Release 4 SESAR Solution #54
Flow Based Integration of Arrival and Departure Management

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.

Improvement in Air Traffic Management (ATM)

The SESAR Solution "Flow Based Integration of Arrival and Departure Management" allows increasing predictability and to reduce or at least better manage delays in a busy single runway environment. Also, the solution contributes to a small increase in runway throughput and reduction of fuel consumption.

The solution enhances the coordination method currently in use between the approach and the tower by introducing a new operational method where both controllers pro-actively agree on a defined "**sequence pattern**" of arrivals and departures, i.e. the number of departures that will be placed in between successive landings, based on an integrated arrival / departure picture built for the runway:

- Today coordination of sequence pattern and AFI size (Arrival Free Interval, standard amount of nautical miles to be maintained between two consecutive arrivals for departures) are established on subjective decision of the supervisors or controllers. These decisions depend on each controller's experience and skills. This leads to a reactive change of sequence pattern and subsequent increase of delay. Arrival Management (AMAN) and Departure Management (DMAN) systems are used as support tools, but they are not linked;
- With this SESAR solution, co-ordination between the approach and the tower is improved as involved controllers agree in advanced on a defined sequence pattern and AFI size, based on an integrated traffic picture for the respective runway. AMAN and DMAN systems are coupled and provide the operators with an integrated and shared view on the planned runway sequence. Therefore, their situational awareness is increased.

The solution is defined as "**flow-based integration**" since it aims to optimize traffic flows, i.e. coupled pre-departure sequencing and arrival metering. Controllers are requested to follow the pattern but they are not expected to exactly follow the planned sequence of aircraft.

Coupling is set up as a master/slave configuration with AMAN acting as the master and DMAN allocating departures in the AFIs. DMAN can be improved by considering estimated taxi times provided from surface routing and planning function (substituting static taxi-time tables currently used in A-CDM – see SESAR Solution 'Pre-Departure Sequencing supported by Route Planning' for further details). The estimated taxi times are not updated after start-up.

Operational Improvement Steps (OIs) & Enablers

TS-0308[1] Flow based Integration of Arrival and Departure Management (DS14):

Integrated Arrival and Departure management aims at increasing throughput and predictability at an airport by improved co-ordination between En-Route/Approach and Tower controllers. Arrival and Departure flows to the same runway (or for dependent runways) are integrated by setting up fixed arrival-departure pattern for defined periods. The successive pattern might be chosen by the operators or provided by an optimization 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. By setting up the pattern based sequence for arrivals and departures overall delay will be reduced and predictability of TTOT and TLDT will be increased.

Enablers:

- AERODROME-ATC-09a: "Flow based Improvement of operational orchestration among arrival / departure management and surface management services";
- APP ATC 161: "Enhance AMAN to support Flow based Integration of Arrival and Departure Management"

Background and validation process

A fast-time simulation was performed, modelling the coupling of AMAN, DMAN and A-SMGCS and using traffic samples from London Gatwick over ten full days. It confirmed benefits and the need to perform additional validation activities at V2 and V3 levels to address operational feasibility, safety and HMI issues. Sensitivity studies were also performed.

A first V2 shadow mode validation proved that the basic algorithms implemented in the mock-up under test were realistic and that the display of an integrated sequence supports the controllers' working method. This validation also confirmed that the application of arrival / departure patterns worked quite well during times with overlapping arrival and departure peaks. This validation proved that a coupled AMAN / DMAN facilitates the

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[1] Integrated Roadmap DS14 (https://www.atmmasterplan.eu/working)

coordination between the approach and the tower and increases the common situational awareness.

Finally, a V3 real-time simulation of a coupled AMAN-DMAN supporting approach and tower operations at London Gatwick airport was performed. . It showed benefits in increased predictability and increased runway throughput.

Recommendations and Additional activities

No further validation activities are needed. However the number of runs used (28 hours in total) during validation was limited, therefore the improvements actually achievable regarding predictability, runway throughput and fuel burn should be confirmed when preparing for industrialisation.

In the longer term, decisions on runway patterns should be automated and based on Key Performance Indicators (e.g. delay, runway throughput, schedule adherence..), chosen jointly by the air navigation service provider and the airport operator.

Results and performance achievements

The coupling of AMAN-DMAN-A-SMGCS was found to increase predictability of Target Take Off Time (TTOT) and Target Landing Time (TLDT), increase runway throughput and reduce fuel burn, compared to the current baseline of uncoupled AMAN and DMAN. Controllers, i.e. approach supervisors and tower supervisors, who respectively manage the arrival and departure sequence, both found the integrated sequence and the shared view to be useful:

- A common picture can be drawn when the Terminal Manoeuvring Area (TMA) and tower supervisors jointly determine the runway pattern;
- Timelines with arrivals are arranged according to runway patterns;
- Arrivals and Departures are interleaved on the same timeline;
- The controllers have the ability to input multiple runway patterns with different start times.

The coupled AMAN-DMAN is essential to produce an accurate runway sequence on the long range. Therefore it is an enabler for the Extended AMAN for mixed-mode runways. However, more accurate management of the sequence implied a small but acceptable increase of workload for approach and tower supervisors.

Actors impacted by the SESAR Solution

Approach and tower supervisors.
Approach controllers.
Tower clearance delivery controller.
Tower runway controller.

Impact on Aircraft Systems

No impact.

Impact on Ground Systems

The solution necessitates a coupled AMAN/DMAN operating in a master/slave configuration, the AMAN setting-up gaps to be filled by the DMAN (AFIs). This integration relies on a stable and optimized departure sequence supported by an enhanced DMAN, i.e. which provides accurate Target Start-Up Approval Times (TSATs), reliable enough to allow the Controller to adhere to the sequence (see SESAR Solution 'Pre-Departure Sequencing supported by Route Planning' for further details).

Regulatory Framework Considerations

There is no specific topic for regulation to be considered in deployment, beyond the applicable existing one.

Standardization Framework Considerations

There is no specific topic for standardization to be considered in deployment, beyond the applicable existing one.

Considerations of Regulatory Oversight and Certification Activities

There is no specific topic in the field of the regulatory oversight and certification activities to be considered in deployment, beyond the applicable existing ones.

Solution Data pack

The Data pack for this Solution includes the following documents:

- Regulatory overview;
- OSED: DEL-06.08.04 D17 Edition 00.01.01 22/07/2015;
- SPR: DEL-06.08.04 D18 Edition 00.01.11 28/09/2015;
- INTEROP: DEL-06.08.04 D82 Edition 00.01.01 22/07/2015;
- TS - P10.09.02-D55 Edition 00.05.00 04/11/2015 ; and
- TS: 12.04.04 D01 Edition 00.02.00 12/09/2011.

The deliverables under Solution DMAN baseline for AMAN/DMAN integration data pack (in particular TS: 12.03.05 TS D02) are also of interest for this solution.

Intellectual Property Rights (foreground)

The foreground is owned by the SJU.