is provided with an indicator of the recommended spacing on final approach, which calculates or anticipates the compression and the catch-up, which is naturally occurring between successive aircraft on final approach because of the speed difference,"* explained Rooseleer.

> *The demand of traffic is there – so we need to find ways to accommodate that traffic level as efficiently as possible.*

This tool combines an intelligent mixture of live data feeds from aircraft and weather systems with historical information. This allows controllers to receive dynamic recommendations on the most efficient spacing between arriving aircraft.

Machine learning helps to analyse previous traffic situations and identify patterns, with safety buffers kept in place. The solution utilises complex algorithms and data to calculate consistent spacing management that both increases safety and reduces controller workload. *"While it is not a full AI-based solution because this is not yet fully mature for regulatory approvals, it takes advantage of previous work and advanced methods,"* said Rooseleer. *"The controller is still in charge, but it's an aid – which is provided to the controller,"* he added. Overall, eORD creates increased runway throughput capacity due to the reduced, optimised spacing/separation on final approach – as well as a potential positive impact on safety.

Live simulation trials prove potential

At Warsaw Airport, the eORD tool was implemented into the controlled environment of the air traffic control system. After training on the system, air traffic controllers conducted real-time simulations based on realistic traffic scenarios.

The tests found that even in low-wind conditions, the controllers were able to use the tool's recommended spacing to bring arriving aircraft closer to the minimum separation distance safely. Results found that the number of aircraft passing through the airport during the testing periods could be increased by up to 5%.

Standardisation and a new project to come

Following the trials, Warsaw Airport is considering their next steps. Similar eORD solutions are already in place at London Heathrow and Amsterdam Schiphol, and are combined with other time-based spacing tools to help air traffic controllers optimise runway capacity.

"It is hoped that more airports and ANSPs will deploy this solution, considering the benefit provided," said Rooseleer.

For wider deployment, he highlighted the need for greater standardisation, both in terms of operational guidance and the integration of ORD with existing airport systems across Europe.

FACT BOX

Warsaw Chopin Airport tested data-driven tools designed to help air traffic controllers optimise aircraft landing rates per hour, enhancing safety and harnessing greater capacity in existing infrastructure.

Discover the eORD solution

SCAN ME

www.sesarju.eu/sesar-solutions/optimised-runway-delivery-final-approach

SUSTAINABLE

Managing arrivals earlier for smoother flows

Traditional arrival management systems only identify congestion when aircraft are already close to the airport. By sharing real-time information across borders, controllers can now manage arrivals much earlier – helping reduce delays, fuel burn, and emissions.

TAKEAWAYS

- **Congestion in the airspace near busy airports and on the ground can lead to aircraft being held in holding patterns before landing, increasing fuel burn, emissions, and noise.**
- **Extended arrival management (E-AMAN) gives air traffic controllers an earlier view of traffic, allowing them to better sequence the aircraft and reduce the need for holding.**
- **Cross-border coordination helps improve arrival efficiency while supporting more sustainable operations.**

Congested airspace can have a negative knock-on effect on traffic flows. Aircraft may be forced to stay longer into the sky before landing, extending journey times. The standard response to a congested airport runway has traditionally resembled a vertical waiting room. When too many aircraft arrive at peak hours over major airports like Paris-Charles de Gaulle or Paris-Orly, air traffic controllers have had little choice but to stack them in a queue.

Arriving planes are put into tight, circular holding patterns at low altitudes, all waiting for their turn to land. While this process is safe, this traditional approach can increase noise, pilot workload, and fuel burn.

A lack of predictability is often behind this issue. Standard arrival manager systems have historically operated on a short horizon – tracking and sequencing incoming traffic only within a narrow radius

of around 40 nautical miles from the runway.

By the time a controller is able to spot that a bottleneck is forming at the terminal area, the aircraft are already too close to absorb the delay smoothly. Then, they must enter holding patterns and wait.

In a bid to enhance efficiency, DSNA, the French Air Navigation Service Provider, recognised that managing air traffic required looking far beyond the local horizon.

Extending the arrival horizon

Extended arrival management stretches up to 200 nautical miles, rather than the traditional narrow radius. This means that for a flight bound for Paris-Charles de Gaulle or Paris-Orly, a landing sequence slot is assigned while an aircraft is still flying deep over neighbouring regions or countries.

Achieving this requires enhanced data sharing and coordination between Air Navigation Service Providers. Digital tools and advanced arrival software allow real-time information to be shared across borders. When a delay peak is predicted on the Paris airports' runways, controllers hundreds of miles away now receive automated sequencing advisories on their screens and are called into action.

This information is then implemented early by instructing pilots to slightly reduce their cruise speed before they even begin their journey down toward the airport. By easing off the throttle early, the aircraft absorbs the delay smoothly over a massive distance rather than creating a bottleneck closer to the airport.

Cross-border collaboration at scale

Because a 200 nautical mile radius around Paris covers a much larger airspace, the development and execution of this solution requires a high level of operational teamwork with neighbours.

During the live trials, DSNA coordinated inbound traffic flows to Paris using a synchronised network involving five major area control centres including Paris, Reims, Geneva, Zurich, and Milan. Supported by shared data protocols, every controller across these distinct airspaces involved with the project and its trials looked at the exact same real-time arrival sequence data.

This cross-border synchronisation ensured that traffic queues were already smoothed out by the time an aircraft finally entered the Paris terminal area. Delays are instead shifted to this earlier journey phase where planes absorb time linearly by slowing down at fuel-efficient high altitudes, eliminating the need for low-level holding stacks.

This also means that because the arrival order for aircraft is pre-sorted hundreds of miles away, pilots are able to perform smooth, unbroken continuous descent operations into Paris-Charles de Gaulle and Paris-Orly rather than fuel-heavy, stepped staircase descents driven by last-minute holding patterns.

It is not just for efficient queuing that E-AMAN is bringing benefits in Paris. The operational rollout of the technology has so far helped to reduce local Air Traffic Flow Management delays for incoming flights by 5%, cutting on average around one minute of flight time for congestion-prone flights.

E-AMAN has already been implemented in several major airports across Europe as part of the coordinated deployment of key ATM functionalities, as required by the Common Project One Regulation[2].

FACT BOX

Paris-Charles de Gaulle and Paris-Orly are among Europe's busiest airports. As a result, managing arrivals efficiently and enhancing sustainability are key priorities for each airport – with Extended arrival management (E-AMAN) offering benefits in both areas.

Discover the E-AMAN solution

SCAN ME

www.sesarju.eu/sesar-solutions/extended-arrival-management-aman-horizon

2. Extended Arrival Management – Implementation in the European Union https://www.sesardeploymentmanager.eu/extended-arrival-management-implementation-in-the-european-union

SUSTAINABLE

New dashboards help airports deliver more sustainable operations

By breaking down traditional operational silos, airports are converting complex environmental datasets into real-time decision-support tools.

TAKEAWAYS

- The SESAR PEACOCK and EUPHORIA projects are helping airports combine environmental data from across operational teams to create a more complete picture of airport environmental performance.
- Airports including Prague Airport, Paris-Charles de Gaulle Airport, Paris-Orly Airport, Brussels Airport, and Stockholm Arlanda Airport are testing environmental performance dashboards that help operational teams understand how their day-to-day decisions affect emissions, noise, and other environmental indicators.
- By making environmental data accessible through a single dashboard, these projects are enabling airports to make more informed operational decisions that improve environmental performance.

As airports continuously work to improve their environmental performance, they are seeking better ways to monitor and understand where operational changes can make the biggest difference. While they have access to large amounts of environmental data, turning this information into practical action remains a challenge.

"Environmental performance and operational decision making are often managed in separate organisational silos," said **Tomáš Vláčil, a Terminal Operations Development Manager from Prague Airport**.

Environmental performance dashboards aim to break down these organisational silos by bringing relevant information closer to people managing daily operations.

Bridging operational gaps

Traditionally, sustainability departments have focused on monitoring long-term indicators, such as emissions, noise, and energy consumption, while operational teams prioritise safety, capacity, and punctuality.

"We now need to interconnect these two groups, but the question is, how to do it in a way that people from the day-to-day operation understand and realise that their decision-making has some impact on the environment and situation around the airport – so they know how to incorporate changes in their day-to-day operation," said Vláčil.

Showing this data on a dashboard

The environmental dashboard was developed through earlier SESAR research projects and is now being deployed by partners in the SESAR JU PEACOCK Digital Sky Demonstrator project. The forthcoming EUPHORIA project will focus on how the dashboard can support operational decision-making and be integrated into airport operational procedures.

"The dashboard is designed to give information that could be used in management decisions. Airports that use the tools like this will benefit from having a keen understanding of their environmental performance and be better positioned to implement more sustainable operations," said **Thomas Bengtsson, PEACOCK Coordinator at Swedavia**.

The dashboards can be adapted to each airport's needs, displaying relevant environmental indicators in a format accessible to operational teams. Several European airports are testing them, including Paris-Charles de Gaulle and Paris-Orly airports (operated by Groupe ADP), as well as Brussels Airport and Stockholm Arlanda Airport. Each airport is focusing on its own individual environmental improvements.

For example, Groupe ADP is monitoring taxi emissions and noise pollution so they can reduce immediate local emissions in both areas, while in Stockholm, there is a focus on the approach process for aircraft on these impacts over a broader area of the flight path – showcasing how the environmental dashboard can be adapted and personalised for each airport.

> *The dashboard is designed to give information that could be used in management decisions.*

Standardisation is key

A common underlying capability could make it easier for airports to integrate environmental data and compare performance. *"An overall standard that can be used by everyone would be a good result from this environmental performance management project,"* said Bengtsson.

Standardisation is an area where the SESAR JU plays an important role. *"A collaborative framework such as SESAR is essential because it brings together airports, ANSPs, airlines, research organisations, technology providers, and regulators to jointly define common operational concepts, data models, validation methodologies, and interoperability requirements,"* concluded **Rubén Martínez Sevillano, a SESAR Research Partner from Airport Gurus**.

FACT BOX

Airports in Prague, Paris, Brussels, and Stockholm are testing environmental performance dashboards to help teams monitor impacts, share insights, and support operational decisions.

Discover the PEACOCK project

SCAN ME

www.sesarju.eu/projects/PEACOCK

Discover the EUPHORIA project

SCAN ME

www.sesarju.eu/projects/EUPHORIA

Innovative ideas to watch – looking to the future

The future of Europe's aviation sector is bright – with new voices and ideas helping to drive progress. Two recent winners of the SESAR Young Scientist Award explore the innovations which have caught their eyes.

The next generation of industry talent is already making their voices heard and ideas known about the technologies and approaches that could shape tomorrow's operations.

The SESAR Young Scientist Award recognises the contributions of the next generation of aviation talent and shines a light on how their work is changing the industry. The 2025 award winners – **Dr Hannes Braßel** and **Vera Buis** – have their eyes on innovations which could help advance the aviation industry.

Collaboration: the key word for future forecasting success

Buis, whose award-winning project focused on meteorology, believes that airport weather systems need modernisation in Europe. *"Every country and every airport do their own weather forecasting, and I think it could be much more efficient if we combine the strengths from them,"* she explained.

Buis pointed towards her semester studying in the USA where she said the industry was *"much further with aviation forecasting."* In the country, a single access point is open to all and helps to ensure all those working in aviation are doing so from the same playbook. Buis wants to see a similar product created for Europe.

This boost in collaboration would also help towards achieving her ultimate goal of a Single European Sky to improve sectoral performance.

New technology can unlock Europe's innovative future

For Braßel, the future of aviation will see Europe continue to unleash its technology potential. He said that the potential of technology had only just begun to make itself known.

"More powerful computing, new sensor technologies, more capable AI methods and AI-assisted software development are changing what is technically feasible and how fast research prototypes can be built and tested," he explained.

Wider use of these tools could have significant benefits and help Europe to keep up with other innovative regions across the world. One area to watch stood out for Braßel: *"I am especially*

interested in approaches that achieve robust results with affordable sensors, efficient algorithms, and limited data," he said.

These technologies are something which Braßel will continue to work with in the coming years as part of his full-time research job at Dresden University of Technology. *"My next focus is to further strengthen the connection between aviation safety research, unmanned aerial vehicle integration, and realistic test infrastructure. At TU Dresden, I am involved in the planning and development of the Smart Mobility Lab as a new environment for automated flying, connected mobility, and future aviation concepts,"* said Braßel.

With great power comes great responsibility

While technology has great potential, the aviation sector is cautious about its widespread adoption due to the paramount goal of safety.

"AI offers many valuable opportunities for aviation, particularly in perception, prediction, optimisation, and decision support. But safety has to be part of the design process from the beginning, not something added at the end," said Braßel. *"Machine learning and automation should be a tool, and it should not take over control. So, I think that's where the balance is,"* commented Buis.

The sector is working towards finding this balance, and steps are being made. *"Expertise in AI and expertise in safety-critical aviation systems often evolved in separate communities. This is changing, and the next generation of researchers can help by bringing these perspectives together,"* concluded Braßel.

Find out more about the YSA winners

SCAN ME

www.sesarju.eu/news/shaping-safer-smarter-skies-winners-2025-sesar-young-scientist-award-announced

Last word on smarter airports

Europe's aviation sector is entering a new era of transformation, driven by bold ideas, emerging technologies and the people turning innovation into reality.

Across Europe's airports, Air Traffic Management and the wider aviation ecosystem, researchers, engineers and operational experts are developing the digital solutions that will define the future of mobility.

From artificial intelligence and automation to advanced data sharing and new ways of working together, SESAR JU research is showing how innovation can deliver tangible benefits today for passengers and the aviation community, while preparing the sector for the challenges of tomorrow. These advances are helping create operations that are smarter, more seamless, and more sustainable – improving efficiency, strengthening resilience, enhancing safety and supporting better journeys for passengers.

The innovations featured in this publication demonstrate what can be achieved when Europe's aviation community works together. By combining expertise, technology and collaboration, the vital research of SESAR and its research partners is helping to build a connected and competitive aviation system where ideas move from research into real-world impact.

This is the future of the Digital European Sky: a more innovative, sustainable, and resilient Europe, powered by the people and partnerships shaping aviation for generations to come.

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