INDUSTRIAL RESEARCH

SESAR Solution PJ.07-W2-39 SPR-INTEROP/OSED for V3 - Part V - Performance Assessment Report (PAR)

Deliverable ID D3.1.008
Dissemination Level: PU
Project Acronym: PJ07-W2 OAUO
Grant: 874465
Call: H2020-SESAR-2019-1
Topic: SESAR-IR-VLD-WAVE2-06-2019
Consortium coordinator: EUROCONTROL
Edition date: 03 May 2023
Edition: 00.01.01
Template Edition: 00.00.09

Authoring & Approval

Authors of the document

Beneficiary	Date
EUROCONTROL	10/03/2023

Reviewers internal to the project

Beneficiary	Date
SWISS	03/03/2023
EUROCONTROL	03/03/2023

Reviewers external to the project

Beneficiary	Date

Approved for submission to the S3JU By - Representatives of all beneficiaries involved in the project

Beneficiary	Date
EUROCONTROL	

Rejected By - Representatives of beneficiaries involved in the project

Beneficiary	Date

Document History

Edition	Date	Status	Beneficiary	Justification
00.00.01	03/03/2023	First draft	EUROCONTROL	First draft updated with comments from internal review
00.01.00	22/03/2023	Submitted to SJU	EUROCONTROL	Tables 18 and 19 updated with clarifications
00.01.01	03/05/2023	Final	EUROCONTROL	Comments addressed from SJU and C Cliff. In addition, significant changes to: Table 30, sections 4.11.4.1 and 4.15.3.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

PJ07-W2 OAUO

OPTIMISED AIRSPACE USER OPERATIONS

This Performance Assessment Report (PAR) is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874465 under the European Union's Horizon 2020 research and innovation programme.

Abstract

This document provides the Performance Assessment Report for solution PJ.07-W2-39 — "Collaborative framework for managing arrival within an ATFM regulation." The PAR consolidates the performance validation results and presents estimates where no validation results are available.

This Solution introduces a framework for single point of entry for AUs to provide UDPP prioritisations in a harmonised format that will allow the Network Manager to use these prioritisations for arrival ATFM regulations. This Solution greatly extends the ability of an AU to influence the sequence of arrivals for regulated flights in the pre-departure phase. The key benefit will be the reduction of costs to AU operations by minimising the operational and therefore financial impact of delay.

This Solution extends the Airspace Users (AUs) ability to influence the sequence of arrivals whilst the flights are in the pre-departure phase. The Solution introduces a framework for a single point of entry for the AUs to provide a User-driven Prioritisation Process (UDPP) in a harmonised format, to allow the Network Manager (NM) and other ATM stakeholders to utilise the AU prioritisation for the resolution of capacity-constraints for arrivals. Such an approach is primarily expected to result in reducing the costs of AUs' operations, either through their direct use of UDPP mechanisms integrated in NM systems and thus reducing the cost of delay, or through informing ATM stakeholders about the AU needs. The solution provides opportunities adapted to different situations and types of AUs, and in parallel it ensures continued stability and performance of the Network.

This document provides an overview of the performance benefits associated with the solution:

- The reduction of reactionary delays can have a positive economic and operational impact on AUs, leading to improved AU cost-efficiency and operational efficiency.
- The reduction of direct operating costs can positively affect the cost of operations for AUs, and this positively affects AU cost-efficiency.
- Improved punctuality has an overall improvement effect on AUs' operational efficiency.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Table of Contents

List of Tables

EUROPEAN PARTNERSHIP

Co-funded by the European Union

List of Figures

1 Executive Summary

This document provides the Performance Assessment Report (PAR) for SESAR Solution PJ.07 - Collaborative Framework Managing Delay Constraints on Arrivals.

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

Description:

This Solution focuses on the definition of a collaborative framework for managing arrival constraints for Local Demand Capacity Balancing (DCB) issues managed at the Flow Management Position (FMP) or at Airport level, in collaboration with the Network Function and with the participation of Airspace Users (AUs).

Solution PJ.07-W2-39 addresses a single Operational Improvement step (OIs) recorded in the DS-23 Dataset, that is the AUO-0110, **"Collaborative framework for managing arrival within an ATFM regulation"**.

This collaborative framework would enable the integration and necessary coordination of 4D constraints (limited to arrivals management) from various stakeholders (Airports, ANSPs, AUs and NM); it would ensure continuous stability and performance of the network and would provide the opportunity to the Airspace Users to prioritise their most important flights (UDPP application), hence reducing the impact of ATM planning constraints on the costs of their operations.

In the definition of the operational framework, it is presumed that the UDPP process could be started, enabling AUs to make reasonable recommendations for Local Demand Capacity Balancing issues through "What-If" scenario calculations using the information at their disposal. Furthermore, it is assumed that the Local DCB processes would initially find an acceptable solution in the UDPP output.

The benefits of the solution include increased flexibility for AUs which can suggest to the Network Management Function a preferred order for their flights, increased punctuality of flights, especially of those flights whose delays can have a significant impact on the AU fleet and cost-efficiency of AUs. The benefits have been quantified in the context of a validation exercise at Zurich airport and have been extrapolated to wider group of airports in scope of Solution PJ.07-W2-39.

Assessment Results Summary:

The following tables summarise the assessment outcomes per KPI (Table 1) and mandatory PI (Table 2), comparing them side-by side with Validation Targets, where such a target has been set by PJ19 [8]. The impacts of the Solution on performance are described in the Benefit Impact Mechanisms. All the KPIs and mandatory PIs from the Benefit Mechanisms which the Solution potentially impacts had to be assessed based on validation results and expert judgment.

There are three cases:

1. An assessment result of 0 with a confidence level other than 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 a 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 a 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.

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits at Network Level (ECAC Wide or Local depending on the KPI)[1]	Confidence in Results[2]
SAF1: Safety - Total number of estimated accidents with ATM Contribution per year	N/A	N/A	N/A
FEFF1: Fuel Efficiency - Actual average fuel burn per flight	N/A	N/A	N/A
CAP1: TMA Airspace Capacity - TMA throughput, in challenging airspace, per unit time.	N/A	N/A	N/A

[1] Negative impacts are indicated in red.

[2] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

CAP2: En-Route Airspace Capacity - En-route throughput, in challenging airspace, per unit time	N/A	N/A	N/A
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	N/A	N/A	N/A
TEFF1: Gate-to-gate flight time	N/A	N/A	N/A
PRD1: Predictability – Average of Difference in actual & Flight Plan or RBT durations	N/A	N/A	N/A
PUN1: Punctuality – Average departure delay per flight	The validation target assigned prior to the validation exercise was 0.55% to very large airports and 0.45% to large airports. The validation exercises did not provide quantitative evidence of achieving the validation targets. This maybe be owed to the performance of the solution, as well as scope of the exercises and other assumptions.	0.0143 min/flight [0.30% ECAC overall improvement] [0.17 % to very large airports and 0.13 % to large airports]	Medium
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	N/A	N/A	N/A
CEF3: Technology Cost – Cost per flight	N/A	N/A	N/A

Table 1: KPI Assessment Results Summary

Mandatory PI	Performance Benefits Expectations at Network Level (ECAC Wide or Local depending on the KPI)[3]	Confidence in Results[4]
SAF1.X: Mid-air collision - En-Route	0	N/A
SAF2.X: Mid-air collision - TMA	0	N/A
SAF3.X: RWY-collision accident	0	N/A
SAF4.X: TWY-collision accident	0	N/A
SAF5.X: CFIT accident	0	N/A
SAF6.X: Wake related accident	0	N/A
SAF7.X: RWY-excursion accident	0	N/A
SAF8.X ...: Other SAF Risks	0	N/A
SEC1: A security risk assessment has been carried out	0	N/A
SEC2: Risk Treatment has been carried out	0	N/A
SEC3: Residual risk after treatment meets security objective.	0	N/A
ENV1: Actual Average CO2 Emission per flight	0	N/A
NOI1: Relative noise scale	0	N/A
NOI2: Size and location of noise contours	0	N/A

[3] Negative impacts are indicated in red.

[4] High – the results might change by +/-10%
Medium – the results might change by +/-25%
Low – the results might change by +/-50% or greater
N/A – not applicable, i.e., the KPI cannot be influenced by the Solution

NOI4: Number of people exposed to noise levels exceeding a given threshold	0	N/A
LAQ1: Geographic distribution of pollutant concentrations	0	N/A
CAP3.1: Peak Departure throughput per hour (Segregated mode)	0	N/A
CAP3.2: Peak Arrival throughput per hour (segregated mode)	0	N/A
CAP4: Un-accommodated traffic reduction	0	N/A
RES1: Loss of Airport Capacity Avoided	0	N/A
RES1.1: Airport time to recover from non-nominal to nominal condition	0	N/A
RES2: Loss of Airspace Capacity Avoided.	0	N/A
RES2.1: Airspace time to recover from non-nominal to nominal condition.	0	N/A
RES4: Minutes of delays.	0	N/A
RES5: Number of cancellations.	0	N/A
TEFF2: Taxi in time	0	N/A
TEFF3: Taxi out time	0	N/A
TEFF4: TMA arrival time	0	N/A
TEFF5: TMA departure time	0	N/A
TEFF6: En-Route time	0	N/A
PRD2: Variance of Difference in actual & Flight Plan or RBT durations	0	N/A
PUN2: % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather-related delay causes	0	N/A
CEF1: Direct ANS Gate-to-gate cost per flight	0	N/A

AUC3: Direct operating costs for an airspace user	*4.91% improvement*	*Medium*
AUC4: Indirect operating costs for an airspace user	0	N/A
AUC5: Overhead costs for an airspace user	0	N/A
CMC1.1: Allocated vs. Requested ARES duration	0	N/A
CMC1.2: Allocated vs. Requested ARES dimension	0	N/A
CMC1.3: Deviation of Transit Time to/from airbase to ARES	0	N/A
CMC 1.3.1: Allocated ARES duration vs. total mission duration	0	N/A
CMC 1.3.2: Deviation of total mission duration by iOAT FPL validation	0	N/A
CMC 1.4.1: Rate of iOAT FPLs acceptance by NM systems	0	N/A
CMC 1.4.2: Rate of iOAT FPLs acceptance by ATC systems	0	N/A
CMC2.1: Fuel and Distance saved by GAT	0	N/A
HP1: Consistency of human role with respect to human capabilities and limitations	The level of automation will determine the degree of impact on HP, but in general, the HP component of the new operation is expected to be neutral. APT or the local DCB, as well as NM, may be required to verify proposed solutions, implying an increase in workload for these actors.	N/A
HP2: Suitability of technical system in supporting the tasks of human actors	Automation for different parts of the process is envisaged. Overall, impact should be neutral.	N/A
HP3: Adequacy of team structure and team communication in supporting the human actors	The collaborative approach to DCB imbalance resolution should improve situational awareness for all actors.	N/A

	No Impact on team composition and communication	
HP4: Feasibility with regard to HP-related transition factors	No change	N/A
FLX1: Average delay for scheduled civil/military flights with change request and non-scheduled or late flight plan request	0	N/A

Table 2 Mandatory PIs Assessment Summary

Additional Comments and Notes:

N/A

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 SESAR3 Joint Undertaking (S3JU) 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.

2.2 Intended readership

In general, this document provides the ATM stakeholders (e.g., airspace users, ANSPs, airports, airspace industry) and S3JU 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 the use at Master Planning Level, such as deployment scenarios.

2.3 Inputs from other projects

The document includes information from the following SESAR 2020 Wave1 projects:

- PAGAR 2019 [3]: Performance Assessment and Gap Analysis Report (2019), which provides the final benefits from SESAR 2020 Wave1.

PJ19 will manage and provide:

- SESAR Performance Framework (2019) [3], guidance on KPIs and Data collection supports.
- 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. For guidance and support PJ19 have put in place the Community of Practice (CoP)[5] within STELLAR, gathering experts and providing best practices.

2.4 Acronyms and Terminology

Term	Definition
AIBT	Actual In-block Time
ADES	Aerodrome of Destination
ADEP	Aerodrome of Departure
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
AOP	Airport Operations Plans
ARES	Airspace Reservation/ Restriction
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air traffic Service
ATFCM	Air Traffic Flow and Capacity Management
AU	Airspace User
AUO	Airspace User Operations

[5] Go to “Advanced Portfolio Manager” on the left navigation menu, and select “Coordination Group – ATM Performance Assessment (APA)” in STELLAR:

https://stellar.sesarju.eu/?link=true&domainName=saas&redirectUrl=%2Fjsp%2Fproject%2Fproject.jsp%3FobjId%3Dxrn%3Aview%3Axrn%3Adatabase%3Aondb%2Ftable%2FSYS_MESSAGE%402333834.13%40xrn%3AprototypeView%3Adatabase.view.message.private.AllMyMessages

BAD	Benefits Assessment Date
BAER	Benefit Assessment Equipment Rate
CAP	Capacity
CASA	Computer-Assisted Slot Allocation (Network Manager slot allocation for regulations)
CBA	Cost Benefit Analysis
CBA	Cross-Border Area
CCS	Capacity Constraint Situation
CEF	Cost Efficiency
CTOT	Calculated Take-Off Time
DOD	Detailed Operational Description
DAC	Dynamic Airspace Configurations
DB	Deployment Baseline
DCB	Demand Capacity Balancing
EGLL	London Heathrow Airport
EGKK	London Gatwick Airport
E-ATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
EHAM	Amsterdam Airport
EDDF	Frankfurt Airport
EDDM	Munich Airport
ETOT	Estimated Take-Off Time
FDCI	Flight delay critically concept
FMP	Flow Management Position
FEFF	Flight Efficiency

FOC	Flight Operations Centre
FV	Flight value
HP	Human Performance
ICAO	International Civil Aviation Organization
INAP	Integrated Network Management Air Traffic Control Planning
KPA	Key Performance Area
KPI	Key Performance Indicator
LSZH	Zurich Airport
LFPG	Paris Charles De Gaulle Airport
LEMD	Madrid Barajas International Airport
MCP	Mandatory Cherry-Pick
N/A	Not Applicable
NCP	Network Cherry-Pick
NM	Network Manager
NMf	Network Manager function
NMOC	Network Manager Operations Centre
NMVP	Network Manager Validation Platform
NIMS	Prefix of Enablers linked to operational improvement defined in the European ATM master plan
NOP	Network Operations Portal
OE	Operating Environment
OI	Operational Improvement
PAR	Performance Assessment Report
PI	Performance Indicator
PRU	Performance Review Unit

PRD	Predictability
PUN	Punctuality
PV	Passenger value
PAGAR	Performance Assessment Gap Analysis Report
QoS	Quality of Service
RBT	Reference Business / Mission Trajectory
R&D	Research & Development
R-NEST	Research Network Strategic monitoring tool
RTS	Real-Time Simulation
SAF	Safety
SIIU	Safety impact of the Intended Use
SIBT	Scheduled In-block Time
SESAR	Single European Sky ATM Research Programme
S3JU	SESAR3 Joint Undertaking (Agency of the European Commission)
SESAR2020 Programme	The programme which defines the Research and Development activities and Projects for the S3JU.
TMA	Terminal Manoeuvring Area
TFV	Traffic volume
TSA	Temporary Segregated Area
TRA	Temporary Reserved Area
TT	Target Time
TTA	Target Time of Arrival
TTOT	Target Time Over
TTOT	Target Take-Off Time
UC1	Use-Case 1

UDPP	User-Driven Prioritisation Process
VALP	Validation Plan
VALR	Validation Report

Table 3: Acronyms and terminology

2.5 Glossary of terms

See the AIRM Glossary [1] [7] for a comprehensive glossary of terms.

The following is a list of the concepts, terms or definitions introduced or commonly referred to in this document.

Term	Definition	Source
Airport Capacity Focus Area	Capture the peak runway throughput in the most challenging (or constrained) environments at busy hours, i.e., the capacity at a “maximum observed throughput” airport.	PAGAR
Airspace Capacity Focus Area	Capture the capability of a challenging volume of airspace to handle an increasing number of movements per unit time – through changes to the operational concept and technology.	PAGAR
Airspace Reservation/ Restriction (ARES)	Airspace Reservation means a defined volume of airspace temporarily reserved for exclusive or specific use by categories of users (Temporary Segregated Area (TSA), Temporary Reserved Area (TRA), and Cross-Border Area (CBA)) whereas Airspace Restriction designates Danger, Restricted and Prohibited Areas.	EC Regulation No 2150/2005
Airspace User Cost-Efficiency Focus Area	Cost-Efficiency obtained by Airspace Users other than direct gate-to-gate ATS costs (CEF1) or AU cost improvements assessed through other KPIs: Fuel Efficiency, Punctuality, etc. Note: Benefits assessed through other KPIs should not be included in this focus area to avoid double counting of benefits. AU Cost-Efficiency includes reduction of direct (AUC3) and indirect (AUC4) operational costs of the AU, as well as overhead costs (AUC5). In addition, there are two specific PIs, Strategic Delay (AUC1) and Sequence Optimisation Benefit (AUC2).	PAGAR
ARES Capacity	The ability of an ATM system to accommodate specific training events which require airspace reservations and/or restrictions during a specific period of time, taking into account the duration of the training events, ATM inefficiency, planning inefficiency and weather impact on training and operations.	Performance Framework 2017

Term	Definition	Source
ATM Master Plan	The European ATM Master Plan is the agreed roadmap to bring ATM R&I to the deployment phase, introducing the agreed vision for the future European ATM system. It provides the main direction and principles for SESAR R&I, as well as the deployment planning and an implementation view with agreed deployment objectives. Through the SESAR Key Features, the ATM Master Plan identifies the Essential Operational Changes (both Essential Operational Changes featured in the Pilot Common Project and New Essential Operational Changes) and key R&I activities that support the identified performance ambition. The ATM Master Plan is updated on a regular basis in collaboration and consultation with the entire ATM community. Amendments are submitted to the S3JU Administrative Board for adoption. The content of the European ATM Master Plan is structured in three levels (Level 1 – Executive View, Level 2 – Planning and Architecture View, and Level 3 – Implementation View) to allow stakeholders to access the information at the level of detail that is most relevant to their area of interest. The intended readership for Level 1 is executive-level stakeholders. Levels 2 and 3 of the ATM Master Plan provide more detail on the operational changes and related elements and therefore the target audience is expert-level stakeholders.	SESAR2020 Project Handbook, European ATM Master Plan (9 Edition)
Civil-military coordination and cooperation	The coordination between the civil and military parties authorised to make decisions and agree a course of action.	Performance Framework 2017
Cost-Benefit Analysis	A Cost-Benefit Analysis is a process for quantifying in economic terms the costs and benefits of a project or a programme over a certain period, and those of its alternatives (within the same period), in order to have a single scale of comparison for unbiased evaluation. This process helps decision-makers to compare an investment with other possible investments and/or to make a choice between different options / scenarios and to select the one that offers the best value for money while considering all the key criteria affecting the decision.	PAGAR
Deployment Scenario	Set of SESAR Solutions selected to satisfy the specific Performance Needs of operating environments in the European ATM System and based on the timescales in which their performance contribution is needed in the respective operating environments.	PAGAR

Term	Definition	Source
Flexibility KPA	The ability of the ATM System and airports to respond to changes in planned flights and missions. It covers late trajectory modification requests as well as ATFCM measures and departure slot swapping and it is applicable to military and civil airspace users covering both scheduled and unscheduled flights. In terms of specific military requirements, it also covers the ability of the ATM System to address military requirements related to the use of airspace and reaction to short-notice changes.	Performance Framework 2017
Focus Area	Within each KPA, a number of more specific "Focus Areas" are identified in which there are potential intentions to establish performance management. Focus Areas are typically needed where performance issues have been identified.	ICAO Doc 9883
Fuel Efficiency Focus Area	The SESAR performance Focus Area concerned with fuel efficiency. How much fuel is used by aviation or by extension "Fuel efficiency" (how much fuel can be saved?) is one of the performance aspects. Note: Policy places considerable focus on this. Fuel efficiency contributes to 3 of the 11 KPAs defined by ICAO: Cost-efficiency, Efficiency, and Environment.	PAGAR
Gap Analysis	Difference between the validation targets and the performance assessment. It is used to: 1. Anticipate any deviation from the design performance targets; 2. Identify the underlying reasons; 3. Derive the appropriate recommendations to be taken on board to redirect the R&D activities within the Programme towards the ultimate achievement of SESAR2020's performance ambitions.	PAGAR
G2G ANS Cost-Efficiency Focus Area	One of the SESAR performance Focus Areas concerned with Cost Efficiency. Direct G2G ANS costs are those costs that are charged to Airspace Users via unit rates, including ATM/CNS costs, regulatory costs, Met costs and EUROCONTROL Agency costs.	Performance Framework new
Human Performance (HP)	Human capabilities and limitations which have an impact on the safety, security, and efficiency of aeronautical operations.	EUROCONTROL ATM Lexicon

Term	Definition	Source
Key Performance Area	A way of categorising performance subjects related to high level ambitions and expectations. ICAO Global ATM Concept sets out these expectations in general terms for each of the 11 ICAO defined KPAs.	EUROCONTROL ATM Lexicon
Key Performance Indicator	Current/past performance expected future performance (estimated as part of forecasting and performance modelling), as well as actual progress in achieving performance objectives is quantitatively expressed by means of indicators (sometimes called Key Performance Indicators, or KPIs). To be relevant, indicators need to correctly express the intention of the associated performance objective. Since indicators support objectives, they should not be defined without having a specific performance objective in mind. Indicators are not often directly measured. They are calculated from supporting metrics according to clearly defined formulas, e.g., cost-per-flight-indicator = Sum (cost)/Sum (flights). Performance measurement is therefore carried out through the collection of data for the supporting metrics." In SESAR2020 Performance Framework, Key Performance Indicators are those that have a validation target associated derived from the corresponding Performance Ambition.	ICAO Doc 9883 Performance Framework
Local Air Quality Focus Area	One of the SESAR performance Focus Areas concerned with Environment. Local air quality is a term commonly used to designate the state of the ambient air to which humans and the ecosystem are typically exposed at a specific location. In the case of aviation, local air quality studies are generally conducted near airports.	PAGAR
Noise Focus Area	One of the SESAR performance Focus Areas concerned with Environment. The term Noise is used in this document to designate noise pollution, which is defined as unwanted sound. The impact of unwanted sounds on the recipients (in this case, people living around airports) causes adverse effects.	PAGAR
Operational Environment (OE)	An environment with a consistent type of flight operations.	EUROCONTROL ATM Lexicon
Performance Ambitions	Performance capability that may be achieved if SESAR Solutions are made available through R&D activities, deployed in a timely and, when needed, synchronised way and used to their full potential.	EUROCONTROL ATM Lexicon
Performance assessment	This term relates to the quantitative estimate of the potential performance benefit of an operational improvement based on outputs from validation projects, collected and analysed by PJ19.04.02	ICAO Doc 9883 updated in PAGAR

Term	Definition	Source
Performance Framework	1) The overall performance-driven development approach that is applied within the SESAR development programme to ensure that the programme develops the operational concept and technology needed to meet long-term performance expectations. 2) The set of definitions and terminology describing the building blocks used by a group of ATM community members to collaborate on performance management activities. This set of definitions includes the levels in the global ATM performance hierarchy, the eleven Key Performance Areas, a set of process capability areas, focus areas, performance objectives, indicators, targets, supporting metrics, lists of dimension objects, their aggregation hierarchies and classification schemes.	EUROCONTROL ATM Lexicon
Performance Indicator	PIs are defined in the SESAR performance framework and relate to performance benefits in specific KPAs. However, no validation targets are assigned to PIs. SESAR Solutions projects use the results of validation exercises to report performance assessment in terms of the PIs, reporting the expected positive and negative impacts. Certain PIs are mandatory for measurement and reporting by Solution projects.	SESAR2020 Project Handbook
Performance metrics	Sometimes proxies may be used in a validation exercise when it is not possible to measure an impact directly using the specified KPIs and PIs. In these cases, other metrics may be used provided the solution project later converts the results into the reporting KPIs and PIs.	SESAR2020 Project Handbook
Predictability Focus Area	Predictability is focused on in-flight (i.e., off-block to on-block) variability of flight duration compared to the planned duration. It is expected that this area will be extended in the future to reflect the improvement derived from better planning in pre-tactical phase.	Performance Framework 2019
Punctuality Focus Area	Refers to “ATM Punctuality”. It captures ATM issues as well as events related to ATM that cause a temporal perturbation to airspace user schedules.	PAGAR
Resilience Focus Area	Resilience focuses on the ability to withstand and recover from planned and unplanned events and conditions which cause a loss of nominal performance.	Performance Framework updated
Safety	The state to which the possibility of harm to persons or damage to property is reduced, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.	EUROCONTROL ATM Lexicon

Term	Definition	Source
Security	(aviation) Safeguarding civil aviation against acts of unlawful interference. This objective is achieved by a combination of measures and human and material resources. Note: ATM Security is concerned with those threats that are aimed at the ATM System directly, such as attacks on ATM assets, or where ATM plays a key role in the prevention of or response to threats aimed at other parts of the aviation system (or national and international assets of high value). ATM security aims to limit the effects of a threats on the overall ATM Network. ATM Security is a subset of Aviation Security (as defined by ICAO in Annex 17).	EUROCONTROL ATM Lexicon, Notes are from PAGAR
SESAR2020	The Programme for SESAR2020 was created with a clear and agreed need for continuing research and innovation in ATM beyond the SESAR 1 development phase. SESAR2020 is structured into three main research phases, starting with Exploratory Research, which is then further expanded within a Public-Private-Partnership (PPP) to conduct Industrial Research and Validation. Finally, it further exploits the benefits of the PPP in Demonstrating at Large Scale the concepts and technologies in representative environments to firmly establish the performance benefits and risks.	Performance Framework 2017
SESAR Programme	The programme which defines the Research and Development activities and Projects for the S3JU.	EUROCONTROL ATM Lexicon
SESAR Solution	A term used when referring to both SESAR ATM Solution and SESAR Technological Solution.	SESAR2020 Project Handbook
SESAR ATM Solution	SESAR Solutions relate to either an Operational Improvement (OI) step or a group of OI steps with associated Enablers (technical system, procedure, or human), which have been designed, developed and validated in response to specific Validation Targets and that are expected deliver operational and/or performance improvements to European ATM, when translated into their effective realisation. SESAR Technological Solutions relate to verified technologies proven to be feasible and profitable, which may therefore be considered to enable future SESAR Solutions.	SESAR2020 Project Handbook
Single European Sky-High Level Goals	The SES High Level Goals are political targets set by the European Commission. Their scope is the full ATM performance outcome resulting from the combined implementation of the SES pillars and instruments, as well as industry developments not driven directly by the EU.	SESAR2020 Project Handbook
Sub-OE	A subcategory of an Operating environment, classified according to its complexity (e.g., high complexity TMA, medium complexity TMA, low complexity TMA).	EUROCONTROL ATM Lexicon

Term	Definition	Source
Validation targets	Validation targets are the targets that focus on the development of enhanced capabilities by the SESAR Solutions. They aim to secure from R&D the required performance capability to contribute to the achievement of the Performance Ambitions and, thus, to the SES high-level goals. In SESAR2020 validation targets are associated with a KPI.	EUROCONTROL ATM Lexicon

Table 4: Terminology

3 Solution Scope

3.1 Detailed Description of the Solution

This Solution focuses on a collaborative framework for managing arrival constraints at local DCB level.

Solution 39 addresses a single Operational Improvement (OI) step recorded in the DS-23 Dataset, that is the AUO-0110, ***"Collaborative framework for managing arrival within an ATFM regulation"***.

In collaboration with airports, air navigation service providers, airspace users (AUs), and the network manager, SESAR is creating and validating a framework that would allow for the integration and coordination of 4D constraints. This Solution extends the AUs' ability to influence the sequence of arrivals whilst the flights are in the pre-departure phase.

The Solution introduces a framework for a single point of entry for the AUs to provide UDPP prioritisation in a harmonised format, with the aim to allow the Network Manager and other ATM stakeholders to utilise the AU prioritisation for the resolution of capacity-constrained situations on arrivals. Such an approach is primarily expected to reduce the costs of AUs' operations, either through their direct use of UDPP mechanisms integrated in NM systems and thus reducing the cost of delay, or through informing ATM stakeholders about the AU needs. The framework thereby provides opportunities adapted to different situations and types of AUs, and in parallel it ensures continued stability and performance of the Network.

This Solution was initially targeting two Operational Improvement (OIs) steps: AUO-0109 DS-23 collaborative framework for managing arrival constraints at Airport and AUO-0110 DS-23 collaborative framework for managing arrival constraints at Local DCB level. Nevertheless, since the validation of the managing arrival constraints at the Airport was not successful enough to reach the expected maturity(v3), this concept was finally deemed not part of this SESAR solution in the current wave. Consequently, it has been removed from Solution 39.

The Solution provides benefits which include increased flexibility as Airspace Users can suggest to the Network Management Function a preferred order for their flights; improving punctuality of flights, especially where delays would have a significant impact on the AU fleet; and cost-efficiency of airspace users.

More detailed information about the Solution and its goals can be found in the SESAR 2020 Solution PJ.07-W2-39 SPR-INTEROP/OSED V3 - Part I.

3.2 Detailed Description of relationship with other Solutions

Solution Number	Solution Title	Relationship	Rational for the relationship
PJ07-W2-39 with PJ04-W2-28.3	Collaborative management at regional airports	Cross-Effect	Solution PJ.07-W2-39 developed enablers NIMS-46, which were used by PJ.04-W2-28.3. Therefore, PJ.04-W2-28.3 data pack includes PJ.07-W2-39 TS/IRS (D3.1.009) covering NIMS-46. The solution depends also on the inputs from PJ04-W2-28.3 (AOP-NOP integration), which can provide TTAs from the airport perspective (inputs to be considered during the design of the UDPP measure).
PJ07-W2-39 with PJ07-W2-38	Enhanced integration of AU trajectory definition and network management processes	Is preferable to	The solution is linked to PJ07-W2-38, through the provision of Flight delay critically concepts (FDCIs) set-up by the Airspace Users. These inputs are expected to be used in the UDPP measure design (integration to be developed).
PJ07-W2-39 with PJ09-W2-44	Dynamic Airspace Configurations (DAC)	Is preferable to	Link with PJ09-W2-44 with regards to the Integrated network management air traffic control planning (INAP) roles are to be defined.

Table 5: Relationships with other Solutions

4 Solution Performance Assessment

4.1 Assessment Sources and Summary of Validation Exercise Performance Results

Previous Validation Exercises (pre-SESAR2020 Wave 2, etc.) relevant for this assessment are listed below.

Organisation	Document Title	Publishing Date
SESAR 2020 Wave 1, PJ07.01	SESAR Solution 07.01 – VALR V2 - Part I, Edition 00.01.00	September 2019
EUROCONTROL	SESAR Solution PJ.07-02: Validation Report for V2	25/09/2019

Table 6: Pre-SESAR2020 Exercises

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

Exercise ID	Exercise Title	Release	Maturity	Status
EX1-PJ07-W2.39-VALP-001	Real-time simulation for arrivals at Zurich Airport (ZRH)	R12	V3	Completed

Table 7: SESAR2020 Validation Exercises

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

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
EX1-PJ07-W2.39-VALP-001	AUO-0110	This validation exercise consisted of a Shadow Mode human-in-the-loop validation at Zurich airport (LSZH) with SWISS as the main AU stakeholder. This exercise is the first one to be executed through the real time simulation approach, with the objective to address the full set of applicable validation objectives, including human performance aspects. The focus of this exercise was the operational feasibility of the proposed collaborative framework and the validation of AU benefits in an environment that is closer to the operational environment. The exercise was undertaken at Zurich Airport for the arriving traffic, and the exercise focussed on UC1, i.e., the initial resolution of the DCB imbalance is	Confirmation of operational feasibility of the collaborative management of constraints on arrival. Increased AU cost-efficiency Improved punctuality	Real-time simulation (RTS) shadow-mode exercise for validating S39 process based on ATFM regulation High-level goals for the exercise are as follows: - Assess the overall feasibility of the collaborative process for managing arrivals. - Quantify AU benefits from using a UDPP measure instead of standard ATFM regulation. - Measure the impact of UDPP measure on Airport KPIs. - Measure the impact of UDPP measure on DCB issue resolution (efficiency, safety). - Assess HP aspects associated with the use of the S39 collaborative process.

		achieved through an ATFM regulation after which at least one AU – whose flights are part of the given regulation's slot list - participates in the resolution of the imbalance using UDPP mechanisms.		

Table 8: Summary of Validation Results

4.2 Conditions / Assumptions for Applicability

Table 9 summarises the applicable operating environments.

OE	Applicable sub-OE	Special characteristics
Airports [Sabre Market Intelligence data]	Large/Very large airports	• AOP system integrated with NOP UDPP service can use AOP/NOP integrated data to provide AUs with a real-time vision of the current situation according to the status of the network and the airports. Runway, taxiing information etc, can be used to inform AUs on flights' in-block times (IBT) on arrival as an estimation for flight ending time. Accurate IBT information is important in order to manage the landside of the airport, and for AUs to manage the flight rotation (integrating the minimum turn over time - MTTT), crew (crew rotation: flight time limitation, flight duty limitation, rest period), passengers (VIP, passenger in transit…), aircraft maintenance, etc. • AU Capabilities The scope of the Solution covers high-level design and requirements relating to adaptations to the flight operations centre (FOC) system, whilst AUs will manage the detailed design and implementation in their FOC system. Zurich Airport is the geographical location of validation exercise 1 for the scope of this Solution (AUO-0110). The operational environment is centred on the arrival of a large CDM Airport with a CCS. To use UDPP, the arrivals must not be airborne or pre-sequenced. To allocate departure slots, arrivals must depart from airports within the IFPU zone.
		The estimate airspace users that are likely to benefit from the solution is based on an examination of Sabre Market Intelligence data for 2019 for the 32 large and very large airports covered by Solution PJ.07-W2-39. 2.9 million of the approximately 4.2 million flight departures at these airports were from hub airlines and home carriers which are likely to benefit from UDPP capabilities. These would include, for example, Swiss International Airlines at ZRH, Iberia at MAD (including operating carriers such as Iberia Express), or major low-cost carriers at their respective large bases (e.g., EasyJet at CDG).

		For PUN1 metric, average departure delay per flight ECAC wide (2012) is 9.5 min/flight sourced from SESAR Common Assumptions PJ19_2020 Dataset.

Table 9: Applicable Operating Environments.

Table 10 presents an overview of the validation assumptions.

Identifier	Title	Description	Justification	Impact on Assessment
A-PJ07.W2.39-01	UDPP service	UDPP modules are available, verified and follow all relevant rules for manipulating slot lists or TTA lists.	If the modules supporting the integration of UDPP mechanisms into the arrivals management process (i.e., UDPP module with R-NEST[6] and UDPP service in NMVP) are either not available or are not tested and verified to follow the requirements+, then this would otherwise lead to incorrect validation results.	High
A-PJ07.W2.39-02	AU cost-delay curves	Cost-delay curves are available for the exercises and are realistic and valid.	In case the AU cost-delay curves used in exercises are not realistic then the results would otherwise be incorrect and unreliable.	High
A-PJ07.W2.39-03	Simplifying cost calculations	Delaying an already delayed flight further via UDPP would be classified as ATFM delay, not split	This assumption should simplify the cost model. It affects how airspace users spread cost amongst their flights.	Low

[6] RNEST is EUROCONTROL's fast-time simulation platform that allows for exploration of historical data, as well as investigation of new concepts through simulations, typically performed with historical data.

		between ATFM and airspace user delay.		
A-PJ07.W2.39-04	DCB issue resolution	The L-DCB actor resolves the arrival DCB issue in the same fashion in the Reference scenario and in the Solution scenario.	If the initial solution to the DCB issue differs between the two scenarios, then the results would not be directly comparable and may affect the conclusions.	High

Table 10: Validation assumptions overview

4.3 Safety

Solution PJ.07-W2-39 contributes to indirect safety benefits.

4.3.1 Safety Design drivers and Performance Mechanism

The safety information in this PAR draws information from the Solution 39 Safety Assessment Report (SAR) [16] and the PJ07-W2-39 validation report VALR [10].

Based on the SESAR2020 SRM guidance update, in order to address the change introduced by PJ07-W2-39 impacting "Other-than-ATS" operational services (e.g., DCB service provided by NMf), a set of SIIU (Safety impact of the Intended Use) have been identified.

No direct safety impact is expected for airspace users, but the corresponding safety assessment needs to be done to address the safety impact via the ATS services that make use of the "Other than ATS" services and/or Technological Solutions functionalities. PJ07-W2.39 modifies the current NM Flow and capacity management service currently provided by the Network Manager described in the 'NM Flow and capacity management service specification'.

It should be noted that, even though the baseline refers only to regional NM services, the services in the SIIUs defined in this section refer to the NM function (NMf). SIIUs were defined only on the services where it was identified that PJ07-W2-39 is introducing a change with potential safety impact.

SIIUs:

Due to the indirect safety impact that the service might have in the ATS operations in case the service is not properly delivered, the following initial set of Safety impact of the Intended Use (SIIU) needs to be defined:

The following SIIU was derived in order to express in a high-level manner the impact on the Short Term DCB service:

SIIU000: The change introduced by PJ07-W2.39 to the Short Term DCB service shall not increase the number of overloads.

This high-level SIIU needs to be further described according to the components of the Short Term DCB service:

- In order to account for the impact on the ATFCM measure design function inside the "Demand and Capacity Balancing" service. The purpose of this service is to react when the predicted traffic demand is higher than the available capacity by considering, assessing, and implementing adequate solutions such as ATFCM measures. The ATFCM measures contain the following functions that are impacted by the solution- ATFCM measure design and Network cherry-pick regulations.

- *SIIU001: The ATFCM measure design service delivered to ATS, service which is modified by PJ07-W2.39 with the AUs inputs and new functionalities (e.g., What-if/What-else) shall not increase the number of overloads.*
- *SIIU002: The ATFCM measure implementation service delivered to ATS, service which is modified by PJ07-W2.39, shall not increase the number of overloads.*
- *SIIU003: The Network cherry-pick regulations service delivered to ATS, service which is modified by PJ07-W2.39 with the AUs inputs and new functionalities (e.g., What-if/What-else) shall not increase the number of overloads.*

4.3.2 Data collection and Assessment

The safety objective assessment is based on the combination of FMP feedback and quantitative data analysis. The FMP is the stakeholder/actor primarily associated with the safety aspect of the CCS resolution. In essence, any measure deployed to a CCS has to be sufficiently effective to resolve the CCS safely. In case of an ATFM measure, the assumption is that the CCS is significant enough to activate a 'blanket' measure that is based on equal spacing of flights (which is achieved through the regulation rate); this emphasises the safety concern. The objective assesses whether a UDPP measure based on Use Case 1 of Solution 39 concept delivers the same degree of safety as current ATFM regulations.

The FMP feedback clearly confirmed that there were no safety issues from UC1. This is because CASA still computes slots and allocates flights to those slots. The UDPP service becomes the 'supplier' of pseudo-ETOs which are modified from the real ETOs based on the UDPP inputs submitted by the AUs.

The quantitative analysis confirms the FMP's feedback. The analysis was based on extracting the Entry Counts for Traffic load from the operational logs of NMVP (for the Solution scenario) and from the operational logs of the replay (for the Reference scenario). The counts were extracted for the Baseline scenario and for post-Submit, i.e., taking into account the submitted UDPP inputs. This allows a direct comparison of counts to determine any major discrepancies between the Reference and Solution scenarios that would imply a reduced confidence in resolving the CCS safely.

Validation Objective Id	Success Criterion Id	Success Criterion	Validation Results	Validation Objective Status
OBJ-07-W2.39-V3-VALP-SA1	CRT-07-W2.39-V3-VALP-SA1-001	The collaborative framework has no effect on the identification of a CCS and/or definition of a hotspot.	The identification of the CCS is not compromised with the new concept.	OK

Validation Objective Id	Success Criterion Id	Success Criterion	Validation Results	Validation Objective Status
	CRT-07-W2.39-V3-VALP-SA1-002	The DCB imbalance resolution for the arrival CCS, measured through Entry counts, in Solution scenario is equivalent to the reference scenario.	Data shows that the entry counts in the target TFV in the Solution scenarios are equivalent to the Reference scenario entry counts.	
	CRT-07-W2.39-V3-VALP-SA1-003	The DCB imbalance resolution for an arrival CCS does not increase the number of overloads, measured through Occupancy counts, within the Network.	Data shows that the occupancy counts in the observed/monitored TFVs in the Solution scenarios are equivalent to the Reference scenario occupancy counts.	

Table 11:PJ07-W2-39 exercises safety validation objectives, success criteria & Validation results

4.3.2.1 Deriving Safety Requirements at Design level for Normal and Abnormal conditions of operation

The derivation of Safety requirements at design level - SRD for Normal and Abnormal conditions of operation is mainly driven by the SRS (functionality and performance) for Normal and Abnormal conditions of operation.

Meanwhile additional SRD might be identified from the static view and dynamic view analysis of the system behaviour in normal and abnormal operational conditions that needs to be conducted in order to show completeness/correctness of the Safety Requirements (Functionality and Performance).

Finally, any additional SRD resulting from the analysis ensuring that the System design operates in a way that does not have a negative effect on the operation of related ground-based and/or airborne safety nets must be documented here as well.

Safety Requirement ID	Safety Requirement (functionality & performance) description	Related service hazard(s)
REQ-07-W2-39-SPRINTEROP-LDCB.001	Local DCB shall monitor the arrival traffic prediction in Airport, and shall have the possibility to set a UDPP measure	Hz 01
REQ-07-W2-39-SPRINTEROP-LDCB.003	Local DCB shall have the possibility to update or request to update a UDPP measure to manage the change of the	Hz 02

	constraint on arrival traffic at Airport in coordination with NM	
REQ-07-W2-39-SPRINTEROP-LDCB.007	DCB shall have the possibility to optimize the new arrival time of flights by adjusting TTAs	Hz 02
REQ-07-W2-39-SPRINTEROP-NMUD.003	NM internal function shall manage the reference time, calculate the baseline time and cut-off time on each flight according to the current status of the flight, enabling AU prioritisation and the flight transition to Local DCB optimisation	Hz 01
REQ-07-W2-39-SPRINTEROP-NMUD.006	The UDPP functions shall create and maintain the AU UDPP environment to allow AUs prioritisation according to the possible variability of the Network	Hz 02
REQ-S39-TS-LDCB.0001	Local DCB tool can monitor the load and capacity of traffic volumes (En-route, Departure Airport, Arrival Airport)	Hz 01
REQ-S39-TS-LDCB.0002	Local DCB tool shall be able to manage a UDPP measure function (creation, read, update, delete)	Hz 02
REQ-S39-TS-NMUD.0003	The Regional ATFCM system shall maintain for each flight the UDPP cut-off time and prohibit any changes in priority past this time	Hz 01
REQ-S39-TS-NMUD.0006	The Regional ATFCM system shall update the slot allocation when the network evolves or at certain key milestones like SIT1 based on the latest flight prioritisations	Hz 02

Table 12: Safety Requirements at design level (functionality and performance) & potential safety impact (hazards) in case of non-compliance

4.3.2.2 Dynamic Analysis of the initial design level Model – Normal Operational Conditions

The Project made full use of the validation exercises feedback to progressively refine and complete the SPR-INTEROP/OSED requirements (the link with the safety requirements for normal operational conditions has been explained in the previous sub-section).

In addition, a specific Safety Validation Objective was included in the VALP to cover the potential impact on the network stability of several UDPPs applied at the same time, already captured through:

- a Safety Issue (*I001: Impact of several UDPP measures implemented simultaneously at Network level remains to be analysed and tested*) in PJ07.02 SAR **Error! Reference source not found.** in Wave 1 and,

- also covered in this document through the *SRS003: "The implementation of several co-existing UDPP measures at ECAC level shall not negatively impact the stability of the Network"*.

Related to this, the outcome of the Fast-time simulation activity in RNEST (RNEST FTS), collected in the VALR [10] is the following:

"The FTS activity was also used to exploit the RNEST computational capability to derive Occupancy counts from the simulated environment and traffic, with the aim to measure the Network stability in the context of the use of UDPP. This is related to the safety validation objective formulated in Safety Assessment Plan of Solution 39.

The methodology used can be summarised as follows:

- *For each scenario based on AIRAC1909 as described in previously, the Occupancy counts were computed by RNEST. A single definition was used for all Traffic Volumes investigated: 10 minutes of window width and a 5-minute step. E.g., the first occupancy count covered 00:00 – 00:10Z, the following one 00:05-00:15Z etc.*
- *The OCs defined above were applied to simulated traffic and OC values were derived by RNEST for all Traffic Volumes (TFVs) contained within RNEST's database, for all simulated scenarios and for all dates within AIRAC1909.*
- *A selection of TFVs (all EB, ED, LF and EG TFVs, approx. 2600 TFV in total) with their OCs were exported and analysed as a time series of values: adjacent OCs were compared to derive the deltas from one OC to another.*
- *The progression of the OCs was summarised and compared across the scenarios, by using the mean absolute delta for a single OC series.*

A side-by-side comparison of the aggregated statistics for the simulated scenarios show that the Network stability is comparable in all Solution scenarios to the Reference scenario without UDPP interventions.

Scenario	Minimum	1st quartile	Median	Mean	3rd quartile	Max
Baseline	0	0.4112	1.0383	1.0628	1.4887	8.6969
Scenario A	0	0.4112	1.0418	1.0630	1.4913	8.7875
Scenario B	0	0.4112	1.0383	1.0626	1.4878	8.6934
Scenario C	0	0.4112	1.0418	1.0630	1.4913	8.7875

Table 13: Mean of absolute deltas of Occupancy Counts for FTS simulation scenarios

The statistics above were derived from the full set of Traffic Volume + Date + Simulation scenario combinations. The results confirm the expectations that the deployment of UDPP does not alter the Network stability significantly, and that the effects of UDPP interventions are typically masked by the normal variability present even in today's operations."

It can be concluded that the implementation of several UDPP measures at network level will not negatively impact the stability, thus will not impact safety.

4.3.3 Extrapolation to ECAC wide

There is no safety impact from Solution PJ.07-W2-39, therefore extrapolation was not applicable.

4.3.4 Discussion of Assessment Result

There is no safety impact from Solution PJ.07-W2-39.

4.3.5 Additional Comments and Notes

Based on the outcomes of the previous Safety assessment carried out in PJ07-02, the following Safety issue needs to be considered:

Ref	Safety issue	Resolution
I001	Impact of several UDPP measures implemented simultaneously at network level remains to be analysed and tested	The information included in the VALR demonstrates that there is no safety impact (see section 4.3.2.2) As such, this safety issue raised during PJ07-02 SAR in Wave 1 is considered to be resolved and closed
I002	-	-

Table 14: Safety Issues log

The rational for deriving this issue is that the solution introduces a more collaborative way of resolving a Hotspot. From a Safety point of view, it needs to be ensured that this new procedure solves the hotspot in an appropriate and timely manner, while not creating new hotspots in other sectors at short notice or impacting the resolution of other existing hotspots.

4.4 Environment: Fuel Efficiency / CO2 emissions

Solution PJ.07-W2-39 maintains current fuel efficiency/ CO2 emissions levels while not contributing to further benefits.

4.4.1 Performance Mechanism

Solution PJ.07-W2-39 maintains current fuel efficiency/ CO2 emissions levels while not contributing to further benefits.

4.4.2 Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 maintains current fuel efficiency/ CO2 emissions levels while not contributing to further benefits.

4.4.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 maintains current fuel efficiency/ CO2 emissions levels while not contributing to further benefits.

4.4.4 Discussion of Assessment Result

Solution PJ.07-W2-39 maintains current fuel efficiency/ CO2 emissions levels while not contributing to further benefits.

4.4.5 Additional Comments and Notes

Solution PJ.07-W2-39 maintains current fuel efficiency/ CO2 emissions levels while not contributing to further benefits.

4.5 Environment / Emissions, Noise and Local Air Quality

Solution PJ.07-W2-39 maintains current environment/emissions, noise and local air quality levels while not contributing to further benefits.

4.5.1 Performance Mechanism

Solution PJ.07-W2-39 maintains current environment/emissions, noise and local air quality levels while not contributing to further benefits.

4.5.2 Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 maintains current environment/emissions, noise and local air quality levels while not contributing to further benefits.

4.5.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 maintains current environment/emissions, noise and local air quality levels while not contributing to further benefits.

4.5.4 Discussion of Assessment Result

Solution PJ.07-W2-39 maintains current environment/emissions, noise and local air quality levels while not contributing to further benefits.

4.5.5 Additional Comments and Notes

Solution PJ.07-W2-39 maintains current environment/emissions, noise and local air quality levels while not contributing to further benefits.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

4.6 Airspace Capacity (Throughput / Airspace Volume & Time)

Solution PJ.07-W2-39 does not contribute to airspace capacity benefits.

4.6.1 Performance Mechanism

Solution PJ.07-W2-39 does not contribute to airspace capacity benefits.

4.6.2 Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 does not contribute to airspace capacity benefits.

4.6.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to airspace capacity benefits.

4.6.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to airspace capacity benefits.

4.6.5 Additional Comments and Notes

Solution PJ.07-W2-39 does not contribute to airspace capacity benefits.

4.7 Airport Capacity (Runway Throughput Flights/Hour)

Solution PJ.07-W2-39 does not contribute to airport capacity benefits.

4.7.1 Performance Mechanism

Solution PJ.07-W2-39 does not contribute to airport capacity benefits.

4.7.2 Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 does not contribute to airport capacity benefits.

4.7.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to airport capacity benefits.

4.7.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to airport capacity benefits.

4.7.5 Additional Comments and Notes

Solution PJ.07-W2-39 does not contribute to airport capacity benefits.

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

Solution PJ.07-W2-39 does not contribute to resilience benefits.

4.8.1 Performance Mechanism

Solution PJ.07-W2-39 does not contribute to resilience benefits.

4.8.2 Assessment Data (Exercises and Expectations)

No validation of resilience performance took place as part of Solution 28.3.

4.8.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to resilience benefits.

4.8.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to resilience benefits.

4.8.5 Additional Comments and Notes

N/A

EUROPEAN PARTNERSHIP

Co-funded by the European Union

4.9 Flight Times

Solution PJ.07-W2-39 does not contribute to flight time benefits.

4.9.1 Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 does not contribute to flight time benefits.

4.9.2 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to flight time benefits.

4.9.3 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to flight time benefits.

4.9.4 Additional Comments and Notes

Solution PJ.07-W2-39 does not contribute to flight time benefits.

4.10 Predictability

Solution PJ.07-W2-39 does not contribute to predictability benefits.

4.10.1Performance Mechanism

Solution PJ.07-W2-39 does not contribute to predictability benefits.

4.10.2Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 does not contribute to predictability benefits.

4.10.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to predictability benefits.

4.10.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to predictability benefits.

4.10.5 Additional Comments and Notes

Solution PJ.07-W2-39 does not contribute to predictability benefits.

4.11 Punctuality

Solution PJ.07-W2-39 has a positive impact on punctuality.

By increasing the punctuality of individual flights, especially those whose delays can have a significant impact on the AU fleet, Solution PJ.07-W2-39 is anticipated to have a positive effect on overall punctuality.

4.11.1 Performance Mechanism

The **benefit and impact mechanism** refers to two punctuality KPIs:

1. **PUN1** (average departure delay per flight) and **PUN5** (% Flights departing within +/- 15 minutes of scheduled departure time due to reactionary delays, ATM, and weather-related delay causes).

2. **Regarding PUN5**, the maximum Target time of arrival (TTA) that can be allocated by IODA is 10 minutes, unless the FMP asks NM to approve a greater delay. Both PUN1 and PUN2 relate to departure delay, whereas the concept is concerned with arrivals. Arrivals, of course, lead to eventual departures. The schedules of the AUs may absorb some arrival delay, thus further reducing the impact on departure delay KPIs.

Mechanism number	Impact type	Impact direction	Beneficiary
8b	Operational results (delays)	Positive	Airspace Users

Table 15: Punctuality Benefits

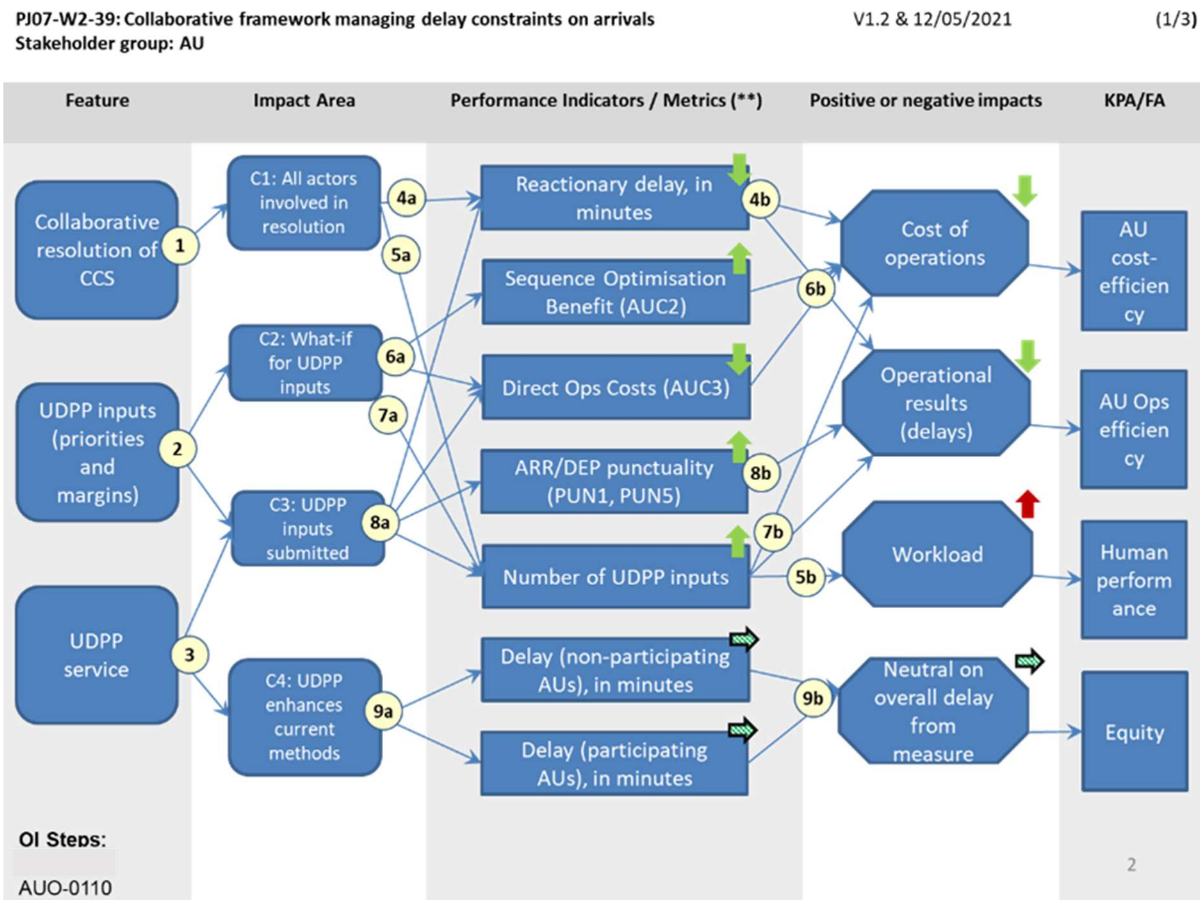

Figure 1: BIM for AUO-0110 – Airspace Users

UDPP aims to act on the ATFM delay of flights within an ATFCM measure in the pre-departure phase, with the goal to manage the reactionary delay **but primarily the cost of this delay in subsequent rotations**. Involvement of AUs in the resolution of the Capacity Constrained Situation by using UDPP mechanisms would help manage the reactionary delay, and thus help the AU manage the subsequent aircraft rotations and associated passenger connections and curfew infringements.

The purpose of the Solution is to improve AU cost-efficiency, not to directly improve punctuality.

NOTE:

Reference scenario - The reference scenario utilises historical flights and all historical ATFM regulations (both airport and en-route) as inputs, and each day is re-run as a simulation. In this scenario none of the ATFM regulations are converted into UDPP measures, and no AUs participate in the UDPP process.

Solution scenarios - The ‘UDPP deployment’ scenarios were constructed in incremental fashion, to reflect certain realistic scenarios

- Scenario A: UDPP at ZRH (LSZH) by SWISS only: any ATFM regulation on Zurich airport arrivals is converted into a UDPP measure, and SWISS are the only participating UDPP AU on those measures.
- Scenario B: UDPP measures for Traffic Volumes of top 7 airfields (EGLL, EGKK, EHAM, LFPG, EDDF, EDDM, LEMD) plus LSZH, with AFR, BAW, DLH, IBE, KLM and SWR as the participating AUs.
- Scenario C: UDPP measures for all airport ATFM regulations and all AUs possibly participating[7].

4.11.2Assessment Data (Exercises and Expectations)

This first exercise was performed as a real time simulation, intended to address the full set of applicable validation objectives, including human performance aspects. The focus in this exercise was to confirm the operational feasibility of the proposed collaborative framework and the validation of AU benefits in an environment that is close to the operational environment.

The exercise was undertaken at Zurich airport for the arriving traffic, and the exercise focussed on UC1, i.e., the initial resolution of the DCB imbalance is achieved through an ATFM regulation after which at least one AU – whose flights are part of the given regulation's slot list - participates in the resolution of the imbalance using UDPP mechanisms. Human actors in the roles of FMP, AU, airport and NMOC took part in the exercise. This scenario is believed to allow for a thorough validation of the HP aspects of the new collaborative framework.

There was no assessment of punctuality, as defined by AOBT-SOBT or AIBT-SIBT, because the exercise was limited to the pre-departure phase.

For this the cost of delay was considered more important than overall punctuality (although the two are loosely related), so AU decisions would be driven to minimise delay cost, not necessarily to improve punctuality.

EX1-OBJ-07-W2.39-VALP-PU1 Results

The punctuality objective was assessed using the operational log datasets from NMVP and from datasets of SWISS. In the absence of the end-of-the-day data, the analysis was based on data capture at the Baseline and UDPP Submit (i.e., based on the submission of UDPP criteria) of each run, using the same operational log from NMVP. The rationale is that the data recorded at the Baseline data retrieval by the AU in a scenario run is equivalent to the Reference scenario data, and that the data recorded after the

[7] The exercise does not specify which AU are assumed to participate and benefit from UDPP in the context of Solution 39. Mindful of the nature of UDPP and swapping of slots, only AU that have a considerable number of flights during the day/ within an hour at one of the airports in scope would benefit. Therefore, only airlines with an operational base and/ or hub activities are likely to benefit.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

UDPP Submit offer the Solution scenario data for direct comparison to measure punctuality benefits of the concept.

The metrics and results below cover all scenario runs in the exercise.

The PUN1 metric measures the departure delay per flight, indicating an average reduction of 0.056 minutes (3.3 seconds) per flight, i.e., a marginal punctuality improvement. The off-block delay was measured using the scheduled off-block time (provided by SWISS) and the CTOT or ETOT (when CTOT was not available) of each flight. Subsequently, 10 minutes of taxi time were assumed to estimate the estimated off-block time. The measurements covered the entire operation of SWISS on the given days; therefore, the punctuality improvements represent the overall net result of all the partial (individual flight) benefits/disbenefits triggered by the UDPP actions.

Using the same dataset as described in the previous paragraph, the average PUN5 metric, measured at the 15 minutes on-time threshold, for all scenario runs shows an 0.42 percentage point improvement in the on-time departure performance following the UDPP submits.

For arrival punctuality performance, the analysis was refocused only on the arrivals to LSZH (Zurich Airport). There was no need to account for the (non)existence of CTOTs for the given flights, as the estimated in-block times did reflect the CTOT when it was present. Therefore, the analysis simply compared the scheduled and estimated in-block times to determine the delay and arrival on-time performance.

The arrival delay improvement for all LSZH arrivals is in a similar region to the departure delay improvement, with an average value of 0.058 minutes per flight. However, the corresponding on-time arrival performance (15 minutes threshold) shows an average decline of -0.02%, which is a marginal degradation of punctuality. This suggests that the mean of the distribution of delays is shifted towards lower values, while there is also a higher cumulative proportion in the >15 minutes tail of the distribution.

Key Results from RNEST FTS

The fast-time simulation (FTS) executed with RNEST was a supporting activity to Solution 39. The results for which are not being used to extrapolate the ECAC wide benefits, but to support and reference it for completeness.

The simulations show that the PUN2 metric (on time performance on 3 minutes of AOBT-SOBT delay) is marginally improved with Scenario B: the average improvement is 0.031%, with Reference scenarios at average of 43.33% and Scenario B average at 43.36%. Scenario A effectively shows no change in the PUN2 metric (average change of +0.005%), while Scenario C also shows a negligible average decrease of -0.002% over the entire AIRAC cycle. These results can be approximated as signifying no change in departure punctuality at network level. These punctuality results imply a balancing effect: improved departure punctuality of some of the (prioritised) arrivals inside the CCS/UDPP measure under resolution and their subsequent rotations are counter-balanced by a degradation in departure punctuality of other arrivals inside the CCS and their subsequent rotations.

The ATM delay portion of the PUN1 metric (expressed in minutes of delay per flight), shows a decrease of -0.008 mins/flights in Scenario B (vis-à-vis the Reference scenario), which points to a minor decrease in overall ATFM delay generated by UDPP measures. Scenario C however shows an average increase ATM contribution to PUN1 metric of +0.003 mins/flight versus the Reference scenario.

The reactionary delay part of the PUN1 metric follows the pattern of ATM delay portion: Scenario B yields an average decrease of -0.006mins/flight, while the Scenarios A and C produced an average increase of +0.005mins/flight.

The RNEST FTS provided the Network-wide view on the punctuality benefits. The Scenario B assuming a rollout of the Solution 39 process at eight very large/large airports, with the appropriate hub AUs participating in the UDPP process, the PUN2 punctuality metric (three-minute departure punctuality) was computed with an average improvement of 0.031% against the Reference scenario simulation (no UDPP).

SESAR Solution Validation Objective ID	SESAR Solution Validation Objective Title	SESAR Solution Success Criterion ID	SESAR Solution Success Criterion	SESAR Solution Validation Results	SESAR Solution Validation Objective Status
		CRT-07-W2.39-V3-VALP-PU1-001	Overall average departure delay (PUN1) for a participating AU is improved in the solution scenario.	PUN1 metric showed a decrease of 0.056 mins/flight for UC1.	OK
		CRT-07-W2.39-V3-VALP-PU1-002	Percentage of flights departing within +/- 15mins of SOBT due to reactionary delays, ATM, and weather-related causes (PUN5) for a participating AU is improved in the solution scenario.	PUN5 metric showed an increase of 0.42 percentage points.	
		CRT-07-W2.39-V3-VALP-PU1-003	Reactionary delays for the full sequence of rotations of a single aircraft stemming from UDPP interventions of a participating AU are reduced.	Reactionary delays not measured due to the execution method of the scenarios.	
		CRT-07-W2.39-V3-VALP-PU1-004	There is no impact on overall arrival punctuality (% of flights within +15mins of AIBT-SIBT) at the airport for which the CCS is resolved in the solution scenario.	AIBT-SIBT in mins/flight showed a decrease of 0.058 mins/flight which is a positive result, however the % performance showed a decrease in performance of 0.02%.	

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Table 16: Summary of Validation Exercises Results

There was no benefit in SESAR 1 or SESAR 2020 Wave 1 for PUN1 as it was not a KPI. On the other hand, there was a 0.0003-minute benefit in SESAR 1 or SESAR2020 Wave 1 for PUN2. Therefore, PJ.07-W2-39 would replace the Wave 1 (PJ.07-02 - V2 completed) results.

Exercise ID or Expert judgement	Benefits contribution to PUN1	Benefits contribution to PUN2
EXE-PJ07-W2.39-V3-VALP-001	PUN1 measures the departure delay per flight shows an average reduction of 0.056 minutes per flight, which means a marginal punctuality improvement.	For the R-NEST activity the PUN2 punctuality metric (3minute departure punctuality) was computed with an average improvement of 0.031% against the Reference scenario simulation (no UDPP).

Table 17: Punctuality benefit per Exercise

OI step	Relative benefits contribution to PUN1	Relative benefits contribution to PUN2
AUO-0110	56.665%	43.335%
TOTAL	100%	100%

Table 18: Punctuality relative benefit per OI step

4.11.3 Extrapolation to ECAC wide

The validation results above present the improvement in punctuality for the validation exercise of Solution 39. The scope of the exercise was limited to eight large and very large airports for six airlines, but it is necessary to extrapolate the benefits to averages per flight at ECAC level.

To translate the benefits observed for the eight airports included in the validation exercise to an overall ECAC wide assessment it is necessary to estimate the number of flights at all airports in scope for Solution PJ07-W2-39 within ECAC, that is to all large and very large airports. This number is then compared with the total number of flights for all airports ECAC wide. This was done via the following methodology:

- The comprehensive list of ECAC area airports, corresponding Airports' Group in 2019 according to SESAR 2020 Airports' Classification Scheme and individual 2019 traffic figures was sourced from

SESAR Airport OE Dataset [Table 32]. Only the Airports' Group scope assessed by the OI step AUO-0110 covered by this validation exercise were selected.[8]

The observed benefits in the validation exercise only accrue to departures. This provided an estimate of **departures** for the 32 large/ very large airports **4,384,065** IFR airport movements and *8,767,907 annual IFR airport movements.*

Airport Size	Number of airports
Very large	14
Large	18

The following assumptions were established for the ECAC wide extrapolation:

Scenario	Number of departures	Percentage of traffic
All airlines in the airports' group scope	4.3 M	50.6%

For PUN1 metric, average departure delay per flight ECAC wide (2012) is 9.5 min/flight sourced from SESAR Common Assumptions PJ19_2020 Dataset.

The estimate of the *IFR departures for in scope airports* are ***4,384,065** movements* and the IFR departures for **ECAC wide** is **8,591,631** movements.

The formula used to extrapolate the benefits for the PUN1 metric is:

$$Number\ of\ IFR\ departures\ for\ in\ scope\ airports * Average\ departure\ delay\ reduction = \text{Absolute expected performance benefit}$$

$$\mathbf{4,384,065 * 0.056 = 245,508\ min}$$

$$\mathbf{\frac{245,508}{8,591,631} = 0.0285\ min/flight}$$

The total delay at all airports ECAC wide was 81,620,495 min. Hence, the reduction in delays represents:

[8] Very large and large hub airports.

$$\frac{245,508}{81,620,495} = 0.30\%$$

This provides an estimated ECAC wide improvement of **0.30%** for the average departure delay per flight. This figure is estimated using traffic from 2019, not 2035. For an extrapolation to 2035 please refer to 4.11.4.1.

The simulations from the R-NEST activity show that the PUN2 metric (on time performance on 3 minutes of AOBT-SOBT delay) is marginally improved with Scenario B: the average improvement is 0.031%, with Reference scenarios at average of 43.33% and Scenario B average at 43.36%. Scenario A effectively shows no change in the PUN2 metric (average change of +0.005%), while Scenario C also shows a negligible average decrease of -0.002% over the entire AIRAC cycle. These results can be interpreted as a no change in departure punctuality at network level.

Similarly, for the PUN5 metric this formula was used to extrapolate the punctuality improvements from the validation exercise to ECAC wide:

$$Punctuality\ improvement * \frac{\text{departures from in scope ECAC aiports}}{total\ number\ of\ flights\ in\ ECAC} = \text{ECAC wide punctuality improvement}$$

To establish the punctuality improvement in terms of the percentage of flights departing within +/- 15 minutes (PUN5) of scheduled departure time due to reactionary delays, ATM, and weather-related delay causes the value from the validation exercise was used, i.e., 0.42%-point difference improvement at the large and very large airports. The number of ECAC departures at these airports was 4,384,065, compared to the total number of ECAC flights was 17,185,911 taken for the year 2019.

$$0.42 * \frac{4,384,065}{8,591,631} = 0.21\%$$

This provides an estimated ECAC wide improvement of **0.21%** for the percentage of fights delayed by no more than +/- 15 minutes (PUN5).

KPIs / PIs	**Unit**	**Calculation**	**Mandatory**	**Absolute expected performance benefit in SESAR2020**	**% Expected performance benefit in SESAR2020**
PUN1 Average departure delay per flight	min/ flight	Average delay (AOBT – SOBT) per flight due to reactionary delays, ATM, and weather-related delay causes.	YES	0.0143 min/flight	0.30% improvement [0.17 % to very large airports and 0.13 % to large airports]

KPIs / PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% Expected performance benefit in SESAR2020
PUN2 % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather-related delay causes	%	% Departures so that |AOBT – SOBT| < +/- 3 min. Difference in Actual Departure Time vs. Scheduled Time due to ATM and weather-related delay causes.	YES	*N/A*	*0.031% average improvement*
PUN5 % Flights departing within +/- 15 minutes of scheduled departure time due to reactionary delays, ATM, and weather-related delay causes	%	% Departures so that (AOBT – SOBT) < +/- 15 min. Difference in Actual Departure Time vs. Scheduled Time due to ATM and weather-related delay causes.	NO	*N/A*	*0.21% improvement*

Table 19: Punctuality benefit for Mandatory KPIs /PI

Table 20 shows the impact on flight phases (provided when it is possible).

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
PUN1 Average departure delay per flight	0.0285 min/flight 0.30% improvement	N/A	N/A	N/A	N/A
PUN2 % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather-related delay causes	0.031% improvement	N/A	N/A	N/A	N/A
PUN5 % Flights departing within +/- 15 minutes of scheduled departure time due to reactionary delays, ATM, and weather-related delay causes	0.21% improvement	N/A	N/A	N/A	N/A

Table 20: Punctuality benefit per flight phase

4.11.4 Discussion of Assessment Result

The punctuality benefit described in relation to Solution PJ.07-W2-39 and observed in the validation exercises appears plausible, based on the specific deployment scenarios that were defined in validation exercise 1, involving Swiss International Airlines at its operational hub at Zurich airport. However, it should be noted that the impact of the solution may vary considerably when applied at other airports and for other AUs. The validation target assigned prior to the validation exercise was 0.55% to very large airports and 0.45% to large airport. However, the validation exercises did not provide quantitative evidence of achieving the validation target, with the ECAC-wide results for overall improvement being 0.30% (very large airports contribute 0.17% of the improvement, and large airports contribute 0.13% of the improvement). This maybe be owed to the performance of the solution, as well as scope of the exercises and other assumptions.

Those AUs which have a considerable operational presence at those airports where UDPP is deployed would be most likely to benefit from the solution, given that the priorisation of flights is only possible if multiple flights are available for optimisation. Therefore, airlines that maintain an operational base and/ or hub operation at one of the airports in scope would benefit more than AUs which operate a very limited number of flights. The benefits enjoyed by hub airlines or home carriers can include a reduction in missed passenger connections (and associated costs), optimised crew and aircraft rotations, optimisation of ground handling activities, a reduction in number of curfew infringements, etc. (and the corresponding costs). In some instances, codeshare partners of these AU may also benefit from the improved operational coordination enabled by UDPP.

The extrapolation for the indicators AUC2 and AUC3 assumes that the per-flight benefits observed in the validation exercise at Zurich airport can be applied to all flight departures at the large and very large airports in scope of Solution PJ.07-W2-39. However, by identifying the relative share of hub airlines and home carriers among all departures at each of the airports in scope (approximately 70%[9]), it would be a more realistic approach to consider that only seventy percent of the departures actually incur the per-flight benefit described.

Also, even without the deployment of Solution PJ.07-W2-39, some degree of non-automated UDPP is likely to already take place today at the Airport Operational Centre’s (APOC) of major airports, especially involving major AU (large hub airlines and home carriers) which by default often have a representative in

[9] The estimate is based in the analysis of Sabre Market Intelligence data for 2019 for the 32 large and very large airports in scope of Solution PJ.07-W2-39. Out of approximately 4.2 million flight departures at these airports, 2.9 million were departures of hub airlines and home carriers. These would include, for example, Swiss International Airlines at ZRH, Iberia (incl. operating carriers like Iberia Express), and so on, as well as major low-cost airlines at their respective large bases (e.g., EasyJet at CDG).

the APOC. In this context, it is not clear if the validation exercises for Solution PJ.07-W2-39 assume that a basic level of coordination of UDPP is already taking place under the baseline scenario.

Specifically, the validation at Zurich airport took place during a limited time window during the operating day (as described above). This may affect the validity of the results, potentially omitting arrivals optimisations towards the end of the day, when they may be particularly helpful to prevent missed connections, crew time infringements, etc. On the other hand, the limited duration of the exercise is not necessarily representative of a longer period of time.

4.11.4.1 Extrapolation to 2035

For 2035, the traffic at very large airports is 71.1% and large airports is 21.3%. If the results of year 2019 are extrapolated up to 2035 for a total traffic movement of 92.4% will give a departure count of 7.85M.

For PUN1 metric, the average departure delay per flight ECAC wide (2012) is 9.5 min/flight sourced from SESAR Common Assumptions PJ19_2020 Dataset.

The estimate of the *IFR departures for in scope airports* are ***7,850,000*** *movements* (for 2035) and the IFR departures for **ECAC wide** is **8,591,631** movements (for 2035).

The formula used to extrapolate the benefits for the PUN1 metric is:

$$Number\ of\ IFR\ departures\ for\ in\ scope\ airports * Average\ departure\ delay\ reduction = \text{Absolute expected performance benefit}$$

$$\mathbf{7,850,000 * 0.056 = 439,600\ min}$$

$$\frac{\mathbf{439,600}}{\mathbf{17,185,911}} = \mathbf{0.025\ min/flight}$$

Similarly, for the PUN5 metric this formula was used to extrapolate the punctuality improvements from the validation exercise to ECAC wide:

$$Punctuality\ improvement * \frac{\text{departures from in scope ECAC aiports}}{total\ number\ of\ flights\ in\ ECAC} = \text{ECAC wide punctuality improvement}$$

To establish the punctuality improvement in terms of the percentage of flights departing within +/- 15 minutes (PUN5) of scheduled departure time due to reactionary delays, ATM, and weather-related delay causes the value from the validation exercise was used, i.e., 0.42%-point difference improvement at the large and very large airports. The number of ECAC departures at these airports was 7,850,000, compared to the total number of ECAC flights was 17,185,911 taken for the year 2019.

$$\mathbf{0.42} * \frac{\mathbf{7,850,000}}{\mathbf{17,185,911}} = \mathbf{0.19}\%$$

This provides an estimated ECAC wide improvement of **<u>0.19%</u>** for the percentage of fights delayed by no more than +/- 15 minutes (PUN5).

4.11.5 Additional Comments and Notes

N/A

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

Solution PJ.07-W2-39 does not contribute to Civil-Military Cooperation and Coordination benefits.

4.12.1 Performance Mechanism

Solution PJ.07-W2-39 does not contribute to Civil-Military Cooperation and Coordination benefits.

4.12.2 Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 does not contribute to Civil-Military Cooperation and Coordination benefits.

4.12.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to Civil-Military Cooperation and Coordination benefits.

4.12.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to Civil-Military Cooperation and Coordination benefits.

4.12.5 Additional Comments and Notes

Solution PJ.07-W2-39 does not contribute to Civil-Military Cooperation and Coordination benefits.

4.13Flexibility

Solution PJ.07-W2-39 may have a positive impact on flexibility. The full participation of AUs through their flight operations centres (FOC) into ATM collaborative processes – including flight prioritisation with UDPP – helps to minimising the impact of deteriorated operations on stakeholders. It allows for a better recovery process that should offer more flexibility to accommodate AUs' changing business priorities and equity in the ATM system. SESAR Wave 1 activities came to the assessment that UDDP increases *airport flexibility in capacity constraint situations and gives airspace users the* ability to solve the problem by lowering costs and increasing network and flight rotation stability, which will naturally increase airport and network stability and increase the number of successful passenger connections. However, flexibility benefits were not included in the validation target for the V3 validation exercises and did not contribute to the KPAs addressed.

4.13.1Performance Mechanism

Solution PJ.07-W2-39 may contribute to flexibility benefits. However, it does not contribute to the KPAs addressed in the scope of V3 the validation exercises.

4.13.2Assessment Data (Exercises and Expectations)

Solution PJ.07-W2-39 may contribute to flexibility benefits. However, it does not contribute to the KPAs addressed in the scope of V3 the validation exercises.

4.13.3Extrapolation to ECAC wide

Solution PJ.07-W2-39 may contribute to flexibility benefits. However, it does not contribute to the KPAs addressed in the scope of V3 the validation exercises.

4.13.4Discussion of Assessment Result

Solution PJ.07-W2-39 may contribute to flexibility benefits. However, it does not contribute to the KPAs addressed in the scope of V3 the validation exercises.

4.13.5Additional Comments and Notes

Solution PJ.07-W2-39 may contribute to flexibility benefits. However, it does not contribute to the KPAs addressed in the scope of V3 the validation exercises.

4.14 Cost Efficiency

Solution PJ.07-W2-39 does not contribute to Cost efficiency benefits.

4.14.1 Performance Mechanism

Solution PJ.07-W2-39 does not contribute to Cost efficiency benefits.

4.14.2 Assessment Data (Exercises and Expectations)

Some data was recorded on the costs saved by prioritising, but unfortunately there was not enough data to make a useful analysis. So, the concept's implied main benefit remains unmeasured.

4.14.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to Cost efficiency benefits.

4.14.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to Cost efficiency benefits.

4.14.5 Additional Comments and Notes

N/A

4.15Airspace User Cost Efficiency

Solution PJ.07-W2-39 contributes to Airspace User Cost efficiency.

The Airspace User Cost Efficiency metrics capture monetized operational and non-operational airspace user benefits that are not already assessed through the other KPIs, meaning, benefits other than ANS cost improvements, fuel efficiency improvements, etc.

4.15.1Performance Mechanism

The Benefit Impact Mechanism for AUO-0110 with Stakeholder group AU, shows that there would be a positive impact on the cost of operations (decrease) which would in turn affect the AU cost efficiency KPA.

The reduction of reactionary delay would have a positive economic and operational impact on the AU, leading to improved AU cost-efficiency and operational efficiency. The reduction of direct operating costs would positively affect the cost of operations for the AU, and thus positively affect AU cost-efficiency.

Mechanism number	Impact type	Impact direction	Beneficiary
4b	Reactionary delay	Positive	Airspace Users
6b	Sequence Optimisation Benefit (AUC2)	Positive	Airspace Users
6b	Direct Ops Cost (AUC3)	Positive	Airspace Users
7b	Number of UDPP inputs	Positive	Airspace Users

Table 21: Airspace User cost efficiency benefits

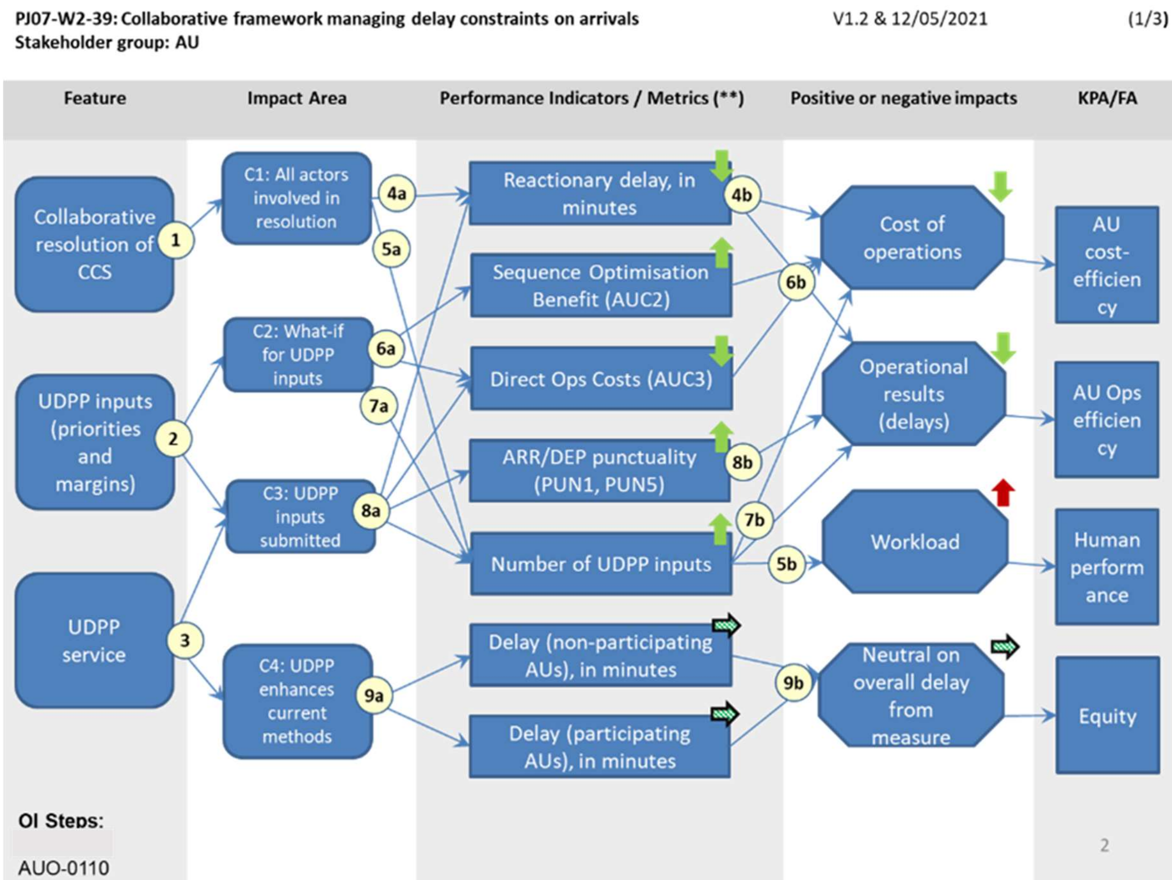

Figure 2: BIM for AUO-0110 – Airspace Users

UDPP aims to act on the ATFM delay of flights within an ATFCM measure in the pre-departure phase, with the goal to not only manage the reactionary delay, but primarily the cost of this delay in the subsequent rotations. Involvement of AUs in the resolution of the Capacity Constrained Situation by using UDPP mechanisms would help manage the reactionary delay, and thus help the AU manage the subsequent aircraft rotations and associated passenger connections and curfew infringements. The reduction of reactionary delays would have a positive economic and operational impact on the AU, leading to improved AU cost-efficiency and operational efficiency. The UDPP inputs submitted by the AU to the UDPP service in the planning phase led to the improvement of the AUC2 and AUC3 metrics for the given participating AU, and to the improvement of punctuality (PUN1, PUN2) of some of participating AU's flights.

UDPP-centric arrivals management is more likely to be utilised for very large and large APTs, as these OEs are more likely to experience capacity constraints that can be resolved by a collaborative approach with UDPP mechanisms. Also, these airports are most likely to host the operational base and/ or be a hub to AU, thus providing AU with a motivation for UDPP deployment in order to optimise passenger connectivity, aircraft and crew rotations, ground handling operations, compliance with curfews at third airports, etc.

NOTE:

Reference scenario - The reference scenario utilises historical flights and all historical ATFM regulations (both airport and en-route) as inputs, and each day is re-run as a simulation. In this scenario none of the ATFM regulations are converted into UDPP measures, and no AUs participate in the UDPP process.

Solution scenarios - The 'UDPP deployment' scenarios were constructed in incremental fashion, to reflect a certain realism:

- Scenario A: UDPP at ZRH (LSZH) by SWISS only: any ATFM regulation on Zurich airport arrivals is converted into a UDPP measure, and SWISS are the only participating UDPP AU on those measures.
- Scenario B: UDPP measures for Traffic Volumes of eight very large airports (EGLL, EGKK, EHAM, LFPG, EDDF, EDDM, LEMD, LSZH), with AFR, BAW, DLH, IBE, KLM and SWR as the participating AUs.
- Scenario C: UDPP measures for all Airport ATFM regulations, and all AUs possibly participating[10].

4.15.2 Assessment Data (Exercises and Expectations)

EX1-OBJ-07-W2.39-VALP-CE1 Results

AU Cost Efficiency is the key objective for Solution PJ.07-W2-39 since it focuses of the UDPP concept. To be able to measure the cost efficiency aspects, it is imperative:

1) To have the business side of the AU operations incorporated alongside the operational data into the process and the AU prototype; and
2) To have the business impact element expressed in monetary terms or any other indicator that could be used in comparative sense to evaluate UDPP choices.

These two requirements were fully covered through the SWISS prototype that had the required functionalities and features to make informed decisions via the Baseline/What-if/Submit facilities built into the tool. In parallel, the AU prototype contained two key indicators:

[10] The exercise does not specify which AU are assumed to participate and benefit from UDPP in the context of Solution 39. Mindful of the nature of UDPP and swapping of slots, only AU that have a considerable number of flights during the day/ within an hour at one of the airports in scope would benefit. Therefore, only airlines with an operational base and/ or hub activities are likely to benefit.

- "Flight Value" (FV) that expressed the business value of the entire flight i.e., as a proxy for direct operating cost a flight, through the computation of delay cost models for each individual flight.
- "Passenger Value" (PV) that expressed the business value of a flight based on delays to passengers and in particular the costs associated with missed connections because of delays.

Given that the FV and PV were only available in the Solution scenario because they were recorded during Solution scenario runs, it is not possible to directly compare the Reference and Solution scenarios. The comparison of pre-Baseline and post-Submit data snapshots in the Solution scenario is the sole focus of the analysis at hand.

The FV serves as the equivalent to the AUC3 metric, and it was designed to express the business penalty imposed on a flight: the starting value for a flight is 0 and any operating cost penalty pushed the FV into negative values. The analysis shows that the average reduction in FV penalty from UDPP Submits is 10.3%.

Similarly, to the punctuality KPIs analysed in previous sections, there is a variance of results from the full set of runs, with both positive and negative outcomes from the Submit actions. Since the Submit action essentially results in a multi-slot-swap situation, it is possible to consider this to be an expression of the AUC2 metric. Due to the results described in the previous paragraph, it is possible to state that the sequence optimisation benefit is not always positive.

In terms of missed connections, this was incorporated into the SWISS AU prototype. The average reduction for all observed runs is 12.5%. The PV penalty can be used as a proxy for the cost penalty for the displacement of passengers and thus for the passengers not reaching their destinations; this indicator shows an average improvement of 15.2%. Since the scenario executions only followed a part of the operational day, the simulation may have missed part of the benefits of UDPP deployment. Particularly at the end of the daily operation where delays tend to cumulate, misconnected passengers cannot easily be booked onto other flights, crews reach the end of their maximum allowed operating hours, or delayed flights risk violating night curfews at certain airports, the FV and PV values are likely to be above average. Hence, there may be upside to the percentage figure described above.

Key Results from RNEST FTS

As a supporting activity to Solution 39, a fast-time simulation (FTS) referred to as RNEST was conducted. The primary goal of the simulation was to observe the EATMN-level effects of simultaneous use of the UDPP concept at multiple locations (to manage arrival constraints, as per the scope of Solution 39) by multiple AUs.

The AU cost-efficiency is expressed through the simple cost of delay (ScoD). This RNEST metric represents the cost of delay (all categories) of each individual flight in isolation, given the cost item inputs.

Scenario	Sum of Flight Delay Cost – daily average for 28 simulated days (full AIRAC cycle)	Delta from Baseline
Baseline	32.497M EUR	-

Scenario A	32.579M EUR	+0.082M EUR
Scenario B	32.306M EUR	-0.191M EUR
Scenario C	32.494M EUR	-0.003M EUR

Table 22: Simulated flight delay costs from RNEST FTS

According to the results, Scenario B appears to be positive in terms of benefits to AUs: the average saving achievable by using the UDPP mechanisms is indicated to be in the region of 0.5% of the overall delay costs incurred by the AUs. The results are not being used to extrapolate the ECAC wide benefits, but to support and reference it for completeness.

The cost savings observed as a result of the RNEST simulation deviate significantly from those observed in the validation exercise involving Swiss at Zurich airport. The cost assumptions applied for the RNEST FTS validation exercise are not known.

SESAR Solution Validation Objective ID	SESAR Solution Validation Objective Title	SESAR Solution Success Criterion ID	SESAR Solution Success Criterion	SESAR Solution Validation Results	SESAR Solution Validation Objective Status
		CRT-07-W2.39-V3-VALP-CE1-001	Overall direct operating costs (AUC3, as calculated by the cost model) for participating AUs reduce when compared to reference scenario.	AUC3 metric showed an average decrease of 10.3%.	OK
		CRT-07-W2.39-V3-VALP-CE1-002	For each UDPP measure and each participating AU, there is a net Sequence Optimisation Benefit (AUC2) when comparing the solution scenario against the reference scenario.	AUC2 metric showed a mix of positive and negative results.	
		CRT-07-W2.39-V3-	Number of missed passenger connections (as calculated by the		

		VALP-CE1-003	passenger flow model) is reduced for participating AUs compared to the reference scenario.		
		CRT-07-W2.39-V3-VALP-CE1-004	Number of passengers (as calculated by the passenger flow model) that do not reach their destination on the same day is reduced for participating AUs compared to the reference scenario.		
		CRT-07-W2.39-V3-VALP-CE1-005	Number of passengers that do not have a flight cancelled due to UDPP prioritisations (e.g., a flight that no longer has a curfew restriction) increase compared to the reference scenarios.	Not assessed in the validations.	

Table 23: Summary of Validation results

Exercise ID or Expert judgement	Benefits contribution to AU3	Benefits contribution to AU4	Benefits contribution to AU5
EXE-PJ07-W2.39-V3-VALP-CE1	Average decrease of 10.3%.	N/A	N/A

Table 24: Airspace User Cost Efficiency benefit per Exercise

OI step	Relative benefits contribution to AU3	Relative benefits contribution to AU4	Relative benefits contribution to AU5
AUO-0110	100%	N/A	N/A
TOTAL	100%	100%	100%

Table 25: Airspace User Cost Efficiency relative benefit per OI step

4.15.3Extrapolation to ECAC wide

The validation results above present the improved AU cost-efficiency and operational efficiency for the validation exercise of Solution 39. The scope of the exercise was limited to eight large and very large airports for six airlines, but it is necessary to extrapolate the benefits to averages per flight at ECAC level.

To translate the benefits observed for all large/very large airports to an overall ECAC wide assessment it is necessary to estimate the delay costs within ECAC. This was done via the following methodology:

- The comprehensive list of ECAC area airports, corresponding Airports' Group in 2019 according to SESAR 2020 Airports' Classification Scheme and individual 2019 traffic figures was sourced from SESAR Airport OE Dataset [Table 32]. Only the Airports' Group scope assessed by the OI step AUO-0110 covered by this validation exercise were selected.
- The *tactical ATFM delay cost* which is incurred on the day of operations is 38 € per min sourced from the EUROCONTROL Standard Inputs for Economic Analyses. In most cases, it is anticipated that the user will find it appropriate to use the full tactical costs to calculate these costs of delay. These include the reactionary costs of 'knock-on' delay in the rest of the network, which are usually considered.
- The *strategic delay cost* (maintenance, fleet, and crew costs) which is accounted for in advance. Strategic costs are typically used to assess the cost of adding buffers to schedules. This could be by airline choice or imposed by scheduling constraints at an airport (and thus considered a cost of congestion, albeit one which offsets tactical delay costs). Strategic costs may also be incurred because of factors which contribute to an increase in flight time in a predictable way, such as delay due to route design.

The average departure delay per flight ECAC wide (2012) is 9.5 min/flight, sourced from SESAR Common Assumptions PJ19_2020 Dataset.

The estimate of the *IFR arrivals for in scope airports* are ***4,094,026** movements* and the IFR arrivals for **ECAC wide** is **8,594,280** movements.

The formula used to extrapolate the benefits for the AUC2 metric is:

$$Average\ reduction\ in\ PV\ penalty * \frac{\text{arrivals from in scope ECAC aiports}}{total\ number\ of\ arrivals\ in\ ECAC} = \text{ECAC wide AUC2 improvement}$$

$$\mathbf{15.2\%} * \frac{\mathbf{4,094,026}}{\mathbf{8,594,280}} = \mathbf{7.24\%}$$

From the airlines perspective, an extrapolation can be done by looking at the flight value (FV) with direct operating costs as a proxy. The cost of delays was reduced by 10.3% at Zurich Airport and it is assumed the same applies to all the 32 large/very large airports in scope of this solution.

The formula used to extrapolate the benefits for the AUC3 metric is:

$$Average\ reduction\ in\ FV\ penalty * \frac{\text{arrivals from in scope ECAC aiports}}{total\ number\ of\ arrivals\ in\ ECAC} = \text{ECAC wide AUC3 improvement}$$

$$\mathbf{10.3\% * \frac{4,094,026}{8,594,280} = 4.91\%}$$

NOTE The two extrapolations above are for 2019 traffic, not traffic for 2035. In 2035 the fraction 4,094,026/8,594,280 could be different, in which case the 7.24% and 4.91% figures would change in proportion. It is likely that, if traffic continues to increase between now and 2035, the fraction will increase because more airports will become large or very large, thus bringing in disproportionately more flights into the numerator. This means that the two percentages could be underestimated for 2035.

PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
AUC2 Sequence Optimisation Benefit	EUR/ movement	Determine the direct benefit obtained by swapping a slot (on average). To be able to aggregate the information, the cost has to be provided per movement (one movement is the arrival plus the departure).	No	N/A	7.24% improvement
AUC3 Direct operating costs for an airspace user	EUR	Impact on direct costs related to the aeroplane and passengers. Examples: fuel, staff expenses, passenger service costs, maintenance and repairs, navigation charges, strategic delay, landing fees, catering.	Yes, where an impact is foreseen on AU cost efficiency	N/A	4.91% improvement
AUC4 Indirect operating costs for an airspace user	EUR	Impact on operating costs that do not relate to a specific flight. Examples: parking charges, crew and cabin salary, handling prices at Base Stations.	Yes, where an impact is foreseen on AU cost efficiency	N/A	N/A
AUC5 Overhead costs for an airspace user	EUR	Impact on overhead costs. Examples: dispatchers, training, IT infrastructure, sales.	Yes, where an impact is foreseen on AU cost efficiency	N/A	N/A

Table 26: Airspace User Cost Efficiency benefit for Mandatory KPIs /PIs

4.15.4 Discussion of Assessment Result

The AU cost-efficiency impact described in relation to Solution PJ.07-W2-39 and observed in the validation exercises appears plausible, based on the specific deployment scenarios that were defined in validation exercise 1, involving Swiss International Airlines at its operational hub at Zurich airport. However, it should be noted that the impact of the solution may vary considerably when applied at other airports and for other AUs.

Those AUs which have a considerable operational presence at those airports where UDPP is deployed would be most likely to benefit from the solution, given that the priorisation of flights is only possible if multiple flights are available for optimisation. Therefore, airlines that maintain an operational base and/ or hub operation at one of the airports in scope would benefit more than AUs which operate a very limited number of flights. The benefits enjoyed by hub airlines or home carriers can include a reduction in missed passenger connections (and associated costs), optimised crew and aircraft rotations, optimisation of ground handling activities, a reduction in number of curfew infringements, etc. (and the corresponding costs). In some instances, codeshare partners of these AU may also benefit from the improved operational coordination enabled by UDPP.

The extrapolation for the indicators AUC2 and AUC3 assumes that the per-flight benefits observed in the validation exercise at Zurich airport can be applied to all flight departures at the large and very large airports in scope of Solution PJ.07-W2-39. However, by identifying the relative share of hub airlines and home carriers among all departures at each of the airports in scope (approximately 70%[11]), it would be a more conservative approach to consider that only seventy percent of the departures actually incur the per-flight benefit described. Therefore, for the cost-benefit analysis of Solution PJ.07-W2-39, this more conservative approach could form part of a sensitivity analysis.

Also, even without the deployment of Solution PJ.07-W2-39, some degree of non-automated UDPP is likely to already take place today at the Airport Operational Centre's (APOC) of major airports, especially involving major AU (large hub airlines and home carriers) which by default often have a representative in the APOC. In this context, it is not clear if the validation exercises for Solution PJ.07-W2-39 assume that a basic level of coordination of UDPP is already taking place under the baseline scenario.

Specifically, the validation at Zurich airport took place during a limited time window during the operating day (as described above). This may affect the validity of the results, potentially omitting arrivals

[11] The estimate is based in the analysis of Sabre Market Intelligence data for 2019 for the 32 large and very large airports in scope of Solution PJ.07-W2-39. Out of approximately 4.2 million flight departures at these airports, 2.9 million were departures of hub airlines and home carriers. These would include, for example, Swiss International Airlines at ZRH, Iberia (incl. operating carriers like Iberia Express), and so on, as well as major low-cost airlines at their respective large bases (e.g., Easyjet at CDG).

optimisations towards the end of the day, when they may be particularly helpful to prevent missed connections, crew time infringements, etc. On the other hand, the limited duration of the exercise is not necessarily representative of a longer period of time.

The observed reductions in FV (10.3%) and PV (15.2%) penalties (i.e., the costs incurred in the baseline scenario) for the flight departures in scope of Solution PJ.07-W2-39 appear plausible, considering that the priorisation of a limited number of critical flights can avoid potentially huge costs for an airspace user, such as having to accommodate a large number of passengers in hotels, having to cancel a flight if crews exceed their operational time limits or night curfews cannot be met, having to delay a flight because of ground handling limitations, etc.[12] The EUROCONTROL Standard Inputs for Economic Analysis provide monetary values that could be used to estimate the costs and potential savings related to tactical flight delays.

The R-NEST Fast time simulation results from the Validation report provides us with the data used for the FTS runs was the full AIRAC1909 dataset, covering the period of 15th August 2019 to 11th September 2019[13]. The scenarios therefore cover the busy summer period.

Scenario	Sum of Flight Delay Cost – daily average for 28 simulated days (full AIRAC cycle)
Baseline	€ 32,497,000.00
Scenario A	€32,579,000.00

The total number of actual departures by airlines 2L, LX and WK in the period in question was 5,470. Based on Eurocontrol data, the average departure delay per flight due to reactionary delays, ATM, and weather-related delay causes (2012) is 9.5 min. Therefore, the results from validation exercise A suggest that the cost per minute of delay for Swiss at Zurich Airport would be €626.94 per minute.

$$\frac{\text{Sum of flight delay cost from Scenario A}}{Total\ number\ of\ departures} * \frac{1}{Average\ departure\ delay\ ECAC\ wide} = \text{ECAC wide total delay cost saved}$$

$$\frac{\boldsymbol{€32,579,000}}{\boldsymbol{5,470}} * \frac{\boldsymbol{1}}{\boldsymbol{9.5}} = \boldsymbol{€626.94\ \text{per min}}$$

This contrasts with the EUROCONTROL Standard Inputs for Economic Analyses, providing a Tactical ATFM delay cost of €38 per min. This significant discrepancy can be owed to the fact that both, the average

[12] To better understand this percentage reduction, for example for PV, one may consider that by optimising and automating the UDPP capability of a major hub airlines, three out of twenty (15%) misconnected passengers who require hotel accommodation and compensation can be avoided.

[13] The Sabre data provides us with the number of departures for Swiss (LX) at Zurich along with operating airlines Helvetic (2L) and Edelweiss (WK) for the period of 15th August 2019 to 11th September 2019.

departure delay per flight due to reactionary delays, ATM and weather related delay causes as well as the standard input for tactical ATFM delay costs, are average values which may be different from those specific to the operation of Swiss at its hub in Zurich.

For example, it seems likely that the tactical ATFM delay cost of a hub airline is higher than the ECAC average (as used in the EUROCONTROL Standard Inputs for Economic Analyses), given the complexity of an intercontinental hub and the associated costs (especially at an airport with a night curfew in a high-cost location, like ZRH).

Also, the average departure delay for flights for Swiss in Zurich may differ from ECAC averages.

Therefore, the monetary assessment of the costs of delay under the R-NEST validation exercise A should be considered with care, as it suggests a very high monetary value per minute of flight delay (€627), compared to ECAC average (€38). Yet, these high results are not entirely impossible, given the specifics of the exercise participants (Swiss) and location.

4.15.5 Additional Comments and Notes

N/A

4.16 Security

4.16.1 The SecRAM 2.0 methodology and the Security Performance Mechanism

Solution PJ.07-W2-39 does not contribute to security levels benefits.

4.16.2 Security Assessment Data Collection

Solution PJ.07-W2-39 does not contribute to security levels benefits.

4.16.3 Extrapolation to ECAC wide

Solution PJ.07-W2-39 does not contribute to security levels benefits.

4.16.4 Discussion of Assessment Result

Solution PJ.07-W2-39 does not contribute to security levels benefits.

4.16.5 Additional Comments and Notes

Solution PJ.07-W2-39 does not contribute to security levels benefits.

4.17Human Performance

4.17.1HP arguments, activities, and metrics

One exercise took place at Solution level to validate the concept (Val. Exe. 1 in Zurich). HP activities were planned and involved human-in-the-loop. The Exercise EXE#1 was the real-time shadow-mode exercise, structured around Use Case 1 and focused on Zurich Airport (LSZH) arrivals. The exercise was undertaken between 4th and 15th October 2021, with the main stakeholders being: Skyguide as FMP (L-DCB), SWISS International Airlines (SWISS) as the main AU participating in the UDPP process, Zurich Airport (participating to a subset of scenarios only) and NMOC Operator (Eurocontrol) interacted during the exercise in a set of validation scenarios.

From the SESAR HP Assessment Process four arguments were considered with a need to be satisfied in the HP assessment, these are as follows:

- Argument 1: The role of the human is considered consistent with human capabilities and limitations.
- Argument 2: Technical systems support the human actors in performing their tasks.
- Argument 3: Team structures and team communication support the human actors in performing their tasks.
- Argument 4: Human Performance related transition factors are considered.

PIs	Activities & Metrics	Second level indicators	Covered
HP1 Consistency of human role with respect to human capabilities and limitations	**Shadow Mode**	**HP1.1** Clarity and completeness of role and responsibilities of human actors	Closed
		HP1.2 Adequacy of operating methods (procedures) in supporting human performance	Open
		HP1.3 Capability of human actors to achieve their tasks in a timely manner, with limited error rate and acceptable workload level	Open
HP2 Suitability of technical system in supporting the tasks of human actors	**Shadow Mode**	**HP2.1** Adequacy of allocation of tasks between the human and the machine (i.e., level of automation).	Open
		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

EUROPEAN PARTNERSHIP

Co-funded by the European Union

PIs	Activities & Metrics	Second level indicators	Covered
HP3 Adequacy of team structure and team communication in supporting the human actors	**Shadow Mode**	**HP3.1** Adequacy of team composition in terms of identified roles	Open
		HP3.2 Adequacy of task allocation among human actors	Closed
		HP3.3 Adequacy of team communication with regard to information type, technical enablers, and impact on situation awareness/workload	Open
HP4 Feasibility with regard to HP-related transition factors	**Shadow Mode**	**HP4.1** User acceptability of the proposed solution	Open
		HP4.2 Feasibility in relation to changes in competence requirements	Open
		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.	Closed

Table 27: HP arguments, activities, and metrics

4.17.2Extrapolation to ECAC wide

Not applicable.

4.17.3Open HP issues/ recommendations and requirements

The HP recommendations and HP requirements developed based on the results of the validation activities, regarding the HMI design and usability, the clarification of concept in terms of roles, responsibilities and the operating procedures had been considered at each step of the process and listed. Additionally, the identification of training on new HMI automation features, new processes and operating methods (MOPS) were identified during the outputs of qualitative questionnaire and debriefing session. However, relevant issues were identified and analysed, and recommendations and requirements consequently developed for Operating methods clarification, training needs, HMI usability and task allocation between human and machine. To prepare the next V-phase, based on the HP activities conducted and results obtained, some recommendations for further research have been developed based on the open issues.

Information on the HP assessment for the arrival aspects can be found in the Solution 39 OSED document Part IV HPAR, Annex A.

PIs	Number of open issues/ benefits	Nr. of recommendations	Number of requirements
HP1 Consistency of human role with respect to human capabilities and limitations	**2**	**9**	**4**
HP2 Suitability of technical system in supporting the tasks of human actors	**2**	**12**	**8**
HP3 Adequacy of team structure and team communication in supporting the human actors	**0**	**1**	**0**
HP4 Feasibility with regard to HP-related transition factors	**0**	**0**	**0**

Table 28: Open HP issues/ recommendations and requirements

4.17.4Concept interaction

N/A

4.17.5Most important HP issues

Table 29 lists important issues that might have a major impact on the performance of the solution.

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	The new operating methods introduce changes in coordination and possibly delegation of responsibilities between all actors including NM, APT and local DCB. The issue can be came from the provided means to delegate/coordinate between actors (Who, When, What...?). It may lead a negative impact on SA, workload, and trust.	N/A

PIs	Most important issue of the solution	Most important issues due to solution interdependencies
	The concept introduces new tasks derived from NM, AUs, APT and local DCB actors' coordination processes, HMI tools and features (physical and cognitive tasks), new problem resolution methodologies and actor involved and the variety of Collaborative mechanisms. The main issue is the negative impact on SA and workload	N/A
HP2 Suitability of technical system in supporting the tasks of human actors	Additional HMIs are expected, in particular on the AUs side in order to manage the UDPP inputs and to submit their inputs to UDPP service. Automation for different parts of the process is envisaged as mitigation to prevent negative impacts on workload. Not enough automation level for different parts of the process may have a negative impact on the workload, trust and Situation Awareness of all actors involved in the decision making.	N/A
	The new allocation of tasks between the human and the machine will require high levels of performance of the technical systems in terms of relevance and accuracy of the information provided, so all actors involved in the process are able to trust the new concept /Timeliness of the information provided, especially when coordination processes are needed/Recovery process in easy way especially when what-if scenario request is done.	N/A
	A degraded performance of the system may not allow actors to keep acceptable level of workload and could negatively impact the feasibility and the acceptance of the concept by users	N/A
HP3 Adequacy of team structure and team communication in supporting the human actors	N/A	N/A
		N/A
		N/A
HP4 Feasibility with regard to HP-related transition factors	N/A	N/A
		N/A
		N/A
		N/A

PIs	Most important issue of the solution	Most important issues due to solution interdependencies
		N/A

Table 29: Most important HP issues

4.17.6 Additional Comments and Notes

N/A

4.18 Other PIs

The other PI impacted by Solution 39 was the Equity KPA. The equity seemed to be maintained, although this KPA was not specifically tested. However, within the NCP and UDPP solution the process itself does not assure equity, but rather the judgement of the operational personnel.

4.18.1 Performance Mechanism

The equity objective evaluated how much influence the actions of UDPP process participant AU have on other AUs, regardless of their participation status.

4.18.2 Assessment Data (Exercises and Expectations)

The objective was to evaluate the equity of UDPP actions within the UDPP measure. A comparison of the regulation flight list at the Baseline stage and the Submit stage of the process was conducted, which revealed that participating AUs' Submit actions do not appear to impact the ATFM delay of non-participating flights. Minor variations at the per-flight level were observed, but these can be attributed to the dynamicity of the network and flight plan changes. Observations by stakeholders during scenario runs supported these findings. The NM stakeholder also observed that the total ATFM delay incurred by the UDPP measure remained stable after most Submit actions. Similarly, the comparison of ATFM delays between the Reference and Solution scenarios showed no significant deviations, particularly around the Baseline retrieval and immediately after the Submit actions.

The equity KPI refer to the impact on the delay as measured at the end of Day zero (Day of operation). Because the exercise stayed in the pre-departure phase it was not possible to do this.

Observations concerning equity:

- **prioritised flights** received three times less delay than non-prioritised flights. This tendency was expected and is desirable;
- The **flights belonging to non-prioritising AUs** received almost twice the delay per flight compared to the flights belonging to AUs that prioritized;
- For **non-participating AUs** (and also for unprioritized flights) the total delay with NCP (the solution scenario) was higher than for MCP (the reference scenario). This was of concern because it shows that non-participants are penalised for their non-participation. In operations, the concept may pressurize all AUs to participate to avoid increasing their chances of receiving more delay.

4.18.3 Additional Comments and Notes

Although it was not part of the validation objectives, some insights on equity were gained. The AU expressed concerns over the lack of transparency in the TTA assignment process, resulting in some flights being prioritized but not actually affected by the measure. The APOC participants tried to maintain equity among all flights by prioritizing resolving imbalances first and then considering AU priorities and TNAs during the simulations.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

4.19Gap Analysis

The objective of the gap analysis is a comparison between the validation targets and the performance assessment.

KPI	Validation Targets – Network Level (ECAC Wide)	Performance Benefits at Network Level (ECAC Wide or Local depending on the KPI)[14]	Rationale[15]
SAF1: Safety - Total number of estimated accidents with ATM Contribution per year	N/A	N/A	N/A
FEFF1: Fuel Efficiency - Actual average fuel burn per flight	N/A	N/A	N/A
CAP1: TMA Airspace Capacity - TMA throughput, in challenging airspace, per unit time.	N/A	N/A	N/A
CAP2: En-Route Airspace Capacity - En-route throughput, in challenging airspace, per unit time	N/A	N/A	N/A
CAP3: Airport Capacity – Peak Runway Throughput	N/A	N/A	N/A

[14] Negative impacts are indicated in red.

[15] Discuss the outcome if the gap indicates a different understanding of the contribution of the Solution (for example, the Solution is enabling other Solutions and therefore is not contributing a direct benefit). **Please contact your PJ19.04 Solution Champion to clarify when the Gap Rational is needed.**

(Mixed mode).			
TEFF1: Gate-to-gate flight time	N/A	N/A	N/A
PRD1: Predictability – Average of Difference in actual & Flight Plan or RBT durations	N/A	N/A	N/A
PUN1: Punctuality – Average departure delay per flight	"Impact Level 3 (0.11 min)" and "0.55% to very large airports & 0.45% to large airport'.	0.0143 min/flight [0.30% ECAC overall improvement] [0.17 % to very large airports and 0.13 % to large airports]	The validation target assigned prior to the validation exercise was 0.55% to very large airports and 0.45% to large airports. The Solution's purpose is to improve AU cost-efficiency, not to directly improve punctuality, so the gap between validation target and measured benefit is not unexpected.
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	N/A	N/A	N/A
CEF3: Technology Cost – Cost per flight	N/A	N/A	N/A

Table 30: Gap analysis Summary

5 References

This PAR complies with the requirements set out in the following documents:

[1] 08.01.03 D47: AIRM v4.1.0

[2] B05 Performance Assessment Methodology for Step 1 PJ19.04.01 Methodology for Performance Assessment Results Consolidation (2020)[16]

[3] SESAR Performance Framework (2019), Edition 01.00.01, Dec 2019

https://stellar.sesarju.eu/?link=true&domainName=saas&redirectUrl=%2Fjsp%2Fproject%2Fproject.jsp%3FobjId%3Dxrn%3Adatabase%3Aondb%2Frecord%2F16414675

[4] Performance Assessment and Gap Analysis Report (2019), Edition 00.01.02, Dec 2019

[5] SESAR Solution PJ.07-W2-38 SPR/INTEROP-OSED for V3 - Part V - Performance Assessment Report (PAR)Performance Assessment and Gap Analysis Report (2021), ed. 00.01.01, 09 July 2021

[6] Methodology for the Performance Planning and Master Plan Maintenance, Edition 0.13, Dec 2017

Content Integration

[7] SESAR ATM Lexicon

Performance Management

[8] PJ19.04 D4.1 Validation Targets - Wave 2 (2020)[17]

Validation

[9] European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

[10] SESAR Solution 39 VALR v00.01.00

[16] At the time of the creation of the PAR template, the Methodology (PJ19.04 Internal Document) is foreseen to be update in 2020.

[17] At the time of the creation of the PAR template the Validation Target is foreseen to be delivered in June 2020

[11] SESAR Final VALP Solution 39 – Part I Ed 01.00.02

Safety

[12]SESAR, Safety Reference Material, Edition 4.0, April 2016

https://stellar.sesarju.eu/jsp/project/qproject.jsp?objId=1795089.13&resetHistory=true&statInfo=Ogp&domainName=saas

[13]SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

https://stellar.sesarju.eu/jsp/project/qproject.jsp?objId=1795102.13&resetHistory=true&statInfo=Ogp&domainName=saas

[14]SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[15]Accident Incident Models – AIM, release 2017

[16] SESAR Solution 39 SPR-INTEROP_OSED - Part II - SAR - v00.00.02

https://stellar.sesarju.eu/servlet/dl/ShowDocumentContent?doc_id=3658775.13&att=attachment&statEvent=Download

Human Performance

[17]16.06.05 D 27 HP Reference Material D27

[18]16.04.02 D04 e-HP Repository - Release note

[19] SESAR Solution PJ07 SPR-INTEROP_OSED V3 - Part IV - HPAR Ed.00.01.00

Environment Assessment

[20]SESAR, Environment Assessment Process (2019), PJ19.4.2, Deliverable D4.0.080, Sep 2019.

https://stellar.sesarju.eu/servlet/dl/DownloadServlet?downloadKey=xrn%3Adatabase%3Aondb%2Frecord%2F14665451&resuming=true&zip=true&disposition=attachment&domainName=saas&domainName=saas

[21]ICAO CAEP – "Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes" document, Doc 10031.

https://www.icao.int/publications/pages/publication.aspx?docnum=10031

Security

[22]16.06.02 D103 SESAR Security Ref Material Level

[23]16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[24]16.06.02 D131 Security Database Application (CTRL_S)

Appendix A Detailed Description and Issues of the OI Steps

OI Step ID	Title	Consistency with latest Dataset
AUO-0110	Collaborative framework for managing arrival constraints at Local DCB level	Dataset 23
AUO-0109	Collaborative framework for managing arrival constraints at Airport	Dataset 23

Table 31: OI Steps allocated to the Solution

The estimated performance contribution of each of the OIs is indicated in the appropriate section of applicable KPAs (see section 4).

Appendix B List of Airports in scope of this solution

List of airports in scope of the study is presented below:

ICAO Code	IATA Code	Short Name of Airport	Airports' Group in 2018 according to SESAR 2020 Airports' Classification Scheme	Annual IFR Movements (2019)
EDDF	FRA	Frankfurt/Main	Very large	513,866
EHAM	AMS	Amsterdam/Schiphol	Very large	509,185
LFPG	CDG	Paris-Charles De Gaulle	Very large	504,887
EGLL	LHR	London Heathrow	Very large	478,081
LTBA	IST	Istanbul/Ataturk	Very large	132,657
EDDM	MUC	Muenchen	Very large	414,222
LEMD	MAD	Madrid/Adolfo Suarez Madrid-Barajas	Very large	426,185
LEBL	BCN	Barcelona/El Prat	Very large	344,508
LIRF	FCO	Roma/Fiumicino	Very large	309,783
EGKK	LGW	London Gatwick	Very large	284,916
LSZH	ZRH	Zurich	Very large	269,223
EKCH	CPH	Kobenhavn/Kastrup	Very large	263,434
ENGM	OSL	Oslo/Gardermoen	Very large	251,872
LOWW	VIE	Wien-Schwechat	Very large	281,716
ESSA	ARN	Stockholm/Arlanda	Large	233,007
EIDW	DUB	Dublin	Large	238,044
LFPO	ORY	Paris-Orly	Large	221,602
EBBR	BRU	Brussels/Brussels-National	Large	229,281
LTFJ	SAW	Istanbul/Sabiha Gokcen	Large	228,616
LEPA	PMI	Palma De Mallorca	Large	217,096
EDDL	DUS	Duesseldorf	Large	225,541
LPPT	LIS	Lisboa	Large	220,938
LGAV	ATH	Athinai/Eleftherios Venizelos	Large	220,639
EGCC	MAN	Manchester	Large	202,935
EGSS	STN	London Stansted	Large	198,511
LIMC	MXP	Milano/Malpensa	Large	233,978
EFHK	HEL	Helsinki-Vantaa	Large	194,634
EPWA	WAW	Chopina W Warszawie	Large	194,160
LTAI	AYT	Antalya (Mil-Civ)	Large	203,062
EDDT	TXL	Berlin-Tegel	Large	191,779
LSGG	GVA	Geneva	Large	179,115
LKPR	PRG	Praha/Ruzyne	Large	150,434

Table 32: Large and Very large airports in scope[18]

ID	Sub-OE	Year	Value	Unit	Comment
APT-VL-2035	Very Large Airport	2035	0.7110	movements / flights	contribution to total APT traffic from the specific sub-OE
APT-L-2035	Large Airport	2035	0.2130	movements / flights	contribution to total APT traffic from the specific sub-OE

[18] Source: Airport OE Dataset is compiled by SESAR 2020 PJ20 sWP2.2 WG. The Airports Dataset file contains a brief set of airports' classification scheme, definitions, and sources. [EUROCONTROL PRU]

EUROPEAN PARTNERSHIP

Co-funded by the European Union