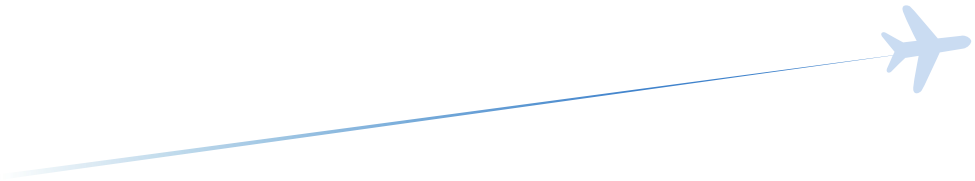

PJ.15-01 COST BENEFIT ANALYSIS (CBA) for Sub-Regional DCB Common Service

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Copyright Statement

COSER

COMMON SERVICES

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Abstract

The Sub-regional DCB Common Service provides capabilities necessary to operate sub-regional demand capacity balancing. PJ.15-01 describes ways of improved overall Cost Efficiency for delivering the necessary capability as a Common Service to the stakeholders involved. This document describes the CBA for the Sub-regional DCB Common Service in TRL6 for PJ.15-01.

Three Solution Scenarios for the Sub-regional DCB Common Service were developed in the TRL2 and TRL4 Business Model. Only one of them is kept in the TRL6 CBA[1].

The main statements already given in TRL4 are still valid. These are summarised below and explained in more detail within the document. Benefits addressing cost reduction and accelerating deployment of DCB capabilities were reassessed and confirmed.

The business case for Sub-regional DCB common services is based purely on cost reduction, thus addressing only the Cost Efficiency KPA.

Consequently, the cost benefit relates to:

- Lower number of system deployments.
- Lower number of technical systems to be securely maintained in operation.

There are no proposed primary benefits in terms of SESAR KPIs other than cost reduction. However, through the availability of an economically attractive Common Service, quicker implementation of Sub-regional DCB capabilities could be envisaged. Additionally, more ANSPs will be triggered to implement Extended Arrival Management. Both have a secondary effect on other SESAR KPIs than cost reduction.

The present document includes the results of the CBA activities performed in TRL6 and must be complemented with the CBA Excel, in order to have a complete view of the economic model.

[1] The Sensitivity Analysis in TRL6 captures the effects that were the cause of creating these 2 further Solution Scenarios. Therefore, to ease the understanding of the CBA model, they have been eliminated.

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1 Executive Summary

The present document is the first *Cost Benefit Analysis (TRL6)* document to be delivered, as part of the *TRL6 Data Pack D2.2.060* under the task *WP2 – Sub-Regional DCB Common Service* of PJ.15. The CBA aims to capture and reflect the expectations from the stakeholders regarding the provision of a Sub-regional DCB Common Service. It highlights the proposed value, the potential consumers and customers and a detailed analysis of performance and cost benefits, among others.

This document builds upon the Deliverable D2.2.055 Business Model (TRL4). A CBA deliverable is only contractually due in 2019 as part of the TRL6 Data Pack, nevertheless substantial efforts were performed already for TRL4. Major updates have been performed in TRL6, in order to achieve an accurate CBA model, to adequately monetise the potential benefits of the solution.

A fundamental aim of the SES programme is the overall reduction of cost through service harmonisation. A Common Service is the provision of a service to consumers that provides a capability in the same form that they would otherwise provide themselves. The advent of service orientation and the use of open standards create opportunities for identifying such common capabilities amongst certain stakeholder groups and encourage their use in the de-fragmentation of ATM.

The purpose of the Sub-regional Demand Capacity Balancing (DCB) Service (Supporting the DCB capability within the ICAO Global Concept [9]) is to facilitate an improved usage of the airspace at the sub-regional level, through enhanced planning and consequently more appropriate tactical intervention in support of AU and AO operations. Consequently, the intent of the Sub-regional DCB common service is to enable the Europe-wide benefits of an integrated Sub-regional operation through reduced cost of service provision.

It is expected that Sub-regional DCB can be applied within a multi-ACC or multi-ANSP environment and facilitate an improved usage of the airspace at the sub-regional level and facilitate tactical interventions when necessary, ensuring that any potential disruptions could be correctly managed. It is not envisaged that a sub-region is limited by geographic boundary other than the need to ensure a detailed knowledge of the airspace (generally limited to adjacent airspace).

Nevertheless, the number of ACCs per sub-region (6) is foreseen as the CBA parameter under a higher degree of uncertainty, and it is recommended to further refine the current value if further maturity is pursued for the solution. With the current value, the solution scenario develops a positive business case (NPV 5.7 M€ in 2040) and has a short payback period (payback year is reached in 2023).

2 Introduction

2.1 Purpose of the document

This chapter presents the TRL6 CBA for Solution PJ15-01. The analysis has concentrated on updating where possible the CBA presented in TRL4 [1] and it follows the structure proposed in the SESAR2020 CBA Template for enabling projects as a guideline [20].

For TRL6, the costs and benefits of the Solution have been refined and monetised for each impacted stakeholder. The new CAPEX and OPEX values differ widely from the ones used in TRL4, since the solution higher maturity has allowed the PJ15-01 to provide with more detailed cost figures to the CBA team. In addition, the IOC and FOC dates of the solution scenarios have been delayed to match the new dates that are proposed on the eATM Portal [47]. Nevertheless, the main change from TRL4 to TRL6 has been the elimination of the "Very Cooperative" and "Low Cooperative" solution scenarios since the cooperation degree among states have been included as a parameter in the sensitivity analysis. This change has been performed to simplify the document structure and, therefore, ease the document understanding for the reader.

2.2 Scope

The increasing delay to air traffic in the latter part of the 20th century lead to the creation of the European Central Flow Management Unit (CFMU) in 1995 which resulted in a significant reduction in delay within the context of an ever-increasing air traffic demand. To date, the Regional Network Manager (evolution of the original CFMU function) has successfully supported local actors in Europe manage the increasing demand, initially through regulations applied close to the time of operation. The SES initiative has resulted in significant enhancement of the Network Management toolset to manage air traffic by improvements in planning ATFCM measures, flexible use of airspace and latterly being specific in delay avoidance measures. Over time, these measures have resulted in an increased need for Collaborative Decision Making and information sharing. The European Network has reached a stage whereby the operational architecture is required to evolve in support of further performance gain.

To date, much of European Network Management has been achieved through interaction between the Regional Network Manager and local actors (e.g. ACC, Airports). The volume and complexity of the interaction needed for future performance improvement necessitate the utilisation of a Sub-region interacting with the Network Manager on behalf of the local actors (see [5] relating to Flow Manager).

The Sub-regional DCB service supports the DCB capability within the ICAO Operational Capability model [9]. The operational sub-regional DCB service uses existing operational processes and services, reorganising them to provide efficiencies, example provision of a focal point for a number of ACC's so reducing the number of point to point connections. The Sub-regional service activities commence during the early planning phases, considering demand and working with regional and local actors to plan airspace capacity in support of the impending demand. As the time of operation approaches, the Sub-region, in the form of the Flow Manager, performs the co-ordination necessary to maintain developed plans, where possible. Where maintenance of plans is not possible, the key benefit of the sub-region is the ability to optimise the close to the time operation based on a detailed knowledge of the prevailing operational situation. This requirement for a detailed understanding necessarily limits the geographical dimensions of a sub-region. The need for a detailed understanding of the airspace

infers service provision by an organisation with an ANSP component, particularly at the point of service delivery.

Subsequently, the Sub-regional actor is involved in the post-operational analysis to improve future performance. Post-operational phase is described in the SESAR 1 7.2 DOD (Step 2) [41].

In summary, the scope of this CBA encompasses the Sub-regional actor, from long term planning (limited by SESAR 1 concepts) to execution and applicable to a continuous geographic area manageable by a Flow Manager in the close to time of operation time frame. The service provider is required to be an organisation with ANSP background and systems provision elements. The consumers will be ANSP, ACC, Airport and other airspace related service provisions for a geographically adjacent location to the provider and accountable for increasingly busy and complex airspace. In the wider European ATM context, Sub-regional coverage is required in order to support regional performance ambitions. The minimal necessary coverage will be investigated as part of SESAR 2020 PJ15-01 but it is proposed that the initial working assumption is complete coverage of European airspace.

2.3 Intended readership

The intended audience for this document is the SESAR Joint Undertaking, the partners in the SESAR 2020 programme, the ATM stakeholders (e.g. airspace users, ANSPs, airports, airspace industry) with those third parties directly affected by its findings and the contributors having dependencies with the solution such as PJ01, PJ25 and PJ19.

Other architectural projects and tasks within the SESAR 2020 programme may also have an interest.

2.4 Structure of the document

This CBA document is structured in the following chapters:

- Executive summary
- Introduction, providing with an overall view of both this document and the solution
- Objectives and scope of the CBA, where the CBA reference and solution scenarios are defined
- Benefits, where the main benefit mechanisms of the solution are shown
- Cost assessment, including the values derived from the stakeholders' analysis
- CBA model, where the attached Excel CBA model is widely described
- CBA results, where the main outcomes of the CBA model are shown and described
- Sensitivity and risk analysis, of the main uncertain parameters affecting the CBA results
- Recommendations and next steps

2.5 Glossary of terms

Term	Definition	Source
Business case	A tool to provide decision makers with the information they need to make a fully informed decision on whether funding should be provided and/or whether an investment should proceed	SESAR P16.06.06
Business model	A framework for creating economic, social, and/or other forms of value. The term' business model' is thus used for a broad range of informal and formal descriptions to represent core aspects of a business, including purpose, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies.	EUROCONTROL ATM Lexicon
Capability	The ability of one or more of the enterprise's resources to deliver a specified type of effect or a specified course of action to the enterprise stakeholders.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Centralised (service) - a particular type of Common Service	A Centralised Service is an ANS support service exercised at pan-European and central network level for harmonisation and cost-efficiency purpose avoiding multiplication of investments, leading to reduced infrastructure costs, supporting the ANSPs and the Member States of the EU to come closer or actually achieving the EU cost efficiency performance targets.	EUROCONTROL
Common Service	A service providing a capability in the same form to consumers that might otherwise have been undertaken by themselves'	SESAR B04.05 D02
Consumer	A user of a service	SESAR B04.05 D02
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 value for money while considering all the key criteria for the decision. A CBA is a tool used within the Business Case Process to provide financial inputs	16.06.06-D68-New CBA Model and Methods 2015-Part 1 of 2
Customer	A consumer of a service under a specific contract.	SESAR B04.05 D02
Deployment Package	Deployment Packages comprise Operational Improvement Steps and Enablers selected to satisfy Performance Needs of Operating Environments in the European ATM System by providing performance benefits confirmed by validation results.	SESAR WP C, though un-reviewed

Node	A logical entity that performs activities. Note: nodes are specified independently of any physical realisation.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Security and safety in the context of a Common Service	Non-Functional Requirements (NFR) and Quality of service (QoS) requirements can be specified at various levels of maturity and from different viewpoints such as from the collaborative enterprise, the logical level, technology and engineering perspectives. Conceptually, NFR and QoS are not always distinguishable. Common Services will focus at the first two viewpoints	ISRM – Modelling guidelines
Service	The contractual provision of something (a non-physical object), by one, for the use of one or more others. Services involve interactions between providers and consumers, which may be performed in a digital form (data exchanges) or through voice communication or written processes and procedures.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Service contract (SLA)	A service contract represents an agreement between the stakeholders involved for how a service is to be provided and consumed. A service contract is specified through the service interface, the QoS and Service policies.	SESAR B.04.03 – Working method on service
Service instance	Service which has been implemented in accordance with its specification in the service catalogue (during the SESAR Development Phase, the service definitions are available in the ISRM) by a service provider (by itself or contracted to a third party).	SESAR B.04.03 – Working method on service
Service Provider	An organisation supplying services to one or more internal or external consumers.	SESAR B.04.05 – D02
Service taxonomy	The service taxonomy describes the categorisation of services provided between ATM stakeholders. It is used to organise the responsibilities of the service design as well as to provide a means of identifying services in the run-time environment.	SESAR B.04.03 – Working method on service
Stakeholder	A stakeholder is an individual, team, or organization (or classes thereof) with interest in, or concerns relative to, an enterprise (e.g. the European ATM). Concerns are those interests, which pertain to the enterprise's development, its operation or any other aspect that is critical or otherwise important to one or more stakeholders.	SESAR2020 PJ19.05 EATMA Guidance Material Version 10.0
Net Present Value	Net Present Value (NPV) is the sum of all discounted cash inflows and outflows during the time horizon period.	Investopedia

Table 1: Glossary of terms

2.6 List of Acronyms

Term	Definition
ACC	Area Control Centre
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
AMAN	Arrival Manager (Controller Support Tool)
AO	ATM Operations
AOM	Airspace Organisation & Management
APP	Approach Control Centre
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATS	Air Traffic Services
AU	Airspace User
AUO	Airspace User Operations
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
COP	Coordination Point
COSER	Common Service
DCB	Demand Capacity Balancing
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
EN	Enabler
ESSIP	European Single Sky Implementation
FCM	Flow and Capacity Management
FOC	Full Operational Capability
HC	High complexity (airport)

ICAO	International Civil Aviation Organisation
IOC	Initial Operational Capability
KPA	Key Performance Area
KPI	Key Performance Indicator
LC	Low complexity (airport)
LSSIP	Local Single Sky Implementation
MIL	Military
MUAC	Maastricht Upper Area Control Centre
N/A	Not Applicable
NPV	Net Present Value
OBJ	Implementation Objective
OI	Operational Improvement
OPEX	Operational Expenditure
OSED	Operational Service Environment Description
PAR	Performance Assessment Report
PCP	Pilot Common Project
PIRM	Programme Information Reference Model
QoS	Quality of Service
RBT	Reference Business / Mission Trajectory
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme, which addresses all activities of the SESAR Joint Undertaking Agency.
SESAR Programme	The programme, which defines the Research and Development activities and Projects for the SJU.
STAM	Short-Tem ATFCM Measures
TMA	Terminal Manoeuvring Area
TWR	Tower

TRL	Technology Readiness Level
WP	Work Package

Table 2: List of acronyms

3 Objectives and scope of the CBA

3.1 Problem addressed by the solution

The Common Service does not address operational improvements itself. It is aiming at the improved cost efficiency of the provision of a necessary capability. The following section reflects this fact.

3.2 SESAR Solution description

The Sub-regional Demand Capacity Balancing Service aims at facilitating an improved usage of the airspace at sub-regional level and facilitate tactical interventions when necessary, ensuring that any potential disruptions could be correctly managed. The scope also includes an AOP Common Service to facilitate the integration of AOP information into the NOP.

One OI has been created for this SESAR solution. It reflects the fact that this solution is only aiming at improving cost efficiency. This OI is linked to the below described EN. *(Text taken from EATMA)*

3.2.1 SDM-0401 Sub-Regional DCB Common Service (Business Improvement)

The concept of Common Services (COSER) aims at addressing the high costs caused by European ATM fragmentation. The idea of sharing a common capability and offer it to different interested consumers is directed at reducing the costs of ATM provision. The Common Service can be provided at different levels, ranging from local to sub regional level, depending on the underlying business model.

The purpose of providing the Sub-regional Demand Capacity Balancing (DCB) Common Service (Supporting the DCB capability within the ICAO Global Concept) is to facilitate an improved usage of the airspace at sub-regional level, through enhanced planning and consequently more appropriate tactical intervention when necessary, ensuring that any potential disruptions could be optimally managed.

3.2.2 EN: SVC-005 Provision of cost-efficient Sub-Regional DCB capabilities using a Common Service

Ground system evolves to provide "SWIM enabled" Hotspot Definition, ATFCM Measures and Post Operations Indicators using common interfaces in support of cost-efficient Sub-Regional DCB capabilities.

3.3 Objectives of the CBA

Following the SESAR2020 Project Handbook [22], the CBA for TRL6 will include:

- All the evidence gathered in terms of impacts, benefits and costs of a solution.
- The NPV overall and per stakeholder groupA sensitivity analysis identifying most critical variables to the value of the project and a risk analysis.
- The CBA model and report.
- Recommendations.

3.4 Stakeholders[2] identification

Table 3 identifies the stakeholder categories that are affected by implementing, operating and benefitting from the PJ.15-01 Solution.

Scenario	Area	Stakeholder	The type of stakeholder and/or applicable sub-OE	Type of Impact	Involvement in the analysis	Quantitative results available in the current CBA version
Solution Scenario	Regional	Network Manager	Flow Management, En-route	Minimal development of current standards	No	No
	Sub-regional	Flow Manager ANSP	ANSP Service Provider	Invest in new developments or adaptation of Legacy systems. Adaptation to new operations. Operating costs.	Yes	Yes
		Flow Manager Adjacent ANSP	ANSP Service Provider		Yes	Yes
		COSER Consumer	Sub-Regional DCB service consumer		Yes	Yes
		COSER Provider	Sub-Regional DCB service provider	Development of DCB tool. Operating costs.	Yes	Yes
	Local	ACCs (Local and Adjacent)	ACC	Adaptation costs to use the COSER	Yes	Yes
		Airport Operators	TMA, APP	Not identified	No	Not applicable
		Airspace Users	Airspace User			
		MIL	Military airspace			

Table 3: SESAR Solution PJ.15-01 CBA Stakeholders and impacts

[2] 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.

3.5 CBA Scenarios and Assumptions

This section describes the scenarios that have been compared in the CBA.

3.5.1 Reference Scenario

The so-called Reference Scenario represents the possible situation at the start of implementation of the Solution with assumptions on how deployment is likely to evolve without Solution 15-01.

By definition, a Common Service is "*a service providing a capability in the same form to consumers that might otherwise have been undertaken by themselves*" [3]. So the Reference Scenario will consider that consumers (ANSPs) will have to undertake (implement) the capability (Sub-regional DCB) by themselves.

Without Sub-regional DCB Common Service being deployed as a COSER but on an individual basis, there are mainly 4 uncertainties for the definition of the Reference Scenario:

1. Sub-Regional DCB capability provision.
2. Number of ANSPs that have Sub-Regional DCB capabilities by 2040.
3. Degree of collaboration among ANSPs for Sub-Regional DCB.
4. Time to deploy IOC/FOC

These 4 uncertainties are studied in the following headings in order to define the Reference Scenario.

3.5.1.1 Sub-Regional DCB capability provision

SESAR PJ.15-01 Solution is aiming at TRL6 and, consequently, it is still difficult to define an exact departing point for Reference Scenario. In other words, what is or would be the expected evolution of current Sub-Regional DCB initiatives if not deployed under a COSER model?

To take a pragmatic approach and circumvent this limitation, the PJ.15-01 Reference Scenario considers a world where SESAR1 initiatives continue as planned and no SESAR2020 Solutions are deployed. In other words, ANSP will undertake Sub-Regional DCB capabilities using the current SESAR1 solutions that can contribute to building a Sub-Regional DCB capability.

PJ.15-01 being an Enabler (EN) and following the EATMA Methodology, Sub-Regional DCB in the Reference Scenario will be achieved by a series of Implementation Objectives (OBJ) as expressed by the blue arrow in Figure 1.

Following the engineering view of the European ATM Master Plan Level 3 - Implementation Plan (ESSIP Plan) 2018 Edition in the eATM Portal, the CBA will study the link between the PCP Elements (PCP) and the Implementation Objectives (OBJ) as expressed by the red arrow in Figure 1.

Departing from the PCP elements to reach the Implementation Objectives has the advantage that the PCP follows a detailed roadmap and timeline specified by EU IR 716/2014. Therefore, the Reference Scenario is based upon expected deployment of the PCP ATM Functionalities.

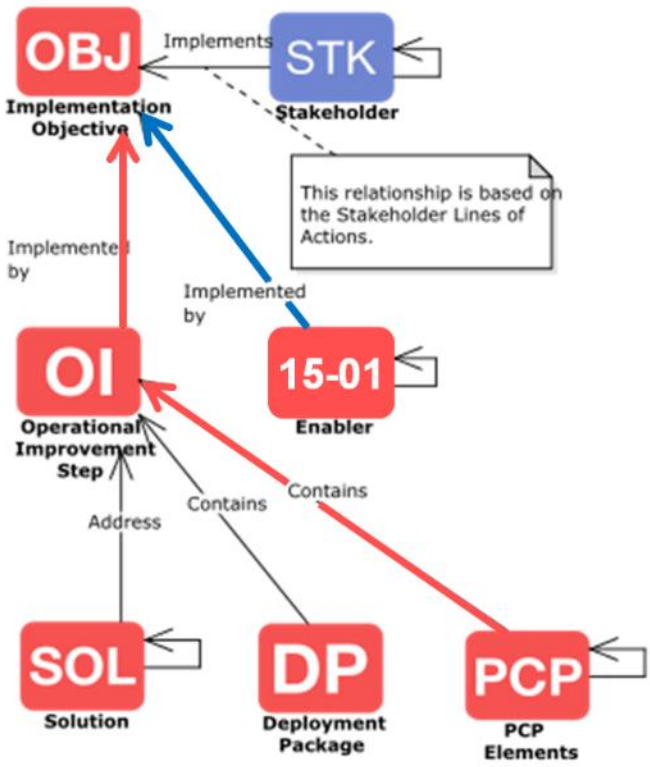

Figure 1: Reference scenario – From PCP Element to Implementation Objective

Following expert judgement, 3 out of the 7 PCP ATM Functionalities have been identified as relevant for performing DCB. The ATM Functionalities AF3, AF4 and AF5 and its Sub-Functionalities in Table 4 are considered necessary in one way or another to perform Sub-Regional DCB.

3.5.1.1.1 PCP elements

No.	PCP ATM Functionality	PCP ATM Sub-Functionality	Necessary for Sub-Regional DCB?
	AF1 Extended AMAN and PBN in high density TMA	(…)	No. Disregarded.
	AF2 Airport Integration and Throughput	(…)	No. Disregarded.
1	**AF3** Flexible Airspace Management and Free Route	**S.AF3.1** Airspace Management and Advanced Flexible Use of Airspace	Yes
2		**S.AF3.2** Free Route	Yes
3	**AF4** Network Collaborative Management	**S-AF4.1** Enhanced Short Term ATFCM Measures	Yes
4		**S-AF4.2** Collaborative NOP	Yes
5		**S-AF4.3** CTOT to TTA for ATFCM	Yes
6		**S-AF4.4** Automated Support for Traffic Complexity Assessment	Yes

7	**AF5** Initial System Wide Information Management	(…) **S.AF5.6** Flight Information Exchange (…)	Yes. Partially.
	AF6 Initial Trajectory Information Sharing	(…)	No. Disregarded.

Table 4: PCP ATM Functionalities related to Sub-Regional DCB

3.5.1.1.2 From PCP to Implementation Objectives

Table 5 goes from PCP Sub-Functionalities to Implementation Objectives passing through the OIs. Up to 14 Implementation Objectives are identified.

PCP ATM Sub-Functionality	OI	Objective	No.
S.AF3.1 Airspace Management and Advanced Flexible Use of Airspace	**AOM-0202-A** Automated Support for strategic, pre-tactical and tactical Civil-Military Coordination in ASM **AOM-0206-A** Flexible and modular ARES in accordance with the VPA design principle	**AOM19.1** ASM support tools to support A-FUA	**1**
		AOM19.2 ASM Management of Real-Time Airspace Data	**2**
		AOM19.3 Full rolling ASM/ATFCM process and ASM information sharing	**3**
S.AF3.2 Free Route	**AOM-0500** Direct Routing for flights both in cruise and vertically evolving for cross ACC borders and in high complexity environments	**AOM21.1** Direct Routing	**4**
	AOM-0501 Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments **AOM-0505** Free Routing for Flights both in cruise and vertically evolving within high-complexity environments in Upper En-Route airspace **CM-0102-A** Dynamic Sectorisation based on complexity	**AOM21.2** Free Route Airspace	**5**
S-AF4.1 Enhanced Short Term ATFCM Measures	**DCB-0308** Advanced Short Term ATFCM	**FCM04.2** Short Term ATFCM Measures (STAM) – Phase 2	**6**
S-AF4.2 Collaborative NOP	**AO-0801-A** Collaborative Airport Planning Interface	**AOP11** Initial Airport Operations Plan	**7**
	AUO-0203 EFPL in NM processes	**FCM08** Extended Flight Plan	**8**
	DCB-0103-A Collaborative NOP for Step 1	**FCM05** Interactive rolling NOP	**9**
S-AF4.3 CTOT to TTA for ATFCM	**DCB-0208** DCB in a trajectory management context	**FCM07** Calculated Take-off Time (CTOT) to Target Times for ATFCM purposes	**10**
	AUO-0203 EFPL in NM processes	**FCM08** Extended Flight Plan	-

S-AF4.4 Automated Support for Traffic Complexity Assessment	**CM-0103-A** Automated Support for Traffic Complexity Assessment	**FCM06** Traffic complexity assessment	**11**
S.AF5.6 Flight Information Exchange	**AUO-0203** EFPL in NM processes	**FCM08** Extended Flight Plan	-
No PCP	**AUO-0101-A** Enhanced ATFM Slot Swapping	**FCM09** Enhanced ATFM slot swapping	**14**

Table 5: SESAR1 Implementation Objectives related to Sub-Regional DCB

3.5.1.1.3 ANSPs categorisation

DCB can be implemented using multiple tools but the CBA will consider that Sub-Regional DCB capabilities are defined by the Implementation Objectives in Table 5. For practical considerations, the CBA assumes the Flow Capacity Management measures (FCM) are the most relevant Implementation Objectives contributing to Enhanced Demand Capacity Balancing among the 14 identified in Table 5. This selection is based on 2 reasons:

- **Operational expert judgement:** based on operational expert view, FCM measures are commonly used to perform Enhanced DCB.
- **Time to deployment:** as it will be shown in section 3.5.1.4 Time to deploy and reach FOC, the FCM04.2 Implementation Objective is the only one slightly delayed and will impact the time to deployment.

Therefore, the current FCM04.2 STAM – Phase 2 deployment status is assumed to be the best criteria for ANSP categorisation. Using the most up-to-date deployment plans communicated by ANSPs in the eATM Portal (see Annex A). Table 6 summarises the ANSP categorisation to be considered:

- 24 ANSPs have implemented, are implementing or having plans to implement FCM04.2.
- 12 ANSPs don't have yet plans to implement although are obliged by PCP.
- 6 ANSPs fall out of the applicability area.

For a detailed analysis of the overall implementation progress of FCM04.2 Short Term ATFCM Measures (STAM) – Phase 2, please refer to Appendix A.

PCP Applicability Area	Overall progress	ANSPs/States considered	Total
Inside	Completed	Lithuania, MUAC, Switzerland, United Kingdom	4
	Ongoing	Austria (10%), Belgium (30%), Bosnia and Herzegovina (53%), Croatia (3%), Czech Republic (5%), Finland (10%), France (28%), Italy (5%), North Macedonia (5%), Poland (92%), Portugal (3%), Slovak Republic (3%), Spain (5%)	13
	Planned	Bulgaria, Cyprus, Denmark, Estonia, Germany, Greece, Slovenia	7
	No plan	Albania, Hungary, Ireland, Latvia, Malta, Montenegro, Netherlands, Norway, Romania, Serbia, Sweden. Turkey	12

Outside	Not applicable	Armenia, Azerbaijan, Georgia, Luxembourg[3], Moldova, Ukraine	6
Total number of states			42

Table 6: Reference Scenario – ANSP categorisation for Reference Scenario

3.5.1.2 Number of ANSPs that have Sub-Regional DCB capabilities by 2040

This section explains the assumptions considered for estimating the number of ANSPs that will have Sub-Regional DCB capability in 2040 – the end of the CBA reference period.

The geographical scope has been defined as the ECAC area. However, this does not necessarily mean all ECAC countries will enjoy Sub-Regional DCB capabilities. This has been a relevant topic for discussion among PJ.15-01 Solution experts.

On the one side, there are operational reasons to assume only a sub-set of ECAC states will be interested to deploy the capability. On the other side, other experts focusing more on long-term traffic figures advocate for full implementation.

Finally, since the Solution Scenario would provide service to the full ECAC area, the Reference Scenario has been assumed to provide service also to the full ECAC area. In this way, the cost-efficiency only purpose of the Common Service is preserved, ensuring that no operational benefits are accounted for.

Table 7 presents the main assumptions to categorise the implementation area.

Implementation area	Number of ANSPs deploying Sub-Regional DCB	ACCs
ECAC full Area (**ECAC**)	42	63

Table 7: Reference Scenario – Implementation

3.5.1.3 Number of Sub-Regions

ANSPs will collaborate into regions for Sub-Regional DCB purposes. Following operational expert judgement, it is considered that the maximum number of ACCs that can be accommodated under a Sub-Region is approximately 7 ACCs[4]. Figure 2 proposes an example for a possible set-up for a Sub-Region for NATS/IAA/part of DSNA.

The round figure of 7 ACCs is assumed as an optimal value for CBA TRL6. A rule of thumb is proposed to be somewhat more conservative:

- **ECAC**: all 63 ACCs in EUROCONTROL Area[5] will collaborate into Sub-Regions following a sub-optimal proportion (6 ACCs per Sub-Region). This gives an initial assumption of around 11 Sub-Regions in the ECAC area for DCB purposes.

[3] All ATFCM measures for Luxembourg are being implemented by the FMP position of Belgocontrol for the entire FIR Brussels in accordance with the established agreements. Therefore, Luxembourg is not in the applicability area of this objective.

[4] NATS with 3 ACCs: London AC, London TC and Prestwick. IAA with 2 ACCs: Dublin and Shannon. France with 2 out of 5 ACCs: Brest and Reims.

[5] CBA for V2 considers the information for EUROCONTROL Area.

Since this assumption (6 ACCs per Sub-region) is subject to a high degree of uncertainty (political issues may affect this sub-optimal design), it is included in the sensitivity analysis that is performed after the CBA results (including optimal 7 optimal ACCs per Sub-region and 5 ACCs per Sub-region).

The Reference Scenario assumes that Industry Partners will develop a Sub-Regional DCB toolkit for each Sub-Region. The initial assumption is to consider that each Sub-Region will develop or buy a toolkit. The number of developments will be then:

- **ECAC**: a total of 11 toolkits are estimated for the 11 Sub-Regions.

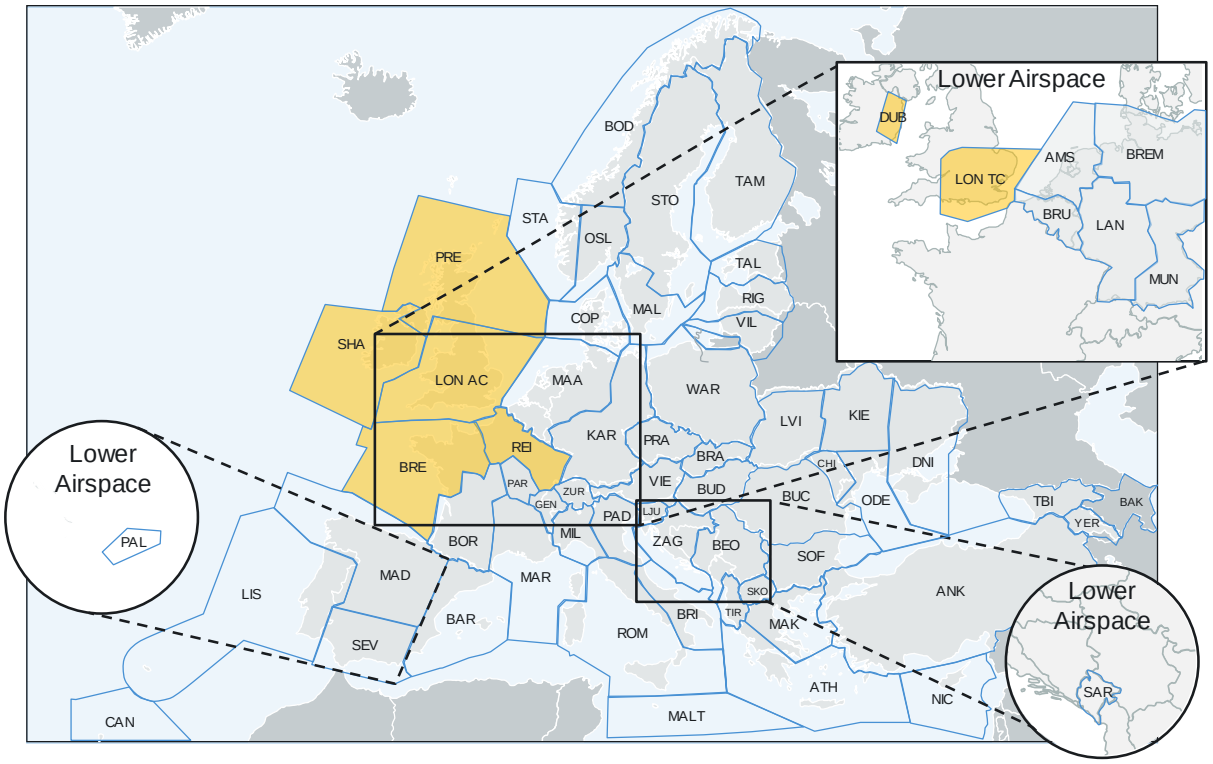

Figure 2: SESAR Solution 15-01 CBA Reference scenario – Illustration of a Sub-region that would be formed by NATS (3 ACCs: London AC, London TC and Prestwick), IAA (2 ACCs: Dublin and Shannon) and DSNA (with 2 out of 5 ACCs: Brest and Reims).

3.5.1.4 Time to deploy and reach FOC

It does not seem realistic to assume that all the ANSPs will deploy Sub-Regional DCB systems and enjoy its benefits at the same pace. There are different factors that can contribute to this assumption, some of them being reflected in the latest reports prepared by the Performance Review Body (PRB) of the Single European Sky [33]. Table 8 explains for both scenarios:

Factor affecting time to deploy	Main driver	ECAC area
Different baseline ATM assets	In general, ATM capabilities for states within the Eastern regions may have different needs to those within the North-West region. It can be expected that not all Eastern ANSPs find among their priorities to invest in Sub-Regional DCB systems	Important
Different incentives for different ANSPs	The main incentive for ANSPs to implement Sub-Regional DCB capabilities is driven by the operational needs of their airspace. Those ANSPs with little airspace complexity or low long term expected traffic growth rates might be reluctant to implement Sub-Regional DCB during the first waves.	Not a main driver for Eastern regions.
Cross-boundary coordination	RP2 Monitoring reports [33] show the deployment of some SESAR1 solutions has been progressing slowly until now partially due to complex cross-border coordination needs.	RP2 applies only to States falling under the Single Sky but cross-border coordination issues are expected in both areas
Financial availability	Another reason for delayed investment is investor's desire to position such service upgrades within the CEF funded projects. ANSPs out of the EU28 cannot benefit from this financial support.	Not applicable to ANSPs out of EU28.

Table 8: Reference Scenario – Time to deploy and reach FOC

Following expert judgment, the most-likely scenario would be to make assumptions based on the expected completion of the SESAR1 Implementation Objectives identified in Table 5. The CBA considers the information provided by:

- The 2018 edition of the European ATM Master Plan Level 3 – Implementation View for the year 2018 [25]. This is the most recent edition – published October 2018.
- PRB RP2 Annual Monitoring Report 2015 [33] concentrating on the progress of investments in Major ATM Changes during the year 2.

The latest PRB RP2 Annual Monitoring Report confirms good progress in Optimised Network Services with States investing in Major ATM Changes for 2015. Traffic complexity tools (FCM06) start being implemented. There is equally satisfactory progress in the implementation of NOP tools (FCM05).

NM is expected to be FOC by 2020 according to the Master Plan Level 3 [25]. The NM technical solution supporting STAM Phase 2 was planned to be delivered on the n-CONECT platform starting in 2017 and followed by a stepped operational deployment until 2019/2020.

The only area where implementation progress is not fully satisfactory is in short-term ATFCM measures implementation (FCM04.2). Delays of maximum one year are expected. The Master Plan Level 3 report confirms this view.

Table 9 summarises the main findings from both sources.

	Objective	PRB RP2 Annual Monitoring Report – CAPEX	Master Plan Level 3 Report
ATFCM	**FCMXX.X**	Romania, Sweden, Austria, France, Norway, Spain, UK	Generally, most of the ATFCM Implementation Objectives have little or no information available for Reporting Year 2015 so no comprehensive assessment of progress can be done. At this moment, there are no major issues to raise. The only Implementation Objective that is not progressing well is FCM01 – Implement STAM Phase 1 which is expected to be 1 year delayed. This delay is expected to be propagated for FCM04.2 STAM Phase 2.
NOP	**FCM05**	Romania, Slovenia, France, Netherlands, Finland	Although still in early phase, implementation is progressing satisfactorily. However, most States reported that this functionality will be delivered on time.
Free Route & AFUA	**AOMXX.X**	Italy, Romania, Slovenia, Netherlands, Norway, Finland	Free Route & AFUA are progressing as expected.

Table 9: Reference Scenario – Implementation Status of SESAR1 Solutions related to DCB – CAPEX and Master Plan Level

For a detailed list of States / ANSPs and their implementation progress, please refer to the European ATM Portal [24].

Taking into consideration that Short-Term ATFCM Measures are one of the most relevant tools for DCB, the CBA considers the most-likely scenario is that the deadline of end 2021 for SESAR1 solutions will not be met and there will be a delay in implementation of Sub-Regional DCB of one year at least.

For defining a timeline for deployment, the CBA proposes to use the **latest monitoring status communicated by States in the Master Plan Level 3 [25].** An ANSP will be considered as Sub-Regional DCB ready if it is implementing or has fully achieved the SESAR1 Implementing Objectives identified in Table 5. Table 10 shows the implementation status in Europe:

- 24 ANSPs today are already reporting a positive degree of implementation of SESAR1 Sub-Regional DCB related Solutions. Some of them are advanced in their implementing plans (Ongoing) or at least they have well-defined plans to deploy the capabilities (Planned). The Reference Scenario assumes they will continue with their implementation plans and improving the service individually.
- 12 ANSPs report that they have no plans to implement Sub-Regional DCB related solutions. The Reference Scenario assumes they will join a Sub-Regional DCB area in the medium-term although the predictions for 2021 are not very optimistic that they will have plans, but it could be due to lack of data.

- 6 States[6] within ECAC do not fall under the PCP regulation but the CBA assumes they will join a sub-region at some point.

Deployment Status	ANSPs status by 2018	ANSPs status by 2021
Completed	4	24
Ongoing	13	0
Planned	7	0
No plans	12	12
Not applicable	6	6
Total	42	42

Table 10: FCM04.2 expected deployment

Figure 3 shows the assumptions on the evolution of FCM04.2 implementation.

- The green bars show the cumulative number of ANSPs (completed and ongoing) ready each year.
- The orange bars show the projected cumulative number of ANSPs (having plans in 2018) ready each forecasted year.
- The light red bars show the projected number of ANSPs (with no plans) ready each year. The CBA assumes those ANSPs that have no plans today will not be able to meet the deadline set by the PCP regulation and will be all fully FOC only by 2026.
- The deep red bars show the projected number of ANSPs (in the not applicability region) ready each year. The CBA assumes those ANSPs that in the not applicability region today will be all fully FOC by 2030.

Yet Figure 3 below does not represent the final date when Sub-Regional DCB capabilities will be operational for consumers but the date when all pre-requisite SESAR1 solutions will be deployed. Some additional time is still necessary for developing a tool and procedures to coordinate at the Sub-Regional layer. This could be developed by ANSPs themselves or contracted to industry. Based on expert judgement, a maximum of 3 years would be needed to have a system running.

Therefore, for the no plan ANSPs, the FOC is assumed to be the PCP deadline +4 years (1 year delay, 3 years to develop the DCB tool). For the not applicable ANSPs, the FOC is assumed to be the no plan ANSPs deadline +4 years (again 1 year delay, 3 years to develop the DCB tool).

PCP deadline	Delay assumed	Time to develop a Sub-Regional DCB tool	Date of FOC for Sub-Regional DCB operations
By 1st January 2022	1 year	3 years	• 1st January 2022 (for the planned ANSPs) • 1st January 2026 (for the no plan ANSPs) • 1st January 2030 (for the not applicable ANSPs)

Table 11: Reference Scenario – Assumption on a date for FOC operations

[6] Armenia, Azerbaijan, Georgia, Luxembourg, Moldova, Turkey and Ukraine.

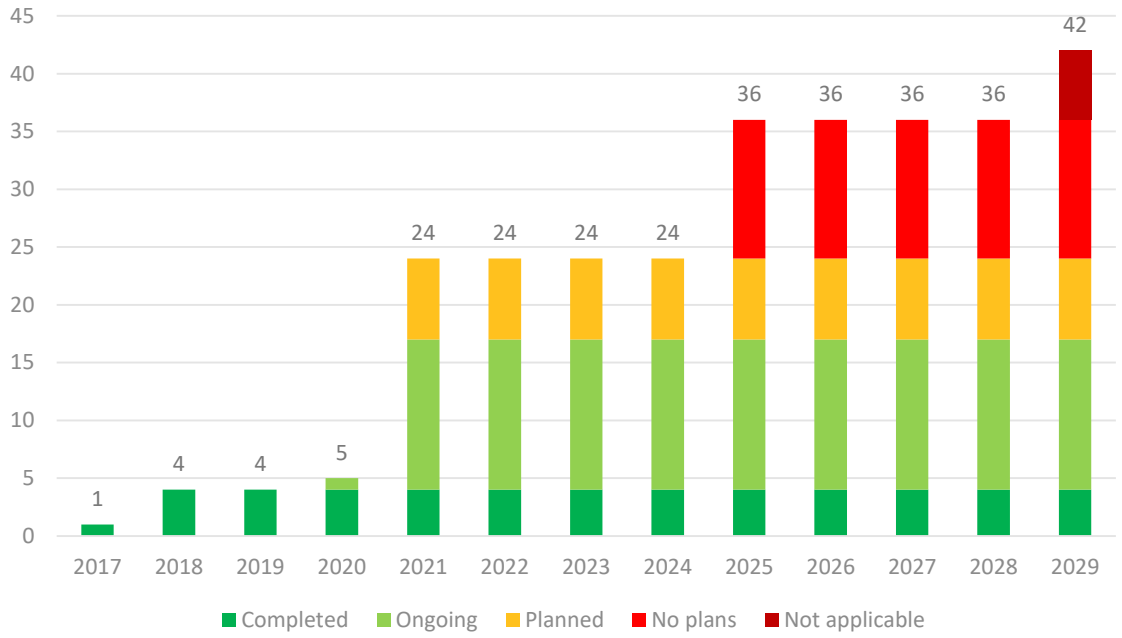

Figure 3: Reference scenario – Assumptions on the evolution of FCM04.2 implementation

3.5.1.5 Summary of Reference Scenario

Table 12 summarises the assumptions proposed for the Reference Scenario.

No.	Uncertainty	CBA Assumption proposed	Source
1	Sub-Regional DCB capability provision	Driven by FCM04.2 measures	Expert judgement as per 3.5.1.1
2	Number of ANSPs that have Sub-Regional DCB capabilities by 2040	42	Expert judgement as per 3.5.1.2 using ACE 2015 [27]
3	Number of Sub-Regions	11	Expert judgment as per 3.5.1.3
4	Start of deployment	1st January 2016	Appendix A using FCM04.2 implementation timeline
5	Time to deploy and reach IOC	1st January 2017	Appendix A using FCM04.2 implementation timeline
6	Time to deploy and reach FOC	1st January 2030	Expert judgement as per 3.5.1.4 using PCP Regulation [15]
7	Toolkits developed	11	Expert judgement

Table 12: Reference Scenario – Summary of assumptions

3.5.2 Solution Scenario

Following the SESAR2020 CBA template [18] the following points need to be clarified:

1. **Time-horizon of the CBA:**

The Solution Scenario considers the same time-horizon (2019-2040) as the Reference Scenario.

2. **Geographical scope:**

The Solution Scenario considers the same geographical scope (ECAC area) as the Reference Scenario.

3. **Discount rate**

Based on the SESAR2020 Common Assumptions [21], the CBA for PJ.15-01 will consider a discount rate of 8% for all stakeholders in calculating the preliminary NPV of this CBA for TRL6.

3.5.2.1 CBA Solution Scenario definition

This scenario assumes all ECAC members will collaborate into 9 Sub-Regions for DCB purposes. This is a conservative scenario assuming a "most-likely" degree of cooperation among adjacent ANSPs/States.

The main assumption is that under a COSER model, the number of Sub-Regions can be optimised. ANSPs can use one of the available standards toolsets that will be developed by the Common Service Provider. There is no need to develop one toolset per Sub-Region like in the Reference Scenario.

Figure 4 below helps to realise the cost-saving advantages offered by this scenario in comparison with the Reference Scenario:

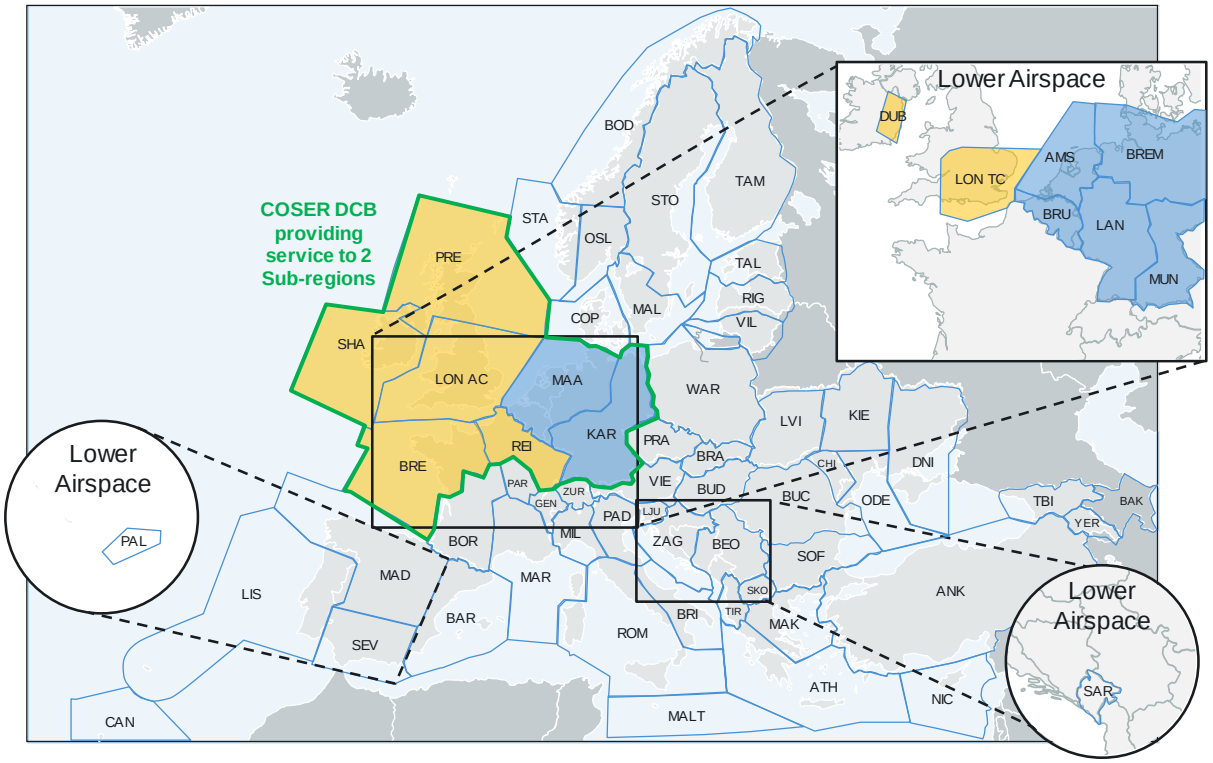

Figure 4: Solution scenario – Cooperation among Sub-regions

3.5.2.1.1 Optimisation of Sub-Regions

Collaboration among ANSPs is not anymore sub-optimal (11 Sub-Regions) like for the Reference Scenario. Sub-Regional DCB systems should diminish technical coordination issues and should be able to "talk to each other" easier if based on the COSER model and the number of Sub-Regions could be now streamlined according to operational practices. The assumption is that an optimal of 9 Sub-Regions would be created for DCB purposes.

3.5.2.1.2 Reduction of investments at the European level

The Cooperative Solution Scenario assumes that Industry Partners will develop Sub-Regional DCB toolkits for the different Sub-Regions. A round figure of 1 Toolkit developed per 2 Sub-Regions is established. So, for 9 Sub-Regions, the CBA considers 5 toolkits developed by different Industry Partners.

3.5.2.1.3 Deployment rate for Europe

In TRL2 and TRL4, Sub-Regional DCB COSER was agreed to bring a faster deployment rate for Europe. Based on expert judgement, it was established that those ANSPs less prone to implement Sub-Regional DCB or running late for SESAR1 Implementation Objectives could benefit from fully operational and tested Sub-Regional DCB systems under a COSER model in a reduced time-horizon that they would otherwise should they require investing and developing in their own capabilities. Their time to FOC could be considerably reduced. Following expert judgement, it was proposed that FOC would be 1st January 2024.

This would create additional benefits to the Solution Scenario "cooperative" versus the Reference Scenario. During the years where Sub-Regional DCB under a COSER model was already implemented, PJ.15-01 could deliver additional Performance Benefits in all KPAs/KPIs defined for SESAR2020. In other words, if an Industry Partner could commercialise a standard sub-regional DCB system that could be relatively easily bought and implemented in other ANSPs in ECAC, this would deliver extra years of additional Performance Benefits. Nevertheless, these potential performance benefits were never assessed in the previous TRL4 CBA, within the Business Model.

However, IOC and FOC have now been differently set on the eATM Portal [47] to:

- Start of deployment: 31st December 2023
- IOC: 31st December 2023
- FOC: 31st December 2029

Therefore, for consistency reasons, PJ.15-01 has decided to perform the CBA establishing the above-indicated dates for the Solution Scenario. This point reduces the potential benefits of moving towards a COSER model, so that it is a conservative approach.

In the same sense, to avoid the Reference Scenario to have performance benefits due to a shorter implementation period (in TRL2 and TRL4, it was assumed 2026 as the FOC year, instead of 2030), its FOC date has been matched to the Solution Scenario one, as described in section 3.5.1.4.

3.5.2.2 Summary of Solution Scenario

A summarised comparison of the Solution and Reference Scenarios is shown in the table below:

No.	Uncertainty	CBA Assumption proposed	Source
1	Sub-Regional DCB capability provision	Driven by FCM04.2 measures.	Expert judgement as per 3.5.1.1
2	Number of ANSPs that have Sub-Regional DCB capabilities by 2040	42	Expert judgement

3	Number of Sub-Regions	9	Expert judgment as per section 3.5.2.1.1
4	Start of deployment	31st Dec 2023	eATM Portal [47]
5	Time to deploy and reach IOC	31st Dec 2023	eATM Portal [47]
6	Time to deploy and reach FOC	31st Dec 2029	eATM Portal [47]
7	Toolkits developed	5	Expert judgement a per section 3.5.2.1.2

Table 13: Solution Scenario – Summary of assumptions

The number of toolkits developed is one of the parameters analysed within the sensitivity analysis as it mainly conditions the cost-efficiency benefit of the Solution Scenario.

3.5.3 Summary of differences between the Solution and the Reference Scenarios

Error! Reference source not found. compares the Reference and the Solution Scenario.

No.	Uncertainty		
		Reference Scenario	Solution Scenario
1	Sub-Regional DCB capability provision	Driven by FCM04.2 measures	
2	Number of ANSPs that have Sub-Regional DCB capabilities by 2040.	42 ANSPs	42 ANSPs
3	Number of Sub-Regions	11	9
4	Start of deployment	1st Jan 2016	1st Jan 2024
5	Time to reach IOC	1st Jan 2017	1st Jan 2024
6	Time to reach FOC	1st Jan 2030	1st Jan 2030
7	Toolkits developed	11	5

Table 14: Comparison Reference vs Solution

4 Benefits

The benefits of the Solution Scenarios compared to the Reference that are foreseen are the following:

1. Cost-efficiency due to lower investment and operating costs under a Common Service pattern.
2. Scale economies for those ANSPs wishing to have Sub-Regional DCB capabilities but not having the financial means to prioritise this over other projects.
3. Reduction of unnecessary Sub-Regional DCB toolkits development.

Mainly, the benefits in the CBA come from the improved cost-efficiency of the Solution Scenario in comparison with the Reference Scenario.

5 Cost assessment

PJ.15-01 performed the first cost assessment in TRL4 according to SESAR 2020 CBA methodology. For TRL6, this cost assessment has been reviewed and updated since the progress in the project has allowed performing a more accurate cost estimation.

This section provides a detailed cost categorisation following the main cost drivers identified along with the project and consolidated with the partners and stakeholders that could be consulted.

The SESAR 2020 CBA Template [18] recommends using *"only the differential (or delta) value implied by the Solution Scenario over the Reference one"*. This might be a useful approach for SESAR2020 projects contributing to Performance Areas different than Cost-Efficiency. However, PJ.15-01 would like to challenge the suitability of this method for Sub-Regional DCB Common Services. The cost assessment includes the absolute costs of the systems, which are relatively similar. This is due to the fact that there are only some specific capabilities that change from the legacy system to the one capable of working as a COSER. As a result, the overall results will not depend much on the system cost difference but on the detailed characterisation of the scenarios.

Table 3 showed that the major stakeholders when assessing the cost-efficiency KPA are the ANSPs, COSER provider/consumer and ACCs. These costs have been captured with the concept of DCB toolkit. In fact, if the cost of a DCB toolkit is known, **Error! Reference source not found.** can be easily translated into a cost-efficiency benefit. This has been the approach that has been followed during the CBA development and that is shown along this section.

5.1 DCB toolkit costs

Table 15 identifies the basic costs, identified per type, applying to ANSPs.

ANSP costs	Type of cost	Main costs
CAPEX	Pre-implementation costs:	• Software development • Operational procedures • Testing and validation activities • Safety case
	One-off costs:	• Project Management • Administrative costs • Certification • Installation/Commissioning (Infrastructure replacement activities) • Integration in specific ATS System (release planning) • Initial Training
	Capital implementation costs:	• Dedicated infrastructure (equipment, computer storage, network) • Physical connections • Logical/Operational connections • Software (Interfaces)

	Transition implementation costs:	• Operational and technical trials for entry into operation • Project management during trials • Human and material resources
OPEX	Maintenance costs:	• Yearly DCB toolkit equipment maintenance • Training
	Administration costs	• Communication costs • Energy, Supplies, Utilities, Property Taxes • Rent & Lease • Furniture & equipment

Table 15: ANSPs basic costs

5.1.1 DCB toolkit cost approach

During TRL6, the consortium has dedicated significant effort into obtaining information for a dedicated cost analysis and cost inputs evidence.

The CBA team has undergone through a process of consultation with partners following SESAR CBA methodology. The consultation process was performed through various discussions that allowed reviewing the cost structure and categorisation, in order to facilitate the work to find estimates figures or range of values. These figures were then aggregated to build total CAPEX and OPEX values.

The approach to evaluating the ANSP costs was to provide an Excel template to the ANSP stakeholders with the cost categorisation and a table to be filled, related to the Enabler of the solution. Since it is widely known that companies are reluctant to give a good degree of detail on numbers and specific costs, the table to be filled only contained the intermediate level of cost groups. Hence, the CBA is able to have estimates of pre-implementation, one-off, capital implementation, transition implementation, maintenance, and administration costs.

This is useful to check the order of magnitude of the values and one could eventually compare among the different categories and sub-categories in each group.

5.1.2 DCB toolkit cost assessment

After reviewing the stakeholders, it has been identified that costs are largely the same as for the reference scenario, but slightly more as training would be increased and also there would be a need to implement network connections to sub-regional actors and develop a client system suitable for deployment at sub-regional locations.

Maintenance costs are likely to be larger than the reference scenario to maintain and support all associated links across the network to third parties.

During TRL4 a first cost estimation was performed to obtain information for dedicated cost analyses or cost inputs evidence. AT TRL6, this cost estimation has been reviewed and improved. This work has allowed incorporating more accurate unit cost figures for the individual toolkits that need to be developed.

Scenario	Detailed unit costs						Overall costs	
	Pre-impl. (€)	One-off impl. (€)	Capital impl. (€)	Transition impl. (€)	Maintenance (€/year)	Administration (€/year)	**CAPEX (€/20years)**	**OPEX (€/year)**
Reference	100.000	3.000.000	2.900.000	500.000	100.000	20.000	**6.500.000**	**120.000**
Solution	100.000	3.500.000	3.000.000	700.000	150.000	20.000	**7.300.000**	**170.000**

Table 16: Detailed unit costs for the DCB toolkit without COSER capability (Reference scenario) and with COSER capability (Solution scenario)

Please note, the cost figures provided represent those costs associated with implementing and maintaining a full DCB solution, as would be required by an ANSP to deliver and operate the capability. Therefore, the information provided within this CBA includes the 3 services which have been developed and validated by the project, but also extends to cover other elements that are foreseen to be required as part of the capability.

Furthermore, it has been included in the model a renewal period for the infrastructure of 20 years. This period translates into expending the CAPEX every 20 years.

It is important to note that, since the DCB toolkit is a technological package, the estimation on the cost of developing and implementing it depends only slightly on the number of deployed toolkits and the same cost figure can be applied when analysing different number of deployed toolkits within the sensitivity analysis.

5.1.3 Number of investment instances (units)

Based on the scenarios explained in section 3.5, the number of instances is represented in the Table 17.

Scenario	Area	ANSPs	Instances (toolkits/systems)
Reference	ECAC	42	11
Solution	ECAC	42	5

Table 17: Number of investment instances – ANSPs

6 CBA Model

The CBA model has been built in Excel. This Excel file is a deliverable at TRL6. Therefore, the present document and the aforementioned Excel file complement each other and must be studied together in order to have a complete view of the work that has been undertaken.

As a summary, it must be highlighted that the only KPA that is monetised is Cost Efficiency. Therefore, the main inputs to the model are the solution and reference scenarios CAPEX and OPEX costs for the DCB toolkit, as indicated in section 5.1. In addition to this, implementation timelines for the solution and reference scenarios have been assumed (described in the sections below).

6.1 Summary of scenarios costs

Cost assessment results are summarised in the table below. This table builds the major input of the CBA model.

Solution Scenario	Overall scenario costs			Deployment period	
	Number of DCB toolkits	CAPEX	OPEX	IOC	FOC
Reference	11	6.500.000 (€/20years)	120.000 (€/year)	2017 (as for FCM04.2)	2030 (section 3.5.1.4)
Solution	5	7.300.000 (€/20years)	170.000 (€/year)	2024 [47]	2030 [47]

Table 18: Summary of overall costs for the PJ.15-01 CBA scenarios

In addition to the CAPEX and OPEX in the table above, an extra once-only conversion cost from Reference Scenario to Solution Scenario has been considered. This cost accounts for the decommissioning/adaptation of the already deployed Reference Scenario systems by the start of the deployment of the Solution Scenario. It has been estimated by multiplying the CAPEX of the already deployed DCB systems in the Reference Scenario by the end of 2023 (just before the start of the deployment of the Solution Scenario) for 17% (typical value for CNS systems [46]).

6.2 Reference scenario implementation timeline

Based on the current (end of 2018) situation, planned FCM04.2 deployment for 2021 and assumed 2025 and 2029 degree of implementation, an S curve has been used. This S curve is based on a Gaussian distribution that has been set to match (minimising the squared error) the next points:

Year	2017	2018	…	2021	…	2025	…	2029
ACCs	2	7	N/A	40	N/A	56	N/A	63
DCB toolkits	1	2	N/A	7	N/A	10	N/A	11
% Implementation	9%	18%	N/A	64%	N/A	91%	N/A	100%

Table 19: Reference scenario – Deployment expectation as per Appendix A

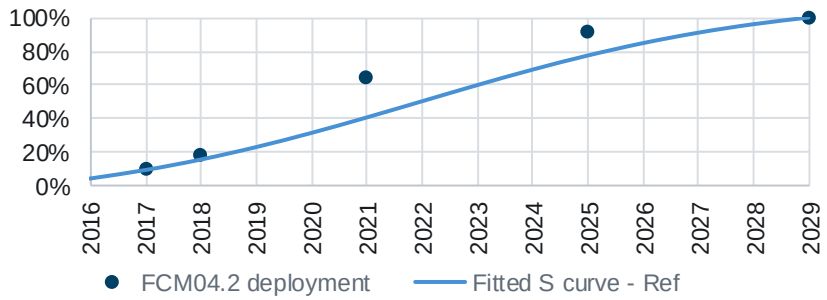

Figure 5: Reference scenario – Deployment curve

Thus, the curve allows extrapolating the implementation value (%) for all the deployment period in a more realistic and progressive way than using the values of Figure 3 (FOC-only based curve).

6.3 Solution scenario implementation timeline

Solution Scenario implementation curve has been calculated using the same Gaussian distribution (same standard deviation than in the Reference Scenario) but selecting a shorter deployment period to match the different FOC year.

First CAPEX applies in 2024, same year of the IOC of the Solution Scenario, as indicated in Reference [47], and last one in 2029, one year before the FOC of the Solution Scenario. Start of deployment and IOC dates are coincident. This is reflected in the CBA model in the following way: since the start of Solution Scenario deployment year is the first year that the Reference Scenario is not implemented, its cost is avoided, meaning the first benefit (cost-saving) of the Solution Scenario (IOC).

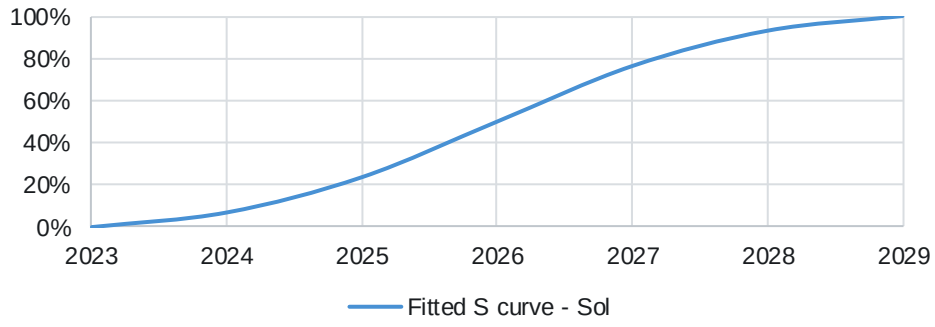

Figure 6: Solution Scenario – Deployment curve

6.4 Data sources

The data sources have been specified along with the document. All sources are listed in section 10.

Since the CBA only assesses the Cost Efficiency KPA, the main data source for the cost figures is the consultation of the stakeholders. This consultation resulted in the estimated values in section 5.1.

Regarding complementary parameters for the NPV calculation, the model takes into account an 8% discount rate [21] and a timeframe that goes from 2019 to 2040 [21]. The start of deployment year for the solution scenarios is assumed to be 2026 [47]. Nevertheless, the NPV calculation considers 2019 to 2040, being unity the discount factor in 2019 [47]. Finally, the payback year has been calculated using the discounted cumulative cash flow.

6.5 CBA Excel Model

SESAR PJ15-01
Sub-regional DCB C

7 CBA Results

The CBA results are provided in the present section CBA for TRL6. Results could be produced thanks to the cost assessment exercise after the stakeholders' consultation. The results presented are partial and cannot be conclusive. The CBA has been built gathering the following information:

- The Investments costs (pre-implementation and implementation costs) and Change in Operating Costs have been identified for the DCB toolkit, differentiating for the case or a COSER-capable one and a de-localised one.
- The impact of PJ.15-01 on the Operating Expenditures (OPEX) and on the Capital Implementation (CAPEX) are, thus, derived from the installation of the COSER-capable DCB toolkits, instead of the de-localised ones. This impact is difficult to assess and, therefore, has been considered in the Sensitivity Analysis.
- No other benefits, rather than Cost Efficiency, are provided since they cannot be demonstrated or validated.

Results of the defined Solution Scenario are described next, including cash flow analysis, NPV and payback year calculation.

7.1 Solution Scenario

Costs and benefits are presented in the table below:

- Implementation savings over the period 2019-2040 add a total of 17.5 M€, split between CAPEX saving (9.3 M€) and OPEX saving (8.2 M€). These savings are coming only from the Cost-Efficiency KPA.
- At the end of the time horizon, the overall net undiscounted savings are 17.5 M€ (5.7 M€ with an 8% discount rate).

	Concept	Value	Units
Solution scenario	**Number of ANSPs**	42	ANSPs
	Number of ACCs	63	APTs
	Number of DCB toolkits	5	Instances
Reference scenario	**Number of ANSPs**	42	ANSPs
	Number of ACCs	63	ACCs
	Number of DCB toolkits	11	Instances
Total savings and costs	**Total cumulated CAPEX saving (periodic CAPEX & conversion cost)**	9.3	M€
	Total cumulated OPEX saving	8.2	M€
Balance	**Total benefit**	**17.5**	**M€**
	Payback year	**2023**	**year**
	NPV	**5.7**	**M€**

Table 20 CBA inputs and results for the 2019-2040 timeframe

Figure 7 provides an overview of the ANSPs level of investment, expected benefits (cost savings) and cash flow evolution over the period 2020-2040:

- The ANSPs periodic CAPEX savings rise up to 14.2 M€ and are periodically spread over the period 2019 to 2040 every 20 years. The once-only conversion cost implies 4.9 M€ that reduces this CAPEX saving to 9.3M€. The corresponding OPEX savings increases according to the implementation of the toolkits.
- Once the implementation is finished, the OPEX saving is estimated at 0.4 M€/year, remaining constant until the end of the timeframe (2040).
- The conversion cost has been applied in 2023, thus, one year before the IOC of the Solution Scenario.
- The breakeven point is achieved in 2023, since conversion to the Solution Scenario is cheaper than the saving coming from avoiding the implementation of the Reference Scenario in 2023.
- The avoided cost per year follows is cyclic once the FOC is reached, since the renewal rate for the CAPEX saving is 20 years, whereas the OPEX saving remains constant.

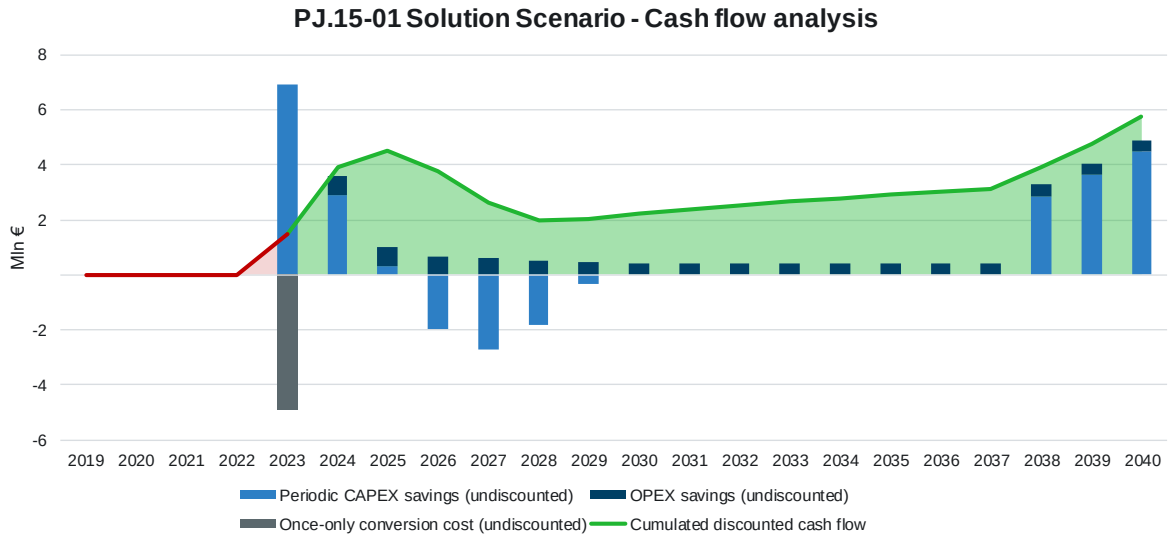

Figure 7: Cash flow analysis (2019-2040) for the Solution Scenario

Please, notice that the cash flow is kept red in the chart above till 2023, which is the year when it becomes constantly positive. In 2023 (one year before the IOC), the conversion cost is lower than the potential saving of avoiding the implementation of the Reference Scenario, so that the scenario becomes positive from the start of the solution deployment.

Finally, CAPEX savings appear again in 2038, relating to the renewal of the investment done for the Reference Scenario in 2017 (20 years of renewal time for the deployed systems). The implementation of the Reference Scenario in 2017 matches, as fully described in previous sections, with the FCM04.2.

8 Sensitivity and risk analysis

The following section provides an analysis of the impact of the main uncertainties identified when designing the PJ.15-01 CBA Model and calculating the final NPV.

These uncertainties come mainly from the internal cost estimation, based on stakeholder expert judgement, on cost savings and entry into service date of the Solution Scenario. The rest of the parameters of the CBA assessment have been gathered from external inputs that seem to be well established and reasonably reliable.

All the analysis presented in this section is "*ceteris paribus*" meaning changing one variable at the time and leaving the others constant.

8.1 Solution Scenario

8.1.1 Variables analysed and associated uncertainties

Table 21 shows the most sensitives variables regarding the uncertainty that every cost assessment or entry into operation estimation implies. Furthermore, the degree of cooperation across Europe is also captured by the study.

	Concept	Description	Decrement	Baseline	Increment
Cost estimation	**CAPEX**	Non-COSER DCB toolkit COSER DCB toolkit	-10%	See Table 18	+10%
	OPEX	Non-COSER DCB toolkit COSER DCB toolkit	-10%	See Table 18	+10%
	Exchange rate	Rate at which the CAPEX saving applies	-2 years	20	+2 years
Deployment	**IOC year**	Initial operational capability year	-2 years	2024	+2 years
	FOC year	Full operational capability year	-2 years	2030	+2 years
Degree of cooperation	**ACCs per sub-region in Reference Scenario**	Degree of cooperation in Reference Scenario (one DCB toolkit every X ACCs)	-1 ACC	6	+1 ACC
	DCB toolkits in Solution Scenario	Degree of cooperation in Solution Scenario	-1 toolkit	5	+1 toolkit

Table 21 Variable analysed in the sensitivity analysis for the Solution Scenario

8.1.2 Sensitivity and risk analysis

Figure 8 shows the results of the sensitivity analysis on the NPV value. The major conclusions, applicable for both, are highlighted below:

- The most sensitive variables are the ones capturing the degree of cooperation. Since the Cost-Efficiency is the only benefit of the Solution Scenario, the number of toolkits deployed in both Reference Scenario and Solution Scenario are mainly determining the NPV.
- Regarding the cost estimation, the CAPEX values have a greater effect on the CBA model than the OPEX values, highlighting that the main saving of the Solution Scenario would happen while deploying (and/or renewing the equipment).

- Finally, the IOC year shows also a significant negative impact when getting delayed. This is linked to the fact that the conversion costs would be higher in the model, as well as the cost saving would reduce (fewer implementation years of the Reference Scenario would be avoided). However, since the TRL2 and TRL4 IOC year was estimated at 2021 by the PJ.15-01 experts, it does not seem that the current TRL6 IOC year of 2024 could be delayed more (conservative value).

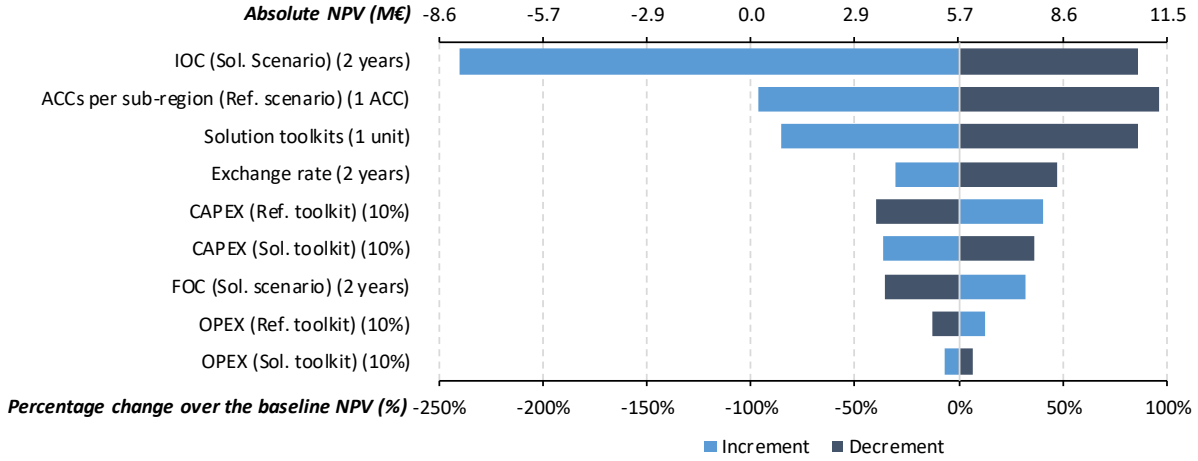

Figure 8: NPV sensitivity analysis for the Solution Scenario

Light blue bars show the effect of increasing the analysed parameters over their baseline value. Dark blue bars show the effect of decreasing the analysed parameters over their baseline value.

In addition, as seen in Figure 8, the NPV for 7 ACCs per sub-region is almost zero. If this value goes up to 8 ACCs, the business case would be negative. Nevertheless, during the consultation process of the stakeholders, it was highlighted that the baseline value of 6 ACCs per sub-region seems to be quite conservative. It could be expected that, due to geographical and political boundaries, the real value would be between 3 and 5 ACCs for the Reference Scenario, making the business case quite more positive. This effect is captured in the next table:

ACCs per sub-region in Reference Scenario	NPV (M€)	Total savings (M€)	Payback year
6	5.7	17.5	2023
5	11.2	29.4	2023
4	19.5	47.2	2023
3	33.2	77.0	2023

Table 22 Positive effect for the business case of the reduction in the ACCs per sub-region value for the Reference Scenario

9 Recommendations and next steps

The PJ.15-01 partners, representing the main stakeholders for the solution (ANSPs and industry), have made a considerable effort on the CBA assessment for the TRL6. The cost and benefit estimation has resulted in the production of the cash flow analyses, payback year estimation and NPV calculation for the Solution Scenario, ending up in the first version of the CBA document.

The progress done guarantees mature enough results for TRL6 version of the document. A further round of stakeholders review for the cost assessment would be advisable to keep updated the cost figures, if the project is to be continued in the future to further maturity levels.

In this sense, further discussion on the baseline value for the Reference Scenario of the number of ACCs per sub-region would be advisable, in order to avoid underestimating the potential savings of the Solution Scenario. The NPV is highly sensitive to the number of Sub-regions that can join efforts into the joint COSER implementation. Nevertheless, this joint implementation implies higher complexity at operational, organisational and political level, which could prevent this closer collaboration. In this sense, SESAR is considered a necessary initiative to foster this cooperation and unlock the potential benefits of the Common Service.

10 References and Applicable Documents

10.1 Applicable Documents

[1] SESAR PJ.15-01 D.15-01.VN.3 Business Model (TRL4) for Sub-Regional DCB Common Service, 00.02.03

[2] SESAR 08.01.03, AIRM Glossary, Ed. 00.07.00.

[3] Foundation Method on Common Services

[4] Working Method on Services (S2020 edition)

[5] SESAR 2020 Transition ConOps

[6] PAR for OFA06.03.01 Sub-regional DCB

[7] B04 05 Deliverable - Options of Common Services V01.00

[8] Business Model Generation: Alexander Osterwalder & Yves Pigneur, www.businesmodelgeneration.com

[9] ICAO Global Operating concept Doc 9854

[10] SESAR 2020 Multi Annual Work Programme

[11] SESAR 2020 Project Handbook

[12] SESAR 16.06.06-D26_04, Guidelines for Producing Benefit and Impact Mechanisms, Edition 03.00.01

[13] SESAR 16.06.06-D26_03, Methods to Assess Costs and Monetise Benefits for CBAs, Edition 00.02.02

[14] SESAR 2020 Multi Annual Work Programme, edition TRL2.0, 08/07/2015

[15] EU IR 716/2014: Pilot Common Project

[16] SESAR1 B04.02 – Update and maintenance of the development of the Concept of Operations (CONOPS) and associated ATM Services

[17] SESAR1 WP07 Global Co-ordination and Management and SESAR1 WP13 Enhanced DCB

10.2 Reference Documents

EUROCONTROL: Challenges of Growth 2013, Task 4: European Air Traffic in 2035

[19] EUROCONTROL – Standard Inputs for EUROCONTROL Cost-Benefit Analyses, Ed. 8.0, 2018

[20] SESAR2020 CBA Template for EN projects

[21]SESAR 2020 Common assumptions, Edition 01.00.00 (17 May 2018)

[22]SESAR2020 Project Handbook

[23]SESAR B.04.05-D02, Options on Common Services, Edition 00.01.00

[24]eATM Portal – Working view. OBJ FCM04.2 – Short Term ATFCM Measures (STAM) – phase 2. Accessed on 16-04-2019 via: https://www.eatmportal.eu/working/depl/essip_objectives/1000103

[25] European ATM Master Plan Level 3 – Implementation View. Report 2018. Updated version of July 2018.

[26]PJ.15-01 COST BENEFIT ANALYSIS (CBA) for Sub-Regional DCB Common Service, D103, SESAR 1 Project 16.6.2

[27]ATM Cost-Effectiveness (ACE) 2015 Benchmarking Report with 2016-2020 outlook. Accessed on 15-08-2017 via: http://www.eurocontrol.int/press-releases/eurocontrol-issues-its-latest-atm-cost-effectiveness

[28]ATM Cost-Effectiveness (ACE) 2016 Benchmarking Report with 2017-2021 outlook. Accessed on 21-12-2018 via: http://www.eurocontrol.int/press-releases/eurocontrol-issues-its-latest-atm-cost-effectiveness

[29]EUROCONTROL: Seven-year forecast February 2017, Flight Movements and Service Units 2017-2023.

[30]SESAR1 B.04.05 - T3 Service Identification

[31]PRR 2016 – Performance Review Report – Draft Final Report for consultation with stakeholders (17 March – 07 April 2017).

[32]PRR 2017 – Performance Review Report.

[33]PRB RP2 Annual Monitoring Report 2015. Volume 3 – CAPEX. Version 2.2 from 20/12/2016. Accessed on 11/04/2017 via: https://ec.europa.eu/transport/sites/transport/files/prb_annual_monitoring_report_2015_vol_3_capital_expenditures.pdf

[34]EATMA, European ATM Architecture baseline 10.0 applicable to this document.

[35]PJ.15-01 Sub-Regional Imbalance Data Service Description Document TRL-4, ID D2.1.00

[36]PJ.15-01 Post Operations Indicators Service Description Document TRL-4, ID D2.1.090

[37]*P13.2.3 - Update of* Enhanced DCB SPR for Step 1 - Final (SPR) D323

[38]*P13.2.3* - Enhanced DCB Safety and Performance Requirements for Step 1 - Final (SPR) Annex 1 - Safety Assessment Report

[39]SESAR 2020 Security Assessment Report (Low Risk Material) PJ15-01 Part A

[40]SESAR 2020 Security Assessment Report (Medium Risk Material) PJ15-01 Part B

[41]PJ.15-01 Hotspot Definition and Proposed Solution Service Description Document TRL-4, ID D.2.1.010

[42]ICAO Service Delivery Management (ATM SDM), Circular 335

[43]Validation Targets (2018) Edition 01.00.00

[44]07.02 Step 2 Release 4 Detailed Operational Description (DOD)

[45]PJ.15-01 COST BENEFIT ANALYSIS (CBA) for Sub-Regional DCB Common Service

[46]SESAR, PJ.15-01 COST BENEFIT ANALYSIS (CBA) for Sub-Regional DCB Common Service

[47]eATM Portal: Research & Deployment view (Dataset 20 Draft, EATMA V13.0 Draft, MP L3 Plan 2018). Accessed on 18/06/2019: https://www.eatmportal.eu/working/data/sesar_solutions/15877135

[48]SESAR Stellar – Boards – Cost Benefit Analysis – Start year discussion (Marco Gibellini, 3rd April). Accessed on 19-06-2019: https://stellar.sesarju.eu/

Appendix A LSSIP 2018. Implementation view for FCM04.2

The most updated information regarding deployment status of SESAR1 Solutions as reported by Member States for Master Plan Level 3 is available via the European ATM Portal. It contains the latest edition of the LSSIP (2018) showing the overall progress reported by Member States. It is updated up to Dataset DS19.

A.1 FCM04.2 Short Term ATFCM Measures (STAM) – Phase 2

MS	Overall Progress	L1 Comments	L1 Implementation date	L1 % completed	Number of ACCs
AL	Not yet planned	There is no plan so far for this objective.	-	0%	1
AM	Not Applicable	Armenia is not in the applicability area of the objective and there are not many ATFCM regulations in Armenia.	-	0%	1
AT	Ongoing	Initial activity started as part of FAB CE DAM/STAM Project (ex. P3), kicked off in 2017. It is likely that STAM phase 2 will be implemented with the availability of this function in the n-CONECT Tool, planned for implementation end of 2021.	31/12/2021	10%	1
AZ	Not Applicable	The capacity exceeds the air traffic demand, so the objective not yet planned. The objective will be reviewed in the future when circumstances change.	-	0%	-
BE	Ongoing	Ref to ASP comments	31/03/2020	30%	1
BA	Ongoing	Initial actions have started as part of FAB CE DAM/STAM Project (ex. P3). It is likely that STAM phase 2 will be implemented with the availability of this function in the N-connect Tool, planned for implementation end of 2021.	31/12/2021	53%	-
BG	Planned	There is a common EU policy for STAM - Phase 2 that BG is a part of.	31/12/2021	0%	1
HR	Ongoing	Initial actions have started as part of FAB CE DAM/STAM Project (ex. P3). It is likely that STAM phase 2 will be implemented with the availability of this function in the N-connect Tool, (NM STAM Tool) planned for implementation 2019+. A plan for implementation (own development or NM Tool) will be made in 2019, with possible development within COOPANS alliance. STAM Phase 2 processes will be tested between CCL and ACG in summer 2019 within the SESAR PJ24 activities.	31/12/2021	3%	1
CY	Planned	The Nicosia ACC-FMP shall assess the obligations and applicability of this objective. The FMP function will pursue the objective in coordination with NM	31/12/2021	0%	1

CZ	Ongoing	Initial actions have started as part of FAB CE DAM/STAM Project (ex. P3). It is likely that STAM phase 2 will be implemented with the availability of this function in the N-connect Tool, planned for implementation end of 2019.	31/12/2019	5%	1
DK	Planned	-	31/12/2021	0%	1
EE	Planned	EANS plans to introduce Short Term ATFCM Measures.	31/12/2021	0%	1
FI	Ongoing	Planning started, for Finland STAM 1 or 2 has not been a requirement before year 2016, though many of STAM 1 functionalities are operational and will form a basis for STAM 2.	31/12/2021	10%	1
FR	Ongoing	DSNA has launched a program named SALTO to cover the need of local tool.	31/12/2021	28%	5
GE	Not Applicable	Not applicable	-	0%	1
DE	Planned	The implementation of Short Term ATFCM Measures (STAM) - phase 2 is planned to be finished within the timeframe of the objective.	31/12/2021	0%	3
GR	Planned	Actions in progress for the implementation of the objective.	31/12/2021	0%	1
HU	Not yet planned	HungaroControl has general intention to implement this objective by 12/2021 but there has not been defined project management and implementation plan for this objective with assigned financial and human resources yet. At FAB CE level Initial actions have started as part of FAB CE DAM/STAM Project (ex. P3). It is likely that STAM phase 2 will be implemented with the availability of this function in the N-connect Tool.	-	0%	1
IE	Not yet planned	This is a new objective that has not been considered by the IAA. Currently, IAA and NATS (as FAB partners) agree manually applied STAMs as required. Automation of this process in consultation with NM (centrally through the IRL/UK FAB AMC) will be examined in in consultation between the FAB partners and the NM, utilising B2B functionality.	-	0%	2
IT	Ongoing	ENAV is developing a local system	31/12/2021	5%	4
LV	Not yet planned	Currently there is no practical necessity in Latvia to implement STAM.	-	0%	1
LT	Completed	STAM procedures will be implemented together with Poland (FAB partner) to improve cooperation between adjacent countries and increase operational capacity.	31/10/2018	100%	1

LU	Not Applicable	All ATFCM measures for Luxembourg are implemented by the FMP position of Belgocontrol for the entire FIR Brussels in accordance with the established agreements. Therefore, Luxembourg is not involved in the implementation of this objective.	-	0%	-
MAS	Completed	In 2017, MUAC successfully validated the Targeted-CASA and the Regulation Proposal service via B2B with the Network Manager. MUAC also validated the publishing via B2B of the sector configurations and the capacity values. The Regulation Proposal service and the publishing of sector configurations and capacity values were successfully implemented in 2018. For 2019, validation and implementation of further B2B functionalities (Regulation Exclusion and Force CTOT) with NM is planned.	31/12/2018	100%	1
MT	Not yet planned	There is no plan yet to this objective	-	0%	1
MD	Not Applicable	No operational need due to low traffic demand.	-	0%	1
ME	Not yet planned	Currently only tentative planes exist regarding this objective.	-	0%	-
NL	Not yet planned	In 2017 LVNL started activities on the further development of capacity management. These will continue in the years to come and will also focus on STAM procedures. In 2018 LVNL will work on the what-if function of our Workload Model. This will provide an upgrade in the local systems for STAM procedures. Project for STAM procedures are not defined yet.	-	0%	1
MK	Ongoing	Currently there is no operational need for STAM P2. However, the new system will have the capability to support STAM P2. The new system is planned to be operational 31/12/2021	31/12/2021	5%	1
NO	Not yet planned	Avinor Flysikring AS has not yet made any plans for implementing STAM2. If an upgrade of our ATM system is needed, that will be postponed until our new ATM system is operational. Avinor ANS has no intention of developing local solutions related to the STAM2 functionality.	-	0%	3

PL	Ongoing	PANSA implemented re-sectorisation of airspace in 2017, FMP development – pre-tactical and tactical support to ATFM managed by Senior Controllers and Traffic Managers of ACC, generation of ACC Slot improvement and Slot Exclusions possibility, Re-sectorisation of airspace, additional layer planned in 2019.	31/12/2021	92%	1
PT	Ongoing	NAV Portugal already use STAM phase1 procedures. The remaining procedures, to reduce the traffic complexity for ATC referred at STAM CONOPS, will be developed in order to comply with Pilot Common Project Regulation (EU) No 716/2014.	31/12/2021	3%	2
RO	Not yet planned	ROMATSA has not yet defined a project management/implementation plan for this objective.	-	0%	1
RS	Not yet planned	Currently only tentative plans exist regarding this objective.	-	0%	1
SK	Ongoing	Initial actions have started as part of FAB CE DAM/STAM Project (ex. P3). STAM Phase 2 will be implemented with the availability of this function in the N-connect Tool.	31/12/2021	3%	1
SI	Planned	Initial actions have started as part of FAB CE DAM/STAM Project (ex. P3). It is likely that STAM phase 2 will be implemented with the availability of this function in the N-connect Tool, planned for implementation end of 2021.	31/12/2021	0%	1
ES	Ongoing	STAM phase 2 requires the upgrade of supporting tools for FMPs in cooperation with NM.	31/12/2021	5%	5
SE	Not yet planned	No plan yet.	-	0%	2
CH	Completed	STAM - phase 2 are being implemented between Geneva and Zürich ACCs	30/06/2017	100%	2
TR	Not yet planned	Not yet planned.	-	0%	2
UA	Not Applicable	Ukraine is outside the Applicability Area.	-	0%	4
UK	Completed	-	30/12/2018	100%	3

Table 23: FCM04.2 Short Term ATFCM Measures (STAM) – Phase 2 implementation status

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