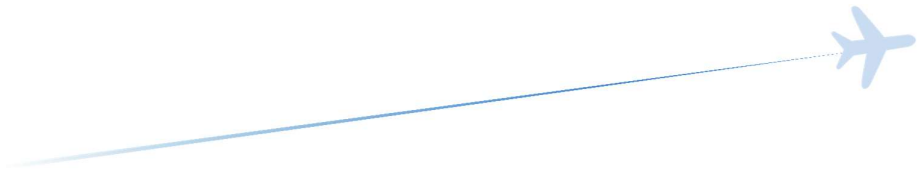

SESAR SOLUTION PJ.07-01: COST BENEFIT ANALYSIS (CBA) FOR V2

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Copyright Statement

PJ.07 OAUO

AU PROCESSES FOR TRAJECTORY DEFINITION

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Abstract

This V2 CBA describes the V2 cost benefit analysis for PJ.07 Solution 1 "Airspace Users Processes for Trajectory Definition".

The main objective of Solution PJ.07-01 is to develop requirements and validate procedures and workflows for Airspace User Flight Operations Centres that will enable them to interact better with other Air Traffic Management stakeholders. This is especially the case with the Network Manager regarding trajectory definition in the planning phase. The Solution involves the deployment of the following Operational Improvement steps:

- AUO-0207 - Preliminary flight planning
- AUO-0208 - Use of Simple AU Preferences in DCB Processes
- AUO-0219 - Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning

This V2 CBA estimates the costs and benefits of deploying AUO-0208 and AUO-0219 together and independently across ECAC. AUO-0207 will be included in Wave 2 as there was insufficient data to include it in the CBA at the time of writing.

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1 Executive Summary

This document provides the V2 Cost Benefit Analysis (CBA) for SESAR Project PJ.07 - Solution 01 - Airspace Users Processes for Trajectory Definition.

PJ.07-01 will support the development of Airspace User (AU) Flight Operations Centres (FOC) related processes for the management and update of the Shared Business Trajectory.

The idea is to achieve the full integration of FOCs in the Air Traffic Management (ATM) Network processes. The aim is to accommodate individual airspace user's business needs and priorities without compromising the optimum ATM system outcome and the performances of all stakeholders. The integration will enable the FOC to better interact with other ATM stakeholders and especially with the Network Manager Function (NMF) regarding trajectory definition in the planning phase (i.e. preliminary flight plan preparation, use of ATFM (Air Traffic Flow Management) Measures and enriched Demand and Capacity Balancing (DCB) information).

PJ.07-01 includes three Operational Improvement steps:

- AUO-0207 — Preliminary flight planning
- AUO-0208 — Use of Simple AU Preferences in DCB Processes
- AUO-0219 — Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning

This V2 CBA estimates the costs and benefits of deploying AUO-0208 and AUO-0219 together and independently across ECAC. AUO-0207 will be included in Wave 2 as there was insufficient data to include it in the CBA at this time.

The expected benefits from PJ.07-01 are mainly **ATFM delay reduction** and **reduced Airspace User (AU) costs for critical flights and in counterpart a slight increase of fuel burn**.

The deployment of PJ.07-01 will require the following stakeholders[1] to invest:

- **Airspace Users** to use and update the shared business trajectory.
- The **Network Manager** who will develop the solution functionalities in the network management system.

The CBA results are discounted at 8% between 2019 and 2040, with PJ.07-01 being deployed between 2023 and 2027 and with benefits starting to be realised in 2024. The **Net Present Value is 195 M€** and the **payback year is 2031**. The undiscounted net benefits are 861 M€. The level of confidence in the results is low as some input values are purely based on expert judgment and there are still many assumptions to be clarified in V3 and a sensitivity analysis to the level of overload in the network

[1] For AUO-0208, there will be the need to be some light investments over the longer term, at least in term of Flow Management Position (FMP) training. However, for simplification purposes, the Air Navigation Service Provider (ANSP) stakeholder has not been considered in this version of the CBA.

should be performed. The level of confidence is particularly low for AUO-0208 for which Wave 1 validation exercises have not produced any quantitative results in terms of benefits.

The key recommendations for developing the PJ.07-01 in the V3 phase are:

- Conduct further quantitative assessment of benefits to increase the level of confidence
- Review the cost estimations in light of any updated OI Step / Enabler links as well as any updated enabler description information
- Include the costs and benefits associated with AUO-0207
- Consider the relationship with other Solutions

2 Introduction

2.1 Purpose of the document

This document provides V2 Cost Benefit Analysis (CBA) results based on an ECAC-level view of the deployment of **SESAR Solution PJ.07-01: Airspace Users Processes for Trajectory Definition**.

The key aim of this V2 CBA is to provide a view on the costs and benefits of deploying the Operational Improvement (OI) steps included in Solution PJ.07-01. The V2 validation activities have produced evidence to show that the solution concept is feasible. However, there are still many assumptions included in the production of the CBA results, which focuses on the deployment of the Solution. The assumptions are described in relevant sections of the document to allow future iterations of the CBA to be revised and updated as clearer information on costs (required enablers) and benefits (from validation exercises) becomes available (i.e. during the V3 phase).

2.2 Scope

The scope of this document is the V2 CBA for PJ.07-01 and it builds on the Interim V2 CBA delivered in late 2018.

The Solution includes three Operational Improvement steps:

- AUO-0207 — Preliminary flight planning
- AUO-0208 — Use of Simple AU Preferences in DCB Processes
- AUO-0219 — Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning

This V2 CBA estimates the costs and benefits of deploying AUO-0208 and AUO-0219 together and independently across ECAC. AUO-0207 will be included in Wave 2 as there was insufficient data to include it in the CBA at the time of writing.

2.3 Intended readership

The intended audience of this document is:

- PJ.07 Members – Optimised Airspace User Operations
- Airspace Users involved in PJ.07
- PJ.19 as the Content Integration Project
- PJ.09 - Advanced Demand and Capacity Balancing (DCB), specifically Solution PJ.09-03 – Collaborative Network Management Functions
- PJ.04-01 Total Airport Management
- SESAR Joint Undertaking / SESAR Programme Management
- PJ.20 as Master Plan Maintenance project

2.4 Structure of the document

The following sections of this document cover:

- Section 3 describes the objectives and scope of the V2 CBA including an overview of the concept and details of the CBA Scenarios
- Sections 4 and 5 detail, respectively, the benefits and the costs
- Sections 6, 7 and 8 contain, respectively, details of the CBA model, the CBA results and the sensitivity analysis
- Section 9 currently provides recommendations
- Section 10 lists applicable and reference documents
- Appendix A show the mapping of Key Performance Areas (KPA)
- Appendix B includes the PJ.07-01 OI-Step – Enabler – Stakeholder matrix
- Appendix C provides a summary of what is expected in a V2 CBA from the S2020 Project Handbook

2.5 Background

The PJ.07-01 is a follow-up of the validation activities performed in the SESAR1 project P07.06.02 "Optimised Airspace User Operations". The main concept developed there [10] was the process of submission of the Airspace User's 4D business trajectory to the Network Management Function (NMF) for accommodation in the ATM network during the Business Trajectory Short Term Planning Phase. P07.06.02 [11] also analysed the FF-ICE (Flight and Flow Information for a Collaborative Environment) Planning, and in particular, an evolution of the Extended Flight Plan processes to align with the FF-ICE Provisions. See the PJ.07-01 OSED [12] for further background details.

2.6 Glossary of terms

Term	Definition	Source of the definition
DCB Constraint	Activated ATM constraints (for DCB reasons) that impact a trajectory. (Example of DCB constraints: ATFCM regulations, scenarios applied to the flight)	Newly defined term in the project. PJ.07-01 OSED V2
DCB Measure	Trajectory change that is notified to an AU for a flight due to DCB constraints. (Example of DCB measures: CTOT or Target time, re-routing or level-capping imposed in the context of scenarios or STAMs)	Newly defined term in the project. PJ.07-01 OSED V2
Congestion Level Indicators	Congestion Level Indicators are categorized ratios of traffic counts (entry or occupancy type) over declared capacity values on airports or monitored	Newly defined term in the project. PJ.07-01 OSED V2

Term	Definition	Source of the definition
	airspaces along the Route/Trajectory of the Preliminary Flight Plan (PFP).	
Desired 4D Trajectory	The current 4D trajectory that is requested and generated by the airspace user with knowledge of the ATM system's operational constraints and resource contention.	Manual on FF-ICE
Enabler	An Enabler represents new or modified technical system/infrastructure, human factors element, procedure, standard or regulation necessary to make (or enhance) an operational improvement.	EATMA
Enriched DCB Information	Information provided to AU (in addition to DCB constraints and measures) to give awareness of DCB situation along the trajectory (and possibly nearby the trajectory depending on AU requirements). This includes for example hotspot information, congestion level indicators, provisional CTOT/TT (i.e. CTOT/TT information before being officially published).	Newly defined term in the project. PJ.07-01 OSED V2
FDCI	Flight Delay Criticality indicator. Indicator provided by the AU for a flight requesting NMF operators - both at regional or local level - to limit as much as possible the ATFCM delay allocated to the flight. The FDCI can be viewed as falling in the scope of simple preference information (OI AUO-0208).	Newly defined term in the project. PJ.07-01 OSED V2
Filed Flight Plan (FPL or eFPL)	The flight plan as filed with an ATM Service Provider by the pilot or a designated representative, without any subsequent changes	ICAO 4444 PANS proposed amendment from ATMRPP
Full Operational Capability (FOC)	FOC Is reached when the maximum effective number of "instantiations" or deployments of an OI Step (or enabler) have reached Operating Capability.	EATMA
Hotspot	Local demand/capacity imbalance on the day of operations, which may result from a complex traffic situation or a short period of high demand. A hotspot is created to raise awareness of the situation and may act as a precursor to solving the imbalance (STAM or ATFM regulation).	STAM CONOPS

Term	Definition	Source of the definition
Initial Operational Capability (IOC)	Indicates the date from which benefits can be expected.	EATMA
Negotiating 4D Trajectory	4D trajectory proposed by airspace user or ASP as a potential agreed 4D trajectory. Explanation: For trajectory planning purposes, multiple trajectories may be required. However, participants would be allowed only one negotiating 4D trajectory at a time, which represents their most recent proposal in the negotiation. These trajectories may not necessarily be a gate-to-gate trajectory. These trajectories are intended to be transitory.	Manual on FF-ICE
NMF	NMF is an integrated ATM activity with the aim of ensuring optimised Network Operations and ATM service provision meeting the Network performance targets, which encapsulates: • Collaborative layered planning and execution processes, including the facilitation of business/mission trajectories. • Airspace organisation and management processes. • Demand and Capacity Balancing processes through all planning and execution phases to ensure the most efficient use of airspace resources, to anticipate and solve workload/complexity issues and to minimise the effects of ATM constraints. • The enabling of UDPP process. • The provision and maintenance of Operation Plans covering the range of activity, i.e. Network to Local. • The provision of relevant complexity resolution advice to ATC operations. Based on CDM, the Network Management Function is executed at all levels (Regional, Sub-regional, and Local), throughout all planning and execution phases, involving, as appropriate, the adequate actors.	SESAR 1 WP7.2 DOD
OI Step	OI Step is the elementary level of an operational improvement. Operational Improvement Steps	EATMA

Term	Definition	Source of the definition
	(OI Steps) are the means to describe changes in the ATM Operational Environment.	
Preliminary Flight Plan	Specified information submitted by an operator to conduct collaborative planning of a flight prior to submission of a Filed Flight Plan.	ICAO 4444 PANS proposed amendment from ATMRPP
Short Term ATFCM Measures (STAM)	Specific and dedicated measures for demand capacity balancing (DCB) applied to a limited number of targeted airborne and/or pre-departure flights or flows reducing the complexity and/or demand of anticipated/ identified local traffic peaks on the day of operation	STAM CONOPS

Table 1: Glossary of terms

2.7 List of Acronyms

Term	Definition
ACC	Area Control Centre
ADD	Architecture Definition Document
AN	Availability Note
ANSP	Air Navigation Service Provider
AOWIR	Aircraft Operator What-If Reroute
ASP	Air Service Provider
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATM MP	Air Traffic Management Master Plan
ATMRPP	Air Traffic Management Requirements and Performance Panel (ICAO)
AU	Airspace User
B2B	Business to Business
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CFSP	Computerised Flight plan Service Provider
CMC	Civil Military Cooperation and Coordination
CONOPS	Concept of Operations

Term	Definition
CTOT	Calculated Take-Off Time
D-1	Day of Operations minus 1 (i.e. day before operations)
D-6	Day of Operations minus 6 (i.e. 6 days before operations)
DCB	Demand Capacity Balance
DOD	Detailed Operational Description
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
ECTRL	EUROCONTROL
eFPL	FF-ICE filed flight plan
E-OCVM	European Operational Concept Validation Methodology
FDCI	Flight Delay Criticality Indicator
FEFF	Fuel Efficiency
FF-ICE	Flight and Flow Information for a Collaborative Environment
FL	Flight Level
FLX	Flexibility
FMP	Flow Management Position
FOC	Flight Operations Centre
FOC	Full Operational Capability
FPL	Flight Plan
GAT	General Air Traffic
HIL	Human In the Loop
IBP	Industrial Based Platform
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IRS	Interface Requirements Specification
INTEROP	Interoperability Requirements
IOC	Initial Operational Capability
Kg	Kilogramme
KPA	Key Performance Area
KPI	Key Performance Indicator
LTM	Local Traffic Manager
M€	Millions of Euros
NOP	Network Operations Plan

Term	Definition
NPV	Net Present Value
NM	Network Manager (EUROCONTROL)
NMF	Network Management Function (Includes the global Network from local ANSP to EUROCONTROL)
O	Optional (Enabler)
OI	Operational Improvement Step
OPEX	Operating Expenditure
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PANS	Procedures for Air Navigation Services
PCP	Pilot Common Project
PFP	Preliminary Flight Plan
PI	Performance Indicator
PIRM	Programme Information Reference Model
PUN	Punctuality
PRD	Predictability
R	Required (enabler)
R&D	Research and Development
RBT	Reference Business Trajectory
SAF	Safety
SBT	Shared Business Trajectory
SES	Single European Sky
SESAR	Single European Sky ATM Research Programme
SIM	Simulation
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements
STAM	Short Term ATFCM Measures
SUT	System Under Test
SWIM	System Wide Information Management
TRL	Technology Readiness Level
TS	Technical Specification
TT	Target Time
UC	Use Case

Term	Definition
UDPP	User Defined Prioritisation Process
V2	E-OCVM lifecycle phase: Feasibility
V3	E-OCVM lifecycle phase: Pre-industrial development & integration
VFR	Visual Flight Rules

Table 2: List of Acronyms

3 Objectives and scope of the CBA

3.1 Problem addressed by the solution

In today's situation, when regulations are applied, there is no consideration of the preferences of the airspace users. For example, they may prefer to prioritise a flight with many connecting passengers so that those connections are successfully made as this avoids the costs and effort associated with re-planning the journeys of passengers who miss their connections. However, that preference is unknown to the Network Manager and they will allocate delays to flights based on 'other' criteria and so the AU preferences are not considered.

The solution responds to the need to accommodate individual airspace user business needs and priorities without compromising optimum ATM system outcome and the performances of all stakeholders.

3.2 SESAR Solution description (a summary)

PJ.07-01 is developing processes to accommodate the airspace user preferences in the planning phase.

The following section (*in italics*) is based on the EATMA data in Dataset 20 Draft from the eATM Portal [5] where Solution PJ.07-01 is described in the following way.

As specified in the latest FF-ICE (Flight and Flow Information for a Collaborative Environment) Provisions [13]*: "The FF-ICE Planning Service is provided to facilitate ATM and operator planning for flights in airspace where significant constraints exist, and/or where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services concerned. The Planning Service shall provide operational acceptability, applicable constraints and, when possible, viable alternatives in response to submitted flight plan information".*

The request for the FF-ICE Planning Service is an option for the airspace user, but it is highly recommended when the flight is planned to traverse airspace of medium or high traffic complexity, or depart/land at airports having to manage high complexity departures and arrivals. It is also up to the airspace user to decide for which category of flights (short-haul, long-haul etc.) they will request the service, depending on the benefits that this will bring according to prior airspace user's business analysis.

The provision of the Planning Service introduces a new phase in the flight planning process where a preliminary flight plan is prepared in coordination, via a CDM process, with the Planning Service provider for operational acceptance prior to flight plan filing and distribution to the relevant ATC Units.

This solution is focusing on refining operational requirements for the Planning Service, so as to provide additional benefits to the Airspace Users for requesting the Planning Service from the Network Management Function, with the assumption that the Network Management Function will become the FF-ICE Planning Service Provider for the ICAO European Region.

This solution includes refining timing operational requirements for submitting preliminary flight plan desired 4D trajectory information to the Network Management Function, so as to improve the outcome of the Air Traffic Flow and Capacity Management (ATFCM) /Airspace Management (ASM) process for the benefit of the Airspace User.

This solution also includes detailing operational requirements for the provision of ATFCM measures/constraints, their impact on the Airspace User's desired 4D trajectory and the expected behaviour from the Airspace User upon notification of this information and in particular if the Airspace User would like to engage in a 4D trajectory negotiation process.

This solution also analyses the provision of enriched DCB information like Hotspots and Congestion Level Indicators along alternative (negotiating) 4D trajectories that the Airspace User may submit to the Network Management Function during a 4D trajectory negotiation; this enriched DCB feedback could assist the Airspace User's alternative 4D trajectory choice following a 4D trajectory negotiation.

As mentioned earlier, the main objective of Solution PJ.07-01, in Wave 1, was the development of requirements and the validation of FOC procedures and workflows for the management and update of the Shared Business Trajectory. These will enable the FOC to better interact with other ATM stakeholders and especially with the Network Manager Function (NMF) for trajectory definition in the planning phase (i.e. preliminary flight plan preparation, use of Air Traffic Flow Management (ATFM) Measures and enriched DCB information). This is why there are links with Solution PJ09-03: Collaborative Network Management Functions[2].

The new procedures will increase the FOCs role in Trajectory Management by achieving their full integration in the ATM Network processes. PJ.07-01 also investigated the impact of such integration on the performance of all concerned ATM actors. The processes need to accommodate individual airspace user business needs and priorities without compromising the optimum ATM system outcome and the performances of all stakeholders.

PJ.07-01 has developed three topics each focussed on one of the OI Steps:

1) Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning (AUO-0219)

Enriched Demand and Capacity Balancing (DCB) information will be available to improve AUs decision-making process when planning or re-planning trajectories. Enriched DCB information encompasses DCB constraints/measures information like ATFCM regulations / CTOT (calculated Take-Off Time) / STAM (Short Term ATFCM Measures); and additional DCB information such as hotpots and congestion level indicators. Enriched DCB information is provided either for the trajectory planned by the AU, as part of a submitted flight plan, or for alternative trajectories considered in the context of an advanced what-if. The information can be used in different use-cases such as proactive management of fleet delays by AUs or CDM processes triggered by flow managers (e.g. STAM/Cherry picking measures).

[2] PJ.09-03 includes the OI Step DCB-0217: DCB Support to FF-ICE. This link will be developed further during the Wave 2 activities.

Enriched DCB information and advanced what-if functions will be accessible via SWIM services to enable full integration of flight planning and ATFCM information in AU systems and further automation of AU decisions related to flow management constraints.

NOTE: In term of DCB information provided to AUs in flight planning, two categories are distinguished:

- *Core DCB Information* provided as part of the core planning service (FF-ICE provisions):

  DCB constraints: the activated ATM constraints (for DCB reasons) that impact a trajectory (e.g. ATFCM regulations, scenarios applied to the flight).

  DCB measures: it is a trajectory change that is notified to an AU for a flight due to DCB constraints (e.g. CTOT or Target time, re-routing or level-capping imposed in the context of scenarios or STAMs).

- *Enriched DCB information* that could be provided to AUs as part of an extension of the FF-ICE planning service: in addition to DCB constraints and measures, information provided to AU to give awareness of DCB situations along the trajectory (and possibly nearby the trajectory depending on AU requirements). This includes, for example, hotspot information, congestion level indicators and provisional CTOT/TT (i.e. CTOT/TT information before it is officially published).

2) Use of Simple AU Preferences in DCB Processes (AUO-0208)

As part of Collaborative Decision Making (CDM) processes, the AU can provide preference information either before or after the publication of DCB constraints. This information can be taken into account in the DCB processes to define measures that reduce the impact on the AU costs. Simple preferences refer more specifically to light information like Flight Delay Criticality Indication (FDCI) that can be considered by NMF human operators and systems - either at regional, sub-regional or local levels - to avoid ATFCM delay (e.g. slot exemption or level capping/re-routing proposal to avoid an ATFCM regulation) for critical flights.

Within this topic, the solution aimed at refining the operational requirements for the provision of the simple AU preferences (Flight Delay Criticality Indicators (FDCIs)), to indicate that the flight is critical, and the use of this information by the NMF.

3) Preliminary flight planning (AU0-0207)

In the flight-planning phase, the Shared Business Trajectory (SBT) management processes are aligned with ICAO FF-ICE increment 1 scenarios. SBT management will start with the provision of the Preliminary Flight Plan (PFP) by the AU. This will trigger the trajectory negotiation processes and ATM constraint information exchanges along the planned trajectory. Anticipated provision of PFPs will allow improved traffic predictions and better knowledge of AU optimum trajectories leading to more efficient ASM and DCB processes in pre-tactical (from D-6 to D-1) and early tactical planning phases.

Within this topic, the solution did not perform any validation activities and hence there are no benefit inputs available for this iteration of the CBA.

For completeness, the following tables provide the full list of OI Steps and Enablers currently associated with PJ.07-01 (DS20 Draft). However, as mentioned previously, only AUO-0208 and AUO-0219 are included in this version of the CBA.

SESAR Solution ID	OI Step code	OI Steps ref. (coming from the Integrated Roadmap)
PJ.07-01	AUO-0207	Preliminary Flight Planning
	AUO-0208	Use of Simple AU Preferences in DCB Processes
	AUO-0219	Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning

Table 3: SESAR Solution PJ.07-01 Scope and related OI steps

The information in the table below are those present in the eATM Portal Dataset 20 Draft on 02/10/2019, updated with additional inputs *(in italic*) or proposed unlinking (~~*italic strikethrough*~~) from the project (i.e. changes that will be made in future versions of the dataset). These changes are included here to support the CBA team maintain traceability from DS20 Draft to the Project Team's latest updates.

OI Steps ref.	Enabler[1] ref.	Enabler definition	Applicable stakeholder
AUO-0207	AOC-ATM-25 (R)	Integration of PFP/eFPL submission in the flight planning	Civil Flight Operations Centre
	NIMS-57 (R)	Integration of PFP/eFPL processing into Traffic Demand Management	Network Manager
	NIMS-58 (R)	*Enhance the DCB functions to provide the enriched DCB data for a flight trajectory*	*Network Manager*
	NIMS-61 (R)	*Enhance the DCB functions to provide the DCB constraint data for a flight trajectory*	*Network Manager*
	SWIM-APS-19 (R)	Provision of the FF-ICE Planning Service	Network Manager
	SWIM-APS-20 (R)	Consumption of the FF-ICE Planning service	Civil Flight Operations Centre
	SWIM-APS-21 (R)	Provision of the FF-ICE Flight Information Service	Network Manager
	SWIM-APS-22 (R)	Consumption of the FF-ICE Flight Information Service	Civil Flight Operations Centre
AUO-0208	NIMS-21a (O) (PCP)	Initial Flight Planning management enhanced to support 4D for Step 1 (according to DS20 Draft this enabler is currently being implemented)	Network Manager
	Additional enablers are being added to this OI Step via a Change Request (03451). These enablers will be addressed in the V3 CBA activities.		
AUO-0219	AOC-ATM-24 (R)	Integration of the AOWIR service provisions (update functions to use DCB constraints and enriched DCB data)	Civil Flight Operations Centre
	~~*AOC-ATM-26 (R)*~~	~~*Integration of the AOWIR service provisions (integration of proposeRoutes and whatIfReroute functions)*~~	~~*Civil Flight Operations Centre*~~

[1] This includes System, Procedural, Human, Standardisation and Regulation Enablers

OI Steps ref.	Enabler[1] ref.	Enabler definition	Applicable stakeholder
	HUM-019 (R)	New task to analyse the DCB impact and decide on the next action for the flight plan	Civil Flight Operations Centre
	NIMS-58 (R)	*Enhance the DCB functions to provide the enriched DCB data for a flight trajectory*	*Network Manager*
	NIMS-61 (R)	*Enhance the DCB functions to provide the DCB constraint data for a flight trajectory*	*Network Manager*
	SVC-006 (R)	FF-ICE Planning Service updated for the provision of the DCB data and enriched DCB data for a preliminary flight plan	Civil Flight Operations Centre Network Manager
	SVC-007 (R)	FF-ICE Flight Information Service updated for the provision of the DCB data and enriched DCB data for a PFP and eFPL.	Civil Flight Operations Centre Network Manager
	SVC-011 (R)	Enhance AOWIR SWIM service with the DCB constraint data for the AU or proposed trajectories	Civil Flight Operations Centre Network Manager
	SVC-012 (R)	Enhance AOWIR SWIM service with enriched DCB data	Civil Flight Operations Centre Network Manager
	~~*SWIM-APS-19 (R)*~~	~~*Provision of the FF-ICE Planning Service*~~	~~*Network Manager*~~
	SWIM-APS-20 (R)	Consumption of the FF-ICE Planning service	Civil Flight Operations Centre
	SWIM-APS-21 (R)	Provision of the FF-ICE Flight Information Service	Network Manager
	SWIM-APS-22 (R)	Consumption of the FF-ICE Flight Information Service	Civil Flight Operations Centre
	SWIM-APS-23 (R)	Consumption of the AOWIR service	Civil Flight Operations Centre
	SWIM-APS-24 (R)	Integration of the AOWIR service provisions (update functions to use DCB constraints and enriched DCB data)	Network Manager
	SWIM-APS-25 (R)	Provision of the AOWIR service with the enhanced DCB data	Network Manager

Table 4: PJ.07-01 OI steps and related Enablers

3.3 Objectives of the CBA

The V2 CBA is to provide information on the costs and benefits of deploying Solution PJ.07-01 in the Solution's ECAC-level CBA Scenario. This assessment will help build the 'big picture' of the whether the Solution is worth deploying. While the views of individual stakeholders involved in the deployment are considered, this CBA does not provide CBA results for specific local deployments.

3.4 Stakeholders identification

There are only two stakeholders involved in the deployment of this solution:

- Airspace Users[1]: Flight Operations Centre (FOC)
- Network Manager

Note that the Airspace Users who have FOCs are generally the Scheduled Airlines (split into Mainline and Regional in the CBA). Some Business Aviation operators have FOC, however, they are not considered here explicitly because their flight planning priorities often differ from those of the Scheduled Airlines; this assumption can be reviewed in V3 as necessary.

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		While ANSPs have no costs or benefits, the traffic they handle will differ from current traffic following the deployment of the Solution. Further work is needed to assess if the differences will affect workload.		
Airport Operators		While Airport Operators have no costs or benefits, the traffic they handle will differ from current traffic following the deployment of the Solution.		
Network Manager	Network manager system	Costs: Invest to update the NM system to provide the functionalities required by this solution.	Provision of costs for NM enablers	NM costs are included

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

Stakeholder	The type of stakeholder and/or applicable sub-OE	Type of Impact	Involvement in the analysis	Quantitative results available in the current CBA version
		Benefits: No directly monetisable benefits, however, the Solution should improve network efficiency.		
Scheduled Airlines (Mainline and Regional)	Flight Operation Centre	Costs: Invest in the flight operations centre software to use the information provided by NM. Benefits: Reduction of ATFM delays, direct AU costs	Provision of costs for AUs enablers Approval of the benefits (order of magnitude)	Costs and Benefits results are included
Business Aviation		Not impacted		
Rotorcraft		Not impacted		
General Aviation IFR		Not impacted		
General Aviation VFR		Not impacted		
Military – Airborne		Not impacted		
Military – Ground		Not impacted		
Other impacted stakeholders (ground handling, weather forecast service provider, NSA….)		Not impacted		

Table 5: PJ.07-01 CBA Stakeholders and impacts

3.5 CBA Scenarios and Assumptions

This CBA only covers the following OI Steps:

- AUO-0208: Use of Simple AU Preferences in DCB Processes
- AUO-0219: Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning

AUO-0207 is not included in this iteration because as it was not the focus of the validation activities, there are not yet any benefit results to include in the CBA so the costs have also been excluded for now.

The CBA considers the deployment of Solution PJ.07-01. This means that the full costs for the enablers are included in the CBA even if they will actually enable other Solutions[2] too. In addition, the starting assumption for the CBA is that the Solution OI Steps are considered to be deployed in each relevant deployment location.

The CBA Solution Scenario (green box in Figure 1) considers the situation where the Solution OI Steps are being deployed at relevant locations across ECAC. The CBA Reference Scenario (orange box in Figure 1) describes the same future situation but where the Solution is not being deployed. The CBA reflects the delta (difference) between the CBA Reference and Solution Scenarios (i.e. between the orange and green boxes in Figure 1).

Defining the Reference Scenario can be challenging because of the assumptions that need to be made regarding the 'ongoing deployments' (blue arrow in Figure 1) such as other Solutions and initiatives. As there is no defined approach, and to avoid being blocked by this uncertainty, the V2 CBA considers some elements based on the difference between the current situation (2019) and the Solution Scenario.

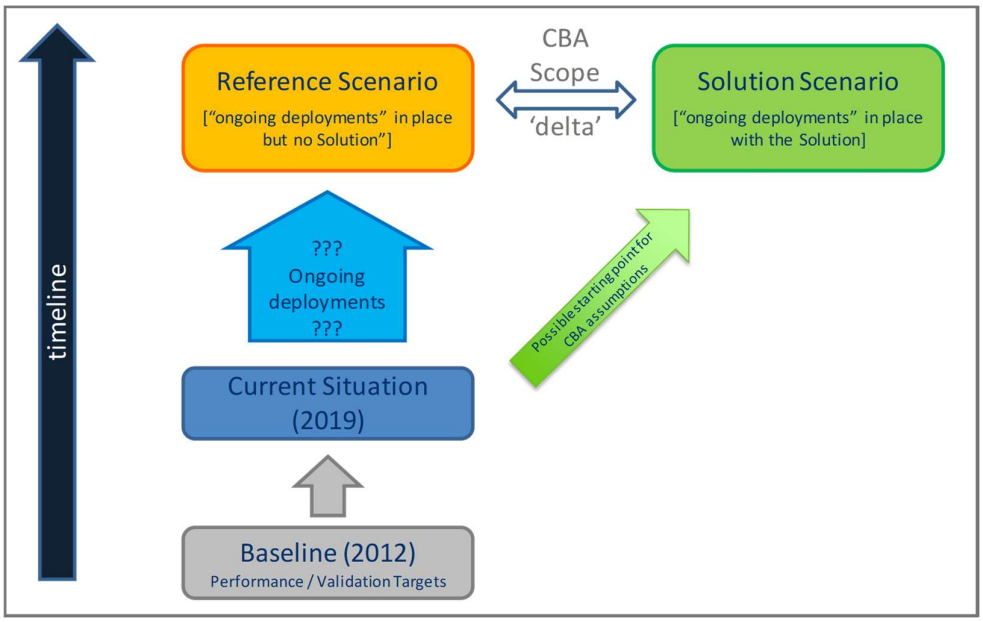


Figure 1: CBA Scenario Overview

Within the CBA, the Solution is considered to be deployed when the assigned Stakeholders have deployed the required enablers and the system is operational and providing benefits.

3.5.1 Reference Scenario

The CBA Reference Scenario correspond to today's situation (without the solution) and it is assumed that the situation does not change significantly during the CBA scope.

[2] Issues of double-counting will need to be addressed by PJ.19/PJ.20 when considering the deployment of multiple solutions

3.5.2 Solution Scenario

The CBA Solution Scenario considers deployment of the relevant enablers by the following stakeholders in the applicable listed sub-operating environments (sub-OE).

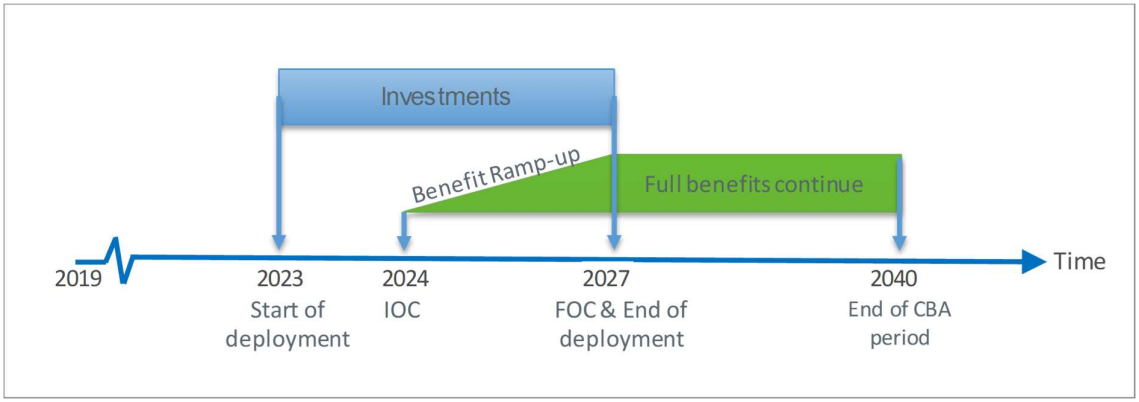
- **Civil Airspace users (Ground)** will deploy in the Flight Operating Centres the component to manage and update the shared business trajectory.
- The **Network Manager** will deploy the NM enablers to equip their systems with the necessary functionalities.

3.5.3 CBA Timeline

Table 6 lists the key dates used in the CBA and Figure 2 shows them over a timeline. These dates are provided by the Project and differ from those in DS20 Draft as they occur earlier in time. This is because the DS20 Draft dates are calculated, by PJ.20, from the enabler V3 dates, provided by the Solution. As the DS20 Draft enabler list, especially for AUO-0208, is not yet aligned with the Project's view of the Solution then this results in misaligned dates, which will be updated in the V3 CBA.

Dates	PJ.07-01
Start of deployment date: the start of investments for the first deployment location	2023
End of deployment date: the end of the investments for the final deployment location	Same as FOC
Initial Operating Capability (IOC): the time when the first benefits occur following the ***minimum deployment*** necessary to provide them. Costs continue after this date as further deployment occurs at other locations.	2024
Final Operating Capability (FOC): Maximum benefits from the ***full deployment***[3] of the Solution at applicable locations. Investment costs are considered to end[4] here although any operating cost impacts would continue.	2027

Table 6: CBA Investment and Benefit Dates



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

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

Figure 2: Overview of PJ.07-01 CBA Dates

Figure 2 shows that:

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

In line with PJ.19-04 guidance, the CBA model calculates the cash flows up to 2040 and then discounts the values back to 2019[5] to calculate the Net Present Value. The discount rate of 8% is used for all stakeholders.

3.5.4 Assumptions

Stakeholder related assumptions with relevance to their cost data are detailed in Chapter 5.

Table 7 includes some additional traffic-related assumptions.

Scenario feature		Year 2019	Year 2025	Year 2040	Source
ECAC traffic (M # flights) in line with [4]		11.4	14.0	19.5	STATFOR Long Term forecasts [2018]
Equipage rate		N/A – no airborne equipage required for PJ.07-01			
Applicability: Number of locations where Solution is deployed (# OEs)		Deployment location values are provided in the cost assessment section			PJ.20 WP2.2 sub-OE data files
Impacted traffic, i.e. experiencing the benefits from the Solution(s)	'000 # IFR flights per year	Scheduled Airline traffic (which makes up 89% of ECAC traffic) is considered for the Airspace User benefits, however, only a small fraction of this traffic will actually be impacted.			ECAC traffic above
	'000 # IFR flight hours per year	No benefits are based on flight hours			-

Table 7: PJ.07-01 CBA Solution Scenario Assumptions

In addition, it must be highlighted that for the OI AUO-0219 (Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning), most of the validation activities have been performed in low or medium traffic situations (mainly the winter period). One key assumption of this CBA is that the solution is also applicable in highly network constrained situations (e.g. the summer period), however there will be fewer opportunities to apply the solution because there is less spare

[5] as specified in the PJ.19.04 Common Assumptions [4]

network capacity. To avoid overestimating the benefits, conservative assumptions regarding the ATFM delay reduction in the summer period have been used. The Performance Assessment Report (PAR) [9] provides further details about the assumptions and extrapolation mechanisms to assess benefits and costs for the full year period covering all traffic situations. This applies to ATFM delay reduction and fuel efficiency areas; see section 4.

4 Benefits

PJ.07-01 has used the Single Solution CBA model developed by PJ.19-04 and therefore the benefits are calculated using the benefit monetisation mechanisms that it includes. The mechanism diagrams shown in the following sections are taken from or based on the CBA Reference material [3].

The content in the table below is extracted from PJ.07-01 PAR 2019 [9]. The validation activities did not address AUO-0207 so, as previously mentioned, AUO-0207 is not included in this version of the CBA.

The benefits monetised in this CBA are summarised in Table 8.

KPA	Performance Assessment Result (in CBA)	Stakeholder that benefits in the CBA
FEFF1: Fuel Efficiency – Fuel burn reduction per flight	+0.699 kg/flight (**increased** fuel burn so additional costs)	AU (change in fuel burn and CO2 emissions)
ATFM Delay reduction[6]	7% if en-route ATFM delays <= 2.5 min/flight 5% if en-route ATFM delays >2.5 min/flight	AU (reduced delay)
AUC3: AU Cost Reduction	27 M€ annual savings for airspace users	AU (cost saving)

Table 8: PJ.07-01 Performance Assessment Results monetised in the CBA

PJ.07-01 also has validation targets for Predictability (2.18%) and Punctuality (0.35%). Predictability benefits are not included in this CBA as the improvements are expected from AUO-0207 (which, as mentioned above, is not included in this version of the CBA). Punctuality benefits are not included in the CBA because the definition of punctuality used in Wave 1 is not readily monetisable[7]. This will be reviewed in the V3 CBA activities.

PJ.07-01 does not have any validation targets related to ATCO Productivity (defined as Flights per ATCO-Hour on duty), however, as this Solution will affect the traffic distribution there is scope for potential impacts on workload. Again, this will be considered in the V3 CBA activities.

4.1 Fuel Efficiency (FEFF1)

The Fuel Efficiency impact only concerns AUO-0219 (Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning).

[6] The standard ATFM delay related benefit monetisation mechanism in the Single Solution CBA model calculates delay reduction based on increased en-route capacity. As this solution calculated delay directly, an alternative monetisation mechanism was developed based on the specific data available from the validation activities.

7 The punctuality definition refers to a % of departures departing within < +/- 3 mins vs. schedule due to ATM causes. Monetising this would require information on the actual ECAC number of impacted departures, which is not currently available.

In this case, the Solution results in an increase in fuel burn which is a negative impact. The overall (undiscounted) monetary value of the additional costs associated with burning more fuel and) of Fuel Efficiency and CO2 is 146 M€.

FEFF1: Fuel Efficiency – Fuel burn per flight	+0.699 kg/flight (negative impact)

Table 9: Fuel Efficiency Performance Result

The figure below shows the monetisation mechanisms used in the CBA model. The calculation is made in each year so the values includes the evolution of the number of flights and fuel price over the CBA period. The model automatically calculates the change in CO2 costs when there is a change in fuel burn.

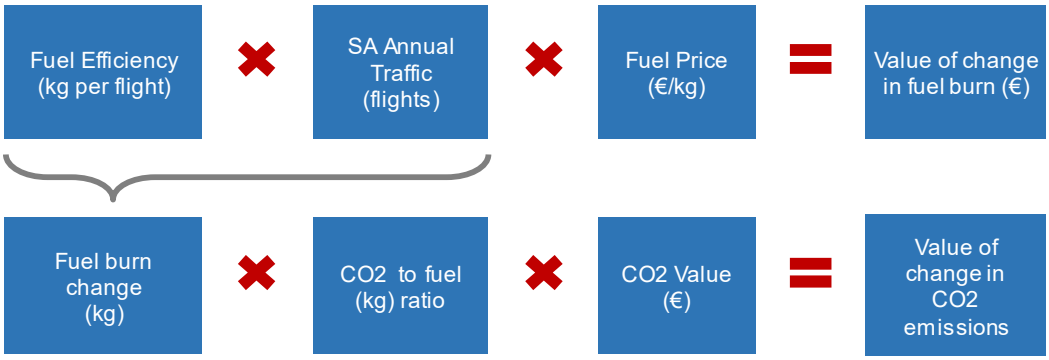


Figure 3: Fuel Efficiency and CO2 Monetisation Mechanisms

4.2 ATFM Delay Reduction

The ATFM Delay Reduction only concerns AUO-0219 (Use of Enriched DCB Information and Enhanced What-Ifs to Improve AU Flight Planning).

PJ.07-01 is expected to reduce tactical delay by improving the management of flight planning. Noting that Tactical ATFM Delay is the unpredictable delay on the day of operations that exceeds the delay buffer foreseen in the flight plan.

ATFM Delay Reduction	7% if en-route ATFM delays <= 2.5 min/flight 5% if en-route ATFM delays >2.5 min/flight

Table 10: ATFM Delay Reduction Performance Results

The overall (undiscounted) monetary value of Delay Reduction is 1,010 M€.

The figure below shows the monetisation mechanisms used in the CBA model. The calculation is made in each year so the values includes the evolution of the number of flights and fuel price over the CBA period.

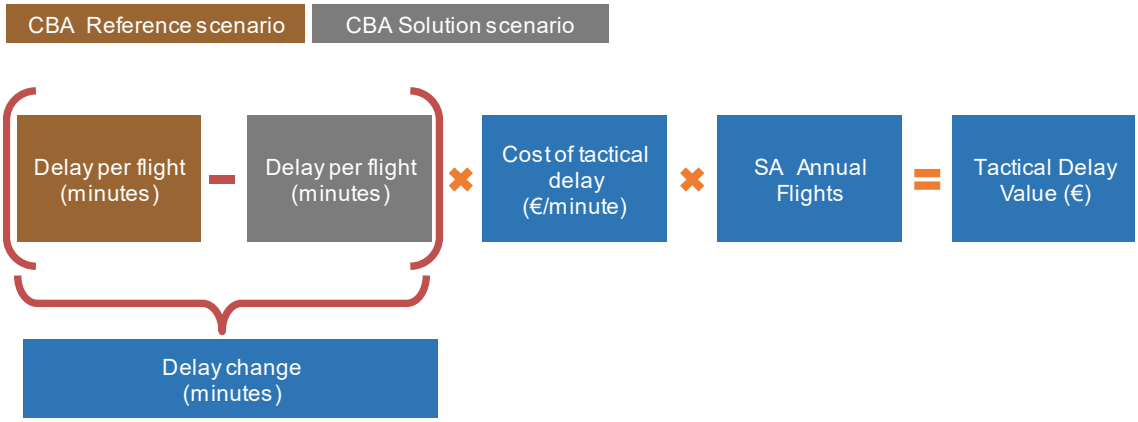


Figure 4: ATFM Delay Reduction Monetisation Mechanism

4.3 Airspace User Cost Reduction (AUC3)

The Airspace User Cost Reduction only concerns AUO-0208 (Use of Simple AU Preferences in DCB Processes).

PJ.07-01 is expected to provide airspace user cost savings by avoiding regulations for critical flights.

AU cost reduction	27 M€ annual savings for airspace users

Table 11: Airspace User Cost Reduction – Annual Savings

The overall (undiscounted) monetary value of AU cost reduction is 419 M€.

The figure below shows the monetisation mechanisms used in the CBA model. The calculation is made in each year so the values includes the evolution of the number of flights and fuel price over the CBA period.

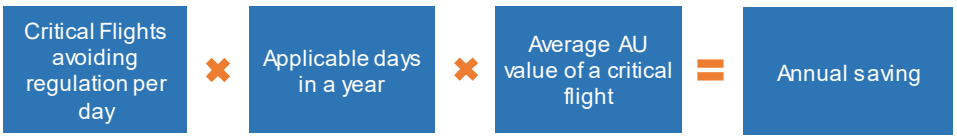


Figure 5: Airspace User Cost Reduction Monetisation Mechanism

The cost reduction corresponds to the value of delay reduction obtained by the solution for a critical flight.

It is assumed that:

- there are 10 critical flights per day
- the AU preferences can be applied for 180 days in a year
- the value of the delay for a critical flight is, on average, 15,000€

The two first assumptions are purely based on SESAR experts' judgement. During the review process, some AU experts have expressed the opinion that these values seem too high. Therefore, these values need to be carefully refined in V3 validation activities and included in the V3 CBA.

The third assumption refers to a cost model developed by the UDPP solution (PJ.07-02, [15]) from AU experts' inputs. Some AU experts involved in Solution PJ.07-01 have confirmed that the order of magnitude for an average value seems correct.

4.4 Benefit Monetisation of the Performance Framework KPI/PI

Performance Framework KPA[11]	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2040
Cost Efficiency	ANS Cost efficiency	**CEF2** Flights per ATCO-Hour on duty	Nb	ATCO employment Cost change	€/year	No Validation Target
				Support Staff Employment Cost Change	€/year	
				Non-staff Operating Costs Change	€/year	
		CEF3 Technology cost per flight	EUR / flight	G2G ANS cost changes related to technology and equipment	€/year	No Validation Target
	Airspace User Cost efficiency	**AUC3** Direct operating costs for an airspace user	EUR	Impact on direct costs related to the aeroplane and passengers. Examples: staff expenses, passenger service costs, maintenance and repairs, navigation charges, strategic delay, landing fees, catering	€	**1429 M€** (419 M€ +1,010 M€)
		AUC4 Indirect operating costs for an airspace user	EUR / flight	Impact on operating costs that do not relate to a specific flight. Examples: parking charges, crew and cabin salary, handling prices at Base Stations	€/year	No Validation Target
		AUC5 Overhead costs for an airspace user	EUR / flight	Impact on overhead costs. Examples: dispatchers, training, IT infrastructure, sales.	€/year	No Validation Target
Capacity	Airspace capacity	**CAP1**	% and # movements	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target

[11] For information, the mapping to the Performance Ambition KPAs (used in the ATM Master Plan) is available in [6].

Performance Framework KPA[11]	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2040
		TMA throughput, in challenging airspace, per-unit time	% and # movements	Strategic delay cost (avoided-; additional +)	€/year	No Validation Target
		CAP2 En-route throughput, in challenging airspace, per-unit time	% and # movements	Tactical delay cost (avoided-; additional +)	€/year	No validation target€
			% and # movements	Strategic delay cost (avoided-; additional +)	€/year	
	Airport capacity	**CAP3** Peak Runway Throughput (Mixed mode)	% and # movements	Value of additional flights	€/year	No Validation Target
	Resilience	**RES4a** Minutes of delays	Minutes	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target
		RES4b Cancellations	% and # movements	Cost of cancellations	€/year	
		Diversions	% and # movements	Cost of diversions	€/year	
Predictability and punctuality	Predictability	**PRD1** Variance of Difference in actual & Flight Plan or RBT durations	Minutes^2	Strategic delay cost (avoided-; additional +)	€/year	To be considered in the V3 CBA
	Punctuality	**PUN1** % Departures < +/- 3 mins vs. schedule due to ATM causes	% (and # movements)	Tactical delay cost (avoided-; additional +)	€/year	To be considered in the V3 CBA
Flexibility	ATM System & Airport ability to respond to changes	**FLX1** Average delay for scheduled civil/military flights with	Minutes	Tactical delay cost (avoided-; additional +)	€/year	No Validation Target

Performance Framework KPA[11]	Focus Area	KPI/PI from the Performance Framework	Unit	Metric for the CBA	Unit	Total benefits from IOC to 2040
	in planned flights and mission	change request and non-scheduled / late flight plan request				
Environment	Time Efficiency	**FEFF3** Reduction in average flight duration	% and minutes	Strategic delay: airborne: direct cost to an airline excl. Fuel (avoided-; additional +)	€/year	No Validation Target
	Fuel Efficiency	**FEFF1** Average fuel burn per flight	Kg fuel per movement	Fuel Costs	€/year	Additional 146 M€ of costs (negative impact)
		FEFF2 CO2 Emissions	Kg CO2 per movement	CO2 Costs	€/year	
Civil-Military Cooperation & Coordination	Civil-Military Cooperation & Coordination	**CMC2.1a** Fuel saving (for GAT operations)	Kg fuel per movement	Fuel Costs	€/year	No significant benefits expected

Table 12: Results of the benefits monetisation per KPA

5 Cost assessment

As a reminder, the costs of AUO-0207 are not included in this version of the CBA as there is no benefit data available yet.

The standard SESAR CBA approach is to use the enablers associated with the OI Steps as the basis for the cost assessment exercise. As there is still ongoing work to create, update and refine the PJ.07-01 enablers, especially for AUO-0208, the cost assessment has been supplemented by expert judgement, from the Solution partners, on the new functionalities and system changes that will be required to deploy the Solution.

This section contains the enablers per stakeholder associated with AUO-0208 and AUO-0219 (as listed in section 3.2). While this is acknowledged as being incomplete, it aims to give the reader an idea of the enablers that will be needed. These aspects will be reviewed in the V3 CBA.

Concerning the enabler tables in this section, the blue boxes indicate which enablers are linked with each OI Step. An 'R' shows they are 'Required' while an 'O' means they are 'Optional'. The green boxes with an X show which stakeholder has been assigned that enabler in DS20 Draft. See Appendix B for an overview table including all the current enablers and stakeholders.

5.1 ANSPs costs

There are no enablers assigned to ANSP for this solution.

5.2 Airport Operators costs

There are no enablers assigned to Airport Operator for this solution.

5.3 Network Manager costs

5.3.1 Network Manager cost approach

Network Manager costs are provided based on a previous cost estimation exercise covering NM-relevant SESAR 2020 Enablers. The current cost range has a 'low confidence' level as detailed understanding of the changes that will be required to provide the enabler functionalities are still being assessed. This also reflects that the solution requires new NIMS enablers.

NM costs cover the Enablers in the table below (which are required for the Solution):

AUO-0208	AUO-0219	EN code	Enabler Title	NET-MAN
R		NIMS-21a (PCP)	Initial Flight Planning management enhanced to support 4D for Step 1	x
	R	*NIMS-58*	*Enhance the Regional ATFCM DCB functions to provide the enriched DCB data for a flight trajectory*	x
	R	*NIMS-61*	*Enhance the Regional ATFCM DCB functions to provide the DCB constraint data for a flight trajectory*	x
	R	SVC-006	FF-ICE Planning Service updated for the provision of the DCB data and enriched DCB data for a preliminary flight plan	x

AUO-0208	AUO-0219	EN code	Enabler Title	NET-MAN
	R	SVC-007	FF-ICE Flight Information Service updated for the provision of the DCB data and enriched DCB data for a PFP and eFPL.	x
	R	SVC-011	Enhance AOWIR SWIM service with the DCB constraint data for the AU or proposed trajectories	x
	R	SVC-012	Enhance AOWIR SWIM service with enriched DCB data	x
	R	SWIM-APS-19	Provision of the FF-ICE Planning service	x
	R	SWIM-APS-21	Provision of the FF-ICE Flight Information service	x
	R	SWIM-APS-24	Provision of the AOWIR service with the DCB constraint data	x
	R	SWIM-APS-25	Provision of the AOWIR service with the enhanced DCB data	x

Table 13: Network Manager Enablers

Costs for PCP enabler (NIMS-21a) are not included as it is assumed to already be deployed.

5.3.2 Network Manager cost assumptions

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

5.3.3 Network Manager costs

Network Manager costs are provided based on a previous cost estimation exercise and should be considered as having a 'low confidence'.

Cost category	Network Manager
Implementation costs	31 M€ (6 M€ for the enablers linked to AUO-0208 and 25 M€ for the enablers linked to AUO-0219)
Operating costs	No impact on annual operating cost was identified at this stage, further analysis of this will be performed for the V3 CBA activities foreseen in Wave 2

Table 14: Cost Per-Unit - NM

5.4 Airspace User costs

5.4.1 Airspace User cost approach

The Airspace User costs consider the set of enablers allocated to the Airspace Users for deployment in their FOC; see the table below.

AUO-0219	EN code	Enabler Title	AU-CIV-FOC
R	AOC-ATM-24	Integration of the AOWIR service provisions	x
R	~~AOC-ATM-26~~	~~Integration of the AOWIR service provisions~~	x
R	HUM-019	New task to analyse the DCB impact and decide on the next action for the flight plan	x
R	SVC-006	FF-ICE Planning Service updated for the provision of the DCB data and enriched DCB data for a preliminary flight plan	x
R	SVC-007	FF-ICE Flight Information Service updated for the provision of the DCB data and enriched DCB data for a PFP and eFPL.	x
R	SVC-011	Enhance AOWIR SWIM service with the DCB constraint data for the AU or proposed trajectories	x
R	SVC-012	Enhance AOWIR SWIM service with enriched DCB data	x
R	SWIM-APS-20	Consumption of the FF-ICE Planning service	x
R	SWIM-APS-22	Consumption of the FF-ICE Flight Information Service	x
R	SWIM-APS-23	Consumption of the AOWIR service	x

Table 15: Airspace User Enablers

The green boxes indicated which Airspace User enablers are linked with each OI Step. The R shows that an enabler is 'Required'.

5.4.2 Number of deployment locations (units)

The SESAR Integrated CBA model considers there are 100 Civil Airspace User Flight Operation Centres (FOC) for costing purposes. However, it is acknowledged that the systems and operations of FOC can vary depending on the size and operations of the relevant airspace user, e.g. Scheduled Airlines with hub and spoke operations, low cost Scheduled Airlines operating point-to-point, etc. Therefore the overall investments (number of deployment locations x cost per-unit values) should be considered a cost envelope where some FOC will have higher implementation costs while other will have lower costs.

Flight Operation Centres	Deployment locations: 100

Table 16: Number of Airspace User Deployment Locations

5.4.3 Cost Per-Unit

The cost per-unit is calculated as an average assuming that there are 100 FOC (i.e. 100 airlines in Europe) to be equipped.

- For AUO-0208, the average estimated costs are 0.10 M€ per Flight Operating Centre, so the total capital expenditure (CAPEX) at ECAC level is 10 M€.
- For AUO-0219 the estimated per-unit costs are:
    - 7M€ each for 20 major airlines.
    - 1M€ each for the other 80 airlines.

  Therefore, the total capital expenditure (CAPEX) is (7 M€ x 20) + (1 M€ x 80) = 220 M€ which gives an average of 2.2 M€ per FOC.

  These costs are considered to include the FPL system evolutions although cost estimates have not been received directly from the Computerised Flight Plan Service Providers (CFSP) as they were not partners in the Solution.

The Airspace User FOC per-unit costs are summarised in Table 17.

Cost category	Flight Operating Centre
Implementation costs	2.3 M€ per FOC 0.1 M € (AUO-0208) + 2.2 M€ (AUO-2019)
Operating costs	0.1 M€/year per FOC (AUO-0208)

Table 17: Cost Per-Unit – FOC

These values also take into account the assumptions made when defining FOC related investments across other network related projects. The current assumptions and per-unit costs are high-level and will need to be defined in more detail in the V3 CBA activities in Wave 2.

5.5 Military costs

There are no enablers assigned to Military for this solution.

5.6 Other relevant stakeholders

No other stakeholders have been identified.

5.7 Cost Summary

This section provides a summary of how the data in the previous sections is used to feed the CBA model.

	Cost per-unit		Deployment Locations		Cost
NM	31 M€	x	1	=	31 M€
Airspace Users (FOC)	2.3 M€	x	100	=	230 M€
				Total	**261 M€**

Table 18: Cost Summary – Capital Expenditure (CAPEX)

	Cost per-unit		Deployment Locations		Cost
Airspace Users (FOC)	0.1 M€ per year	x	100	=	10 M€ per year

Table 19: Cost Summary – Operating Expenditure (OPEX)

6 CBA Model

The model used to calculate the CBA results is Single Solution CBA model developed by PJ.19.

s6.3.8__PJ07-01_v5.x lsm

6.1 Data sources

Cost Inputs

The sources for the Solution cost data are the relevant PJ.07-01 partners.

Benefit Inputs

The source for the benefit calculation inputs are the Performance Assessment Results from the PJ.07-01 Performance Assessment Report [9].

Other Input Parameters

The data sources for the non-Solution specific CBA Model parameters are referenced in the various inputs sheets of the CBA Model with details provided in the sheet 'Source of Reference'. These are all part of the Common Assumptions.

7 CBA Results

The CBA results[12] for these V2 CBAs reflect the CBA data available at the time of writing and further review and revision should be performed during the V3 phase.

This section is structured in the following way:

- 7.1 provides the PJ.07-01 CBA results
- 7.2 contains the AUO-0208 CBA results
- 7.3 contains the AUO-0219 CBA results

7.1 Results for PJ.07-01

The PJ.07-01 CBA results are visible in the CBA model (see section 6) by selecting Scenario 1.

7.1.1 Discounted Values

This section provides the discounted CBA results. The values shown below are discounted to account for the time value of money[13]. Undiscounted values are shown in the next section.

The Net Present Value (NPV) for PJ.07-01 is **195 M€**. This is calculated with an 8% discount rate over the period 2019 to 2040.

The payback year is **2031** as shown in Figure 6 where the discounted cumulative net benefits line crosses back over the x-axis.

PJ.07-01 - 2019 - 2040

Discounted	NPV (M€)	Costs (discounted)	Benefits (discounted)	Discount rate	Discounted
Network Manager	-18	18	0	8%	
Scheduled Airlines	214	191	405	8%	
Overall	**195**	**209**	**405**		

Table 20: PJ.07-01 Discounted CBA results (per stakeholder and overall)

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

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

[12] Any differences in totals are due to rounding errors

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

Figure 6 shows these discounted values on a year-by-year basis. The net benefits are the benefit value per year minus the cost value for that year; these are then shown cumulatively as a line in the figure.

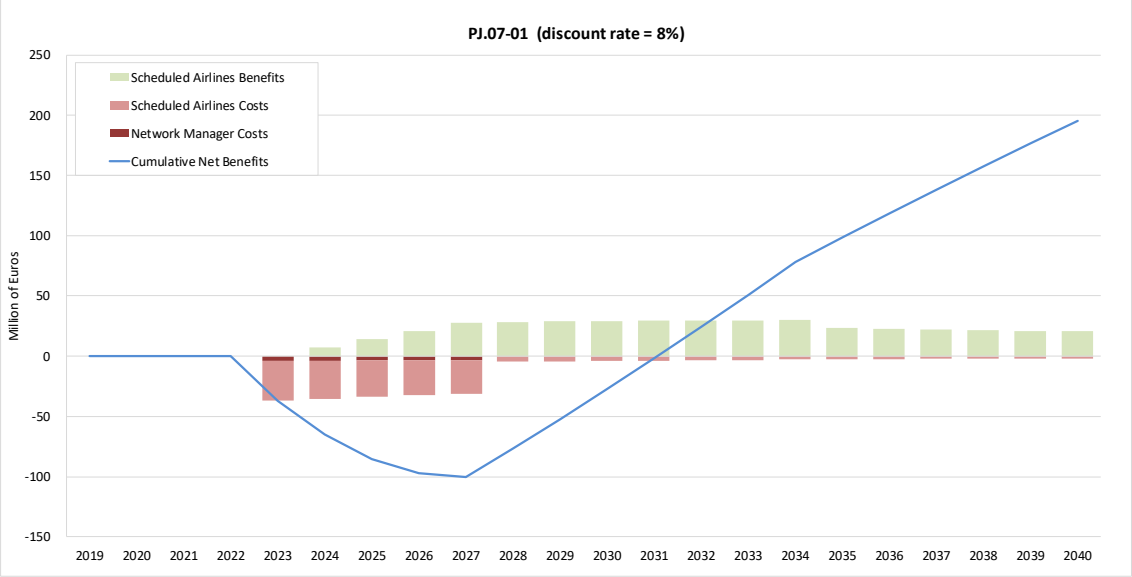


Figure 6: PJ.07-01 Annual Investment Levels and Benefits (discounted)

Figure 7 shows the cost and benefit data without the cumulative net benefits line so that the scale of the costs and benefits per stakeholder are easier to read.

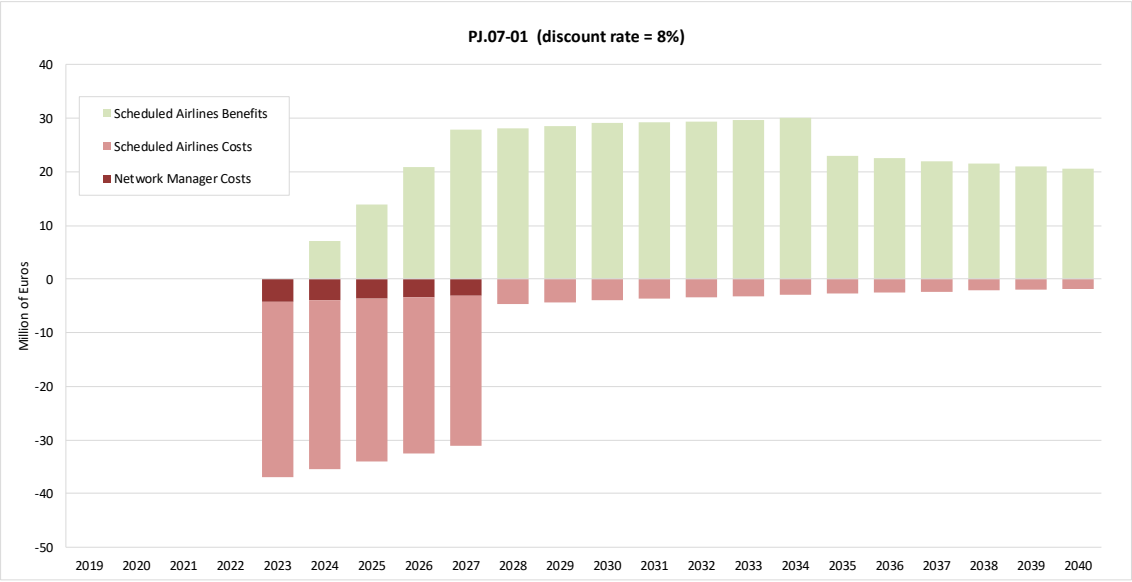


Figure 7: PJ.07-01 Annual Investment Levels and Benefits (discounted) - expanded

7.1.2 Undiscounted Values

The values shown in this section do not consider the time value of money, so one unit of currency spent or received in 2040 is considered to have the same value as one unit of currency spent or received today.

Table 21 contains the undiscounted values, which show that without discounting, i.e. doing the CBA calculation with a discount rate of 0%, the overall net benefits are **861 M€**.

PJ.07-01 - 2019 - 2040				
Undiscounted		Net Benefits (M€)	Costs (undiscounted)	Benefits (undiscounted)
	Network Manager	-31	31	0
	Scheduled Airlines	892	390	1,282
	Overall	**861**	**421**	**1,282**

Table 21: PJ.07-01 Undiscounted CBA results (per stakeholder and overall)

Figure 8 shows the undiscounted costs and benefits over each year. The undiscounted cumulative net benefits line is not included to avoid readers considering the point it crosses the x-axis as the payback year.

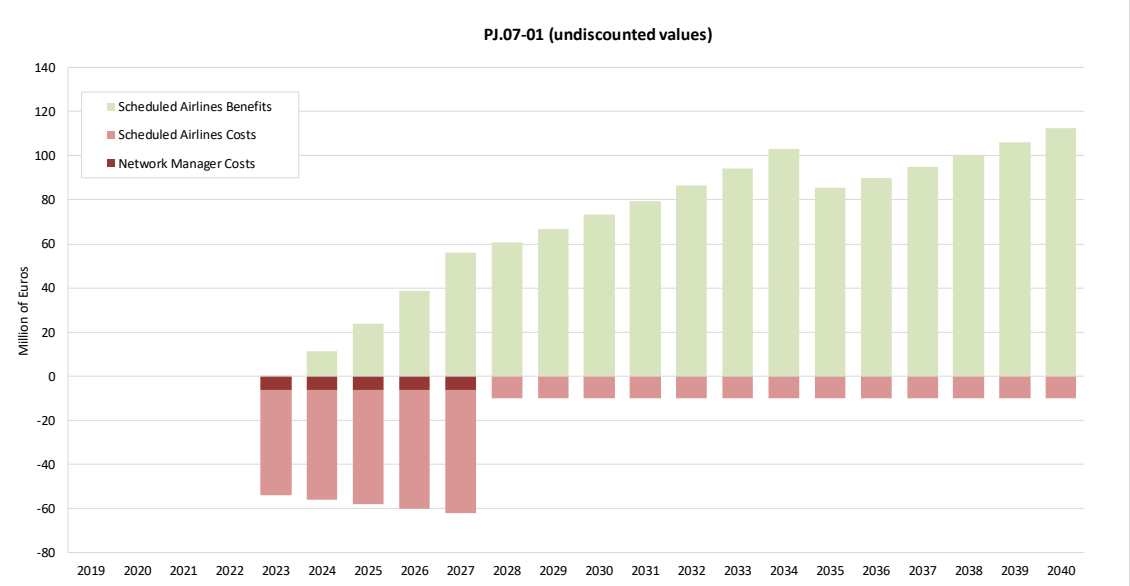


Figure 8: PJ.07-01 Annual Investment Levels and Benefits (undiscounted)

The undiscounted values are useful, especially for the costs, as they provide an idea of the overall investments that will be required. For example, based on these results, the stakeholders will need to invest 421 M€ to deploy this Solution over the deployment period. The 209 M€ discounted cost value, Table 20, simply reflects the present value of those investments in 2019.

7.2 Results for AUO-0208

The AUO-0208 CBA results are visible in the CBA model (see section 6) by selecting Scenario 2.

7.2.1 Discounted Values

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

The Net Present Value (NPV) for PJ.07-01 AUO-0208 is **74 M€**. This is calculated with an 8% discount rate over the period 2019 to 2040.

AUO-0208 - 2019-2040					
Discounted		NPV (M€)	Costs (discounted)	Benefits (discounted)	Discount rate
	Network Manager	-3	3	0	8%
	Scheduled Airlines	77	59	135	8%
	Overall	**74**	**62**	**135**	

Table 22: AUO-0208 Discounted CBA results (per stakeholder and overall)

The payback year is **2026** as shown in the figure below where the discounted cumulative net benefits line crosses back over the x-axis.

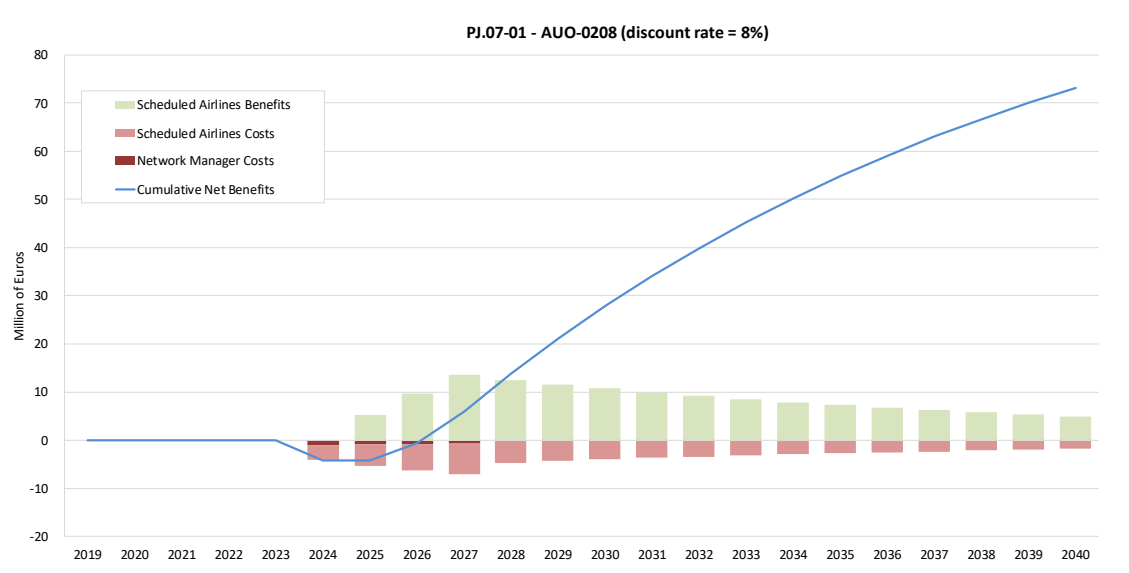


Figure 9: AUO-0208 Annual Investment Levels and Benefits (discounted)

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

Figure 10: AUO-0208 Annual Investment Levels and Benefits (discounted) - expanded

7.2.2 Undiscounted Values

The values shown in this section do not consider the time value of money, so one unit of currency spent or received in 2040 is considered to have the same value as one unit of currency spent or received today.

The table below contains the undiscounted values, which show that without discounting, i.e. doing the CBA calculation with a discount rate of 0%, the overall net benefits are **234 M€.**

AUO-0208 - 2019 - 2040				
Undiscounted		Net Benefits (M€)	Costs (undiscounted)	Benefits (undiscounted)
	Network Manager	-6	6	0
	Scheduled Airlines	240	165	405
	Overall	**234**	**171**	**405**

Table 23: AUO-0208 Undiscounted CBA results (per stakeholder and overall)

The figure below shows the undiscounted costs and benefits over each year. The undiscounted cumulative net benefits line is not included to avoid readers considering the point it crosses the x-axis as the payback year.

Figure 11: AUO-0208 Annual Investment Levels and Benefits (undiscounted)

As mentioned previously, the undiscounted values are useful, especially for the costs, as they provide an idea of the overall investments that will be required. For example, based on these results, the stakeholders will need to invest 171 M€ to deploy this Solution over the deployment period. The 62 M€ discounted cost value, Table 22, simply reflects the present value of those investments in 2019.

7.3 Results for AUO-0219

The AUO-0219 CBA results are visible in the CBA model (see section 6) by selecting Scenario 3.

7.3.1 Discounted Values

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

The Net Present Value (NPV) for PJ.07-01 AUO-0219 is **119 M€**. This is calculated with an 8% discount rate over the period 2019 to 2040.

AUO-0219 - 2019 - 2040					
Discounted		NPV (M€)	Costs (discounted)	Benefits (discounted)	Discount rate
	Network Manager	-15	15	0	8%
	Scheduled Airlines	134	134	268	8%
	Overall	**119**	**149**	**268**	

Table 24: AUO-0219 Discounted CBA results (per stakeholder and overall)

The payback year is **2033** as shown in the figure below where the discounted cumulative net benefits line crosses back over the x-axis.

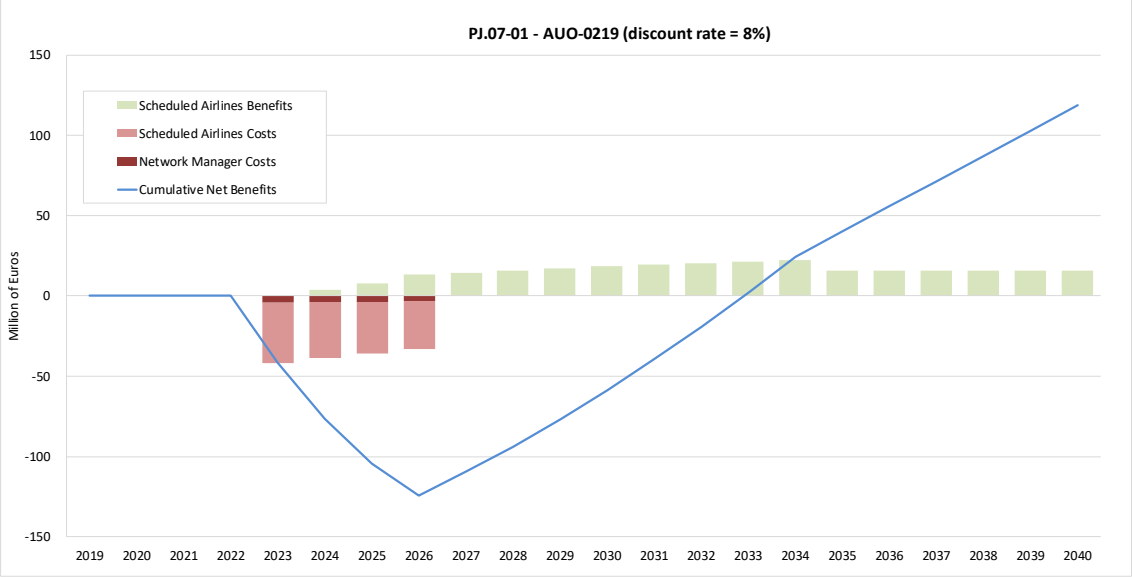


Figure 12: AUO-0219 Annual Investment Levels and Benefits (discounted)

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

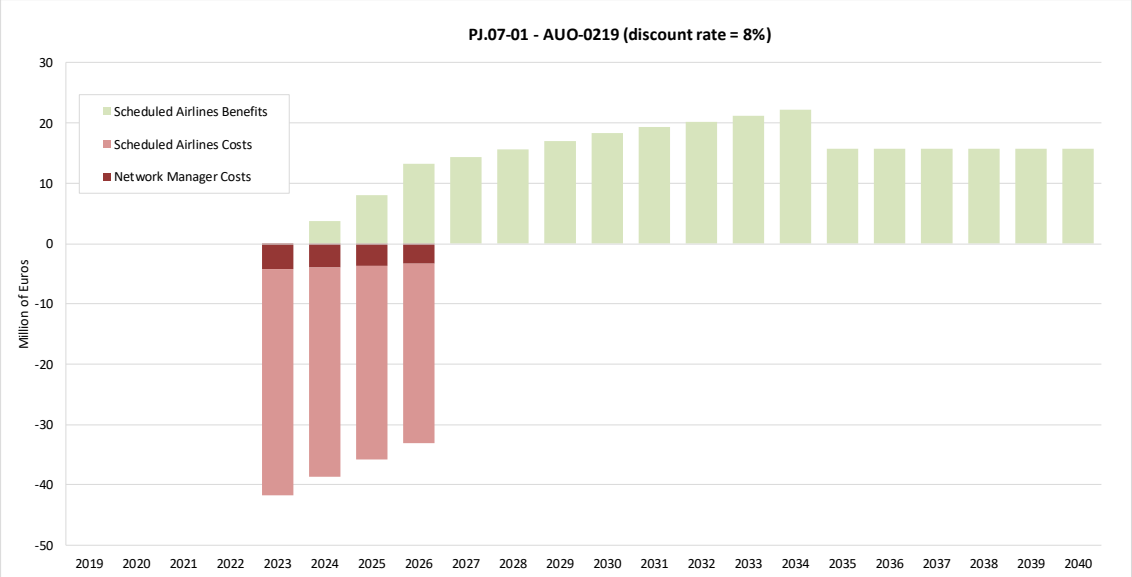


Figure 13: AUO-0219 Annual Investment Levels and Benefits (discounted) - expanded

7.3.2 Undiscounted Values

The values shown in this section do not consider the time value of money, so one unit of currency spent or received in 2040 is considered to have the same value as one unit of currency spent or received today.

The table below contains the undiscounted values, which show that without discounting, i.e. doing the CBA calculation with a discount rate of 0%, the overall net benefits are **465 M€.**

AUO-0219 - 2019 - 2040				
Undiscounted		Net Benefits (M€)	Costs (undiscounted)	Benefits (undiscounted)
	Network Manager	-25	25	0
	Scheduled Airlines	655	220	875
	Overall	**630**	**245**	**875**

Table 25: AUO-0219 Undiscounted CBA results (per stakeholder and overall)

The figure below shows the undiscounted costs and benefits over each year. The undiscounted cumulative net benefits line is not included to avoid readers considering the point it crosses the x-axis as the payback year.

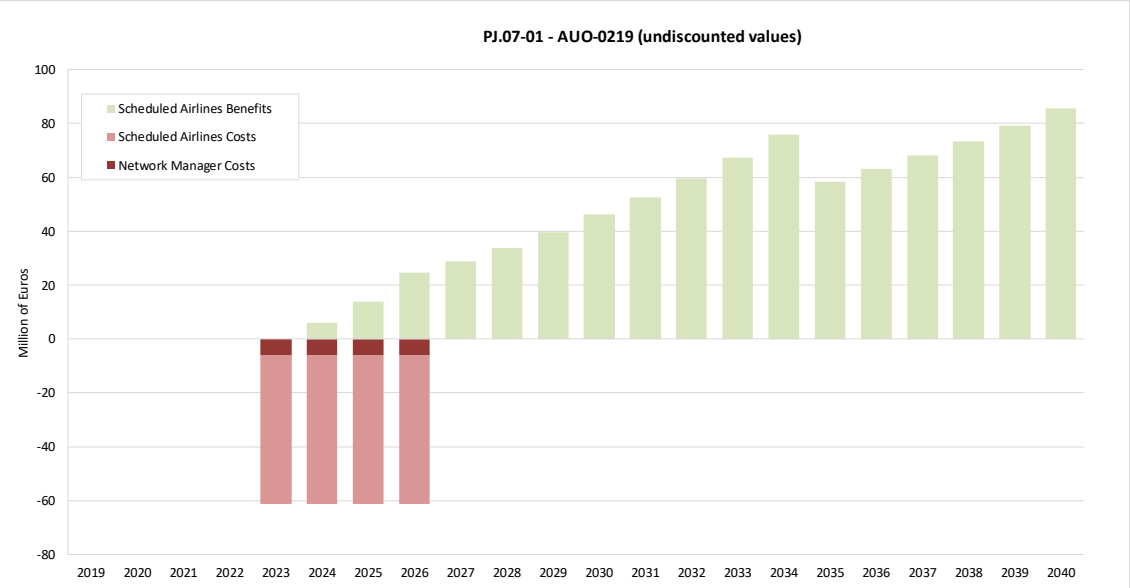


Figure 14: AUO-0219 Annual Investment Levels and Benefits (undiscounted)

As previously mentioned, the undiscounted values are useful, especially for the costs, as they provide an idea of the overall investments that will be required. For example, based on these results, the

stakeholders will need to invest 245 M€ to deploy this Solution over the deployment period. The 149 M€ discounted cost value, Table 24, simply reflects the present value of those investments in 2019.

8 Sensitivity and Risk Analysis

This section[14] only considers the PJ.07-01 CBA; it does not look at the individual OI Step CBAs.

The results shown here explore a set of what-ifs to see how sensitive the CBA results are to changes in the input values. The 'base' values, which produce the discounted results in section 7, are shown with a green background.

The following sub-sections look at these questions:

- 8.1) What-if we use a lower discount rate?
- 8.2) What-if we increase or reduce the NM cost values?
- 8.3) What-if we increase or reduce SA cost values?
- 8.4) What-if we increase or reduce the benefits?

Each of the what-ifs is considered separately, i.e. only the mentioned values are changed and all other inputs are set at their 'base' values.

8.1 Discount Rate

The discount rate is used to reflect the time value of money[15] so reducing the discount rate reduces the difference between the value of money today and its value in the future.

Table 26 shows that using a lower discount rate increases the NPV.

Discount Rate	Change compared to base case	NPV (M€)		Change compared to base case
8%	0%	**195**	As shown in Table 20	0%
6%	-25%	284		46%
4%	-50%	411		111%
2%	-75%	595		205%
0% (undiscounted)	-100%	861	As shown in Table 21	342%

Table 26: Sensitivity Analysis – Discount Rate

[14] Risk Analysis has not been performed for this V2 CBA and will be addressed in the V3 phase if an appropriate tool / Excel functionality is available. Risk Analysis uses Monte Carlo simulation techniques to calculate the NPV results for thousands of scenarios where different combinations of the input values (taken from probability distributions) are used in each.

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

8.2 Sensitivity to the NM Costs

Table 27 shows that reducing/increasing the NM costs by 35% only increased/reduces the NPV by around 4%.

NM investments	Change compared to base case	NPV (M€)	Change compared to base case
20	-35%	202	4%
31	0%	**195**	0%
42	35%	189	-3%

Table 27: Sensitivity Analysis – NM Costs

8.3 Sensitivity to the SA Costs

Table 28 and Table 29 show that the impact of the SA investments and the operating costs increase have a non-negligible impact on the results. It is important to further analyse and improve these inputs in the next validation phase (V3).

SA investments per FOC	Change compared to base case	NPV (M€)	Change compared to base case
1.6	-30%	236	21%
2.3	0%	**195**	0%
3.0	30%	154	-21%

Table 28: Sensitivity Analysis – SA Costs (CAPEX)

SA Operating costs	Change compared to base case	NPV (M€)	Change compared to base case
5	-50%	224	15%
10	0%	**195**	0%
15	50%	167	-14%

Table 29: Sensitivity Analysis – SA Operating Costs (OPEX)

8.4 Sensitivity to the Benefits (delay reduction and threshold)

Table 30 and Table 31 show that these inputs, as expected, have a big impact on the results. Considering that the level of confidence on these inputs is low, it is important to provide more evidence and improve the level of confidence in the next validation phase (V3).

Delay reduction	Change compared to base case	NPV (M€)	Change compared to base case
4.2% - 3%	-40%	72	-63%
5.6% - 4%	-20%	134	-31%
7% - 5%	0%	**195**	0%
8.4% - 6%	20%	257	32%
9.8% - 7%	40%	319	64%

Table 30: Sensitivity Analysis – Delay reduction

Delay threshold	Change compared to base case	NPV (M€)	Change compared to base case
1	-60%	142	-27%
2	-20%	175	-10%
2.5	0%	**195**	0%
3	20%	217	11%
4	60%	239	23%

Table 31: Sensitivity Analysis – Delay threshold

9 Recommendations and next steps

The key recommendations for developing the PJ.07-01 CBA in the V3 phase are to:

- Conduct further quantitative assessment of the benefits to increase the level of confidence
- Review the cost estimations in light of any updated OI Step / Enabler links as well as any updated enabler description information
- Include the costs and benefits associated with AUO-0207
- Consider the relationship with other Solutions

The next steps involve planning how and when to put the recommendations into action and will take place during the relevant Wave 2 planning activities.

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] SESAR 2020, PJ19, D4.0.30 S2020 Common Assumptions (2019), Edition 00.00.02

[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, D4.4, PJ.19-04: Performance Framework (2018), Edition 01.00.00, 27/08/2018

[8] SESAR 2020, D4.8, PJ19: Validation Targets (2019), Edition 00.01.00, 05/04/19

[9] SESAR 2020, D1.2, PJ.07-01 Initial SPR-INTEROP/OSED for V2 – Part V Performance Assessment Report (PAR), Edition 00.00.05, 26/09/2019

[10]SESAR 1, D69, P07.06.02 Optimised Airspace Users Operations Step 2 V1 Business Trajectory Updated OSED, 09/11/2016

[11] SESAR 1, D56, P07.06.02 Optimised Airspace Users Operations Step 1 Business Trajectory final OSED 2016, 01/09/2016

[12] SESAR 2020, D1.2, SESAR Solution PJ.07-01 Initial SPR-INTEROP/OSED for V2 – Part I, Edition 00.00.15, 25/09/2019

[13] ATMRPP2 WP 718 FF-ICE Provisions Consolidated, Montreal, Canada 14 to 18 November 2016

[14] SESAR 2020, D2.2.040, SESAR Solution PJ.07-01: Validation Report (VALR) for V2 – Part I, Edition 00.00.08, 27/09/2019

[15] SESAR 2020, D3.1.030, SESAR Solution PJ.07-02: Cost Benefit Analysis (CBA) for V2, Edition 00.01.01, 09/10/2019

Appendix A KPA mapping

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
Operational Efficiency	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
	PA2 - 3-6% reduction in flight time	Environment	Fuel efficiency	(FEFF3)	Reduction in average flight duration

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
	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>	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

Table 32: Mapping between ATM Master Plan Performance Ambition KPAs and SESAR 2020 Performance Framework KPAs, Focus Areas and KPIs

Appendix B OI Step - Enablers - Stakeholder Matrix

The information in the table below are the same as those in section 3.2, so the enablers are those present in the eATM Portal Dataset 20 Draft on 02/10/2019, updated with additional inputs (in italic) or proposed unlinking (italic strikethrough) from the project (i.e. changes that will be made in future versions of the dataset). These changes are included here to support the CBA team maintain traceability from DS20 Draft to the Project Team's latest updates.

To read the table:

- In the OI Step columns, a blue box with R shows that the enabler in that row is required for the OI Step in that column.
- In the stakeholder columns, a green box with an X shows that the stakeholder in that column has been assigned that enabler in the DS20 Draft.
    - AU-CIV-FOC: Civil Airspace User Flight Operations Centre
    - NET-MAN : Network Manager

OI Steps			Enabler code	Enabler Title	AU	NM
AUO-0207	AUO-0208	AUO-0219			AU-CIV-FOC	NET-MAN
R			AOC-ATM-25	Integration of PFP/eFPL submission in the flight planning	x	
		R	AOC-ATM-24	Integration of the AOWIR service provisions	x	
		R	~~*AOC-ATM-26*~~	~~*Integration of the AOWIR service provisions*~~	x	
		R	HUM-019	New task to analyse the DCB impact and decide on the next action for the flight plan	x	
	R		NIMS-21a (PCP)	Initial Flight Planning management enhanced to support 4D for Step 1		x
R			NIMS-57	Integration of PFP/eFPL processing into Traffic Demand Management		x
R		R	*NIMS-58*	*Enhance the Regional ATFCM DCB functions to provide the enriched DCB data for a flight trajectory*		x

OI Steps			Enabler code	Enabler Title	AU	NM
AUO-0207	AUO-0208	AUO-0219			AU-CIV-FOC	NET-MAN
R		R	*NIMS-61*	*Enhance the Regional ATFCM DCB functions to provide the DCB constraint data for a flight trajectory*		x
		R	SVC-006	FF-ICE Planning Service updated for the provision of the DCB data and enriched DCB data for a preliminary flight plan	x	x
		R	SVC-007	FF-ICE Flight Information Service updated for the provision of the DCB data and enriched DCB data for a PFP and eFPL.	x	x
		R	SVC-011	Enhance AOWIR SWIM service with the DCB constraint data for the AU or proposed trajectories	x	x
		R	SVC-012	Enhance AOWIR SWIM service with enriched DCB data	x	x
R		~~R~~	SWIM-APS-19	Provision of the FF-ICE Planning service		x
R		R	SWIM-APS-20	Consumption of the FF-ICE Planning service	x	
R		R	SWIM-APS-21	Provision of the FF-ICE Flight Information service		x
R		R	SWIM-APS-22	Consumption of the FF-ICE Flight Information Service	x	
		R	SWIM-APS-24	Provision of the AOWIR service with the DCB constraint data		x
		R	SWIM-APS-23	Consumption of the AOWIR service	x	
		R	SWIM-APS-25	Provision of the AOWIR service with the enhanced DCB data		x

Table 33: OI step – Enabler – Stakeholder Matrix

Appendix C V2 CBA Criteria

The SESAR 2020 Handbook [1], section 5.2 (CBA methods and practices overview), page 84, states that:

> In **V2**, the feasibility phase, the CBA assesses the economic feasibility of the solution(s) and can help to compare different alternatives e.g. a system implemented with a centralised or local backups or whether a solution is deployed everywhere or only in most complex environments. In this phase, there is a **quantitative assessment of both costs and benefits** (i.e. the performance assessment) of SESAR Solutions. In areas such as safety, security, environment and human performance the benefits are assessed only qualitatively but the costs (e.g. to implement associated requirements) need to be monetised. Critical variables to the economic value of the solution(s) are identified and recommendations for further research to reduce critical uncertainties and improve quality of inputs are made for V3. In V2, the output should already include a first order of magnitude of benefits and net present value (NPV) of the different options being compared.

The V2 Maturity Assessment Criteria against which the CBA will be assessed at the Maturity Gate is PER.V2.7:

> Has a V2 CBA been developed and documented following PJ.19 Reference Material?
>
> It shall include:
> (1) CBA scenarios and impact on different stakeholders
> (2) monetisation of deployment costs to the different stakeholders possibly in Low-High ranges
> (3) monetisation of benefits using the validation results for the different KPAs possibly in Low-High ranges
> (4) sensitivity analysis identifying the most critical variables and uncertainties for further analysis
> (5) recommendations on whether it's economically worthwhile for this solution to move to V3 including options and scenarios to include in the validation, uncertainties, benefit and cost variables on which to focus future validation activities. If CBAs have already been developed for this solution (or parts of this solution), traceability to these CBAs (including the outline CBA in V1) should also be part of this Preliminary CBA.
>
> *(Validation exercises provide the evidence needed to build a credible CBA)*

-END OF DOCUMENT-