



SESAR Solution PJ03a-04 SPR/INTEROP-OSED for V3 - Part V - Performance Assessment Report (PAR)

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SUMO

ENHANCED VISUAL OPERATIONS

This [insert type of result] is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 734153 under European Union's Horizon 2020 research and innovation programme.



Abstract

This document is part of SPR/INTEROP-OSED V3 the solution (PJ.03a-04) “Enhanced Visual Operations”.

This document describes the Performance Assessment which shall consolidate performance validation results from validation exercise:

- Validation Exercise V3 Landing operation with HMD
- Validation Exercise V3 Taxi operations with HMD
- Validation Exercise V3 Landing operation with active sensor

Each of these exercises have been executed and the results reported.

The outcomes of the PJ03a-04 validation exercises have confirmed the V3 maturity level of HMD technology for taxi and landing operations.

The validation exercise for active sensor landing operations cannot confirm V3 maturity level, as expected during project time being due to lower sensor maturity.

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1 Executive Summary

This document provides the Performance Assessment Report (PAR) for Solution 04 Enhanced Visual Operations.

The PAR is consolidating Solution performance validation results addressing KPIs/PIs and metrics from the SESAR2020 Performance Framework [3].

Description:

PAR is consolidating Solution performance validation results addressing KPIs/PIs and metrics from the solution 04 Enhanced Visual Operation focusing on improved operation by the electronic means providing the pilots with enhanced vision for approach, land and taxi operation in low visibility condition by providing visual references and/or flight guidance display technology without increased demand on ground based infrastructure. Two technologies are considered in the content of solution.

Head-Worn (and/or Head Mounted) displays combined with situational awareness cues (based on EFVS and SVS technologies) and legacy sensors improves access to airports and provides EFVS operational credits on published approach minima as well as surface navigation management in degraded weather conditions (night and low visibility).

Active sensor as part of EFVS/CVS with improved performances in adverse weather conditions than existing legacy sensors. It allows to operate in “*all weather*” conditions by provision of EFVS-like operational credit on published minima. Focus area is a resilience to low visibility condition in case of insufficient performance of existing EFVS/CVS sensors. The resilience should lead to increased capacity of secondary and less equipped runways without need to invest on ground based infrastructure

Assessment Results Summary:

The following tables summarises the assessment outcomes per mandatory PI (**Error! Reference source not found.**) puts them side-by-side against Validation Targets in case of KPI from PJ19 [18]. The impact of a Solution on the performances are described in Benefit Impact Mechanism. All the mandatory PI from the Benefit Mechanism were the Solution potentially impact have to be assessed via validation results, expert judgment etc.

There are three cases:

1. An assessment result of 0 with confidence level other level High, Medium or Low indicates that the Solution is expected to impact in a marginal way the KPI or mandatory PI.
2. An assessment result (positive or negative) different than 0 with confidence level High, Medium or Low indicates that the Solution is expected to impact the KPI or mandatory PI.
3. An assessment result of N/A (Not Applicable) with confidence level N/A indicates that the Solution is not expected to impact at all the KPI or mandatory PI consistently with the Benefit Mechanism.

2 Introduction

2.1 Purpose of the document

The Performance Assessment covers the Key Performance Areas (KPAs) defined in the SESAR2020 Performance Framework [3]. Assessed are at least the Key Performance Indicators (KPIs) and the mandatory Performance Indicators (PIs), but also additional PIs as needed to capture the performance impacts of the Solution. It considers the guidance document on KPIs/PIs [3] for practical considerations, for example on metrics.

The purpose of this document is to present the performance assessment results from the validation exercises at SESAR Solution level. The KPA performance results are used for the performance assessment at strategy level and provide inputs to the SESAR Joint Undertaking (SJU) for decisions on the SESAR2020 Programme.

In addition to the results, this document presents the assumptions and mechanisms (how the validation exercises results have been consolidated) used to achieve this performance assessment result.

One Performance Assessment Report shall be produced or iterated per Solution.

2.2 Intended readership

In general, this document provides the ATM stakeholders (e.g. airspace users, ANSPs, airports, airspace industry) and SJU performance data for the Solution addressed.

Produced by the Solution project, the main recipient in the SESAR performance management process is PJ19, which will aggregate all the performance assessment results from the SESAR2020 solution projects PJ1-18, and provide the data to PJ20 for considering the performance data for the European ATM Master Plan. The aggregation will be done at higher levels suitable for use at Master Planning Level, such as deployment scenarios. Additionally, the consolidation process will be carried out annually, based on the SESAR Solution's available inputs.

2.3 Inputs from other projects

The document includes information from the following SESAR 1 projects:

- B.05 D72 [5]: SESAR 1 Final Performance Assessment, where are described the principles used in SESAR1 for producing the performance assessment report.

PJ19 will manage and provide:

- PJ19.04.01 D4.1 [3]: Performance Framework (2018), guidance on KPIs and Data collection supports.
- PJ19.04.03 D4.0.1: S2020 Common assumptions, used to aggregate results obtained during validation exercises (and captured into validation reports) into KPIs at the ECAC level, which will in turn be captured in Performance Assessment Reports and used as inputs to the CBAs

produced by the Solution projects. Where are also included performance aggregation assumptions, with traffic data items.

- For guidance and support PJ19 have put in place the Community of Practice (CoP)¹ within STELLAR, gathering experts and providing best practices.

2.4 Glossary of terms

See the AIRM Glossary [1] for a comprehensive glossary of terms.

2.5 Acronyms and Terminology

Term	Definition
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
BAD	Benefits Assessment Date
BAER	Benefit Assessment Equipment Rate
CBA	Cost Benefit Analysis
DOD	Detailed Operational Description
E-ATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
DB	Deployment Baseline
KPA	Key Performance Area
KPI	Key Performance Indicator

1

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N/A	Not Applicable
OI	Operational Improvement
PAR	Performance Assessment Report
PI	Performance Indicator
PRU	Performance Review Unit
QoS	Quality of Service
RBT	Reference Business / Mission Trajectory
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SESAR2020 Programme	The programme which defines the Research and Development activities and Projects for the SJU.

Table 1: Acronyms and terminology

3 Solution Scope

3.1 Detailed Description of the Solution

The high level objective for this solution is to take credit of visual based technologies such as EFVS and SVS combined through CVS in order to increase the operational efficiency in both taxi and landing while significantly improving situational awareness. A unique advantage of this solution is that it is mainly supported by the aircraft system instead of airports and the need of complex and costly ground infrastructures.

For taxi, the vision based system solution will assist the crew avoiding misunderstanding, and limiting routing deviations, clearance infringement and potential collision due to traffic flow and voice communication high density. It will make the crew prompt to detect and to react to evolving situation and improve crew decision making. This concerns mainly the main aerodromes with complex taxi layout and busy nature of the traffic.

For approach, the Vision based System is an aircraft's on board alternative solution to heavy ground infrastructures for enabling approach in Low Visibility Conditions at most of secondary aerodromes. In addition to operational credit, the Vision Systems will boost situational awareness in all conditions for all operators at all airports and will contribute to increase safety margin all the time.

From the ATM perspective, the PJ03a-04 solutions will make Equivalent Visual Operations accessible to more aircraft types, more efficient, and more attractive financially. The will lead to a large deployment of these operations in all the aviation segments and will extend the PBN capabilities.

From a global ATM network standpoint, the vision systems will **increase accessibility at most of secondary aerodromes providing operational credit at most of runways end with precision or non-precision landing minima** (LPV, LNAV/ VNAV, ILS CAT1...).

In addition, as Vision Systems provide the crew with a simple and comprehensive image of the situation, they require less mental effort and **potentially allow for alleviated crew training** and reduced operator constraints.

These advantages will make the Vision Systems a key operational capability especially for the business aviation community that is mainly composed of small/ medium operators with limited resources and operating frequently at small/medium airports. The Vision Systems are beneficial also for other types of aircrafts operating at small/medium airports.

Beyond operational credit, the Vision Systems will boost situational awareness in all weather conditions for all operators at all airports contributing to increase safety margin all the time. However, developed solutions themselves do not increase safety margin.

The solution focuses on two main on-board technologies which brings various benefits. First, Head Mounted Display (HMD) as equivalent of currently broadly used Head Up Display (HUD) is developed in the solution as display unit of EFVS/CVS. The development focuses on taxi and approach phases and brings benefits in terms of **human factors** for pilots. The development of HMD aims at V3 maturity and the end of Wave 1. Second, active sensor as substitute or supplement of current IR cameras brings improved performance in LVC within EFVS/CVS approach operation. Therefore, performance improvement is **resilience** to adverse weather within approach operation. The maturity of the active sensor is lower than V3 and is not part of AUO-0405 aiming at V3 maturity.

3.2 Detailed Description of relationship with other Solutions

Solution Number	Solution Title	Relationship	Rational for the relationship
PJ.18-04a	AIM information	Cross effect	PJ18-04a will support the validations providing required data. Yi: Independent cross-effect. Estimate of 30% improvement on aggregated benefits. SAF FEFF1 PRD1 PUN1 CEF2 HP SEC
PJ03.03a	Enhanced navigation and accuracy in low visibility conditions (LVC) on the airport surface	Is preferable to PJ.03a-04	Technical enabler for the development and deployment of the solution. FEFF1 PRD1 PUN1
PJ02.06	Improved access into secondary airports in low visibility conditions	No Cross effect	FEFF1 PRD1 PUN1

Table 2: Relationships with other Solutions

Technological Solution PJ.18-04a aims to design and develop improved AIM services or capabilities that provide AIM information contributing to enhanced situational awareness of information consumer.

The solution PJ.18-04a has developed the Aeronautical Dataset Service that provides the expected enhanced aeronautical data of value for the operational solution PJ.03a-04, in the form of datasets in accordance with the defined query parameters. This is implementation option which is described in Technical Specification part A.2.1 Data acquisition.

The solution Pj03a-04 does not utilize any new MET service compare to current approach, landing and taxi operations.

4 Solution Performance Assessment

4.1 Assessment Sources and Summary of Validation Exercise Performance Results

SESAR Validation Exercises of this Solution (completed ones and planned ones) are listed below.

Exercise ID	Exercise Title	Release	Maturity	Status
EXE-03a.04-V3-VALP-HMD.001	EFVS operation with HMD	2019	V3	Done
EXE-03a.04-V3-VALP-HMD.002	Increase of awareness during taxi phase thanks to HMD	2019	V3	Done
EXE-03a.04-V3-VALP-SENSOR.001	Capability of system to provide visual references for approach operation in low visibility condition with utilizing the active sensor	2019	Non-V3	Done

Table 3: SESAR2020 Validation Exercises

Exercises EXE-03a.04-V3-VALP-HMD.001 and EXE-03a.04-V3-VALP-SENSOR.001 are focused on approach operation. Exercise EXE-03a.04-V3-VALP-HMD.002 validates using HMD with taxi phase.

The following tables give an overview of the validation exercises that were executed for HMD.

All related assumptions are presented in 4.2.

HMD reaching V3 maturity level

Identifier	EXE-03a.04-V3-VALP-HMD.001
Title	EFVS operation with HMD
Description	Live trials in several airports on EFVS approaches using HMD to demonstrate the same operational gain (EFVS down to 100ft) as for HUD. The objective is to assess the use of monocular coloured head mounted display during EFVS operations. A Human Performance analysis will be conducted as well as part of the activities.
Expected Achievements	Demonstrate that an EFVS approach can be performed with a monocular HMD displaying a conformal EVS image as well as coloured symbology.

V Phase	<V3>
Use Cases	CVS to 100ft above TDZE approach with HMD/HUD, Non-nominal operation (from the SPR-INTEROP/OSED)
Validation Technique	Flight Trials
KPA/TA Addressed	<Efficiency><Human Performance>
Start Date	01/01/2019
End Date	01/04/2019
Validation Coordinator	DA
Validation Platform	Dassault Falcon 8X
Validation Location	TBD
Status	<in progress>
Dependencies	Other dependent exercises

Linked Element Type	Identifier
<SESAR Solution>	PJ.03a-04
<Sub-Operating Environment>	APT Small / Medium
<Validation Objective>	OBJ-03a.04-V3-VALP-HMD.002

Table 4: Validation Exercise layout

Identifier	EXE-03a.04-V3-VALP-HMD.002
Title	Increase of awareness during taxi phase thanks to HMD
Description	Live Trial in CDG Airport on taxi routing using HMD to improve environmental awareness by displaying non-conformal taxi route indication to the crew as well as traffic information on a 360° field of view. The objective is to assess the safety situational awareness improvement in an Airport with complex taxiway configuration. A Human Performance analysis will be conducted as well as part of the activities.

Expected Achievements	Improvement in environmental awareness during taxi phase on complex airport.
V Phase	<V3>
Use Cases	Taxi with HMD
Validation Technique	Flight Trials
KPA/TA Addressed	<Efficiency><Human Performance>
Start Date	01/01/2019
End Date	01/04/2019
Validation Coordinator	DA
Validation Platform	Dassault Falcon 8X
Validation Location	Paris CDG
Status	<in progress>
Dependencies	Other dependent exercises

Linked Element Type	Identifier
<SESAR Solution>	PJ.03a-04
<Sub-Operating Environment>	APT Very large / Large
<Validation Objective>	OBJ-03a.04-V3-VALP-HMD.001

Table 5: Validation Exercise layout

Active sensor not reaching V3 maturity level

Identifier	EXE-03a.04-V3-VALP-SENSOR.001
Title	Capability of system to provide visual references for approach operation in low visibility condition with utilizing the active sensor
Description	The objective is to assess the performance of the system using active sensor and supporting enhanced visual operation in low visibility condition. Increased Capacity in low visibility conditions including enhanced accessibility at small airports.

Expected Achievements	Improvement Capacity Resilience
V Phase	<V3>
Use Cases	CVS to 100ft above TDZE approach with HMD/HUD, Non-nominal operation (from the SPR-INTEROP/OSED)
Validation Technique	Fast Time Simulation, Data collection, Real time simulation
KPA/TA Addressed	<Resilience>
Start Date	01/12/2018
End Date	28/03/2019
Validation Coordinator	Honeywell
Validation Platform	PC Simulation framework, Honeywell Experimental Aircraft, Simulator
Validation Location	EU Honeywell facilities, US airports
Status	<in progress>
Dependencies	N/A

Linked Element Type	Identifier
<SESAR Solution>	PJ.03a-04
<Sub-Operating Environment>	APT Small / Medium
<Validation Objective>	OBJ-03a.04-V3-VALP-SENSOR.001
<Validation Objective>	OBJ-03a.04-V3-VALP-SENSOR.002

Table 6: Validation Exercise layout

The following table provides a summary of information collected from available performance outcomes.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EXE-03a.04-V3-VALP-HMD.001	AUO-0405	Live trials in several airports on EFVS approaches using HMD to demonstrate the same operational gain (EFVS down to 100ft) as for HUD.	Although several improvements of the HMD prototype have been required to perform the EFVS operations successfully,	During one flight four EFVS approaches have been performed with the HMD on Treviso airport in LVC

			THALES considers none of them as <u>technical show stopper</u> and has a <u>good level of confidence</u> in the technical feasibility of the concept.	conditions (announced RVR down to 350 meters).
EXE-03a.04-V3-VALP-HMD.002	AUO-0406	Live Trial in CDG Airport on taxi routing using HMD to improve environmental awareness by displaying non-conformal taxi route indication to the crew as well as traffic information on a 360° field of view	The Exercise has been able to demonstrate that HMD associated to taxi routing concept provides clear benefits in term of human performance during taxi operations in complex aerodrome environment. The display of taxi routing guidance information has reduced pilot workload, enabling the crew to be more focused on other tasks.	
EXE-03a.04-V3-VALP-SENSOR.001	Not in Wave 1 (CRs in pipeline)	Assessment of active sensor capability to provide visual runway references in low visibility. FTS and Data collection scenarios focused on one CAT I runway.	The initial prototype sensor provides a part of visual runway references	Low visibility condition was only simulated and validated by FTS. Data collection exercise was not performed CAVOK.

Table 7: Summary of Validation Results.

4.2 Conditions / Assumptions for Applicability

The Solution aims to demonstrate how EFVS and SVS combined through CVS and displayed in coloured HMD could increase the operational efficiency in both taxi and landing while significantly improving situational awareness and increase accessibility in all weather conditions at most of secondary aerodromes.

In fact, at these aerodromes where the main operational terminal facilities, in case of normal operations dropped due to airport operating capacity reduction (low visibility conditions), the Vision Basic System "KIT" provides operational "support" at most of runways end with precision or non-precision landing minima reduced (LPV, LNAV/ VNAV, ILS CAT1...), without any increment and/or additional costs for complex and ground infrastructures for these airports.

The following Table 8 summarises the applicable operating environments.

OE	Applicable sub-OE	Special characteristics
Airport	APT Very Large / Large	Large airport with numerous taxiways for taxi operation
Airport	APT Small / Medium	Small and Medium airports without CAT II/CATIII procedures

Table 8: Applicable Operating Environments.

The following Table 9 summarises the essential deployment details.

Benefits assessment date	Specific geographical and/or stakeholder deployment
2022 (publication of new CSO)	Deployment requires aircraft operators have been approved for EFVS operations. As EFVS operation approval includes aerodrome suitability check, deployment requires aerodromes have been determined as suitable for EFVS operations. NPA 2018-06 provides guidance.
2022	For business and regional aviation

Table 9: Deployment details.

There is no equipage details and how equipage influences benefits in the ramp-up phase because benefits are same for entire lifetime and there is no evolution.

4.3 Safety

With respect to Equivalent Visual Landing operations in Low Visibility Conditions, the PJ03a-04 solution is only assessing the use of the monocular colour-capable HMD equipment as an acceptable alternative to HUD equipment that is already certified for EFVS operations (reference scenario) and active sensor as a feasible alternative to imaging sensors that is already certified for EFVS operations (reference scenario). At OSED level, safety aspect associated to HUD or equivalent system and EFVS operations, i.e impacts on ATM/ aerodrome have been addressed in LSD 02.02 SESAR project. ATM/ aerodrome recommendations produced by French ANSP and Dassault were considered by EASA for drafting the NPA 2018-06 and are being to be assessed in full Operational environment through the SESAR AAL2 (VLD) project. SESAR AAL2 project involves the full set of key relevant stakeholders that are required for achieving this task (ANSP, aerodrome operators, air users as well as the regulator).

With respect to Equivalent Visual Taxi operations in Low Visibility Conditions, according to grant agreement n° 734153 the PJ03a-04 solution is only focusing on human factor aspects associated to Head Worn Display using legacy sensors. As there is neither ANSP nor safety expert at OSED level involved in the solution, no other than qualitative information already provided in sections §3.3, 3.4 and 3.5 about safety of operation at OSED level is delivered as part of PJ03a-04 solution in this safety report.

4.4 Environment / Fuel Efficiency

N/A

4.4.1 Performance Mechanism

N/A

4.5 Environment / Noise and Local Air Quality

N/A

4.6 Airspace Capacity (Throughput / Airspace Volume & Time)

N/A

4.7 Airport Capacity (Runway Throughput Flights/Hour)

N/A

4.8 Resilience (% Loss of Airport & Airspace Capacity Avoided)

4.8.1 Performance Mechanism

Resilience KPA, as explained onto the above paragraph where the FUEL Efficiency has been analysed. It is expected to be impacted by the Solution PJ03a-04.

Enhanced Visual operation using EFVS/CVS with active sensor as substitute or supplement of current IR cameras brings improved performance in LVC within approach operation. Improved performance on sensor side reduces number of go-arounds (delays, diversion etc.) because sensor is almost independent on weather compare to current IR sensors and provides visual cues at decision height more often. Therefore, it causes more accomplished landings in such environment. The operational improvement for the active sensor provides resilience to adverse weather because.

Validation exercise EXE-03a.04-V3-VALP-SENSOR.001 contained Fast Time Simulation. The fast time simulation initially indicates that the active sensor model is capable to provide visual references for the approach lighting system under LVC. This capability / performance indicator positively impacts ability to continue in approach operation in adverse weather and therefore provides increased resilience to LVC within the approach operation on less equipped airports. Active sensor focuses on RVR less than required for CAT I straight-in approach operation and simultaneously higher than for CAT II approach operation. Nevertheless, the level of significance and quality of fast time simulation results is lower due to limited functionality of the simulator platform.

4.8.2 Assessment Data (Exercises and Expectations)

Performance indicators described in CBA [43]:

- **RES1** Loss of airport capacity – This indicator is hardly dependent on probability of LVC (RVR less than required for CAT I straight-in approach operation and simultaneously higher than for CAT II approach operation) on specific airports. The probability for airport depends on many factors such as geographic location and environmental conditions related to weather. The probability of LVC condition is assumed to range from 0.2% to 2.8% (data from SESAR LSD02.02 AAL1 [[42]]) per analysis on 11 different CATI airports in 2014, assuming only airport opening hours. This corresponds to a total volume of 15h to 160h and has affected from 10 to 63 different days over 2014. When LVC arise at an airport, all arriving aircrafts without sufficient equipment are affected (delayed, diverted or cancelled). Expected performance is 0,46% based on weather statistics, benefits model in CBA and fast time simulation.

- **RES4** Minutes of delays – Indicator is described in CBA. Result from CBA indicate 4,43 minutes of delay per aircraft in one year with assumptions listed in CBA.
- **RES5** Number of cancellations – Indicator is described in CBA. Result from CBA indicate 0,19 minutes of delay per aircraft in one year with assumptions listed in CBA.

Nevertheless, the level of significance and quality of fast time simulation results is lower due to limited functionality of the simulator platform

PIs	Unit	Calculation	Mandatory	Benefit in SESAR1 (if applicable)	Absolute expected performance benefit in SESAR2020
RES1 Loss of Airport Capacity Avoided	% and Movements per hour	Loss of Airport Capacity with the concept divided by the loss of Airport Capacity without the concept.	YES	NO	0.46% (CBA [43])
RES4 Minutes of delays	Minutes	Impact on AUs measured through delays resulting from capacity degradation ² . RES1 and RES2 KPIs drive this PI, though the PI may need to be measured on a condition-by-condition basis (e.g. fog, wind, system outage).	YES	NO	4,43 / aircraft and year (CBA [43])
RES5 Number of cancellations	Nb flights	Impact on AUs measured through Cancellations resulting from capacity degradation ³ . RES1 and RES2 KPIs drive this PI, though the PI may need to be measured on a condition-by-condition basis (e.g. fog, wind, system outage).	YES	NO	0.19 / aircraft and year (CBA [43])

² Reactionary delay out of the scope since they could be due to many different reasons other than capacity degradation, in addition the cause of reactionary delay are not recorded in detail.

³ Reactionary delay out of the scope since they could be due to many different reasons other than capacity degradation, in addition the cause of reactionary delay are not recorded in detail.

4.8.3 Extrapolation to ECAC wide

N/A

4.8.4 Discussion of Assessment Result

N/A

4.8.5 Additional Comments and Notes

N/A

4.9 Predictability (Flight Duration Variability, against RBT)

4.9.1 Performance Mechanism

Operation improvement for taxi phase focuses on HMD as enabler. Predictability is not considered as a KPA for this solution as the use of HMD does not improve predictability during taxi phase and not-at-all during approach.

Predictability KPA was expected to be impacted by the Solution PJ03a-04, even if not in quantitative terms of "reduction" or "alignment" of the average taxi values, but in terms of greater number of aircraft that can perform taxi operations on the movement area due to weather conditions that do not allow standard operations on the airport thanks to the implementation of the "technical support" that provide an assisted guidance during the taxi phase and so permits the pilot to maintain a sort of standard taxi speed associated with an advanced condition of awareness of the real position of the aircraft onto the manoeuvring area even in low visibility conditions.

The approach/taxi phase variability is more linked to traffic density, weather conditions or flight delay. HMD will improve none of the above. Only the display of taxi guidance information could prevent the crew from getting lost on large airports during taxi which remains a rare situation. Therefore, taxi guidance information do not have any impact on Predictability.

No Validation Target is expected in this KPA by the Solution 03a-04.

4.10 Punctuality (% Departures < +/- 3 mins vs. schedule due to ATM causes)

4.10.1 Performance Mechanism

Operation improvement for taxi phase considers HMD as enabler for the Punctuality KPA. Nevertheless, HMD by itself as enabler for operational improvement does not improve Punctuality compared to HUD. The foreseen operational gains remain the same for both technologies.

In fact, Punctuality KPA was expected to be impacted by the Solution PJ03a-04 not in quantitative terms of "alignment" or "reduced" starting time for push back from stand to the main active runway for take-off, but in terms of greater number of aircraft that can perform their airport ground movements, previously reduced due to weather conditions that do not allow standard operations on the airport.

The Punctuality KPA could only be enhanced by the use of an active sensor as part of EFVS/CVS that would provide significant better performances than IR sensor. Improvement by active sensor is classified as resilience because difference between landing on first attempt in case of system with enabler and landing on second attempt in case system without enabler is larger than 3 minutes.

No Validation Target is expected in this KPA by the Solution 03a-04.

4.11 Civil-Military Cooperation and Coordination (Distance and Fuel)

N/A

4.12 Flexibility

N/A

4.13 Cost Efficiency

According to the Validation Target, the 15-20% impact on Human Performance thanks to the ability for Flight Crew to take-off in low visibility conditions. In reality, the take-off flight phase was not considered in this solution. Solution focuses only on taxi and approach operations, thus the ATCO Productivity KPA (CEF2) is not considered.

4.14 Airspace User Cost Efficiency

The Airspace User Cost Efficiency is expected to be impacted by the Solution PJ03a-04.

The main impact of solution supporting approach and landing enhanced vision operation by EFVS/CVS using HMD is reduction of acquisition costs improving affordability of this solution. The operational benefits are same as current solution provided in LVC. Therefore, cost efficiency comes only from the costs reduction.

There are two main impacts of solution supporting approach and landing enhanced vision operation by EFVS/CVS using active sensor to Airspace User Costs efficiency. First impact is linked with increased availability of visual references for pilot during approaches in low visibility conditions. It leads to reduction of direct costs related to the aeroplane and passengers e.g. fuel, staff expenses, passenger service costs, strategic delay, etc.. Second impact is reduction of acquisition costs improving affordability of this solution.

The above detailed description certainly brings benefits in terms of KPIs concerning the G2G trajectory and flight management;

However, it is clear that the EFVS/CVS system that uses HMD collaborates for a fundamental part in achieving this target.

Nevertheless, given that the technological solution is certainly a harbinger of cost reduction for the on-board technology of the aircraft (as already specified in the VALR), the PIs concerning AUC have NO IMPACT on the Cost Efficiency to be reported both at the solution level and to be extrapolated at Level ECAC too.

In conclusion, differently from the MP expectation that have a target for this Solution relative to FEEF set to 4.37 kg of fuel (relative value 0.87%), taxi time and environment KPA are not expected to be directly impacted or any reduction by the solution PJ03a-04. The impact is supported by Fast time simulation and Cost benefit analysis [43]. Nevertheless, the level of significance and quality of fast time simulation results is lower due to limited functionality of the simulator platform. Therefore, the validation results shall be confirmed in future. The active sensor does not aim at target maturity V3. Potential active sensor impact on fuel consumption is described only in Cost Benefit Analysis [43].

4.14.1 Performance Mechanism

Fast Time Simulation (FTS) for the advanced EFVS active sensor in solution exercise confirm sensor performance improvement (qualitative). Validation exercise related to enhanced visual approach operation using HMD was focused on operational feasibility of this solution, preliminary qualitative results from both exercise support our assumptions listed in CBA. Thus, CBA indicates benefits in Airspace User Cost Efficiency. There are no validation targets directly validated in exercise considering EFVS/CVS active sensor and HMD.

4.15 Security

4.15.1 The SecRAM 2.0 methodology and the Security Performance Mechanism

Cyber-security and security aspects are not particularly relevant for this Solutions. Thus, PJ03a.04 Solution has been not prioritized by the Cyber-security Task Force.

According to SecRAM2.0 methodology, for non-prioritized Solution at V3 the SRA level should be finalized since the identification of Vulnerabilities and Threats.

PJ03a.04 partners went through the SRA process, Scoping & solution environment assumptions, Primary Assets Identification, Supporting Assets identification, Vulnerabilities and Threats Identification. Due to the confidential nature of security topics, obtained data cannot be shared in details.

4.15.2 Security Assessment Data Collection

Just very high-levels considerations have been reported in order to preserve security-sensitive information.

PIs	Unit	Calculation	Mandatory	Current value
SEC1 A security risk assessment has been carried out	Binary Vector – with maximum 7 components with Y/N (according to the prioritization and maturity level of the solution)	A security risk assessment has been carried out applying SecRAM 2.0, and the following steps have each been carried out : The identification of Primary Assets, Supporting Assets, Threat Scenarios and Vulnerabilities; The evaluation of Impacts, Likelihoods and Risks.	YES (different steps are mandatory for different prioritization and maturity levels)	Y, Y, Y, Y, N, N, N
SEC2 Risk Treatment has been carried out	Binary Vector – 2 components with Y/N	Following SecRAM 2.0, Security controls have been identified by Security Experts and implemented in the Solution.	YES (implementation just at higher maturity levels – V4)	N/A

PIs	Unit	Calculation	Mandatory	Current value
SEC3 Residual risk after treatment meets security objective.	Risk Level – 2 levels are possible: medium or low	After Security Controls have been implemented, the Risk Level achieved per Supporting Asset decreases (H → M, M → L, H → L). It is important to notice that according to SecRAM the Risk Level achieved should be “Low” otherwise justifications must be provided.	YES	N/A.
SEC7 Personnel (safety) risk after mitigation	Risk 3 levels are possible: high, medium or low	Qualitative assessments are derived from application of the SESAR2020 Security Risk Assessment Methodology (SecRAM 2.0). The PI is the maximum risk evaluated for the SESAR Solution after application of the recommended controls and considering the Personnel Impact Area only.	According to the SESAR Solution prioritization list and to the maturity level of the solutions	N/A
SEC8 Capacity risk after mitigation	Risk – 3 levels are possible: high, medium or low	Qualitative assessments are derived from application of SecRAM 2.0. The PI is the maximum risk evaluated for the SESAR Solution after application of the recommended controls and considering the Capacity Impact Area only.	According to the SESAR Solution prioritization list and to the maturity level of the solutions	N/A
SEC9 Economic risk after mitigation	Risk – 3 levels are possible: high, medium or low	Qualitative assessments are derived from application of SecRAM 2. This PI is the maximum risk evaluated for the SESAR Solution after application of the recommended controls and considering the Economic Impact Area only.	According to the SESAR Solution prioritization list and to the maturity level of the solutions.	N/A

It is important to notice that SEC2-SEC9 PIs are not applicable due to the fact that the Solution is at V3 and non-prioritised. The Solution went through all the mandatory steps of SecRAM 2.0 according to its maturity level and prioritization level.

4.15.3 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.16 Human Performance

4.16.1 HP arguments, activities and metrics

The HP activities have focused on the two enablers studies in the frame of Pj03a-04: Head Mounted Display (HMD) and active sensor.

- The HMD (providing a monocular coloured image with 360° field of view) has been assessed with regard to Human Performances during flight trials performed in February/March 2019

with a Dassault Falcon 8X. Human Performances evaluation was aiming at demonstrating that HMD could provide the same advantages in term of awareness and operational credit as Head-Up Displays. The evaluation has been performed according to the validation exercises described in [VALP/VALR] and have demonstrated that HMD was overall suitable from a HP perspective during taxi phase. However the HMD has not been considered mature enough to be used as an enabler for EFVS operations. Technical improvements of the HMD have been recommended to fully achieve operational credit with HMD during EFVS approaches.

HMD activity addresses the following arguments: Arg. 1.2.1, Arg. 1.2.2., Arg. 1.2.5., Arg. 2.3.1.

- The Real-Time simulations initially foreseen to assess HP for active sensor were not performed due to lower-than-expected maturity of the simulator. As a consequence, all related HP activities could not be conducted.

Active sensor activity addresses the following arguments: 1.2.1. PJ03A-04_02; 1.2.2. PJ03A-04_01; 1.2.3. PJ03A-04_01; 1.3.5 PJ03A-04_02; 2.2.1. PJ03A-04_01; 2.2.2. PJ03A-04_01; 2.3.1. PJ03A-04_02.

A description of activity, arguments and metrics can be found in part IV of OSED (Human Performance Assessment Report)

PIs	Activities & Metrics	Second level indicators	Covered
HP1 Consistency of human role with respect to human capabilities and limitations	Flight Trials	HP1.1 Clarity and completeness of role and responsibilities of human actors	closed
		HP1.2 Adequacy of operating methods (procedures) in supporting human performance	closed
		HP1.3 Capability of human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level	closed
HP2 Suitability of technical system in supporting the tasks of human actors	Flight Trials	HP2.1 Adequacy of allocation of tasks between the human and the machine (i.e. level of automation).	closed
		HP2.2 Adequacy of technical systems in supporting Human Performance with respect to timeliness of system responses and accuracy of information provided	open
		HP2.3 Adequacy of the human machine interface in supporting the human in carrying out their tasks.	open
		HP3.1 Adequacy of team composition in terms of identified roles	N/A

PIs	Activities & Metrics	Second level indicators	Covered
HP3 Adequacy of team structure and team communication in supporting the human actors		HP3.2 Adequacy of task allocation among human actors	N/A
		HP3.3 Adequacy of team communication with regard to information type, technical enablers and impact on situation awareness/workload	N/A
HP4 Feasibility with regard to HP-related transition factors		HP4.1 User acceptability of the proposed solution	open
		HP4.2 Feasibility in relation to changes in competence requirements	N/A
		HP4.3 Feasibility in relation to changes in staffing levels, shift organization and workforce relocation.	N/A
		HP4.4 Feasibility in relation to changes in recruitment and selection requirements .	N/A
		HP4.5 Feasibility in terms of changes in training needs with regard to its contents, duration and modality.	N/A

Current design HMD does not provide the pilot with sufficient usable information for EFVS. Therefore, some HP points are still open.

4.16.2 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.16.3 Open HP issues/ recommendations and requirements

PIs	Number of open issues/ benefits	Nr. of recommendations	Number of requirements
HP1 Consistency of human role with respect to human capabilities and limitations	0	0	0
HP2 Suitability of technical system in supporting the tasks of human actors	0	1	0
HP3 Adequacy of team structure and team communication in supporting the human actors	0	0	0
HP4 Feasibility with regard to HP-related transition factors	0	1	0

4.16.4 Concept interaction

No interaction with other SESAR solution was identified.

4.16.5 Most important HP issues

The following recommendation has been identified

PIs	Most important issue of the solution	Most important issues due to solution interdependencies
HP1 Consistency of human role with respect to human capabilities and limitations		N/A
		N/A
		N/A
HP2 Suitability of technical system in supporting the tasks of human actors		N/A
	remaining technical enhancements have to be implemented to fully achieve EFVS with Ops credit operation.	N/A
	remaining technical enhancements have to be	N/A

PIs	Most important issue of the solution	Most important issues due to solution interdependencies
	implemented to fully achieve EFVS with Ops credit operation.	
HP3 Adequacy of team structure and team communication in supporting the human actors		N/A
		N/A
		N/A
HP4 Feasibility with regard to HP-related transition factors	remaining technical enhancements have to be implemented to fully achieve EFVS with Ops credit operation.	N/A
		N/A
		N/A
		N/A
		N/A

4.16.6 Additional Comments and Notes

N/A

4.17 Other PIs

N/A

4.18 Gap Analysis

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