Release 5 SESAR Solution #22

Automated assistance to controllers for surface movement planning and routing

Contextual note – SESAR Solution description form for deployment planning

Purpose:

This contextual note introduces a SESAR Solution (for which maturity has been assessed as sufficient to support a decision for industrialization) with a summary of the results stemming from R&D activities contributing to deliver it. It provides to any interested reader (external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of scope, main operational and performance benefits, relevant system impacts as well as additional activities to be conducted during the industrialization phase or as part of deployment. This contextual note complements the technical data pack comprising the SESAR deliverables required for further industrialization/deployment.

Improvements in Air Traffic Management (ATM)

The SESAR Solution "Automated assistance to controllers for surface movement planning and routing" consists of the following improvements, which are made available to the Tower controllers:

- **The Advanced Surface Movement Guidance & Control Systems (A-SMGCS) Routing function**: This improvement has been foreseen in the International Civil Aviation Organisation (ICAO)'s A-SMGCS Manual (Doc. 9830) but is not part of A-SMGCS currently in operation in Europe. It allows the planning and assignment of a route to individual aircraft and vehicles to provide safe, expeditious and efficient operations on the airport movement area. Routes are automatically created prior to the movement using available information and can be displayed to and modified by Tower controllers via their working position, so that they match clearances given to aircraft and vehicles. An estimation of the taxi time associated to each route is also computed by the A-SMGCS. In the SESAR concept of operations, these detailed taxi routes and times provide the key information which enables a number of other SESAR Solutions, such as:
    - Guidance assistance through airfield ground lighting (SESAR Solution #47),
    - D-TAXI service for the CPDLC application (Solution #23),
    - Airport safety nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances (Solution #02).
- **An enhanced Airport Flight Data Processing System (AFDPS):** As taxi routes become crucial information to enable high performing airport operations, they need to be centralised, managed and distributed to interested users. The AFDPS has been enhanced to play this central role in airport Air Traffic Control (ATC) and provide the necessary information, interfaces and functionalities to enable the above-mentioned SESAR Solutions. This is essentially achieved by associating the taxi route with the flight plan of each aircraft and the movement plan of each vehicle under ATC. The

AFDPS ensures information stability, and allows SESAR Solutions for airport ATC working together and supports collaborative planning.

Working procedures for the Tower controllers are adapted to ensure that detailed taxi clearances given to aircraft and vehicles are input in the system by the Tower controllers.

These two improvements build on A-SMGCS, AFDPS and controller working positions with electronic flight strips currently in operation at several major European airports. The integration and enhancement of these functionalities provide the means to automatically create operationally realistic taxi routes for individual aircraft and vehicles and, for the Tower controllers, to interact with these taxi routes so that they ultimately correspond to the clearances they give to these mobiles. As the A-SMGCS Routing function relies on an accurate description of the aerodrome layout, it is strongly recommended that it comes from a standardised Aerodrome Mapping Data Base, in an effort to improve interoperability with cockpit systems displaying taxi routes to flight crews and to minimise the costs of updating this description in the A-SMGCS Routing function when changes occur.

The benefits of this SESAR Solution are in **safety** because these improvements are expected to improve the situational awareness of Tower controllers, particularly in low visibility conditions, and in **predictability** as the estimated taxi times computed for each taxi route are available to airport sequencers to improve the planning of ground movements.

Operational Improvement Steps (OIs) & Enablers

The following Operational Improvement is under the scope of SESAR Solution #22:

- AO-0205: Automated Assistance to Controller for Surface Movement Planning and Routing[1]. It is fully covered by this Solution.

The following required enablers are supporting SESAR Solution #22[2]:

- AERODROME-ATC-12: Provision of the optimised ground route minimising conflicts[3]
- AERODROME-ATC-13: Surface movement information processing system enhanced with storage and dissemination of surface routes
- AERODROME-ATC-50: Advanced Controller Working Position (A-CWP) supporting A-SMGCS functionalities
- REG-0201[4]: Means of Compliance for A-SMGCS Routing and Planning
- REG-0513[5]: CS/AMC on Airport CDM (PCP)

Applicable Integrated Roadmap Dataset is DS16.

Notes: following the conclusions achieved by SESAR 1 on Solution #22, there is a need to update the integrated roadmap, which has been recorded and should be considered in DS17. The following notes detail these required changes.

1. In DS16, this OI mentions taking into account potential conflicting situations when generating taxi routes, but a Change Request has been raised to remove this reference as it is not covered by Solution #22.
2. ASMGCS-STD-01 (ED-87 rev D MASPS and new MOPS for A-SMGCS new functions for PCP) is also required, but is not identified as such in the current DS16. Although the enabler mentions that MOPS are required, this reference should be removed as none will be developed (cf. "Standardization Framework Considerations" section).
3. In DS16, this enabler mentions minimising conflicts, but a Change Request has been raised to remove this reference as it is not covered by Solution #22.
4. The need for this enabler is not identified in the Pilot Common Project (PCP), but is identified as required in DS16. It is expected to be confirmed by the European Aviation Safety Agency (EASA) through their rulemaking task on the Airport integration and throughput functionality from the PCP (cf. Regulatory Framework Considerations section).
5. The need for this enabler is not identified in the PCP, but is identified as required in DS16. It is expected to be confirmed by EASA through their rulemaking task on the Airport integration and throughput functionality from the PCP (cf. Regulatory Framework Considerations section).

Background and validation process

SESAR Solution #22 has been validated through a series of activities including 3 Fast time Simulations, 9 Real Time Simulations and 2 Shadow Mode Trials, focusing on the design of an automatic taxi route generator taking into account planning constraints and optimisation criteria, the usability of the A-SMGCS Routing and Planning functions by the ATCOs and the predictability improvements accrued from the availability of more precise taxi times.

- Fast Time Simulations:
    1. At V1 maturity level, initial quantification of the influence of an automatic taxi route generator on average taxi times in Paris Charles de Gaulle (CDG) environment, comparing recorded taxi routes with both nominal taxi routes conforming to current Paris CDG operational procedures and to optimised taxi routes.
    2. At V2 maturity level, assessment of the influence of several route optimisation criteria (e.g. shortest distance, shortest time, or minimum number of conflicts) on performance indicators related to predictability and efficiency, in Madrid Barajas environment.
    3. Still at V2 maturity level, assessment of the performance of a conflict detection function, depending on such factors as taxi speed variability, minimum distance between mobiles and ability to dynamically re-route mobiles, in Paris CDG and Madrid environments.

- Real Time Simulations with Tower controllers in the loop, in Barcelona, Hamburg, Madrid Barajas, Milan Malpensa and Paris CDG environments:
    1. At V1 and V2 maturity levels, assessment of the usability of the A-SMGCS Routing and Planning function by Tower controllers, through the ability of the taxi route generator to propose the most suitable routes for mobiles and the impact on Tower controller workload of having to input taxi routes into the ATC system.
    2. At V2 maturity level, validation of the level of accuracy of the estimated taxi times calculated by the A-SMGCS Routing function.
    3. At V2 and V3 maturity levels, assessment of the improvement to Tower controller situational awareness deriving from having a graphical display of taxi clearances given to mobiles.
    4. At V2 and V3 maturity levels, validation of the management procedure of the route for a mobile from planned phase to execution phase including route update, route display, and optimised route including push-back procedure.
- At V3 maturity level, Shadow Mode Trials, addressing the same objectives as the real time simulations above in a live environment, at Milan-Malpensa and Riga airports. These trials also enabled validating the A-SMGCS Routing function with actual airport surveillance and mobiles, rather than simulated traffic.

Results and performance achievements

Regarding the A-SMGCS Routing function, its ability to detect conflict situations in the planning phase has been shown to be limited by the uncertainty on the taxi speeds of aircraft, which resulted in this feature not being retained in SESAR Solution #22.

The utility of Solution #22 was confirmed in all validation activities, with controllers from 5 ANSPs concluding that having a display of the taxi routes allocated to mobiles and their status improved their situational awareness.

Solution #22 requires controllers to input the detailed taxi clearances they provide to aircraft and vehicles in the ATC system. This is a new task compared to today operations and it thus increases the workload of controllers. Whether this increase is acceptable depends highly on the implementation and on the operational context. Controllers stressed a very efficient Human Machine Interface (HMI) is required, particularly in demanding environments and when having to modify taxi routes.

Estimated taxi times computed by the A-SMGCS Routing function have been found accurate, providing improved predictability of aircraft sequencing on the ground.

Recommendations and Additional activities

SESAR Solution #22 builds on systems currently used in operations at major European airports. As a baseline, it uses A-SMGCS surveillance, Electronic Flight Strips and AFDPS. If Airport Collaborative Decision Making (CDM) is also available, CDM milestones are used to support the management of taxi routes.

SESAR Solution #22 is a pre-requisite for SESAR Solution #02, also retained in the PCP, and requires controllers to input the detailed taxi clearances they provide to aircraft and vehicles in the ATC system in a timely manner through their CWP. This new task also results in increased workload and head-down time.

Therefore, when implementing Solution #22 at a given ATC unit, it is recommended that:

- the working methods of controllers be adapted if needed, and the controllers be trained on these new working methods.
- the efficiency of its HMI and its integration in the CWP be considered as critical for the acceptability of Solution #22 by controllers.
- local operations and procedures (e.g. existing baseline, runway and taxiway configuration management, use of alternative parallel taxiway routing, de-icing operations …) be considered in order to adapt the route generation algorithm to local needs and thus to improve the efficacy of the support it provides to controllers.

In terms of future activities, SESAR Solution #47 (Guidance Assistance through Airfield Ground Lighting) has been demonstrated to allow flight crews to taxi in a smoother manner and to reduce the variability of taxi times, the performance of the conflict detection feature should be re-assessed in an environment where Solution #47 is implemented. In addition, further investigation should be conducted on how optimisation criteria can improve the efficiency of the taxi phase.

Actors impacted by the SESAR Solution

Tower Ground Controllers, Apron Managers.

Tower Runway Controllers may also be concerned if their areas of responsibility include a significant part of the aerodrome taxiway network.

Impact on Aircraft System

There is no impact on aircraft systems.

Impact on Ground Systems

The A-SMGCS processing needs to be upgraded to include a taxi route generator able to automatically generate routes for individual aircraft and vehicles, as well as estimate the corresponding taxi times.
The AFDPS needs to be enhanced to store, manage and distribute taxi routes and estimated taxi times.
An interface between these two systems is required so that the A-SMGCS processing can obtain the information necessary to automatically generate taxi routes (flight plan data, surveillance information, but also flight times, stand allocation and de-icing information).
The Tower controller working positions also need to be upgraded to allow the display of taxi routes stored in the AFDPS and the input of changes to these routes so that they match clearances given to aircraft and vehicles. At large airports where ATC is distributed over several areas of responsibility, these clearances also drive the management of the taxi routes.

Regulatory Framework Considerations

SESAR Solution #22 is part of the Pilot Common Project under ATM Functionality AF#2 “Airport Integration and Throughput” in Regulation (EU) No 716/2014. Deployment is required from 1 January 2024 at designated European airports.
Although no specific regulatory activity for the A-SMGCS Routing function is indicated in Regulation (EU) No 716/2014, the Integrated Roadmap of the European ATM Master Plan identifies regulatory enablers for this Solution:

- Means of Compliance for A-SMGCS Routing and Planning (REG-0201)
- CS/AMC on Airport CDM (PCP) (REG-0513)

EASA Rulemaking programme for the 2016-2020 timeframe identifies a rulemaking task (RMT.0682) covering the implementation needs for the Airport integration and throughput functionality, which SESAR Solution #22 is part of. It is thus expected that this task will confirm the need for REG-0201 and REG-0513 to support the deployment of SESAR Solution #22 and the form this regulation may take.

Standardization Framework Considerations

EUROCAE, through its Working Group WG-41 (A-SMGCS), needs to develop the following standard:

- Update of the Minimum Aviation System Performance Specification (MASPS) for the A-SMGCS to integrate, inter alia, this SESAR Solution (leading to ED-87 Rev. D).

Note: The enabler ASMGCS-STD-01, which is considered as required for this Solution, indicates that "new MOPS of A-SMGCS new functions for PCP" are required. However, EUROCAE WG-41 has determined that the new functionality would be adequately covered by the revised MASPS and that Minimum Operational Performance Standards (MOPS) were not necessary. In addition, Regulation (EU) No 716/2014 does not clarify this aspect. Consequently, the provision of MOPS is not considered as required for this Solution.

EUROCONTROL has initiated the revision of the A-SMGCS Implementation Package which should lead to the development of a single A-SMGCS Specification Document, in collaboration with EUROCAE WG-41. This A-SMGCS Specification Document considers this SESAR Solution.

Considerations of Regulatory Oversight and Certification Activities

SESAR has not identified needs for the oversight of the new systems. It is expected that the rulemaking task (RMT.0682) covering the implementation needs for the Airport integration and throughput functionality will address this aspect.

Validation activities carried out by SESAR have identified that this Solution could increase the workload of tower controllers and their head-down time. These results are recommended to be considered in the safety argument when implementing this Solution.

Solution Data pack

The Data pack for this SESAR Solution includes the following documents:

- OFA04.02.01 (Integrated Surface Management) Final OSED; 06.07.02-D46; 00.01.02; 10/11/2016. This document contains the operational requirements of SESAR Solution #22, as part of the new operational service "Route generation integrated with planning information".

- OFA04.02.01 (Integrated Surface Management) Final SPR; 06.07.02-D45; 00.01.01; 24/10/2016. This document contains the safety and performance requirements of SESAR Solution #22, as part of the new operational service “Route generation integrated with planning information”.
- OFA04.02.01 (Integrated Surface Management) Final INTEROP; 06.07.03-D28; 00.01.00; 16/09/2016. This document contains the interoperability requirements of SESAR Solution #22, as part of the new operational service “Route generation integrated with planning information”.
- Final Technical Specifications for enhanced surface routing; 12.03.03-D36; 00.03.00; 19/05/2016. This document contains the technical requirements of the surface route server supporting this SESAR Solution. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements.
- Final Technical Specifications for enhanced FDPS at airports; 12.04.03-D38; 00.03.00; 25/05/2016. This document contains the technical requirements of the airport flight data processing system supporting this SESAR Solution. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements.
- Final System Requirements, 12.05.04-D93, 00.03.00, 27/09/2016. This document contains the technical requirements of the controller working position supporting this SESAR Solution. However, due to the closure of SESAR 1, the document was delivered after the verification results were known and after the last validation activities took place but before the results of these validations were published. Therefore, there may be discrepancies between the operational and the system requirements

Intellectual Property Rights (foreground)

The foreground is owned by the SJU.