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SORT

SAFELY OPTIMISED RUNWAY THROUGHPUT

This VLD3-W2-SORT DEMO report – Part V Performance Assessment Report (PAR) for WP3 is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874520 under European Union’s Horizon 2020 research and innovation programme.



Abstract

This document is the fifth part of the DEMO Report document for WP3 of the SESAR 2020 VLD3-W2-SORT project that addresses the results on the pre-industrialization activities performed for the so-called wake decay enhancing devices (Plate Lines) with the resulting safety gains and the potential gains in runway throughput capacity.

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1 Executive Summary

This document provides the Performance Assessment Report (PAR) for WP3, hence is part of the contractual deliverable D1.4 (DEMOR). It consists of Part V of the DEMOR for the exercise EXE-VLD-03-002 which aims to industrialize the plate line concept into a prototype of the plate and its installation, which is suitable for permanent deployment and ready for approval by authorities.

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

Description:

The installation of plate lines beyond the runway ends under the glide path reduces wake vortex lifetime and circulation strength leading to safety benefits by reducing the number of wake vortex encounters and go-arounds. Several use cases assess the achievable reductions of aircraft separation minima. Additionally, a technical plate line design for permanent deployment at an airport has been elaborated allowing near-term plate line installations at the runways of congested airports.

More Information can be found in Chapter 2!

Assessment Results Summary:

The following tables summarise the assessment outcomes per KPI (Table 1) and mandatory PI (Table 2) puts them side-by side against Validation Targets in case of KPI from PJ19 [7]. The impact of a Demo on the performances are described in Benefit Impact Mechanism. All the KPI and mandatory PI from the Benefit Mechanism were the Demo potentially has an impact have to be assessed via validation results, expert judgment etc.

There are three cases:

1. An assessment result of 0 with confidence level other level High, Medium or Low indicates that the Demo is expected to impact in a marginal way the KPI or mandatory PI.
2. An assessment result (positive or negative) different than 0 with confidence level High, Medium or Low indicates that the Demo is expected to impact the KPI or mandatory PI.
3. An assessment result of N/A (Not Applicable) with confidence level N/A indicates that the Demo 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	Medium	1 No.	Low
FEFF1: Fuel Efficiency - Actual average fuel burn per flight	NA		
CAP1: TMA Airspace Capacity - TMA throughput, in challenging airspace, per unit time.	NA		
CAP2: En-Route Airspace Capacity - En-route throughput, in challenging airspace, per unit time	NA		
CAP3: Airport Capacity – Peak Runway Throughput (Mixed mode).	Medium	3% - 25% (local)	Medium
TEFF1: Gate-to-gate flight time	NA		
PRD1: Predictability – Average of Difference in actual & Flight Plan or RBT durations	NA		

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

PUN1: Punctuality – Average departure delay per flight	NA		
CEF2: ATCO Productivity – Flights per ATCO -Hour on duty	NA		
CEF3: Technology Cost – Cost per flight	NA		

Table 1: KPI Assessment Results Summary

Mandatory PI	Performance Expectations at Network Level (ECAC Wide or Local depending on the KPI) ³	Benefits at Network	Confidence in Results ⁴
SAF1.X: Mid-air collision - En-Route	NA		
SAF2.X: Mid-air collision - TMA	NA		
SAF3.X: RWY-collision accident	NA		
SAF4.X: TWY-collision accident	NA		
SAF5.X: CFIT accident	NA		
SAF6.X: Wake related accident	25%		Low
SAF7.X: RWY-excursion accident	NA		
SAF8.X: Other SAF Risks	NA		
SEC1: A security risk assessment has been carried out	NA		
SEC2: Risk Treatment has been carried out	NA		

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

Mandatory PI	Performance Expectations at Network Level (ECAC Wide or Local depending on the KPI) ³	Benefits at Network	Confidence in Results ⁴
SEC3: Residual risk after treatment meets security objective.	NA		
ENV1: Actual Average CO2 Emission per flight	NA		
NOI1: Relative noise scale	NA		
NOI2: Size and location of noise contours	NA		
NOI4: Number of people exposed to noise levels exceeding a given threshold	NA		
LAQ1: Geographic distribution of pollutant concentrations	NA		
CAP3.1: Peak Departure throughput per hour (Segregated mode)	NA		
CAP3.2: Peak Arrival throughput per hour (segregated mode)	3% - 25% (local)		Medium
CAP4: Un-accommodated traffic reduction	NA		
RES1: Loss of Airport Capacity Avoided	10 go-arounds less per year		Low
RES1.1: Airport time to recover from non-nominal to nominal condition	NA		
RES2: Loss of Airspace Capacity Avoided.	NA		
RES2.1: Airspace time to recover from non-nominal to nominal condition.	NA		
RES4: Minutes of delays.	NA		
RES5: Number of cancellations.	NA		
TEFF2: Taxi in time	NA		
TEFF3: Taxi out time	NA		
TEFF4: TMA arrival time	NA		
TEFF5: TMA departure time	NA		
TEFF6: En-Route time	NA		

Mandatory PI	Performance Expectations at Network Level (ECAC Wide or Local depending on the KPI) ³	Benefits at Network	Confidence in Results ⁴
PRD2: Variance of Difference in actual & Flight Plan or RBT durations	NA		
PUN2: % Flights departing within +/- 3 minutes of scheduled departure time due to ATM and weather related delay causes	NA		
CEF1: Direct ANS Gate-to-gate cost per flight	NA		
AUC3: Direct operating costs for an airspace user	NA		
AUC4: Indirect operating costs for an airspace user	NA		
AUC5: Overhead costs for an airspace user	NA		
CMC1.1: Allocated vs. Requested ARES duration	NA		
CMC1.2: Allocated vs. Requested ARES dimension	NA		
CMC1.3: Deviation of Transit Time to/from airbase to ARES	NA		
CMC 1.3.1: Allocated ARES duration vs. total mission duration	NA		
CMC 1.3.2: Deviation of total mission duration by iOAT FPL validation	NA		
CMC 1.4.1: Rate of iOAT FPLs acceptance by NM systems	NA		
CMC 1.4.2: Rate of iOAT FPLs acceptance by ATC systems	NA		
CMC2.1: Fuel and Distance saved by GAT	NA		
HP1: Consistency of human role with respect to human capabilities and limitations	NA		
HP2: Suitability of technical system in supporting the tasks of human actors	NA		
HP3: Adequacy of team structure and team communication in supporting the human actors	NA		

Mandatory PI	Performance Expectations at Network Level (ECAC Wide or Local depending on the KPI) ³	Benefits at Network	Confidence in Results ⁴
HP4: Feasibility with regard to HP-related transition factors	NA		
FLX1: Average delay for scheduled civil/military flights with change request and non-scheduled or late flight plan request	NA		

Table 2: Mandatory PIs Assessment Summary

Additional Comments and Notes:

2 Introduction

2.1 Purpose of the document

The Performance Assessment covers the Key Performance Areas (KPA) 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 Demo. 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 Demo 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 Demo addressed.

Produced by the SESAR 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, and provide the data to PJ20 for considering the performance data for the European ATM Master Plan. The aggregation will be done at higher levels suitable for use at Master Planning Level, such as deployment scenarios.

2.3 Inputs from other projects

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

- PAGAR 2019: Performance Assessment and Gap Analysis Report (2019), where are collected 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. Where are also included performance aggregation assumptions, with traffic data items.

- For guidance and support PJ19 have put in place the Community of Practice (CoP)⁵ within STELLAR, gathering experts and providing best practices.

2.4 Glossary of terms

See the AIRM Glossary [1] [6] for a comprehensive glossary of terms.

2.5 Acronyms and Terminology

Term	Definition
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
BAD	Benefits Assessment Date
BAER	Benefit Assessment Equipment Rate
CBA	Cost Benefit Analysis
DLR	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt)
DOD	Detailed Operational Description
EASA	European Aviation Safety Agency
E-ATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
DB	Deployment Baseline
ICAO	International Civil Aviation Organization

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.vi%3Aew.message.private.AllMyMessages

KPA	Key Performance Area
KPI	Key Performance Indicator
N/A	Not Applicable
NLR	Royal Netherlands Aerospace Centre
OI	Operational Improvement
PAR	Performance Assessment Report
PI	Performance Indicator
PRU	Performance Review Unit
PWS	Pair-Wise Separation
QoS	Quality of Service
RECAT-EU	EU-Proposed Wake Turbulence Re-Categorisation Scheme
RECAT-EU-PWS	EU-Proposed Pair-Wise Wake Turbulence Scheme
RBT	Reference Business / Mission Trajectory
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.
SORT	Safely Optimised Runway Throughput

Table 3: Acronyms and terminology

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

Term	Definition	Source
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
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

Term	Definition	Source
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
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

Term	Definition	Source
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
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

Term	Definition	Source
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
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

Term	Definition	Source
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
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, Note 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 Demo Scope

3.1 Detailed Description of the Demo

A short description of the Demo can be found in the Executive Summary!

The installation of plate lines beyond the runway ends under the glide path reduces wake vortex lifetime and circulation strength leading to safety benefits by reducing the number of wake vortex encounters and go-arounds. Several use cases assess the achievable reductions of aircraft separation minima. Additionally, a technical plate line design for permanent deployment at an airport has been elaborated allowing near-term plate line installations.

3.2 Detailed Description of relationship with other Solutions

Solution Number	Solution Title	Relationship	Rational for the relationship
PJ.02-01-04	AO-0306 – RECAT-EU-PWS: Wake Turbulence Separations (for Arrivals) based on Static Aircraft Characteristics	Preferable	Once RECAT-EU-PWS will be approved by EASA, the introduction of RECAT-EU-PWS supported by the installation of plate lines may advance runway throughput capacity and safety at the same time (SAF, CAP3)
PJ.02-01-05	AO-0310 – Weather-Dependent Reductions of Wake Turbulence Separations for Final Approach; PJ.02-01-05	Preferable	As most encounters occur in ground proximity, plate lines can increase operating times and reduce separations of weather-dependent reductions (SAF, CAP3)
PJ02-08	Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337). Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338).	Dependent	Prediction of runway occupancy times increase the potential of reduced minimum separations facilitated by plate lines (CAP3)

PJ02-03	Minimum Separations based upon Required Surveillance Performance (RSP)	Radar based upon Surveillance	Dependent	Reduced minimum radar separations increase the potential for reduced minimum separations facilitated by plate lines (CAP3)
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Table 5: Relationships with other Solutions

4 Demo 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
DLR	A. Stephan, F. Holzäpfel, T. Misaka, Hybrid simulation of wake-vortex evolution during landing on flat terrain and with plate line, International Journal of Heat and Fluid Flow, Vol. 49, 2014, pp. 18-27, http://dx.doi.org/10.1016/j.ijheatfluidflow.2014.05.004	2014
DLR	F. Holzäpfel, A. Stephan, T. Heel, S. Körner, Enhanced Wake Vortex Decay in Ground Proximity Triggered by Plate Lines, Aircraft Engineering and Aerospace Technology, Vol. 88, Issue 2, 2016, pp. 206-214, http://dx.doi.org/10.1108/AEAT-02-2015-0045	2016

Table 6: Pre-SESAR2020 Exercises

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

Exercise ID	Exercise Title	Release	Maturity	Status
PJ.02-01-07 EARTH AO-0325	Wake Decay Enhancing Devices, LT10		TRL6	completed
PJ.02-01-07 VLD3- SORT AO-0325	Wake Decay Enhancing Devices		TRL7 (intended)	almost 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
PJ.02-01-07 (TRL 6)	AO-0325	LT10: installation of temporary Plate Lines at Vienna airport and measurement of wake vortex behaviour	plate lines comply with EASA and ICAO requirements approved by Austrian authorities (BMVIT) preliminary analysis of measurement data regarding	

			reduced vortex lifetime and strength	
PJ.02-01-07 (TRL 7)	AO-0325	thorough analysis of LT10 data assessment of achievable reductions of aircraft separation minima technical plate design	reduction of wake vortex lifetime and circulation strength quantified potential for reduced separations quantified for several use cases plate design ready for installation at airports, prototypes installed	

Table 8: Summary of Validation Results.

4.2 Conditions / Assumptions for Applicability

The following Table 9 summarises the applicable operating environments.

OE	Applicable sub-OE	Special characteristics
medium to very large airports	runway throughput for arrivals	congested airports

Table 9: Applicable Operating Environments.

4.3 Safety

4.3.1 Safety Design drivers and Performance Mechanism

Here the relevant OI step is AO-0325 “Reduction of wake turbulence risk considering acceleration of wake vortex decay in ground proximity”.

In ground proximity vortex descent is restricted and the vortices tend to rebound due to the interaction with the ground surface. Weak crosswinds may compensate the self-induced lateral propagation of the upwind vortex, such that it may hover over the runway directly in the flight path of the following aircraft. As a consequence, aircraft experience wake vortex encounters time after time, even under adherence to separation standards. During final approach, pilots usually respond to encounters by initiating go-arounds, since their options to counteract the imposed rolling moment and re-stabilize the approach are restricted at low heights above ground. So, plate lines may contribute safety gains by reducing the number of encounters in this critical phase of flight where reductions of aircraft separations by the introduction of RECAT separations, time-based separations (TBS) and other measures might rather increase encounter risks.

A series of vertical plates with heights of 4.5 m and lengths of 9 m is installed under the glide path. This wake decay enhancing method is passive, low-cost, robust, and safe. Wake vortices generated by landing aircraft induce secondary vortices at the plates' surfaces that approach the primary vortices and trigger premature wake vortex decay.

First, the safety gains that can be achieved by the installation of plate lines were quantified based on the measurement data gathered in the field measurement campaign LT10 conducted in Wave 1 at Vienna airport. These safety gains are achieved by the acceleration of wake vortex decay during final approach in ground proximity, the phase of flight with most encounters. The acceleration of wake vortex decay was quantified in two ways: On one hand, by the determination of the reduction of the lifetime of the long-lived wake vortices, and, on the other hand, by the reduction of circulation strength at relevant vortex ages.

The accelerated wake vortex decay is also used to estimate encounter frequencies for different wake vortex separation schemes at Vienna airport and the encounter frequencies are extrapolated to the ECAC airports.

Second, the plate design for permanent installation at an airport was conducted such that it complies with airport requirements set forth by ICAO and EASA. All material required for authority approval like expert opinions on statics etc. for the installation of plate lines at an airport location has been prepared. The design process consisted of i) the development and prioritisation of requirements, ii) the development of 15 potential designs and selection of four most promising ones, and iii) the detailed design and strength analysis of the four remaining concepts enabling the selection of the best design.

4.3.2 Data collection and Assessment

The measurement data used for the current analysis were collected in the field measurement campaign LT10 conducted in PJ02.01 at Vienna airport within a time frame ranging from 6 May 2019 to 28 November 2019. During that time frame 9473 approaches on runway 16 were measured in the

majority of cases with all three available lidars. Because of the time-consuming and partly interactive lidar data processing procedure, only a part of the measurements could be made available to the analysis. 235 approaches with plates were processed corresponding to 589 individual vortex pair evolutions. Without plates 266 approaches were processed with 637 individual vortex pair evolutions.

The lidar measurements were selected for processing according to their potential to facilitate wake vortex encounters of the follower aircraft. Accordingly, the data analysis followed primarily an evaluation strategy focusing on safety aspects. Amongst other criteria, only wake vortices residing within a safety area of ± 50 m from the runway centreline were considered relevant, only landings at weak headwinds below 2 m/s and weak crosswinds below 1.5 m/s entered the analysis, to enable the comparison of wake vortices generated by different aircraft types, parts of the data characterizing vortex decay were normalized (made dimensionless), the circulation reduction was estimated as an average of several circulation percentiles, vortex lifetime reduction was computed from different vortex lifetimes percentiles for given circulation strengths, statistical significance was ensured using statistical hypothesis testing with the Wilcoxon rank-sum test. The measurement campaign and the applied data evaluation strategy are described in detail the safety assessment report [13].

In summary, the analysis shows that the plate lines substantially reduce both the lifetime of wake vortices as well as their circulation at vortex ages relevant for aircraft separations in a safety corridor along the final approach path. The lifetime reductions increase with aircraft size from 22% for the A320 to 37% for the B777-200ER. For the two investigated Heavy aircraft types the mean circulation reduction amounts to 50% assuming a 120 s separation to following Medium weight class aircraft.

To develop a technical design of the plate lines for the permanent installation at airports, a five-stage design process was carried out by DLR and Austro Control [13]. First, the requirements for the plate line design were developed and prioritized in an expert consultation. Most important are the opposing requirements of stability against storms and frangibility. Second, a longlist of possible plate designs was compiled and reduced to a shortlist of viable designs. The four most suitable designs were selected in a formalized voting process. In a third step, the four selected designs were matured into technical solutions and modelled in detail using finite element methods, finally enabling the selection of the most suitable design: four frangible aluminium lattice masts with nine aluminium sandwich composite panels. In a fourth step, the technical documentation, all needed drawings, a bill of materials, as well as a construction manual were created for the plate line. The fifth step encompassed external review and adaptation of the design based on the received feedback from the external expert. As a result, all documentation needed for the installation of plate lines at an airport and for the obtainment of authority approval was produced and the plate line prototype was deemed ready for installation.

4.3.3 Extrapolation to ECAC wide

The installation of plate lines may increase safety at all major and busy ECAC airports.

The Vienna data base has also been analysed in order to assess the potential for reducing minimum aircraft separations facilitated by plate lines during approach and landing following the RECAT-EU and RECAT-EU-PWS methodologies for revised wake turbulence categorization. For this purpose, the RECAT-EU(-PWS) methodology has been adopted as close as possible in order to estimate most realistic potential capacity gains that already meet to a large extent the requirements for future approval by the authorities and operational implementation. Details of the applied method and achieved potential separation reductions are described in [13].

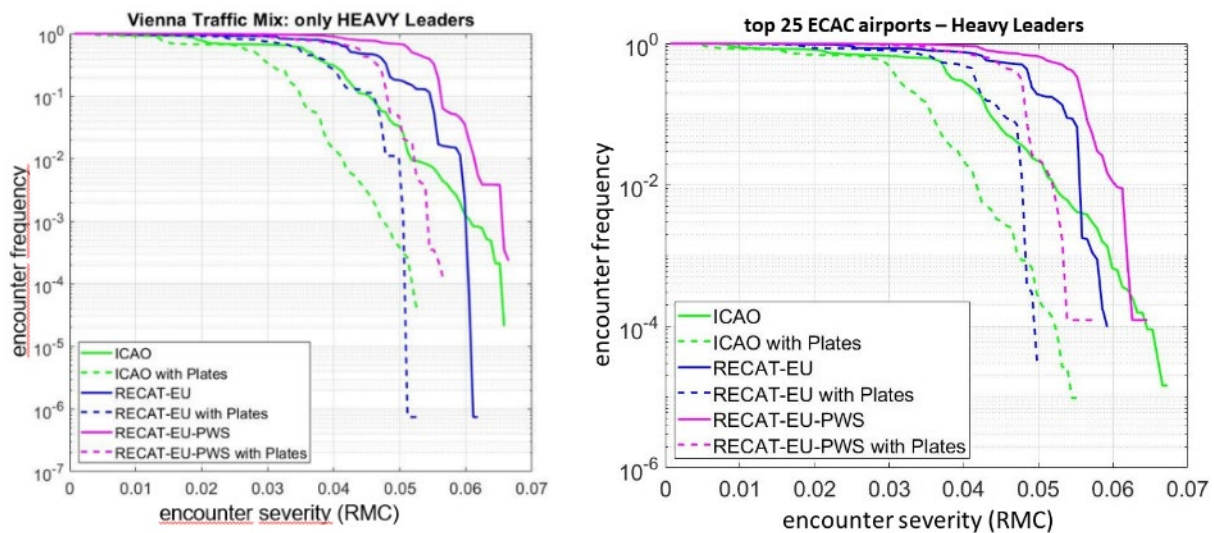


Figure 1: Relative comparison of encounter frequencies and their severity for different aircraft separation schemes with and without plate lines for traffic mix of Vienna airport (left) and top 25 ECAC airports (right).

Figure 1 left shows a cumulative distribution of encounter frequency as a function of the encounter severity for the traffic mix of Vienna airport. The extrapolation to the traffic mix at the top 25 ECAC airports is shown in Figure 1 right. The encounter severity is estimated via the rolling moment coefficient [14] resulting from the circulation strength of the wake vortices generated by a specific leader aircraft type followed by a specific aircraft type at the aircraft separation prescribed by three different separation schemes. Figure 1 elucidates that the most severe encounters are quite rare. For example, for RECAT-EU the strongest encounters are weaker than those occurring with ICAO separations, while less severe encounters become more frequent. With plate lines the most severe encounters are substantially less severe for all three separation schemes and the different considered airports. For RECAT-EU-PWS with plates the encounters are much less severe than those of the less efficient scheme RECAT-EU without plates.

4.3.4 Discussion of Assessment Result

The analysis of the measurement data collected at Vienna airport indicates that the installation of plate lines at the runway ends of busy airports will increase the safety and potentially the runway throughput capacity. The passive, low-cost, robust and safe plate lines reduce the lifetime of long-lived vortices by 22% for Medium weight class aircraft to 37% for Heavies. The reduced wake vortex lifetime in turn reduces the frequency of wake vortex encounters and go-arounds. The lifetime reduction corresponds to a circulation reduction by 50% for Mediums behind Heavies.

The analysis of the reduction of wake vortex lifetime and circulation strength by the installation of plate lines provides a clear picture of the benefits with respect to safety gains. However, in order to develop a safety case for reducing aircraft separations more detailed knowledge is needed. So, the limited number of processed measurements in the individual lidar planes didn't allow to derive direct conclusive results regarding the efficiency of the plate effects depending on the distance to the plate lines and the flight height. However, a refined analysis with the P2P wake vortex model allowed to derive a propagation speed of the plate disturbances allowing conclusions on the plate line coverage. Also, at Vienna airport the number of landings of different heavy aircraft types is limited such that only aircraft specific results for the B763 and the B772 aircraft types could be derived. A safety case for reduced separations enabled by plate lines will require data of more heavy aircraft types.

The technical plate design is ready for installation. The plate design process was conducted very systematically with an intense exchange with experts leading to excellent results. A prototype plate has been installed near Vienna airport and another one will be installed on DLR premises in Oberpfaffenhofen. Further, the documentation needed for authority approval for the installation of plate lines at an airport location has been produced such that the installation of plate lines at an airport can be brought forward efficiently.

Once RECAT-EU-PWS will be approved by EASA, the introduction of RECAT-EU-PWS supported by the installation of plate lines may advance runway throughput capacity and safety at the same time.

4.3.5 Additional Comments and Notes

4.4 Environment: Fuel Efficiency / CO2 emissions

Does the Demo impact this KPA? Yes

Accelerated wake vortex decay will reduce the number of wake vortex encounters which in turn reduces the number of go-arounds and thus contributes to fuel efficiency. The increase of runway throughput capacity at congested airports may reduce the frequency of holding patterns and reduce the average delay per flight which also contributes to fuel efficiency.

4.4.1 Performance Mechanism

The installation of plate lines at a runway will reduce wake vortex lifetime which will reduce wake vortex encounters which in turn will reduce the number of go-arounds. A reduction of the go-around rate is leading to increased fuel efficiency. During the LT10 live trial this could not be confirmed directly, as go-arounds are rare and didn't occur during measurement days. But it is a straightforward assumption that accelerated vortex decay will also reduce the number of wake vortex encounters and go-arounds and thus will increase fuel efficiency.

Once plate lines may also increase runway throughput in combination with optimised aircraft separation schemes, further mechanisms to increase fuel efficiency will be released. Reductions of average delay per flight and avoidance of holding patterns during traffic peaks achieved by a revision of wake separations will lead to further benefits in fuel efficiency. With respect to these performance benefits the potential of three use cases has been assessed with promising results, which however require further research. The most near-term benefit would be the increase of runway throughput capacity and safety at the same time by the introduction of RECAT-EU-PWS together with the installation of plate lines, once RECAT-EU-PWS will be approved by EASA.

4.4.2 Assessment Data (Exercises and Expectations)

NA

4.4.3 Extrapolation to ECAC wide

Were there any benefits obtained in SESAR2020 Wave1 for this Solution? Yes.

If yes, does the S2020 Wave2 performance comes in addition to S2020 Wave1 or replace it?

The different plate line use cases have been elaborated only in Wave2 such that the benefits are more clear now.

4.4.4 Discussion of Assessment Result

Benefits in fuel efficiency are only discussed qualitatively as the number of go-arounds due to wake vortex encounters is relatively rare (on the order of 10 go-arounds per year) and the additional flight time may vary substantially between different airports. Potential runway throughput capacity gains during peak demand have been estimated for different use cases (see section 4.7). Estimates of the resulting savings in flight time highly depend on the traffic situation and airport and are beyond the scope of this study.

4.4.5 Additional Comments and Notes

4.5 Environment / Emissions, Noise and Local Air Quality

Does the Demo impact this KPA? No

4.6 Airspace Capacity (Throughput / Airspace Volume & Time)

Does the Demo impact this KPA? No

Is there a Benefit Mechanism available? No.

4.7 Airport Capacity (Runway Throughput Flights/Hour)

Does the Demo impact this KPA? Yes

Wake vortex decay accelerated by plate lines may be translated into runway throughput increase for arrivals by combining the plate lines with different separation schemes: RECAT-EU, RECAT-EU-PWS, REDSEP, RECAT-III (pairwise dynamic separations) or by defining a new separation scheme that takes into account the accelerated wake vortex decay.

4.7.1 Performance Mechanism

Is there a Benefit Mechanism available? Yes.

Reduced wake separations for arrivals increase the runway throughput allowing for an increased number of movements, thus higher capacity. Figure 2 features five plate line use cases. While use case I focuses on the related safety gains, use cases II to V pave the way for increased runway throughput for arrivals. The estimated runway throughputs for peak demand (see capacity in Figure 2) employ Vienna Mode S traffic data of the year 2019. The runway throughput estimated for use case V “dynamic pairwise separations” corresponds to the achievable maximum throughput, which can be realised under favourable environmental conditions, allowing minimum radar separation of 2.5 NM for all aircraft pairs.

- Use Case I. Reduced wake-vortex lifetime will reduce encounter frequency corresponding to an improved safety performance. The reduced encounter frequency will reduce the go-around rates, leading to positive impacts on fuel efficiency, resilience and capacity.
- Use Case II. The introduction of the RECAT-EU scheme or the RECAT-EU-PWS (PairWise Separation) scheme together with the installation of plate lines may advance both, runway throughput for arrivals (three or five additional landings per hour during peak demand) and safety in terms of the wake vortex encounter risks. The PWS scheme requires the installation of some controller support like the separation delivery tool LORD (Landing with Optimum Runway Delivery) developed by ECTL.
- Use Case III. On top of use case II additional capacity gains of up to two additional landings per hour during peak demand can be made accessible by translating accelerated wake vortex decay into reduced separations following the methods developed for RECAT-EU and RECAT-EU-PWS. Preliminary consideration of the effects along the glide slope reduces these expected capacity gains mainly for the RECAT-EU scheme.
- Use Case IV. The application range of the REDSEP method developed for airport Vienna may be extended to situations with weak winds. This still has to be shown in future work.
- Use Case V. On top of use cases I to IV aircraft separation may be reduced tactically depending on the prevailing weather conditions and the resulting wake vortex behaviour. The delivery of pairwise dynamic separations (RECAT III) requires monitoring and prediction of weather conditions along the glide path. As separations are limited by vortex evolution in ground proximity in about 85%, plate lines may improve the performance of the respective wake vortex advisory system.

Plate Line Use Cases

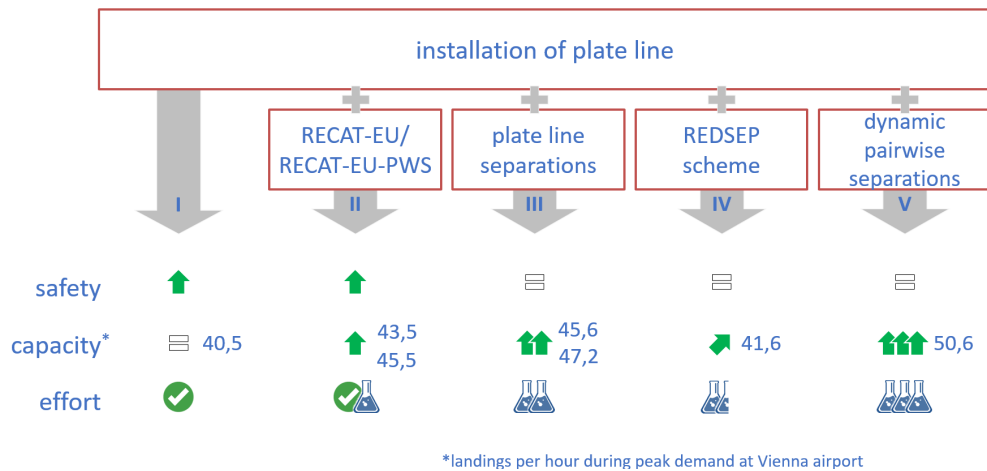


Figure 2: Plate Line Use Cases

4.7.2 Assessment Data (Exercises and Expectations)

The analysis of potential runway throughput gains employs data of over 100,000 landings collected at Vienna airport throughout the year 2019. Mode S protocol data provide the landing runway, the types of the leading and the following aircraft as well as the spatial and temporal separations. Phases of peak demand were identified by selecting aircraft pairings that were separated by less than 1.1 times of the ICAO minimum separations. Minimum radar separation was set to 2.5 NM. The resulting number of landings during peak demand at Vienna airport amounts on average to 40.5 (see *use case I* in Figure 2).

For *use case II* with RECAT-EU 43.5 landings per hour during peak demand were estimated by applying the minimum separations for the respective RECAT-EU aircraft category combinations [24]. For RECAT-EU-PWS the corresponding pairwise separations [25] were applied leading to 45.5 landings per peak hour.

The method applied to determine the separations for *use case III* is described in detail in section 4.2.2 “Assessment of achievable reductions of separation minima” of the DEMOR [23] and in several scientific publications [26], [27], [28]. The analysis follows the steps of the RECAT-EU and RECAT-EU-PWS methods to generate non-dimensional so-called reasonable worst-case circulation decay curves; one as a reference for nominal operations without plates and one representing the accelerated wake vortex decay brought about by the plate lines. The difference between the two circulation decay curves corresponds to the time-based aircraft separation reduction potential that can be translated into distance-based separation gains. Depending on the particular RECAT-EU category combination, the attained aircraft separation reduction potential ranges between 12% and 15%.

Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines. Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft

category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines. Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines.

Applying the same method to the PWS matrix yields potential separation reductions between 12% and 24% (average 15%). The landings per hour of 45.6 and 47.2 during peak demand (Figure 2) were achieved by applying the aircraft category combinations and individual aircraft type combinations only considering the accelerated vortex decay in ground proximity. Potential separation reductions ranging from 12% to 15% were evaluated. The same method was applied to the RECAT-EU-PWS pairwise separations, yielding a potential separation reduction due to the plates of 12% to 24% (average 14.8%). Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines. Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines. Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines. Even though plate lines are only effective close to the ground, they still support a potential reduction of the separation further up on the glideslope. When using RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines.

The landing rates shown in Figure 2 do not yet consider restrictions of the separation further up on the glideslope. A preliminary analysis of these restrictions indicates that for RECAT-EU as reference, substantial benefits can only be gained for some – albeit relevant – aircraft category combinations. When using RECAT-EU-PWS as reference, for most aircraft pairings, benefits of about 0.5 NM (15%) separation reduction seem to be possible when using plate lines.

For *use case IV* REDSEP it is assumed that the separations for Medium-Medium pairings and Medium-Heavy pairings are reduced by 0,11 NM corresponding to 3 s under favourable conditions supporting the REDSEP scheme.

Finally, *use case V* assumes that atmospheric conditions like for example strong crosswinds allow to reduce separations to the minimum radar separation of 2.5 NM. The corresponding aircraft throughput of 50.6 landings per hour corresponds to the maximum landing rate that can be applied under favourable atmospheric conditions and the applicable minimum radar separation .

Table 10 lists the range of runway throughput gains for landings during peak demand for the use cases II to V in relation to the reference throughput (use case I) in percent and absolute numbers.

Exercise ID or Expert judgement	Benefits contribution to CAP3	Benefits contribution to CAP3.1	Benefits contribution to CAP3.2	Benefits contribution to CAP4
EXE-VLD-03-002			3% – 25%; 41.6 – 50.6	

Table 10: Airport Capacity benefits per Exercise

Table 11, Table 12, Table 13, Table 14 and Table 15 show other benefits either for airport capacity or resilience aspects.

OI step	Relative benefits contribution to CAP3	Relative benefits contribution to CAP3.1	Relative benefits contribution to CAP3.2	Relative benefits contribution to CAP4
AO-0325			100%	
TOTAL	100%	100%	100%	100%

Table 11: Airport Capacity relative benefits per OI step

KPIs / Pls	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
CAP3 Peak Runway Throughput (Mixed mode)	% and Flight per hour	% and also total number of movements per one runway per one hour for specific traffic mix and density (in mixed mode RWY operations). The percentage change is measured against the maximum observed throughput during peak demand hours in the mixed-mode RWY operations airports group.	YES	<i>To be completed with a single or a range of values if easier</i>	<i>To be completed with a single or a range of values if easier (%)</i>
CAP3.1 Peak Departure throughput per hour (Segregated mode)	% and Flight per hour	% and also total number of departures per one runway per one hour for specific traffic mix and density (in segregated mode of operations). The percentage change is measured against the maximum observed throughput during peak demand hours in the segregated-mode RWY operations airports group.	YES	<i>To be completed with a single or a range of values if easier</i>	<i>To be completed with a single or a range of values if easier (%)</i>
CAP3.2 Peak Arrival throughput per hour (Segregated mode)	% and Flight per hour	% and also total number of arrivals per one runway per one hour for specific traffic mix and density (in segregated mode of operations). The percentage change is measured against the maximum observed throughput during peak demand hours in the segregated-mode RWY operations airports group.	YES	<i>To be completed with a single or a range of values if easier</i>	<i>To be completed with a single or a range of values if easier (%)</i>
CAP4 Un-accommodat	Flights/year	Reduction in the number of un-accommodated flights i.e. a flight that would have been scheduled if there were	YES For CBA.	<i>To be completed with a single or a range of values if easier</i>	<i>To be completed with a single or a range of</i>

KPIs / Pls	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
ed traffic reduction		available slots at the origin/destination airports. NB: Supports CBA Inputs. NB: Relates to Airport Capacity because this is STATFOR computation. CBA calculate this based on the assessment of the runway throughput we provide with and without the solutions and STATFOR data.			values if easier (%)

Table 12: Airport Capacity for Mandatory KPIs /Pls

Were there any benefits obtained in SESAR2020 Wave1 for this Demo? No.

If yes, does the S2020 Wave2 performance comes in addition to S2020 Wave1 or replace it?

4.7.3 Extrapolation to ECAC wide

Plate lines can be installed to increase runway throughput at any medium to very large airports that reach limitations of runway capacity for approach and landing.

4.7.4 Discussion of Assessment Result

Once RECAT-EU-PWS will be approved by EASA, the introduction of RECAT-EU-PWS supported by the installation of plate lines may advance runway throughput capacity and safety at the same time. Plate Line use cases III – V and corresponding safety cases should be brought forward and approved to facilitate safety and capacity gains at major congested airports.

4.7.5 Additional Comments and Notes

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

Does the Demo impact this KPA? Yes

4.8.1 Performance Mechanism

Is there a Benefit Mechanism available? Yes

The reduced encounter frequency will reduce the go-around rates, leading to positive impacts on resilience.

4.8.2 Assessment Data (Exercises and Expectations)

Exercise ID or Expert judgement	Benefits contribution to RES1	Benefits contribution to RES1.1	Benefits contribution to RES2	Benefits contribution to RES2.1	Benefits contribution to RES4	Benefits contribution to RES5
EXE-VLD-03-002	10 go-arounds less per year					

Table 13: Resilience benefits per Exercise

OI step	Relative benefits contribution to RES1	Relative benefits contribution to RES1.1	Relative benefits contribution to RES2	Relative benefits contribution to RES2.1	Relative benefits contribution to RES4	Relative benefits contribution to RES5
AO-0325	100%					
TOTAL	100%	100%	100%	100%	100%	100%

Table 14: Resilience relative benefits per OI step

PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
RES1 Loss of Airport Capacity Avoided	% and Movement s per hour	Loss of Airport Capacity with the concept divided by the loss of Airport Capacity without the concept.	YES	To be completed with a single or a range of values if easier	To be completed with a single or a range of values if easier (%)
RES 1.1 Airport time to recover from non-nominal to nominal condition	Minutes	Duration of Airport lost capacity from non-nominal to nominal condition.	YES for Airport OE Demos	To be completed with a single or a range of values if easier	To be completed with a single or a range of values if easier (%)
RES2 Loss of Airspace Capacity Avoided	% and Movement s per hour	Loss of Airspace Capacity with the concept divided by the loss of Airspace Capacity without the concept	YES	To be completed with a single or a range of values if easier	To be completed with a single or a range of values if easier (%)
RES2.1 Airspace time to recover from non-nominal to nominal condition	Minutes	Duration of Airspace lost capacity compared to non-nominal to nominal condition.	YES for Airspace OE Demos	To be completed with a single or a range of values if easier	To be completed with a single or a range of values if easier (%)

PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
RES4 Minutes of delays	Minutes	Impact on AUs measured through delays resulting from capacity degradation ⁶ . RES1 and RES2 KPIs drive this PI, though the PI may need to be measured on a condition-by-condition basis (e.g. fog, wind, system outage).	YES	<i>To be completed with a single or a range of values if easier</i>	<i>To be completed with a single or a range of values if easier (%)</i>
RES5 Number of cancellations	No flights	Impact on AUs measured through Cancellations resulting from capacity degradation ⁷ . RES1 and RES2 KPIs drive this PI, though the PI may need to be measured on a condition-by-condition basis (e.g. fog, wind, system outage).	YES	<i>To be completed with a single or a range of values if easier</i>	<i>To be completed with a single or a range of values if easier (%)</i>

Table 15: Resilience for Mandatory PIs

Were there any benefits obtained in SESAR2020 Wave1 for this Demo? Yes

If yes, does the S2020 Wave2 performance comes in addition to S2020 Wave1 or replace it?

No new insights from wave2.

⁶ Reactionary delay out of the scope since they could be due to many different reasons other than capacity degradation, in addition the cause of reactionary delay are not recorded in detail.

⁷ Reactionary delay out of the scope since they could be due to many different reasons other than capacity degradation, in addition the cause of reactionary delay are not recorded in detail.

4.9 Flight Times

Does the Demo impact this KPA? No

4.10 Predictability

Does the Demo impact this KPA? No

4.10.1 Performance Mechanism

Is there a Benefit Mechanism available? No.

4.11 Punctuality

Does the Demo impact this KPA? No

4.11.1 Performance Mechanism

Is there a Benefit Mechanism available? No.

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

Does the Demo impact this KPA? No

4.12.1 Performance Mechanism

Is there a Benefit Mechanism available? No.

4.13 Flexibility

Does the Demo impact this KPA? No

4.13.1 Performance Mechanism

Is there a Benefit Mechanism available? No.

4.14 Cost Efficiency

Does the Demo impact this KPA? Yes

The Cost Efficiency performance metric is the direct gate-to-gate ANS cost per flight. It is being assessed by means of the following two KPIs:

- ATCO Productivity improvement (%) – En-Route or TWR/APP, assessing the reduction of workload per controlled flight hour.
- Technology Related Cost-Efficiency Improvement (%) – by assessing the contributions of the technology enablers to a change in asset costs and/or operating costs (maintenance, etc), including support costs improvements (support personnel productivity).

4.14.1 Performance Mechanism

Is there a Benefit Mechanism available? Yes

On one hand, benefits from the accelerated wake vortex decay lead to less encounters and go-arounds. The number of avoided go-arounds for large airport is estimated to ten per year.

Estimated increases of landing runway throughput during peak demand vary from one landing per hour to seven landings per hour depending on the use case (see section 4.7). Favourable weather may even allow for 10 additional landings (dynamic pairwise separations). For some airports such a capacity increase may even avoid or postpone building a new runway.

The costs extrapolated from the plate prototype installed at DLR premises in Oberpfaffenhofen are on the order of € 400,000 for a plate line consisting of eight plates including the foundations. Installation costs are on the order of € 100,000. The production of a complete plate line consisting of eight plates will reduce the cost per plate. There are also already design modifications at hand for reducing the costs. On the other hand, there will be other costs needed for planning of the plate line and approval of the installation by the authorities.

Setting the costs and benefits into perspective is not attempted here as the savings regarding avoided delays, holding patterns, avoided go-arounds or even delaying building new runways vary extremely and also depend largely on specific airports.

4.14.2 Assessment Data (Exercises and Expectations)

NA

4.14.3 Extrapolation to ECAC wide

NA

Were there any benefits obtained in SESAR2020 Wave1 for this Demo? Yes

If yes, does the S2020 Wave2 performance comes in addition to S2020 Wave1 or replace it?

Comes in addition.

4.14.4 Discussion of Assessment Result

Additional Comments and Notes

4.15 Airspace User Cost Efficiency

Does the Demo impact this KPA? No

4.15.1 Performance Mechanism

Is there a Benefit Mechanism available? No.

4.16 Security

Does the Demo impact this KPA? No

4.17 Human Performance

Does the Demo impact this KPA? No

4.18 Other PIs

NA

4.19 Gap Analysis

NA

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⁸ At the time of the creation of the PAR template, the Methodology (PJ19.04 Internal Document) is foreseen to be update in 2020.

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