

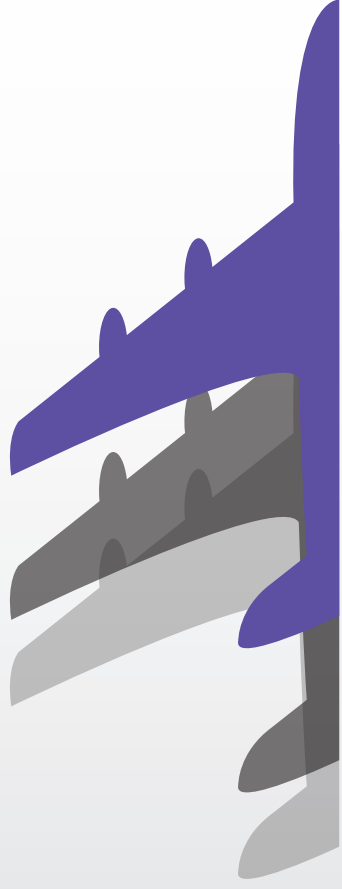
2013-14



founding members



SESAR Release Results





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Table of Contents

01	SESAR explained	04
02	SESAR release process	06
03	Meeting ATM performance needs	08
04	Solutions ready for industrialisation and deployment	10
05	Solutions in the pipeline	16
06	Conclusion	22
07	Glossary	23





SESAR explained

The performance of Europe's air traffic management (ATM) system is critically important for the sustainability of aviation and air transport, two sectors which drive European competitiveness, mobility and employment. With this in mind, in 2004, the Single European Sky Air Traffic Management Research (SESAR) project was set up to modernise and harmonise ATM systems through the definition, development and deployment of innovative technological and operational solutions.

SESAR is the technological pillar of the Single European Sky, an EU-wide policy designed to enable ATM to handle a three-fold increase in capacity, improve safety by a factor of 10, enable a 10% reduction in CO₂ emissions per flight and reduce the unit cost of ATM services to the airspace users by 50%. SESAR contributes to these high-level goals by harnessing the expertise and resources of the entire ATM community, from the Network Manager and civil and military air navigation service providers, to airports, civil and military airspace users, staff associations, academia and research centres.

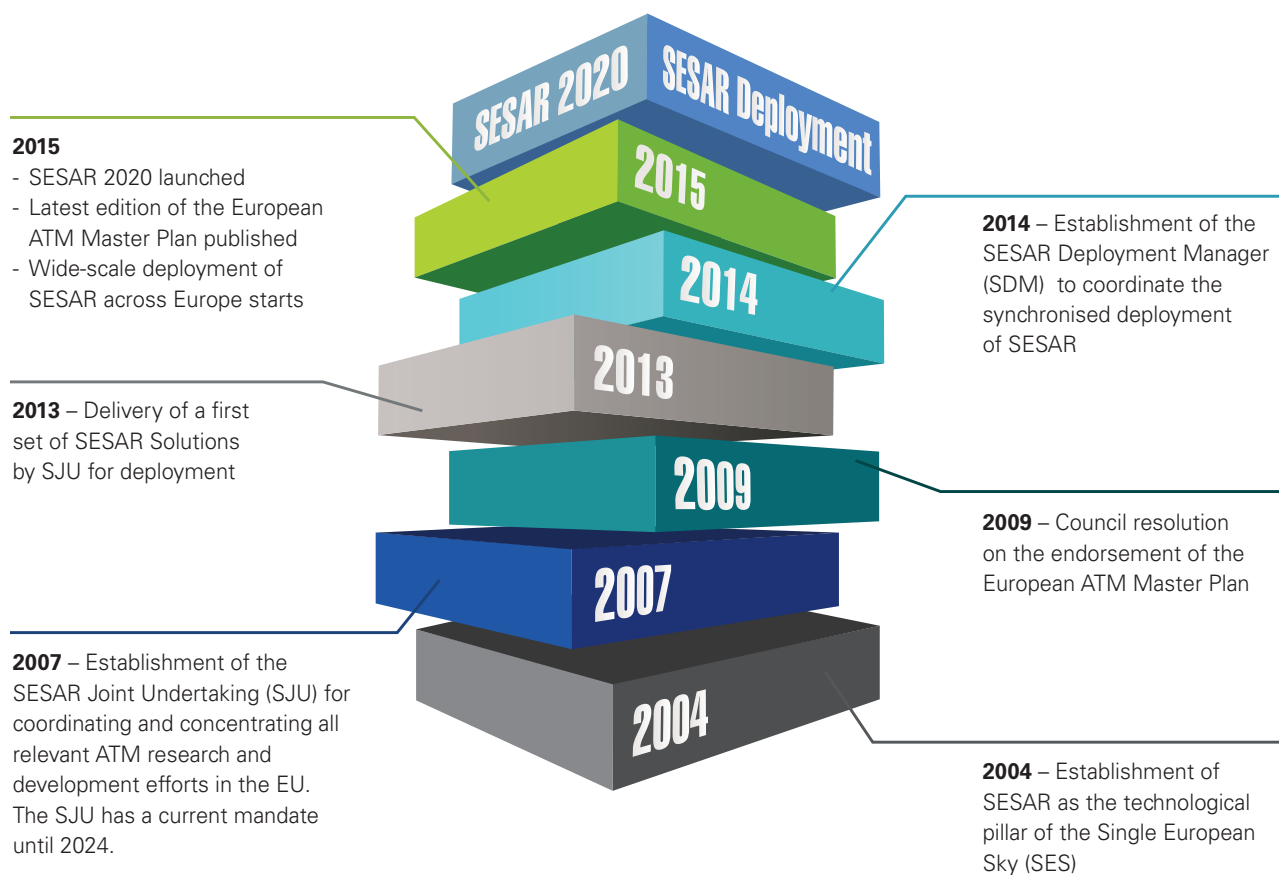
Guided by the European ATM Master Plan, the SESAR Joint Undertaking (SESAR JU) is responsible for concentrating

all ATM research and innovation (R&I) efforts, and for defining, developing and validating SESAR Solutions in preparation for their deployment. These solutions address all parts of the ATM value chain, from airports, air traffic services to the network, as well as the underlying systems architectures and technological enablers, which are validated in real day-to-day operations.

The early implementation of several of these solutions is already underway, demonstrating SESAR's role in transforming Europe's ATM network into a modern, cohesive and performance-based operational system. Further proof of the readiness of SESAR R&I is the decision by the European Commission to package a first set of SESAR Solutions into a Pilot Common Project (PCP)¹, which are considered mature enough for synchronised deployment across Europe (2015-2020). The SESAR Deployment Programme, which is managed by the SESAR Deployment Manager, aims to ensure that solutions delivered by the SESAR JU enter into everyday operations across Europe, resulting in significant benefits for airspace users and the environment. This means that Europe is well on its way to building the ATM system that it needs to increase the performance and sustainability of its aviation sector.

(1) European Commission Implementing Regulation (EU) N° 716/2014 of 27 June 2014 on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan Text with EEA relevance

Figure 1: SESAR building blocks



02 SESAR release process

/ 6

The SESAR JU has established an innovation pipeline towards deployment, which is stimulating new thinking in the ATM domain, while also validating and demonstrating the viability and benefits of SESAR Solutions. In SESAR, solutions undergo thorough pre-industrial development and integration testing within a given timeframe in order to establish their readiness for industrialisation and subsequent deployment.

This process is known as a Release and is carried out on annual basis. In this framework, since 2011, the SESAR JU and its members and partners have carried out a total of 300 flight trials, simulations and other validation exercises, focusing on V3-level activities.

Figure 2: SESAR lifecycle

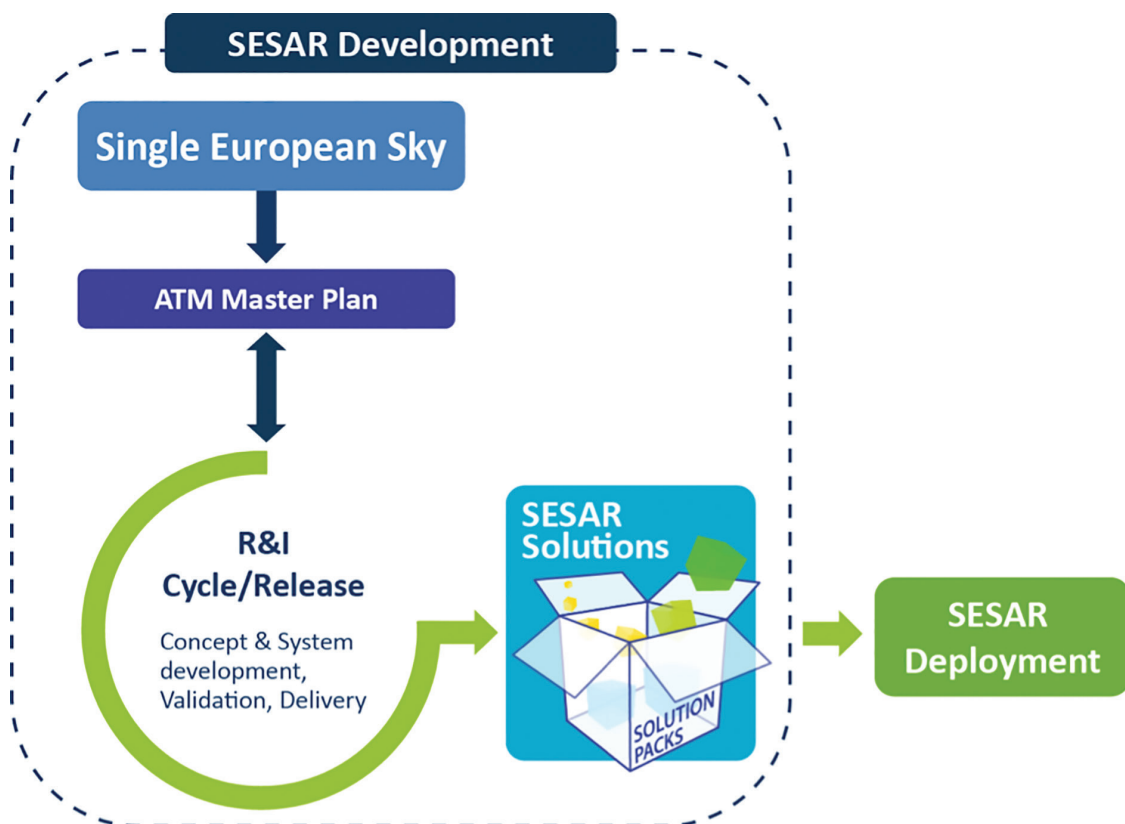


Figure 3: Releases 1-5 in a nutshell

Release 1 included 25 operational validation exercises throughout Europe. The exercises centred on the development of efficient and green terminal airspace operations, initial 4 dimension (i4D) trajectory management, end-to-end traffic synchronisation, and ground and airborne safety nets.

Release 2 built on the experience gained during Release 1, widening the scope of the work and comprised 28 exercises, which took place across 18 European locations. The main results of these exercises focused on: refining the time-based separation minima between arrival aircraft, optimising air traffic control (ATC) sectorisation to better cope with traffic demand, providing new direct routing for airlines and increasing ATC efficiency.

Release 3 covered 13 solutions, out of which 3 are mature enough to support a decision for their industrialisation. The 19 exercises supporting these solutions focused on traffic synchronisation in complex environments, arrival management solutions, ATC services and aerodrome flight information services (AFIS) services in a single low-density aerodrome provided from a remote tower, enhanced-short term conflict alert (STCA) with down-linked parameters and enhanced flight data exchange.

Release 4 included 20 exercises that delivered a total of 8 solutions mature enough to support a decision for their industrialisation. The exercises supporting these solutions focused on such areas as airborne separation assistance (ASAS), initial i4D trajectory management, controlled time of arrival (CTA), extended arrival management horizon (E-AMAN), pre-departure sequencing supported by advanced surface movement guidance and control systems (A-SMGCS), ground-based augmentation system (GBAS) and precision approaches using GBAS CAT II/III (based on GPS L1), among others.

Release 5 includes 38 validation exercises that addressed 32 potential SESAR Solutions, several of which are featured in the plans for European-wide deployment by the SESAR Deployment Manager. The exercises supporting these solutions focus on such areas as airport operations plan (AOP)/ network operations plan (NOP) integration, A-SMGCS, airport safety nets, free routing, advanced STAM and decision support tools to planning and tactical controllers.

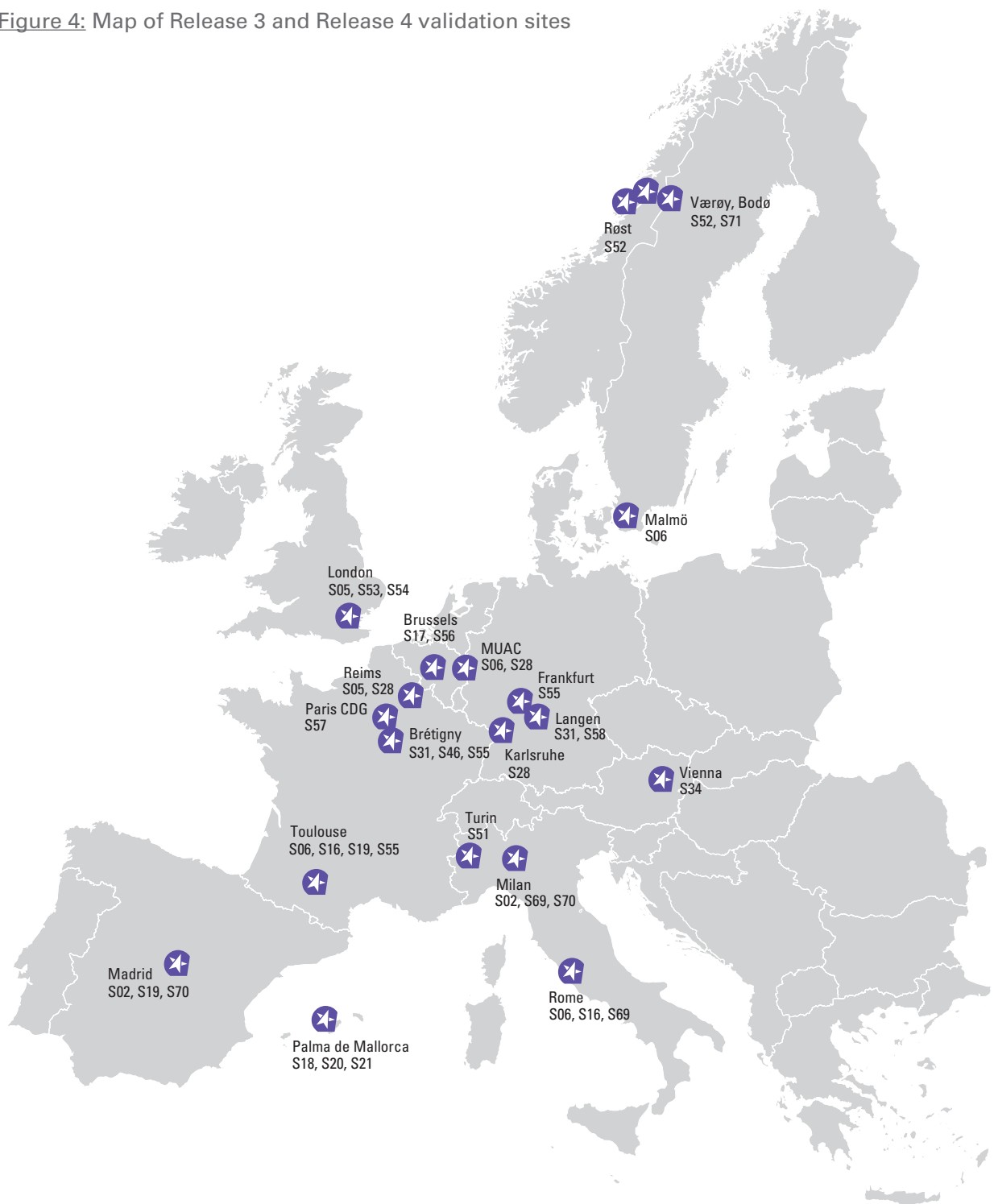
Meeting ATM performance needs

Release 3 and Release 4 delivered a total of 11 solutions deemed mature enough to go forward for industrialisation, while making significant progress on 13 solutions for which further R&I is required. These solutions are categorised according to the European ATM Master Plan²:

	Ready for industrialisation	Further R&I required
Traffic Synchronisation		
S05 Extended arrival management (E-AMAN) horizon	●	
S06 Controlled time of arrival (CTA) in medium density and complexity environments		●
S16 Airborne separation assistance system (ASAS) spacing applications "remain behind" and "merge behind"		●
S51 Enhanced terminal operations with localiser performance with vertical guidance (LPV) procedures	●	
S53 Pre-departure sequencing supported by route planning	●	
S54 Flow-based AMAN/DMAN integration	●	
Airport Integration & Throughput		
S02 Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances		●
S21 Airport operations plan (AOP) and AOP-NOP seamless integration		●
S52 Remote tower for two low-density airports	●	
S55 Precision approaches using GBAS CAT II/III based on GPS L1	●	
S70 Enhanced ground controller situation awareness in all weather conditions	●	
S71 ATC and aerodrome flight information service (AFIS) in a single low-density aerodrome from a remote tower	●	
Network Collaborative Management and Dynamic Capacity Balancing		
S17 Advanced Short ATFCM Measures (STAM)		●
S18 Calculated Take-Off Time (CTOT) and Target Time of Arrival (TTA)		●
S19 Automated support for Traffic Complexity Detection and Resolution		●
S20 Collaborative network operations plan (NOP) for Step 1		●
S31 Variable profile military reserved areas and enhanced (further automated) civil-military collaboration		●
S56 Air traffic flow management slot swapping	●	
S57 User-driven prioritisation process (UDPP) departures	●	
Conflict Management and Automation		
S28 Automated assistance to controller for seamless coordination, transfer and dialogue through improved trajectory data sharing		●
S58 Display and use of ACAS resolution advisory downlink on the controller working position		●
S69 Enhanced short-term conflict alert (STCA) with down-linked parameters	●	
System Wide Information Management (SWIM)		
S34 Digital integrated briefing		●
S46 Initial SWIM		●

(2) 2012 edition

Figure 4: Map of Release 3 and Release 4 validation sites



Solutions ready for industrialisation and deployment

Thanks to a rigorous validation process, a total of 11 solutions reached full maturity and a decision to move forward to industrialisation was made. This section describes these solutions, the steps taken to validate them and the results to prove their readiness.



Several of the solutions featured are part of a first package of SESAR Solutions for synchronised deployment across Europe (2015-2020), and are highlighted in this brochure using a PCP stamp.

with the UK in real operational conditions characterised by high traffic density. The solution demonstrated the following benefits:

- Manageable controller workload, particularly in the en-route sectors serving the E-AMAN horizon;
- A reduction of up to a minute spent in holding stacks, with each minute representing up to 60 kilograms in fuel savings. This amounts to an average 8 % reduction in fuel consumption per flight, as well as a reduction of nearly 90 % of airborne waiting time;
- When extended to an annual fuel burn, the stack hold fuel burn benefit would amount to approximately 2.63 Kt in fuel savings (EUR 1.25 million in fuel saved) and 5000 tonnes in CO₂ emissions;
- Reduced noise beneath the stacks.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation. This solution is planned for synchronised deployment at 24 European airports in accordance with the PCP.

S05 – Extended arrival management (E-AMAN) horizon

Today, arriving airport traffic is managed and sequenced in the airspace close to the airport. Faced with increasing traffic, airports are looking for ways to overcome congestion and reduce the need for holding. The SESAR Solution, extended arrival management (E-AMAN), allows for the sequencing of arrival traffic much earlier than is currently the case, by extending the AMAN horizon from the airspace around the airport to further upstream. Controllers in the upstream sectors, which may be in a different control centre or even a different functional airspace block (FAB), obtain system advisories to support an earlier pre-sequencing of aircraft. Controllers implement those advisories by instructing pilots to adjust the aircraft speed along the descent or even before top-of-descent (TOD), thereby reducing the need for holding and reducing fuel consumption.



Validation results

Exercises in Reims validated the application of the E-AMAN horizon on operations for cross-border arrival management

S51 – Enhanced terminal operations with localiser performance with vertical guidance (LPV) procedures

The solution refers to the use of GNSS-based advanced required navigation performance (A-RNP) approach procedures to enhance terminal area operations (TMA). Vertical guidance along the approach may be based on either barometric (BARO/VNAV) flight management system (FMS) guidance or geometric guidance down to LPV minima based on EGNOS-augmented GPS navigation, which provides localiser-like performance with glide-slope-like vertical guidance. SESAR has worked on the introduction of radius-to-fix (RF) turns onto a short final and during missed approach segments, thereby increasing the flexibility in the design of landing procedures.



Unlike ILS or GBAS, LPV procedures do not require any new equipment at the airport. This makes them an ideal low-cost alternative to increase access to secondary airports that may not be ILS equipped on all runways. For ILS-equipped runways, the new approach design may be useful either to shorten the flightpath for certain traffic flows or simply to overlay the existing ILS and be used as a fall-back procedure in case of airborne or ground ILS-equipment malfunction.

Validation results

Exercises in Turin focused on paving the way for the operational implementation of advanced features made possible by GNSS/EGNOS, from the perspective of both ground and air segments. The assessment looked at all aspects of the implementation process, starting from procedure design and coding issues up to avionics behaviour for regional aircraft and operational procedures (i.e. crew and controller workload, situational awareness, etc.). The exercises concluded the following:

- Feasibility for pilots to fly stabilised approaches with both three and four degree glide path angles in clean configuration, while maintaining a good situational awareness and a manageable workload;
- Feasibility for air traffic controllers to manage workload with good situational awareness comparable to the current situation;
- Reduced mileage, resulting in less fuel consumption and associated CO₂ emissions;
- Increased flight path predictability for air traffic controllers and pilots;
- Increased airport accessibility through the provision of instrument approach procedures to runway ends with no existing published instrument approaches;
- Maximised fuel efficiency and noise reduction when integrated with continuous descent approaches (CDA).

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation. This

solution is planned for synchronised deployment in 25 European airports in accordance with the PCP.

S71 – ATC and AFIS services in a single-low density aerodrome from a remote tower

Small or local airports are life-lines to local and regional economies, generating mobility of goods, services and people. But keeping these airports open with air traffic services is a challenge given the costs involved in running them compared to the number of flights they handle. SESAR's remote tower services (RTS) offer new possibilities for places where it is too expensive to build, maintain and staff conventional tower facilities and services, or at airports where such services are currently unavailable. In this solution remote tower services are provided remotely to a single low-density airport.

Validation results

Exercises were conducted at Værøy heliport, an island in Norway, where aerodrome flight information services (AFIS) were provided by a tower located in Bodø on the mainland. The exercises focused on the provision of AFIS (including weather information) through an enhanced platform and improved functionalities using different technical enablers. The results were as follows:

- Operational feasibility of the solution due to the high quality visualisation tools;
- Maintained levels of safety in normal and degraded conditions;
- Acceptability of remote service provision by controllers.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation. In 2014, the world's first RTS opened for business in Sundsvall, serving Örnsköldsvik airport over 150 km away.

S52 – Remote tower for two low-density airports

Building on the validation of remote tower operations to a single aerodrome, this solution refers to the provision of ATC services and AFIS to two low-density airports simultaneously by a single controller located at a remote location.

Validation results

An iterative validation programme, including simulations and live trials, tested the provision of ATC services and AFIS in nominal and non-nominal situations. In the live trial, AFIS were provided simultaneously to Røst airport and Værøy heliport from one remote controller position at the Bodø facility on the Norwegian mainland. The validation was constrained to two airfields of very low intensity where, should simultaneous movements occur, traffic at one could be safely held or delayed while traffic at the other was attended to.

The results were as follows:

- Positive feedback from controllers of the overall out-the-window (OTW) view, in terms of accuracy and the high quality resolution, screen size and contrast. The controllers noted that the OTW was even sharper than in a local tower;
- Improvement to the controllers' situational awareness both in good and limited visibility conditions, thanks to infrared (IR) and pan-tilt-zoom (PTZ) cameras, which contributed to the clarity of the image feedback for the advanced visual features;
- Need for careful management of traffic to ensure safe service provision.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation.

S53 – Pre-departure sequencing supported by route planning

Pre-departure management delivers optimal traffic flow to the runway by factoring in accurate taxi time forecasts and route planning. The planned pre-departure sequences are used to assign to each flight a target start-up approval time (TSAT) that takes into account the gate where the aircraft is parked and how long it takes for the aircraft to taxi to the departure runway. Tower clearance delivery controllers follow the TSAT-window when issuing start-up approval.



The solution allows for:

- Reduced waiting time at the runway holding point, which saves fuel and allows workload efficiency;
- Increased accuracy of taxi time-out prediction and hence take-off time predictability, which in turn allows the aircraft to adhere to their target take-off time (TTOT);
- Provision of a more stable pre-departure sequence.

These improvements in turn may be used by the Network Manager (NM) to optimise network management.

Validation results

Exercises at London Gatwick validated the use of route planning information provided by A-SMGCS for departure management (DMAN) compared to static tables used in current airport collaborative decision making (A-CDM). The results indicated that the solution allowed for more accurate calculation of an integrated arrival and departure sequence. The solution also allowed for increased predictability and stability of actual times and target times for taxi-out.

The exercises noted that the benefits of estimating taxi times based on the routing functionality compared to static taxi time tables used in A-CDM can vary due to a number of factors:

- The level of sophistication of the static taxi time tables: estimated taxi times offer fewer benefits when the tables are sophisticated;

- Complexity of the taxi layouts: airports with a complex taxi layouts benefit more;
- Taxi route length: airports where taxi route lengths can vary significantly benefit the most from taxi times calculated by the A-SMGCS routing and planning function. While during nominal situations the validation results did not show major improvements of both TTOT and TSAT accuracy; during non-nominal situations (e.g. closed taxiway) slight improvements of both TTOT and TSAT accuracy were reported.
- Enabler for accurate runway sequencing to facilitate E-AMAN;
- Positive feedback from controllers regarding the integrated sequence, shared view and ability to input multiple runway patterns with different start times.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation. DMAN synchronised with pre-departure sequencing is planned for deployment at 24 European airports in accordance with the PCP.

S54 – Flow-based AMAN/DMAN integration

With this solution, integrated AMAN and DMAN aims at increasing throughput and predictability at airports by improved coordination between en-route, approach and tower controllers. Arrival and departure flows to the same runway (or for dependent runways) are integrated by setting up a fixed arrival departure pattern for defined periods. The successive pattern might be chosen by the operators or provided by an optimisation algorithm considering arrival and departure demand. Departure flow to the runway is managed by pre-departure sequencing (integrating route planning), while arrival flow to the runway is managed by arrival metering.

Validation results

Exercises at London Gatwick validated the use of route planning information provided by A-SMGCS to improve AMAN and DMAN integration. The results were as followed:

- Increased predictability in terms of TTOT and target landing time (TLDT), resulting in increased runway throughput and reduced fuel burn;

S55 – Precision approaches using GBAS CAT II/III based on GPS L1

GBAS augments the global navigation satellite system (GNSS) signals by sending the positioning corrections to aircraft for precision approach and landing. Precision approaches using GBAS offer possibilities to develop new approach paths and to enable all-weather access to airports where no ILS is installed. In particular, GBAS used for Category II/III approaches (1000 feet or 300 metres) or less of runway visual range offers a viable and cost-effective solution for low visibility operations, overcoming ILS operational limitations such as for critical and sensitive areas. GBAS is also more cost-effective since its single ground station can serve several runway ends.

Validation results

Exercises in Toulouse validated airport operations and the interoperability between air and ground systems during approach and landing. The results of these exercises were as follows:

- Sustained accuracy for aircraft guidance on final approach and good performance in operational conditions, with no interference from previous landing aircraft;
- Interoperability between air and ground systems during approach and landing;
- Increased runway throughput, while maintaining safety and human performance levels, and increased resilience in poor weather conditions.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation.

S56 – Air traffic flow management slot swapping

Slot swapping is a means to reduce the impact of delays on airspace user operations. It is estimated that between 100 and 200 slot swaps take place each day in Europe. With this solution, aircraft operators' tactical priorities are introduced in a cooperative process with the NM through air traffic flow management (ATFM) slot exchanges made between flights within a single airline company. Both the NM and the airspace user can propose a slot swap. However it is not always easy to identify which flights would benefit from a swap. This solution offers system support for the slot-swapping process, and makes it possible to carry out multiple swaps for a single flight, thereby splitting the delay assigned to one flight between a maximum of three flights.

Validation results

Exercises simulating European city pairs validated a swapping tool for identifying viable swaps and for allowing multi-swap whereby airspace users could swap the same flight up to three times, and for substituting slots in case of cancellation. Over a 7-week time period, 199 swaps requests were made using the tool with only a 5% rejection. The results were as follows:

- At the network level, the additional features offered by the solution were acceptable for the Network Management Operating Centre (NMOC) in terms of workload with no perceived change in the response time to requests;
- Airspace users indicated that the average cost saved per swap was between EUR 4600 and EUR 4900, while costs saved per flight varied from less than EUR 1000 euros and more than EUR 10000.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation.

S57 – User-driven prioritisation process (UDPP) departure

Taking place during pre-tactical operations, this solution provides airspace users with an easy and user-friendly way to identify their best swapping partners, as well as accrued flexibility in the slot-swapping rules such as multi-swap and substitution on cancellation. The slot-swapping tool allows airspace users to gain efficiency in the process of querying and identifying a partner for a slot-improvement, delay, or substitution on flight cancellation.

Validation results

As part of the SESAR DFlex demonstration project and using a pre-departure sequencing process currently in operation at Paris Charles de Gaulle Airport, exercises validated flight re-ordering based on airline business requirements. The results were as follows:

- Increased flexibility for airspace users to re-order their flights in the pre-departure sequence;
- Maintained levels of safety, air traffic control operations, airport capacity and overall traffic punctuality;
- Increased decision-making and re-ordering activities by flight operations centre staff.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation. This locally-deployed solution relies on having A-CDM in operation, and a pre-departure sequencing strategy to assign TSATs well in advance based on the "first-scheduled-first-served" principle. Adaptations would be needed in order to deploy this solution at airports with alternative pre-departure sequencing policies.

S69 – Enhanced short-term conflict alert (STCA) with down-linked parameters

The STCA is a ground-based system designed to act as a safety net to prevent loss of separation between aircraft. The system, which can be used in both en-route and TMAs, generates an alert to warn air traffic controllers when separation minima between aircraft look likely to

be infringed. The enhanced system makes use of down-linked aircraft parameters (DAP), available through Mode S enhanced surveillance (EHS) (i.e. selected flight level, roll angle/track angle rate), in order to improve the precision of the conflict assessment and to increase the reliability and accuracy of the alerts, while reducing the incidence of nuisance alerts.

Validation results

Exercises in Milan and Rome validated the operational feasibility of enhanced STCA using existing down-link parameters and an enhanced STCA prototype. The results were as follows:

- Improved warning times within the en-route and TMA airspace, leading to increased safety;
- Reduced number of nuisance alarms and maintained rate of genuine alerts;
- Better management of controller workload, generating a higher level of confidence by staff and an increased trust in the system.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation.

S70 – Enhanced ground controller situation awareness in all weather conditions

With increased air traffic to and from Europe, airports are faced with the challenge of more ground operations and surface traffic moving across runways, taxiways and aprons. SESAR airport safety nets are tools to detect and provide alerts for safety critical issues (e.g. risk of collision, route deviations, etc.) on the airport surface, and include runway conflicting ATC clearance detection, conformance monitoring alerts for tower controllers, among others.

Validation results

Exercises in Madrid and Milan validated the use of several prototypes of airport safety nets for tower controllers. The safety nets were assessed for their ability to identify vehicles and aircraft mobiles in the ground area, and notify

controllers of any potential runway incursions or area intrusions. The coexistence with already deployed alerts (runway incursions, area intrusions), presenting new alerts to the controllers were also jointly validated. The results were as follows:

- Operational acceptance of airport safety nets, with some adjustments such as filters for prioritising and displaying alerts, and a refining route planning feature;
- Increased situational awareness in low visibility conditions;
- Enhanced safety thanks to the generation of real alerts.

Status

The validation results for this solution are conclusive and sufficient to support a decision for industrialisation.

Solutions in the pipeline

The Release process is all about validating solutions to assess their operational feasibility but also their readiness for industrialisation. Further R&I work will continue on the following 13 solutions:

S02 – Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances

This solution refers to a system that detects conflicting ATC clearances and non-conformance to procedures for traffic on runways, taxiways and in the apron, stand and gate areas. The system aims to provide the appropriate indications and alerts to controllers.



Validation results

Real-time simulations in Madrid and Milan looked at how the system could reduce the risk of collisions thanks to early detection and alerts provided to the controllers. Specifically the validation exercise assessed whether the system could improve routing calculations and tower supervisor decision making, and enhance safety and efficiency through the use of datalink for departure clearances. The results were as follows:

- Enhanced situational awareness for controllers and overall safety thanks to alerts, but with a need for further filtering;
- Appreciation by controllers of additional functionalities made accessible through the controller's working position and via datalink.

Status

Further validation activities will be conducted as part of Release 5 to refine the functionalities and safety performance of the solution.

S06 – Controlled time of arrival (CTA) in medium density and complexity environments

Modern avionics allow aircraft to meet a time constraint over a waypoint through the use of the required time of arrival (RTA). This may be used to support arrival management; in current operations, controllers issue instructions for aircraft to reduce speed for absorbing delay. In CTA operations, aircraft will instead downlink the RTA min/max window to the ground system, corresponding to the earliest and latest time the aircraft can reach the metering fix. This window is taken into account by AMAN which allocates delay and assigns a corresponding time of arrival. This time constraint (CTA) is then uplinked directly from the ground systems to the airborne systems, allowing the aircraft to self-manage its speed in order to reach the metering waypoint at the specified time. CTA is applied only to aircraft that can absorb the attributed delay by managing their speed.

Validation results

Real-time simulations in Rome, Malmö, Toulouse and Maastricht confirmed CTA as a feasible sequencing management tool. Aircraft managed by CTA benefit from the CTA self-management concept because they are able to optimise the way they absorb their delay. However, the need to ensure safe separation along the descent may limit the applicability of the CTA.

Status

Further validation activities will be conducted as part of Release 5. The exercises will focus on ground-ground and air-ground interoperability and improving controller human-machine interface (HMI), and on quantifying the impact of the use of CTA on SESAR KPAs. The effect of using CTA for sequencing followed by ASAS sequencing and merging (ASPA-IM-S&M) will also be investigated.

S16 – Airborne separation assistance system (ASAS) spacing applications “remain behind” and “merge behind”

ASPA-IM-S&M manoeuvres allow flight crew to achieve and maintain spacing for a designated aircraft. The applications are specified in new air traffic control instructions, allowing flight crew to achieve and maintain a given spacing in distance or time from a designated aircraft. Separation provision, however, remains the controller’s responsibility and applicable separation minima remain unchanged.

Validation results

Real-time simulations were carried out in Rome and Toulouse to validate four ASPA-IM-S&M procedures: “remain behind”, “merge behind”, “vector then merge behind”, “follow route then merge behind”. These were assessed within an environment featuring a precision area navigation (P-RNAV) route structure and a point merge system (PMS). The use of “remain behind” and “merge behind” manoeuvres on traffic that had been sequenced by CTA was also simulated. ASAS operations were found to be safe and feasible.

Status

Further validation activities will be conducted as part Release 5 to complete the assessment of ASAS on SESAR’s key performance areas.

S17 – Advanced short ATFCM measures (STAM)

STAMs enable ANSPs to improve the predictability of operations and optimise traffic throughput thanks to ATFCM measures coordinated between upstream and downstream ATC sectors (e.g. flight-level capping, re-routing). Advanced STAM includes a set of automated support tools for hotspot detection at the network level, allowing easier STAM



coordination by making all relevant information visible to all parties (i.e. concerned ACCs and the NM). The advanced STAM toolset also includes “what-if” functionalities to evaluate what the effect of a STAM will be before effectively applying it. These enhancements make the use of STAMs more effective without increasing local flow management positions (FMP) or NM workload. Improved STAM visibility will have benefits not only during operations, but will also allow detailed post-operations analysis.

Validation results

Live trials were carried out in the core European airspace to validate diversion and tactical flow management processes and network coordination. They successfully demonstrated the application of STAM on a larger scale in the core European area, with the following observations:

- Reduction in the delay, contributing to the resolution of hotspots;
- Demonstrated operational feasibility of the solution at a network level, with some level capping and re-routings causing small fuel penalties, instead of penalising aircraft with CTOTs on the ground;
- Increased collaboration between all actors, providing them with a common view on the application of STAM, and allowing for feedback and sharing of different approaches;
- Provision of recommendations for further refinement, notably with regard to ergonomics, the distribution of responsibility and the better exploitation of capacity.

Status

Further validation activities will be conducted as part of Release 5. Specifically, the activities will aim to refine the solution to allow ANSPs to choose between using an improved NM STAM client that was already tested in Release 4 or connect to the NM STAM server by using their own local FMP tools. STAM is part of deployment plans in accordance with the PCP.

S18 – Calculated take-off time (CTOT) and target time of arrival (TTA)

In current operations, when arrival demand into an airport exceeds capacity, a CTOT is generated by the NM and imposed to the departing aircraft to guarantee its landing in a time period wherein capacity is available at the arrival airport. The solution consists in defining a target time of arrival (TTA) that is generated in collaboration with the arrival TMA and airport, in addition to the CTOT. The CTOT and TTA solution will allow arrival airports and TMAs to participate in the regulation process and ensure arriving aircraft can better comply with the airport capacity. Increased CTOT and TTA adherence will smooth the presentation or arrival traffic, which will be taken over by AMAN for final sequencing.



Validation results

Live trials were conducted with arrival traffic into Palma de Mallorca, where TTAs were disseminated to airlines. The possibility of aircraft changing speed or rejecting tactical direct clearances in order to adhere to their pre-departure TTA was explored. A prototype tool to allow Palma airport to collaborate with NM in setting TTAs was tested, and the process proved to be feasible.

Status

Collaboration between local actors and the NM in arrival demand capacity balancing (DCB) will continue to be explored in Release 5. In addition, a SESAR large-scale demonstration will test iAMAN, a new prototype tool to allow Paris TMA to effectively collaborate with the NM in TTA allocations.

S19 – Automated support for traffic complexity detection and resolution

This solution enables flow management positions (FMP) staff to identify, assess and resolve local complexity



situations, thereby reducing traffic peaks through the early implementation of measures for workload balancing. The solution contains a traffic complexity assessment tool, as well as automated support for resolving situations where too high a complexity is predicted. Resolution actions will preferably consist of dynamically re-arranging sectorisation schemes, but may also include imposing changes on trajectories of an individual aircraft or even full traffic flows.

Validation results

Shadow mode trials took place in Toulouse and Madrid with prototype tools that compute the complexity of traffic based not only on traffic counts or occupancy, but also on sophisticated algorithms that aim at giving more weight to flights that will have a greater impact on the controller's cognitive workload.

Status

Further validation activities will be conducted as part of Release 5, where work will be undertaken to refine the complexity algorithm and assess performance benefits. Automated support for traffic complexity is part of deployment plans in accordance with the PCP.

S20 – Collaborative network operations plan (NOP) for step 1

This solution is a collaborative NOP information structure, which provides updated data exchanges between the NM and stakeholders systems to the required level of service, thus allowing shared operational decision-making. The collaborative NOP framework allows real-time exchange of a wide variety of operationally-relevant data, including full information on TTAs, STAMs and the extended flight plan (EFPL). The structure includes an information model and a classification system to capture the different types of actions, influencers, performance objectives, relationships, among other data.



Validation results

EFPLs include data on planned climb/descent profile as calculated by the airline based on the latest weather and payload of each flight, as well as a full 4D profile. Extensive shadow-mode validations showed that EFPL data combined with NM-known constraints (e.g. profile tuning restrictions to reflect operational transfer conditions between ACCs) allows for a more accurate prediction of sector traffic loads across Europe.

Status

Several collaborative NOP-relevant exercises are planned for Release 5, including the exchange and use, as well as collaborative STAM management (related to S17) and TTA dissemination (related to S18). Collaborative NOP is part of deployment plans in accordance with the PCP.

S21 – Airport operations plan (AOP) and AOP-NOP seamless integration

This solution offers services to steer, monitor and manage airport performance, as well as perform post-operations analysis. The solution also provides processes and tools to ensure airport performance in normal, adverse and exceptional operating conditions. An increased scope and timescale of data is shared between AOP and NOP.



Validation results

The prototype used for S18 to allow Palma airport to collaborate with the NM in TTA management showed the feasibility and great potential of AOP-NOP integration. A prototype runway manager (RMAN) to support controllers assessing the impact at airport and network level of a runway configuration change was also trialled.

Status

Different aspects of AOP-NOP data exchange and integration will continue to be explored in Release 5. These will include not only an evolution of the RMAN and

AOP-NOP prototypes, but all-new airport performance monitoring prototypes, TTA data exchange tools, and NOP to AOP airport-relevant airspace status information. AOP-NOP seamless integration is part of deployment plans in accordance with the PCP.

S28 – Automated assistance to controller for seamless coordination, transfer and dialogue through improved trajectory data sharing

This solution allows for better coordination, integration and identification of a controller's tasks thanks to improved trajectory data sharing (enabled by the flight object) in predefined and user preferred route environments. It is envisaged that the solution supersedes current OLDI data-exchange to allow full cross-border visibility of trajectory data. This solution is therefore key to delivering ground-ground interoperability in Europe and enhancing overall network performance and capacity.



Validation results

Taking place in Reims, Karlsruhe and Maastricht, the exercise validated the system requirements and system architecture for the flight object exchange as further refined in the SESAR technical specifications and defined in the EUROCAE standard ED-133. The exercise also aimed to demonstrate the suitability of the flight object to implement the reference business trajectory (RBT) within en-route and TMAs. The exercise showed the operational potential of connecting three European air traffic service units through flight object operations (ground-ground interoperability). At the same time, it also demonstrated the technical challenges that need to be overcome in the European environment for allowing seamless integration of ground systems produced by different vendors.

Status

Further work and validation activities based on a subset of relevant operational use cases will be carried out

in Release 5. This solution is planned for synchronised deployment at 24 European airports in accordance with the PCP.

S31 – Variable profile military reserved areas and enhanced (further automated) civil-military collaboration

This solution offers greater flexibility by allowing dynamic airspace management in all phases of ATM operations, from initial planning through to the execution phase, taking into account local traffic characteristics. The solution includes support tools, operational procedures and processes for real-time airspace status data exchange and for managing variable profile areas (VPAs).



Validation results

Real-time simulations in Spanish and North European free route airspace (NEFRA) assessed the impact of an activated VPA on capacity in the route network and on flight and fuel efficiency and environmental sustainability in a free route environment. The results were as follows:

- Fewer flights were impacted by ATFCM measures and consequently delay values for regulated traffic volumes were lower in the route network environment when applying a VPA design for airspace reservation;
- No significant impact on sector capacity was observed;
- The impact of military training on civil traffic was reduced without affecting military mission objectives.

Status

The exercise demonstrated the partial maturity of the SESAR Solution. Further validation activities will be conducted as part of Release 5, during which safety and security assessments will be made, as well as an analysis of other key performance benefits.

S34 – Digital integrated briefing

This solution aims to improve information sharing between pilot, flight dispatchers and air traffic controllers for all phases of flight through the exchange of more accessible and better filtered digital aeronautical (including digital NOTAM) and MET data.

Validation results

Real-time simulations were conducted in Vienna, but could be applied to any airport in order to assess digitally enhanced pre-flight briefing services (ePIB) using Digital NOTAM encoded applications (prototypes). The results were as follows:

- Reduced “noise” caused by flight irrelevant notifications;
- Improved quality and efficiency of the transferred information;
- Acceptability and usability of ePIB by pilots;
- Identified benefits without increased costs.

Status

The exercise demonstrated the partial maturity of the SESAR Solution. Further validation activities will be conducted as part of Release 5, which will further refine the pilot briefing application.

S46 – Initial system-wide information management (SWIM)

This solution brings together several core elements for the initial implementation of SWIM, namely services for information exchange and governance; SWIM security; SWIM technical infrastructure profiles; SWIM foundation; ATM information reference model (AIRM) and information service reference model (ISRM).

Validation results

Three validation exercises contributed to validate SWIM services under the scope of this solution, such as aeronautical and aerodrome maps, runway management, arrival management and airport meteorological now casts.



Status

Work using SWIM-based information sharing will continue in Release 5. Initial SWIM is part of deployment plans in accordance with the PCP.

S58 – Display and use of ACAS resolution advisory downlink on the controller working position

Controllers are automatically informed when ACAS generates a resolution advisory (RA). This improvement is intended to complement voice reporting by pilots.

Validation results

Real-time simulations in Langen confirmed the solution's feasibility; however they did not reach conclusive

results on the best operational procedure, the solution's contribution to safety and the final specifications for the human-machine interface. Quantitative results were not collected since the exercise was unable to reproduce authentic RAs using the safety support tools.

Status

The exercises partially demonstrated the maturity of the SESAR Solution. Further R&D is required to:

- establish an operationally acceptable procedure (including legal aspects);
- quantify safety benefits;
- evaluate the interaction with other controller working position (CWP) functions;
- evaluate equipment costs.



06 Conclusion

/ 22

The results of Release 3 and 4

clearly demonstrate that SESAR Solutions are not only operationally feasible and acceptable, but are also offering tangible performance benefits to stakeholders across the ATM system. Proof of SESAR's maturity is that several of the solutions described in this brochure are part of plans for Europe-wide deployment, while local implementation has started on others. The results of these releases also demonstrate the added-value of the SESAR JU's formula of pooling public and private resources, and coordinating European ATM research and innovation activities. SESAR has built significant momentum over the years. These latest achievements are clearly indicative of this continued drive and of the positive and transformative effect that SESAR is now having on ATM and aviation in Europe.

Stakeholders across the ATM community are set to benefit from the solutions described in this brochure and the change that SESAR is setting in motion.

Through SESAR:

- **Air Navigation Service Providers (ANSPs)** can deliver a better quality of service at a lower unit cost for airspace users, and can seamlessly interoperate with

service providers across the network and beyond.

- **Air traffic controllers, pilots and engineers** have tools and systems that are built to their needs and support their ability to operate in an increasingly complex environment.
- **Airport operators** have access to more integrated systems into which they share valuable data to enable greater predictability and more efficient operations.
- **Airspace users (civilian and military)** can operate closer to their business or mission needs, while reducing fuel costs, service charges and reducing impact on the environment.
- **Regulator and administrators** can build their activities based on validated solutions agreed across the European ATM stakeholder community.
- **Suppliers** can gain access to the market, allowing them to develop their products in an innovative and competitive environment, confident that the user requirements are commonly agreed.
- **Scientific experts** have the opportunity to make an important contribution to the future of ATM in Europe.
- **Air passengers and European citizens** can benefit from shorter and more reliable journeys, lower costs and enhanced safety.

DELIVERING BENEFITS TO EUROPE AND ITS CITIZENS



AFIS	Aerodrome flight information services
A-CDM	Airport collaborative decision making
AIMS	Aircraft integrated monitoring system
ANSP	Air navigation service provider
AOP	Airport operations plan
AMAN	Arrival manager
APV	Approach with vertical guidance
ASAS	Airborne separation assistance system
A-SMGCS	Advanced surface movement guidance and control system
ATC	Air traffic control
ATFM	Air traffic flow management
CDA	Continuous descent approach
CFMU	Central flow management unit
CTOT	Calculated take-off time
CTA	Controlled time of arrival
DAP	Downlinked aircraft parameter
DCB	Demand capacity balancing
DMAN	Departure manager
E-AMAN	Extended AMAN
EHS	Enhanced surveillance
ePIB	Enhanced pre-flight briefing services
EU	European Union
FAB	Functional airspace block
FAP	Future ATM profile
GNSS	Global navigation satellite system
GPS	Global positioning system
HMI	Human machine interface
i4D	initial 4 dimension (i4D) trajectory management
ILS	Instrument landing system

iRBT	Initial reference business trajectory
JU	Joint Undertaking
LPV	Localiser performance with vertical guidance
LVP	Low visibility procedure
NEFRA	North European free route airspace
NOP	Network operations plan
OTW	Out-the-window
PCP	Pilot Common Project
P-RNAV	Precision area navigation
PTZ	Pan tilt zoom
RA	Resolution advisory
RBT	Reference business trajectory
R&I	Research and innovation
RNP	Required navigation performance
RTS	Remote tower services
S&M	Sequencing & merging
SES	Single European Sky
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SMGCS	Surface movement guidance and control system
STAM	Short-term ATFM measures
STCA	Short-term conflict alert
SWIM	System wide information management
TMA	Terminal manoeuvring area
TTA	Target time of arrival
UDPP	User-driven prioritisation process
WFS	Web feature service
WMS	Web map service

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