# PJ.15-02 COST BENEFIT ANALYSIS (CBA) FOR E-AMAN Common Service



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## Copyright Statement

# COSER

COMMON SERVICES

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## Abstract

The present document is the first *Cost Benefit Analysis (TRL6)* document to be delivered, as part of the *TRL6 Data Pack D3.2–* under the task *T.3.110 Development of Analysis of Costs (CBA)* for Work Package WP3 "E-AMAN"[1] of PJ.15. The CBA aims to capture and reflect the expectations from the stakeholders regarding the provision of an E-AMAN 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 D.3.1.060 Business Model (TRL4) [1] where substantial CBA 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.

[1] By request of SJU, the name of the solution was changed from ''Delay Sharing'' to ''E-AMAN''

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# 1 Executive Summary

The E-AMAN Common Service[2] provides capabilities necessary to operate Arrival Management with an extended horizon. PJ.15-02 will describe 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 Delay Sharing / E-AMAN Common Service Common Service in TRL6 for PJ.15-02.

Scenarios for the E-AMAN Common Service have been developed in the TRL2 and TRL4 Business Model and two of them kept in the TRL6 CBA[3], which are:

## Colocation of E-AMAN

*The capability provided by the Common Service here is the provision of a consolidated technical E-AMAN capability on a local (ANSP) level. The output of the Common Service is delivered to the end-users (e.g. adjacent ACCs / UACs) by the consolidated capability itself. No relocation or distribution of functions between stakeholders is performed, relocation and redistribution of functions is performed only at an ANSP scale (see Chapter 3.5.1).*

## Federation of E-AMAN

*The capability provided by the Common Service here is the capability of harmonising the output of local E-AMAN technical capabilities on different geographic or organisational levels (ECAC, FAB), however any other scaling could be considered in principle. The output of the Common Service is delivered to the end-users (e.g. adjacent ACCs / UACs). By this, relocation of functions between stakeholders is performed (see Chapter 3.5.2).*

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

The business case for Extended AMAN common services is based purely on cost reduction. In particular, the Pilot Common Project (PCP [2]) mandates E-AMAN deployment in 25 major European airfields (Including Istanbul). The expectation is for a SWIM based solution. A small number of ANSPs have deployed AMAN systems and there have been a number of E-AMAN enhancements.

Assuming that few competing providers are available within Europe, provision of E-AMAN, based on a SWIM foundation, deploying a common service results in:

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[2] Also referred to as „Delay Sharing Common Service“. The „Delay Sharing“ is an advanced concept of E-AMAN which is not mature enough to be currently considered in PJ15-02

[3] A third scenario “Generic E-AMAN” was discarded in TRL-4 because due to complexity the feasibility to be implemented was not seen.

- The requirement to deploy fewer (as opposed to 25) engineered capabilities - ANSPs will only bear a cost consistent with the services they receive.
- Service improvement roadmap across Europe is consistent and the associated costs are spread across common service ANSP consumers.

Consequently, the cost benefit relates to:

- Lower number of system deployments.
- Lower number of technical systems to be securely maintained in operation.
- Synchronisation of the evolutionary roadmap enabling consistency of concept.

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, a quicker implementation of E-AMAN capabilities could be envisaged. Further, more ANSPs will be triggered to implement Extended Arrival Management. Both have a secondary effect on other SESAR KPIs than cost reduction.

Resulting in a fewer number of endpoints for accessing E-AMAN information by the deployment of E-AMAN Common Services, the number of Point-To-Point connections between stakeholders is reduced. By this, deployment of the capability can be significantly accelerated, as efforts for establishing, testing and maintenance of the connections are significantly reduced[4].

The present document includes the results of the CBA activities performed in TRL6, complemented with new aspects.

The theoretical geographical scope of ECAC wide coverage of any of the three E-AMAN Common Service scenarios is not seen as feasible and was removed.

[4] Benefit reassessed in TRL4 activities and the effect is judged considerably higher than judged in TRL2

# 2 Introduction

## 2.1 Purpose of the document

This chapter presents the TRL6 CBA for Solution PJ15-02. The analysis has concentrated in updating where possible the CBA presented in TRL4 [4] and it follows the structure proposed in the SESAR2020 CBA Template for enabling projects as a guideline [10].

For TRL6, the costs and benefits of the Solution have been refined and monetised for each impacted stakeholder.

## 2.2 Scope

The E-AMAN Common Service provides functions necessary to operate Arrival Management with an extended horizon in an environment where multiple actors are involved e.g. multiple Airports, AMANs, ACCs, UACs and other interested parties, e.g. NM (i.e. Cross Boarder Arrival Management).

The level of capability considered here is matching basic E-AMAN requirements (excl. concepts of CTA, TTO, ETA min/max, EPP, coupled AMAN/DMAN). The mentioned advanced concepts are not validated up to a level of sufficient maturity to be used in the context of Extended Arrival Management [5].

These basic E-AMAN functions are:

- Arrival Sequencing / Planning
- Arrival Management Information Distribution to all involved actors

This Service will have to provide the E-AMAN information for different consumers and purposes and will output local Arrival Planning results (e.g. total delay) aggregated to serve different purposes of the involved actors (e.g. queue management). These will be used in the planning/tactical phase (e.g. departure delay) and in real-time/operations (e.g. delay and/or speed advisories).

The E-AMAN Common Service provides the “technical” capability necessary to operate Extended Arrival Management.

## 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 PJ19 and SESAR1 Solution #05.

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 Background

The E-AMAN Common Service was identified, described and processed in SESAR 1 B.04.05 as a pilot for Common Services [6] and [7]. It was revised and re-evaluated in SESAR 2020 PJ15-02 with a changed focus on scenarios deployment opportunities, which are envisaged as most beneficial to the partners contributing to the solution.

PJ15-02 uses the method described in SESAR B4.5 for processing of Common Services [6].

## 2.6 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 |

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|---|---|---|
| **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.<br>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.<br>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.<br>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.<br>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 |

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|---|---|---|
| **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**

## 2.7 List of Acronyms

| Term | Definition |
|---|---|
| **ACC** | Area Control Centre |
| **ANS** | Air Navigation Service |
| **ANSP** | Air Navigation Service Provider |
| **AMAN** | Arrival Manager (Controller Support Tool) |
| **ATC** | Air Traffic Control |
| **ATCO** | Air Traffic Control Officer |
| **ATM** | Air Traffic Management |
| **ATS** | Air Traffic Services |
| **ATSU** | Air Traffic Service Unit |
| **CBA** | Cost Benefit Analysis |
| **COP** | Coordination Point |
| **E-AMAN** | Arrival Management with Extended Horizon |
| **EATM** | European Air Traffic Management |
| **EATMA** | European ATM Architecture |
| **E-ATMS** | European Air Traffic Management System |
| **ECAC** | European Civil Aviation Conference |

| | |
|---|---|
| **EFTA** | European Free Trade Association |
| **EN** | Enabler |
| **EU** | European Union |
| **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 |
| **N/A** | Not Applicable |
| **NPV** | Net Present Value |
| **OSED** | Operational Service Environment Description |
| **OI** | Operational Improvements |
| **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. |
| **STA** | Scheduled Time of Arrival / Requested Time by E-AMAN |
| **STO** | Scheduled Time Over (a point) / Requested Time by E-AMAN |

| | |
|---|---|
| **TMA** | Terminal Manoeuvring Area |
| **TRL** | Technology Readiness Level |
| **TWR** | Tower |
| **UAC** | Upper Area Control Centre |
| **WP** | Work Package |
| **XMAN** | Cross-border AMAN |

**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 E-AMAN Common Service provides capabilities necessary to operate Arrival Management with an extended horizon. PJ.15-02 will describe ways of improved overall Cost Efficiency for delivering the necessary capability as a Common Service to the stakeholders involved.

Two OI have been created for this SESAR solution. They reflect the fact that this solution is only aiming at improving cost efficiency. *(Text taken from EATMA)*

### 3.2.1 SDM-0402 Delay Sharing 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 Delay Sharing common Service will have to provide the E-AMAN information for different consumers and purposes and will output local Arrival Planning results (e.g. total delay) aggregated to serve different purposes of the involved actors (e.g. queue management). These will be used in the planning/tactical phase (e.g. departure delay) and in real-time/operations (e.g. delay and/or speed advisories).*

*The Delay Sharing Common Service provides the "technical" capability necessary to operate Extended Arrival Management. These functions are:*

- *Arrival Sequencing / Planning.*
- *Arrival Management Information Distribution to all involved actors.*
- *The area of implementation is very wide, ranging from local ATSUs to groups of States and/or FABs.*

### 3.2.2 SVC-004 Provision of cost-efficient E-AMAN capabilities using a Common Service

*Ground systems evolve to provide "SWIM enabled" Arrival Sequence Information using common interfaces in support of cost-efficient E-AMAN capabilities.*

### 3.2.3 Related OI Steps

The Capability which is in scope of the E-AMAN Common Service is mainly described by the following OI Step 0305-A. *(Text taken from EATMA)*

#### 3.2.3.1 TS-0305-A – Arrival Management Extended to En-Route Airspace – single TMA

*The system integrates information from arrival management systems operating out to an extended distance (beyond the typical Step 0 E-TMA horizon into En-Route) to provide an enhanced and more consistent arrival sequence. The system helps to reduce holding by absorbing some of the queuing time further upstream well into En-Route. It includes integration of traffic departing from within the AMAN horizon of the destination airport. In Step 1, the "newly" impacted En-Route sectors are expected to contribute to the sequencing towards a single TMA.*

*In Step 1, the AMAN horizon is extended to the En-Route airspace further from the TMA and may extend across several En-Route sectors, potentially including across borders, requiring an increased degree of cross-border cooperation and support from "distant" ATM actors to resolve problems for an airport far outside their normal sphere of operations.*

*By further extending the Capability provided by the Service, the following OIs might be supported by the Common Service as well (not in scope of this document).*

## 3.3 Objectives of the CBA

Following the SESAR2020 Project Handbook [17], 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 group.
- A 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[5] identification

Table 3 identifies the stakeholder categories that are affected by implementing, operating and benefitting from the PJ.15-02 Solution.

| Scenario | Stakeholders considered | The type of stakeholder and/or applicable sub-OE | Type of impact | Involvement in the analysis | Quantitative results available in the current CBA version |
|---|---|---|---|---|---|
| Colocation of E-AMAN on a local level | E-AMAN hosting ANSP | High density TMAs | Invest in collocated E-AMAN | Yes | Yes |
| | Receiver of E-AMAN Service Data | Primarily associated en-route sectors but also e.g. Tower ATC | small investment to support AMAN requests | | |
| Federation of E-AMAN | E-AMAN hosting ANSP | High density TMAs | Minimal development of current 'in service' E-AMAN systems | Yes | |
| | Common Service Provider | Service Provider | Transformation of old format data into new standard | No | |
| | Receiver of E-AMAN Service Data | Primarily associated en-route sectors but also e.g. Tower ATC | Minimum investment to support AMAN requests | Yes | |

**Table 3: SESAR Solution PJ.15-02 CBA Stakeholders and impacts**

## 3.5 CBA Scenarios and Assumptions

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

### 3.5.1 Reference Scenario

In this scenario an ANSP acts as consumer who decides to use the Common Service from a third-party stakeholder to deliver the Arrival Management functionalities in an extended horizon.

[5] 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.

The provision of this E-AMAN would be limited to the purely technical capabilities, including the generation and update of the arrival management information for one or several airports, and its distribution to the consumers. Consequently, the consuming ANSP is still the responsible of the sequence from the operational perspective, and can manually refine the arrival sequence and approves its distribution to other users, e.g. the upstream En-Route Air Traffic Service Units (ATSUs) who need this information to know the delay apportioned to the sectors under their control.

With regard to the input information necessary for calculating the arrival sequence, several options could be considered:

- The Common Service provider could receive all the inputs from the consuming ANSP (who would in this case act as a “broker” and forward all the relevant information).
- The Common Service provider receiving all the inputs directly from the respective original sources. The provider needs to obtain airspace and meteorological information from regional authorities; planning and tactical flight information from the concerning ANSPs; and departure planning information from the destination airport.

The different options will be further explored within the Use Cases described in the next sections.

The provider could be either an existing European ATM stakeholder or a completely new actor. The provider will have the infrastructure facilities and related SWIM capabilities for the service provision. These core interfaces provide the capability to deliver E-AMAN Common Service anywhere in Europe (PCP mandates such provision in 24 specific European airfields). Once the E-AMAN service is provided to a single customer the actual cost of adding further airport services is significantly less.

In this scenario it is understood that the consumer does no longer need to deploy its own solution, (although an own system could be considered as a backup for contingency purposes). The maintenance and update of the proprietary systems are obviously not required as well. Therefore, the key strategic benefit is the cost reduction in operation and in implementing an E-AMAN evolution roadmap.

In order to encourage an extensive use across the European ATM landscape, it is expected that the E-AMAN Common Service will be following SWIM specifications, by relying on applicable SWIM Technical Infrastructure to support the exchange of messages using the associated service and information reference models. A fundamental prerequisite for this scenario is the definition and implementation of standard based interfaces, on both, the provider and the consumer sides, so the provision of the Common Service can be seen as a “plug-and-play” service. In this sense, it is expected that the ATM industry will progressively move to a SWIM based infrastructure, making it acceptable for consumers to invest in new SWIM capability.

The business relationship will be formalised by means of a service contract between the provider and the consumer.

Each Airspace User will wish receive the output from the E-AMAN information service from all of the airports they fly to, implying that a hand full of cooperative providers (other providers can also consume E-AMAN information) will be able to meet the tactical AMAN related information needs for the whole European airspace, conceptually reducing the overall cost of ATM.

#### 3.5.1.1 CBA reference scenario definition

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 PJ15-02.

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*" [13] . So the Reference Scenario will consider that consumers (ANSPs) will have to undertake (develop) the capability (E-AMAN) by themselves.

Without PJ15-02 E-AMAN being deployed as a Common Service but by consumers themselves, the CBA has identified mainly four uncertainties for the definition of the Reference Scenario:

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

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

#### 3.5.1.2 E-AMAN capability provision

To take a pragmatic approach and circumvent this limitation, the PJ15-02 CBA considers that without implementation of E-AMAN under a Common Service (PJ15-02), consumers would use the E-AMAN solutions that are already available today by SESAR1 or would be developed by SESAR2020 in the coming years.

Table 4 below shows the possible SESAR Solutions that include at least some elements of AMAN.

| SESARJU Programme | SESAR Solution | Decision |
|---|---|---|
| SESAR1 | • #05 – Extended Arrival Management (AMAN) Horizon | Considered |
| SESAR2020 | • PJ.01 EAD – Enhanced Arrivals and Departures<br>• PJ.04 TAM – Total Airport Management<br>• PJ.25 XSTREAM – Cross Border SESAR Trials for Enhanced Arrival Management | Disregarded |

**Table 4: Reference Scenario – SESAR1 and SESAR2020 Solutions evaluated**

Based on expert judgement, the three SESAR2020 solutions in Table 4 have been disregarded for consideration in the Reference Scenario. It is still too early to make reasonable projections on the evolution of such solutions. Additionally they are only partially related to E-AMAN operations.

Contrary, the SESAR1 Solution #05 – Extended Arrival Management (AMAN) Horizon is considered a good alternative for those ANSPs that would like to have Extended AMAN capabilities without using the Common Service Business Model.

Consequently, the Reference Scenario for the PJ15-02 CBA will consider that ANSPs would adopt SESAR1 #05 Solution when providing the E-AMAN capability.

Once it has been explained SESAR1 Solution #05 would be adopted under the Reference Scenario, the analysis of the SESAR Implementation Objectives associated to it help to make projections on the future expected evolution of the Reference Scenario. The logic is described in Figure 1 below:

- SESAR1 Solution #05 – Extended Arrival Management (AMAN) Horizon addresses a series of Operational Improvement Steps.
- The OIs are implemented when a series of Implementation Objectives are fulfilled.
- SESAR2020 Solution PJ.15-02 (Enabler) being deployed would implement the same Implementation Objectives.
- The PCP Regulation defines a roadmap and binds those States in the applicability area to achieve those Implementation Objectives. The PCP requirements can be considered as a good approximation of the evolution of the Reference Scenario.

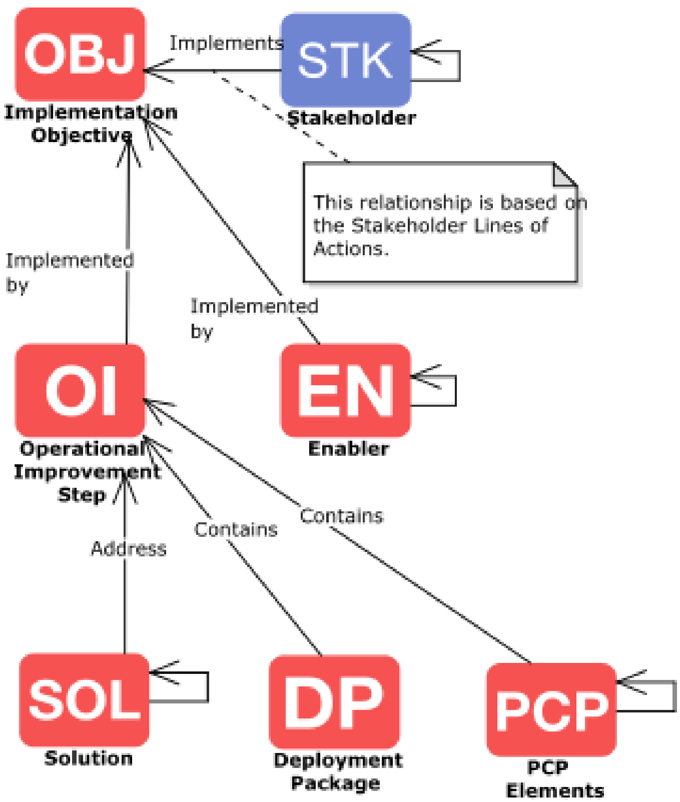


**Figure 1: Reference Scenario – Linking Enablers with Implementation Objectives**

Two Implementation Objectives dealing with AMAN were defined in SESAR1, namely those in Table 5 below.

| Implementation Objective | SESAR Solution | OI Step | PCP element |
|---|---|---|---|
| **ATC15.1:** Implement, in en-route operations, information exchange mechanism, tools and procedures in support of basic AMAN | - | **TS-0305** — Arrival Management Extended to En-Route Airspace | No |

| | | | |
|---|---|---|---|
| **ATC15.2:** Arrival Management extended to en-route Airspace[6] | **SESAR1 #05** – Extended Arrival Management (AMAN) horizon | **TS-0305-A** — Arrival Management Extended to En-Route Airspace - single TMA | **S-AF1.1** — AMAN extended to En-Route Airspace |

**Table 5: SESAR1 Objectives**

SESAR1 Implementation Objective ATC15.1 is disregarded, as it does not present the full picture of a PJ.15-02 Reference Scenario as it supports basic AMAN only. Equally, OI Step TS-0305-B have been included here but will not be considered as they are out of the scope of the document. Please, refer to section 3.2.2.

To conclude, the CBA Reference Scenario assumes the most-likely option for consumers to undertake PJ15-02 by themselves would be to make assumptions based on the expected evolution of SESAR1 Solution #05 – Extended Arrival Management (AMAN) horizon.

#### 3.5.1.3 Number of ANSPs and APTs that will have an E-AMAN

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

From Figure 2, the geographical scope has been defined as the ECAC area. However, it is not realistic to assume that all the 44 States within will operate E-AMAN systems. 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 [27]:

- **Different departing ATM assets**: In general, ATM capabilities for states within the Eastern regions are not as developed as those within the North-West region. It can be expected that not all Eastern ANSPs find among their priorities to invest in E-AMAN systems.
- **Different incentives for different ANSPs**: the PCP considers E-AMAN in the High Density TMAs among the ATM functionalities that need to be implemented by a selected set of European ANSPs. This is imposing a requirement on a reduced number of Northwestern (and Turkey) ANSPs to be ready by end of 2023. Only 14 out 44 ECAC States must implement the E-AMAN.
- **Cross-boundary coordination**: RP2 Monitoring reports [27] show the deployment of extended AMAN has been progressing very slowly until now partially due to complex cross-border coordination needs.
- **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.
- **Opportunistic behaviour**: some ANSPs might behave opportunistically and wait for investing in E-AMAN capabilities by themselves and wait until SESAR PJ15 – Common Service Solutions prove eventually their cost-efficiency.

[6] PCP element S-AF5 Initial SWIM is supporting the implementation objective ATC15.2 in the PJ15-02 scope

All the above factors being clarified, the CBA proposes to classify ANSPs according to their expected behaviour in terms of E-AMAN readiness. Three different categories have been assumed:

1. ***ANSP PCP Implementer:*** 14 ANSPs in ECAC are obliged to implement E-AMAN in at least one of their airports by the PCP Regulation. Some of them either are close to FOC or well advanced in their implementing plans. The Reference Scenario assumes they will continue with their implementation plans and all of them will implement E-AMAN.
2. ***ANSP Requested:*** 8 ANSPs report in the European ATM Portal [28] that they have plans to implement "receiving E-AMAN" capabilities to support neighbouring ANSP of *ANSP PCP implementer* category. *ANSPs requested* will not implement fully E-AMAN capabilities but strictly the updates to their systems and coordination for being able to operate with neighbouring ANSPs.
3. ***ANSP Indifferent:*** from the remaining ANSPs in the ECAC area, some of them are outside of the applicability area and some of them report that traffic levels do not justify the investment. These ANSPs are assumed not to implement any E-AMAN capability at all during the CBA Reference Period.

Table 6 summarises the ANSPs/States considered under each category. Table 7 does the same reporting the airports considered within each ANSP.

| Category | Pattern | ANSPs/States considered | ANSPs |
|---|---|---|---|
| PCP Implementer | ANSPs with at least one APT addressed by PCP and also acting on AMAN requests for neighbouring units | Austro Control, Belgocontrol, Skyguide, DFS, NAVIAIR, ENAIRE, DSNA, IAA, ENAV, LVNL, Avinor, LFV, DHMI and NATS | 14 |
| Requested | ANSPs acting on AMAN requests for neighbouring units | BULATSA, HCAA, Croatia Control, HungaroControl, MUAC, PANSA, NAV Portugal and LPS | 8 |
| Indifferent | ANSPs without AMAN operational needs or outside ATC15.2 applicability area | Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Cyprus, Czech Republic, Estonia, Finland, Georgia, Lithuania, Luxembourg, Latvia, Moldova, Montenegro, FYROM, Malta, Romania, Serbia, Slovenia, Ukraine | 20 |
| | | **ANSPs with an E-AMAN** | **14** |

**Table 6: Reference Scenario – Number and categorisation of ANSPs with an E-AMAN**

IR 716/2014 (PCP) [2] requires Arrival Management Extended to en-route Airspace to be deployed in a list of 25 Airports.

| ATC15.2 implementation progress | ANSPs | Total ANSPs | Airports (in PCP) | Total airports |
|---|---|---|---|---|
| Completed | NATS, DFS, DHMI, Naviair | 4 | LHR, LGW, STN, MAN, FRA, MUC, DUS, BER, IST, CPH | 10 |
| Ongoing | Skyguide, DSNA, ENAV, Avinor, LFV, Austro Control | 6 | ZRH, CDG, ORY, NCE, MXP, FCO, OSL, ARN, VIE | 9 |

| | | | | |
|---|---|---|---|---|
| Planned | ENAIRE | 1 | MAD, BCN, PMI | 3 |
| No Plan | LVNL, Belgocontrol, IAA | 3 | AMS, BRU, DUB | 3 |
| **ANSPs with an E-AMAN capability** | | **14** | **E-AMAN systems deployed** | **25** |

**Table 7: Reference Scenario – Number and categorisation of APTs with an E-AMAN**

Figure 2 below represents in a map the identified airports within ECAC.

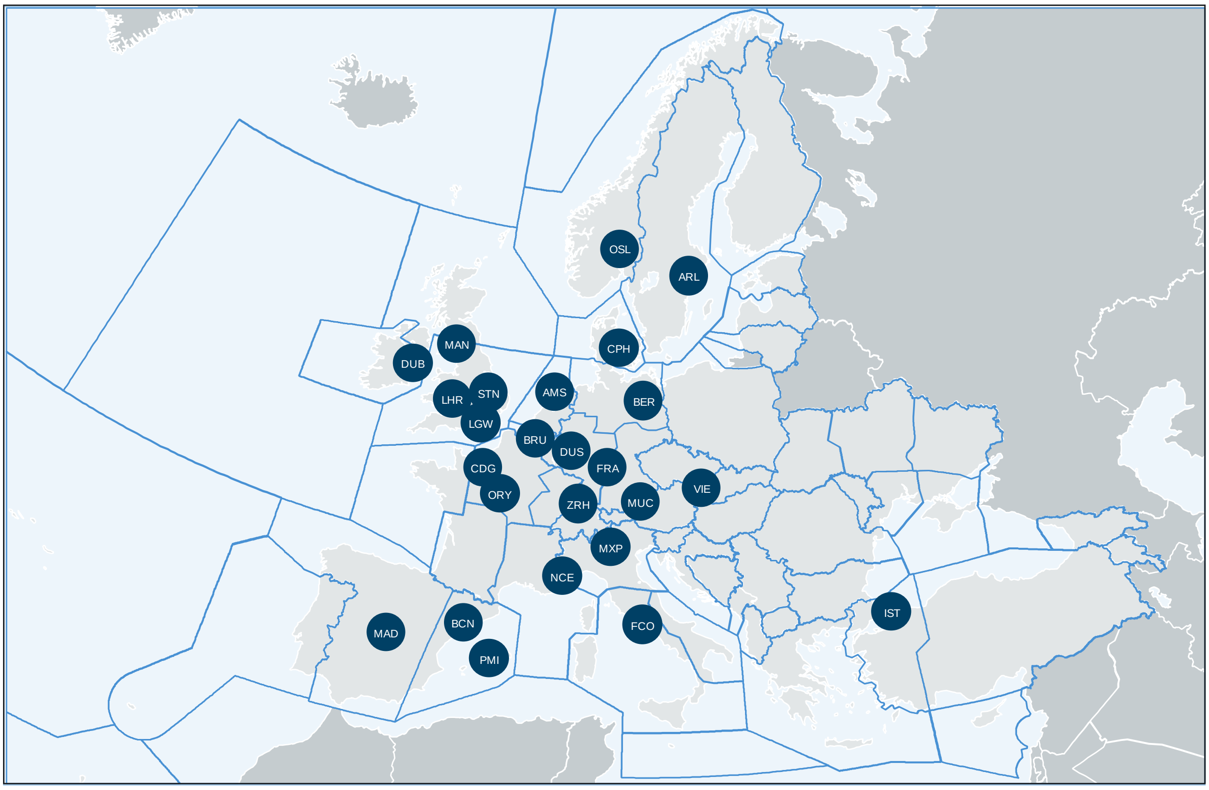


**Figure 2: Reference Scenario – Airports implementing E-AMAN**

### 3.5.1.4 Degree of collaboration

The geographical scope defined in Figure 2 in agreement with IR 716/2014 [2] assumes E-AMAN systems will provide arrival sequence time information into en-route ATC systems up to 180-200 nautical miles from the arrival airport in continental airspace.

However there is tight coordination performed between ANSPs in several forums, e.g. FABEC XMAN project, the Reference Scenario assumes there is no collaboration among ANSPs in terms of common use of E-AMAN platforms.

### 3.5.1.5 Time to deploy E-AMAN (IOC/FOC)

The time when ANSPs will have fully operational E-AMAN capabilities in the TMAs of the 25 PCP airports has some degree of uncertainty.

On the one side, the 14 ANSPs identified in Table 6 as PCP implementers should all achieve E-AMAN FOC for their 25 airports by the end of 2023 to comply with the IR. On the other side, having a look at the latest monitoring and implementing reports by the PRB [27] and European ATM Portal [28], the deployment of solutions in the Enhanced Arrival Sequencing domain (ATC15.1 and ATC15.2) show a deferred deployment status. As highlighted in 3.5.1.3, the reasons for delay being complex coordination and financial constraints.

The CBA considers the most-likely scenario is that the PCP deadline will not be met by all ANSPs and there will be a delay in implementation of E-AMAN in some of the ANSPs and Airports.

To make assumptions on the timeline for E-AMAN deployment the CBA considers the information provided by the 2018 edition of the Master Plan Level 3 as reported in the European ATM Portal [28]. It covers the data reported by Member States as per end of year 2018.

The deployment picture for Arrival Management extended to en-route Airspace (ATC15.2) looks pessimistic too. At the end of 2018, the actual progress was only 40%. The deployment of extended AMAN has been progressing very slowly up until now. Hence, the CBA assumes it is not realistic to assume that Arrival Management extended to en-route Airspace is FOC by end of 2023. Instead, the CBA will assume a delay in its implementation of +3 years.

Table 8 shows the implementing status of ATC15.2. For a detailed list of States / Airports and their ATC15.2 implementation progress, please refer to Appendix A.

| SESAR1 Implementation Objective | Required finish date by PCP | Progress | States / Airports completed | Latest estimated achievement |
|---|---|---|---|---|
| ATC15.2: Arrival Management extended to en-route Airspace | 31-12-2023 | 40% | 10 | 31-12-2026 |

**Table 8: Reference Scenario – Implementation Status of ATC15.2**

Figure 3 shows the assumption on the evolution of E-AMAN capabilities:

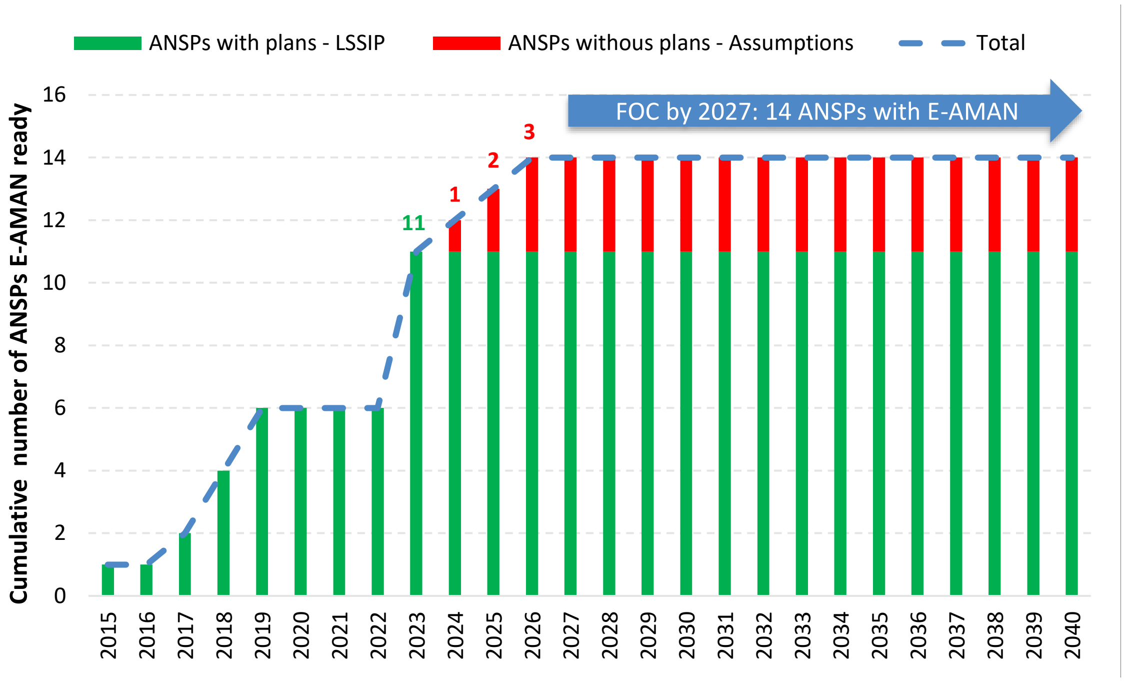


**Figure 3: Reference scenario – Evolution of E-AMAN capabilities by ANSPs**

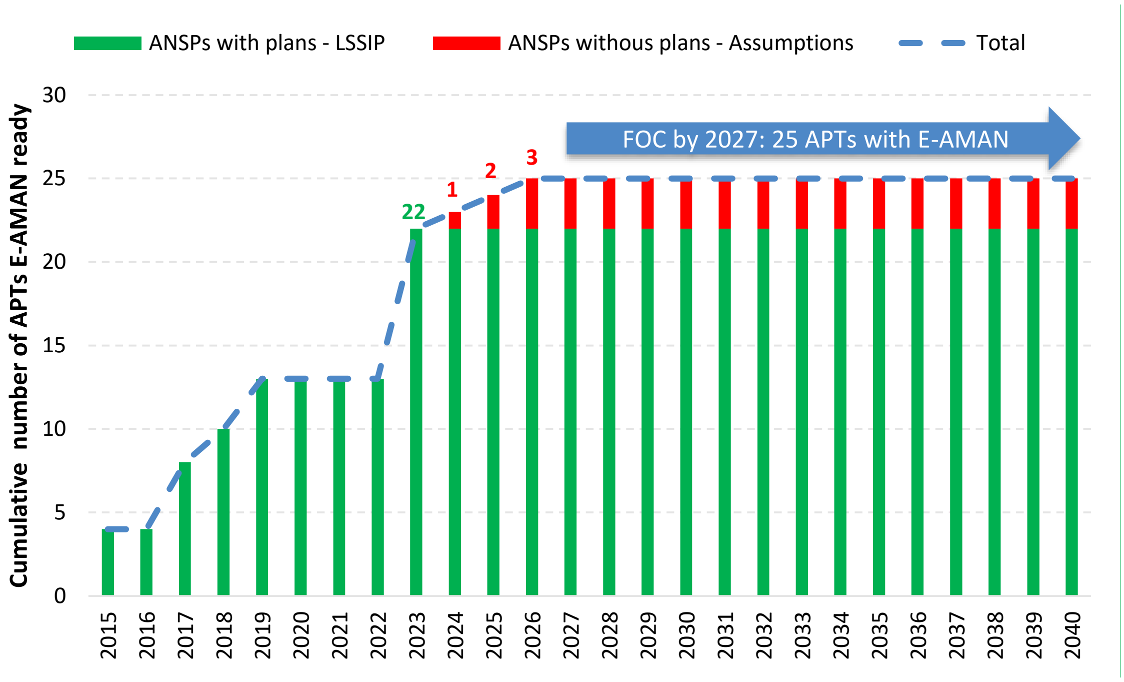


**Figure 4: Reference scenario – Evolution of E-AMAN capabilities by APTs**

#### 3.5.1.6 Summary of Reference Scenario

| No. | Uncertainty | CBA Assumption proposed | Source |
|---|---|---|---|
| 1 | Number of ANSPs that will have E-AMAN capabilities by 2040. | • 14 ANSPs implement E-AMAN in the TMAs of the 25 airports required by PCP.<br>• 8 ANSPs act on AMAN requests to support en-route operations of neighbouring sectors.<br>• 20 ANSPs do not implement E-AMAN or support AMAN requests. | PCP + expert judgement |
| 2 | Degree of collaboration among ANSPs for common use of E-AMAN capabilities. | • No collaboration among ANSPs. | Expert judgement |
| 3 | Time to deploy IOC/FOC. | • Monitoring reports show Europe is at least 2 years late for ATC15.1 and very slow progress for ATC15.2.<br>• Assumption then that E-AMAN will be +3 years delayed compared to PCP deadline. | PRB + expert judgement |

**Table 9: Reference Scenario – Summary of assumptions**

### 3.5.2 Solution Scenario – Colocation

This scenario follows the Common Service Pattern of “Consolidation” and might apply mainly to ANSPs, which already have AMAN or E-AMAN systems in place.

The classic E-AMAN deployment pattern is to have dedicated E-AMAN systems onsite at each location of the APP Centre responsible for Arrivals towards one or more specific airports. Often the E-AMAN systems are integral part of the ER-APP ATC system itself with all dependencies, which result from this.

An ANSP who finds himself in the above situation may decide to provide the technical E-AMAN capabilities by a Common Service locally for the airports where he is in charge of. This Common Service would be realized by colocation of the E-AMAN systems at a single site, e.g. a data center location. The operational processes executed around the E-AMAN technical capability are still executed by the original APP Centre.

The driver for this scenario would be the envisaged effect of “Economy of scale” which should allow reducing maintenance costs by central system management, requirements engineering, and product management. The software development, e.g. the extension of the arrival management horizon, necessary to comply with PCP regulations, can be planned and executed more efficiently when the separate systems are part of one operating entity inside the stakeholders organization.

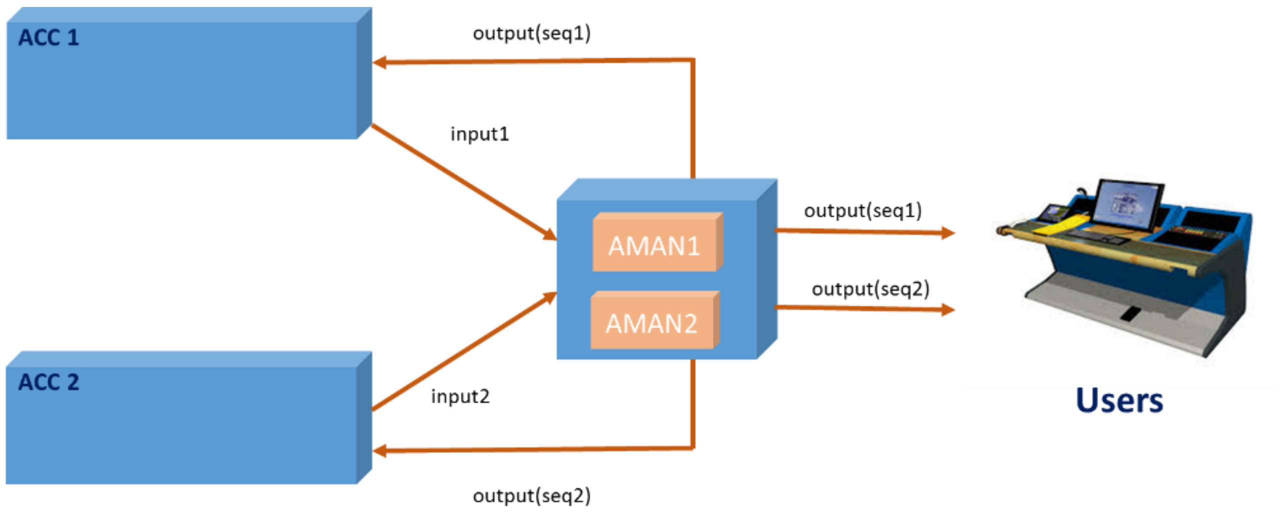


**Figure 5: Overview of data flows in Collocation scenario**

The data necessary to cover the extended arrival horizons of all mandated airports overlap and can be concentrated at a single site. This might lead to fewer interfaces, which need to be established. This also might lead to a reduction of infrastructure costs and necessary bandwidth. Virtualization options could further contribute to cost efficient resource utilization and thus reduced costs in providing the E-AMAN service.

#### 3.5.2.1 CBA Colocation solution scenario definition

In terms of CBA analysis, the Solution Scenario for Colocation at Local Level does not represent a fundamental change in the level of collaboration between stakeholders compared to the Reference Scenario. The main difference is the "Consolidation" of different E-AMAN systems at one site, e.g. one APP Centre of the ANSP for arrivals towards the airports where the ANSP is in charge of. This scenario follows the Common Service Pattern of "Consolidation" and might apply mainly to ANSPs, which already have AMAN or E-AMAN systems in place.

For the TRL6 CBA, the main assumption is that in the Colocation at Local Level, ANSPs who have PCP airports in the Reference Scenario will integrate their different E-AMANs (if more than one) into a single E-AMAN system (or cluster / system of systems) for all their controlled airspace providing a single service endpoint. Figure 6 provides a graphical example of E-AMAN collocated at Local Level. ENAIRE would consolidate the three E-AMAN systems for the three PCP Airports under its responsibility.

Another important assumption is that there will not be inter-ANSP collaboration among neighbouring ANSPs for building up a shared E-AMAN capability.

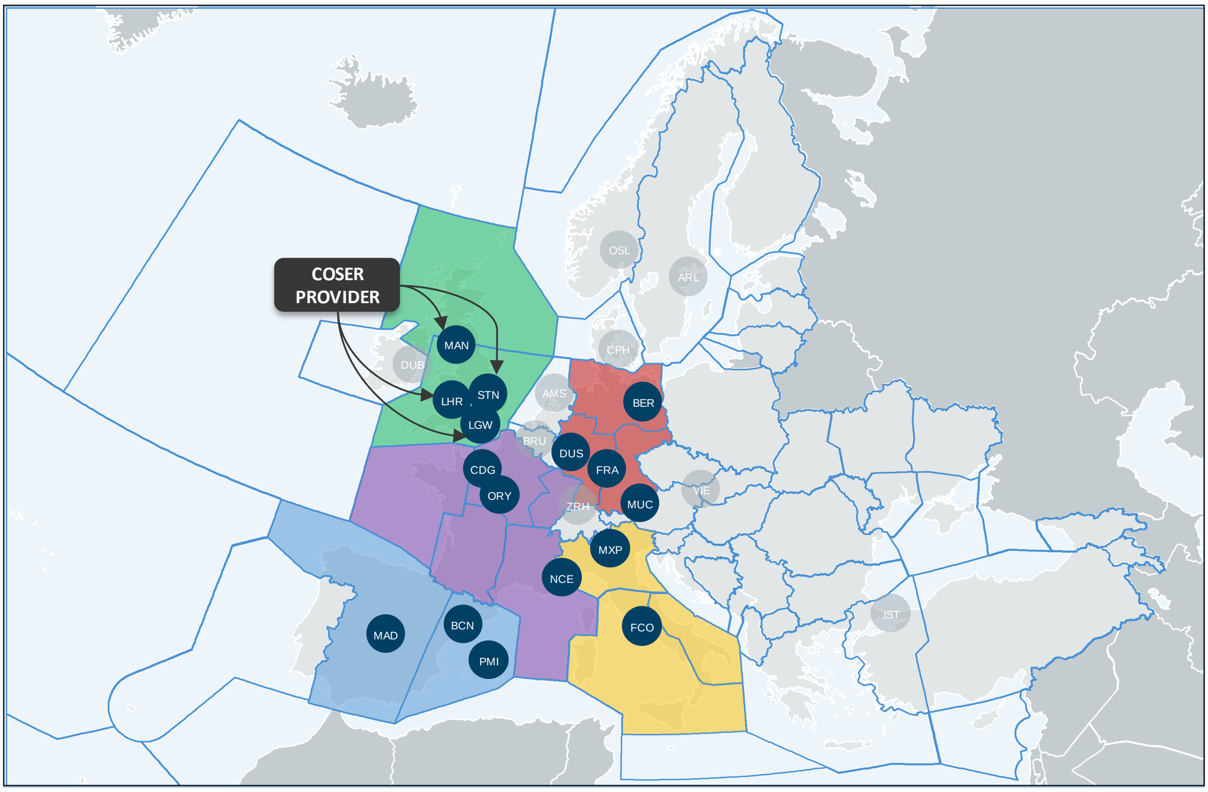


**Figure 6: Solution Scenario Colocation – Example of Colocation at Local Level**

Similarly, to the Reference Scenario, ANSPs can be classified according to their assumed behaviour in terms of developing Collocated E-AMANs. The same three different categories in Table 6 are maintained – PCP implementers, requested and indifferent. Table 10 summarises the ANSPs/States considered under each category.

| Category | Pattern | ATC15.2 progress | Collocated E-AMANs assumed |
|---|---|---|---|
| PCP Implementer | ANSPs with at least one APT addressed by PCP and supporting AMAN for neighbouring units | Completed | 4 |
| | | Ongoing | 6 |
| | | Planned | 1 |
| | | No plan | 3 |
| Requested | ANSPs supporting AMAN for neighbouring units | Not applicable | Not considered. Some of them are implementing E-AMAN |
| Indifferent | ANSPs without AMAN operational needs or outside ATC15.2 applicability area | Not applicable | Not considered. Some of them are implementing E-AMAN |
| | | **Collocated E-AMANs deployed** | **14** |

**Table 10: Solution Scenario Colocation – Number of ANSPs with an E-AMAN**

#### 3.5.2.2 Summary of Colocation Scenario

Table 11 summarises the Reference and the Colocation scenarios.

| No. | Uncertainty | Reference Scenario | Solution Scenario Colocation at Local Level |
|---|---|---|---|
| 1 | Number of ANSPs and APTs that will have E-AMAN capabilities by 2040. | • 14 ANSPs PCP implementers in 25 airports<br>• 8 ANSPs requested<br>• 20 ANSPs indifferent | • Same as Reference Scenario. |
| 2 | Degree of collaboration among ANSPs for common use of E-AMAN capabilities | • No collaboration inter-ANSPs | • Collaboration is only intra-ANSP. Only the E-AMAN systems for APTs from a given ANSP are consolidated. |
| 3 | Time to deploy IOC/FOC. | • E-AMAN will be FOC 3 years after the PCP deadline so in 2027. | • Start of deployment: 31-12-2024 [43].<br>• IOC: 31-12-2026 [43].<br>• FOC: 31-12-2030 [43]. |
| | **Collocated E-AMANs deployed** | **25 E-AMAN systems** | **14 E-AMAN systems** |

**Table 11: Solution Scenario Colocation – Comparison Reference vs Colocation**

### 3.5.3 Solution Scenario – Federation

This scenario follows the Common Service Pattern of “Federation” and applies mainly to ANSPs that have AMAN/E-AMAN systems in place.

The Common Service receives data from ANSPs current AMAN/E-AMAN systems and provides a Common Service based on sequences provided by ANSPs in a standardised way that can be consumed by other ANSPs.

The Common Service provider is responsible for receiving the data from the ANSP provider and providing the data to the ANSP consumer meeting any new technical standards, e.g. from EUROCAE for Arrival Management and SWIM.

The ANSP provider therefore does not need to spend money or put at risk the current operation making changes to in service systems and the ANSP consumer is able to develop systems using standard interfaces. The Common Service does not constrain ANSPs from using current interfaces directly or providing direct interfaces that meet the same standards as the Common Service Provider.

Without the Federator, an En-Route ATSU of ANSP A would need to implement legacy and SWIM interfaces, with the Federator only the Legacy interface he is capable of. An En-Route ATSU of ANSP B, with the Federator, is able to receive XMAN requests from Legacy partners, without having to implement the Legacy interface.

The Common Service allows current systems to be transitioned to new standards based interfaces in a controlled way at minimal cost whilst maintaining current capabilities as required. When the provision of a generic E-AMAN capability is available, this scenario would allow ANSPs to switch between their current systems and a generic capability. This would serve to gain confidence in any new generic capability and provide a contingent capability (using existing systems) as standard interfaces are being used.

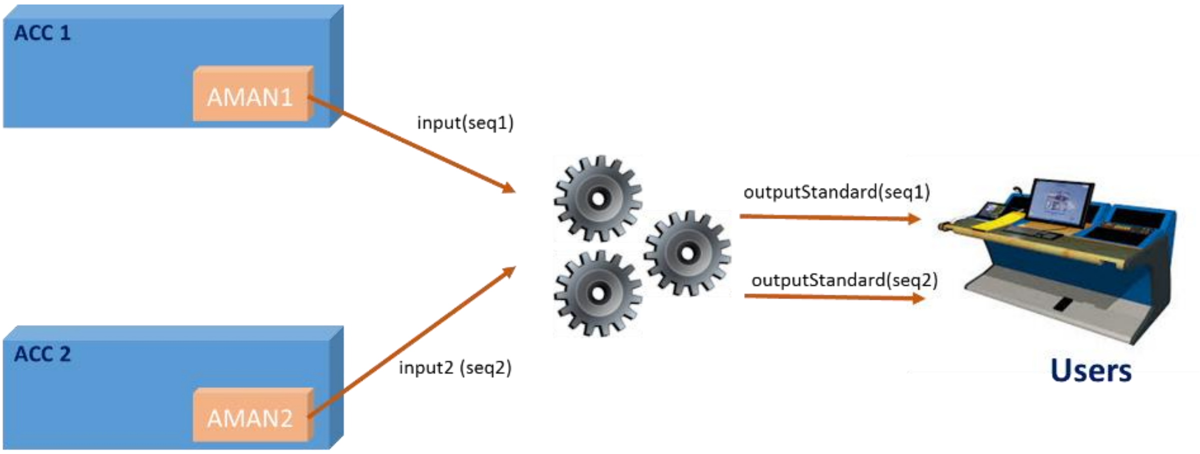


**Figure 7: Overview of data flows in Federation scenario**

#### 3.5.3.1 CBA Federation solution scenario definition

In terms of CBA analysis, the Solution Scenario for Federation follows the Common Service scenario identified in Figure 8. It applies to ANSPs that have today E-AMAN/AMAN systems in place. The main modification of actual systems is the creation of a Common Service, which will deliver sequences based in agreed formats suitable for achieving backward compatibility between ANSPs legacy systems and modern SWIM based solutions.

The Common Service receives data from ANSPs current AMAN/E-AMAN systems and provides a Common Service based on sequences provided by ANSPs in a standardised way that can be consumed by other ANSPs.

For the TRL6 CBA, the main assumption is that in the Federation Scenario there is no inter-ANSP collaboration for developing common E-AMAN capabilities. This means the number of E-AMAN systems remains constant compared to the Reference Scenario. Figure 8 provides a graphical example of E-AMAN Federation for ENAIRE and DSNA. The Common Service Provider would receive E-AMAN data from Spain and France that would distribute in the chosen standard.

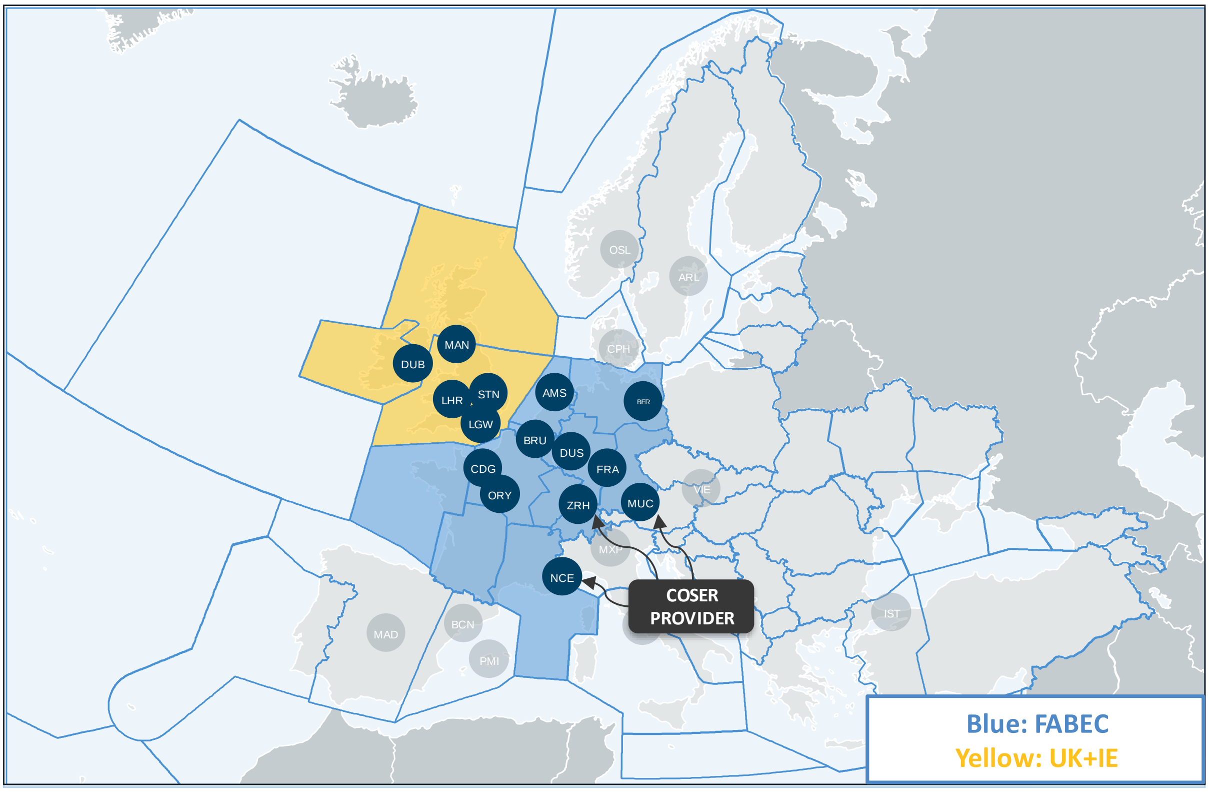


**Figure 8: Solution Scenario Federation – Example of Federation**

The main benefit of the Federation Scenario comes from the fact, that in a transition period, legacy systems and modern SWIM based systems will exist in parallel and need to interoperate. Currently there are two main protocols used in the AMAN output requests:

- OLDI AMA / ADEXP
- XML / Webservice

Most of the systems in place can produce and read only one of the two protocols. The systems capable of providing and receiving both are today a minority. Whenever there is a conflict between the two protocols exchanged, then a translation is necessary. This is the problem addressed by the Common Service Federator.

For CBA purposes, ANSPs and its APTs with AMAN capabilities can be classified according to the Protocols type in which they produce their AMAN outputs. At TRL6, PJ.15 has currently information for those E-AMAN systems in place in FABEC and UK-IE airports, which are part of the FABEC XMAN project. The CBA proposes to differentiate the airports according to the availability of information.

### 3.5.3.2 Airports with protocol information

From the 25 PCP airports, PJ.15 has information only for 14[7] of them. They are presented in bold text in Table 12. The information available on the AMAN protocol used is summarised by Table 13.

| Category | ATC15.2 progress | FAB | Airports with AMANs | APTS with info |
|---|---|---|---|---|
| PCP Implementer | Completed | UK-IE + FABEC + Turkey + NEFAB | **LHR, LGW, STN, MAN, FRA, MUC, DUS, BER,** IST, CPH | 8 |
| | Ongoing | FABEC + BLUE MED + NEFAB + FABCE | **ZRH, CDG, ORY, NCE,** MXP, FCO, OSL, ARN, VIE | 4 |
| | Planned | SW FAB | MAD, BCN, PMI | 0 |
| | No plan yet | FABEC + UK-IE | **BRU**, **AMS**, **DUB** | 3 |
| Requested | - | | | |
| Indifferent | - | | | |
| | | | **Airports in FABEC or UK-IE** | **15** |

**Table 12: Solution Scenario Federation – Airports with information on E-AMAN protocol**

| Protocol | Airports with AMANs | APTS with info |
|---|---|---|
| XML / Webservice | CDG, ORY, NCE, LHR, LGW, STN, MAN | 7 |
| OLDI AMA / ADEXP | AMS, FRA, MUC, BER, DUS, DUB, BRU | 7 |
| Both protocols | ZRH | 1 |

**Table 13: Solution Scenario Federation – Number of interactions among extended horizons**

The 14 FABEC and UK-IE APTs have approximately 124 interactions with neighbouring ACCs (request to support for ACC neighbouring sectors) of other FABEC and UK-IE partners. Studying the interactions on a case by case and deducting the interactions where there is no information now or there is no need of translation, a total of 14 interactions APT-ACC would need a translation of the protocols. These are the cases where a Federation Common Service would be useful. The information is taken as a snapshot from the FABEC XMAN Roadmap [14].

Whereas in the Reference Scenario a total of 14 translations of protocols would be needed, a Common Service Federator used by the FABEC and UK-IE partners would provide standardised XMAN output that could be used by all FABEC and UK-IE parties. This would make necessary only a unique “translation” capability of the Common Service Federator.

### 3.5.3.3 Summary of Federation Scenario

Table 14 summarises the Reference and the Federation scenarios. In terms of the four uncertainties identified for the general description of the CBA scenarios, the Reference and the Federation Scenarios

[7] Those from FABEC and UK-IE (There is no information for Brussels Airport)

are similar. In addition, the number of E-AMAN systems remains unvaried. The different comes in the number of “translations” of protocols needed.

Remark is that this is not for the ECAC area but for FABEC and UK-IE area, where sufficient detailed information is available in TRL6.

| No. | Uncertainty | Reference Scenario | Solution Scenario Federation |
|---|---|---|---|
| 1 | Number of ANSPs and APTs that will have E-AMAN capabilities by 2040. | • 7 ANSPs PCP implementers in 15 airports.<br>• 7 ANSPs requested. | • Same as Reference Scenario. |
| 2 | Degree of collaboration among ANSPs for common use of E-AMAN capabilities. | • No collaboration inter-ANSPs. | • Collaboration on service endpoint level is achieved |
| 3 | Time to deploy IOC/FOC. | • E-AMAN will be FOC 3 years after the PCP deadline so in 2027. | • Start of deployment: 31-12-2024 [43].<br>• IOC: 31-12-2026 [43].<br>• FOC: 31-12-2030 [43]. |
| | **E-AMAN deployed** | **15 E-AMAN systems** | **15 E-AMAN systems** |
| | **Number of “translations” necessary for PCP area** | **Approximately 12 translations** | **1 translation only for the Common Service** |

**Table 14: Solution Scenario Federation – Comparison Reference vs Federation**

For this TRL6 CBA version, two technological options for the Federation Solution Scenario have been identified:

- Cloud-based COSER provider
- Traditional installation per ANSP COSER provider

The cloud-based COSER provider option seems to be the most promising one since it would be more cost-effective. However, both options have been considered and studied within the CBA analysis to build a complete picture of the Federation Solution Scenario.

### 3.5.4 Summary of Solution Scenarios

The Table 15 below summarises the differences between the Solution Scenarios and the Reference Scenario (RS). The results of the Colocation Scenario are to be compared against the column Reference ECAC and the results of the Federation Scenario should be assessed against the column Reference FABEC & UK-IE. Cells shaded in green colour represent the cases where the Solution PJ15-02 delivers advantages compared to the applicable Reference Scenario (REF ECAC or REF FABEC & UK-IE).

| Uncertainty | Reference | Colocation | Federation[8] |
|---|---|---|---|
| Number of ANSPs and APTs that will have E-AMAN capabilities by 2040. | • 14 ANSPs PCP Implementers in 25 APTs<br>• 8 ANSPs Requested<br>• 20 ANSPs Indifferent | • Same as RS | • Same as RS |
| Degree of collaboration among ANSPs for common use of E-AMAN capabilities. | • No inter-ANSP collaboration | • Collaboration is only intra-ANSP. Only AMAN systems for APTs from a given ANSP are consolidated | • Collaboration on service endpoint level is achieved |
| Time to deploy IOC/FOC. | • PCP deadline + 3 years | • Start of deployment: 31-12-2024 [43].<br>• IOC: 31-12-2026 [43].<br>• FOC: 31-12-2030 [43]. | • Start of deployment: 31-12-2024 [43].<br>• IOC: 31-12-2026 [43].<br>• FOC: 31-12-2030 [43]. |

<table>
<tr><th></th><th>ECAC</th><th>FABEC & UK-IE</th><th>Colocation vs REF ECAC</th><th>Colocation vs REF FABEC & UK</th><th>Federation vs REF ECAC</th><th>Federation vs REF FABEC & UK</th></tr>
<tr><td>ANSPs with E-AMAN capability</td><td>14</td><td>7</td><td>14 (same as REF)</td><td rowspan="4">Scenario not assessed</td><td rowspan="4">Not applicable</td><td>7 (same as REF)</td></tr>
<tr><td>APTs with E-AMAN capability</td><td>25</td><td>15</td><td>25 (same as REF)</td><td>15 (same as REF)</td></tr>
<tr><td>E-AMAN instances deployed</td><td>25</td><td>15</td><td>14 instead of 25</td><td>15 (same as REF)</td></tr>
<tr><td>Protocol translations[9]</td><td>Not applicable</td><td>12</td><td>Not applicable</td><td>1 instead of 12</td></tr>
</table>

**Table 15: Summary of Solution scenarios**

[8] For the Federation scenario, the Reference scenarios numbers are adjusted to the scope of FABEC and UK-IE

[9] Protocol translations are only analysed for the Federation Scenario

### 3.5.5 Assumptions

Based on the SESAR 2020 Common Assumptions [21], the CBA for 15-02 will consider a discount rate of 8% for all stakeholders in calculating the NPV in the final TRL6 CBA.

# 4 Benefits

There are two types of benefits that realisation of E-AMAN following a COSER model could deliver.

Firstly, the primary benefit that PJ15-02 delivers is in the KPA of Cost-Efficiency. Namely, it addresses the KPI CEF3 – Technology Cost.

On top of the expected benefits of Cost Efficiency, PJ15-02 Solution has two advantages that could bring benefits not limited to one particular KPA but contributing to many indeed. Further research and validation will need to confirm this point but at least for TRL6 PJ15-02 is believed to offer:

1. Quicker E-AMAN capability deployment because of standardisation of protocols and collaboration. This would allow to achieve Full Operational Capability earlier.
2. *"Europeanisation/Universalisation"* of the service. Some ANSPs do not consider E-AMAN deployment in their short-term strategies because of other operational and financial priorities. Having a Common Service solution available at European level could facilitate their access to the E-AMAN capability.

Following the EATMA logic that Enabling Projects / Technological Solutions (PJ15-02) enable and/or support ATM Solutions (SESAR1 #05), we can say that PJ15-02 accelerates the benefits that #05 provides.

By having a look at the Implementation View of the European ATM Master Plan Level 3 [34] or the latest information in the eATM Portal [35], Figure 9 below shows the KPA where Solution #05 contributes.

Expected Performance Benefits

| | |
|---|---|
| **Safety** | Maintained. |
| **Capacity** | Optimal use of TMA capacity. |
| **Operational efficiency** | Improved arrival flow. |
| **Cost efficiency** | - |
| **Environment** | Delays are resorbed by reducing speed in early phases of arrivals leading to reduction of holding and vectoring which has a positive environmental impact in terms of fuel savings. |
| **Security** | - |

**Figure 9: Expected Performance benefits of Solution SESAR1 #05**

Consequently, as PJ15-02 supports the faster deployment of the OI Step TS-0305-A satisfied by SESAR1 Solution #05, we can say that PJ15-02 enables benefits in Capacity, Operational efficiency and Environment for those extra years of FOC.

The following table summarises the benefits identified for the E-AMAN Common Service as described in [4].

| KPA (KPI) | KPI | Performance Benefits Expectation local to Direct Consumer | Performance Benefits Expectations at Network Level (ECAC Wide)[10] |
|---|---|---|---|
| **Environment / Fuel Efficiency (Fuel Burn per Flight)** | FEFF1 | | An E-AMAN Common Service could provide AMAN capabilities for a region where it is not economically viable to run such a service in isolation. This might lead to secondary performance contributions. |
| **Airspace Capacity (Throughput / Airspace Volume & Time)** | CAP1, CAP2 | | An E-AMAN Common Service could provide AMAN capabilities for a region where it is not economically viable to run such a service in isolation. This might lead to secondary performance contributions. |

[10] Negative impacts are indicated in red.

| KPA (KPI) | | KPI | Performance Benefits Expectation local to Direct Consumer | Performance Benefits Expectations at Network Level (ECAC Wide)[10] |
|---|---|---|---|---|
| **Airport Capacity (Runway Throughput Flights/Hour)** | | CAP3 | | An E-AMAN Common Service could provide AMAN capabilities for a region where it is not economically viable to run such a service in isolation. This might lead to secondary performance contributions. |
| **Predictability (Flight Duration Variability, against RBT)** | | PRD1 | | An E-AMAN Common Service could provide AMAN capabilities for a region where it is not economically viable to run such a service in isolation. This might lead to secondary performance contributions. |
| **Safety** | **Mitigation of safety risk** | - | | |

| KPA (KPI) | | KPI | Performance Benefits Expectation local to Direct Consumer | Performance Benefits Expectations at Network Level (ECAC Wide)[10] |
|---|---|---|---|---|
| **Cost Efficiency** | **Cost of operation** | CEF3 | **High**<br>Cost of Operation is significantly reduced by reduction of Human Resources (including both deployment and maintenance), necessary to operate Extended Arrival management | **Medium**[11]<br>Cost of Operation is overall slightly reduced.<br>The number of Point-To-Point connections between stakeholders are reduced. By this, deployment of the capability can be significantly accelerated, as efforts for establishing, testing and maintenance of the connections are significantly reduced. |
| **Cost Efficiency** | **ATCO Productivity** | CEF2 | | |

**Table 16: Expected PJ.15-02 Benefits**

[11] Considered Medium instead of Low (TRL2) due to new aspect of reduction of endpoints

# 5 Cost assessment

PJ15-02 has dedicated a significant effort to perform a rigorous cost assessment as required by SESAR 2020 CBA methodology. This section provides only a rough assessment and should be treated accordingly.

The SESAR 2020 CBA Template [10] recommends using *"only the differential (or delta) value implied by the Solution Scenario over the Reference one".* This approach has been kept in the assessment, also motivated by confidentiality reasons, for the Colocation Solution Scenario. However, in the case of the Federation Solution Scenario, the stakeholders have provided absolute cost values. Both approaches have resulted to be valid to provide cost figures and, therefore, both have been accepted. To avoid losing the uniformity of the conducted work, the cost assessment in both cases follows the same structure, allowing to perform comparable and totally aligned CBAs in both cases.

It is not possible to validate that Common Service contributes to other Performance Areas than Cost-Efficiency. Therefore, the cost assessment is essential to achieve a good degree of accuracy when assessing the potential benefits of the E-AMAN COSER.

| Scenario | Stakeholders considered | The type of stakeholder and/or applicable sub-OE | Type of impact | Involvement in the analysis | Quantitative results available in the current CBA version |
|---|---|---|---|---|---|
| Colocation of E-AMAN on a local level | E-AMAN hosting ANSP | High-density TMAs | Invest in collocated E-AMAN | Yes | Yes |
| | Receiver of E-AMAN Service Data | Primarily associated en-route sectors but also e.g. Tower ATC | Small investment to support AMAN requests | Yes | Yes |
| Federation of E-AMAN | E-AMAN hosting ANSP | High-density TMAs | Minimal development of current 'in service' E-AMAN systems | Yes | Yes |
| | Common Service Provider | Service Provider | Transformation of old format data into new standard | Yes | Yes |
| | Receiver of E-AMAN Service Data | Primarily associated en-route sectors but also e.g. Tower ATC | Minimum investment to support AMAN requests | Yes | Yes |

**Table 17: Stakeholders that have been considered in the CBA quantitative results**

## 5.1 ANSPs costs

Table 18 identifies the basic costs, identified per type, applying to ANSPs.

| ANSP costs | Type of cost | Main costs |
|---|---|---|
| CAPEX | Pre-implementation costs: | • Software development<br>• Operational procedures<br>• Testing and validation activities<br>• Safety case |
| | One-off costs: | • Project Management<br>• Administrative costs<br>• Certification<br>• Installation/Commissioning (Infrastructure replacement activities)<br>• E-AMAN system interface version adaptation to the current system (different E-AMAN lifecycles within an ANSP)<br>• Integration in specific ATS System (release planning)<br>• Initial Training |
| | Capital implementation costs: | • Dedicated infrastructure (equipment, computer storage, network)<br>• Physical connections<br>• Logical/Operational connections<br>• Software (Interfaces) |
| | Transition implementation costs: | • Operational and technical trials for entry into operation<br>• Project management during trials<br>• Human and material resources |
| OPEX | Maintenance costs: | • Yearly E-AMAN equipment maintenance<br>• Training |
| | Administration costs | • Communication costs<br>• Data operation<br>• Energy, Supplies, Utilities, Property Taxes<br>• Rent & Lease<br>• Furniture & equipment |

**Table 18: ANSPs basic costs**

### 5.1.1 ANSPs 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 ANSPs Colocation Solution Scenario cost assessment

For the Colocation Solution Scenario, the following main costs have been identified. In all of them, a delta value has been found between the solution and the reference scenarios:

| ANSP costs | Type of cost | Main costs |
|---|---|---|
| CAPEX | Pre-implementation costs: | • Software business logic (E-AMAN, requirements, testing, developments, deployment)<br>• Software business logic (E-AMAN, requirements, testing, developments, deployment)<br>• Software Common Service function |
| | One-off costs | • Training (initial and on renewal) |
| | Capital implementation costs: | • Server hardware (E-AMAN host, virtualisation of server hardware and network) |
| | Transition implementation costs: | • Network technical connections (E-AMAN host and receiving units*). Assumptions:<br>  ○ One E-AMAN connects to an average of 3 receiving units (half connections in the COSER scenario)<br>  ○ No separate leased line costs as usage of the existing network (i.e. PENS)<br>  ○ Initial and on changes that affect communication (format, infrastructure) |

| | | |
|---|---|---|
| OPEX | Maintenance costs: | • Product lifecycle planning (product management, troubleshooting, change requests, release planning, requirements engineering)<br>• Training (regular) |
| | Administration costs | • System operation (E-AMAN host, system management personnel costs) |

*Receiving unit costs is included in the cost figures provided for the full ANSP estimation

**Table 19: ANSPs Colocation scenario vs Reference scenario. Only costs where a delta has been identified**

**As indicated in the previous section, due to confidentiality considerations, the CBA only includes the aggregated values of the pre-implementation, one-off, capital implementation, transition implementation, maintenance, and administration costs, avoiding the release of the unit costs of each concept referred in**
*Receiving unit costs is included in the cost figures provided for the full ANSP estimation

Table 19. The Colocation scenario allows to an ANSP with multiple E-AMAN instances going from multiple delocalised E-AMAN instances to a single E-AMAN Common Service. Therefore, the cost saving highly depends on the number of E-AMAN instances deployed by ANSP in the Reference scenario. In this sense, only ANSPs with more than one E-AMAN instance in the reference scenario would benefit of the Colocation scenario. This idea is shown in Table 20.

| Colocation vs Ref. scenario | Detailed scenario costs (€) | | | | | | Overall scenario costs (€) | |
|---|---|---|---|---|---|---|---|---|
| | Pre-impl. | One-off impl. | Capital impl. | Transition impl. | Mainten. | Administr. | CAPEX (€ / 6 years) | OPEX (€ / year) |
| 2 E-AMAN instances ANSP | -720.000 | 40.000 | -120.000 | -120.000 | -137.333 | -3.000 | -920.000 | -140.333 |
| 3 E-AMAN instances ANSP | -1.760.000 | 60.000 | -180.000 | -180.000 | -134.000 | -63.000 | -2.060.000 | -197.000 |
| 4 E-AMAN instances ANSP | -2.800.000 | 80.000 | -240.000 | -240.000 | -130.667 | -123.000 | -3.200.000 | -253.667 |

**Table 20: Detailed delta costs for the PJ.15-02 Colocation vs Reference scenarios, including the concepts indicated in Table 19**

### 5.1.3 ANSPs Federation Solution Scenario cost assessment

For the Federation Solution Scenario, the following additional costs for the ANSPs have been identified (Table 21).

| ANSP costs | Type of cost | Main costs |
|---|---|---|
| CAPEX | Pre-implementation costs: | • Connector for the FDP client. Connection between ANSP and COSER provider<br>• Only if cloud-based COSER provider:<br>  ○ Firewall change<br>  ○ Support to COSER provider for the first connection<br>• Only if traditional installation COSER provider:<br>  ○ Test - ROM, includes test documentation and VCRM etc.<br>  ○ Certification plus overall project management<br>  ○ Safety case and software assurance |
| | One-off costs | • Proxy and Firewall Rule Updates (includes change request, configuration management and documentation)<br>• Security Risk Assessment Update (need to include new subscriber of Arrival Sequence Service)<br>• System Documentation Updates (need to include new subscriber of Arrival Sequence Service)<br>• Operational Response / SLA documentation to be updated (add new contacts and response times)<br>• Data Consumer Agreement (needs legal work)<br>• Assumption: No assurance work as data boundary is at the provider end point and the system is assured to provide data<br>• Initial connection: there would be a test environment setup and support provided<br>• Only if cloud-based COSER:<br>  ○ Minor documentation updates required for ops response and SLAs or data consumer agreements |
| | Capital implementation costs: | • Only if traditional installation COSER provider:<br>  ○ Hardware (3 Off The Shelf server nodes) |
| | Transition implementation costs: | N/A |
| OPEX | Maintenance costs: | • Only if traditional installation COSER provider:<br>  ○ 24/7 support 1st and 2nd line |
| | Administration costs | N/A |

**Table 21: ANSPs Federation solution scenario costs**

Again, due to confidentiality considerations, the CBA only includes the aggregated values of the pre-implementation, one-off, capital implementation, transition implementation, maintenance, and administration costs, avoiding the release of the unit costs of each concept referred in Table 21.

| Solution scenario costs | Detailed scenario costs (€) | | | | | | Overall scenario costs (€) | |
|---|---|---|---|---|---|---|---|---|
| | Pre-impl. | One-off impl. | Capital impl. | Transition impl. | Mainten. | Administr. | CAPEX (€ / 6 years) | OPEX (€ / year) |
| ANSP (Cloud-based) | 203.770 | 30.875 | N/A | N/A | N/A | N/A | 234.645 | N/A |
| ANSP (Traditional) | 489.850 | 23.750 | 225.000 | N/A | 100.000 | N/A | 738.600 | 100.000 |

*The costs are based on a person-day fee of 760€ (95€ per hour, as indicated as an average of all staff in ANSPs within the EUROCONTROL are in [42])

**Table 22: ANSPs detailed costs for the PJ.15-02 Federation scenario, including the concepts indicated in Table 21**

Regarding the benefits (cost saving) of moving towards a Federation Solution Scenario, no monetisable concepts have been found. The idea of implementing a federated COSER provider foresees potential future implementation savings when implementing new technologies. Nevertheless, these potential benefits would not derive directly of the E-AMAN COSER provision and they are not monetisable yet. Thus, for the purpose of this CBA study, and based on the idea shown in Table 14 of the reduction on the number of required translations, the cost saving of the Federation scenario has been estimated equal to the software saving found in the Colocation scenario (for a 3 E-AMAN instances ANSP), as shown in the table below:

| Solution scenario costs | Detailed scenario costs (€) | | | | | | Overall scenario costs (€) | |
|---|---|---|---|---|---|---|---|---|
| | Pre-impl. | One-off impl. | Capital impl. | Transition impl. | Mainten. | Administr. | CAPEX (€ / 6 years) | OPEX (€ / year) |
| ANSP, both cloud-based and traditional | - | - | - | - | - | - | -2.160.000 (every 3-EMAN instances) | -216.000 (every 3-EMAN instances) |

**Table 23: ANSPs cost saving in the Federation Solution Scenario. OPEX has been estimated as the 10% of the CAPEX saving (usual value for software solutions)**

## 5.2 COSER provider costs

### 5.2.1 COSER provider 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 COSER provider costs was to provide an Excel template to the Industry 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.

### 5.2.2 COSER provider Colocation Solution Scenario cost assessment

Not applicable, since all delta identified costs have been included in the ANSP cost assessment.

### 5.2.3 COSER provider Federation Solution Scenario cost assessment

In the case of the COSER provider, the granularity of the cost estimation allows only indicating the final CAPEX and OPEX values. The assumptions that have been performed by the stakeholders are shown in Table 24.

| COSER provider costs | Type of cost | Main costs |
|---|---|---|
| CAPEX | N/A | • Pre-implementation is covered by the ANSP<br>• ANSP covers all certification, overall Project management<br>• Safety Case is covered by the ANSP<br>• Operational trials and transition is covered by the ANSP<br>• ED-109 AL-4 is sufficient for the safe and secure development and implementation of the system |
| OPEX | N/A | • 24/7 support 1st and 2nd line provided by the ANSP<br>• Administration, connection costs covered by ANSP |
| General | N/A | • Federation is for three (3) existing AMAN instances and output is SWIM Yellow Profile ED-254 to aviation stakeholders |

**Table 24: COSER provider Federation solution scenario costs**

The above-mentioned assumptions translate into the next CAPEX and OPEX values for the COSER provider:

| Solution scenario costs | Detailed scenario costs (€) | | | | | | Overall scenario costs (€) | |
|---|---|---|---|---|---|---|---|---|
| | Pre-impl. | One-off impl. | Capital impl. | Transition impl. | Mainten. | Administr. | CAPEX (€ / 6 years) | OPEX (€ / year) |
| **COSER provider (Cloud-based)** | - | - | - | - | - | - | 346.000 (every 3 E-AMAN instances) | 76.000 (every 3 E-AMAN instances) |
| **COSER provider (Traditional)** | - | - | - | - | - | - | 461.000 (every 3 E-AMAN instances) | 33.500 (every 3 E-AMAN instances) |

**Table 25: COSER provider costs for the PJ.15-02 Federation scenario**

# 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 the Cost Efficiency. Therefore, the main inputs to the model are the solution and reference scenarios CAPEX and OPEX costs for the ANSPs, 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). Finally

## 6.1 Summary of scenarios costs

Cost assessment results (section 5) are summarised in the table below. This table builds the major input of the CBA model.

| Solution Scenario | Overall scenario costs | | |
|---|---|---|---|
| | **Observations** | **CAPEX** | **OPEX** |
| **Colocation (delta values)** | 2 E-AMAN ANSP | -920.000 (€ /6 years) | -140.333 (€ / year) |
| | 3 E-AMAN ANSP | -2.060.000 (€ / 6 years) | -197.000 (€ / year) |
| | 4 E-AMAN ANSP | -3.200.000 (€ / 6 years) | -253.667 (€ / year) |
| **Federation (absolute values)** | ANSP cost (cloud-service) | 234.645 (€ / 6 years) | N/A |
| | ANSP cost (traditional installation) | 738.600 (€ / 6 years) | 100.000 (€ / year) |
| | ANSP saving (per E-AMAN instance) | 720.000 (€ / 6 years) | 72.000 (€ / year) |
| | COSER provider (cloud-service) | 346.000 (€ / 6 years) | 76.000 (€ / year) |
| | COSER provider (traditional installation) | 461.000 (€ / 6 years) | 33.500 (€ / year) |

**Table 26: Summary of overall costs for the PJ.15-02 CBA scenarios**

## 6.2 Generic E-AMAN Reference Scenario for the Colocation Solution Scenario implementation timeline

Based on the LSSIP 2018. Implementation view for ATC15.2, Figure 10 shows the assumed timeline for the implementation of the above-mentioned reference scenario. Green data are based on actual ANSPs plan. Red data have been assumed linear from the PCP deadline to the estimated FOC of 2027.

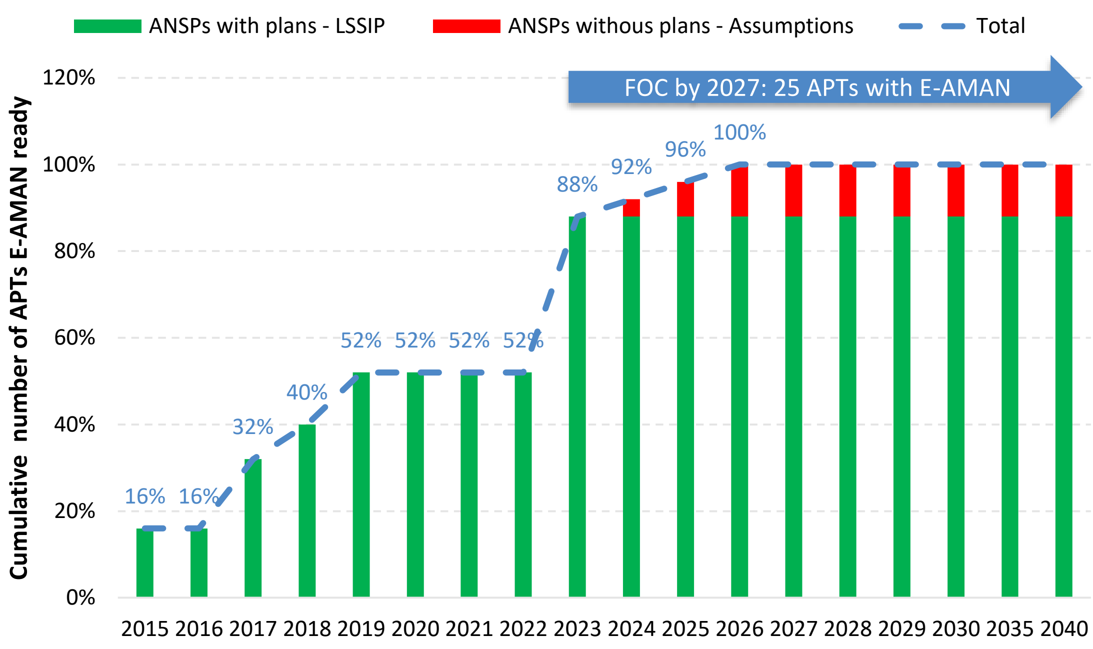


**Figure 10: Reference Scenario for the Colocation Solution Scenario – Technology implementation timeline based on the cumulative number of APTs E-AMAN ready (see Figure 4 and section LSSIP 2018. Implementation view for ATC15.2)**

Please, note that CAPEX applies the same year of the implementation but the increase in the OPEX has been assumed to apply one year later than implementation.

## 6.3 Generic E-AMAN Reference Scenario for the Federation Solution Scenario implementation timeline

Following the same reasoning, Figure 11 shows the assumed timeline for the implementation of the reference scenario for the Federation solution case. Green data are based on actual ANSPs plan. Red data have been assumed linear from the PCP deadline to the estimated FOC of 2027.

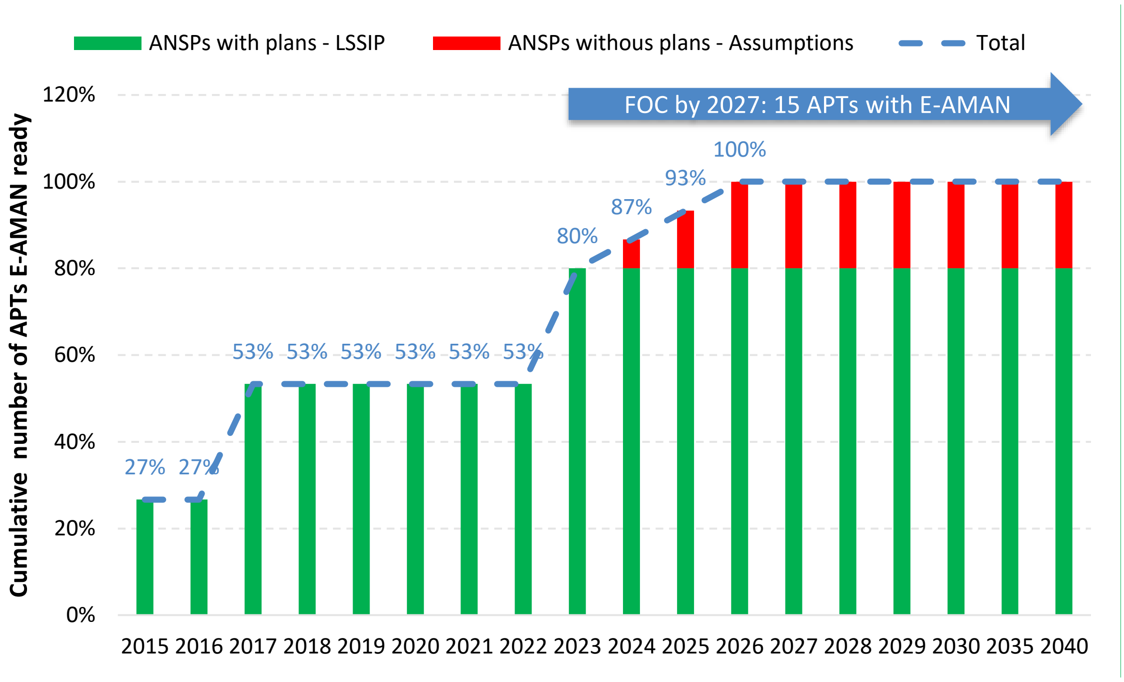


**Figure 11: Reference Scenario for the Federation Solution Scenario – Technology implementation timeline based on the cumulative number of APTs E-AMAN ready (see Figure 4 and section LSSIP 2018. Implementation view for ATC15.2)**

Please, note that CAPEX applies the same year of the implementation but the increase in the OPEX has been assumed to apply one year later than implementation.

## 6.4 Colocation scenario implementation timeline

For Colocation Scenario, 2027 has been fixed as the IOC year. Since the Reference Scenario is already being implemented and the Solution Scenario would deliver same technical capabilities, it has been assumed that the Solution Scenario will be deployed per ANSP the year the Reference Scenario is planned to be deployed (if planned for later than IOC year) or the year is planned to be renewed (every 6 years as indicated in Table 26 for the CAPEX delta cost value). It must be noticed that both IOC year and renewal rate will be part of the sensitivity analysis in later sections of the document.

Colocation Scenario only applies to ANSPs with more than one E-AMAN in the Reference Scenario. Therefore, for the geographical scope of the Colocation Scenario, the next ANSPs are identified as potential cost savers when implementing COSER E-AMAN capabilities:

| E-AMAN instances | ANSPs | APTs |
|---|---|---|
| **2 E-AMAN instances** | ENAV | MXP, FCO |
| **3 E-AMAN instances** | DSNA, ENAIRE | CDG, ORY, NCE, MAD, BCN, PMI |
| **4 E-AMAN instances** | DFS, NATS | FRA, MUC, DUS, BER, LHR, LGW, STN, MAN |

**Table 27: Identified ANSPs within the Colocation Scenario geographical scope with more than one E-AMAN instance that can benefit from implementing COSER capabilities**

The Solution Scenario deployment timeline can be observed in the Figure 12, for 2027 as the IOC year and a renewal rate of 6 years.

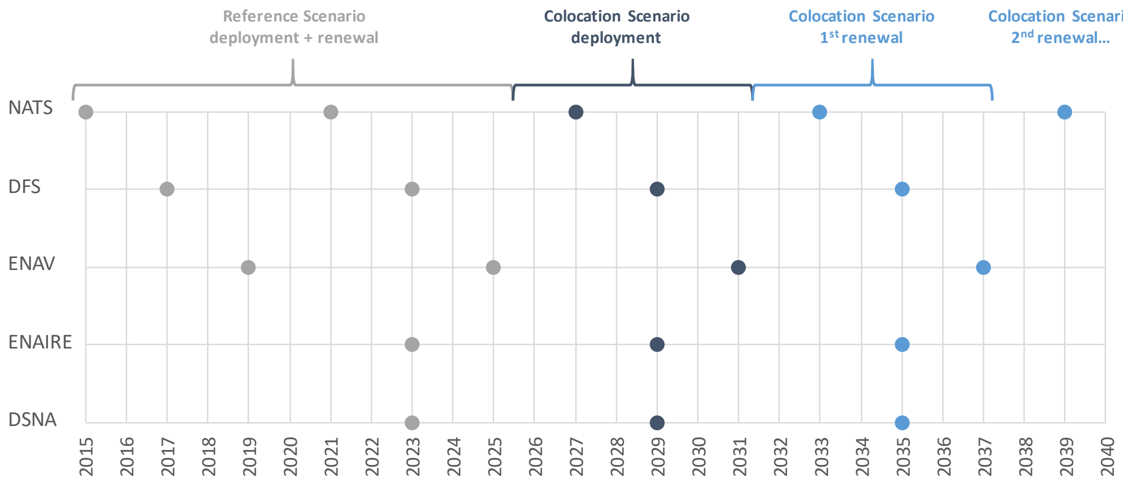


**Figure 12: Colocation solution scenario deployment and renewal timeline, for a renewal rate of 6 years and 2027 as the IOC year. CAPEX cost saving applies each time a point is found in the chart. OPEX saving applies since the first point per ANSP appears (after IOC) and remains constant for the rest of the timeline. Conversion cost is accounted during two years before the Solution Scenario deployment per ANSP**

Please, note that CAPEX applies the same year of the implementation but the increase in the OPEX has been assumed to apply one year later than implementation.

In addition to the CAPEX and OPEX costs, 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. For every impacted ANSP, the conversion cost from delocalised E-AMAN service to Colocation COSER has been assumed to be equal to decommissioning every E-AMAN instances but one within the ANSP (i.e. 3 E-AMAN instances for DFS out the 4 that are present in the Reference Scenario). The conversion cost has been assumed to be 17% of the renewal cost [41] of the E-AMAN instances and applies two years before the deployment of the Solution Scenario (half the total value of conversion each year). This renewal cost has been assumed to be 4 million Euro per E-AMAN instance. Since no cost figure was available, this value comes from the PCP CBA [40], which shows a cost of 5 million Euro per ACC upgraded from AMAN to E-AMAN (#3, AF-01 Extended AMAN and PBN in high-density TMAs) and a total of 20 ACCs included within the Colocation Scenario geographical scope. Thus, a total cost of 100 million Euro is estimated for the 25 E-AMAN instances (4 million Euro per E-AMAN instance as an average).

Again from Figure 11, it can be derived that the FOC year for the Colocation Scenario COSER E-AMAN implementing five ANSPs is 2031 (one year after the last ANSP to implement the COSER capability). In addition, the FOC year for the full Colocation Scenario remains 2031 since the non-COSER nine ANSPs would finish the implementation of the E-AMAN capability in 2027 (as shown in section 6.2).

## 6.5 Federation scenario implementation timeline

For the Federation Scenario, 2027 has been fixed as the IOC year too. The deployment timeline for the Federation Scenario has been established following a different idea than the Colocation timeline, i.e.:

both the ANSPs (data providers) and the COSER provider follow an independent implementation timeline (linear implementation, IOC in 2027, FOC in 2031).

Nevertheless, the Reference Scenario implementation timeline is still of major importance, since the implementation savings depend on the number of times that the Reference Scenario CAPEX is avoided. Following a similar approach to the one in the Colocation solution scenario, it has been assumed that avoided CAPEX per ANSP applies the year the Reference Scenario is planned to be deployed (if planned for later than the IOC year of the Federation scenario) or the year is planned to be renewed (every 6 years).

The main difference in the model with respect to the Colocation Scenario is that in Federation the cost estimation is absolute, instead of delta savings, thus both scenarios implementation timelines can be deployed independently.

Federation Scenario only applies to ANSPs within the FABEC and the FAB UK-IE. Therefore, for the geographical scope of the Federation Scenario, the next ANSPs are identified as potential cost savers when implementing COSER E-AMAN capabilities:

| E-AMAN instances | ANSPs | APTs |
|---|---|---|
| **1 E-AMAN instance** | Skyguide, Belgocontrol, IAA, LVNL | ZRH, BRU, DUB, AMS |
| **2 E-AMAN instances** | N/A | N/A |
| **3 E-AMAN instances** | DSNA | CDG, ORY, NCE |
| **4 E-AMAN instances** | DFS, NATS | FRA, MUC, DUS, BER, LHR, LGW, STN, MAN |

**Table 28: Identified ANSPs within the Federation Scenario geographical scope at least one E-AMAN instance that can benefit from implementing COSER capabilities**

The Solution Scenario deployment timeline can be observed in the Figure 13, for 2027 as the IOC year and a renewal rate of 6 years.

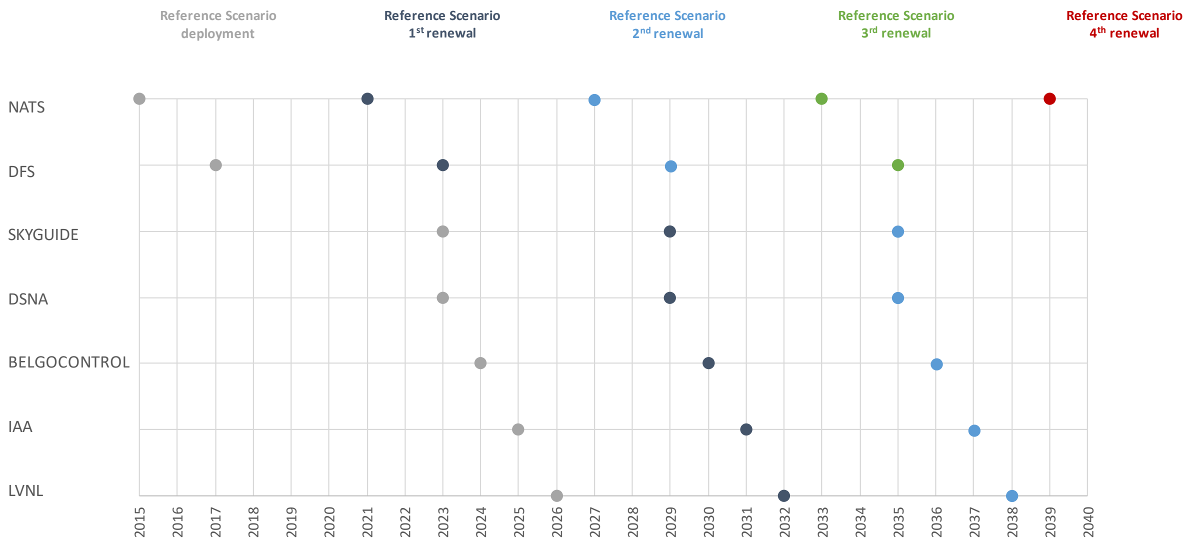


**Figure 13: Reference scenario deployment and renewal timeline for FABEC and FAB UK-IE only, for a renewal rate of 6 years and 2027 as the IOC year. CAPEX cost saving applies each time a point is found in the chart.**

**OPEX saving applies since the first point per ANSP appears (after IOC) and remains constant for the rest of the timeline.**

Please, note that CAPEX applies the same year of the implementation but the increase in the OPEX has been assumed to apply one year later than implementation.

## 6.6 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 2025 (two years before the IOC), based on expert judgement and the current solution maturity. Nevertheless, the NPV calculation takes into account from 2019 to 2040, being unity the discount factor in 2019 [44]. Finally, the payback year has been calculated using the discounted cumulative cash flow.

# 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 main stakeholders impacted: ANSPs and COSER provider.
- The impact of PJ.15-02 on the Operating Expenditures (OPEX) has been analysed and the additional costs on top of what could be expected of the Reference Scenario have been estimated in the cost assessment and integrated into the CBA Model as well. Those costs are difficult to assess and thus will be taken into account in the Sensitivity Analysis and further refined in TRL6 level.
- Benefits have been estimated and monetised in the CBA Model for the ANSPs.
- No other benefits, rather than Cost Efficiency, are provided for ANSPs since they cannot be demonstrated or validated.

Results of the 2 defined solution scenarios are described next, including cash flow analysis, NPV and payback year calculation.

## 7.1 Solution Scenario: Colocation

### 7.1.1 Colocation Scenario

Costs and benefits for ANSPs are presented in the table below:

- ANSPs savings over the period 2019-2040 add a total of 29.6 M€, split between CAPEX saving (17.9 M€) and OPEX savings (11.7 M€).
- At the end of the time horizon, the overall net undiscounted savings are 29.6 M€ (8.3 M€ with an 8% discount rate).

| | Concept | Value | Units |
|---|---|---|---|
| **Solution scenario – Colocation** | **Number of ANSPs** | 14 | ANSPs |
| | **Number of APTs** | 25 | APTs |
| | **Number of E-AMAN instances** | 14 | Instances |
| **Reference scenario – PCP ECAC** | **Number of ANSPs** | 14 | ANSPs |
| | **Number of APTs** | 25 | APTs |
| | **Number of E-AMAN instances** | 25 | Instances |
| **Total savings and costs** | **Total cumulated CAPEX saving (periodic CAPEX & conversion cost)** | 17.9 | M€ |
| | **Total cumulated OPEX saving** | 11.7 | M€ |
| **Balance** | **Total benefit** | **29.6** | **M€** |
| | **Payback year** | **2029** | **year** |
| | **NPV** | **8.3** | **M€** |

**Table 29 CBA inputs and results for the 2019-2040 timeframe**

Figure 14 provides an overview of the ANSPs level of investment, expected benefits (cost savings) and cash flow evolution over the period 2019-2040:

- The ANSPs CAPEX savings of 26.1 M€ are periodically spread over the period 2020 to 2040 every 6 years. The once-only conversion cost implies 8.2 M€ that reduces this CAPEX saving to 17.9M€. The corresponding OPEX savings increases according to the implementation of the toolkits.
- During the implementation years the OPEX saving will increase from 0.2 M€/year to 1.0 M€/year, once the last ANSP has moved to the COSER solution and remaining constant until the end of the timeframe (2040).
- Last conversion cost (Costs of IP in the chart) applies in 2030, thus, one year before the last ANSP to implement the E-AMAN COSER capability. The total conversion cost of 8.2 M€ is split between the 5 implementing ANSPs, going from 0.7 M€ for 2 E-AMAN instances ANSPs (i.e. ENAV) to 2.0 M€ for 4 E-AMAN instances ANSPs (i.e. NATS).
- The breakeven point is achieved in 2029, once the cumulated cash flow recovers from the initial expense in conversion, which is overcome by the CAPEX and OPEX savings.
- The avoided cost per year follows is cyclic once the FOC is reached, since the renewal rate for the CAPEX saving is 6 years, whereas the OPEX saving remains constant.

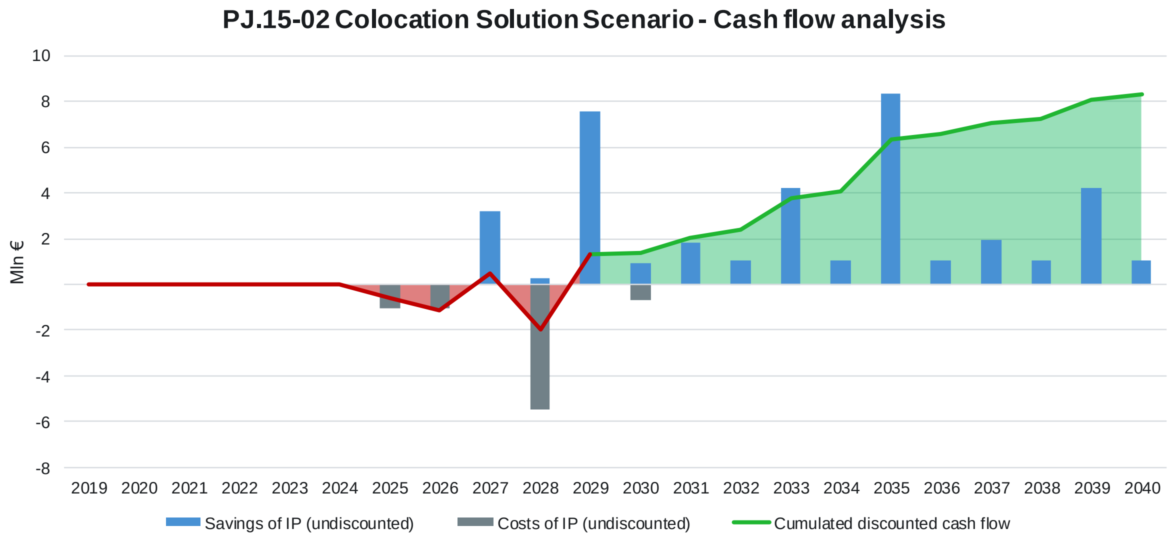


**Figure 14: Cash flow analysis (2019-2040) for the Colocation Scenario**

## 7.2 Solution Scenario: Federation

In the Federation Solution Scenario, it must be noticed that the benefits (cost saving) of implementing a Federated COSER provider have been estimated based on inputs of the Colocation Scenario stakeholders. Thus, the results must be analysed with major caution.

### 7.2.1 Cloud-based COSER provider

Costs and benefits for ANSPs are presented in the table below:

- ANSPs savings over the period 2019-2040 add a total of 36.5 M€, split between CAPEX saving (24.5 M€) and OPEX savings (12.0 M€).
- Implementation costs over the period 2019-2040 add a total of 11.5 M€, split between CAPEX cost (3.4 M€) and OPEX cost (4.8 M€) for the COSER provider and a CAPEX cost of 3.3 M€ for the ANSP.
- At the end of the time horizon, the overall net undiscounted savings are 25.0 M€ (7.7 M€ with an 8% discount rate).

| | Concept | Value | Units |
|---|---|---|---|
| **Solution scenario – Federation** | **Number of ANSPs** | 7 | ANSPs |
| | **Number of APTs** | 15 | APTs |
| | **Number of E-AMAN instances** | 15 | Instances |
| **Reference scenario – FABEC + UK-IE** | **Number of ANSPs** | 14 | ANSPs |
| | **Number of APTs** | 25 | APTs |
| | **Number of E-AMAN instances** | 25 | Instances |
| **Total savings and costs** | **Total ANSP CAPEX saving** | 24.5 | M€ |
| | **Total ANSP OPEX saving** | 12.0 | M€ |
| | **Total ANSP CAPEX cost** | 3.2 | M€ |
| | **Total ANSP OPEX cost** | N/A | M€ |
| | **Total COSER provider CAPEX cost** | 3.4 | M€ |
| | **Total COSER provider OPEX cost** | 4.8 | M€ |
| **Balance** | **Total benefit** | **25.0** | **M€** |
| | **Payback year** | **2027** | **year** |
| | **NPV** | **7.7** | **M€** |

**Table 30 CBA inputs and results for the 2019-2040 timeframe**

Figure 15 provides an overview of the ANSPs level of investment, expected benefits (cost savings) and cash flow evolution over the period 2019-2040:

- The ANSPs CAPEX savings of 24.5 M€ are periodically spread over the period 2019 to 2040 every 6 years. The corresponding OPEX savings increase according to the implementation of the solution scenario.
- During the implementation years, the OPEX saving will increase from 0.3 M€/year to 1.0 M€/year, once the last ANSP has moved towards the COSER solution, and remaining constant until the end of the timeframe (2040).
- The breakeven point is achieved in 2027, once the cumulated cash flow recovers from the initial expense, which is overcome by the CAPEX and OPEX savings.
- The avoided cost per year follows is cyclic once the FOC is reached, since the renewal rate for the CAPEX saving is 6 years, whereas the OPEX saving remains constant.

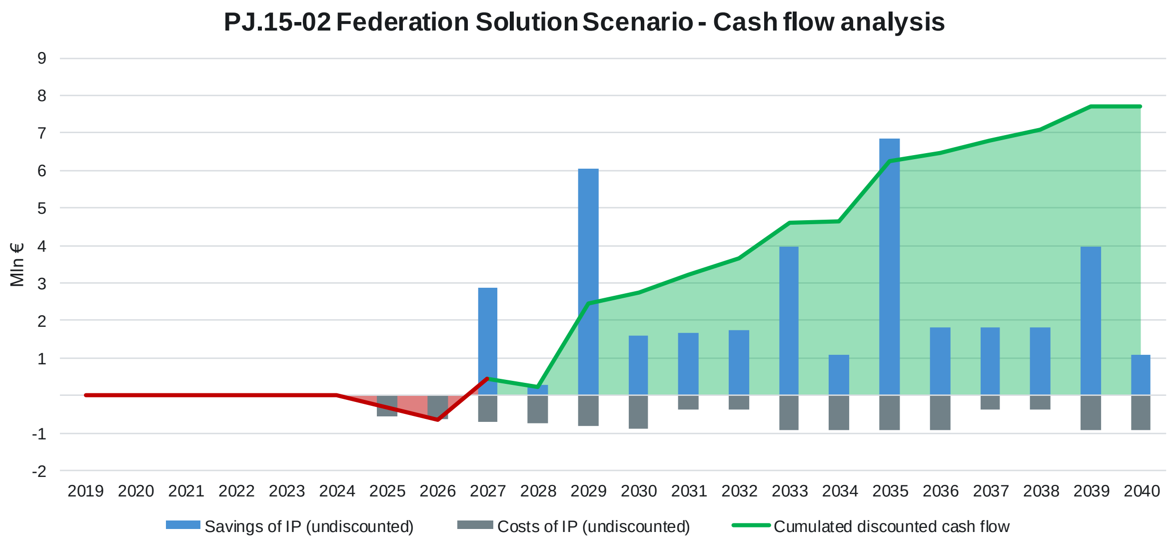


**Figure 15: Cash flow analysis (2019-2040) for the Federation Scenario – Cloud-based**

### 7.2.2 Traditional installation COSER provider

Costs and benefits for ANSPs are presented in the table below:

- ANSPs savings over the period 2019-2040 add a total of 36.5 M€, split between CAPEX saving (24.5 M€) and OPEX savings (12.0 M€). These savings are equal to the cloud-based option
- Implementation costs over the period 2019-2040 add a total of 25.8 M€, split between CAPEX cost (4.6 M€) and OPEX cost (2.0 M€) for the COSER provider and CAPEX cost (10.3 M€) and OPEX cost (8.8 M€) for the ANSP.
- At the end of the time horizon, the overall net undiscounted savings are 10.7 M€ (2.9 M€ with an 8% discount rate).

| | Concept | Value | Units |
|---|---|---|---|
| Solution scenario – Federation | Number of ANSPs | 7 | ANSPs |
| | Number of APTs | 15 | APTs |
| | Number of E-AMAN instances | 15 | Instances |
| Reference scenario – FABEC + UK-IE | Number of ANSPs | 14 | ANSPs |
| | Number of APTs | 25 | APTs |
| | Number of E-AMAN instances | 25 | Instances |
| Total savings and costs | Total ANSP CAPEX saving | 24.5 | M€ |
| | Total ANSP OPEX saving | 12.0 | M€ |
| | Total ANSP CAPEX cost | 10.3 | M€ |
| | Total ANSP OPEX cost | 8.8 | M€ |
| | Total COSER provider CAPEX cost | 4.6 | M€ |
| | Total COSER provider OPEX cost | 2.0 | M€ |

| | Concept | Value | Units |
|---|---|---|---|
| Balance | Total benefit | 10.7 | M€ |
| | Payback year | 2029 | year |
| | NPV | 2.9 | M€ |

**Table 31 CBA inputs and results for the 2019-2040 timeframe**

Figure 16 provides an overview of the ANSPs level of investment, expected benefits (cost savings) and cash flow evolution over the period 2019-2040:

- The ANSPs CAPEX savings of 24.5 M€ are periodically spread over the period 2019 to 2040 every 6 years. The corresponding OPEX savings increase according to the implementation of the solution scenario.
- During the implementation years, the OPEX saving will increase from 0.3 M€/year to 1.0 M€/year, once the last ANSP has moved towards the COSER solution, and remaining constant until the end of the timeframe (2040).
- Notice that cost savings are equal to the cloud-based option.
- The breakeven point is achieved in 2029, once the cumulated cash flow recovers from the initial expense, which is overcome by the CAPEX and OPEX savings.
- The avoided cost per year follows is cyclic once the FOC is reached, since the renewal rate for the CAPEX saving is 6 years, whereas the OPEX saving remains constant.

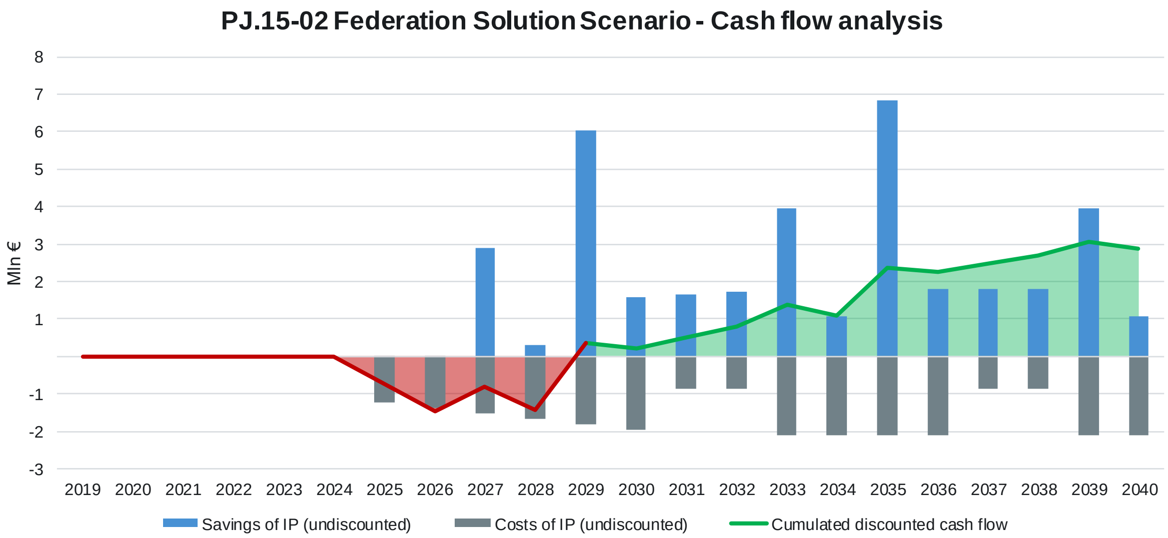


Figure 16: Cash flow analysis (209-2040) for the Federation Scenario – Traditional installation

# 8 Sensitivity and risk analysis

The following section provides an analysis of the impact of the main uncertainties identified when designing the PJ.15-02 CBA Model and calculating the final NPV.

These uncertainties come mainly from the internal estimation, based on stakeholder expert judgement, on cost savings and entry into service date of the Solution Scenarios. 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: Colocation

### 8.1.1 Variables analysed and associated uncertainties

Table 32 shows the most sensitives variables regarding the uncertainty that every cost assessment or entry into operation estimation implies.

| | Concept | Description | Decrement | Baseline | Increment |
|---|---|---|---|---|---|
| **Cost estimation** | **CAPEX** | Particularised for the cost saving for a 2, 3 and 4 E-AMAN instances ANSP | -10% | See Table 26 | +10% |
| | **OPEX** | Particularised for the cost saving for a 2, 3 and 4 E-AMAN instances ANSP | -10% | See Table 26 | +10% |
| | **Exchange rate** | Rate at which the CAPEX saving applies | -1 year | 6 | +1 year |
| **Entry into service estimation** | **IOC year** | Initial operational capability year | N/A | 2021 | +1 year |

**Table 32 Variable analysed in the sensitivity analysis for the Colocation Scenario**

### 8.1.2 Sensitivity and risk analysis

Figure 17 shows the results of the sensitivity analysis on the NPV value. The major conclusions, applicable for both of them, are highlighted below:

- The most sensitive variable is the exchange rate. This is due to the fact that the number of times that the CAPEX saving applies within the CBA timeframe is determined by this factor.
- Regarding the CAPEX and OPEX values, the higher the number of E-AMAN instances, the higher the impact on the NPV. This point is explained by the fact that the cost savings grow in absolute terms with the number of E-AMAN instances.
- Finally, the IOC year does not have a big impact in comparison with the rest of the assessed variables.

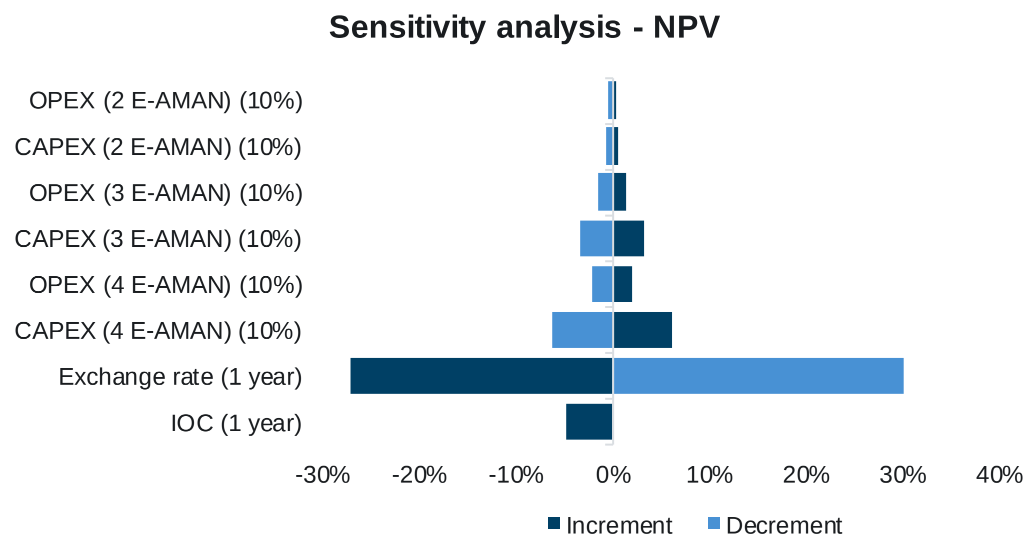


**Figure 17: Sensitivity analysis for the Colocation Scenario**

Nevertheless, it must be noticed that for all the analysed variables the NPV remains positive and, therefore, the business case shows to be robust and well justified.

## 8.2 Solution Scenario: Federation

### 8.2.1 Variables analysed and associated uncertainties

Table 33 shows the most sensitives variables regarding the uncertainty that every cost assessment or entry into operation estimation implies.

| | Concept | Description | Decrement | Baseline | Increment |
|---|---|---|---|---|---|
| **Cost estimation** | **CAPEX** | Particularised for the cost and savings of the ANSP and of the COSER provider | -10% | See Table 26 | +10% |
| | **OPEX** | Particularised for the cost and savings of the ANSP and of the COSER provider | -10% | See Table 26 | +10% |
| | **Exchange rate** | Rate at which the CAPEX saving applies | -1 year | 6 | +1 year |
| **Entry into service estimation** | **IOC year** | Initial operational capability year | N/A | 2021 | +1 year |
| | **FOC year** | Final operational capability year | -1 year | 2027 | +1 year |

**Table 33 Variable analysed in the sensitivity analysis for the Colocation Scenario**

### 8.2.2 Sensitivity and risk analysis – Cloud-based option

Figure 18 shows the results of the sensitivity analysis on the NPV value. The major conclusions, applicable for both of them, are highlighted below:

- The most sensitive variable is the exchange rate. This is due to the fact that the number of times that the CAPEX saving applies within the CBA timeframe is determined by this factor.

- Regarding the CAPEX and OPEX values, the ANSP saving values are the ones with more influence in the model. The baseline value of these parameters has been estimated based on the Colocation scenario inputs. Therefore, the results of the CBA model may not be accurate.

- Finally, the IOC year shows a higher impact than the FOC. This is due to the fact that, in the CBA model, the FOC year only affects the deployment of the COSER provider and the implementation of the ANSP as a data provider; whereas the savings are determined by the actual implementation plan (see Figure 11).

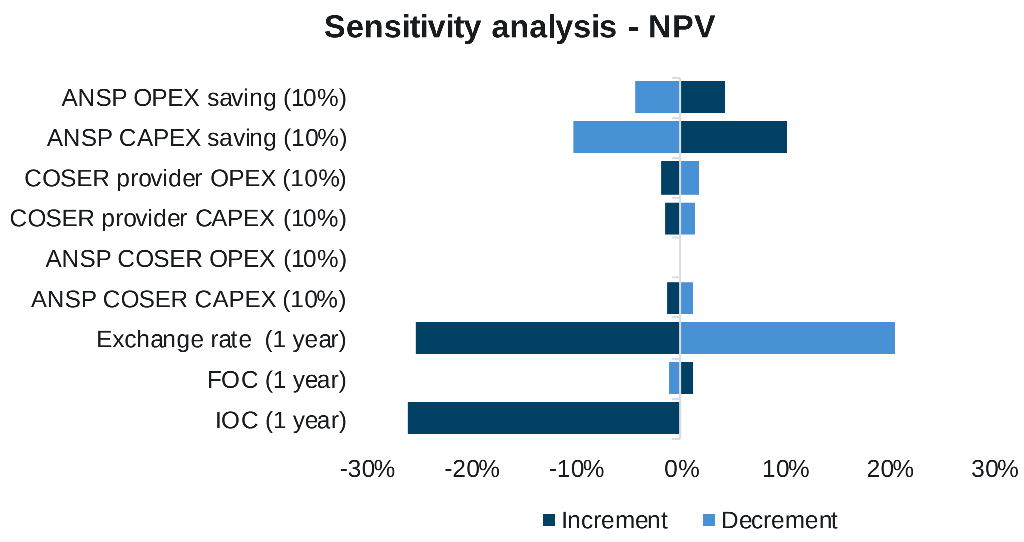


**Figure 18: Sensitivity analysis for the Federation Scenario – Cloud-based**

### 8.2.3 Sensitivity and risk analysis – Traditional installation option

The Traditional installation option shows a similar behaviour within the sensitivity analysis to the one for the cloud-based option.

The business case for the Federation Solution Scenario happens to be less robust and stable than the one for the Colocation Scenario. This fact may be due to the estimation on the scenario savings that have been performed. This estimation, not based on actual stakeholder inputs about the federating scenario, seems to be a source of a high degree of uncertainty in the model.

The recommendation of TRL6 would be to reassess, if possible, the potential benefits of this scenario and achieve a more precise monetisation of them.

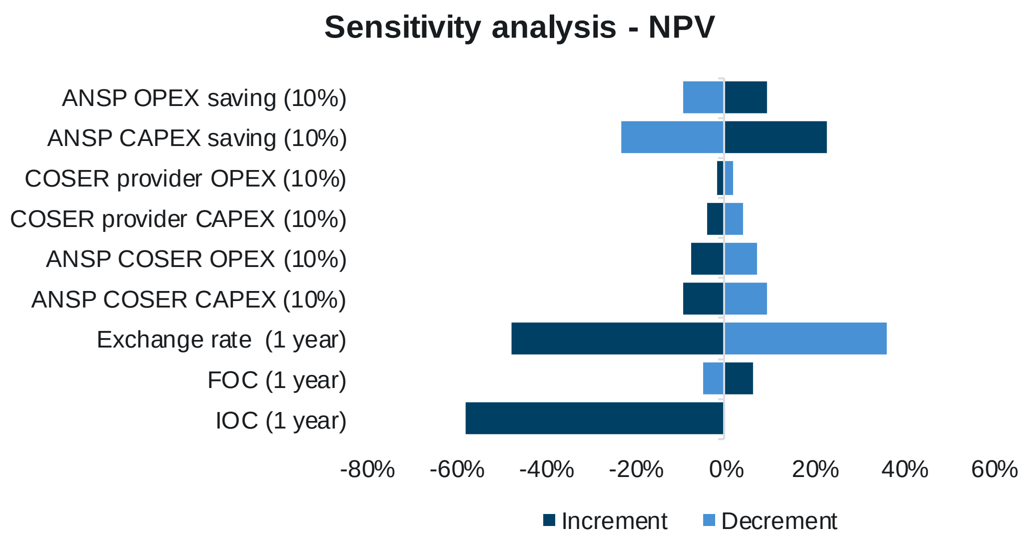


**Figure 19: Sensitivity analysis for the Federation Scenario – Traditional installation**

# 9 Recommendations and next steps

The PJ.15-02 stakeholders have made a considerable effort on the CBA assessment for the TRL6. The cost and benefit estimation has resulted on the production of the cash flow analyses, payback year estimation and NPV calculation for both Colocation and Federation Scenario, ending up in the first version of the CBA document.

The progress done for the Colocation Scenario seems to be enough for TRL6 maturity level. Regarding this scenario, a further round of stakeholders review for the cost assessment would be advisable to keep updated the cost figures, as the solution development continues and the industrialisation phase progresses.

However, in the case of the Federation Scenario, the cost assessment has achieved the same level of accuracy and progress than the Colocation one, but the benefits would need to be addressed in a more precise way. As it has been already discussed, the current version of the CBA includes an estimation of these benefits based on the Colocation scenario. This estimation should be further refined in future versions of the CBA and, if possible, substituted by an estimation based on inputs for the Federation scenario coming from the stakeholders. This may be considered as a task to be developed during the industrialisation phase, since further inputs will be available as the solution development continues.

# 10 References and Applicable Documents

## 10.1 Applicable Documents


[1] SESAR PJ.15-02, Business Model (V2) for Delay Sharing Common Service, 00.01.01

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

[3] SESAR B4.5, D02 Options Of Common Services 00.01.00

[4] SESAR B4.5, D15 PJ.15-02 COST BENEFIT ANALYSIS (CBA) FOR E-AMAN Common Service, 00.02.01

[5] Final SESAR 1 Maturity Assessment Report Executive Summary, 01.00.00

[6] SESAR P05.06.07, D53 Update of 5 6 4 SPR-INTEROP - Step 1 - Edition 2, 00.01.00, Safety and Security Risk assessment, Safety Requirements, as well as Information Exchange requirements containing Safety / Security relevant aspects

[7] SESAR P.05.06.04, D34-001 Safety Assessment Report for Tactical TMA and En-route Queue Management, Edition 00.01.06SESAR

[8] P05.06.07, D49 VALR_EXE-5 6 7-VP-695, 00.02.00, Safety Assessment Plan in Appendix A

[9] Security Prioritisation 01_00_00(1.0).xls, 31.10.2017

[10]SESAR2020 CBA Template

[11]ICAO Global Operating concept Doc 9854

[12]SESAR 2020 Multi Annual Work Programme, edition V1.0, 08/07/2015

[13] B04.05 - D04 Common Services Foundation Method

[14]FABEC XMAN/AMAN Roadmap, Version 3.1, 03.11.2016

[15]SESAR PJ.15-02, D21 T-VALR TRL6 – E-AMAN, 00.01.00

[16]SESAR PJ.15-02, D21 T-SDD TRL6 – E-AMAN, 00.01.00

[17]SESAR 2020 Project Handbook

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

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


## 10.2 Reference Documents


[20]Business Model Generation. A. Osterwalder and Y. Pigneur. Wiley, 2010.

[21]SESAR 2020 D4.0.1 S2020 Common Assumptions. Edition 08.00.00 of 17 May 2018.

[22]EUROCONTROL: Challenges of Growth 2013, Task 4: European Air Traffic in 2035. Edition June 2013.

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

[24]SESAR Frequently Asked Questions. Extended Arrival Manager (E-AMAN).

[25]SESAR Demonstration. Extended AMAN. Presentation at the World ATM Congress 2015, Madrid.

[26]Release 4 SESAR1 Solution #05 Extended Arrival Manager Horizon. Contextual note – SESAR Solution description form for deployment planning. Accessed on 10/04/2017 via: http://www.sesarju.eu/sesar-solutions/advanced-air-traffic-services/extended-arrival-management-aman-horizon

[27]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

[28]European ATM Portal – Working view. Accessed on 19/02/2019 via: https://www.eatmportal.eu/working/depl/essip_objectives/map

[29]EUROCONTROL: SEVEN-YEAR FORECAST February 2017, Flight Movements and Service Units 2017-2023.

[30]SESAR1 B.04.03 - D102 Service Method Update 2015 Report

[31]SESAR1 B.04.05 - T3 Service Identification

[32]SESAR 2020 D4.1 Performance Framework (2017)

[33]SESAR 2020 D4.5 Validation Targets (2018)

[34]European ATM Master Plan 2018 – Level 3 – Implementation View

[35]European ATM Portal (eATM Portal). Accessed on 21/09/2018 via: https://www.eatmportal.eu/working/depl/essip_objectives/1000255

[36]Common assumptions for CBAs as maintained by PJ19

[37]SESAR C.02-D110, Updated D02 after MP Campaign, Edition 00.01.00

[38]SESAR 2020 D108, Transition Performance Framework, Edition 00.06.00

[39]SESAR 2020 D86, Guidance on KPIs and Data Collection – Support to SESAR2020 transition

[40]SESAR Proposal on the content of a Pilot Common Project , Edition 1.0

[41]SESAR Recommendation on the content of a Common Project 2, Edition 00.01.01

[42]Standard inputs for EUROCONTROL Cost-Benefit Analyses, 2018, Ed. 8.0

[43]SESAR eATM portal – Solution PJ.15-02 – E-AMAN Service. Accessed on 19-06-2019: https://www.eatmportal.eu/working/data/sesar_solutions/16109430

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

# Appendix A Airports falling under the PCP EU Regulation

As per Article 3 of the PCP EU regulation [2], Extended Arrival Management and Performance Based Navigation in the High Density Terminal Manoeuvring Areas is among the ATM functionalities that will have to be implemented by a selected set of stakeholders. As per 1.3 in the Annex:

*"ATS providers and the Network Manager shall ensure that ATS units providing ATC services within the terminal airspace of the airports referred to in point 1.2 and the associated en-route sectors operate Extended AMAN and PBN in high density TMAs as from 1 January 2024".*

## A.1 EU and EFTA Member States

Extended AMAN and PBN in high density TMAs and associated en-route sectors shall be operated at the following airports:

| No. | Airport name | IATA Airport code | Country |
|---|---|---|---|
| 1 | London-Heathrow | LHR | United Kingdom |
| 2 | Paris-CDG | CDG | France |
| 3 | London-Gatwick | LGW | United Kingdom |
| 4 | Paris-Orly | ORY | France |
| 5 | London-Stansted | STN | United Kingdom |
| 6 | Milan-Malpensa | MXP | Italy |
| 7 | Frankfurt International | FRA | Germany |
| 8 | Madrid-Barajas | MAD | Spain |
| 9 | Amsterdam Schiphol | AMS | Netherlands |
| 10 | Munich Franz Josef Strauss | MUC | Germany |
| 11 | Rome-Fiumicino | FCO | Italy |
| 12 | Barcelona El Prat | BCN | Spain |
| 13 | Zurich Kloten (1) | ZRH | Switzerland |
| 14 | Düsseldorf International | DUS | Germany |
| 15 | Brussels National | BRU | Belgium |
| 16 | Oslo Gardermoen (2) | OSL | Norway |
| 17 | Stockholm-Arlanda | ARN | Sweden |
| 18 | Berlin Brandenburg airport | BER | Germany |
| 19 | Manchester Ringway | MAN | United Kingdom |
| 20 | Palma de Mallorca Son San Juan | PMI | Spain |
| 21 | Copenhagen Kastrup | CPH | Denmark |

| | | | |
|---|---|---|---|
| 22 | Vienna Schwechat | VIE | Austria |
| 23 | Dublin | DUB | Ireland |
| 24 | Nice Cote d'Azur | NCE | France |

**Table 34: PCP E-AMAN implementing airports, belonging to EU and EFTA member states**

## A.2 Other third countries

Extended AMAN and PBN in high density TMAs should be operated at the Istanbul Ataturk Airport:

| No. | Airport name | IATA Airport code | Country |
|---|---|---|---|
| 25 | Istanbul Ataturk | IST | Turkey |

**Table 35: PCP E-AMAN implementing airports, non-belonging to EU and EFTA member states**

# Appendix B LSSIP 2018. Implementation view for ATC15.2

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.

## B.1 ATC15.2 Arrival Management extended to en-route airspace

| MS | Overall Progress | L1 Comments | L1 Implementation date | L1 % completed | IATA APT code |
|---|---|---|---|---|---|
| AT | Ongoing | Apart from the implementation of the basic AMAN tool, which has been put into operation in November 2018, the upgrade of the ATC System (TopSky/COOPANS) will coherently support the functionality of an Extended AMAN (AMA messages to be processed and likewise to be distributed, plus processing of those data, providing the most accurate trajectory prediction information available) Concluding, the Extended AMAN is considered as a collaborative project with all adjacent partners / ATC Units concerned, plus Network Manager.<br>Timeframe to become fully operational with all eligible ATC Units is estimated till end 2023 at the latest. | 31/12/2023 | 6% | VIE |
| BE | Not yet planned | Refer to ASP comments | - | 0% | BRU |
| CH | Ongoing | An AMAN is implemented in Zurich. In the frame of the FABEC activities an XMAN project was launched<br>in 2015. Initial step is to receive XMAN information (Munich) from DFS and integrate them in Zurich<br>ACC for operational use by ACC ATCOs. Also with this step, XMAN information is sent to Munich, Langen<br>& Reims for operational use by ACC ATCOs of these adjacent centres. | 31/12/2023 | 49% | ZRH |

| | | | | | |
|---|---|---|---|---|---|
| DE | Completed | In line with the PCP Implementing Rule 716/2014 and the associated Deployment Programme, the planning horizons of the AMAN systems serving Frankfurt, Munich, Dusseldorf and Berlin airport will be extended up to 220NM into the area of responsibility of identified upstream control centres until the given PCP deadline (31.12.2023). Due to dependencies of neighbouring partners and their schedules, the connections to all upstream centres and vice versa still require time. However, the objective is considered as “Completed” because the DFS systems, procedures and agreements are ready and prepared for implementation. | 12/10/2017 | 100% | FRA, MUC, DUS, BER |
| DK | Completed | Functionality technically implemented with OLDI. Only in use with Malmo ACC. For now it is not judge necessary to extent implementation to other ACCs due to the traffic demand at EKCH and we haven't received requests from neighbouring ACCs to receive AMA messages from other Airports. When future demand and request necessitate this the functionality will be extended to cover this as well | 30/06/2018 | 100% | CPH |
| ES | Planned | ENAIRE has finished (31/10/2018) the deployment of objective ATC15.1 (Implement, in en-route sectors, information exchange mechanisms, tools and procedures in support of basic AMAN) for the availability of AMAN sequence in the en-route sectors. Once completed that objective, the systems will be upgraded to meet the requirements of ATC15.2 | 31/12/2023 | 0% | MAD, BCN, PMI |
| FR | Ongoing | The objective should be fully implemented by the end of 2023 | 31/12/2023 | 73% | CDG, ORY, NCE |
| IE | Not yet planned | New objective. While there is no specific plan commenced, the IAA has responsibility for delivery of traffic from the en-route airspace to state airports in Ireland: EIDW, EICK, EINN and Regional, non-state airports: EIDL, EISG, EIKN, EIKY and EIWF. This task is managed internally with the IAA ATM system for state airports and more manually for non-state airports.<br>In line with the ATC 15.1 objective, it is the position of the IAA that there is no need for further development in this area, when the geographical location of IAA controlled en-route airspace and the interfaces with this airspace are considered.<br>This objective will be re-visited for the LSSIP 2017 report. | - | 0% | DUB |

| | | | | | |
|---|---|---|---|---|---|
| IT | Ongoing | ENAV is going to implement AMAN concept, investing in a solution able to offer the functionalities of the Basic AMAN combined with the feasibility to extend the operational horizon of the tool from the TMA to the En-route scenario, according to PCP EU Regulation 716/2014 timing and system requirements | 31/12/2019 | 20% | MXP, FCO |
| NL | Not yet planned | In 2017 LVNL has developed an AMAN roadmap. Extended AMAN to en-route airspace is part of this roadmap. No activities are planned yet. | - | 18% | AMS |
| NO | Ongoing | Extended AMAN is planned and functionality will be part of new ATM system. It will not be a part of the initial delivery, but the new ATM system will be designed to support implementation of extended AMAN. | 31/12/2023 | 10% | OSL |
| SE | Ongoing | - | 31/12/2019 | 26% | ARN |
| TR | Completed | Extended AMAN project for Istanbul TMA and related ACC sectors including Sofia ACC has been started. | 31/12/2018 | 100% | IST |
| UK | Completed | NATS provides extended arrival management (XMAN) for Heathrow only at this time. We are currently working on bringing Gatwick XMAN on-line via a SESAR 2020 project as a trial. | 30/04/2015 | 100% | LHR, LGW, STN, MAN |

**Table 36: ATC15.2 Arrival Management extended to en-route airspace implementation status**

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