Release 4 SESAR Solution #53

Pre-departure sequencing supported by route planning

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 objective of pre departure sequencing supported by route planning is to optimise the traffic flow delivered to the runway. This SESAR Solution is supported by a Departure Manager (DMAN) and the routing and planning function of an A-SMGCS.

The combination of the two systems allows:

- To reduce the waiting time at the runway holding point;
- To increase the taxi-out accuracy and hence take off time predictability (Target Take-Off Time, TTOT);
- To provide a more stable pre- departure sequence (Target Start-Up Approval Time, TSAT).

These improvements in turn may be used by the Network Manager to optimize network management.

Current Operating Method

The current operating method reflects the use of a current basic DMAN at a CDM airport. The following procedures are used:

- The Clearance Delivery Controller provides start-up approval based on the Target Start-Up Approval Time (TSAT) calculated by the DMAN (considering a +/- 5mn TSAT window);
- The Tower Ground Controller and Tower Runway Controllers are not provided with any sequence information.

The basic DMAN uses the Target Off-Block Time (TOBT) provided by the Airport Collaborative Decision Making (A-CDM) process as an input to build both the pre-departure sequence (i.e. TSAT) and the departure sequence (i.e. TTOT). The basic DMAN calculates the TTOTs and TSATs by taking as inputs estimated taxi-out times derived from static parameters tables. Depending on the local implementation these static taxi times might be manually adjusted by the controller (either for a single flight or for all flights using a factor).

Release 4 SESAR Solution #53

Pre-departure sequencing supported by route planning

SESAR Solution Operating Method

The routing and planning function of the A-SMGCS calculates accurate taxi times depending on the airport environment (e.g. runway configuration) and traffic on the airport surface. These taxi times are used by the DMAN instead of static taxi-time tables. The DMAN uses the same rules for calculating TTOT and TSAT as in the current operating method.

The following procedures are used:

- The Clearance Delivery Controller provides start-up approval TSAT as in the current operating method. The only change is that TSAT and TTOT calculation is based on more accurate estimated taxi time provided by the A-SMGCS routing and planning function. Once the aircraft is off blocks, the taxi time and hence TTOT is not recalculated;
- The Tower Runway Controller gets the TTOT from the DMAN. Like in the current operating method he/she verifies that the runway is clear and that the aircraft will meet arrival/departure separation requirements. Take-off sequence optimization and execution remains under the Tower Runway Controller's responsibility. He/she does not have to adhere to the TTOT.

Operational Improvement Steps (OI Steps) & Enablers

TS-0202[1]: "Pre-Departure Sequencing supported by Route Planning" (DS14): Pre-Departure management has the objective of delivering an optimal traffic flow to the runway. Accurate taxi time forecasts provided by route planning are taken into account for TSAT-Calculation before off-block. Pre-Departure sequence (TSAT sequence) is set up by Tower Clearance Delivery Controllers who will follow TSAT-window when issuing start-up approval.

Enablers:

- AERODROME-ATC-18: "Interfacing between DMAN and Routing module"
- AERODROME-ATC-49: "Advanced CWP (A-CWP) to support Airport DCB and integration of DMAN"
- AIRPORT-36: "Provision by the Airport Operator of the relevant constraint to Aerodrome ATC"

Background and validation process

Real Time Simulations at V2 maturity level were conducted in Paris Charles de Gaulle and Milan Malpensa airports, allowing the feasibility to integrate a DMAN with the routing and planning function of an A-SMGCS in two different environments to be successfully evaluated.

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

In parallel, V3 real time simulations allowed an enhanced routing and planning function of the A-SMGCS coupled with a DMAN to be tested in Madrid and Milan Malpensa environments. These validations allowed the benefits of coupling a DMAN and an A-SMCGCS to be measured versus a stand-alone DMAN. The coupling was limited to the provision of more accurate taxi time by the A-SMGCS routing and planning function prior to TSAT. Traffic was not monitored after TSAT (i.e. any deviation of the aircraft in comparison with the issued taxi-out route did not trigger the DMAN to recalculate the pre-departure sequence). Another real-time simulation focussing on the routing and planning function of the A-SMGCS in CDG environment completed the series of V3 validations performed in 2012;

In 2012 a fast-time simulation modelled the coupling of AMAN, DMAN and A-SMGCS using traffic samples from London Gatwick over ten full days. It confirmed benefits and the need to perform a real-time simulation to address operational feasibility, safety and HMI issues. Sensitivity studies were also performed. Thus the final exercise consisted of a V3 real-time simulation of a coupled AMAN-DMAN supporting approach and tower operations at London Gatwick airport.

Results and performance achievements

The benefit of the calculation of estimated taxi times based on the routing functionality compared to static taxi time tables used in A-CDM depend on different factors:

- The level of sophistication of the static taxi time tables: the more sophisticated the static taxi time tables, the less the potential benefits brought by taxi times based on routing and planning function:
  - Stand Areas: the more granular the stands modelled in the tables, the less the potential improvement. The granularity might vary from using just one taxi time for the whole airport for all stand areas up to using a different taxi time for each stand;
  - Traffic Density: if increased taxi times due to high traffic density can be adjusted in the tables (modelling reduced taxi speeds), the potential improvement will be lesser;
  - Weather Influence: if, due to different weather conditions, different taxi times may be adjusted in the tables modelling various taxi speeds, the potential improvement will be lesser.
- Taxiway Layout: the benefits brought by taxi times based on A-SMGCS routing and planning will be higher at airports with a complex taxi layout.
- Taxi route length: airports where taxi route lengths can vary significantly will 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.

In addition, V2 activities in Paris CDG provided evidence of 12 seconds average reduction of taxi out, equating to 1.6% reduction of taxi time, while similar validations in Milan Malpensa provided evidence of 3% reduction in medium density operations and 9% in high density operations. For DMAN/A-SMGCS the reduced taxi times result in decreased fuel and hence fuel efficiency benefit. However, taxi fuel is assumed to be around 2.5% of overall fuel, hence a relatively small impact.

V3 validation activities showed that the accuracy and stability of TOBT and TSAT were improved when pre-departure sequence (supported by A-SMGCS routing and planning function) was integrated with coupled AMAN-DMAN (Solution #54), but not to the expected target of 95% accuracy/stability.

Recommendations and Additional activities

No additional activities are needed.

Actors impacted by the SESAR Solution

Tower ATCOs: Tower Clearance, Delivery, Ground and Runway Controllers.
Airspace Users: Pilots (standard VHF start up clearances or data-link if available).

Impact on Aircraft Systems

No impact.

Impact on Ground Systems

DMAN and A-SMCGS need to be integrated in order to compute and provide the most accurate information: TSAT and TTOT are calculated and provided by the pre-departure sequencing function of the DMAN, using accurate taxi times provided by the A-SMGCS routing and planning function.

The taxi route i.e. the description of the path to be followed by the flight and the timing of events along this path, and the taxi time, i.e. the time from off-block to the runway holding point, are calculated and provided by the A-SMGCS routing and planning function. The estimated taxi times are provided only up to start-up. After that, no update on remaining taxi time is provided.

Regulatory Framework Considerations

There is no specific topic in the field of the regulatory framework to be considered in deployment, beyond the applicable existing one.

Release 4 SESAR Solution #53

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Standardization Framework Considerations

Results are relevant for:

- The update of EUROCONTROL A-CDM Manual and A-CDM standards under the scope of EUROCAE WG-69 in support of DMAN synchronised with pre-departure sequencing;
- The update of the A-SMGCS standards under the scope of EUROCAE WG-41.

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; 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.