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.*

> **"Integrated tactical and medium conflict detection & resolution (CD&R) services and conformance monitoring tools for En-Route and TMA"**

The SESAR Solution PJ10-02a1 *Integrated tactical and medium conflict detection & resolution (CD&R) services and conformance monitoring tools for En-Route and TMA* aims at improving the separation (tactical layer) in the **En-Route and TMA** (but not APP) **operational environments** through improved ground trajectory prediction. This is achieved using existing information on lateral and vertical clearances that are known by the ground system and airborne information such as Mode S data.

This solution is built on SESAR 1 Sol. #27. Therefore, the baseline of 10.02a1 is MTCD[Error! Bookmark not defined.] resulting from FASTI and benefits from sol #27, i.e. TCT[Error! Bookmark not defined.] in En-Route.

New features and enhancement brought by PJ10.02a1 are :

- Extension of TCT to all environments : TMA & ER

- Improvement of the MTCD to handle level segments

- Enhanced resolution features for MTCD & TCT including what-if and what-else probes.

- Conformance monitoring tool, based on improved ground trajectory prediction and enriched with additional alerts, such as rate monitoring.

Outstanding R&D needs to improve trajectory prediction, reduce the number of nuisance alerts and enhance the accuracy of conflict detections, are:

- A deeper focus on the use of improved TCT in **TMA airspace**

- Enhance **functionalities for CD/R tools** (e.g. : what if / what else probing)

- Enhance **functionalities for conformance tools** with new alerts

- Use of **Mode S Data to improve ground trajectory.** The ones who brought **measured benefits** to the solution are :

    o **Selected Flight Level**

    o **Heading**

    o **Rate of Climb / Descent**

Operational Improvement Steps (OIs) & Enablers

CM-0206 Conflict Detection and Resolution in the TMA using trajectory data

CM-0208-A Automated Ground Based Flight Conformance Monitoring in the TMA

CM-0209 Conflict Detection and Resolution in En-Route using enhanced ground predicted trajectory in Predefined and User Preferred Routes environments

CM-0210 Ground Based Flight Conformance Monitoring in En-Route using enhanced ground predicted trajectory

CM-0211 Advanced support for conflict detection and resolution for ATC planning in En Route

Most enablers (mandatory & optional) linked to the above OIs are addressed. For readability purpose they are not listed here. Please refer to the applicable Integrated Roadmap Dataset DS19[1].

Background and validation process

The SESAR Solution has been validated in Wave 1 through a series of V2 and V3 activities spread from Q3 2017 to Q2 2019.

V2 activities (performed in the frame of the V2 phase of solution PJ10-02a) included one Fast Time Simulation and four Real Time Simulations, focusing on the tactical controller on one hand and on the planning controller on the other hand. Both aspects were studied in TMA and in En-Route. In addition, within solution PJ-10.02a1, Free Route environment was addressed in one Real Time Simulation and one Shadow Mode Trial. Different Organisations were addressed in two Real Time Simulations and one Shadow Mode Trial.

Fast Time Simulation
1. Modelling the relationship between TP accuracy, MTCD performance and controller workload with the aim of defining required minimum performance specifications for CD&R tools, to enrich TP improvement study performed through PJ18-06 (Eurocontrol, ANS-CR)

Real Time Simulations:
1. En-Route Separation management with an MTCD using improved trajectory data, such as wind data and improved HMI (DSNA)
2. TC Aid developed through SESAR1 by DFS tested over a new TMA environment over Copenhagen.

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[1] A few changes are still on-going and should be integrated in final issue of DS20 or DS21. This concerns the change for the official name of the solution PJ10.02a1 *"Integrated tactical and medium conflict detection & resolution (CD&R) services and conformance monitoring tools for En-Route and TMA"* and changes linked to the split of solution PJ10.02a in two to adjust OIs and Enablers and reflect new scope of each sub-solution.

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3. Building and testing of predictive models based on significant ATC intent (subtle factors) and TMA data in the separation management and provision of an HMI displaying the information to the tactical controller. This was a three steps exercise, including a first FTS with an expert paper analysis and the final RTS (PANSA).

4. Tactical encounter solver assistant (TESLA) tool for separation management in TMA environment, speeding up the controllers' decision making related to the tactical problem solving. It will provide a range of resolution assistance functionalities based on trajectory prediction and conformance monitoring (BULATSA, Airbus D&S)

V3 activities include six Real Time Simulations. Please note that one of them also partially addresses V2 solution 10.02a2.

Real Time Simulations:

1. "CD&R Aids in En-Route upper sectors focus on MTCD in En-Route" performed by DSNA. This exercise focuses on the assessment of an enhanced MTCD with detection of conflict between Aircraft-Volume with high traffic density. This activity addressed 10.02a1.

2. "COOPANS/Thales Tactical Controller Tool (TCT) for conflict detection and resolution optimization in TMA" performed by COOPANS and Thales. The exercise focuses on understanding to which extend the new TCT tools will positively impact the controller's task performance in conflict detection and resolution in TMA and extended TMA airspace with high traffic density including a high percentage of vertical movements. This activity addressed 10.02a1.

3. "CD&R aids in Free Route Environment" performed by ENAV. The ENAV En-Route & TMA platform is used to perform a real time simulation in En-Route operational environment with free route structure. This activity addressed 10.02a1

4. "Controller Support Tools (CDT – MONA)" performed by skyguide. The exercise focuses on assessing the Controller Support Tools and Monitoring Aids adapted to a Free Routing environment on Predictability, Capacity, Safety and Human Performance. This activity addressed 10.02a1.

5. "Early Conflict Resolution Using Enhanced CD&R Tools" performed by ECTL, ANS-CR, Thales. The exercise addresses an enhanced working method, enabled by more reliable CD&R tools (achieved by more accurate trajectory prediction), that is expected to reduce executive controller workload. This activity addressed 10.02a1.

6. "CD&R and enhanced conformance monitoring for TC and PC" performed by Airbus D&S and BULATSA. TMA separation management and transition to En-Route sectors with TESLA tool taking into account the results from the V2 phase. TP improvement in V3 will address combination of calculated system trajectories enhanced with aircraft derived data (EPP emulation). This exercise addresses both solutions 10.02a1 & 10.02a2

Results and performance achievements

Results and main validated findings

Based on the analysis through the two threads of exercises, it is possible to conclude that this solution brings important benefits for a reasonable investment costs and **has reached V3 maturity**.

The main conclusions with regard to the validated tools and functionalities are:

- The MTCD service is designed in consistency with TCT, What-if and What-else services as **an overall eco-system of ATC tools.**
- MTCD and What-if offered **better ATCO situational awareness and decision-making support**.
- Adapted to Free Route high complex environment, **Trajectory Management tools, Conflict Detection and Resolution tools, Monitoring Aids and Electronic Coordination, improved situation awareness of controllers.**
- The use of RTE VIA (tool to de-conflict with closed loop clearances) by the planner controller indicated **possible safety benefits** in terms of **earlier resolution, better predictability and greater separation margins**. In addition, the RTE VIA has been shown to be helpful to **reduce executive controller workload**, particularly in busy traffic.
- The What-else tool was found essential in **FRA environment**, especially in high density traffic.
- From **a technical perspective**, the improved TCT, MTCD, RTE VIA and What if services were effective in supporting the controller in managing the traffic.

Performance Assessment per KPA

Capacity : All exercises indicate a positive trend in TMA, En-Route and Free Route environments. This trend has been calculated at an average of **4%**[2] (by CBA analysis) for **MTCD En-Route**. The gain for **TCT (ER and TMA)** is **5,93%** (as an extension of #27 figures to TMA).

Human Performance : The TCT, MTCD, RTE VIA and What-if services supported controllers in developing and maintaining a mental model of the situation. A potential for controller workload reduction has emerged. The controllers also pointed out the importance for them to understand and know the limits of the tools, as well as a need for a training to develop a sufficient level of trust, to be well accustomed and familiar with the tools and benefit fully from the level of automation.

Safety : Due to unavailability of quantitative data, the impact on safety was assessed mainly through expert analysis of any safety relevant events that occurred during the runs. However, in most exercises, the experimental conditions and a low number of conflicts prevented any conclusive results. Where it was possible to analyse events, a tendency of reduction of conflicts has been observed.

Cost Efficiency : this was assessed as a function of controller's productivity in terms of workload and situational awareness: controllers have more capacity due to reduced workload and increased situational awareness to safely handle more flights per hour, which results in staffing cost efficiency where a higher traffic volume can be operated by the same staff. The obtained results show that controller's workload decreases when using improved separation management tool in **En-Route (between 1,6% and 5,6%)** & **TMA (0,7%)** environments and clearly indicating positive impact on cost efficiency. However, due to experiments conditions and lack of quantitative results, no conclusion can be derived on the actual value related to the CEF2 assessment in FRA environment and further investigation is recommended.

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[2] This figure is an average value computed based on results and expert judgments for the CBA needs. It is to be understood as gain compared to the reference.

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Environment : this has been assessed through two exercises for Fixed Route and three exercises for Free Route environment. Results are diverging regarding the reduction of emissions, however they converge to indicate that there is no significant negative impact on amount of fuel burnt when using the improved separation management supporting tools, and therefore no negative effect on aircraft emissions and noise with high complexity and high traffic density. In Free Route, two exercises are actually indicating a reduction of flight path lengths which could suggest a greater potential for aircraft emissions reduction than in Fixed Route.

Main Performance Benefits at ANSP level

The current analysis showed **significant benefits for ANSPs** thanks to the expected gain of capacity and ATCO efficiency (based on exercises results, an average of around 4% capacity gain is expected, directly leading to an increase in cost effectiveness), with **an expected initial investment important for ANSP to develop and/or upgrade tools with the services included in 10.02a1**. However expected benefits are estimated to reach more than 50% of the initial investment after a year which permits to reach a positive Net Product Value very quickly.

Main Performance Benefits at AU & NM levels

The solution is considered most profitable given that no major costs are foreseen and both stakeholders should benefit from the capacity and the cost effectiveness increase.

Recommendations and Additional activities

Based on the obtained results, it can be concluded that the improved separation management tools/functionalities can work coherently together and **are capable of delivering the required benefits**. Nevertheless, in order to reach their full potential and to integrate them successfully into the target ATM, **detailed analysis of the existing operational settings and accordingly tools' parameters adjustment is required**.

A set of recommendations has been provided regarding **the integration of the tools in the ATM system**. They concern especially tools improvements activities and some specific technical topics notably linked to tools' settings.

Additionally, further enhancements have been provided for future validation activities, to increase the **degree of realism of the simulations (e.g. : reduce bias, increase number of runs, involve AUs)** and thus the level of confidence of the results and continue increase the solution maturity level.

Recommendations for updating ATM Master Plan Level 2

10.02a1 is a consequence of the split of PJ10.02a solution. As a consequence, several change requests have been emitted (and endorsed). This needs now to be effective on the next DS to fulfil the work.

Recommendations for deploying in local ANSP

The CBA results are based at ECAC wide level with average values used to compute simulations and costs. We strongly recommend to perform a CBA at local level to take into account all specificities and constraints prior launching deployment of the solution PJ10.02a1, in order to assess accurate expected costs and benefits.

Recommendation on Aircraft integration

The Airspace Users' Community expressed the need to improve the integration of aircraft side into this kind of solution. Maybe this has to be anticipated at the beginning of each wave, with identified associated budgets.

Actors impacted by the SESAR Solution

En-Route & TMA Controllers are the main actors impacted by this SESAR Solution which aims at providing them with improved tools based on enhanced trajectory prediction to assist the separation management task.
AU and NM will also gain benefits from the solution.

Impact on Aircraft System

There is no specific topic in the field of the aircraft system to be considered within this SESAR Solution, beyond the existing systems.

Impact on Ground Systems

For the usage of the surveillance data, the information exchange uses the existing ASTERIX data format.

GRIB standard is used as well to obtain weather data.

Regulatory Framework Considerations

There is no specific topic in the field of the regulatory framework to be considered within this SESAR Solution, beyond the applicable regulation currently existing.

Standardization Framework Considerations

There is no specific topic in the field of the standardization framework to be considered within this SESAR Solution, beyond the applicable standards currently existing.

Considerations of Regulatory Oversight and Certification Activities

As this solution deals with automated tools, the procedures for degraded mode and failure will have to be developed in line with the existing methods and take into account the results of safety assessment performed. It is nonetheless reasonable to assume that the same principles will apply regardless of whether insufficient assistance is caused by A/C data downlink failure or by a visual reproduction that is for some reason degraded. However, in the case of degraded mode operations, care must be taken to ensure that all involved actors are able to effectively keep situational awareness and can continue to provide safe operations in certain non-nominal conditions.

In addition, although this SESAR Solution does not address directly them, it should contribute, through its validation path, to provide elements to regulation and working methods for the listed areas:

- Non-traditional organisations implementation, notably SPO, MSP and EAP.

- Free Route environments implementation

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Solution Data pack

V2 Data pack: D4.1 (solution PJ.10-02a)

- D4.1.010 - V2 SPR-INTEROP-OSED
- D4.1.020 - V2 TS/IRS
- D4.1.110 - V2 CBA
- D4.1.100 - V2 VALR

V3 Data pack: D4.2 (solution PJ.10-02a1)
- D4.2.010 – V3 SPR-INTEROP-OSED
- D4.2.020 – V3 TS/IRS
- D4.2.120 – V3 CBA
- D4.2.110 – V3 VALR

Note : "V3" Data pack is for 10.02a. Each document includes parts related to PJ.10-02a1 (V3) and 10-02a2 (V2)

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