

PJ.02-W2-14.2 CBA Final

Deliverable ID:	D4.2.010
Dissemination Level:	PU
Project Acronym:	AART
Grant:	874477
Call:	H2020-SESAR-2019-1
Topic:	SESAR-IR-VLD-WAVE2-03-2019 PJ.02 W2 AIRPORT AIRSIDE AND RUNWAY THROUGHPUT
Consortium coordinator:	EUROCONTROL
Edition date:	24 August 2022
Edition:	00.01.00
Template Edition:	02.00.06

Authoring & Approval

Authors of the document

Beneficiary	Date
EUROCONTROL	26/07/2022

Reviewers internal to the project

Beneficiary	Date
EUROCONTROL	29/07/2022

Reviewers external to the project

Beneficiary	Date
None	

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

Beneficiary	Date
EUROCONTROL	29/07/2022

Rejected By - Representatives of beneficiaries involved in the project

Beneficiary	Date
None	

Document History

Edition	Date	Status	Beneficiary	Justification
00.00.01	20/07/2021	Draft	EUROCONTROL	Intermediate draft version for SJU review
00.00.02	26/07/2022	Draft	EUROCONTROL	Final version for SJU quality check
00.01.00	24/08/2022	Final	EUROCONTROL	Final version for data pack

Copyright Statement © 2022 – EUROCONTROL. All rights reserved. Licensed to SESAR3 Joint Undertaking under conditions.

AART

AIRPORT AIRSIDE AND RUNWAY THROUGHPUT

This CBA document is part of a project that has received funding from the SESAR 3 Joint Undertaking under grant agreement No 874477 under European Union's Horizon 2020 research and innovation programme.



Abstract

This document provides the Cost Benefit Analysis (CBA) at V3 level for **PJ.02-W2-14.2** Second Runway Aiming Point (SRAP), which is an Enhanced Arrival Procedure (EAP). The associated OI Step is AO-0319: Enhanced approach operations using a second runway aiming point (SRAP).

This deliverable includes the quantification and monetisation of costs and benefits attached to the implementation of the SRAP procedure at relevant airports across ECAC.

Table of Contents

Abstract	3
1 Executive Summary	8
2 Introduction.....	10
2.1 Purpose of the document	10
2.2 Scope.....	10
2.3 Intended readership.....	10
2.4 Structure of the document	11
2.5 Background.....	11
2.6 Glossary of terms	12
2.7 List of Acronyms.....	14
3 Objectives and scope of the CBA	19
3.1 Problems addressed by the solution	19
3.2 SESAR Solution description	19
3.3 Objectives of the CBA	21
3.4 Stakeholder identification	21
3.5 CBA Scenarios and Assumptions	23
3.5.1 CBA Reference Scenario.....	24
3.5.2 CBA Solution Scenario.....	24
3.5.3 Assumptions	27
4 Benefits.....	28
4.1 Noise Reduction (NOI)	29
4.2 Airport Capacity (CAP3)	31
4.3 Fuel Efficiency (FEFF1) and CO₂ Emissions (ENV1)	32
4.4 Time Efficiency (TEFF2)	33
4.5 Cost Efficiency (CEF2)	34
4.6 Benefit Monetisation of the Performance Framework KPI/PI.....	35
5 Cost assessment	39
5.1 ANSPs costs.....	39
5.1.1 ANSPs cost approach	39
5.1.2 ANSPs cost assumptions	39
5.1.3 Number of investment instances (units)	39
5.1.4 Cost per unit	39
5.2 Airport operators costs.....	40
5.2.1 Airport operators cost approach	41
5.2.2 Airport operators cost assumptions	41
5.2.3 Number of investment instances (units)	41
5.2.4 Cost per unit	41
5.3 Network Manager costs	41

68	5.4	Airspace User costs	41
69	5.5	Military costs	42
70	5.6	Other relevant stakeholders	42
71	5.7	Cost Summary	42
72	6	CBA Model.....	43
73	6.1	Data sources	43
74	7	CBA Results	44
75	7.1.1	Discounted Values	44
76	7.1.2	Undiscounted Values	46
77	8	Sensitivity and risk analysis.....	48
78	8.1	Discount Rate.....	48
79	8.2	Sensitivity Comparison	48
80	8.3	Sensitivity Scenario	49
81	8.3.1	Costs double	49
82	8.3.2	Benefits halved	50
83	8.3.3	Pessimistic Scenario CBA Results.....	50
84	9	Recommendations and next steps.....	51
85	10	References and Applicable Documents.....	52
86	10.1	Applicable Documents.....	52
87	10.2	Reference Documents	52
88	Appendix A	Description of the Second Runway Aiming Point (AO-0319).....	53
89	Appendix B	List of Very Large and Large Airports.....	54
90	Appendix C	Linking Benefit and Impact Mechanisms to the CBA benefits.....	56
91	C.1	Ground benefit and impact mechanisms.....	56
92	C.2	Airspace User Benefit and Impact Mechanism.....	58
93	Appendix D	Discount rate	62
94	Appendix E	Mapping ATM Master Plan Performance Ambition KPAs and SESAR 2020	
95		Performance Framework KPAs.....	63
96			
97		List of Tables	
98		Table 1: Glossary of terms	14
99		Table 2: List of acronyms	18
100		Table 3: SESAR Solution PJ.02-W2-14.2	20
101		Table 4: AO-0319 related Enablers	21
102		Table 5: SESAR Solution PJ.02-W2-14.2 CBA Stakeholders and impacts	23
103		Table 6: CBA Investment and Benefit Dates	27
104		Table 7: PJ.02-W2-14.2 Performance Assessment Results.....	29

105	Table 8: Noise Indicator descriptions.....	29
106	Table 9: Environmental price of traffic noise for EU28 (CE Delft - Handbook on the external costs of	
107	transport Version 2019).....	30
108	Table 10: Airport Capacity Result.....	31
109	Table 11: Fuel Efficiency Result.....	33
110	Table 12: Time Efficiency Result for SA.....	33
111	Table 13: ATCO Productivity values	34
112	Table 14: Results of the benefits monetisation per KPA	38
113	Table 15: Number of investment instances - ANSPs.....	39
114	Table 16: ANSP Costs per Enabler.....	40
115	Table 17: Cost per Unit – ANSP including the optional tool	40
116	Table 18: Number of investment instances - Airports.....	41
117	Table 19: ANSP Costs per Enabler.....	41
118	Table 20: Cost per Unit - Airport.....	41
119	Table 21: Airspace User (Scheduled Airlines and Business Aviation) Training Costs.....	42
120	Table 22: Investment Cost Summary	42
121	Table 23: Operating Cost Summary	42
122	Table 24: PJ.02-W2-14.2 Discounted CBA results (per stakeholder and overall)	45
123	Table 25: PJ.02-W2-14.2 Undiscounted CBA results (per stakeholder and overall).....	46
124	Table 26: Investment Cost Summary	49
125	Table 27: Operating Cost Summary	50
126	Table 28: PJ.02-W2-14.2 Pessimistic Scenario - Discounted CBA results (per stakeholder and overall)	
127		50
128	Table 29: List of Very Large and Large airports.....	55
129	Table 30: Mapping between ATM Master Plan Performance Ambition KPAs and SESAR Performance	
130	Framework KPAs, Focus Areas and KPIs	64
131		
132	List of Figures	
133	Figure 1: Scenario Overview	24
134	Figure 2: Overview of CBA Dates	27
135	Figure 3: Noise reduction Monetisation Mechanism	30
136	Figure 4: Airport Capacity Monetisation Mechanisms – Airport, ANSP and Airspace User benefits ...	32

137	Figure 5: Fuel Efficiency and CO ₂ Monetisation Mechanisms	33
138	Figure 6: Time Efficiency Monetisation Mechanism for SA	34
139	Figure 7: ATCO Productivity	34
140	Figure 8: PJ.02-W2-14.2 Annual Investment Levels and Benefits (discounted)	45
141	Figure 9: PJ.02-W2-14.2 Annual Investment Levels and Benefits expanded (discounted)	46
142	Figure 10: PJ.02-W2-14.2 Annual Investment Levels and Benefits (undiscounted)	47
143	Figure 11: Sensitivity Analysis – Discount Rate.....	48
144	Figure 12: Tornado diagram.....	49
145	Figure 13: SRAP procedure with one interception altitude	53
146	Figure 14: SRAP procedure with two interception altitudes	53
147		
148		

1 Executive Summary

This report¹ provides the V3 Cost Benefit Analysis (CBA) for SESAR Solution **PJ.02-W2-14.2 Second Runway Aiming Point (SRAP)**, which is an Enhanced Arrival Procedure (EAP) that uses two active thresholds on a single runway.

Solution PJ.02-W2-14.2 has validated to V3 level the Operational Improvement Step (OI Step) AO-0319: Enhanced approach operations using a Second Runway Aiming Point (SRAP). The CBA focuses on the **deployment** of the Solution at ECAC²-level and is not limited to the scope of the validation activities.

Benefits

The expected SRAP **benefits** that are monetised in the CBA are:

- Reduced environmental impact from **Noise Reduction** below the final approach in peak and non-peak periods for aircraft using the SRAP
- Increases in **Airport Capacity** during capacity-constrained peak periods when both runway aiming points are used to optimise wake turbulence separations for specific combinations of leader/follower aircraft pairs
- Improvements in **Fuel Efficiency** and **Time Efficiency** in peak and non-peak periods where the airport layout allows a reduction in runway occupancy time and taxi-in time for aircraft using the SRAP

An airport will choose to deploy a second runway aiming point based on their operational needs, for example, to optimise wake turbulence separations or to optimise taxi-in times.

The CBA is presented at the ECAC-level following an extrapolation of local benefits from the validation activities. For this Solution ECAC-level is considered to be five³ capacity-constrained airports from the Very Large and Large operating environment categories (SESAR 2020 Airport Classification Scheme) operating in segregated mode. These airports have been identified as potential candidates to deploy SRAP for capacity and noise related reasons. Other airports in the Very Large, Large and Medium operating environment categories could also deploy the solution and benefit from the noise reduction aspects, however, the associated costs and benefits are not included in this CBA.

The noise benefits were calculated per airport based on the results of the IMPACT tool⁴. These results show the reduction of noise contours around the airport areas when implementing SRAP; this translates to a reduction in aircraft noise for impacted residents.

CBA Results

The Net Present Value (NPV) of 217 M€ reflects that the benefits from deploying this Solution are expected to exceed the costs of deploying and operating it. Confidence in the benefits is medium as they are based on Fast Time Simulation results.

¹ The opinions expressed herein reflect the authors' view only. Under no circumstances shall the SESAR 3 Joint Undertaking be responsible for any use that may be made of the information contained herein.

² European Civil Aviation Conference

³ The airport names are not provided as they were chosen based on criteria and have made no commitment to deploy.

⁴ IMPACT is a web-based modelling platform that enables consistent trade-off analyses between fuel burn and emissions, on the one hand and noise, on the other hand. <https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform>

The NPV has been calculated with an 8% discount rate over the period 2022 to 2043, with PJ.02-W2-14.2 being deployed between 2025 and 2030 and with benefits starting to be realised from late 2026. The payback year is 2031, which reflects when the cumulative net benefits will exceed the costs.

The sensitivity analysis shows that even if the costs doubled and the benefits halved, the deployment, as described in the CBA Solution Scenario, would still have a positive NPV of 26 M€.

Costs

On the cost side the deployment of SRAP will require ANSPs⁵, Airport Operators and Airspace Users to invest.

- ANSP costs are based on a controller tool to support final approach operations as well as a controller separation support tool (enhanced Optimised Runway Delivery tool, eORD⁶) to support the use of SRAP and training for both.
- Airport Operator costs relate to runway markings, lighting and PAPI (precision approach path indicator) for each second runway aiming point.
- Airspace User costs relate to pilot training requirements. There are no airborne or flight operation centre investments required.

Some of the enablers required for this Solution will also enable other Solutions, however, the full enabler cost has been included in this CBA as a conservative approach.

While not included in the CBA, approach guidance is required for the operation of SRAP. This can be RNP (Required Navigation Performance), SBAS (Satellite Based Augmentation System) or GBAS (Ground Based Augmentation System). RNAV (Required Vertical Navigation Performance) guidance is also considered because it is anticipated that in 2025 most aircraft will be able to follow RNAV procedures, whereas only 25% of the fleet is expected to be GBAS-equipped.

Recommendations and next steps

PJ.02-W2-14.2 is a Solution that an airport could choose to deploy if they face capacity-constraints and noise issues around the airport. However, each airport needs to assess if this Solution is the best way to meet their operational needs and they should develop their own CBA based on their specific infrastructure, operations, layout, etc. to assess the scale of their potential benefits. They should also review related solutions, such as PJ.02-W2-14.3 Increased Second Glide Slope and PJ.02-W2-14.5 Increased Glide Slope to Second Runway Aiming Point, to ensure they deploy the most appropriate solution for their needs.

⁵ It is assumed that air traffic control (ATC) systems located at airports are owned by the ANSPs that provide the service; ANSPs are therefore assigned the relevant upgrade costs of these systems in the CBA. In reality the situation will differ across airports as some airports may own the systems.

⁶ The eORD is included in this CBA although the tool is optional for airports that would focus solely on the noise benefits (i.e. with lower traffic levels who do not need the Airport Capacity benefits)

2 Introduction

2.1 Purpose of the document

This document provides the Cost Benefit Analysis (CBA) for SESAR Solution **PJ.02-W2-14.2 Second Runway Aiming Point (SRAP)**, which is an Enhanced Arrival Procedure (EAP) that has been validated to V3 level. The CBA looks at the **affordability of deploying the SRAP solution** with respect to its expected benefits.

This V3 CBA considers the impacts, benefits and costs of deploying the solution at ECAC-level. It includes the Net Present Value (NPV) for the Solution and per impacted stakeholder group, as well as a sensitivity analysis to identify the most critical variables to the value of the project.

2.2 Scope

Deploying a Second Runway Aiming Point will allow aircraft to land further along the runway which can provide benefits in terms of:

- Reduced environmental impact from **Noise Reduction** below the final approach in peak and non-peak periods for aircraft using the SRAP
- Increases in **Airport Capacity** during capacity-constrained peak periods when both runway aiming points are used to optimise wake turbulence separations for specific combinations of leader/follower aircraft pairs
- Improvements in **Fuel Efficiency** and **Time Efficiency** in peak and non-peak periods where the airport layout allows a reduction in runway occupancy time and taxi-in time for aircraft using the SRAP

This PJ.02-W2-14.2 V3 CBA provides the costs and benefits of the SRAP Solution Operational Improvement Step (OI Step AO-0319) and associated enablers; see section 3.2. It considers the standalone deployment of the Solution, i.e. independently from any other SESAR Solution(s). This means that the costs of any enablers that also enable other solutions are fully included here.

The CBA covers the period from 2022 to 2043. The Solution is assumed to be available to deploy from 2025, with initial benefits starting in late 2026 and full benefits from 2030. The CBA includes five airports, from the Very Large and Large categories [8], which have been identified as candidates for deployment due to their traffic patterns including capacity-constrained peaks. Other airports in the Very Large, Large and Medium operating environment categories could also deploy the solution and benefit from the noise reduction aspects, however, the associated costs and benefits are not included in this CBA.

2.3 Intended readership

The intended readership for this document includes:

- PJ.02-W2-14.2 Solution members
- PJ.02 Increased Runway and Airport Throughput – Other Project partners
- PJ.19 who provides inputs such as the assumptions and who will consolidate the CBA results (where required by PJ20).
- PJ.20 in its role of Master Plan Maintenance project
- SESAR Programme Management
- Stakeholders (ANSPs and airports) interested in deploying this solution

- Airspace Users (Scheduled Airlines, Business Aviation) interested in the deployment of this solution

2.4 Structure of the document

This report is structured as follows:

- Section 1 contains the executive summary
- Section 2 provides the scope, intended readership, document structure, background, glossary of terms and acronyms
- Section 3 presents the objectives and scope of this CBA, including a description of the Second Runway Aiming Point Solution, information on the main stakeholders and descriptions of the CBA scenarios
- Section 4 describes the benefits and how they are monetised as well as a view on the overall contribution to Key Performance Indicators (KPIs)
- Section 5 details the costs along with the cost approach per stakeholder group and the associated assumptions
- Section 6 includes the CBA model and information on the sources of data used to feed it;
- Section 7 provides the CBA results
- Section 8 includes the sensitivity analysis
- Section 9 includes recommendations and next steps
- Section 10 includes the references and applicable documents.
- The appendices provide a visual overview of the concept, the list of Very Large and Large Airports, the links between the Benefit and Impact Mechanisms and the CBA as well as the rationale of the use of 8% discount rate and some information on Key Performance Areas.

2.5 Background

The PJ.02-W2-14.2 SRAP solution builds on the PJ.02-02 Solution “Enhanced Arrival Procedures” from SESAR 2020 Wave 1. PJ.02-02 considered a group of five Enhanced Arrival Procedures (EAP). In Wave 2 each EAP has been defined as a separate Solution:

- **PJ.02-W2-14.1** (AO-0308) Closely Spaced Parallel Runways optimised operations using Staggered Thresholds (CSPR-ST) – *frozen in Wave 2*
- **PJ.02-W2-14.2** (AO-0319) Enhanced Arrival procedures using Second Runway Aiming Points (SRAP) – focus of this CBA
- **PJ.02-W2-14.3** (AO-0320) Enhanced Arrival procedures using Increased Second Glide Slope (ISGS)
- **PJ.02-W2-14.4** (AO-0321) Enhanced Arrival procedures using Adaptive Increased Glide Slope (A-IGS) - *frozen in Wave 2*
- **PJ.02-W2-14.5** (AO-0331) Enhanced Arrival Procedure using an Increased Glide Slope to a Second Runway Aiming Point (IGS-to-SRAP)

As each Solution is separate, they each have a stand-alone CBA (PJ.02-W2-14.2 SRAP, PJ.02-W2-14.3 ISGS and PJ.02-W2-14.5 IGS-to-SRAP) developed from the PJ.02-02 CBA deliverable [9] from Wave 1 that included a consolidated analysis for the five EAP concepts. The CBA is based on nominal conditions and so the non-nominal validation exercises performed in SESAR 2020 Wave 2 have not provided additional inputs for this CBA.

The PJ.02-02 Solution built on validation work produced during SESAR 1 for projects:

- P06.08.08 D07 – Enhanced Arrival Procedures Enabled by GBAS - OSED Consolidation [10] and,
- P06.08.05 D04 – Operational Service and Environment Definition (OSED) Displaced Thresholds [11].

2.6 Glossary of terms

Term	Definition	Source of the definition
Benefit	A Benefit is the positive value of the return on investment to (some or all) stakeholders.	SESAR 16.06.06 - <i>Methods to Assess Costs and Monetise Benefits for CBAs (D26, Edition 00.02.02, July 2016)</i>
Benefit and Impact Mechanism	A Benefit and Impact Mechanisms a cause-effect description of the positive and negative impacts of the Solution proposed by the project	SESAR 16.06.06 – <i>Guidelines for Producing benefit and Impact Mechanisms (D26_04, Edition 03.00.00)</i>
Business Case	A Business Case is a tool for decision-makers, it aims to provide them with the information they need to make a fully informed decision on whether funding should be provided and/or whether an investment should proceed. A Business Case is much more than just a financial analysis as it also includes quantitative and qualitative arguments on performance and transversal activities that are key to determining the value of the project.	SESAR 16.06.06, <i>SESAR Business Case Example – Remote Tower, D48, Edition 00.01.02, 06/05/14</i>
Cash Flow	Cash flow is the difference between the cash inflows and outflows related to the project during the time horizon in which they occur.	SESAR 16.06.06 - <i>ATM CBA for Beginners, D26-01, October 2014</i>
Cost	A Cost is the monetary value of an investment used up to produce or acquire the benefit.	SESAR 16.06.06 - <i>Methods to Assess Costs and Monetise Benefits for CBAs (D26, Edition 00.02.02, July 2016)</i>
Cost Benefit Analysis	A Cost Benefit Analysis is a process of quantifying in economic terms the costs and benefits of a project or a program 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. A CBA is a neutral financial tool that 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	SESAR 16.06.06, <i>SESAR Business Case Example – Remote Tower, D48, Edition 00.01.02, 06/05/141</i>

	value for money while considering all the key criteria for the decision.	
Cost mechanisms	Cost mechanisms are a description of the potential costs of the project broken down into relevant cost categories (e.g. investment, operating).	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Discount Rate	Discount Rate is a way to capture the time value of money. This is a percentage that represents the increase in the amount of money needed or estimated to keep the same value as one year ago.	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
IMPACT Tool	IMPACT is a web-based modelling platform that enables consistent trade-off analyses between fuel burn and emissions, on the one hand and noise, on the other hand.	<i>EUROCONTROL/ Environment</i>
Initial Operational Capability	Initial Operational Capability is the state archives when a capability is available in its minimum usefully deployable form. In other words, it identifies the start of benefits and the benefit ramp-up period.	<i>16.06.06-D68-New CBA Model and Method 2015- Part1 of 2</i>
Inflation	Inflation is a rise in the general level of prices of goods and services in an economy over a period of time.	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Net Present Value (NPV)	Net Present Value (NPV) is the sum of all discounted cash inflows and outflows during the time horizon period.	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Sensitivity Analysis	Sensitivity refers to the impact one given input to the model has on the overall NPV.	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Stakeholder	Stakeholders are organizations and entities who will have to pay for or will be impacted by the project directly or indirectly.	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Time Horizon	Time horizon refers to a definite period during which all cost and benefits related to a given project occur.	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Time Value of Money	Time Value of Money means that the same (nominal) amount of money received at different points in time has different value	<i>SESAR 16.06.06, ATM CBA for Beginners, D26-01, October 2014</i>
Unaccommodated traffic	This reflects the flight demand that is forecast in the STATFOR Long Term Forecasts but which cannot be accommodated due to a lack of forecast capacity at airports.	<i>STATFOR</i>

Wake Turbulence	Wake turbulence is a function of an aircraft producing lift, resulting in the formation of two counter-rotating vortices trailing behind the aircraft. Wake turbulence from generating aircraft can affect encountering aircraft due to the strength, duration, and direction of the vortices.	<i>PJ.02-01 partners</i>
Wake Vortex	Wake vortex is a circular pattern of rotating air left behind a wing as it generates lift.	<i>PJ.02-01 partners</i>

Table 1: Glossary of terms

2.7 List of Acronyms

Acronym	Definition
AART	Airport Airside and Runway Throughput
AERO	Aerodrome
A-IGS	Adaptive Increased Glide Slope
ANS	Air navigation services
ANSP	Air Navigation Service Provider
AO	Airport Operator
APP	Approach Centre
APT	Airport
APV-Baro	Approach Procedures with Vertical Guidance (using barometric altitude info)
APV-SBAS	Approach Procedures with Vertical Guidance (using barometric altitude info)
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATS	Air Traffic Services
AU	Airspace User
AUC	Airspace User Costs
BA	Business Aviation
BIM	Benefit and Impact Mechanisms
CAP	Capacity
CAPEX⁷	Capital Expenditure

⁷ Note that the term CAPEX has been used in the CBA Report to indicate all the investments (pre-implementation and implementation costs).

CBA	Cost Benefit Analysis
CEF	Cost Effectiveness
CMC	Civil Military Coordination
CO₂	Carbon dioxide
CP1	Common Project 1
CSPR-ST	Closely Spaced Parallel Runways - Staggered Thresholds
db	decibel
DS	Data Set
EAO	Enhanced Arrival Operations
EAP	Enhanced Arrival Procedures
EATM	European ATM (Portal, database, dataset)
EATMA	European ATM Architecture
EC	European Commission
ECAC	European Civil Aviation Conference
EN	Enabler
ENV	Environment (KPA)
eORD	Enhanced Optimised Runway Delivery (Tool)
EU	European Union
EUR	Euro
EUROCONTROL	European Organisation for the Safety of Air Navigation
FEFF	Fuel Efficiency
FLX	Flexibility
FOC	Final Operating Capability / Flight Operations Centre
FTS	Fast Time Simulation
G2G	Gate to Gate
GAT	General Air Traffic
GBAS	Ground-Based Augmentation System
GLS	GNSS (Global Navigation Satellite System) Landing System
H	High complexity (En-route/Terminal Airspace classification)
H2020	Horizon 2020
HP	Human Performance
HUM	Human (enabler)
ICAO	International Civil Aviation Organization
IGS	Increased Glide Slope
IGS-to-SRAP	Increased Glide Slope to a Second Runway Aiming Point

ILS	Instrument Landing System
IMPACT	Integrated Aircraft Noise and Emissions Modelling Platform
INTEROP	Interoperability
IOC	Initial Operating Capability
IR	Industrial Research
ISGS	Increased Second Glide Slope
IT	Information Technology
KG (kg)	Kilogram
KM	Kilometre
KPA	Key Performance Area
KPI	Key Performance Indicator
L	Large (Airport classification) / Low complexity (En-route/Terminal Airspace classification)
LC	Low complexity (airport)
Lden	Day-evening-night noise level
M	Medium (Airport classification) / Medium complexity (En-route/Terminal Airspace classification)
M€	Millions of euros
NM	Network Manager / Nautical Mile
NOI	Noise
NPV	Net Present Value
NSA	National Supervisory Authority
O	Optional (enabler)
OE	Operating Environment
OI	Operational Improvement
OPEX	Operating Expenditure (Considers Changes in Operating Costs)
ORD	Optimised Runway Delivery (Tool)
OSD	Operational Service and Environment Definition
PAGAR	Performance Assessment And Gap Analysis Report
PAPI	Precision Approach Path Indicator
PAR	Performance Assessment Report
PAX	Passengers
PBN	Performance Based Navigation
PI	Performance Indicator
PJ	Project
PRD	Predictability

PUN	Punctuality
PWS	Pair Wise Separation
R	Required (enabler)
RECAT	Wake Turbulence Re-categorisation
REG	Regulation (enabler)
RES	Resilience
RET	Rapid Exit Taxiway
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP APCH	Required Navigation Performance Approach
ROT	Runway Occupancy Time
RTS	Real Time Simulation
RWY	Runway
S	Small (Airport classification)
S3JU	SESAR3 Joint Undertaking
SA	Scheduled Aviation
SAF	Safety
SBAS	Satellite-based Augmentation Systems
SDM	SESAR Deployment Manager
SEC	Security
SESAR	Single European Sky ATM Research Programme
SOL	Solution
SPR	Safety and Performance Requirements
SRAP	Second Runway Aiming Point (SRAP)
STATFOR	EUROCONTROL Statistics and Forecasts Service
STD	Standardisation (enabler)
sWP	Sub-Work Package
TEFF	Time Efficiency (KPA)
TMA	Terminal Manoeuvring Area
V3	Pre-industrial development and integration stage of the Concept Lifecycle Model (E-OCVM)
VASI	Visual Approach Slope Indicator
VH	Very High complexity (En-route/Terminal Airspace classification)
VL	Very Large (Airport classification)
VLD	Very Large Demonstration
VT	Validation Target

W1	SESAR 2020 Wave 1
W2	SESAR 2020 Wave 2
WHO	World Health Organisation

Table 2: List of acronyms

3 Objectives and scope of the CBA

3.1 Problems addressed by the solution

Two problems, currently faced by certain airports, which could be improved by deploying Second Runway Aiming Points are:

- 1) Managing arrival traffic during high-demand periods when there is a mix of aircraft sizes. Traffic in the heavy category is increasing at major airports and also at secondary airports where such traffic was rare in the past. In these airports, it tends to be more and more difficult to manage the cohabitation of large aircraft with the much smaller aircraft that have historically operated from secondary airports or that are interested in establishing new business jet connections with major airports. This difficulty in managing the wake vortex separations pushes the airports to not accept smaller aircraft during peak hours.
- 2) The noise impact of aircraft flying ILS (Instrument Landing System) approaches, especially during the night. This noise impact is a major limitation that constrains the operations at some airports because most airports provide straight-in ILS precision approaches on a standard 3-degree glide slope that obliges aircraft to fly low over built-up, often residential, areas. The aircraft are not always able to follow trajectories that allow optimum flap settings and engine thrust for both fuel consumption and noise.

To summarise, SRAP will help airports meet their operational needs to optimize wake turbulence separations between arrivals while reducing the noise below the final approach.

3.2 SESAR Solution description

The Solution description in EATMA (DS23 draft) is:

This Solution introduces the Second Runway Aiming Point (SRAP) as a new concept of enhanced approach operations. The distance between the second threshold and the nominal one is at least of 1100m.

SRAP increases runway performance by using two active thresholds on a single runway. By doing so, the environmental impact (e.g. noise, fuel) should be reduced. In addition, runway throughput may be increased (e.g. via optimization of runway occupancy time (ROT) and/or wake turbulence separations).

The following description is based on the Solution description from the OSED, section 3.1 (version 00.01.00, dated 03/06/22) [12].

Enhanced approach operations using a Second Runway Aiming Point (SRAP) will:

- allow inbound aircraft to reduce their noise footprint impact in the surrounding areas of the airport;
- allow a potential increase in runway capacity (via optimization of (ROT) and/or wake turbulence separations);
- possibly allow reductions in runway occupancy time and/or taxi-in time (depending on the airport layout).

The SRAP concept is a published approach procedure, enabling aircraft to land on a second runway aiming point further along the runway with associated runway ground markers, lights and visual aids.

The SRAP procedure is designed with a glide slope parallel to the nominal one operated for the first aiming point, see Appendix A. The distance between the second threshold and the nominal one is at least 1100m.

Choosing an SRAP approach (over the conventional one) could be the result of the best compromise between available runway length, preferential runway exit use, noise, wake turbulence separation constraints, and runway occupancy time.

The capacity related benefits of the SRAP Solution will be realised at capacity-constrained airports in periods of over-demand related to wake turbulence separation minima. Constraints such as weather, runway configuration, mode of operations and traffic mix will need to be considered.

The aim is to optimise traffic throughput with the existing infrastructure, while improving safety. As using a second runway aiming point could also serve as an enabler for reducing the wake vortex encounter risk, therefore potentially bringing a secondary benefit in reducing wake vortex separation minima for specific combination of leader/follower aircraft pairs. For example, SRAP permits 'light wake' category aircraft to fly a final approach above the approach profile of heavier aircraft flying to the primary runway threshold; this enables the smaller aircraft to avoid the wake vortex of the larger aircraft, and results in an increase in runway throughput.

Approach guidance is required for the operation of SRAP. This can be RNP (Required Navigation Performance), SBAS (Satellite Based Augmentation System) or GBAS (Ground Based Augmentation System). RNAV (Required Vertical Navigation Performance) guidance is also considered because it is anticipated that in 2025 most aircraft will be able to follow RNAV procedures, whereas only 25% of the fleet is expected to be GBAS-equipped.

The SRAP function aims at being compatible with any approach with vertical guidance: ILS, GLS (GBAS), APV-Baro or APV-SBAS based approaches.

Table 3 provides the OI Step currently associated with SRAP (DS23 draft).

SESAR Solution ID	OI Step ref.	OI Step definition	Source Reference
Second Runway Aiming Point (SRAP)	AO-0319	Enhanced approach operations using a second runway aiming point (SRAP)	EATMA – DS23 draft

Table 3: SESAR Solution PJ.02-W2-14.2

Costs and benefits are both calculated on the assumption that all required enablers are deployed by the relevant stakeholders. In addition, as the simulation exercise results used to calculate the benefits were based on the use of the separation delivery tool, so the optional enablers corresponding to the tool have also been included in this CBA.

Enabler ⁸ ref	Enabler definition	Applicable stakeholders
AERODROME-ATC-25 (O)	Aerodrome ATC system to support SRAP operations (separation delivery): the ATCO needs to identify without ambiguity which final approach procedure is assigned to each arrival flight.	Air Navigation Service Provider - Civil ATS Aerodrome Service Provider - Military ATS Aerodrome Service Provider
AERODROME-ATC-102 (R)	Aerodrome ATC system to support final approach operations (distinguish approach procedures)	Air Navigation Service Provider - Civil ATS Aerodrome Service Provider - Military ATS Aerodrome Service Provider
AIRPORT-56 (R)	Runway marking, lighting and PAPI for SRAP/IGS-to-SRAP approach procedures	Civil APT operator Military APT operator

⁸ This includes System, Procedural and Human Enablers

Enabler ⁸ ref	Enabler definition	Applicable stakeholders
APP ATC 115 (O)	Approach ATC system to support SRAP operations (separation delivery)	Air Navigation Service Provider - Civil ATS Approach Service Provider - Military ATS Approach Service Provider
APP ATC 170 (R)	Approach ATC system upgraded to support approach procedure assignment	Air Navigation Service Provider - Civil ATS Approach Service Provider - Military ATS Approach Service Provider
HUM-023 (R)	Flight Crew new role for handling SRAP approach	Airspace User - Civil Scheduled Aviation - Civil Business Aviation-Fixed Wing - Civil General Aviation - Military Fighter - Military Transport - Military Light Aircraft
HUM-031 (R)	ATC new role for handling SRAP approach	Air Navigation Service Provider - Civil ATS Aerodrome Service Provider - Civil ATS Approach Service Provider - Military ATS Aerodrome Service Provider - Military ATS Approach Service Provider

Table 4: AO-0319 related Enablers

3.3 Objectives of the CBA

This V3 Cost Benefit Analysis helps to build an assessment of whether PJ.02-W2-14.2 is worth deploying from an economic perspective for the involved stakeholders.

The objective is to provide an assessment of the costs and benefits of deploying second runway aiming points (SRAP) at the 5 airports that have been included in the ECAC-level CBA Solution Scenario. These airports are not named in the CBA to avoid the implication that those airports have made any commitment to deploy PJ.02-W2-14.2.

This CBA assesses whether the benefits of the deployed Solution are expected to exceed the costs over the CBA time horizon (up to 2043). It does this using discounted cash flow analysis which provides the Net Present Value (NPV) for the Solution and per stakeholder group. As there is a positive NPV, the break-even year and payback period are provided; respectively, these are the year from which the benefits will cover the costs incurred and the number of years from the start of the project before this occurs.

The CBA results are also explored through a sensitivity analysis to assess the impact on the NPV of changes to the input values, e.g. a doubling of the costs or a halving of the benefits.

As the CBA provides results at ECAC-level it does not provide sufficient detail to support individual deployment decisions that must take into account the local environment/situation (e.g. current operational systems, their lifespan(s), replacement timing, etc.). However, interested parties can take the mechanisms and inputs used here and refine them for their local CBAs, if appropriate.

3.4 Stakeholder identification

The CBA results are presented at solution level and individually from the viewpoint of each impacted stakeholder group, i.e. those that need to invest and those who will receive benefits from the Solution.

In summary the key stakeholders for PJ.02-W2-14.2 are:

- ANSPs providing approach (APP) and tower (AERO) services at the deploying airports

- 398 • Airport Operators at the deploying airports
- 399 • Airspace Users⁹ who operate at the deploying airports
- 400 • Society focused on the inhabitants living around the deploying airports

401 Table 5 describes how each stakeholder is impacted by the SRAP solution in terms of costs and

402 benefits.

403 Note that the key inputs for the PJ.02-W2-14.2 CBA come from the SRAP related data from SESAR

404 2020 Wave 1 PJ.02-02 as no additional performance data will be produced by the Wave 2 validation

405 activities. Cost data was originally provided by PJ.02-02 members and has been reviewed in Wave 2

406 with Airport Operator costs being updated.

Stakeholder	Type of stakeholder and/or applicable sub-OE	Type of Impact	Involvement in the CBA task	Quantitative results available in the CBA
ANSPs	ATCOs, Terminal Airspace (APP) and Tower Control Centres (AERO)	<u>Benefits:</u> ANS charges from the additional movements <u>Costs:</u> implementation of tools and functionalities to allow the ATCO to handle arrivals to two runway aiming points.	PJ.02 partners providing cost inputs	Costs and monetised benefits
Airport Operators	Very Large and Large Airports	<u>Benefits:</u> - Noise reduction in the areas close to the airport could reduce capacity restrictions due to noise allowing an improved quality of service to AUs - Runway Occupancy Time reduction, leading to potential increase in runway capacity <u>Costs:</u> investments are needed for the runway (lighting, marking) and PAPI (Precision Approach Path Indicator)	No involvement	Costs and monetised benefits
Network Manager	Network	<u>Benefits:</u> no direct benefits for NM although the network will benefit from additional runway capacity during relevant airport capacity-constrained periods <u>Costs:</u> no costs as there are no changes to NM systems or operations	No involvement	No costs nor benefits included

⁹ Note that the terminology used to describe AU stakeholders in the CBA differs from that associated with Enablers in the dataset. This is due to costing being provided for different types of aircraft regardless of the operations they perform.

Stakeholder	Type of stakeholder and/or applicable sub-OE	Type of Impact	Involvement in the CBA task	Quantitative results available in the CBA
Airspace Users: Scheduled Airlines (Mainline and Regional) / Business Aviation	Flight Crew, Schedule Planner, Safety and Training Departments	<u>Benefits:</u> time efficiency and fuel efficiency associated with any reduced runway occupancy time and shorter taxi routes when using the SRAP. AU will also benefit from the increase of runway capacity during peak periods which can enable additional flights (reduce unaccommodated demand). <u>Costs:</u> investments are needed for flight crew training (pilot) for SRAP procedures	No involvement	Costs and benefits monetised
Regulation Authority	National Supervisory Authority (NSA) / Ministry of Transport	New operations need to be approved before they can become operational and provide the stakeholder benefits mentioned in this table. Benefits: no benefits Costs: no costs for regulatory authorities, the cost for regulation drafting are taken into account in the ANSP costs	No involvement	No costs or benefits
Society	Communities around airports and passengers	Benefits: Communities around airports are interested in environmental benefits, especially noise reduction, coming from the implementation of the SRAP solution Passengers will indirectly benefit from SRAP through the increase in runway capacity, which could result, for example, in an increase in available destinations and the avoidance of diversions due to missing curfews.	No involvement	Societal benefits have been monetised following the reduction in noise contours around the airports. The other mentioned passenger benefits are not included in the CBA.

Table 5: SESAR Solution PJ.02-W2-14.2 CBA Stakeholders and impacts

3.5 CBA Scenarios and Assumptions

This section describes the scenarios that are compared in the CBA. The comparison is between the CBA Reference scenario (where the Solution is not deployed - the orange box in Figure 1) and the Solution scenario (reflecting the proposed deployment of the Solution at applicable locations across ECAC - the green box in Figure 1). The CBA uses a delta approach where the focus is on the costs and benefits associated with the ECAC-level deployment of the solution, i.e. with the changes from the CBA Reference Scenario.

Defining the CBA Reference Scenario has proven to be very challenging for many Solutions because of the assumptions that need to be made regarding the ‘ongoing deployments’ (blue arrow in Figure 1). To avoid being blocked by this issue this V3 CBA is currently based more on the difference between the current situation (2022) and the Solution Scenario.

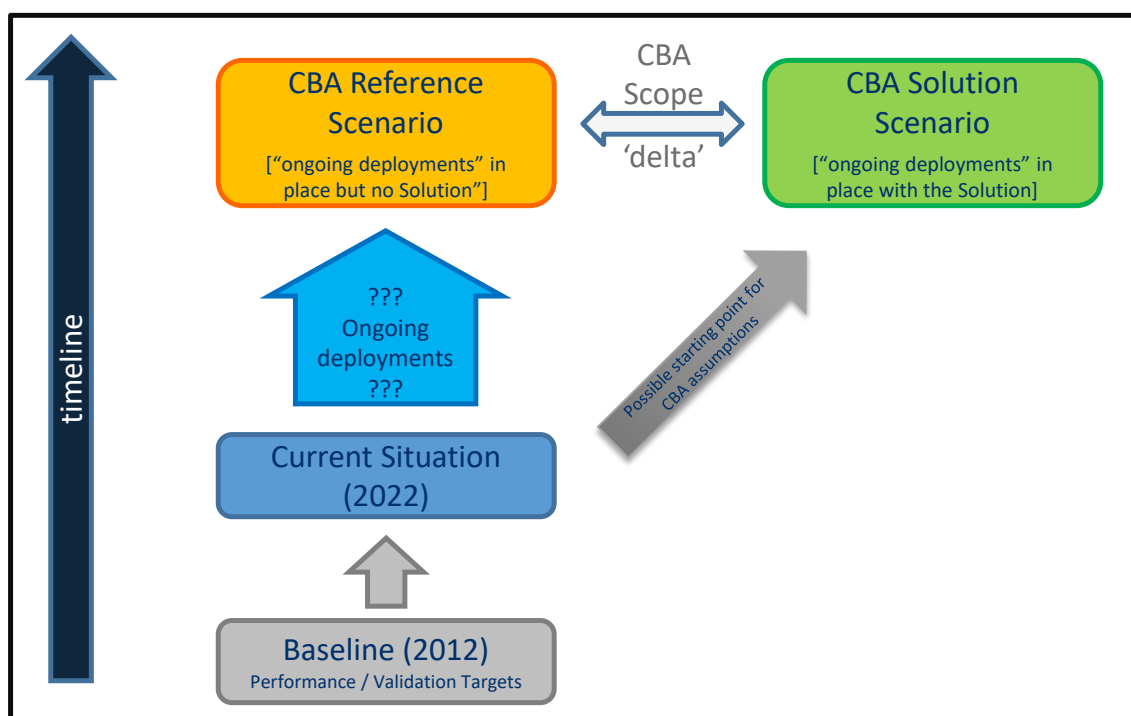


Figure 1: Scenario Overview

3.5.1 CBA Reference Scenario

The CBA Reference Scenario reflects the future situation where PJ.02-W2-14.2 is not deployed.

It is assumed that any relevant Common Project 1 (CP1) elements have been deployed at applicable airports in line with the SESAR Deployment Programme planning.

For the wake turbulence schemes, the current operational environment is assumed in the CBA Reference Scenario i.e. RECAT-EU¹⁰ and ICAO¹¹ (3 categories+A380). Relevant benefits are assessed from this starting point.

3.5.2 CBA Solution Scenario

The deployment of the Solution involves the implementation of the enablers listed in section 3.2, which include:

- The runway markings, lighting and PAPI for each second runway aiming point (Airport-56 (R))
- A controller tool to support final approach operations (Aerodrome-ATC-102 (R), APP ATC 170 (R))

¹⁰ [RECAT-EU: European Wake Turbulence Categorisation and Separation Minima on Approach and Departure](#) (applicable scheme at Charles de Gaulle and London Heathrow)

¹¹ ICAO Wake Turbulence Scheme https://www.skybrary.aero/index.php/ICAO_Wake_Turbulence_Category (applicable scheme at all other airports)

- A controller separation support tool (eORD) to support the use of SRAP (optional for lower traffic levels where the focus is on the noise benefits) (Aerodrome-ATC-25 (O), APP ATC 115 (O))
- ATCO training (HUM-031 (R))
- Flight crew training (HUM-023 (R))
- Relevant standards and regulation (REG-0529 (R), STD-112 (R)) are required for the HUM enablers

The 5 airports included in the CBA Scenario are assumed to deploy SRAP to achieve these benefits. The airports come from the Very Large and Large airport categories [8] as airports in both groups can have significant numbers of movements and periods of capacity-constrained peak traffic. Appendix B lists the Very Large and Large airport for information, however, the 5 airports included in the CBA are not named to avoid the implication that those airports have made any commitment to deploy PJ.02-W2-14.2. Other Very Large, Large and Medium airports may also choose to deploy the solution to gain the noise reduction benefits, however, such deployments are not included in the CBA.

The capacity related concepts of SRAP are considered to be attractive for airports during capacity-constrained periods (peaks). The capacity benefits will depend on the percentage of Medium aircraft that are able to use the SRAP and on the distance between the two thresholds. The CBA includes capacity benefits for 5 airports. However, it is expected that the number of airports with peaks and the duration of peaks will both increase over time, which would result in additional capacity benefits in the future.

For each airport the exact benefits will depend on several factors including specific traffic mix, length of traffic peak, wind conditions, applicable surveillance minima, glide parameters, fraction of aircraft type operating on the SRAP, runway occupancy time, glide length, runway layout, airport infrastructure, etc.

The main cost and benefit inputs for the PJ.02-W2-14.2 CBA are taken from the SESAR 2020 Wave 1 PJ.02-02 CBA [9]. For the benefits there is no additional performance data from the Wave 2 validation activities. The Performance Assessment Report [13] was developed during Wave 1 and assesses the achievement of the solution based on the PJ19.04 common assumptions. It includes some results aggregated to ECAC-level. The cost data was originally provided by PJ.02-02 members and has been reviewed in Wave 2 with Airport Operator costs being updated for Airport-56 (runway markings, lighting and PAPI), see section 5.2 for details.

The key criteria that identify an airport as a potential deployment location are:

1) Final Spacing

SRAP is assumed to be compatible with both current and future separation schemes such as Time Based Spacing. It is however worth noting that Enhanced separation minima, based on legacy ICAO wake turbulence categories or on RECAT-EU categories, are specified as a function of which approach the lead and follower aircraft are flying, the EAO glideslope angle and the distance between the conventional landing threshold and the displaced one. This, for example, may allow a safe separation minima reduction of up to 1.5 NM for some pairs like Lower Medium behind Upper Heavies, compared to the standard in-trail separation.

2) Airport layout

SRAP is applicable to any airport layout from single to multiple runways with simple or complex taxiway structures. However, the overall airport layout along with airport neighbourhood topography may bring constraints that will be determine if implementation is

feasible and will bring the intended benefits, (e.g. the runway length which needs to be long enough to accommodate the second threshold, the availability or lack of rapid runway exits (RET) at appropriate positions, the impact on runway occupancy time).

3) Runway operating mode

SRAP is applicable to both dependent and independent runways in both mixed and segregated mode operations.

4) En-Route/TMA Operations

SRAP is applicable to any arrival traffic management operations (radar vectoring, PBN route structure, vertical instructions, Continuous Descent Operations, speed instructions, etc.)

5) Traffic Mix

SRAP is applicable to airports serving both SRAP capable and non-capable aircraft. Any aircraft wake category mix can be serviced. However, it is worth noting that, as anticipated on the near to medium term horizon, only part of the traffic will be equipped with advanced satellite-based approach capability (e.g. GBAS or SBAS), some aircraft types from the Medium or Light category groups will need to remain on the conventional approach if RNP APCH types are needed. In order to apply the adequate separation minima for an arrival pair, the Approach and Tower ATCOs need to know which aircraft type are eligible to use the SRAP.

6) Runway conditions

SRAP is applicable regardless of the runway conditions.

7) Airspace consideration

SRAP is compatible with both high traffic density and low traffic density situations, although the realised benefits will differ. SRAP will be conducted only in controlled airspace where separation is ensured (classes A, B, C, D and E, according to ICAO classification of airspaces).

CBA timeline

The CBA covers the period from 2022 to 2043 as defined by PJ19.04; this mean that Net Present Value is calculated by discounting the cash-flows back to 2022 (the end of Wave 2).

The table below lists the key dates used in the CBA and Figure 2 shows them over a timeline.

Dates	PJ.02-W2-14.2
Start of deployment date: the start of investments for the first deployment location	2025
End of deployment date: the end of the investments for the final deployment location, same as FOC	2030
Initial Operating Capability (IOC): the time when the first benefits occur following the <i>minimum deployment</i> necessary to provide them. Costs continue after this date as further deployment occurs at other locations.	Late 2026

Final Operating Capability (FOC): Maximum benefits from the *full deployment*¹² of the Solution at applicable locations. Investment costs are considered to end¹³ here although any operating cost impacts would continue.

2030

Table 6: CBA Investment and Benefit Dates

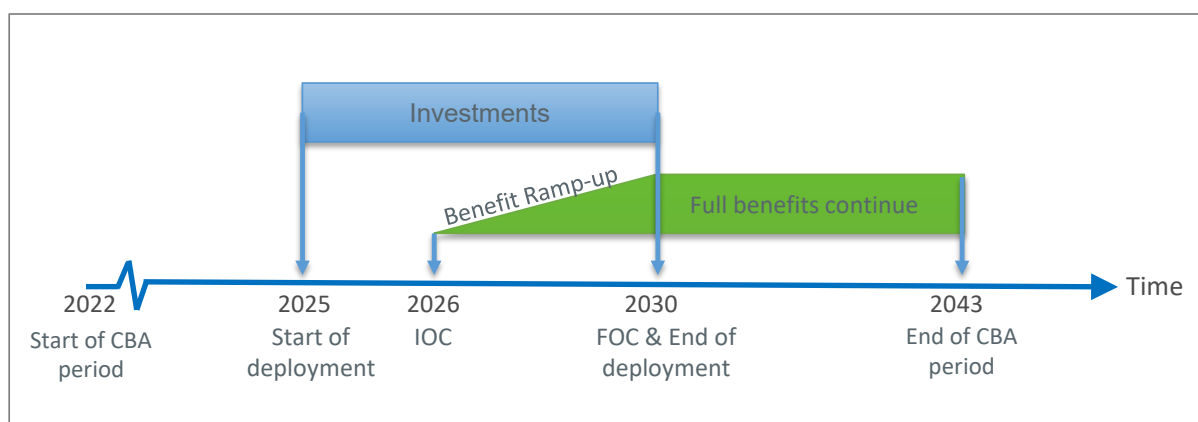


Figure 2: Overview of CBA Dates

Figure 2 shows that:

- Investment costs are spread linearly between the Start and End of Deployment dates.
- Benefits ramp-up linearly between IOC and FOC and then continue up to the end of the CBA period.
- Operating cost impacts (increases or decreases) would also start at IOC and ramp-up linearly to FOC before continuing for the rest of the CBA duration.

3.5.3 Assumptions

Costs and benefits have been computed from fast-time validation exercise results, partners' contributions and average values taken from the PJ.19.04 Common Assumptions for extrapolation to ECAC-Level.

As it is not feasible to identify exact costs for each airport separately, the costs have been estimated assuming that they would be of same order of magnitude, implying that all targeted airports will support the same kind of costs.

¹² Where **full deployment** means deploying the Solution in the all the locations where it makes sense to deploy it (i.e. it does not mean it has to be deployed everywhere)

¹³ The basic assumption is that infrastructure does not need to be replaced during the CBA period

4 Benefits

The deployment of PJ.02-W2-14.2 is expected to bring benefits¹⁴ in the following areas:

- Reduced environmental impact from Noise Reduction below the final approach in peak and non-peak periods for aircraft using the SRAP (KPA: Environment)
- Increases in Airport Capacity during capacity-constrained peak periods when both runway aiming points are used to optimise wake turbulence separations for specific combinations of leader/follower aircraft pairs (KPA: Airport Capacity)
- Improvements in Fuel Efficiency and Time Efficiency in peak and non-peak periods where the airport layout allows a reduction in runway occupancy and taxi-in times for aircraft using the SRAP (KPA: Operational Efficiency)

PJ.02-W2-14.2 has used the Single Solution CBA model developed by PJ.19-04 and therefore the benefits are calculated using the benefit monetisation mechanisms that it includes. The mechanism diagrams shown in the following sections are taken from or based on the SESAR CBA Reference material [2]. One addition to the Single Solution CBA model for PJ.02-W2-14.2 is the inclusion of societal benefits related to noise reduction¹⁵.

The benefit input values used in the CBA are shown in Table 7. The values are based on the Performance Assessment results [13], however, as some of the PAR benefits were not extrapolated to ECAC-level¹⁶ an intermediate step was need to produce the CBA values.

KPA	Validation Targets	ECAC-level value (used in CBA)	Stakeholder that benefits in the CBA
<u>Environment</u> NOI2: Noise - Size and location of noise contours NOI4: Noise - Number of people exposed to noise levels exceeding a given threshold	Validation targets not set for noise	See section 4.1 for details	<u>Societal benefit</u> (reduction in number of people exposed to aircraft noise over a given threshold)
<u>Capacity</u> CAP3.2: Airport Capacity - Peak Arrival throughput per hour (Segregated mode)	Impact level ¹⁷ 2	0.18%	<u>Airspace User</u> (additional movements, avoided additional delay) <u>Airport Operator</u> (fees from additional movements and additional passengers) <u>ANSP</u>

¹⁴ Appendix C provides an overview of the links between the Benefit and Impact Mechanisms, from the OSED, and the benefits included in the CBA.

¹⁵ The noise benefits are calculated outside the Single Solution CBA model and only the final results are included to calculate the overall CBA results and per stakeholder CBA results.

¹⁶ The PAR does not require some benefits to be aggregated to ECAC-level because that level is not used in the Performance and Gap Analysis Report (PAGAR) (e.g. Airport Capacity). However, ECAC-level aggregation is required for the CBA.

¹⁷ The SESAR Performance Framework [14] section 2.2 describes the qualitative scale used for the validation targets. Impact level 3 is the highest impact, then level 2 and level 1 or no impact.

KPA	Validation Targets	ECAC-level value (used in CBA)	Stakeholder that benefits in the CBA
			(fees from additional movements)
CAP4: Unaccommodated traffic reduction - flights/year	Validation targets not set for CAP4	Calculated in the CBA from CAP3.2	<u>Airspace User</u> (additional flights)
Operational Efficiency			
FEFF1: Fuel Efficiency – Fuel burn reduction per flight (kg)	No validation target assigned	0.28kg/flight	<u>Airspace User</u> (reduced fuel burn and avoided CO ₂ emissions)
ENV1: CO₂ Emissions – CO ₂ reduction per flight (kg)	No validation target assigned	Calculated from FEFF1 value	<u>Airspace User</u> (avoided CO ₂ emissions)
TEFF2: Time Efficiency – Average of the distribution of actual taxi-in (including ground queuing during taxi-in) durations	No validation target assigned	0.059%	<u>Airspace User</u> (reduced delay)
Cost Efficiency CEF2: ATCO Productivity - Flights per ATCO-Hour on duty	Impact level 1	0.05%	<u>ANSP</u> (handle the additional flights without increasing ATCO-hours on duty)

Table 7: PJ.02-W2-14.2 Performance Assessment Results

The Airspace Users considered here are Scheduled Aviation and Business Aviation who are the main users at the Very Large and Large airports that are candidates to deploy SRAP.

The benefits monetised in the CBA are based on fast time simulation results that included the use of an ATCO separation delivery support tool (ORD).

The noise related benefits of SRAP are considered to be attractive for many airports while the airport capacity benefits only apply during capacity-constrained operating periods (peaks); outside these periods there is available airport capacity to meet an increased demand.

4.1 Noise Reduction (NOI)

PJ02-W2-14.2 is expected to reduce the impact of noise because when a flight follows an SRAP procedure it flies higher for further than a flight on a conventional approach procedure. This moves the noise contours for the final approach towards the airport area and provides an environmental benefit to the inhabitants living under the final approach who will be exposed to a lower level of noise through the use of SRAP. However, the increase in traffic from the increased airport capacity will offset this to some degree, as will any increase in urbanisation that results in a higher number of people living in areas experiencing such noise.

In general, noise can be defined as unwanted sounds of varying duration, intensity or other quality that causes physical or psychological harm to humans.

NOI2: Noise - Size and location of noise contours

NOI4: Noise - Number of people exposed to noise levels exceeding a given threshold

Table 8: Noise Indicator descriptions

The noise reduction benefit is monetised in the CBA, see Figure 3, as the noise contour change (reduction) around the airport area when a SRAP is deployed. The value is then multiplied by the number of people affected around the airport in a radius of 10km and the value of cost of noise per person (Table 9). These benefits are ramped-up over time to reflect that ECAC-level benefits will increase as more candidate airports deploy.

The overall (undiscounted) monetary value of the noise reduction for the 5 airports is 7.1 M€.

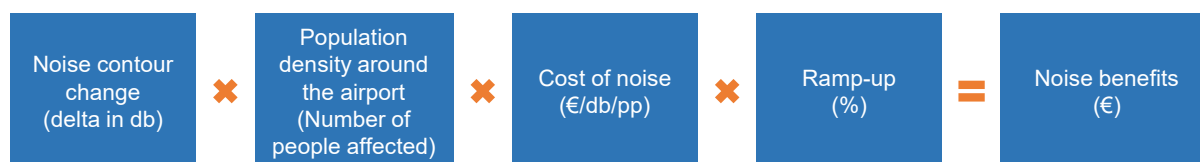


Figure 3: Noise reduction Monetisation Mechanism

The noise contour changes were calculated using the EUROCONTROL IMPACT tool based on two main inputs (1) the traffic mix observed at the 5 airports including the number of flights operating on each glideslope and (2) the approach speed profile followed by each aircraft type which directly affects its noise footprint. The results are calculated per decibel band which matches the cost of noise data, see Table 9 which are also calculated per decibel band.

Population density around each airport has been calculated by EUROCONTROL Environment team using available data sources and standard methods.

The ‘environmental price of traffic noise’ reflects the welfare loss that occurs with one extra decibel of noise. The recommended environmental prices for noise (EU28 averages) calculated by CE Delft (on behalf of European Commission) in the ‘Handbook on the external costs of transport Version 2019’ [15] take into account only health and annoyance costs. For this reason the benefits appear as Societal Benefits in section 7.

Environmental price of traffic noise for the EU28 (€2016/dB/person/year)			
Aviation			
Lden (db(A))	Annoyance	Health	Total
50-54	34	5	39
55-59	68	6	74
60-64	68	9	77
65-69	129	12	141
70-74	129	16	145
≥ 75	129	21	150

**Table 9: Environmental price of traffic noise for EU28
(CE Delft - Handbook on the external costs of transport Version 2019)**

Annoyance represents the disturbance individuals experience when they are exposed to traffic noise. It can hinder people in performing certain activities, which may lead to a variety of negative responses, including irritation, disappointment, anxiety, exhaustion and sleep disturbance (WHO, 2011). Sleep disturbance is not considered as a separate component in this value in order to avoid potential double counting. If one is asked about their annoyance they are inclined to also take into account the effects of sleep disturbance; therefore sleep disturbance is assumed to be included in the annoyance.

Concerning *health*, the exposure to noise results in a number of health endpoints due to prolonged and frequent exposure to transport noise. According to the CE Delft report “these health endpoints can take a multitude of forms. Health endpoints for which significant evidence is available are: ischaemic heart disease, stroke, dementia and hypertension. For health endpoints not mentioned in the list above, e.g. breast cancer and depression, only fragmented evidence is available. Therefore, these costs are not included in the noise costs estimated in this study. For the same reason, productivity losses (e.g. due to loss of concentration) and environmental impacts of traffic noise (e.g. harmful effects on wildlife) are not covered. Finally, direct material damages as a result of vibrations are not included in the costs of noise in this study, as the vibrations are not necessarily an effect of noise, but rather an external effect on its own.”

Further benefits related to noise reduction around airports have not been included in this CBA due to a lack of available data. These benefits include lower noise-related costs for airspace users through reduced noise charges/taxes, avoided fines and alleviation of operational restrictions such as curfews or limitations on early arrivals. These benefits are dependent on any local noise schemes, often defined by the Airport or Local Authority, that reflect how operational noise is considered a key driver of an airports environmental impact.

4.2 Airport Capacity (CAP3)

PJ.02-W2-14.2 is expected to provide additional airport capacity by increasing runway throughput during capacity-constrained peak hours via optimised wake vortex separations. This additional capacity is monetised in the CBA as the value from the additional flights for the Airspace User and as the additional charges associated with those flights for the Airport Operator and the ANSP providing services in the terminal airspace and at the airport.

CAP3.2: Peak Runway Throughput per hour (segregated mode)	+0.18% (ECAC-level)
CAP4: Unaccommodated traffic reduction - flights/year	Calculated in the CBA from CAP3.2

Table 10: Airport Capacity Result

The overall (undiscounted) monetary value of the increase in Airport Capacity is 317 M€.

The overall (undiscounted) monetary value related to the reduction of unaccommodated traffic is 84 M€.

The capacity benefits identified are an estimation applicable to very large and large airports that are capacity-constrained during traffic peaks because of the wake turbulence constraints and the separation delivery on approach.

Only half the additional movements are considered to increase capacity to reflect that half of the spacing saved is used to reduce delay. This 50/50 split is a Solution assumption and in reality each airport would decide how to use the additional spacing based on their delay situation and capacity needs.

The Airport Capacity benefits from the Performance Assessment Report (PAR) [13] assume a specific traffic mix and that each airport has a traffic peak of 1-2 hours a day. The reality is that airports can experience multiple traffic peaks per day, often of differing durations. This has an impact when quantifying the benefit obtained, for example one airport can have 4.5% increase in runway throughput compared to 0.8% at another.

In addition, the PAR results are at the local airport level so they need to be scaled to ECAC-level for the CBA. This has been done by considering the total number of movements for the 5 main candidate airports against the total number of movements for the whole ECAC area. For each of the 5 airports the traffic peaks and related traffic mix were identified from 2018 NM data in order to better characterize the benefits. SRAP provides benefits when the runways are constrained at the airport; when runways are not capacity-constrained there is already available capacity that is not being used.

These values have been monetised in terms of additional flights that can be operated per year at airports which are otherwise congested, multiplied by the reference values provided in EUROCONTROL Standard Inputs [3].

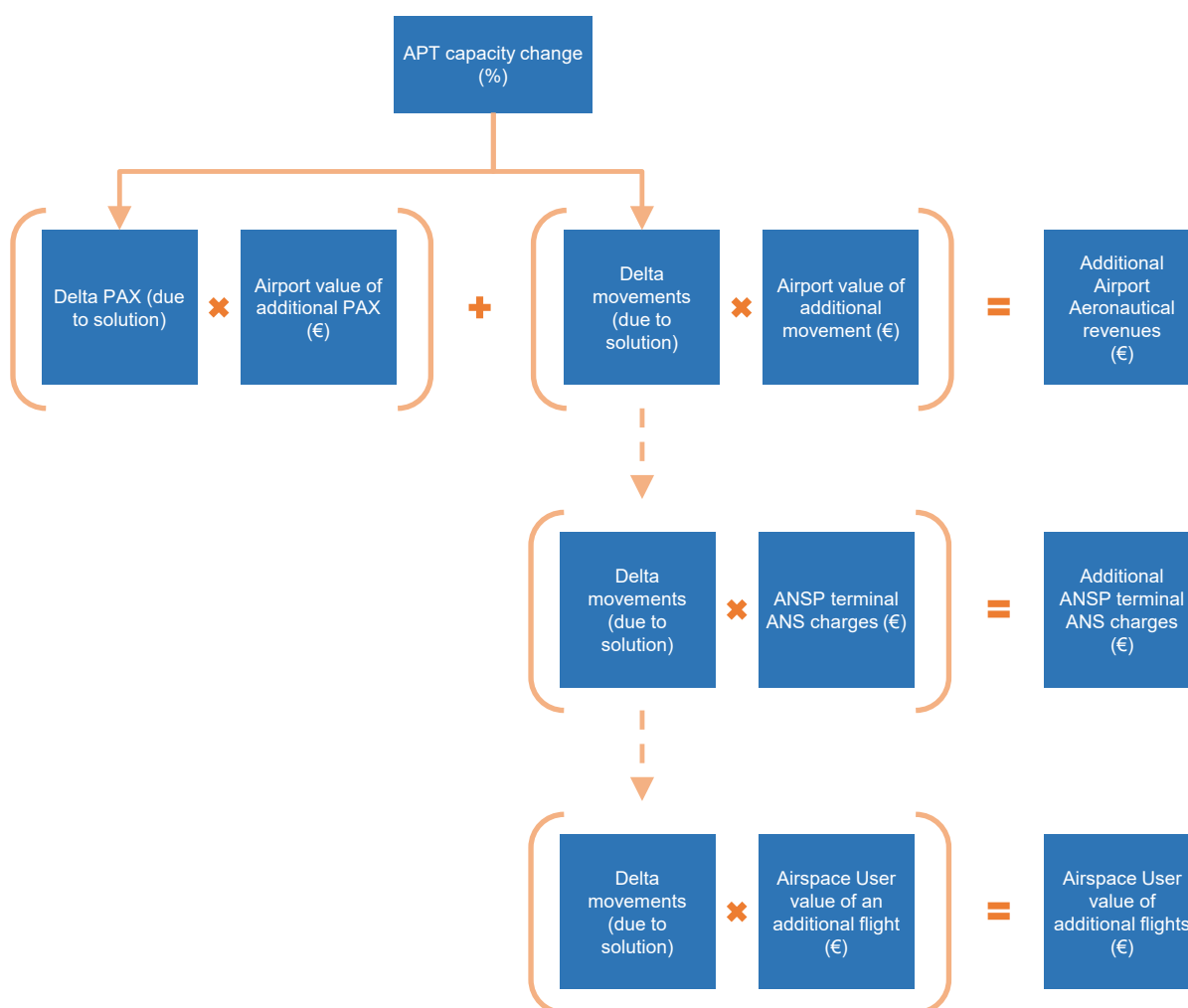


Figure 4: Airport Capacity Monetisation Mechanisms – Airport, ANSP and Airspace User benefits

4.3 Fuel Efficiency (FEFF1) and CO₂ Emissions (ENV1)

PJ.02-W2-14.2 is expected to improve fuel efficiency through optimised taxi-routes. Aircraft using the second runway aiming point will land further along the runway and will generally use a different runway exit (than if they had landed at the conventional aiming point) which, depending on the airport layout, may offer a shorter taxi-route. This depends on airport layout and performance objectives when planning SRAP operations (e.g. priority of taxi optimization or wake separation reduction).

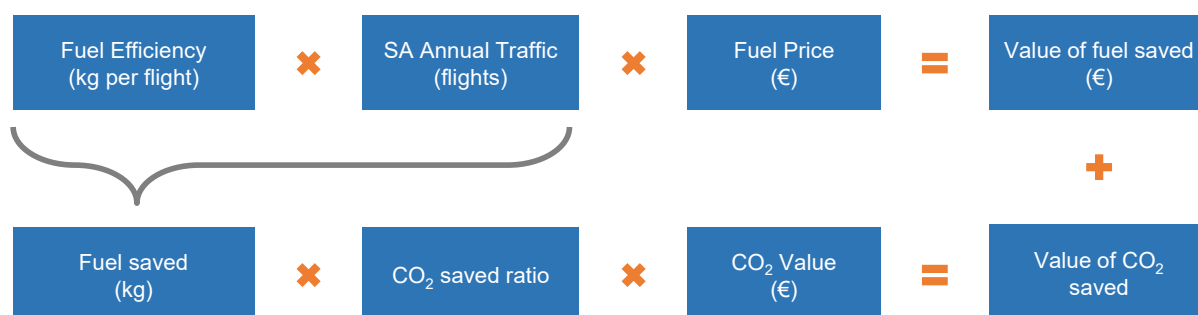
FEFF1: Fuel Efficiency – Fuel burn reduction per flight	-0.28 kg/flight (positive impact)
---	-----------------------------------

ENV1: CO ₂ Emissions – CO ₂ emissions reduction per flight (kg)	-0.28 kg x 3.15 = -0.88 kg/flight (positive impact)
---	---

Table 11: Fuel Efficiency Result

Fuel Efficiency is monetised in the CBA as the value of fuel saved which also links to the value of CO₂ saved. The overall (undiscounted) monetary value of fuel saved and CO₂ saved is 60 M€.

Figure 5 shows the monetisation mechanisms used in the CBA model. The calculation is made in each year so the values includes the evolution of the number of flights and fuel price over the CBA period. The model automatically calculates the change in CO₂ costs when there is a change in fuel burn. The same calculations are applied for the Business Aviation (BA) benefits but using the BA annual traffic.

**Figure 5: Fuel Efficiency and CO₂ Monetisation Mechanisms**

4.4 Time Efficiency (TEFF2)

As for FEFF1, PJ.02-W2-14.2 is expected to improve time efficiency through optimised taxi-routes. Aircraft using the second runway aiming point will land further along the runway and will generally use a different runway exit (than if they had landed at the conventional aiming point) which, depending on the airport layout, may offer a shorter taxi-route. This depends on airport layout and performance objectives when planning SRAP operations (e.g. priority of taxi optimization or wake separation reduction).

Time savings are calculated as the average flight time saved in Terminal Airspace (minutes/flight) for each aircraft. The value is then divided by two as for each new movement is considered that half of the time saved is used to reduce delay and half to increase the capacity.

Benefits have been scaled by total number of movements for the 5 airports and then divided by number of movements for all ECAC area.

The overall (undiscounted) monetary value of the improvement in Time Efficiency is 315 M€.

TEFF2: Average of the distribution of actual taxi-in (including ground queuing during taxi-in) durations (under 'FEFF3: Reduction in average flight duration' in Wave 1 PAR as TEFF was introduced in Wave 2)	-0.059%
---	---------

Table 12: Time Efficiency Result for SA

Figure 6 shows the monetisation mechanism included in the CBA model.



Figure 6: Time Efficiency Monetisation Mechanism for SA

4.5 Cost Efficiency (CEF2)

PJ02-W2-14.2 enables additional movements at the five airports that will be handled by the controllers. Following the validation activities, it is expected that the additional flights can be handled without requiring additional ATCO hours thereby avoiding additional ATCO employment costs.

The mechanisms in the CBA model assume that the ATCO Productivity in Figure 7 remains stable so additional ATCO hours would be required to handle additional traffic. To avoid this increase, the ATCO productivity value in Table 13 is included in the CBA model so that the hours on duty do not increase with the additional traffic. The value does not come from the validation activities nor the Performance Assessment Report (PAR).

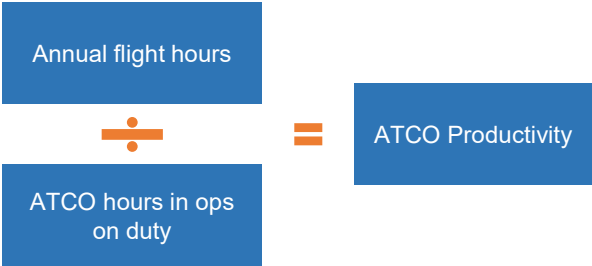


Figure 7: ATCO Productivity

CEF2: ATCO Productivity - Flights per ATCO-Hour on duty	0.05%
---	-------

Table 13: ATCO Productivity values

680 4.6 Benefit Monetisation of the Performance Framework KPI/PI

Performance Framework KPA ¹⁸	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2043
Cost Efficiency	ANS Cost efficiency	CEF2 Flights per ATCO-Hour on duty	Nb	ATCO employment Cost change	€/year	No Validation Target
				Support Staff Employment Cost Change	€/year	No Validation Target
				Non-staff Operating Costs Change	€/year	No Validation Target
	Airspace User Cost efficiency	CEF3 Technology cost per flight	EUR / flight	G2G ANS cost changes related to technology and equipment	€/year	No Validation Target
		AUC3 Direct operating costs for an airspace user	EUR / flight	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	€/year	No Validation Target
		AUC4 Indirect operating costs for an airspace user	EUR / flight	Impact on operating costs that do not relate to a specific flight. Examples: parking charges, crew and cabin salary, handling prices at Base Stations	€/year	No Validation Target

¹⁸ For information, the mapping to the Performance Ambition KPAs (used in the ATM Master Plan) is available in the Appendix F

Performance Framework KPA ¹⁸	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2043
		AUC5 Overhead costs for an airspace user	EUR / flight	Impact on overhead costs. Examples: dispatchers, training, IT infrastructure, sales.	€/year	No Validation Target
Capacity	Airspace capacity	CAP1 TMA throughput, in challenging airspace, per unit time	% and movements	Tactical delay cost (avoided-; additional +)	€/year	No validation target€
			% and movements	Strategic delay cost (avoided-; additional +)	€/year	No Validation Target
		CAP2 En-route throughput, in challenging airspace, per unit time	% and movements	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target
			% and movements	Strategic delay cost (avoided-; additional +)	€/year	No Validation Target
	Airport capacity	CAP3 Peak Runway Throughput	% and movements	Value of additional flights	€	317 M€
	Resilience	RES4a Minutes of delays	Minutes	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target
		RES4b Cancellations	% and movements	Cost of cancellations	€/year	No Validation Target
		Diversions	% and movements	Cost of diversions	€/year	No Validation Target
Predictability and punctuality	Predictability	PRD1 Variance of Difference in actual & Flight Plan or RBT durations	Minutes^2	Strategic delay cost (avoided-; additional +)	€	No Validation Target

Performance Framework KPA ¹⁸	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2043
	Punctuality	PUN1 % Departures < +/- 3 mins vs. schedule due to ATM causes	% (and # movements)	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target
Flexibility	ATM System & Airport ability to respond to changes in planned flights and mission	FLX1 Average delay for scheduled civil/military flights with change request and non-scheduled / late flight plan request	Minutes	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target
						No Validation Target
Environment	Time Efficiency	TEFF2 (FEFF3) Reduction in average flight duration	% and minutes	Strategic delay: airborne: direct cost to an airline <u>excl. Fuel</u> (avoided-; additional +)	€	315 M€
	Fuel Efficiency	FEFF1 Average fuel burn per flight	Kg fuel per movement	Fuel Costs	€	56 M€
	Fuel Efficiency	FEFF2 CO ₂ Emissions	Kg CO ₂ per movement	CO ₂ Costs	€	4 M€
	Noise	NOI2 Surface of these contours(Km2)	km ² (per decibel band)	Cost of noise	€	7.1 M€
	Noise	NOI4 Number of people inside noise contours	People affected			
Civil-Military Cooperation Coordination &	Civil-Military Cooperation Coordination &	CMC2.1a Fuel saving (for GAT operations)	Kg fuel per movement	Fuel Costs	€/year	

Performance Framework KPA ¹⁸	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2043
		CMC2.1b Distance saving (for GAT operations)	NM movement per	Time Costs	€/year	

681

Table 14: Results of the benefits monetisation per KPA

5 Cost assessment

The CBA considers the costs associated with implementing a second runway aiming point at the five candidate airports. The costs include the investment costs of acquiring or developing the systems, specific adaptations and functionalities, additional inputs of static information, integration costs, training costs, regulatory costs as well as the costs associated with the project management and development and documentation of procedures, (i.e. everything needed to get the SRAP into operations). An assessment has also been made of changes in annual operating costs following the deployment, for example, changes in maintenance costs or ongoing training costs.

The cost values were estimated during SESAR 2020 Wave 1. A bottom-up approach was used to estimate the stakeholders' implementation and operating costs. The scope of each enabler was analysed, discussed, reviewed and challenged within the PJ.02-02 (Enhanced Arrival Procedures) CBA team as well as with other operational and technical experts in PJ.02-01 (Wake Turbulence Separation Optimization). With the support of the Solution leader and the partners it was possible to associate a cost to each enabler. The enabler cost values were reviewed in Wave 2.

5.1 ANSPs costs

The ANSP stakeholder covers several different service provision aspects, for PJ.02-W2-14.2 this includes ATS provision at Aerodromes (tower) and in Approach. Within DS23 draft, some of the enablers are identified as applicable for Military ANSPs, however, due to the candidate airports included in the CBA the Military stakeholders are not applicable for this solution¹⁹.

5.1.1 ANSPs cost approach

Costs were estimated based on expert judgement and are in line with other PJ.02 solutions using the same separation delivery tool (ORD) as an optional enabler (reflected as a different enabler in the other solutions due to additional adaptations relevant to each OI Step).

5.1.2 ANSPs cost assumptions

Costs for this solution are mainly borne by the ANSPs (APP and TWR) assuming that airport system costs and relevant maintenance are incurred by the ANSPs²⁰.

5.1.3 Number of investment instances (units)

Table 15 shows that the CBA includes the ANSPs providing services at the 5 candidate airports included in the CBA Solution Scenario.

Airport				Terminal Airspace				En-route			
VL	L	M	S	VH	H	M	L	VH	H	M	L
5		0	0	Not applicable				Not applicable			

Table 15: Number of investment instances - ANSPs

5.1.4 Cost per unit

Table 16 shows the cost per enabler as well as the total cost per location. For information, the bottom row provides the cost to deploy the Solution without the optional enablers related to the wake

¹⁹ Some enablers are also required or optional for other solutions in which the Military stakeholders may have a role.

²⁰ In reality the situation will differ across airports as some airports may own the systems.

715 separation tool. This is applicable, for example, at medium airports wanting to deploy SRAP for the
 716 noise benefits who would not need the optional tool.

Enabler	Enabler Title	Implementation Costs (M€)	Operating costs (M€/year)
AERODROME-ATC-102 (R)	Aerodrome ATC system to support final approach operations (distinguish approach procedures)	0.20	
AERODROME-ATC-25 (O)	Aerodrome ATC system to support SRAP operations (separation delivery)	2.50	0.05
APP ATC 115 (O)	Approach ATC system to support SRAP operations (separation delivery)	7.50	0.05
APP ATC 170 (R)	Approach ATC system upgraded to support approach procedure assignment	0.20	-
REG-0529 ²¹ (R)	Regulatory provisions for Second Runway Aiming Points operations (SRAP)	0.05	-
HUM-31 (R)	ATC training for SRAP approach	Included in the tool costs	
Total for AO-0319	With optional Separation tool (used in CBA)	10.45	0.1
	Without the optional Separation tool (for info)	0.45	0

717 **Table 16: ANSP Costs per Enabler**

718 Table 17 shows the cost for an ANSP deploying the solution at an airport including the optional wake
 719 separation tool. If an ANSP does not need to deploy that tool then the ANSP per unit costs would be
 720 0.45 M€.

Cost category	Airport			
	VL	L	M	S
Pre-Implementation Costs	10.45 M€ per ANSP		No deployment considered at these locations	
Implementation costs				
Operating costs	0.1 M€ per ANSP per year			

721 **Table 17: Cost per Unit – ANSP including the optional tool**

722 5.2 Airport operators costs

723 The Airport operator enabler is identified within the DS23 draft as being applicable to both civil and
 724 military airports. Due to the candidate airports included in the CBA the Military airport operators are
 725 not applicable for this solution²².

²¹ REG-0529 is a regulatory enabler that is now assigned to several of the system and human enablers rather than appearing as a standalone enabler. However, it remains listed here to reflect the structure when the cost assessment was performed.

²² Some enablers are also required or optional for other solutions in which the Military stakeholders may have a role.

5.2.1 Airport operators cost approach

The cost data were collected during Wave 1 and revised during Wave 2 within the Solution team.

5.2.2 Airport operators cost assumptions

Airports will incur costs related to installing runway lighting, marking and PAPI.

The CBA model also calculates costs related to induced investments that the airports would have to do following the additional passengers that the increase in airport capacity brings.

5.2.3 Number of investment instances (units)

Table 18 shows that the CBA includes the ANSPs providing services at the 5 candidate airports included in the CBA Solution Scenario.

The CBA considers that 5 airports from the Very Large and Large categories will deploy SRAP.

Airport			
VL	L	M	S
5		0	0

Table 18: Number of investment instances - Airports

5.2.4 Cost per unit

Table 19 shows the cost per enabler as well as the total cost per location.

Enabler	Enabler Title	Development Costs (M€)	Operating costs (M€/year)
AIRPORT-56 (R)	Runway marking and lighting for SRAP approach procedures	1.4	0.30
Total for AO-0319		1.4	0.3

Table 19: ANSP Costs per Enabler

Table 20 shows cost for an Airport operator deploying the solution at a candidate airport.

Cost category	Airport			
	VL	L	M	S
Pre-Implementation Costs	0.14 M€ per airport			No deployment considered at these locations
Implementation costs				
Operating costs	0.3 M€ per airport per year			

Table 20: Cost per Unit - Airport

5.3 Network Manager costs

No Network Manager investments are required.

5.4 Airspace User costs

Airspace users will incur some costs related to pilots' training for the SRAP procedures.

Table 21 shows the Airspace User (Scheduled Airlines and Business Aviation) training costs based on the SESAR Training cost tool data [16]. The value considers ECAC pilots, across a range of Scheduled Airlines and Business Aviation operators, who will operate at the candidate airports. Within the CBA model these costs are allocated 90% for Scheduled Airlines and 10% for Business Aviation.

Enabler	Enabler Title	Development Costs (M€)	Operating costs (M€/year)
HUM-23 (R)	Flight Crew training for SRAP approach	17.5	0
Total for AO-0319	With optional Separation tool (used in CBA)	17.5	0

Table 21: Airspace User (Scheduled Airlines and Business Aviation) Training Costs

There are no investments required at the Flight Operation Centres (FOC) (ground) or in the aircraft (airborne).

5.5 Military costs

No Military investments are required.

5.6 Other relevant stakeholders

No other stakeholders are required to invest for PJ.02-W2-14.2.

5.7 Cost Summary

This section provides a summary of how the data in the previous sections is used to feed the CBA model. The tables show the values that are used to produce the CBA results in section 7.

Investment Costs

	Cost per-unit		Deployment Locations		Cost
ANSP	10.45 M€ per airport	x	5	=	52.25 M€
Airport Operator	1.40 M€ per airport	x	5	=	7.00 M€
Airspace Users (SA)	17.5 M€ total cost x 90%			=	1.75 M€
Airspace Users (BA)	17.5 M€ total cost x 10%			=	15.75 M€
Total Investment Costs					76.75 M€

Table 22: Investment Cost Summary

Annual Operating Cost changes

	Annual costs		Deployment Locations		Cost
ANSP	0.1 M€ per airport	x	5	=	0.5 M€
Airport Operator	0.3 M€ per airport	x	5	=	1.5 M€
Annual Operating Cost Change					2.0 M€

Table 23: Operating Cost Summary

6 CBA Model

The model used to calculate the CBA results is the Single Solution CBA model (version 7.4.1) developed by PJ.19.04. This CBA Model has been developed in Excel and calculates the costs and benefits of the implementation of PJ.02-W2-14.2 based on the CBA Solution Scenarios defined for the Solution.



s7.4.1-for-PJ02-S14_
v2.3_sc1.xlsm

6.1 Data sources

Cost Inputs

Cost data reflect a combination of inputs from relevant partners gathered in Wave 1 projects PJ.02-01 and PJ.02-02. Costs relating to the lighting systems and PAPI have been reviewed within PJ.02-W2-14.2 based on expert judgements. The CBA team together with other project team members calculated pilot training using available information on the number of ECAC pilots.

Benefit Inputs²³

The main source for the benefit calculation inputs is the fast time simulation (FTS12) from Wave 1. More information on the calculation of these benefits is available in the Benefit section.

Other Inputs Parameters

The data sources for the non-solution specific CBA Model parameters are referenced in the various inputs sheets of the CBA Model with details provided in the sheet 'Source of Reference'. These are part of the PJ.19.04 Common Assumptions [17].

7 CBA Results

The following section provides the results of the PJ.02-W2-14.2 V3 CBA that has assessed the deployment of SRAP at 5 candidate airports that have capacity-constrained peaks and will realise airport capacity benefits.

The CBA has been built on the following information:

- The Investments costs (pre-implementation and implementation costs) and Operating Costs have been identified for the main stakeholders impacted: ANSPs, Airports and Airspace Users.
- The impact of SRAP on the Capital Expenditures (CAPEX) (investments) has been analysed and only the costs on top of what could be expected in the CBA Reference Scenario have been estimated in the cost assessment and integrated in the CBA Model.
- Benefits (noise reduction, airport capacity, fuel and time efficiency) have been estimated and monetised in the CBA Model for Airspace Users (Scheduled Airlines and Business Aviation operating in the 5 candidate Very Large and Large airports) and Airport Operators. The benefit inputs are a combination of results from PJ.02-02 Performance Assessment Report (PAR) [13], calculations based on NM actual data and potential improvement using results from Fast Time Simulations.
- No costs or benefits are included for Medium airports and airport operating in mixed mode due to lack of peaks and limitations in the FTS modelling tool.

The noise related aspects of SRAP are considered to be attractive for all airports. This analysis has limited the scope and assessed noise benefits only for the 5 candidate airports.

The **Net Present Value (NPV)** is **217 M€**, this is discounted at 8% over the period 2022 to 2043. Table 25 shows the undiscounted values, which show that **without discounting the overall net benefits are 759 M€.**

7.1.1 Discounted Values

This section provides the discounted CBA results. The values shown in table 14 below are discounted to account for the time value of money²⁴. Undiscounted values are shown in the next section.

The Net Present Value (NPV) for PJ.02-W2-14.2 is **217 M€**. This is calculated with an 8% discount rate²⁵ over the period 2022 to 2043.

The payback year is 2031 as shown in Figure 8 where the discounted cumulative net benefits line crosses back over the x-axis.

²⁴ The time value of money reflects the idea that 1€ received today has more value than 1€ received in 2040 because it could be invested and earn interest over that period.

²⁵ Appendix D provides a brief explanation of why an 8% discount rate has been chosen.

814

	NPV	Capex	Opex	Benefits
ANSP	-8	-31	-2	25
Airport operators	80	-9	-7	96
Business Aviation	24	-1	0	25
Scheduled Aviation	118	-9	0	128
Societal Benefits	2	0	0	2
Overall	217	-51	-9	277

815

Table 24: PJ.02-W2-14.2 Discounted CBA results (per stakeholder and overall)

816

Based on the current assumptions and inputs, the expected benefits offset the overall costs.

817

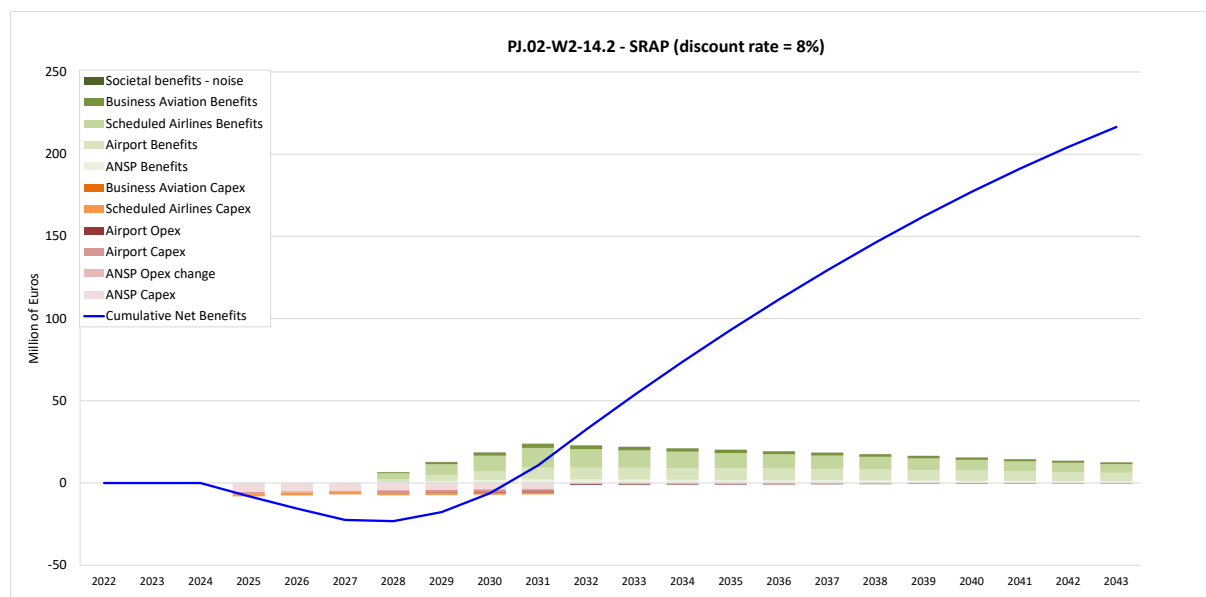
The sensitivity analysis in section 8 explores these results in more detail to see the impact on the NPV of changing some of the input values.

818

819

Figure 8 shows these discounted values on a year-by-year basis. The net benefits are the benefit value per year minus the cost value for that year; these are then shown cumulatively as a line in the figure.

820



821

822

Figure 8: PJ.02-W2-14.2 Annual Investment Levels and Benefits (discounted)

823

Figure 9 shows the cost and benefit data without the cumulative net benefits line so that the scale of the costs and benefits per stakeholder are easier to read.

824

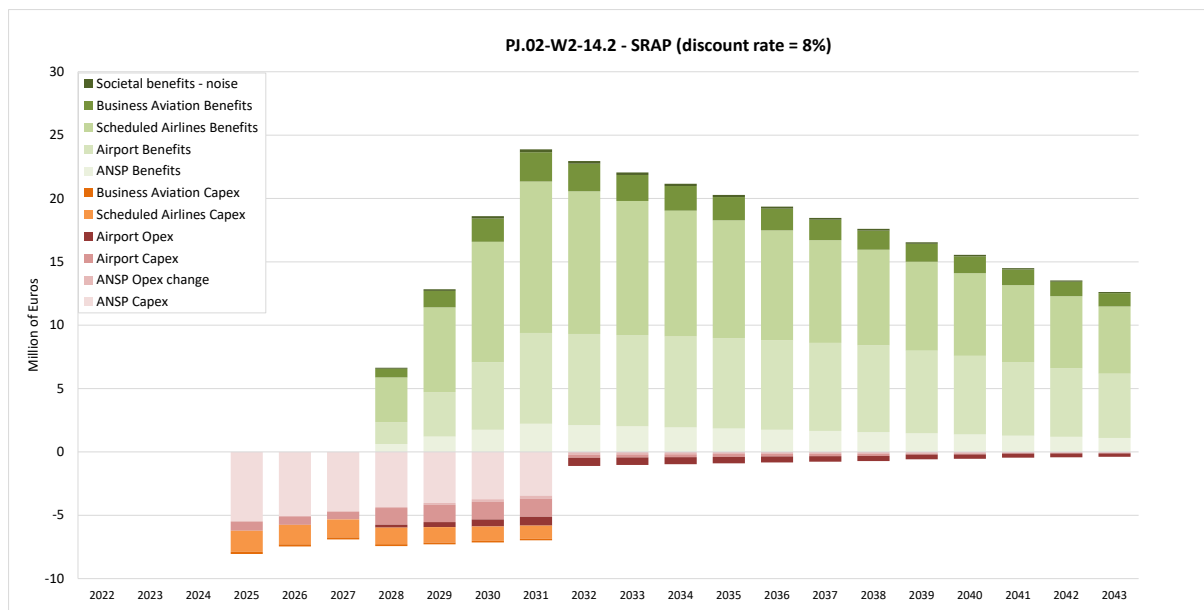


Figure 9: PJ.02-W2-14.2 Annual Investment Levels and Benefits expanded (discounted)

7.1.2 Undiscounted Values

The values shown in this section do not consider the time value of money, so one unit of currency spent or received in 2043 is considered to have the same value as one unit of currency spent or received today.

Table 25 contains the undiscounted values, which show that without discounting, i.e. doing the CBA calculation with a discount rate of 0%, the overall net benefits are **759 M€**.

	Net Benefits	CAPEX	OPEX	Benefits
ANSP	20	-52	-7	79
Airport operators	276	-19	-22	317
Business Aviation	77	-2	0	78
Scheduled Aviation	380	-16	0	396
Societal Benefits	7	0	0	7
Overall	759	-89	-29	877

Table 25: PJ.02-W2-14.2 Undiscounted CBA results (per stakeholder and overall)

Figure 10 shows the undiscounted costs and benefits over each year.

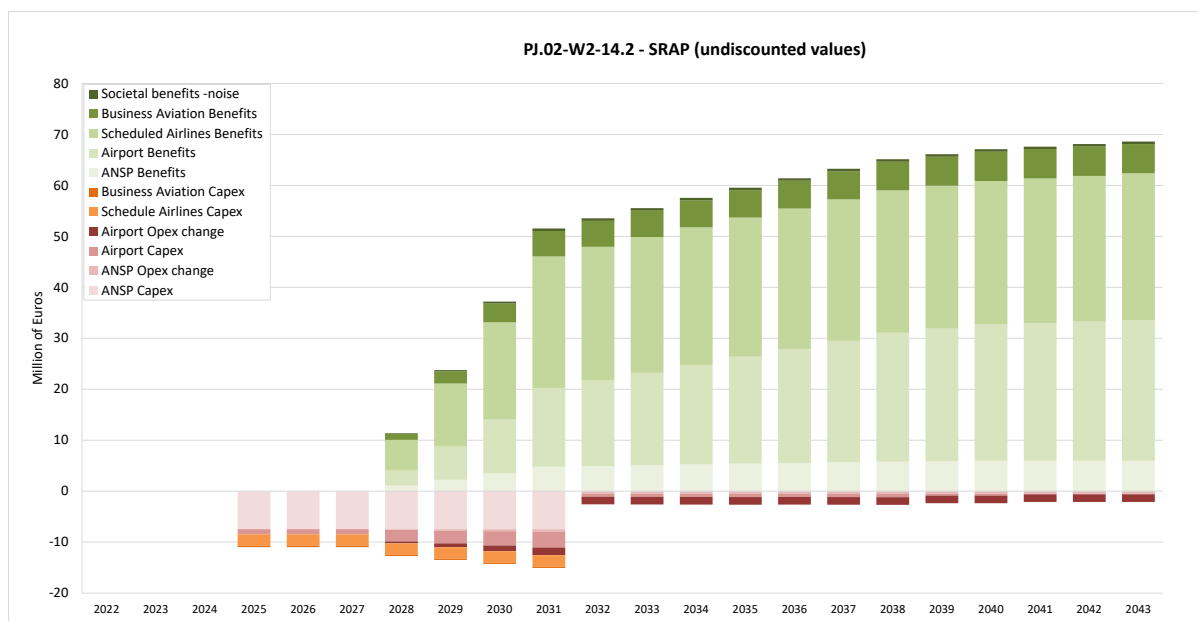


Figure 10: PJ.02-W2-14.2 Annual Investment Levels and Benefits (undiscounted)

The undiscounted values are useful, especially for the costs, as they provide an idea of the overall investments that will be required. For example, based on these results, the stakeholders will need to invest **118.0 M€** (89 M€ CAPEX + 29 M€ OPEX) to deploy this Solution over the deployment period. The **60.0 M€** discounted cost value, Table 24, simply reflects the present value of those investments in 2022.

8 Sensitivity and risk analysis

This section²⁶ provides data on how sensitive the CBA results are to changes in the inputs values. When making investments it is useful to know which values can have the most impact on the results to help focus further work on refining data and assumptions.

8.1 Discount Rate

The discount rate is used to reflect the time value of money²⁷ so reducing the discount rate reduces the difference between the value of money today and its value in the future. There is often much discussion on which discount rate to use so it is useful to look at a range of values. In this case the Net Present Value remains positive until the discount rate reaches around 43%.

Figure 11 shows that using a lower discount rate increases the NPV.

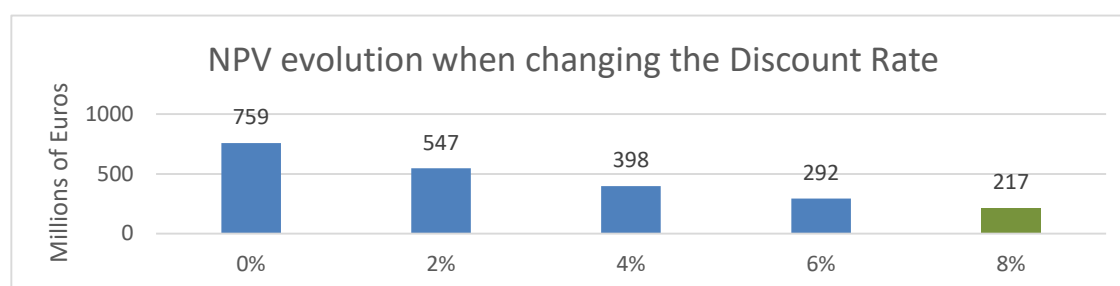


Figure 11: Sensitivity Analysis – Discount Rate

8.2 Sensitivity Comparison

Figure 12 shows the tornado diagram produced when the different cost and benefit inputs were each varied by -10% to +10%. The input values which produce the larger changes in the NPV are candidates for further investigation as they have the most potential to negatively impact the NPV.

The figure shows that the inputs **Time savings** and **Airport Capacity** have the largest impact on the results, while **Societal Benefits** is the input with the lowest impact on the results.

For the Time savings, the tornado diagram shows that a 10% reduction in time saving benefits would result in almost a 6% reduction in the Net Present Value. The CBA is considered to be very sensitive to an input value if the impact on the NPV is higher than the change in the input value, e.g. a 10% change in the input value resulted in a 15% change in the NPV.

²⁶ Risk Analysis has not been performed for this CBA as the Excel CBA model is not designed to apply Monte Carlo simulation techniques which are needed to calculate the NPV results for thousands of scenarios where different combinations of the input values (taken from probability distributions) are used in each.

²⁷ The time value of money reflects the idea that 1€ received today has more value than 1€ received in 2040 because it could be invested and earn interest over that period.

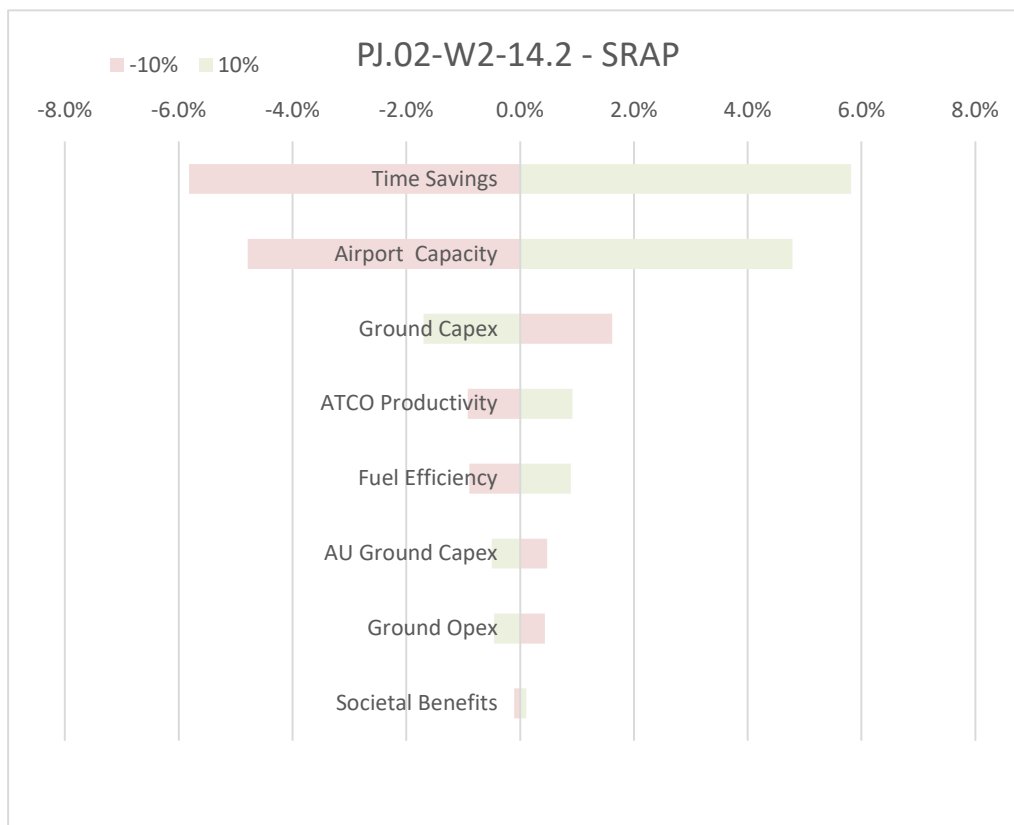


Figure 12: Tornado diagram

8.3 Sensitivity Scenario

This section provides the Net Present Value when the cost inputs are doubled at the same time that the benefit inputs are halved. This can be considered as a pessimistic view.

The CBA input values are shown below.

8.3.1 Costs double

Investment Costs

	Cost per-unit		Deployment Locations		Cost
ANSP	20.9 M€ per airport	x	5	=	104.5 M€
Airport Operator	2.8 M€ per airport	x	5	=	14.0 M€
Airspace Users (SA)	35 M€ total cost x 90%			=	3.5 M€
Airspace Users (BA)	35 M€ total cost x 10%			=	31.5 M€
Total Investment Costs					153.5 M€

Table 26: Investment Cost Summary

Annual Operating Cost changes

	Annual costs		Deployment Locations		Cost
ANSP	0.2 M€ per airport	x	5	=	1.0 M€

Airport Operator	0.6 M€ per airport	x	5	=	3.0 M€
Annual Operating Cost Change					4.0 M€

Table 27: Operating Cost Summary

8.3.2 Benefits halved

The benefit values shown in section 4 were halved for:

- Noise benefits (societal benefits)
- Airport capacity gains (0.09%) which reduces unaccommodated demand benefit
- Fuel efficiency (0.14kg/flight) which halves the CO₂ benefits
- Time Efficiency (0.0295%)
- ATCO Productivity (0.025%)

8.3.3 Pessimistic Scenario CBA Results

Table 28 shows that even in the pessimistic situation where the costs doubled and the benefits halved, the NPV was still positive, although much lower, at 26 M€.

	NPV	Capex	Opex	Benefits
ANSP	-54	-62	-5	13
Airport operators	23	-11	-14	48
Business Aviation	11	-2	0	13
Scheduled Aviation	45	-19	0	64
Societal Benefits	1	0	0	1
Overall	26	-93	-19	138

Table 28: PJ.02-W2-14.2 Pessimistic Scenario - Discounted CBA results (per stakeholder and overall)

9 Recommendations and next steps

In summary, the PJ.02-W2-14.2 V3 CBA results are positive with a Net Present Value (NPV) of **217 M€** reflecting that the benefits from deploying this Solution at 5 candidate airports are expected to exceed the costs of deploying and operating it. Confidence in the benefits is medium as they are based on Fast Time Simulation results.

The NPV has been calculated with an 8% discount rate over the period 2022 to 2043, with PJ.02-W2-14.2 being deployed between 2025 and 2030 and with benefits starting to be realised from late 2026. The payback year is 2031, which reflects when the cumulative net benefits will exceed the costs.

The sensitivity analysis shows that even if the costs doubled and the benefits halved, the deployment, as described in the CBA Solution Scenario, would still have a positive NPV of 26 M€.

The validation activities have shown that the Solution works and will bring benefits when deployed at airports meeting the solution conditions including, but not limited to, traffic mix, runway length and capacity-constrained peak periods. However, the validation results showed that the scale of the results differed across airports. The main recommendation is therefore, that airports considering the deployment of this Solution to address their operational needs, should review the content of this CBA and develop their own CBA based on their specific infrastructure, operations, layout, etc. to assess the scale of their potential benefits. They should also review related solutions, such as PJ.02-W2-14.5 Increased Glide Slope to Second Runway Aiming Point, to compare the costs and benefits and ensure they deploy the most appropriate solution for their needs.

10 References and Applicable Documents

10.1 Applicable Documents

- [1] SESAR 2020 Project Handbook, edition 02.02.00, 08 June 2020
- [2] SESAR Cost-Benefit Analysis Model²⁸ (Single Solution Wave 2)
- [3] EUROCONTROL, Standard Inputs for EUROCONTROL Economic Analyses, Edition 9, December 2020
- [4] SESAR 16.06.06-D26_03, Methods to Assess Costs and Monetise Benefits for CBAs, Ed. 00.02.02
- [5] EUROCONTROL, Method to assess cost of European ATM improvements and technologies, v1.0, 28 July 2014
- [6] SESAR 16.06.06-D26_08, ATM CBA Quality checklist, Edition 02.00.01
- [7] SESAR 16.06.06-D26_04, Guidelines for Producing Benefit and Impact Mechanisms, Ed. 03.00.01

10.2 Reference Documents

- [8] SESAR 2020 W1, PJ20 Classification of APTs (Airport OE_October 2019 Version (1_0).xlsx)
- [9] SESAR 2020 W1, PJ.02-02 CBA (V3), Deliverable D2.1.05, Edition 00.01.00, 25 March 2020
- [10] SESAR 1, P06.08.08 D07 Enhanced Arrival Procedures enabled by GBAS – OSED Consolidation, Edition 00.01.01
- [11] SESAR 1, P06.08.05 D04 – Operational Service and Environment Definition (OSED) Displaced Thresholds, 00.02.00
- [12] SESAR 2020, PJ.02-W2-14.2, D4.2.002, SPR-INTEROP/OSED - Part I final, Edition 00.01.00, 03 June 2022
- [13] SESAR 2020 PJ.02-W2-14.2, D4.2.005, SPR-INTEROP/OSED V3 - Part V - Final, Performance Assessment Report Deliverable, Edition 00.00.01, 28 May 2021
- [14] SESAR 2020 D4.7, PJ19.04: Performance Framework (2019), Edition 01.00.01, 30 November 2019
- [15] CE Delft (on behalf of European Commission)- Handbook on the External Costs of Transport – Version 2019
- [16] SESAR1 Training Cost assessment framework and database, Edition 2, 2019
- [17] SESAR 2020, PJ19, D4.0.30 S2020 Common Assumptions (2019), Edition 00.00.02
- [18] SESAR 2020 D4.0.1, PJ19-W2: Validation Targets – SESAR 2020 Wave 2 & Wave 3, Edition 00.01.00, 04 May 2021
- [19] SESAR 2020 W1, PJ.02-02 VALR (V3), Deliverable D2.1.048, Edition 00.00.01, 10 September 2019

²⁸ This reference is no more accessible from Programme library but it is now available in ATM Performance Assessment Community of Practice.

Appendix A Description of the Second Runway Aiming Point (AO-0319)

SRAP concept consists in having two runway thresholds active at the same time on a runway, with both final approach segments following an ILS conventional slope (usually 3°). In the figure below 'D' reflects the distance between the 2 aiming points.

Having two arrival slopes active at the same time, it can be envisaged to have one or two interception altitudes, according to each local case. The figures below show the two cases. See the OSED [12] for further details.

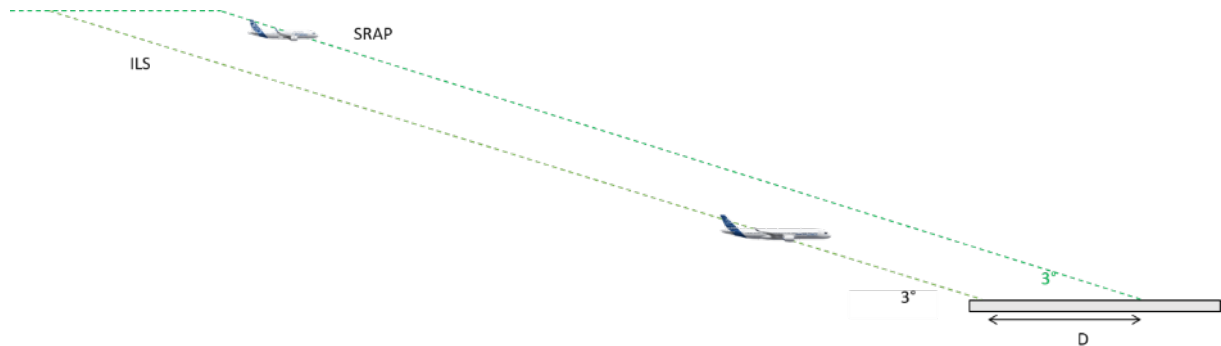


Figure 13: SRAP procedure with one interception altitude

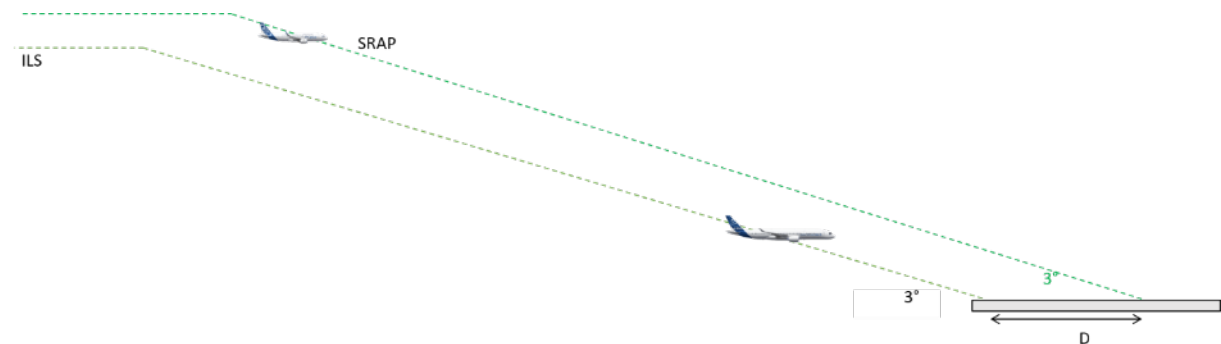


Figure 14: SRAP procedure with two interception altitudes

Appendix B List of Very Large and Large Airports

The table below presents the list of Very Large and Large airports as defined by PJ20 [8]. These are the Very Large and Large airports in 2018. Between 2018 and 2040 it is expected that many more airports will become capacity-constrained.

ICAO Code	Full Name of Airport	State Name	Airports' Group in 2018 according to SESAR 2020 Airports' Classification Scheme
EDDF	Flughafen Frankfurt/Main	Germany	Very large
EHAM	Amsterdam Airport	Netherlands	Very large
LFPG	Aéroport de Paris-Charles de Gaulle	France	Very large
EGLL	Heathrow Airport	United Kingdom	Very large
LTBA	Atatürk International Airport	Republic of Türkiye	Very large
EDDM	Munich Airport	Germany	Very large
LEMD	Aeropuerto de Adolfo Suárez Madrid-Barajas	Spain	Very large
LEBL	Aeropuerto de Barcelona-El Prat	Spain	Very large
LIRF	Aeroporto di Roma-Fiumicino	Italy	Very large
EGKK	Gatwick Airport	United Kingdom	Very large
LSZH	Flughafen Zürich	Switzerland	Very large
EKCH	Copenhagen Airport	Denmark	Very large
ENGM	Oslo-Garnemoen Airport	Norway	Very large
LOWW	Vienna International Airport	Austria	Very large
ESSA	Stockholm-Arlanda Airport	Sweden	Large
EIDW	Dublin Airport	Ireland	Large
LFPO	Aéroport de Paris-Orly	France	Large
EBBR	Brussels Airport	Belgium	Large
LTFJ	Sabiha Gökçen International Airport	Republic of Türkiye	Large
LEPA	Aeropuerto de Palma de Mallorca	Spain	Large
EDDL	Düsseldorf International Airport	Germany	Large
LPPT	Lisbon Airport	Portugal (Madeira and Azores)	Large
LGAV	Athens International Airport	Greece	Large
EGCC	Manchester Airport	United Kingdom	Large

ICAO Code	Full Name of Airport	State Name	Airports' Group in 2018 according to SESAR 2020 Airports' Classification Scheme
EGSS	Stansted Airport	United Kingdom	Large
LIMC	Milano Malpensa	Italy	Large
EFHK	Helsinki-Vantaa Airport	Finland	Large
EPWA	Warsaw Frederic Chopin Airport	Poland	Large
LTAI	Antalya International Airport	Republic of Türkiye	Large
EDDT	Tegel Airport	Germany	Large
LSGG	Genève Aéroport	Switzerland	Large
LKPR	Prague Airport	Czech Republic	Large

Table 29: List of Very Large and Large airports

Appendix C Linking Benefit and Impact Mechanisms to the CBA benefits

C.1 Ground benefit and impact mechanisms

The BIMS shown below are taken from the OSED Part I, Appendix A [12].

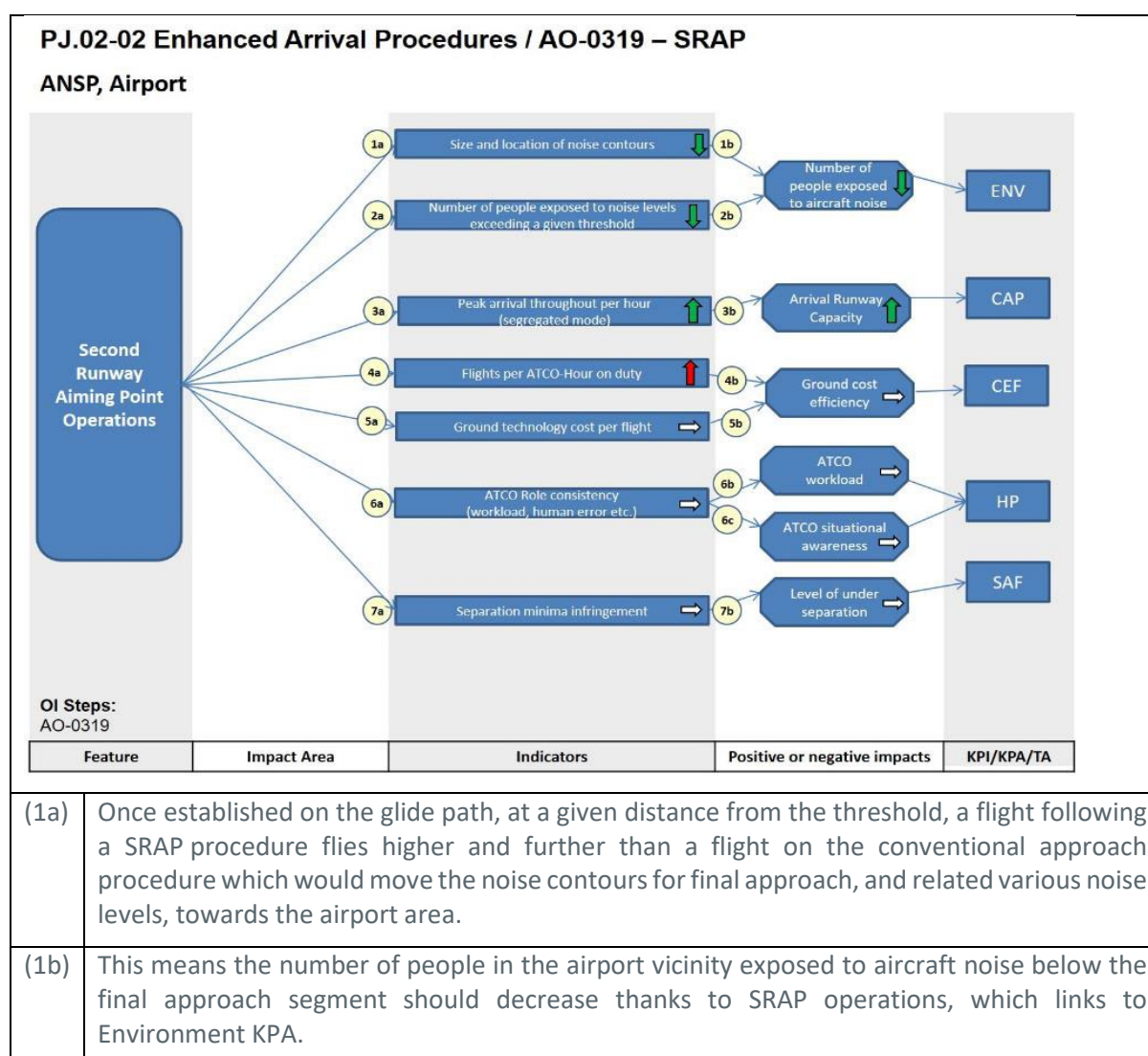
They are included here to provide the link between the impacts they include and the monetisation in the CBA.

The following impacts from the ANSP, Airport BIM are monetised in the CBA:

- ENV (NOI2/NOI4): noise benefits (1b) and (2b) – see section 4.1 for more details
- CAP (CAP3): increased arrival runway capacity (3b) – see section 4.2 for more details
- CEF (CEF2): Ground cost efficiency (4b) – see section 4.5

The following impacts from the ANSP, Airport BIM are not monetised in the CBA:

- HP: ATCO Role consistency. (6b) shows a stable ATCO workload which is aligned with the CEF2 assumption above that the ATCO can handle the additional flights with the support tool.
- SAF: no safety costs or benefits are included in the CBA.



(2a)	As described in (1a), SRAP operations would reduce the size of noise contours around the airport area which would lead to reduce the number of people exposed to noise levels exceeding a given threshold.
(2b)	This means the number of people in the airport vicinity exposed to aircraft noise below the final approach, and related various noise levels, will decrease thanks to SRAP operations, which links to Environment KPA.
(3a)	" Depending on the aircraft types, if the follower aircraft is flying a higher approach glideslope than the leading traffic, the wake turbulence separation between aircraft can be reduced, in particular behind large aircraft leader. For SRAP, the separation reduction depends on the distance between the thresholds, and the accuracy of the navigation technique (e.g. higher with GBAS or SBAS compared to APV-Baro). In some cases, when the lead aircraft is flying on the upper glide, the separation will however be increased. If the approach procedures are given to aircraft in a way to maximise the separation reductions compared to the cases when separations have to be increased, then the separation between aircraft pair is reduced on average. This is obtained when the Heavy / Super aircraft are assigned onto the 'lower' glide and most of the Medium/Light are assigned onto the 'upper' glide. An arrival runway capacity increase between 2 and 6% is predicted • when operating with high percentage of usage of the SRAP (>75%) • with benefits larger for major airports (with high rate of Heavy and Medium aircraft) • with benefits larger when operating RECAT-EU or RECAT-EU-PWS schemes."
(3b)	As the separation between aircraft pair could be reduced on average, SRAP operations should increase Arrival Runway Capacity which links to Capacity.
(4a)	Linked to the average positive impact of SRAP operations on peak arrival runway throughput, the flights per ATCO-Hour on duty would as well be higher when activating SRAP operations.
(4b)	That would not affect or affect positively the ground cost efficiency, and so the Cost Efficiency.
(5a)	The wake separation tables to be used when SRAP operations are active are complex because depending on aircraft pairs, and on the glides flown by leader and following aircraft. Some operational conditions may be identified when these separation tables could be simplified in order to be manageable by controllers without support. Such conditions are to be determined at each airport level but encompass the following cases: • When there are few wake turbulence categories operated at an airport (e.g. ICAO legacy), the complexity induced by the introduction of SRAP approaches may be lower and still manageable without controller separation support tool, only with the support of simpler separation rules/matrices (possibly reducing the capacity gains). • When the local separation minima (or spacing for example during night) applied at the considered airport are higher than the separations needed due to the introduction of SRAP approaches. • When these conditions cannot be met, a separation support tool will be necessary to help controllers manage the separations. Nevertheless, it has to be noted that such a tool may be already in use due to the complexity of the separation tables applied even without SRAP operations. Thus, only an adaptation of the tool to take into account the particularities linked to SRAP operations may be needed. In addition, SRAP operations increase the number of published approach procedures active at a time, which may increase the complexity of some of the ATCO's tasks (For instance,

	optimisation of the sequence to reduce as much as possible the average separation, monitor conformance to various glide paths). ATCO's task performance (workload, taskload) and situational awareness might be therefore negatively impacted necessitating new ATC support tools. In addition, as one new threshold has to be created on the runway, there is a need to implementing the additional visual aids (runway markings, approach lighting system and PAPI) to be built for that threshold, generating ground costs. In conclusion, the impact of SRAP introduction on the ground technology cost per flight might be negative, increasing the ground technology cost per flight, but the impact would be lower in case a separation assistance tool is already used by controllers because of the complexity of the separation scheme of the airport.
(5b)	That would negatively impact the ground cost efficiency, and so the Cost Efficiency.
(6a)	As explained in (5a), either the separation tables to be applied can be locally simplified or a controller separation support tool will be deployed to support controllers. Therefore, it is expected that the workload and the human error are maintained at the same level as today.
(6b)	The ATCO workload would be maintained. Finally, no impacts on the Human performance KPA are expected.
(6c)	The ATCO situational awareness would be maintained. Finally, no impacts on the Human performance KPA are expected.
(7a)	As explained in (5a), either the separation tables to be applied can be locally simplified or a controller separation support tool will be deployed to support controllers. So either the situation in terms of separation minima infringement will be as today or it will be improved when a tool will be used.
(7b)	The number of under separation situations is thus expected to be as of today or reduced, and Safety maintained.

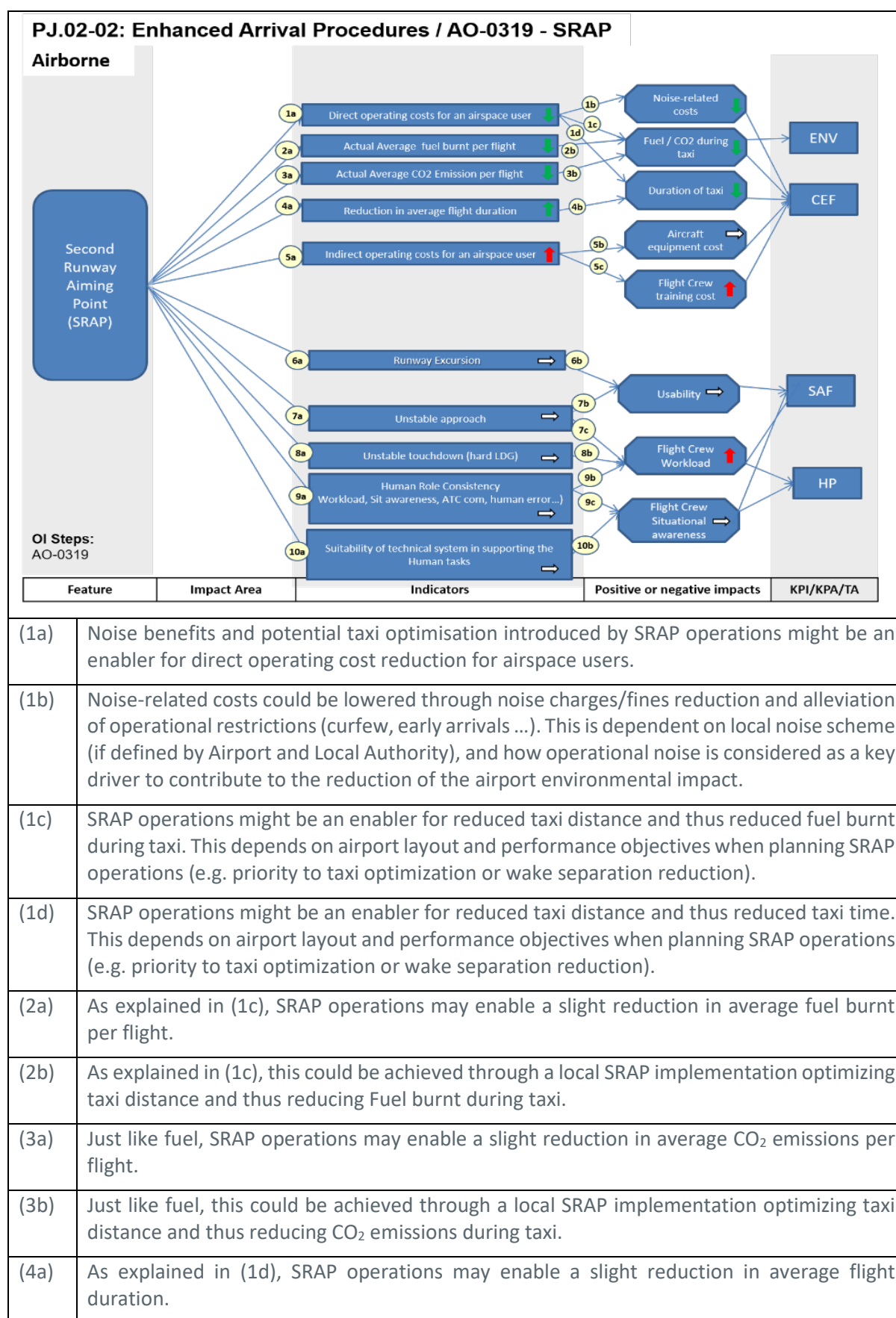
C.2 Airspace User Benefit and Impact Mechanism

The following impacts from the Airspace User BIM are monetised in the CBA:

- ENV (ENV1), Operational Efficiency (FEFF1): reduced fuel burn and CO₂ emissions (2b) and (3b) – see section 4.3 for more details
- TEFF (TEFF2): reduced flight time (taxi-in) (4b) – see section 4.4 for more details
- CEF (AUC3): direct operating costs for an airspace user (1c) and (1d) – see sections 4.3 (fuel, CO₂ emissions) and 4.4 for flight time (taxi-in). These benefits are monetised under the bullet points above (ENV1, FEFF1 and TEFF2) to avoid double counting.
- Flight Crew Training Cost (5c) is included as a cost in the CBA, see section 5.4.

The following impacts from the Airspace User BIM are not monetised in the CBA:

- CEF (AUC3): direct operating costs for an airspace user (1b) – noise related costs for Airspace users are not monetised in the CBA, related costs would include fines for noise infringements, charges for noise taxes as well as diversion and cancellation costs related to the impacts of curfews.
- SAF: no safety costs or benefits are included in the CBA.
- HP: other than the training costs, no Flight Crew HP impacts are included in the CBA.



(4b)	As explained in (1d), this could be achieved through a local SRAP implementation optimizing taxi distance and thus reducing taxi duration.
(5a)	The introduction of SRAP operations may lead to a limited increase in indirect operating cost for airspace users mainly due to training costs.
(5b)	No specific aircraft equipment or certification is required to fly SRAP approaches. Manufacturers may recommend the use of a runway overrun prevention function, but it cannot be mandatory since it is not required for current operations on shorter runways. Thus, no equipment costs are identified.
(5c)	No specific flight crew training is required to fly SRAP approaches. However, to ensure an easy-to-use operation on a daily basis when SRAP operations get widely deployed, it seems necessary to reinforce pilots training for such operations regarding assessment of available landing distance as well as differences in visual references (runway marking & lighting, VASI/PAPI, etc). Thus, training costs would slightly increase.
(6a)	Second runway aiming points SRAP should not affect the runway excursion rate.
(6b)	Pilots are used to compute the landing distance available for each approach. They will be made aware during the training that this latter is reduced. By construction, the SRAP threshold is defined considering the aircraft categories that can land vs the available landing distance. Moreover, appropriate runway markings & lightings should be provided to the crew. So SRAP should not have any impact on runway excursion.
(7a)	SRAP operations should not increase the rate of unstable approach and then of Go-around.
(7b)	SRAP operations meaning a shift profile further down the runway there is no negative impact on aircraft deceleration capability and it is expected to be maintained at the same level of current operations.
(7c)	SRAP operations are just a shift of approach profile further down the runway. So, the usability may remain unchanged.
(8a)	SRAP operations should not impact the flare manoeuvre.
(8b)	SRAP operations should impact the flight crew workload, but the effect is to be determined through RTS.
(9a)	SRAP effect on Human role consistency is to be determined through RTS.
(9b)	SRAP operations do not require any new or different communication between the flight crew and the ATC. However, the Flight Crew need to properly identify the applicable runway marking & lighting in order to avoid misleading with the regular aiming point on the same runway. SRAP solution should ensure it. Therefore, the flight crew workload should slightly be increased.
(9c)	SRAP effect on crew Perceived Subjective Situational Awareness is to be determined through RTS.
(10a)	The flight crew should not need any additional technical on-board system for SRAP operations, but visual aids (marking, lighting, PAPI/VASI) for the second threshold will be developed to support landing on that threshold.
(10b)	The adequacy of visual Aids (VASI/PAPI) provided to the Flight crew when flying SRAP operations are expected to potentially negatively impact the crew situational awareness when combined with a standard approach operation. Indeed, a single visual aid may exist for the standard approach so not appropriate for SRAP threshold. Or, in case of switching of visual aids between the two thresholds when two aircraft following each other do not

	follow the same approach (SRAP vs standard). This means that pilot situational awareness may be negatively impacted, even though this may need to be confirmed.
--	---

993

Appendix D Discount rate

This appendix explains the choice of 8% for the discount rate in the SESAR CBAs.

The discount rate is used to reflect the Time Value of Money (i.e. money received today has more value than money that will be received in 10 years because money received today can be invested to get some income.)

The discount rate used to calculate the Net Present Value (NPV) can be interpreted as the interest on invested money (from a project or a savings account) or as the interest charged on borrowing money (to fund an investment).

The 8% discount rate used in the SESAR CBA model to calculate the NPV reflects the higher end of the range of Cost of Capital values faced by the partners involved in SESAR 2020 Wave 1 PJ.20 sWP2.6 (Business Cases) to acquire the funds necessary to invest. This value is used by some partners in their local CBAs.

If a Solution has a positive NPV at 8% then it will be more positive at lower discount rates. However, a positive NPV with a lower rate, e.g. 4%, may be negative at an 8% discount rate. Therefore 8% is a conservative value, which can also be considered to include a risk premium to cover the uncertainties associated with such broad CBAs. The undiscounted values (i.e. a discount rate of 0%) are also provided to allow a comparison.

In addition, the SESAR CBAs do not consider inflation (i.e. the discount rate is the real rate and not the nominal rate). This is because it would be necessary to make many assumptions about how inflation rates evolve over the CBA period and how they would differ in the different states and how they would apply to the costs and benefits in each state.

Appendix E Mapping ATM Master Plan Performance Ambition KPAs and SESAR 2020 Performance Framework KPAs

Mapping between ATM Master Plan Performance Ambition KPAs and SESAR Performance Framework KPAs, Focus Areas and KPIs, source reference [18]

ATM Master Plan SESAR Performance Ambition KPA	ATM Master Plan SESAR Performance Ambition KPI	Performance Framework KPA	Focus Area	#KPI / (#PI) / <Design goal>	KPI definition
Cost efficiency	PA1 - 30-40% reduction in ANS costs per flight	Cost efficiency	ANS Cost efficiency	CEF2	Flights per ATCO hour on duty
				CEF3	Technology Cost per flight
Capacity	PA7 - System able to handle 80-100% more traffic	Capacity	Airspace capacity	CAP1	TMA throughput, in challenging airspace, per unit time
				CAP2	En-route throughput, in challenging airspace, per unit time
	Airport capacity		CAP3	Peak Runway Throughput (Mixed Mode)	
			Capacity resilience	<RES1>	% Loss of airport capacity avoided
	<RES2>	% Loss of airspace capacity avoided			
	PA4 - 10-30% reduction in departure delays	Predictability and punctuality	Departure punctuality	PUN1	% of Flights departing (Actual Off- Block Time) within +/- 3 minutes of Scheduled Off-Block Time after accounting for ATM and weather related delay causes
Operational Efficiency				PA5 - Arrival predictability: 2- minute time window for 70% of flights actually arriving at gate	Variance of actual and reference business trajectories

ATM Master Plan SESAR Performance Ambition KPA	ATM Master Plan SESAR Performance Ambition KPI	Performance Framework KPA	Focus Area	#KPI / (#PI) / <Design goal>	KPI definition
Environment	PA2 - 3-6% reduction in flight time	Environment	Fuel efficiency	(FEFF3)	Reduction in average flight duration
	PA3 - 5-10% reduction in fuel burn			FEFF1	Average fuel burn per flight
	PA8 - 5-10% reduction in CO ₂ emissions			(FEFF2)	CO ₂ Emissions
Safety	PA9 - Safety improvement by a factor 3-4	Safety	Accidents/incidents with ATM contribution	<SAF1>	Total number of fatal accidents and incidents
Security	PA10 - No increase in ATM related security incidents resulting in traffic disruptions	Security	Self- Protection of the ATM System / Collaborative Support	(SEC1)	Personnel (safety) risk after mitigation
				(SEC2)	Capacity risk after mitigation
				(SEC3)	Economic risk after mitigation
				(SEC4)	Military mission effectiveness risk after mitigation

1019

Table 30: Mapping between ATM Master Plan Performance Ambition KPAs and SESAR Performance Framework KPAs, Focus Areas and KPIs



1020
1021