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PJ.10-W2-PROSA

SEPARATION MANAGEMENT AND CONTROLLER TOOLS

Solution 96 AG is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874464 under European Union's Horizon 2020 research and innovation programme.

Abstract

The PJ.10-W2-Sol.96 AG focuses on the Human Machine Interface (HMI) of the Controller Working Position (CWP). The project is driven by an enabler for Controller productivity enhancements by Attention Guidance at the CWP/HMI.

The PJ.10-W2-Sol.96 AG deals with new methods of controller interaction with Human Machine Interface (HMI), implementing a fade-out algorithm in a low, medium and very high complexity environment to bring a positive effect on the controller productivity with no negative impact on human performance, safety and capacity.

This Technical Validation Report describes the results of the validation exercise planned in the TRL6 phase of PJ.10-W2-Sol.96 Attention Guidance (AG). The aim is to check whether the success criteria for each validation objective has been fulfilled or not.

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1 Purpose

This contextual note provides to any interested reader (external and internal to the SESAR programme) an introduction to the SESAR Solution 96 AG in terms of scope, main operational and performance benefits, relevant system impacts.

When Solution is at TRL6 level it contains as well additional activities to be conducted during the industrialization phase or as part of deployment.

It introduces the technical data pack comprising the SESAR JU deliverables (for TRL6, they are proposed to support industrialization/deployment).

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2 Improvements in Air Traffic Management (ATM)

Switzerland has one of the most challenging and complex airspaces in Europe. This is due to high traffic density and the combination of horizontal crossings and the vertical profiles of the controlled flights. More than 1/3 of the flights skyguide manages are descending to or climbing from airports in Switzerland or the neighbouring countries of France, Germany and Italy.

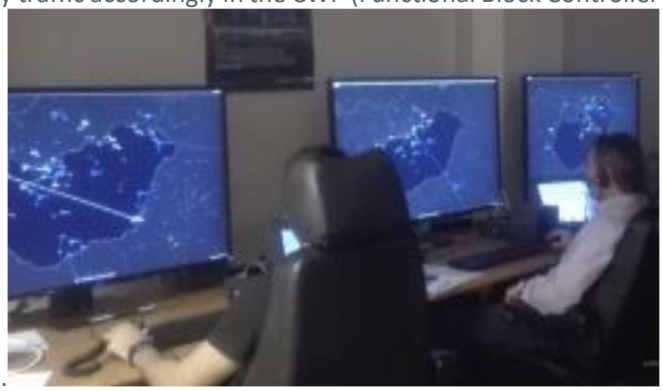
On sector above flight levels 355, there is about 40% of stable flights and those sectors are generating delays every day at the ACC. This is the reasons why it has been decided to implement the fade-out algorithm above flight levels 355.

In En-Route environment Controllers are subject to a huge traffic to be controlled. Attention guidance aims to reduce this workload guiding the attention of the ATCOs to focus only on flights which they will possibly need to interact with during the navigation across their airspace.

Reducing workload will increase the throughput of these sectors and the Solution will reach this goal by means of the implementation of a new algorithm: the “fade-out” algorithm. This mechanism will set flights that presumably will not request interaction with ATCOs to background traffic.

In a En-Route environment for the first time the CWP will take decisions about the priority of flights with regards to the attention needed by ATCOs.

The Functional Block Attention Guidance will be enhanced to include this logic and it will generate the appropriate data to display traffic accordingly in the CWP (Functional Block Controller Human Machine Interaction Management).



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3 Operational Improvement Steps (OIs) & Enablers

The Solution is an enabling solution in the S2020 framework and covers the SESAR Roadmap OIs and Enablers described in the table below. The corresponding Change Request will be endorsed in (DS22).

OI Step	OI description	Open CR
POI-0053-SDM	Improving controller productivity by Attention Guidance (AG) at the ER CWP/HMI	No CR opened in Wave 2, the POI-0053-SDM has been created in Wave 1.
EN code	**EN description**	**Open CR**
ER ATC 182	Introduction of new automated functions for Attention Guidance at the CWP/HMI Management ER for improving the controller productivity.	CR 05659 has been raised in order to create ER ATC 182, as well as to update the EATMA elements (links to Functions)

Table 1 Operational Improvement steps and Enablers for Solution 96 AG

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4 Background and validation process

On PJ16.04-03 Wave 1 project, the use of eye tracking coupled with the information of the current air traffic situation on sectorless ATM contributed to assess the demand of an attention-shift; visual stimuli of various escalation levels were displayed on the radar screen to direct the controller's attention to important information. Depending on the escalation levels, the information was not displayed on the same way. At escalation level 0 (low importance), the information was displayed in the aircraft label. In higher escalation level (medium, high and very high importance), additional attention guidance was shown intensifying the visual cue (e.g.: displaying elements with higher degree of salience by colouring, flashing or motion).

Some recommendations have been proposed with respect to:

- ATCOs appropriate training to ensure a safe and efficient transition with the implementation of the AG.
- fine tuning activities with the collaboration of the ATCOs to finalize HMI once the concept was implemented.

On PJ.10-W2-96 AG, a sectorized ATM airspace was used. Moreover, the exercise took place on sectors with a high traffic density. The objective is to reduce ATCO's workload by reducing the amount of information to analyse in their traffic situation scanning cycles by fading out "largely non-conflictual" flights. When an information turns to be important on fade-out flights, attention guidance will be used with the help of visual cues (e.g.: displaying elements with higher degree of salience by colouring, flashing). ATCO's reaction time was recorded and acceptability of the concept was assessed by the ATCO.

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5 Results and performance achievements

At the beginning the ATCO checks why a track is in fade-out and always manage to figure-out a reason. After few runs, they feel more comfortable with the solution and try to figure-out why a track is still in the scanning pattern/area of the ATCO; they always figure-out the reason why. This process is a step that allows the controller to trust the machine and therefore the algorithm. The general feedback from ATCOs is very positive. They are convinced that this solution would be beneficial for their operation.

Another reason that makes the ATCO trust the solution is that the fade-out algorithm is easily explainable.

Moreover, for an ATCO, the worst case that can happen is that after changing a level, all the fade-out tracks appear again in his/her scan. This solution deals with that case and contributes positively to the ATCO confidence. All the levels that create a potential conflict with fade-out track are coloured indicating the ATCO that those levels are subject to caution.

This solution can increase the ability to handle more traffic or at least the same amount of traffic but more comfortably.

ATCOs see big potential in terms of workload reduction. The benefit of using the fade-out algorithm is that there are tracks in fade-out out in the scanning pattern. The CWPs are most of the time cluttered and the less tracks there are on the radar, the less committed workload there is when analysing the task at hand.

They also see a potential when handling traffic on a big sector area not necessarily crowded but with plenty of spots. This solution allows to focus the attention of the ATCO on what needs its expertise.

To summarize, the ATCO feels at ease and with less workload using the solution. As the platform was stable, the ATCOs really pushed the limits of the system and tried to trick the machine. It is simple to use, user-friendly and they don’t change their way of controlling by using the solution. They could immediately notice the effect on the radar screen and the impact on the workload, which was lower.

The technical and operational validations performed in a realistic and relevant environment closed to the operational one have demonstrated the technical feasibility and fulfil the use cases.

The implementation of the solution has been done using the current version in operation.

All the criterion concerning the objectives have not been satisfied. For some that have not been satisfied, it does not have a negative impact on the TRL6 maturity. For the others, either there is a solution to mitigate the impact or a recommendation.

The solution demonstrates no negative impact on safety and human performance and bring a positive effect on the controller workload.

The proposed recommendations raised in section 5.2 will be addressed during the implementation and deployment phase of the solution in operation in skyguide.

Given the validation exercises’ results, the mitigations and the recommendations, it can be considered that the solution has reached TRL6 maturity level. This have to be confirmed at the solution maturity gate.

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The technical development and implementation, which were based on the operational system, did not revealed major deficiencies even if some improvements have been mentioned.

The validation results show that the fade-out algorithm in low, medium and very high complexity traffic situations has the following impact on performances:

- **The fade-out function** is easy to use, user-friendly and it does not change the way of controlling.
- **Human performance:** the ATCOs consider the fade-out function easy understandable. The task allocation between the human and the machine is adequate. The ATCO's trust in the accuracy of the system has built up during the validations.
- **Safety** has been maintained. The system is useful and usable and is of added value in case of low, medium and very high complexity traffic.
- The **usability and effectiveness of the CWP HMI** were deemed as sufficiently adequate by ATCO even if there is room for improvements. The information provided was also deemed as adequate to perform ATCOs tasks.

ATCOs situational awareness and cognitive workload were considered adequate to perform their work in low, medium and very high complexity environments for level above 355.

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6 Recommendations and Additional activities

Main recommendations are:

Training session:

During the exercise run, the fade-out tracks were largely non-conflictual meaning that the minimum lateral distance between 2 tracks were higher than 20NM.

Even if after one day of training, the ATCO feels at ease with the solution, he/she recommends keeping 20NM as the minimum lateral distance at the beginning and reduce progressively this distance to 15NM at the end. If so, more tracks will be in fade-out, reducing the ATCO workload accordingly.

CWP/HMI and ATC Support tools:

The controllers support tools have been considered efficient during the validation exercises. However, some recommendations to improve their performance and improve the accuracy of the functionality have been raised and listed below:

- The profile could be more accurate using the aircraft on board trajectory. This solution coupled with the PJ18.53, 56 could improve the accuracy of the profiles and therefore contributes to an improvement on the fade-out algorithm
- The use of ATN B2 standard based advanced CPDLC clearances could bring benefits:
    - Less workload on radio communication with the pilot
    - Route clearances on geographical points to avoid conflicts
- The frequency is appearing too early. The ATCO can wait a little bit more to transfer the aircraft because it is in fade-out. It was an ATCO request to display this frequency earlier but they changed their mind during the exercise run.
  This has to be fine-tuned and does not question the fade-out algorithm and the maturity gate. Aircraft in fade-out are by nature non time critical regarding any instructions. Therefore, frequency change, when it occurs, will be performed by the planner with CPDLC. This will contribute to offload executive ATCO that is generally the busiest on the sector.
- All ATCOs agreed that the timing and flashing function was appropriate. However, the blinking track label was not appreciated by all ATCOs. The highlight of flights requiring status change from fade-out to intermediate normal status should be further discussed.
- Fade-out should be inactive during adverse weather situations.
- Controllers stated that the alerts were appropriately driving their attention towards relevant flights and acted as task drivers to trigger correct actions at the correct time. It should be considered during further development to distinguish between alerts and task drivers and follow suitable design principles.

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System degradations were not covered in this TRL stage. It should be covered in further development stages as well as consider the recovery from system crash with safety requirements.

Some improvement mentioned on the recommendation will be required concerning the frequency display and the accuracy of the profile. This tool should be an asset during the industrialization and deployment phase if coupled with the tool developed in the scope of PJ18.53 and PJ18.56 solutions.

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7 Actors impacted by the SESAR Solution

The actors impacted by the Solution are:

- En-Route Controllers, Executive and Planner.

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8 Impact on Aircraft System

This solution investigates technologies for En-Route environment and has no impact on Aircraft Systems.

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9 Impact on Ground Systems

This solution investigates technologies for En-Route environment and has no impact on Aircraft Systems.

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10 Regulatory Framework Considerations

The validation work has not addressed the legal/certification aspects concerning the sharing of responsibility between ground system and controllers (with the ground system being responsible for faded out aircraft and the ATCO being responsible for the rest). This should be addressed in the next phase with an early engagement of Regulatory Authorities to address the concept in the following phases.

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11 Standardization Framework Considerations

The Solution has no impact on Standards development.

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12 Solution Data pack

The D4.2-PJ.10-W2-96 AG solution pack TLR6 includes the following documents:

Solution Data Pack	
Systems Requirements consolidation	**Technical Specification/Interface Requirements Specification (TS/IRS) TRL6 - Final version** D.4.2.020 Edition date: 30/11/2022 Edition: 00.01.00
	TS/IRS Part II (SAR) D.4.2.020 Edition date: 11/11/2022 Edition: 00.01.00
	TS/IRS Part IV (HPAR) D.4.2.020 Edition date: 02/12/2022 Edition: 00.01.00
	PAR *(Additional document for technological solution, non PMP)* Edition date: 02/12/2022 Edition: 00.01.00
Cost Benefit Analysis tailored for the specific Technological Solution (CBAT) TRL6	**Cost Benefit Analysis (CBAT) – TRL6** D4.2.080 Edition date: 19/12/2022 Edition: 00.01.00
Technical Validation Report (TVALR) TRL6	**Technical Validation Report (TVALR) – TRL6** D.4.2.070 Edition date: 11/11/2022 Edition: 00.01.00

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