

SESAR Solution #118 - Cost Benefit Analysis (CBA) for V3

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BASIC EXTENDED ATC PLANNING FUNCTION



Abstract

This document is the final version of the Cost Benefit Analysis, at V3 level, for the deployment of the SESAR Solution #118 - Basic EAP (Extended ATC Planning) function.

The basic EAP (*bEAP*) function consists of an **automated tool supporting the basic communication** between the Local DCB position and the Controllers' Work Positions to be deployed in En-route operating environments of **Medium and High complexity**.

The basic EAP function is expected to facilitate the implementation of ATFCM measures to better match capacity to predicted demand and to reduce the complexity of traffic presentation in order to suit available capacity.

The CBA is firstly presented at a **generic individual level** corresponding to an En-Route **Medium/High complexity operating environment** and then consolidated at the ECAC level

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1 Executive Summary

This document provides the Cost-Benefit Analysis (CBA) related to **Solution #118 - Basic EAP (Extended ATC Planning)** function at V3 level.

The CBA provides an analysis of the most relevant costs and benefits linked to the deployment of Solution #118 and obtain some economic metrics that demonstrate the feasibility of the project. Economic and technical assumptions are described in the document in order to be consistent in the study.

This Cost-Benefit Analysis provides results at two levels:

- Firstly, at a **generic individual level**, corresponding to the **target Operational Environment**, (En-Route, high complexity and/or demand) in support of individual deployment decisions.
- Then, consolidated at the **ECAC level** about the economic and financial viability of deploying the Solution #118 at the European scale.

In addition to the CBA, a sensitivity analysis has been performed to evaluate the impact of **major CBA assumptions** on the results, namely:

- The discount rate;
- The operational organisation of the EAP role; and
- The benefits of the ATCO productivity increase.

The CBA results and the sensitivity analysis show that, in any case, the **payback period** is **2021** therefore less than a year and an half after the investment.

The NPV (Net Present value) obtained is **20.4 M€** at ACC level and **220.1 M€** at ECAC level, taking into account that the Solution #118 will operate from 2020 to 2025 (six years) and the implementation will be done in the first year (2020).

Over the six years of operations the CBA shows a **positive return on investment** indicator of around **5%** for both levels.

As a conclusion of this economic study, it can be confirmed that the implementation of Solution #118 will obtain a positive NPV either at individual ACC level or at ECAC level meaning the project is feasible in economic terms. Moreover those results and the short term payback period decrease the risk level of the solution #118 for potential investors.

2 Introduction

2.1 Purpose of the document

This document provides the Cost-Benefit Analysis (CBA) related to **Solution #118 - Basic EAP (Extended ATC Planning)** function at V3 level.

This CBA investigates whether the benefits of the deployed Solution #118 are expected to exceed the costs over the CBA time horizon, namely **2020-2021**.

The CBA results are expected to support the decision of interested stakeholders (ANSPs) to move towards **operational implementation**.

2.2 Scope

The benefits investigated for Solution #118 - Basic EAP (Extended ATC Planning) function are those evaluated in the scope prepared for the SESAR 1 validation exercise VP687 performed by DSNA in June 2015 in the Reims UAC. To achieve a V3 maturity level, the VP687 VALR (D78) has been enriched with the outcomes from the **4ME** system, a tool operationally deployed in Reims UAC since 2016, which is used as an **enabler for basic EAP** (to display information on CWPs).

The Cost-Benefit Analysis provides results at two levels:

- Firstly, at a **generic individual level**, corresponding to the **target Operational Environment**, (En-Route, high complexity and/or demand) in support of individual deployment decisions, despite the interested parties will have to refine the mechanisms and inputs used in this CBA and review them for adaptation to their local context.
- Then consolidated at the **ECAC level** about the economic and financial viability of deploying the Solution #118 at the European scale.

2.3 Intended readership

The intended audience for this CBA is:

- The key stakeholders targeted by the Solution, i.e.
 - **Airspace Users** who will be directly impacted by the deployment of the *basic* EAP function in En-Route airspace;
 - **ANSPs (Air Traffic Controllers)** who will benefit from a smoothed workload and less complex traffic situations thanks to the STAM or decomplexification measures enabled by the *basic* EAP function, especially in hotspot areas;
- SESAR 2020 PJ09.02 members:

At the time of publication of this VALR, PJ09.02 is developing a solution for the full **EAP concept**; and

- SESAR 2020 Projects developing solutions that can benefit from the deployment of the basic EAP function.

2.4 Structure of the document

This CBA is composed of ten chapters:

- Chapter 2 presents the document purpose, scope and intended readership;
- Chapter 3 provides the general objectives and scope of the CBA;
- Chapter 4 describes the detailed analysis of the benefits of solution #118;
- Chapter 5 presents the cost assessment of solution #118;
- Chapter 6 presents the CBA model;
- Chapter 7 presents the results of the CBA;
- Chapter 8 provides the sensitivity and risk analysis;
- Chapter 9 contains the recommendations stemming from the analysis performed;
- Chapter 10 provides the list of references and applicable documents

2.5 Background

In 2006, DSNA started to work on the concept of a complementary role to the existing Flow Manager to fill the gap between the ATFCM and the ATC. This concept was deemed to be much promising in terms of safety and capacity and moreover, the R&D work to be done was estimated compliant with the SESAR timeframe.

In 2013, the Integrated Network and extended ATC Planning concept (INAP) emerged from projects P04.02 and P07.02. This concept is introducing a new role, the **Extended ATC Planning (EAP)** role, which is intended to fill the gap between ATFCM and ATC.

2.6 Glossary of terms

Term	Definition	Source of the definition
HICP	The Harmonised Index of Consumer Prices is an indicator produced by each European Union member states to help measure their national inflation.	
Initial Operational Capability	Initial Operational Capability is the state archives when a capability is available in its minimum usefully deployable form. In other words, it identifies the start of benefits and the benefit ramp-up period.	<i>Wikipedia and 16.06.06-D68-New CBA Model and Method 2015-Part1 of 2</i>
Opportunity Cost	Opportunity cost refers to a benefit that a person could have received, but gave up, to take another course of action. Stated differently, an opportunity cost represents an alternative given up when a decision is made. This cost is, therefore, most relevant for two	<i>Investopedia</i>

Term	Definition	Source of the definition
	mutually exclusive events. In investing, it is the difference in return between a chosen investment and one that is necessarily passed up.	
Net Present Value	Net Present Value (NPV) is the sum of all discounted cash inflows and outflows during the time horizon period.	<i>Investopedia</i>

2.7 List of Acronyms

Acronym	Definition
ACC	Area Control Centre
ATM	Air Traffic Management
bEAP	Basic Extended ATC Planning
CWP	Controller Working Position
EAP	Extended ATC Planning
FOC	Full Operational Capability
HC	High complexity (airport)
HICP	Harmonised Indices of Consumer Prices
IOC	Initial Operational Capability
LC	Low complexity (airport)
LTM	Local Traffic Management
OE	Operational Environment
PIRM	Programme Information Reference Model
PAR	Performance Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
STAM	Short ATFCM Measure
TFV	Traffic Volume
TMA	Terminal Manoeuvring Area

3 Objectives and scope of the CBA

3.1 Problem addressed by the solution

The increase of air navigation services demand is forecasted to be up to 2.2% annually for IRF flight in Europe. This growth should lead to a total of 11 629 000 IFR flight in the European sky by 2023.

In addition, heterogeneity of the demand across the European airspace sector is not forecasted to rebalance. Currently, this disparity is illustrated in CAPA studies that highlight the Western and Eastern European situation as follows:

- The **10 biggest** western European airports represent together **34%** of the total passenger traffic of the region; and
- **10 eastern European airports** gather **46.06%** of the regional passenger traffic [22].

This demand attributes alongside other air navigation services' characteristics have created a disequilibrium between European airspace sectors. Indeed, some sectors have higher demand and/or more complex traffic than others.

The solution #118 aims, for specific highly complex ACC's, at:

- **Increasing the quality of service** provided to airspace users through reduced delays, better punctuality, fewer ATFCM regulations, while maintaining or even increasing safety.
- **Increasing the ACC's overall en-route capacity** due to the positive impact of the role on the controllers' productivity.

In addition, the basic EAP concept can be considered as a **potential enabler** for the deployment of functionalities such as Extended AMAN or Free Routing operations.

3.2 SESAR Solution description

Operational Concept Elements in the scope of the Solution

The SESAR Solution #118 - Basic EAP (Extended ATC Planning) function is defined in the applicable version of EATMA (Dataset 18) as follows:

Solution #118 — Basic EAP (Extended ATC Planning) function

The basic Extended ATC Planner aims at bridging the gap between Air Traffic Flow and Capacity Management (ATFCM) and Air Traffic Control (ATC) providing real-time and fine-tuning measures to solve ATFCM hotspots and to perform early measures to alleviate complexity closest to ATC activities.

The solution consists of an automated tool and associated procedures supporting the basic communication between the Local DCB position and the Controllers' Work Positions allowing the EAP and the ATC team in identifying, assessing and resolving local complexity situations.

The basic EAP relies on a real time integrated process for managing the complexity of the traffic with capability to reduce traffic peaks through early implementation of fine-tuned solutions to solve

workload imbalances at the local level, compatible with the short term timeframe of execution phase of the flights.

Operational improvement and expected benefits

The basic EAP (Extended ATC Planning) function introduces an initial automated interface together with the related procedures that will facilitate the communication between local DCB position and the Controllers' Work Positions through the provision of optimised solutions to solve workload imbalances compatible with the short term timeframe of execution phase of the flights.

The basic EAP concept introduces also a new role, the EAP role (Extended ATC Planning), which is intended to fill the gap between ATFCM and ATC as illustrated on Figure 1 below:

- The EAP is not an additional staff: it is a role covering a set of services/functions that can be assumed by different personnel of the ATSU (already existing actors, like TC or new actors like MSP or LTM);
- It is highly recommended that the EAP is holding or has held an ATCO rating in the concerned ATSU's airspace

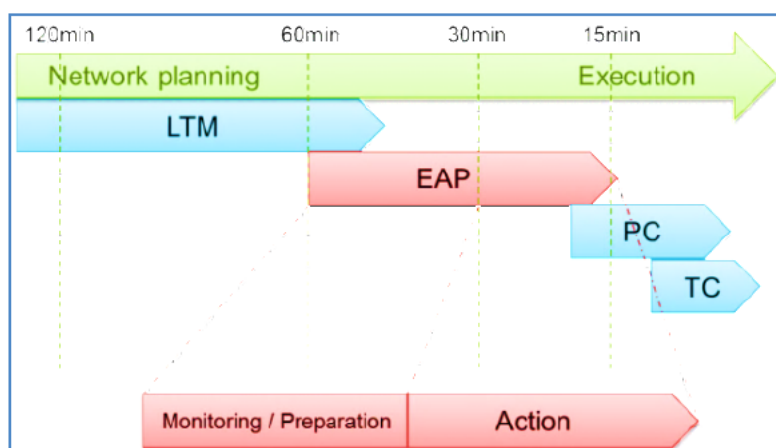


Figure 1: The EAP role fills the gap between ATFCM and ATC

OI Steps and Operational Enablers under the scope of the Solution

Table 1 below summarizes the relevant OI Steps under the scope of the Solution #118 as defined in the applicable version of EATMA.

SESAR Solution ID	OI Steps ID ref.	OI Steps Title	OI Step Coverage	Comments on the OI step title
Solution #118 Basic EAP (Extended ATC Planning) function	CM-0106	Initial support to INAP: basic (Extended ATC Planning) function	Fully covered	N/A

Table 1: SESAR Solution #118 Scope and related OI steps

Table 2 summarizes the relevant **Operational and/or Human Enablers** under the scope of the SESAR Solution according to the applicable version of EATMA.

OI Steps ref.	Enablers ID ref.	Enablers Definition	Enablers Coverage	Applicable stakeholder	Comments on the Enabler / definition
CM-0106	ER-ATC-164	ATC tools to re-organize traffic flows to reduce complexity in the execution phase	Full	ANSP	N/A
	PRO-220a	ATC Procedures related to Detection and Resolution of Complexity, Density and Traffic Flow Problems	Partial – Limited to the execution phase	ANSP	N/A
	PRO-220b	FCM procedures to describe how detection and resolution of complexity, density or traffic flow issues are managed.	Partial – Limited to the execution phase	ANSP	N/A

Table 2: Related Operational and/or Human Enablers

Figure 2 below illustrates OIS and related enablers linked to Solution #118.

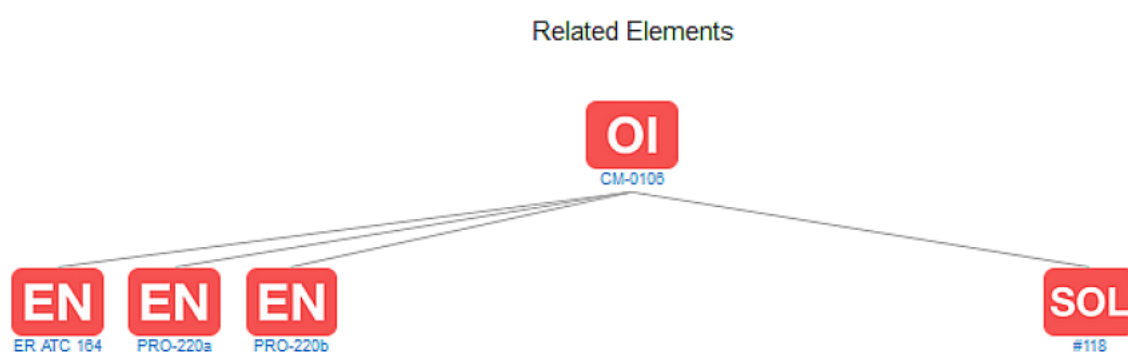


Figure 2: Solution #118 –OIS and related enablers

3.3 Objectives of the CBA

The Cost Benefit Analysis aims at monetising the solution’s cost and benefit in order to determine if the technical effectiveness of the project, presented in the VALR [10], is profitable in the long term for an ANSP and for the overall European Network (ECAC Level).

Therefore the Cost-Benefit Analysis will provide results at two levels:

- Firstly, at a **generic individual level**, corresponding to the **target Operational Environment**, (En-Route, high complexity and/or demand) in support of individual deployment decisions, despite the interested parties will have to refine the mechanisms and inputs used in this CBA and review them for adaptation to their local context.
- Then consolidated at the **ECAC level** about the economic and financial viability of deploying the Solution #118 – *basic EAP* at the European scale.

In order to answer to SESAR 2020 expectation regarding the CBA in V3, this CBA should include all the evidence gathered in terms of impacts, benefits and costs of a solution. The output should be the NPV overall and per stakeholder group, sensitivity and risk analysis, CBA model report and recommendation.

3.4 Stakeholders' identification

Stakeholder	The type of stakeholder and/or applicable sub-OE	Type of Impact	Involvement in the analysis	Quantitative results available in the current CBA version
ANSP	European High Complexity ACCs	Invest in the tool (purchase , implementation, training cost and non-monetized costs such as increase of the FMP workload) Enjoy the non-monetized benefits such as a complexity decrease or an ATCO workload decrease		Yes on both cost (fully) and benefit (partially)
Scheduled Airlines (Mainline and Regional)	All airlines that are using high complexity Airspace	Enjoy monetized benefit such as cost reduction through airborne and ground delays decrease	Not involved in the analysis	Benefits only, no costs

Table 3: SESAR Solution #118 CBA Stakeholders and impacts

3.5 CBA Scenarios and Assumptions

This section presents a brief description of the **reference scenario** and of the **Solution #118 implementation scenario**. In addition this section presents and argues the different general assumptions used to create the solution's framework for the CBA analysis.

3.5.1 Reference Scenario

The Reference Scenario reflects the situation at the start of implementation, with assumptions about what enablers are deployed and how deployment is likely to evolve **without the Solution #118** during the time horizon of the CBA.

The reference scenario of the CBA is based on the current situation of an ACC: it considers that the organisation of the control room is as follows:

- One FMP which executes its role during the ATFCM Horizon
- Two controllers (one planner and one organic) per position that manage the traffic during the ATC Horizon

This scenario takes as an assumption that **all other elements of the ACC environment are being equal**. Therefore, the reference scenario considers that no investments are made during the timeframe of the CBA in ATCO productivity or ATCO workload.

In addition, it is considered that the forecast of STATFOR is realistic, consequently the traffic will increase during the CBA timeframe.

Therefore, the reference scenario will result in a non-optimal situation with for example an increase of ATFCM Delays.

3.5.2 Solution scenario

This section presents the **Solution Scenario** i.e. the scenario corresponding to the deployment of the Solution #118 — Basic EAP (Extended ATC Planning) function.

A “delta” approach is followed to describe the Solution Scenario: only the differential elements implied by the Solution Scenario over the Reference are included in this analysis which establishes the framework used for the CBA.

This section addresses successively:

- The description of the solution deployed;
- The timeframe considered for the CBA;
- The analysis of the appropriate discount rate; and
- The Geographical scope considered for the CBA.

3.5.2.1 Solution deployed

The deployment of Solution #118 is based on both:

- The implementation of an **automated tool** supporting the basic communication between the Local DCB position and the Controllers' Work Positions; and
- The implementation of the **new EAP role**, which is an intermediary role between the ATFCM and the ATC Horizons.

The **EAP role** is expected to improve the efficiency of the procedures related to detection and resolution of complexity, density and traffic flow problems thanks to more up-to-date information.

For the CBA, it is assumed that this new role will be supported by the FMP and therefore the new organisation of an ACC would be described as follows:

- One FMP which executes its role during the ATFCM Horizon and the EAP role ;
- Two controllers (one Planning Controller and one Executive/Tactical Controller) per position that manage the traffic during the ATC Horizon

The EAP role will be supported by the implementation of two types of equipment one for the EAP agent and another one for the CWP. Both types of equipment will be linked to support the communication between the EAP and the controllers' work-positions.

The solution scenario addresses the following OIS and Enablers:

- OI Step CM-0106 Initial support to INAP: basic EAP (Extended ATC Planning) function
- ER-ATC-164: ATC tools to re-organize traffic flows to reduce complexity in the execution phase
- PRO-220a: ATC Procedures related to Detection and Resolution of Complexity, Density and Traffic Flow Problems
- PRO-220b: FCM procedures to describe how detection and resolution of complexity, density or traffic flow issues are managed.

It is worth noting that whilst the OI Step CM-0106 and ER-ATC-164 are fully covered by the solution #118, PRO-220a and PRO-220b are only covered for the execution phase.

3.5.2.2 Timeframe considered for the CBA

It is assumed that the timeframe to be retained for the CBA of Solution #118 has to be relatively short given that a pre-industrial prototype has already been developed by DSNA/DTI and is in operation since 2016 based on simple equipment (tablets).

On the other hand, in the perspective of a deployment at the ECAC level, it is also necessary to consider the time required by an industrial supplier to develop a commercial solution similar to the tool deployed by DSNA.

Consequently, for the CBA, it is assumed that Solution #118 would be available by 2020 at the earliest for any ACCs which would have chosen to invest in it.

In addition, the lifespan of the solution is estimated to be approximately five (5) to seven (7) years.

Therefore the timeframe retained for the CBA of Solution #118 is 2020-2025. The detail of this analysis is presented in the section 3.5.3.1.

3.5.2.3 Discount rate

The analysis of the appropriate discount rate for the CBA of Solution #118 is based on the following inputs:

- The forecasted European inflation rate;
- The short solution's time frame and its limited geographical scope; and
- The Eurocontrol's standard discount rate.

The calculation and the assumption used to determine the aggregated discount rate of 4.48% are detailed in section 3.5.3.2.

3.5.2.4 Geographical scope considered for the CBA

The operational environment of the Solution #118 present in the OSED [10] has detailed that the geographical scope of the solution is defined for En-route operating environments of Medium and High complexity. It is however necessary to specify further this geographical scope to provide the CBA results at ECAC scale.

As the main monetized benefits expected from the deployment of the basic EAP function are due to the decrease of Airspace Users' costs related to En-Route delay , it has been decided that the geographical scope will focus on the En-Route ACCs, managing Medium or High complexity traffic flow, which have high En-Route delays caused by ATC Capacity.

The details of this argument and the list of the ACC identified are presented in the section 3.5.3.3 of this document.

3.5.3 Assumptions

3.5.3.1 Timeframe for the CBA

The technical solution recommended for the basic EAP support tool is not fully integrated into the operational equipment and systems deployed in an ACC as illustrated on the figure below.

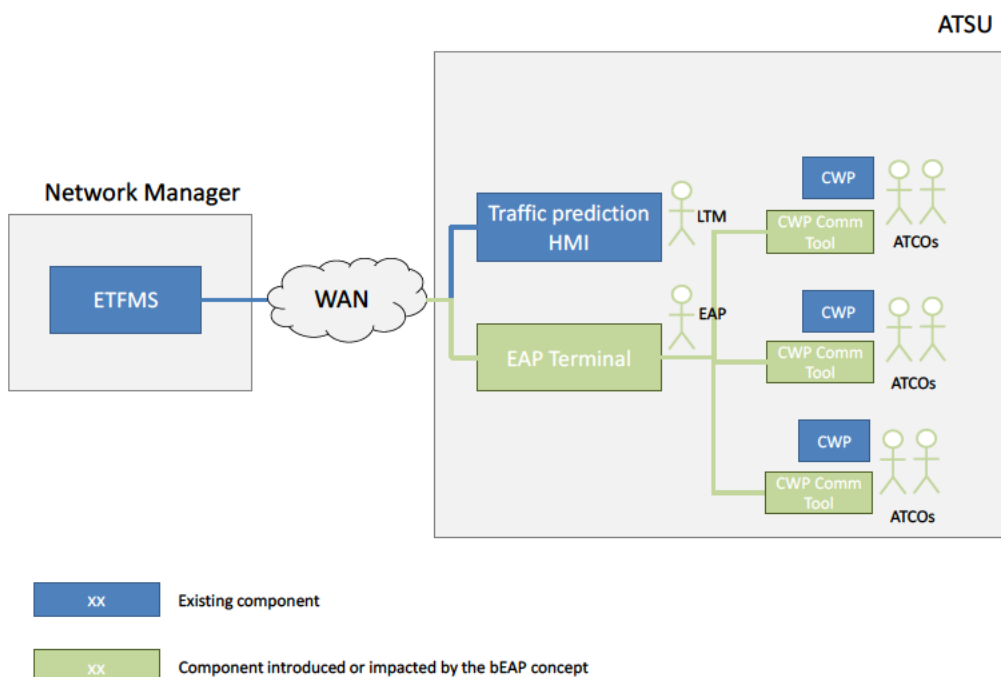


Figure 3: The Solution #118 — Basic EAP (Extended ATC Planning) function SPR-Level Model

Indeed, the basic EAP support tool is based on software used to fulfil communication needs between the EAP role and the CWPs, therefore it does not necessarily require to be integrated in the existing operational environment and hence will not require expensive and time-consuming safety studies.

Anyway, the SESAR studies, the ANSP's decision periods and the software development by an industrial stakeholder need to be taken into account in the CBA timeframe. Even if the basic

Extended ATC Planning software is not complex, because the traffic analysis would still be done on the CHMI, the time required by the industry to develop a commercial solution has to be taken into account.

Taking account of all of these constraints it is assumed that the operational implementation of the basic EAP function should be possible from early 2020 and onwards. This analysis allows concluding that the timeframe up to the Initial Operational Capability (IOC) should be relatively short. It is also assumed that the Full Operational Capability (FOC) should occur the same year.

Finally, considering the fact that the basic Extended ATC Planning is only an intermediate solution that will provide a short-term support to the communication function between the FMP and the CWP, before being fully integrated in the FMP operational tool, the lifespan of the Solution #118 is estimated to be 5 Years.

In conclusion, the assumptions regarding the timeframe to consider for the CBA of the Solution #118 are the following:

- Deployment and implementation period : 2020
- IOC=FOC: 2020
- The end of the operational period of the bEAP Tool : End of 2025

3.5.3.2 Discount Rate

The discount rate refers to the interest rate used in discounted cash flow analysis to determine the present value of future cash flows [18].

In order for the chosen discount rate to be coherent with the CBA needs and the Solution #118 characteristics the 4% standard discount rate proposed by Eurocontrol [17] was taken into account. This value is composed of three different inputs:

- A basic, risk-free, time of money (TFVM)-traditionally of the order of 2.5%
- Compensation for the erosion of the principal by inflation- not taken into account in the standard rate
- A premium for the risk- 1.5% in the standard rate

Nevertheless, the short time frame up to IOC along with the limited geographical scope characteristics of the Solution #118 — Basic EAP (Extended ATC Planning) function, have persuaded us to diminish the premium for the risk to 0.5%.

However, the recent OECD economic outlook report has forecasted the growth of the euro area's economy and of the inflation rate which is expected to increase up to 1.7% by 2019.

This raise represents 2.125 times the HICP of 2016. In order to be coherent with this report and the recent growth of European economies, the inflation rate was taken into account in our nominal discount rate for the Solution #118's CBA.

Therefore the following nominal discount rate is:

$$(1 + n) = (1 + r) * (1 + i)$$

With:

n: nominal discount rate

r: real discount rate; with $r = \text{basic risk free rate} + \text{the risk premium rate}$

i: inflation rate

$$(1 + n) = [1 + (0.005 + 0.025)] * (1 + 0.017)$$

$$(1 + n) = 1.04751$$

$$\mathbf{n \cong 4.48\%}$$

The nominal discount rate used in the CBA to determine the present value of future cash flows is 4.48%.

This assumption on the discount rate is strong and could be considerably affected by multiple non-measurable external factors. It highlights that an error term could be present. That is why this element should be analysed in the sensitivity analysis of the CBA, section 8.1.

3.5.3.3 The Geographical Scope

The Solution #118 - Basic EAP (Extended ATC Planning) function is defined for **En-route operating environments of Medium and High complexity**, with the aim to decrease the traffic complexity level and cope with high level traffic demand through the assessment and resolution of local complexity situations.

In the PRR 2013 [24] , these operating environments are defined according to complexity and traffic volume by a **traffic complexity score** which is as follows:

- En-Route High Complexity: traffic complexity score higher than 6
- En-Route Medium Complexity: traffic complexity score higher than 2 but lower than 6.

This complexity indicator is therefore representative of the level and characteristics of the traffic demand in the airspace and the need for Enhanced DCB including Complexity Management at regional/sub-regional/local level and/or Enhanced Conflict Management and Automation at local level.

The complexity analysis provided in the PRR 2014 [25] illustrates the complexity score computed per ANSPs on Figure 4 below.

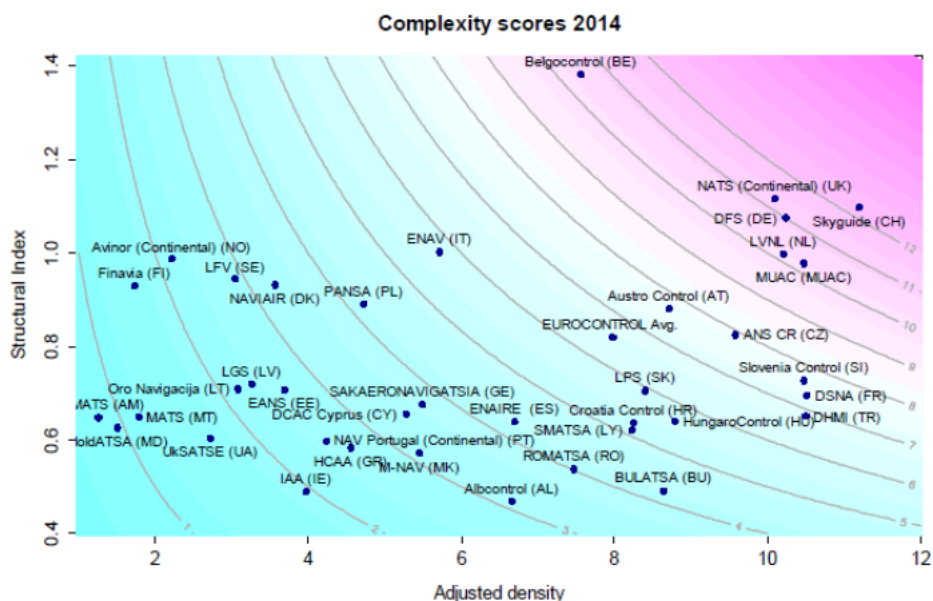


Figure 2-10: Structural complexity and adjusted density at ANSP level (2014)

Figure 4: En-Route complexity at ANSP Level

From the figure above it can be observed that the validation results obtained for the bEAP function in the Reims ACC (score between 7 and 8) correspond to a high complexity En-route environment.

In order to properly extend these results at ECAC level, it is necessary to consider a geographical scope for the CBA that will encompass the ACCs managing traffic of similar complexity. Hence the geographical scope of the CBA will focus on high complexity and/or high demand ACCs.

The map below illustrates how the traffic complexity scores, computed by the PRU for 2016, are allocated to the different European airspaces.

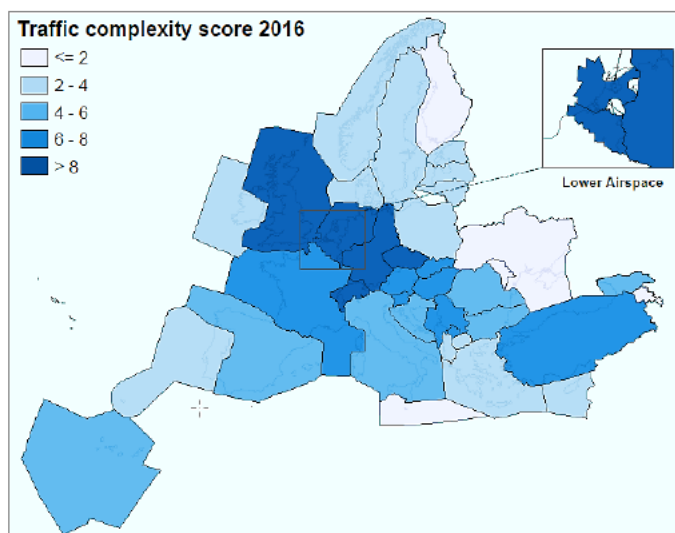


Figure 5: En-Route complexity scores – Source PRR 2016 Report [26]

From the above map it can be observed that most of the upper airspace and the lower airspace of the core area are potentially concerned by the basic EAP function. In these airspaces, all flights operating under GAT IFR rules are eligible to the measures managed by the basic EAP function.

However this preliminary analysis does not allow to precisely selecting the ACCs that would highly benefit from the implementation of the Basic EAP function and that could be in the scope of the CBA to extrapolate benefits at ECAC level.

The analysis of the Monthly Annual Network Operations Reports [19] and of the Performance Result Report [20] has highlighted the 12 ACCs with the highest delays.

From this analysis it has been possible to establish the following list of ACCs that will represent the geographical scope of the CBA for benefits' extrapolation and costs' calculation. This list is presented in Table 4 below.

Geographical scope of the CBA
ATHINAI & MACEDONIA
BARCELONA
BREST UACC
KARLSRUHE UAC
LANGEN ACC
LISBOA ACC UAC
MAASTRICHT UAC
NICOSIA ACC
PARIS ALL ACC
REIMS UACC
WARSZAWA ACC
ZAGREB ACC

Table 4: Geographical Scope based on Monthly Network Operation Report of 2015 [19]

3.5.3.4 Traffic Evolution Forecast

The traffic evolution of the solution scenario is based on the STATFOR analysis of published in February 2017 [23]. According to this Medium-term traffic forecast [23], the most-likely of the 3 scenarios forecast for 2023 is 11.6 million annual IFR flight movements in Europe, which represents 17.2% more than in 2015.

ECAC		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	AAGR 2023/2015	AAGR RP2 2019/2014
IFR Flight Movements (Thousands)	H	.	.	.	.	10,632	10,967	11,369	11,818	12,176	12,545	12,920	3.4%	3.1%
	B	9,603	9,770	9,923	10,197	10,492	10,689	10,800	11,109	11,266	11,451	11,629	1.9%	2.2%
	L	.	.	.	.	10,355	10,421	10,401	10,523	10,516	10,539	10,561	0.5%	1.3%
Annual Growth (compared to previous year unless otherwise mentioned)	H	.	.	.	.	4.3%	3.1%	3.7%	3.9%	3.0%	3.0%	3.0%	3.4%	3.1%
	B	-1.1%	1.7%	1.6%	2.8%	2.9%	1.9%	1.8%	2.1%	1.4%	1.6%	1.6%	1.9%	2.2%
	L	.	.	.	.	1.5%	0.6%	-0.2%	1.2%	-0.1%	0.2%	0.2%	0.5%	1.3%

Table 5: IFR movements Medium Term Forecast (ECAC¹ Region) - Source STATFOR February 2017 [23]

In this forecast all IFR flights, including military and general aviation flights operating under GAT IFR rules, are included.

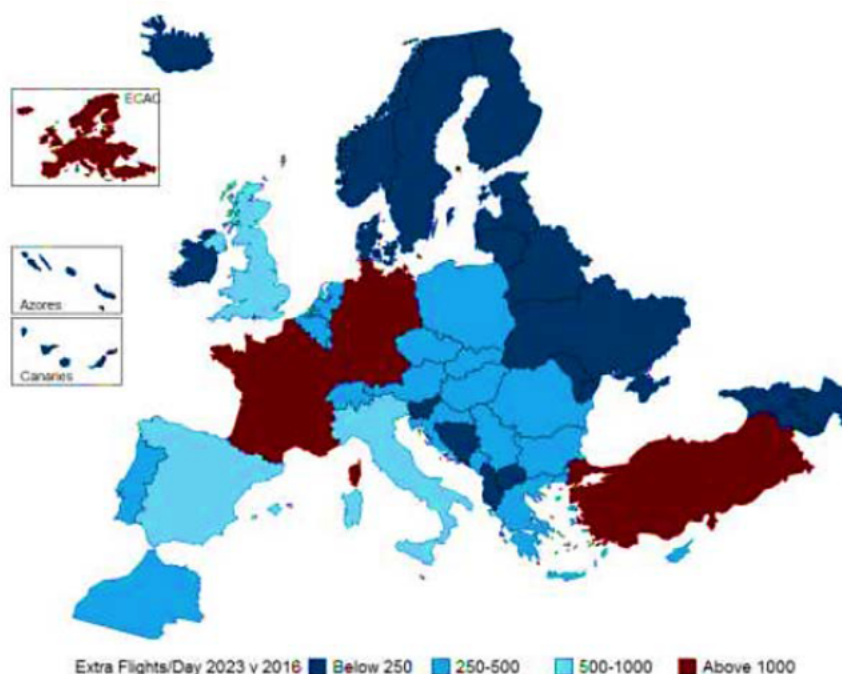


Figure 6: Number of additional movements, 2023 vs. 2016 (Base scenario). – Source STATFOR Feb. 2017 [56]

As illustrated on Figure 6 above it is still the busiest States (France, Germany, Spain, UK and Italy) which will see the greatest number of extra flights per day in 2023 (compared to 2016) which is consistent with the distribution of En-Route Medium and High Complexity airspaces shown on Figure 5 and the selection of ACCs presented in Table 4 that defines the geographical scope of the CBA.

¹ The European Civil Aviation Conference (ECAC) is an intergovernmental organization which was established by ICAO and the Council of Europe. ECAC now totals 44 members, including all 28 EU, 31 of the 32 EASA member states, and all 41 EUROCONTROL member states.

The table below presents the forecasted annual growth rate for the 12 ACCs that define the geographical scope of the CBA.

Geographical Scope	STATFOR annual growth forecast (2017-2023)
ATHINAI & MACEDONIA	3.2%
BARCELONA	3%
BREST U ACC	1.8%
KARLSRUHE UAC	1.7%
LANGEN ACC	1.7%
LISBOA ACC UAC	2.5%
MAASTRICHT UAC	1.4%
NICOSIA ACC	4.4%
PARIS ALL ACC	1.8%
REIMS U ACC	1,8%
WARSAWA ACC	3.0%
ZAGREB	2.6%

Table 6: Forecasted annual growth rate per ACC Identified (Source STATFOR 2017)

Nevertheless, the available STATFOR annual growth traffic forecast is a only 7-year-long estimation of the evolution of the traffic in Europe which does not cover the full timeframe of the CBA.

Hence it assumed that the STATFOR figures are reliable and stable over time and can be extended until the end of the CBA's timeframe.

3.5.3.5 Asset Depreciation

Depreciation is an accounting method of allocating the cost of a tangible asset over its useful life, which allows a company to write off the value of an asset over time [18]. The bEAP concept is based on two types of assets that have specific useful life described as follows:

- EAP and CWP Tablets are electronic equipment which has a lifespan of approximately 3 years. Therefore, the tablet cost will occur twice during the Solution #118 lifespan.
- EAP software will be licenced annually and this licence cost should include the maintenance and update. An overall upgrade should be done every three years to upgrade the software.

3.5.3.6 Operational Organisation

As presented in the Solution #118 — Basic EAP (Extended ATC Planning) function description, the role should be taken in charged by the FMP. However, risk that this operational organisation might not be the choice of every ANSP which invest in the Solution #118 has to be underlined.

This assumption is strong and could highly affect the cost results and structure of the CBA. That is why this element should be analysed in the sensitivity analysis of the CBA section 8.2.

3.5.3.7 Summary

This section is a summary of all the scenario main assumptions and parameters affecting the CBA results. The additional assumptions on the costs and the benefits are presented in section 4 and section 5 of this document.

Scenario feature	Year N	Year N+2	Year N+5	Source
The discount rate	4,48%	4,48%	4,48%	3.5.3.2
The Geographical scope (in Nb of ACC)	12	12	12	3.5.3.3
The average of the annual forecasted traffic growth in the ACC identified.	2,41%	2,41%	2,41%	[14]

4 Benefits

This section of the document will describe the monetised benefits from the implementation of the Solution #118 — Basic EAP (Extended ATC Planning) function scenario presented in the previous section. However, for accurate purposes several assumptions to elaborate our analytic framework were used.

In order to remain consistent with the cost assessment section (§5), the presentation of the monetized benefits has also been split per stakeholder.

The generic results of the monetized benefits are presented in the Table 5 of this section and they will be detailed and analysed in the CBA results section 7 of this document.

4.1 ANSP Benefits

This section will detail the assumptions, the formula and the input used to monetise the benefit for the ANSP.

4.1.1 ATCO's Productivity Increases Assumption

The benefits for the CBA are based on the VALR inputs acquired during the Reims live trial which studied the KPA of ATCO productivity. The result of this one-week exercise was a positive increase of 2% of the ATCO productivity compared to the reference scenario.

However, the SESAR validation context has led to an over-investment in human resources in order to compensate the novelty factor of the role and the tool for both the FMP and the ATCO. Consequently, the assumption on the 2% ATCO productivity increase is a long-term goal result for the bEAP was taken into account.

In addition, we have to take into account that the experience and the knowledge acquirement of the EAP role and tool will take time as it modifies working both FMP and ATCO working method. The other element to take into account in order to be as close as possible to the operational context is the threshold effect. Indeed, the implementation of a new tool in an operational environment does not lead to a continuous increase of productivity. That is why we take as an assumption that the productivity indicator will follow a concave function which leads to a quick growth during the first years of the tool's implementation and then this increase will slowly diminish to reach its maximum of 2% ATCO productivity increase as presented in the following graph:

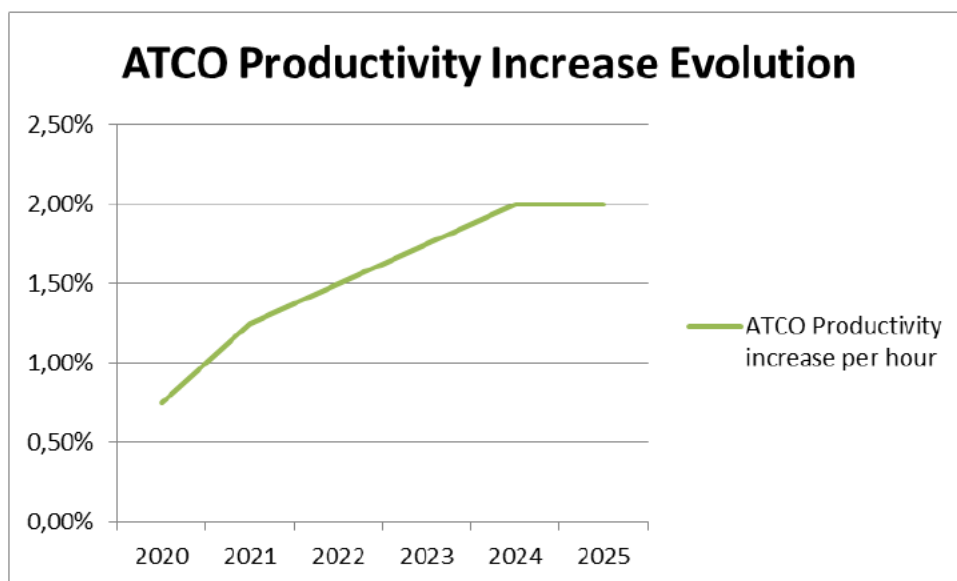


Figure 7: ATCO productivity increase per hour

In conclusion, for the CBA the following assumption regarding the ATCO productivity will be used:

- First year: 0.75% productivity increase compared to the base year
- Second year: 1.25% productivity increase compared to the base year
- Third year: 1.5% productivity increase compared to the base year
- Fourth year: 1.75% productivity increase compared to the base year
- Fifth year: 2% productivity increase from the base year

These assumptions on the productivity index's evolution are strong and could be considerably affected by multiple non-measurable external factors. Therefore the probability that an error term could be present has to be underlined. That is why this element should be analysis in the sensitivity analysis of the CBA.

4.1.2 ANSP Benefit Monetisation Process

The monetisation of the Solution #118 — Basic EAP (Extended ATC Planning) function is based on the New CBA Models and Method Part 1 of 2 SESAR document [9] which provides the following formula to assess the ANS Productivity Cost Saving:

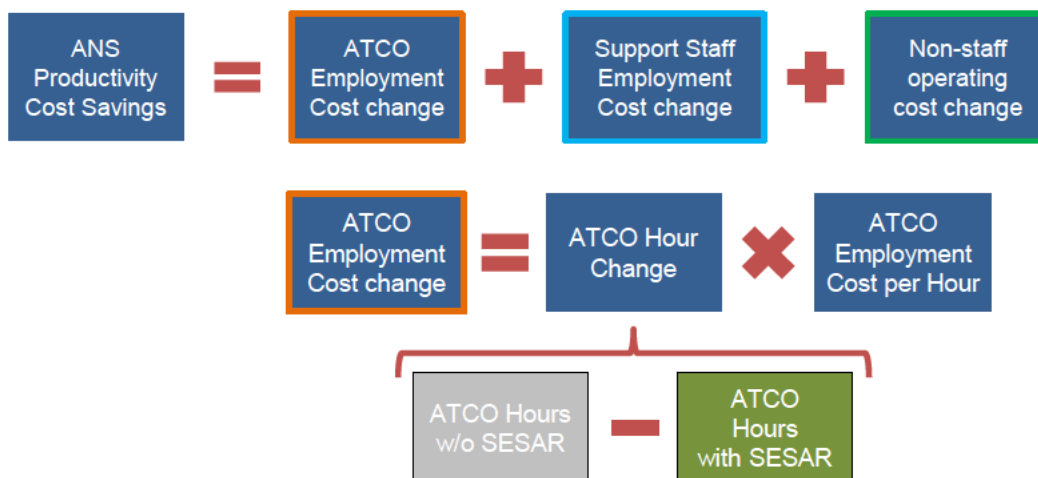


Figure 8: ANS Productivity Cost-Saving Formula, sources [9]

As presented in the previous subsection, it has been taken as an assumption that the 2% productivity increases will be reached during the fifth year of the solution implementation therefore the monetised ATCO productivity increase should be maximised at this period. However, the benefits materialise as soon as the Solution #118 is implemented. That is why the ANSP benefits increases between the first year of implementation and stabilised at the fifth.

The inputs used during for the benefit monetisation are the VALR Results and the standard input of ATCO cost per hour based on the ATM Cost effectiveness benchmarking report 2014 with 2015-2019 outlook [21]. For accuracy purposes, the cost data year by year were recomputed according to the realised and forecasted inflation rate at each specific period.

4.2 Airspace Users' benefits

This section will detail the assumptions, the formula and the input used to monetise the decrease of airborne delay.

4.2.1 Delay Reduction Decrease Assumptions

The benefit calculation of the Solution #118 — Basic EAP (Extended ATC Planning) function is based on the input acquired during Reims live trial presented in the VALR. During this exercise, the STAM proposed by the EAP to the CWP, which resulted in a reduction of delay, were proposed on airborne flight. This result specifies has constrained us to take as an assumption that the delay reduction at ECAC Levels would be airborne delays.

However, in order to deduce the annual airline's benefit in an operational environment we had to determine when the VALR result would materialise. To answer this requirement, the 2015 annual traffic based on the different monthly Network Operation Report [19] has been analysed. This analysis has allowed us to determine that the European traffic had an important seasonality period which based on the most containing ACC in terms of En-Route delays last on average 14 weeks. As the solution aims at decreasing En-Route delays, it has been taken as an assumption that the basic

EAP delays reduction benefit would appear only during the high season, in other words, 14 weeks per year.

This assessment has also highlighted that the En-Route delay causes were numerous; however the bEAP solution has an impact only on the ATC Capacity delay. Therefore, in order to determine the operational benefit of the Solution #118, the average the percentage of delay due this specific cause had to be determined. To compute how much of the VALR delay reduction should be credited to the bEAP role and tool, the Performance Results Report published in 2016 was used and underlined that **55% of the En-Route delays were caused by ATC Capacity.**

In addition, the results in terms of delay reduction in the VALR [10] were presented for the base week scenario with and without the impacts of the 2F regulation on day 6. This specificity highlights that not all of the delay reduction of the solution scenario could be generalized at a national or ECAC operational level. That is why in this CBA, it has been decided to use the data from the based week without the regulation impacts on the total of delays.

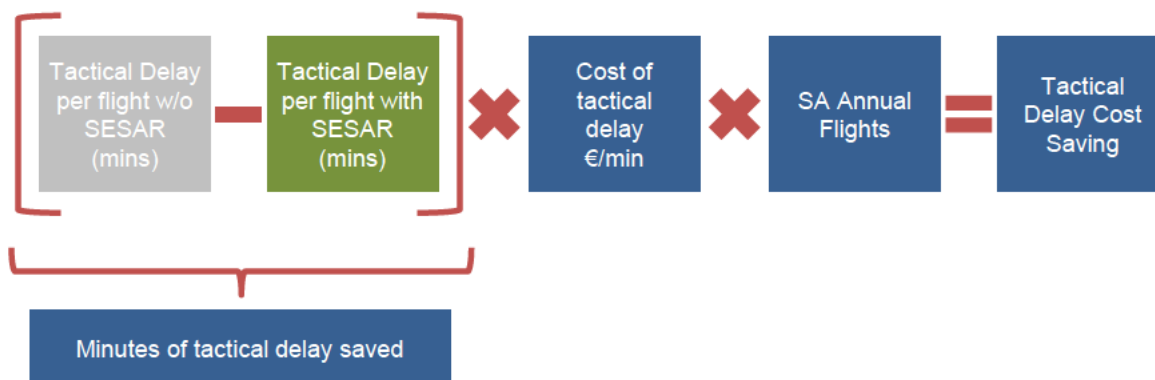
In conclusion, to assess the monetised benefit of the Solution #118 — Basic EAP (Extended ATC Planning) function in the operational environment the following assumptions were used:

- The delays reduction in minutes represents only airborne delays.
- The VALR results are representative for 14 weeks per year.
- 55% of the En-Route delays are due to ATC Capacity.

These assumptions on the characteristics of tactical delay are strong and could be considerably affected by multiple non-measurable external factors. It highlights that an error term could be present. That is why this element should be analysed in the sensitivity analysis of the CBA.

4.2.2 Benefit Monetisation Process

The monetisation of the Solution #118 — Basic EAP (Extended ATC Planning) function is based on the New CBA Models and Method Part 1 of 2 SESAR document [9] which provides the following formula to assess the ATFM delay reduction:



As presented in the previous subsection, the operational benefit's analysis for the airline takes only into account a portion of the total delay reduction presented in the VALR [10]. In addition, it has

been taken into account that the ATCO productivity and the airborne delay reduction are correlated; therefore the delay reduction should follow the ATCO productivity increase concave function.

The inputs used for the monetisation of the airlines benefit are based on the VALR results and the cost of ATFM delay based on EUROCONTROL's Standard Input for CBA [17]. For accuracy purposes the cost data year by year were recomputed according to the realised and forecasted inflation rate at each specific period.



Performance Framework KPA ²	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Year N	Year N+2	Year N+5
Cost Efficiency	ANS efficiency Cost	CEF2 Flights per ATCO-Hour on duty	Nb	ATCO employment Cost change	Thousand€/year	20	38	47
				Support Staff Employment Cost Change	€/year	[N/A]	[N/A]	[N/A]
				Non-staff Operating Costs Change	€/year	[N/A]	[N/A]	[N/A]
		CEF3 Technology cost per flight	EUR / flight	G2G ANS cost changes related to technology and equipment	€/year	[N/A]	[N/A]	[N/A]
	Airspace User Cost efficiency	AUC3 Direct operating costs for an airspace user	EUR / flight	Impact on direct costs related to the aeroplane and passengers. Examples: fuel, staff expenses, passenger service costs, maintenance and repairs, navigation charges, strategic delay, landing fees, catering	€/year	[N/A]	[N/A]	[N/A]
				AUC4 Indirect operating costs for an airspace user	EUR / flight	Impact on operating costs that don't relate to a specific flight. Examples: parking charges, crew and cabin salary, handling prices at Base Stations	€/year	[N/A]

² For information, the mapping to the Performance Ambition KPAs (used in the ATM Master Plan) is available in the Appendix.



Performance Framework KPA ²	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Year N	Year N+2	Year N+5
		AUC5 Overhead costs for an airspace user	EUR / flight	Impact on overhead costs. Examples: dispatchers, training, IT infrastructure, sales.	€/year	[N/A]	[N/A]	[N/A]
Capacity	Airspace capacity	CAP1 TMA throughput, in challenging airspace, per unit time	% and # movements	Tactical delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
			% and # movements	Strategic delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
		CAP2 En-Route throughput, in challenging airspace, per unit time	% and # movements	Tactical delay cost (avoided-; additional +)	Millions€/year	1,9	3,9	5,4
			% and # movements	Strategic delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
	Airport capacity	CAP3 Peak Runway Throughput (Mixed mode)	% and # movements	Value of additional flights	€/year	[N/A]	[N/A]	[N/A]
	Resilience	RES4a Minutes of delays	Minutes	Tactical delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
		RES4b Cancellations	% and # movements	Cost of cancellations	€/year	[N/A]	[N/A]	[N/A]
		Diversions	% and # movements	Cost of diversions	€/year	[N/A]	[N/A]	[N/A]



Performance Framework KPA ²	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Year N	Year N+2	Year N+5
Predictability and punctuality	Predictability	PRD1 Variance of Difference in actual & Flight Plan or RBT durations	Minutes^2	Strategic delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
	Punctuality	PUN1 % Departures < +/- 3 mins vs. schedule due to ATM causes	% (and # movements)	Tactical delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
Flexibility	ATM System & Airport ability to respond to changes in planned flights and mission	FLX1 Average delay for scheduled civil/military flights with change request and non-scheduled / late flight plan request	Minutes	Tactical delay cost (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
					[N/A]	[N/A]	[N/A]	[N/A]
Environment	Time Efficiency	FEFF3 Reduction in average flight duration	% and minutes	Strategic delay: airborne: direct cost to an airline <u>excl. Fuel</u> (avoided-; additional +)	€/year	[N/A]	[N/A]	[N/A]
	Fuel Efficiency	FEFF1 Average fuel burn per flight	Kg fuel per movement	Fuel Costs	€/year	[N/A]	[N/A]	[N/A]
	Fuel Efficiency	FEFF2 CO2 Emissions	Kg CO2 per movement	CO2 Costs	€/year	[N/A]	[N/A]	[N/A]



Performance Framework KPA ²	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Year N	Year N+2	Year N+5
Civil-Military Cooperation & Coordination	Civil-Military Cooperation & Coordination	CMC2.1a Fuel saving (for GAT operations)	Kg fuel per movement	Fuel Costs	€/year	[N/A]	[N/A]	[N/A]
		CMC2.1b Distance saving (for GAT operations)	NM per movement	Time Costs	€/year	[N/A]	[N/A]	[N/A]

Table 7: Results of the benefits monetisation per KPA

5 Cost Assessment

The Solution#118's description has underlined that the costs of the EAP role and tool will be entirely supported by the ANSPs that will choose to invest in the solution to optimise their operations. Therefore this section will only focus on the costs borne by the ANSPs.

5.1 ANSPs costs

This section aims at identifying the ANSPs's Solution #118 cost and the assumptions used in order to monetize them in the CBA model.

5.1.1 ANSPs cost approach

The goal of the CBA is to monetise the costs and benefit in order to determine if the solution is profitable for a specific investor and for the overall network. In order to answers to both of those needs, it has been decided to use generic aggregated European data to monetize the costs.

5.1.2 ANSPs cost assumptions

As the time horizon and the time frame of the project presented in section 3, the implementation costs are supposed be generated in 2020/2021 and the operating cost should materialise from 2020 to the end of 2025. This specificity forces us, for accuracy purposes, to take into account the realised and the forecasted annual inflation rate for all the cost inputs. The calculations are presented in the CBA excel model.

5.1.2.1 Implementation Costs

5.1.2.1.1 One-off costs

Initial Training: The cost evaluation for the initial training is based on three inputs:

- The training period duration for the EAP role implementation and the operational use of the bEAP tool: 3 days for the CWP and 5 days for the FMP.
- The opportunity cost of those training sessions based on the cost of the ATCO hour's standard input and the number of controllers trained: 107, 03 euros per hour in 2020 based on [21] (*EUROCONTROL, ATM Cost effectiveness benchmarking report 2014 with 2015-2019 outlook*).
- The training fees requested by the training entity: 800 euros per training days. However, for accuracy purposes it has been taken into account that the training session should include a maximum of 20 controllers. Therefore a total of 23 days of training for 350 CWP and 5 FMP per ACC.

Project Management: The estimate of the overall project management cost is 500 000 euros for each ANSP that chooses to invest in the SESAR Solution #118 — Basic EAP (Extended ATC Planning) function meaning that if the Solution #118 is implemented in several ACC this cost will only appear once. This envelope includes the project definition, programme management and support, planning costs, procurement management, meeting and travelling costs, processes and documentation costs.

Administrative costs: The bEAP solution does not highly impact the operational procedure. Indeed, as it is an extended ATFCM tool it follows the best effort rule. The administrative costs are therefore very low and for this CBA we will take as an assumption that there will be equal to zero.

Installation and commissioning: The initial test and evolution of the product is the most important subsection of this one-off cost component. Indeed, before deploying the product operationally each ANSPs that have chosen to invest in the SESAR Solution #118, will have to conduct implementation exercises and live trials in order to certify the solution operationally. And those exercises are costly due to the number of staff involved in the process. In the cost analysis the inputs of Reims live trial were used as standard inputs and the overall cost of this exercise validation was 100 000 euros.

In addition to this amount it was taken into account the installation costs that should be relatively low due to the separation of the operational architecture and the basic EAP architecture presented in the SPR-INTEROP/OSED [10]. The installation fees should not go over 50 000 euros per ACC that chooses to invest in the Solution #118 — Basic EAP (Extended ATC Planning) function

Validation and certification costs: As presented in the OSED [10], the impact of the solution on the operational systems and architecture is non-existent. This allows us to take as an assumption that this component of the cost analysis is equal to zero.

5.1.2.1.2 Capital Cost

Equipment & Systems: The Solution #118 — Basic EAP (Extended ATC Planning) function is based on two main components the HMI, a tablet or a 4ME screens, and the bEAP software.

- The cost analysis of this CBA used a benchmark to determine the costs of the tablet which have shown that the cost per unit is around 1 500 euro for the CWP positions and 3 000 euros for the FMP position. This price difference is based on the distinct technical hardware requirement of the EAP and the CWP software.
- The second component of the solution is software which, as presented in the third section of the document, will be proposed as an annual licence per user account. Therefore, the cost of the software included in this implementation cost will be the initial implementation cost and the licenced keys requested by the ANSP according to their needs. The price determination of this initial fee is based on the solution's development period which is forecasted to take 100 days and the industrial daily fee of 2 500 euros. Which represents an overall cost initial cost of the software is: 250 000 euros.

The asset life of a tablet is 3 years and the software important evolution should be around 3 years also; therefore we will have to take into account these costs twice during the project lifespan.

Integration costs: As presented in the OSED [10], the functional architecture of the Solution #118 does not require any integration on the existing operational systems and architecture. This allows us to take as an assumption that this component of the cost analysis is equal to zero.

5.1.2.1.3 Transition Costs

As the Solution #118 — Basic EAP (Extended ATC Planning) function is not impacting operational system or tools there are not transition cost that applies in this CBA

5.1.2.2 Operational costs

Raw Material: As presented in the previous section one of the solution's technical components is the bEAP software which relies on annual licences. The cost of this annual fee should be around 2 500 euros per CWP and 3 700 euros per FMP. This price difference is based on the distinct

technical hardware requirement of the EAP and the CWP software. This cost includes software maintenance and update.

Personnel and training: As the Solution #118 does not include any increase in the ANSPs staff, the personnel costs and support staff subsection are equal to zero. However, as explained in the previous section, the licencing software includes annual update on which the EAP and the controllers should be trained. The estimation on this cost is three days of training for the FMP and a day for the CWP per year.

Maintenance and repairs: The Solution #118 represents a small investment that will not impact the maintenance and repair annual cost of the ANSP therefore this cost component will be equal to 0 in the bEAP's CBA.

5.1.3 Number of investment instances (units)

The Solution #118 — Basic EAP (Extended ATC Planning) function was developed and tests only in En-Route environment that is why it has been taken as an assumption that the Sub Operating Environment of Airport and TMA were not applicable to this study.

The geographical scope assumptions have identified that 12 ACC would highly benefit from the solution implementation due to the important amount of En-Route delay which they generate. In the Cost analysis the based scenario in terms of investments units relies on the geographical assumption which is equal to 12 specific ACC.

As the basic Extended ATC Planning has been developed and tested by the DSNA, it has been taken as an assumption that in the worst scenario case the three French most constraining ACC identified in the geographical scope would invest in the Solution #118.

In the best case scenario the 20 most constraining European ACC in terms of En-Route Delays should invests in the SESAR Solution#118.

The number of investment instances in unit in terms of ACC is presented in the following table:

Airport				TMA			ACC		
HC	HS	LC	LS	H	M	L	H	M	L
							20	12	3
[N/A]				[N/A]					

Table 8: Number of investment instances - ACC

5.1.4 Cost per unit

This section will detail the total cost of the Solution #118 per ACC unit. As presented in the Excel CBA model the Solution #118 cumulated amount of costs is 4 081 824 euro discounted in 2020 euros. This amount represents an annual average of 680 304 euros.

The Low and High ranges of costs monetisation are related to the uncertainty rate related which was computed at 20%. The results of this uncertainty element are presented in the following table:

Cost category	Airport				TMA			ACC		
	HC	HS	LC	LS	H	M	L	H	M	L
Pre-Implementation Costs	[N/A]				[N/A]			[N/A]		
Implementation costs								2,5	2,1	1,6
Operating costs								2,7	2,2	1,8

Table 9: Cost per ACC in millions - ANSP

5.2 Airport Operators Costs

[N/A]

5.3 Network Manager's Costs

[N/A]

5.4 Airspace Users' Costs

[N/A]

5.5 Military Costs

[N/A]

5.6 Other relevant stakeholders

[N/A]

6 CBA Model

6.1 Data sources



Modèle Excel CBA
bEAP5.xlsx

7 CBA Results

As presented in the introduction of the document the result will be presented as follows:

- Firstly, at a **generic individual level**, corresponding to the **target Operational Environment**, (En-Route, high complexity and/or demand) in support of individual deployment decisions, despite the interested parties will have to refine the mechanisms and inputs used in this CBA and review them for adaptation to their local context.
- Then consolidated at the **ECAC level** about the economic and financial viability of deploying the Solution #118 — Basic EAP (Extended ATC Planning) function at the European scale.

7.1 CBA Result at ACC Level

This section will present the CBA generic results at an **individual ACC Level**.

7.1.1 Cost Results

The cost analysis has highlighted that the total cost are evenly distributed between the **CAPEX costs (48%)** and the **OPEX costs (52%)** for the Solution #118. However, we have to underline that the One-off costs driven by the initial training and staffing subsection represents around 72% of the total CAPEX and 35% of the total 2020 cost of the Solution #118. In addition, the assumption on the software licence and the continuous training of the controllers has impacted the OPEX materialize each year. The annual monetised costs of the solution are presented in the following graph.

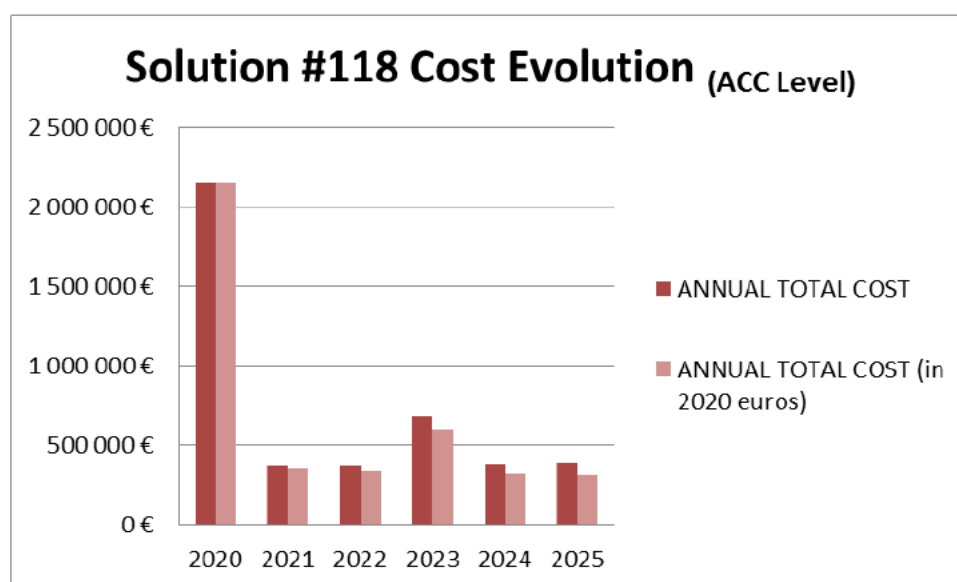


Figure 9: Annual Monetised Costs of Solution #118

7.1.2 Benefits Results

7.1.2.1 Air Navigation Service Provider Benefits

This following graph presents the monetized benefit due to the increase of ATCO productivity.

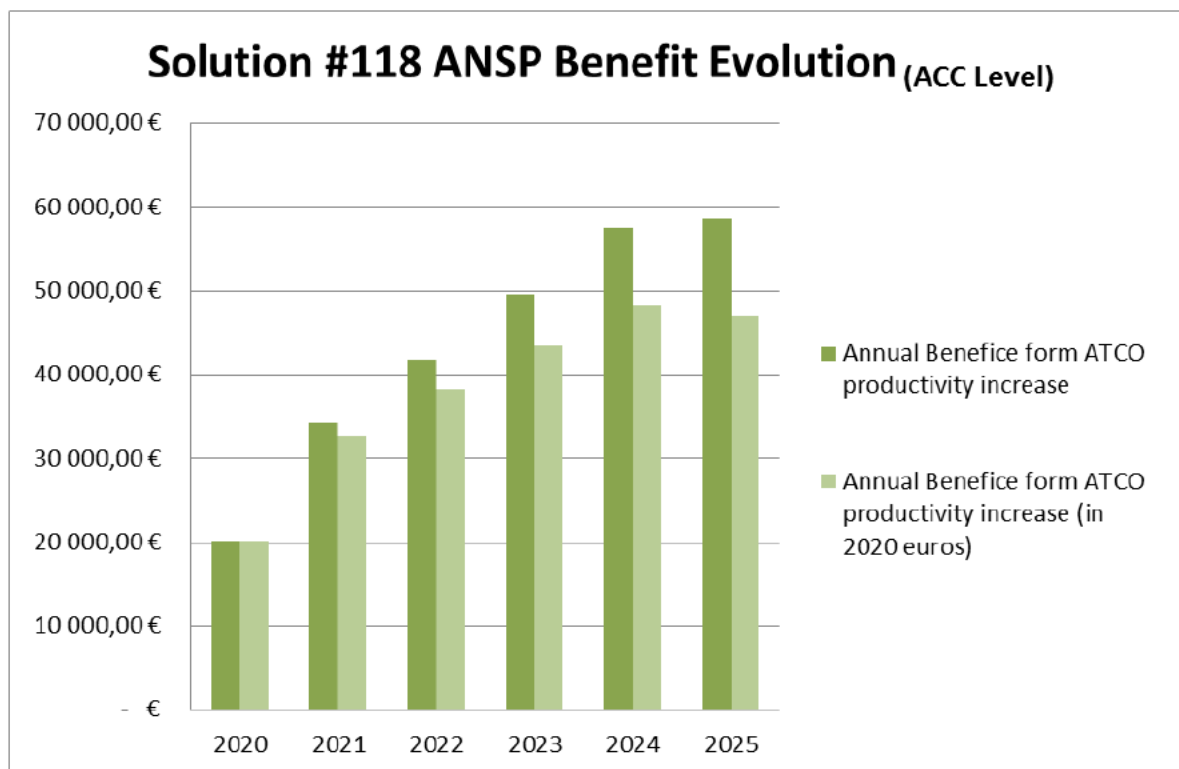


Figure 10: Annual Monetised Benefit of Solution #118 related to Productivity Increase

The results show in the graph underline that the ATCO productivity increase has a relatively marginal impact on the total monetized benefit the Solution #118. However, the VALR results were not sufficient to analyse the ACC Capacity increase. Therefore, all the ANSP benefit derived from the productivity increase could not be monetised in this CBA.

7.1.2.2 Airspace Users Benefits

This following graph presents the monetized benefit due to the decrease of ATC Delays:

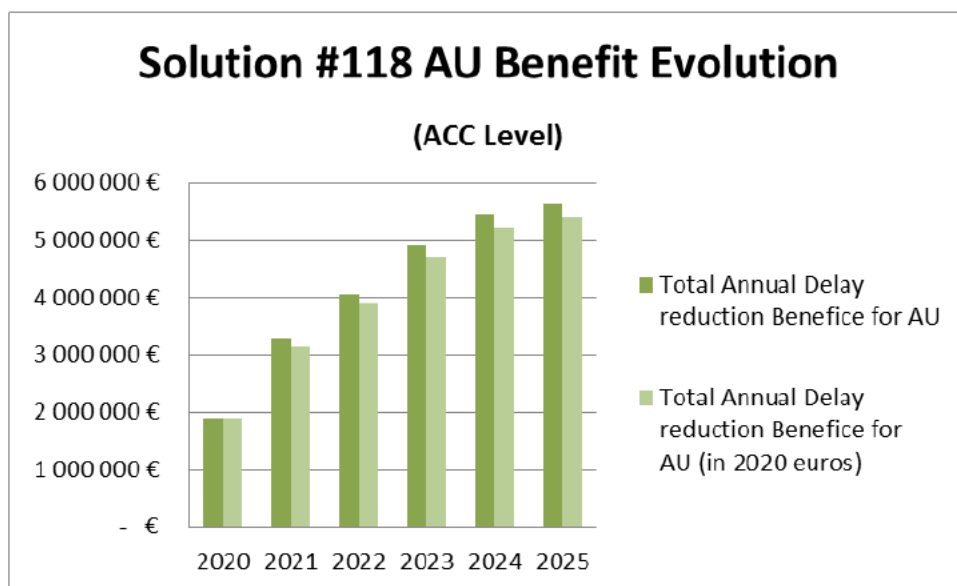


Figure 11: Annual Monetised Benefit of Solution #118 related to Delay decrease

The monetisation of airline cost saving due to Solution #118 performance of the delay reduction is increasing annually to reach a total of 5 400 653 euros (discounted) in 2025. These results underline the economic efficiency of the solution implementation for the airspace users.

7.1.3 CBA Result Analysis

The annual cash flow evolution graph presented below highlights that the Solution #118 — Basic EAP (Extended ATC Planning) function is a very profitable solution for the airlines as it allows them to decrease their costs of delay in a specific constraining ACC. In addition, the CBA results discounted, with a rate of 4.48%, shows that the payback period should be at the end of 2021, therefore approximately less than a year and a half after the Solution #118 implementation.

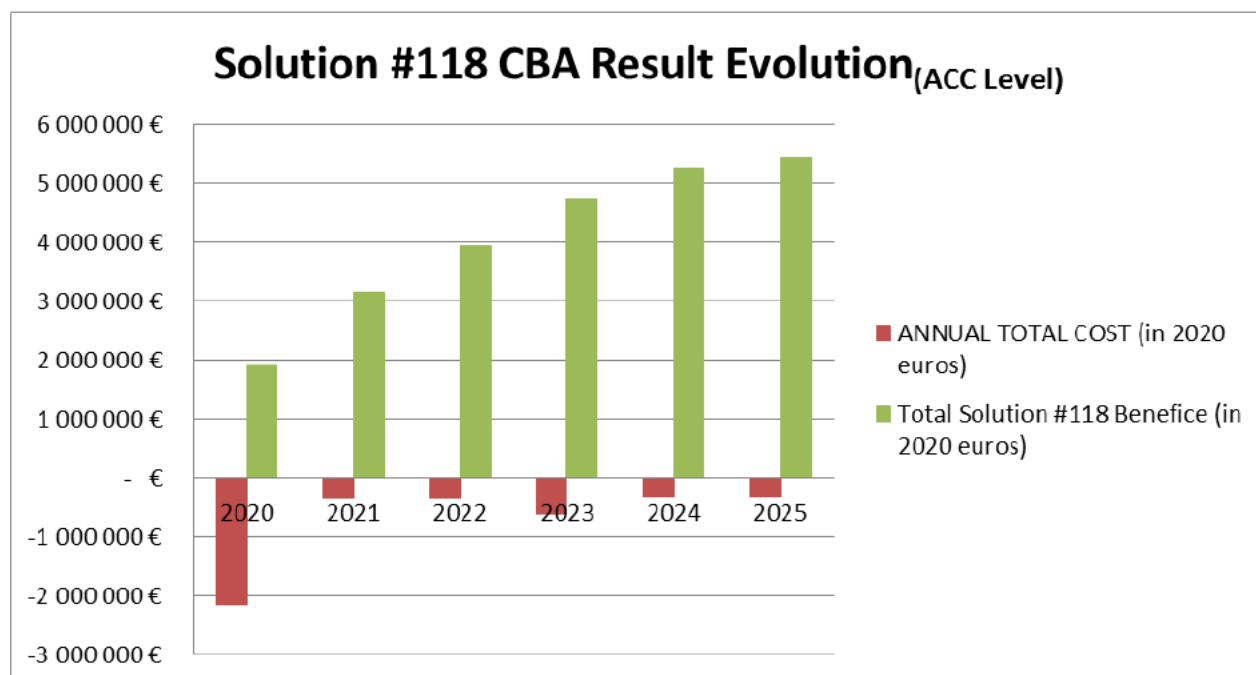


Figure 12: Annual Monetised Cash flows of Solution #118 at ACC Level.

The CBA results are presented in the following table are showing that the Solution #118 — Basic EAP (Extended ATC Planning) function is very profitable solution with a net present value (NPV) of 20 377 391 euros. Indeed, the return on investment (ROI) indicator underlines that the investment in the Solution #118 is 5 times more profitable than not investing.

Payback Period	2021
Return on Investment (ROI)	4,99
Net Present Value (NPV)	20 377 391,62 €

Figure 13: Summary Table of the CBA Result Indicators at ACC Level

However, the fact that the stakeholder that invests in the Solution #118 is not the one that benefits from the monetised benefit has to be underlined. Indeed, the costs are supported by the ANSP and only the airline benefit from the solution. That is why in order to be profitable to the stakeholder who invests in the Solution #118 — Basic EAP (Extended ATC Planning) function; the costs should be transferred to the airline to stimulate the investment of the ANSPS.

7.2 CBA Result at ECAC Level

This section presents the results of the CBA at ECAC Level which takes into account that all the ACC identified in the geographical scope invest in the Solution #118 by 2020.

7.2.1 Costs Results

The cost analysis has highlighted that the total cost are evenly distributed between the CAPEX costs (46%) and the OPEX costs (54%) for the Solution #118. However, we have to underline that the One-off costs driven by the initial training and staffing subsection represents around 69% of the total CAPEX and 32% of the total 2020 cost. In addition, the assumption on the software licence and the continuous training of the controllers has impacted the OPEX materialize each year. The difference of proportion compared to the local level proportion is due to the decrease of project management cost because as presented in the cost assumption section they are generated once for each national ANSP. The annual monetised costs of the Solution #118 are presented in the following graph.

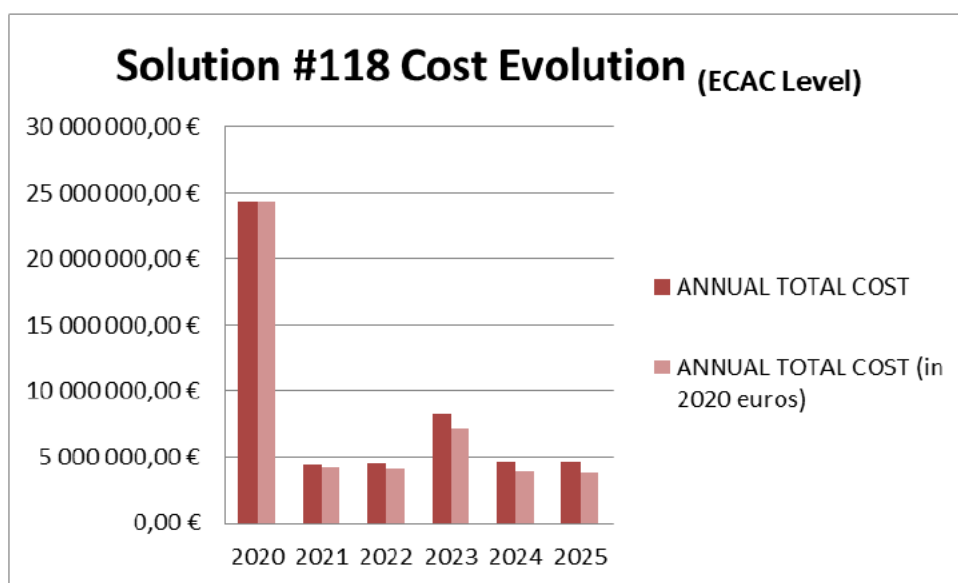


Figure 14: Annual Monetised Costs of Solution #118 at ACC Level.

7.2.2 Benefits Results

The result of the productivity increases benefit monetisation at an ACC Level has underlined that this aspect of the Solution #118 is negligible. That is why it has been chosen not to analyse it at the ECAC level.

This following graph presents the monetized benefit due to the decrease of ATC Delays:

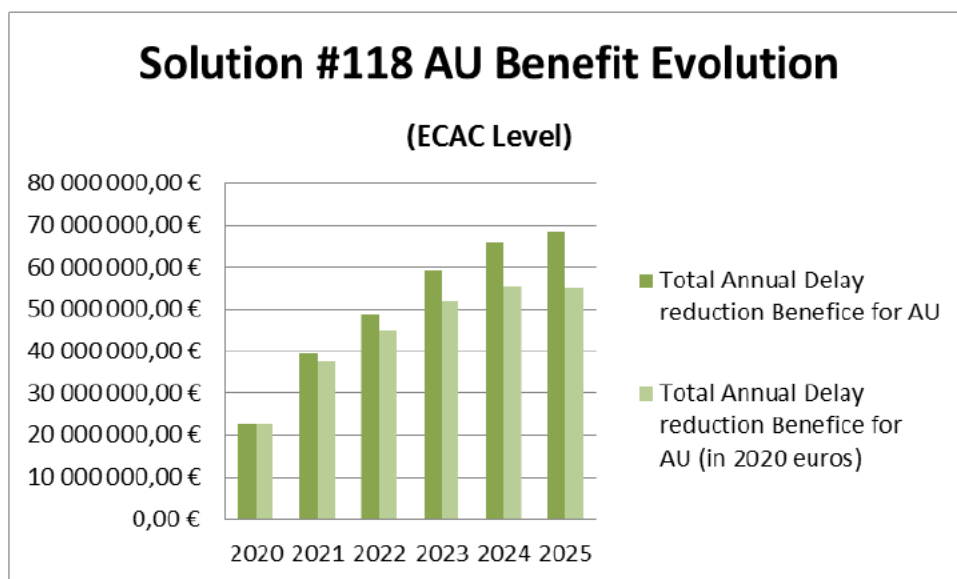


Figure 15: Annual Monetised Benefit of Solution #118 related to Delay decrease

The monetisation of airline cost saving due to Solution #118 performance of the delay reduction is increasing annually to reach a total of 55 023 944 euros (discounted) in 2025. These results underline the economic efficiency of the solution implementation at ECAC Level.

7.2.3 Result analysis

The annual cash flow evolution presented in the following graph, highlights that the Solution #118 is a very profitable solution for the airlines as it allows them to decrease their costs of delay in several specific constraining ACC. In addition, the CBA results discounted, with a rate of 4.48%, shows that the payback period should be at the end of 2021, therefore approximately less than a year and a half after the Solution #118 implementation.

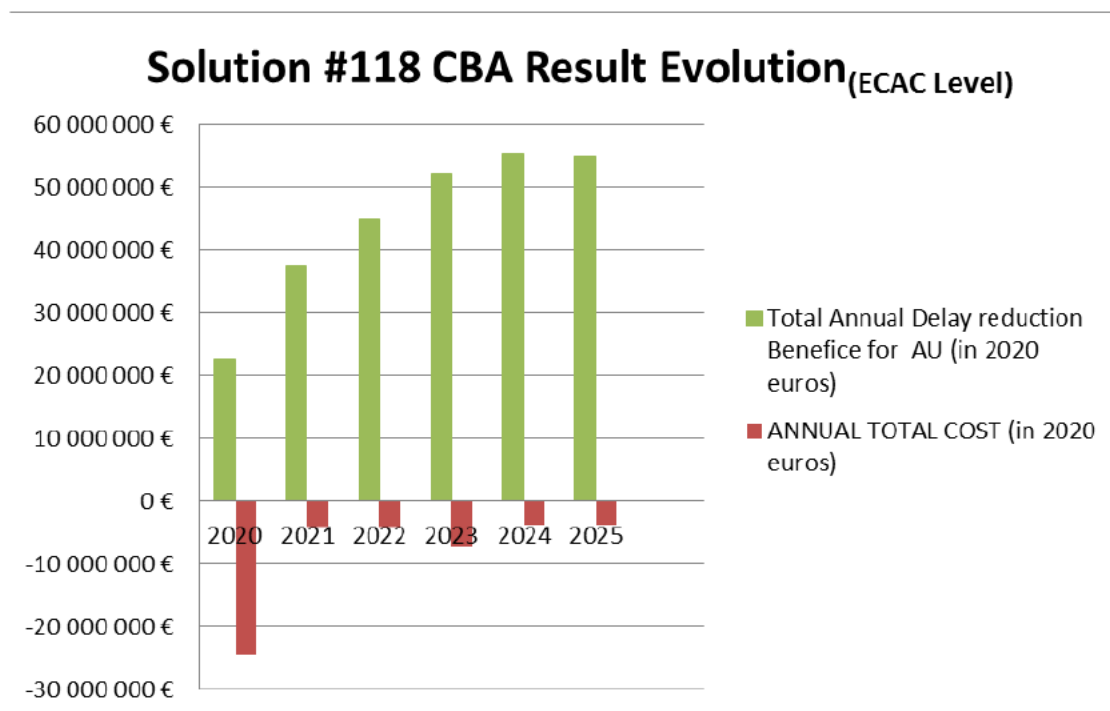


Figure 16: Annual Monetised Cash flows of Solution #118 at ECAC Level

The CBA results are presented in the following table are showing that the Solution #118 — Basic EAP (Extended ATC Planning) function is very profitable solution with a net present value (NPV) of 220 132 253 euros. Indeed, the return on investment (ROI) indicator underlines that the investment in the Solution #118 is 4,64 times more profitable than not investing.

Payback Period	2021
Return on Investment (ROI)	4,64
Net Present Value (NPV)	220 132 253,88 €

Figure 17: Table of the CBA Result Indicators at ECAC Level

However, the fact that the stakeholder that invests in the Solution #118 — Basic EAP (Extended ATC Planning) function is not the one that benefits from the monetised benefit has to be underlined. Indeed, the costs are supported by the ANSP and only the airline benefit from the solution. That is why in order to be profitable to the stakeholder who invests in the Solution #118; the costs should be transferred to the airline to stimulate the investment of the ANSPs.

8 Sensitivity and risk analysis

The sensitivity analysis aims at highlighting the impact of major CBA assumptions on the results. For the Solution #118, the sensitivity analysis focuses on:

- The discount rate;
- The operational organisation of the EAP role; and
- The benefits of the ACTO productivity increase.

8.1 The discount rate

As presented in the section 3.5.3.2, the discount rate taken into account in the CBA was: 4, 48%. To analyse the impact of this element on the CBA results, the discount rate has been increased by 1%. This assessment computed the following evolution:

At a Local CBA level:

Discount rate sensitivity analysis	4.48%	5.48%
Payback period	2021	2021
ROI	4,99	5,02
NPV	20 377 392 euros	20 218 651 euros

These results underline that the CBA local results are not highly impacted by the increase of the discount rate. Indeed, the NVP decreases of 0.77% while the ROI increased in the same proportion. The divergent evolution highlights that the increase of the discount rate leads to a decrease of the total benefits of the CBA in terms of euro, however, the return on investment is higher when the discount rate increases of one percentage.

At an ECAC Level:

Discount rate sensitivity analysis	4.48%	5.48%
Payback period	2021	2021
ROI	4,64	4,56
NPV	220 132 253 euros	213 473 957 euros

These results underline that the CBA local results are impacted by the increase of the discount rate. Indeed, the NVP decreases of 30% while the ROI decreases 1, 7%. The divergent evolution highlights

that the increase of the discount rate leads to an important decrease of the total benefits of the CBA in terms of euro; however, the return on investment stays relatively stable.

8.2 Operational organisation of the EAP function

The Solution #118's CBA cost model relied on the assumption that the Extended ATC Planning was a function and not an additional agent. Because, this assumption depends on each ANSP internal organisation it has been decided to analyse its impact on the CBA results. The sensitivity analysis presented in the following table is showing the increase of 5 additional agents to cover the EAP role annually.

At a Local Level:

	EAP Function	EAP Agent
Payback period	2021	2021
ROI	4,99	1,96
NPV	20 377 392 euros	16 184 033 euros

These results are showing that the assumption on the EAP role is impacting highly the results of the CBA. Indeed, the scenario analysed in the sensitivity analysis has underlined a decrease of the return on investment of the solution of 61% and a decrease of net present value of 21%. This highly negative impact is due to the important increase of the OPEX cost.

However, even in this case the Solution #118 has a positive result and that the payback period is remaining 2021.

At an ECAC Level

	EAP Function	EAP Agent
Payback period	2021	2021
ROI	4,64	1,74
NPV	220 132 253 euros	169 811 954 euros

These results are showing that the assumption on the EAP role is impacting highly the results of the CBA. Indeed, the scenario analysed in the sensitivity analysis has underlined a decrease of the return on investment of the solution of 63% and a decrease of net present value of 23%. This highly negative impact is due to the important increase of the OPEX cost.

However, even in this case the Solution #118 has a positive result and that the payback period is remaining 2021.

8.3 ATCO productivity increase

The ATCO productivity element of the benefit model has been chosen for the sensitivity analysis because it impacts both the ANSP and the AU monetized benefits. To analyse the impact of this assumption on the benefits it has been chosen to set the ATCO productivity increase to 1% instead of 2%. The results are presented in the following tables:

At a Local Level:

	2% Productivity Increase	1% Productivity Increase
Payback period	2021	2021
ROI	4,99	2,28
NPV	20 377 392 euros	9 318 424 euros

These results are showing that the assumption on the ATCO productivity increase is impacting highly the results of the CBA. Indeed, the scenario analysed in the sensitivity analysis has underlined a decrease of 54% for both the return on investment and net present value of the Solution #118. It underlines that this assumption is the most impacting one on the NPV.

At an ECAC Level

	2% Productivity Increase	1% Productivity Increase
Payback period	2021	2021
ROI	4,64	2,08
NPV	220 132 253 euros	98 820 139 euros

These results are showing that the assumption on the ATCO productivity increase is impacting highly the results of the CBA. Indeed, the scenario analysed in the sensitivity analysis has underlined a decrease of 55% for both the return on investment and net present value of the Solution #118. It underlines that this assumption is the most impacting one on the NPV.

9 Recommendations and next steps

This CBA report has provided positive results and return on investment for both the base scenario and the three sensitivity analysis.

However, it has to be taken into account that the CBA results are based on the VALR live trial which consisted on a two-week long exercise only, with a limited list of KPA/KPI investigated.

It would be therefore recommended to evaluate additional indicators in order to obtain metrics that would allow integrating new benefits or costs for the Basic EAP function for the different stakeholders (e.g., if relevant, Fuel burn, Airspace capacity, human performance...).

10 References and Applicable Documents

10.1 Applicable Documents

- [1] SESAR 2020 Project Handbook
- [2] SESAR 16.06.06-D26_04, Guidelines for Producing Benefit and Impact Mechanisms, Edition 03.00.01
- [3] SESAR 16.06.06-D26_03, Methods to Assess Costs and Monetise Benefits for CBAs, Edition 00.02.02

10.2 Reference Documents

- [4] Common assumptions for CBAs as maintained by Pj19 (provisionally the ones included in the 16.06.06- D68_Part 1, New CBA Model and Methods 2015, Edition 00.01.01 can be used)
- [5] European ATM Master Plan Portal <https://www.atmmasterplan.eu/>
- [6] SESAR C.02-D110, Updated D02 after MP Campaign, Edition 00.01.00
- [7] SESAR 2020 D108, Transition Performance Framework, Edition 00.06.00
- [8] SESAR 2020 D86, Guidance on KPIs and Data Collection – Support to SESAR2020 transition
- [9] SESAR 2020 D68, New CBA Models and Method Part 1 of 2
- [10] SESAR Solution#118 – SPR/INTEROP/OSED V3 – Basic EAP - Part I Edition 01.00.01, 15/05/2018
- [11] SESAR Solution#118 – SPR/INTEROP/OSED V3 - Basic EAP - Part IV - HPAR Edition 01.00.01, 15/05/2018
- [12] SESAR Solution#118 – SPR/INTEROP/OSED V3 - Basic EAP - Part V - PAR- Edition 01.00.01, 15/05/2018
- [13] SESAR Solution #118 Final VALR V3 - Edition 01.00.00, 28/02/2018
- [14] 04.07.08 - D78 - Validation Report VP-687, Edition 00.01.02, 23/03/2016
- [15] EUROCONTROL Seven year Forecast, published in February 2017
- [16] OECD, Economic Outlook, volume 2017, Issue 2.
- [17] EUROCONTROL Standard input for CBA
- [18] Investopedia web site <https://www.investopedia.com/terms/d>
- [19] EUROCONTROL, Monthly Network Operation Report of 2015
- [20] EUROCONTROL, Performance Results Report of 2015

- [21] EUROCONTROL, ATM Cost effectiveness benchmarking report 2014 with 2015-2019 outlook
- [22]CAPA, Yearbook 2016, State of aviation market for the Western and Eastern Europe.
- [23]EUROCONTROL **Seven-Year Forecast – February 2017**, Flight Movements and Service Units 2017-2023, STATFOR Team, Edition 17/01/02-100
- [24]PRR 2013 - **Performance Review Report**, An Assessment of Air traffic Management in Europe during the Calendar Year 2013, May 2014
- [25]PRR 2014 - **Performance Review Report**, An Assessment of Air traffic Management in Europe during the Calendar Year 2014, May 2015
- [26]PRR 2015 - **Performance Review Report**, An Assessment of Air traffic Management in Europe during the Calendar Year 2015
- [27]PRR 2016 - **Performance Review Report**, An Assessment of Air traffic Management in Europe during the Calendar Year 2016, June 2017

11 Appendix

Mapping between ATM Master Plan Performance Ambition KPAs and SESAR 2020 Performance Framework KPAs, Focus Areas and KPIs, source reference [7]

ATM Master Plan SESAR Performance Ambition KPA	ATM Master Plan SESAR Performance Ambition KPI	Performance Framework KPA	Focus Area	#KPI / (#PI) / <Design goal>	KPI definition
Cost efficiency	PA1 - 30-40% reduction in ANS costs per flight	Cost efficiency	ANS Cost efficiency	CEF2	Flights per ATCO hour on duty
				CEF3	Technology Cost per flight
Capacity	PA7 - System able to handle 80-100% more traffic	Capacity	Airspace capacity	CAP1	TMA throughput, in challenging airspace, per unit time
				CAP2	En-Route throughput, in challenging airspace, per unit time
	PA6 - 5-10% additional flights at congested airports		Airport capacity	CAP3	Peak Runway Throughput (Mixed Mode)
			Capacity resilience	<RES1>	% Loss of airport capacity avoided
	<RES2>			% Loss of airspace capacity avoided	
PA4 - 10-30% reduction in departure delays	Predictability and punctuality	Departure punctuality	PUN1	% of Flights departing (Actual Off-Block Time) within +/- 3 minutes of Scheduled Off-Block Time after accounting for ATM and weather related delay causes	
PA5 - Arrival predictability: 2 minute time window for 70% of flights actually arriving at gate			Variance of actual and reference business trajectories	PRD1	Variance of differences between actual and flight plan or Reference Business Trajectory (RBT) durations



ATM Master Plan SESAR Performance Ambition KPA	ATM Master Plan SESAR Performance Ambition KPI	Performance Framework KPA	Focus Area	#KPI / (#PI) / <Design goal>	KPI definition
	PA2 - 3-6% reduction in flight time	Environment	Fuel efficiency	(FEFF3)	Reduction in average flight duration
	PA3 - 5-10% reduction in fuel burn			FEFF1	Average fuel burn per flight
Environment	PA8 - 5-10% reduction in CO2 emissions			(FEFF2)	CO2 Emissions
Safety	PA9 - Safety improvement by a factor 3-4	Safety	Accidents/incidents with ATM contribution	<SAF1> see section 3.4	Total number of fatal accidents and incidents
Security	PA10 - No increase in ATM related security incidents resulting in traffic disruptions	Security	Self- Protection of the ATM System / Collaborative Support	(SEC1)	Personnel (safety) risk after mitigation
				(SEC2)	Capacity risk after mitigation
				(SEC3)	Economic risk after mitigation
				(SEC4)	Military mission effectiveness risk after mitigation

[28] Table 10: Mapping between ATM Master Plan Performance Ambition KPAs and SESAR 2020 Performance Framework KPAs, Focus Areas and KPIs

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Founding Members

