INDUSTRIAL RESEARCH

SESAR PJ.13-Solution 115: COST BENEFIT ANALYSIS (CBA) FOR V3

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Authoring & Approval

Authors of the document

Beneficiary	Date
Thales-AVS	20/09/2022
DSNA	20/09/2022

Reviewers internal to the project

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DSNA	20/09/2022

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Beneficiary	Date

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

Beneficiary	Date
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ERICA

ENABLE RPAS INSERTION IN CONTROLLED AIRSPACE (RPAS ACCOMMODATION)

This CBA V3 is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874474 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document provides the V3 Cost Benefit Analysis (CBA) results for **SESAR Project PJ.13 W2 ERICA, Solution 115 (PJ.13-W2-115) – Accommodation of IFR RPAS** (Instrument Flight Rules, Remotely Piloted Aircraft Systems).

As a reminder, the solution's objective is to improve accessibility of **existing/initial** Medium Altitude Long Endurance Remotely Piloted Aircraft System (**MALE RPAS**) in order to access and fly **transit routes in controlled class A-C airspace as General Air Traffic (GAT) under Instrument Flight Rules (IFR)** with **no segregation** and **no technical change to the ATM systems**.

The RPAS are thus considered acquired, and the ATM systems and IFR procedures already in operation.

Costs, in this V3 CBA are only related to:

Reference scenario costs: specific ANSP airspace design for RPAS transit corridors.

RPAS accommodation deployment scenario: additional Air Navigation Service Provider ANSP training.

Benefits are noted, but not monetized, as they are relative to very low numbers of a new type of additional airspace user, RPAS. The RPAS airspace user benefits from reduced planning lead-time to "file and fly" and to perform regular routine RPAS flight access to the whole IFR airspace. Equity is ensured to to all airspace users, RPAS included. Traditional airspace users are also expected to benefit from better route/profile options – thus more efficient flights. ANSPs can also expect a positive outcome from the solution's approach and the **simple concep**t it provides to an iso-traffic management capability to encourage early adoption by European ANSPs who have such demand for RPAS access.

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1 Executive Summary

SESAR PJ13 (ERICA) Solution 115 is a V3 solution in the **existing** European Air Traffic Management (ATM) to accommodate **existing/initial** Medium Altitude Long Endurance Remotely Piloted Aircraft System (MALE RPAS) flying under Instrument flight rules (IFR), as a general air traffic (GAT) non-segregated amongst other manned controlled traffic in controlled airspace classes A to C.

This document provides Solution 115's Cost Benefit Analysis (CBA) related to the V3 level of maturity, which is a prior-step to V4 industrialisation/deployment during which this CBA should be refined and confirmed. It has been matured through workshops, internal and external stakeholder feedback and validation activities.

Solution 115 improves the situation of RPAS operations, which previously required lengthy preparation and required segregation mechanisms and operations for flight (this is the reference scenario).

In the reference scenario, cost incurred by an ANPSs are related to specific airspace design for RPAS transit corridors, which is a long (several months) and resource consuming process when additional reserved transit mid-level routes need to de designed for MALE RPAS specific transit. In this scenario, the operational actors also have associated airspace reservation effort and processes and the ANSP has to implement representation of those segregated airspace sections on controller working positions.

The improvement and change is that the MALE RPAS, with the Solution 115 RPAS Accommodation concept, can now rapidly access and fly a transit flight in shared airspace, amongst all other traffic.

In Solution S115's concept, flight preparation/changes are as short as for a manned aircraft IFR (Instrument Flight Rules) flight and no segregation is used: the RPAS is managed by Air Traffic Control (ATC) as a GAT IFR flight. The RPAS benefits from the available shared controlled airspace to plan and fly its transit flight segment. No priorities are applied, resulting in equitable traffic management of all airspace users as well as the RPAS in the controlled airspace. A derived benefit to other airspace users of the controlled airspace is that their flights can be more efficient as the airspace reservations are no longer required for the RPAS transit flight. An ANSP deploying this concept will not need specific airspace design activities (mid-altitude transit corridor creation).

Solution 115's concept is intended for initial, short-medium term, routine transit operations of low numbers of existing MALE RPAS, in operating environments classified Low/ Medium complexity and derived also to higher complexity operating environments during low traffic periods.

The RPAS are have already been acquired by the operators and the solution is defined for such RPAS to be used at no additional cost in their existing configuration. ATM systems and procedures already exist and are in operation. The solution takes into account some technical and compliance limitations that existing RPAS have and will exist in the short-medium timeframe, and has defined suitable constraints and mitigations, hence the term "accommodation" used to categorise this solution.

The concept deployment requires no or a minor technical change[1] to the ATM systems. The **only CBA factors (costs) for deployment are:**

- **limited ANSPs training costs for relevant ATCOs** (En-Route centres and certain TMA centres concerned by high transit flights) for an operational procedure relative to RPAS.

Benefits are not monetized, and are relative to routine access of very low numbers of a new type of additional airspace user, RPAS. The RPAS airspace users (initial and existing being mainly Military, the concept could apply to future civil applications in the short-term) benefit from reduced planning lead-time to “file and fly”, with ability to rapidly and flexibly adapt the transit flight to the current conditions and needs.

The solution targets the V4 phase : for the first ANSP : deployment starts 2024, IOC 2025 and it provides the initial benefits invoked immediately. Additional ANSPs that decide to accommodate RPAS will most likely do so in staggered steps following the first experience and feedback. Assumption is that the last ANSP will deploy RPAS accommodation in the 2027-2030 period.

The CBA model evaluates the reference scenario one-off investment airspace design costs, and the deployment scenario one-off costs investment costs: training costs. This is a very limited evaluation as described further in this CBA and will have to be refined in the V4 phase.

It is run for incremental deployment scenarios:

- Single ANSP deployment
- Followed by core ANSPs deployment (in initial zones where demand exists)

Finally, the concept provides flexibility to all stakeholders: RPAS, ANSPs and other airspace users. The RPAS operators will be able to perform regular routine non-segregated RPAS flight access in the airspace. Equity is provided to all airspace users, RPAS included with airspace capacity maintained, better flight efficiency for traditional airspace users and no detrimental effects to airspace and traffic management. **ANSPs can also expect a positive outcome from the solution’s approach and the simple concept it provides to an iso-traffic management capability to encourage early adoption by European ANSPs who have such demand for RPAS access.**

[1] minor technical changes costs to ANSPs are negligible or already encompassed in regular changes for ANSPs related to the Surveillance option (specific transponder code alert for a RPAS C2 link loss) the ANSP will use during accommodation.

2 Introduction[2]

2.1 Purpose of the document

This document is the V3 Cost Benefit Analysis (CBA) for the deployment of SESAR Project PJ.13 W2 ERICA, Solution 115 (PJ.13-W2-115)

2.2 Scope

2.2.1 Concept summary

Solution 115 focuses on short-medium term accommodation of MALE RPAS (Medium Altitude Long Endurance Remotely Piloted Aircraft Systems) flying under IFR (Instrument Flight Rules), and controlled/managed by Air Traffic Control (ATC) as GAT (General Air Traffic), in non-segregated shared airspace amongst all other traffic.

RPAS accommodation is the response to the short to medium term user need, which will take place primarily over the 2025 to 2030 timeframe. It fully relies on the existing mechanisms and systems already in place and adds minor procedural adaptations to prepare & manage a specific RPAS condition (C2 link loss). The solution has defined specific provisions on flight planning and on non-segregated RPAS procedural management in Class A-C controlled airspace shared with other manned traffic. This encompasses RPAS flying transit segments in non-segregated controlled class A-C airspace whereas mission specific profiles and departure/arrival remains as currently performed outside the solution's scope.

2.2.2 Deployment assumptions and scenarios

In the short to medium-term timeframe, deployment start as soon as 2025 (Initial Operating Capability for the first ANSP). There is high and constant demand from existing users of large fixed wing remotely piloted unmanned aircraft systems UAS (mainly existing MALE RPAS) to access controlled airspace for transit under Instrument Flight Rules (IFR).

[2] The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein

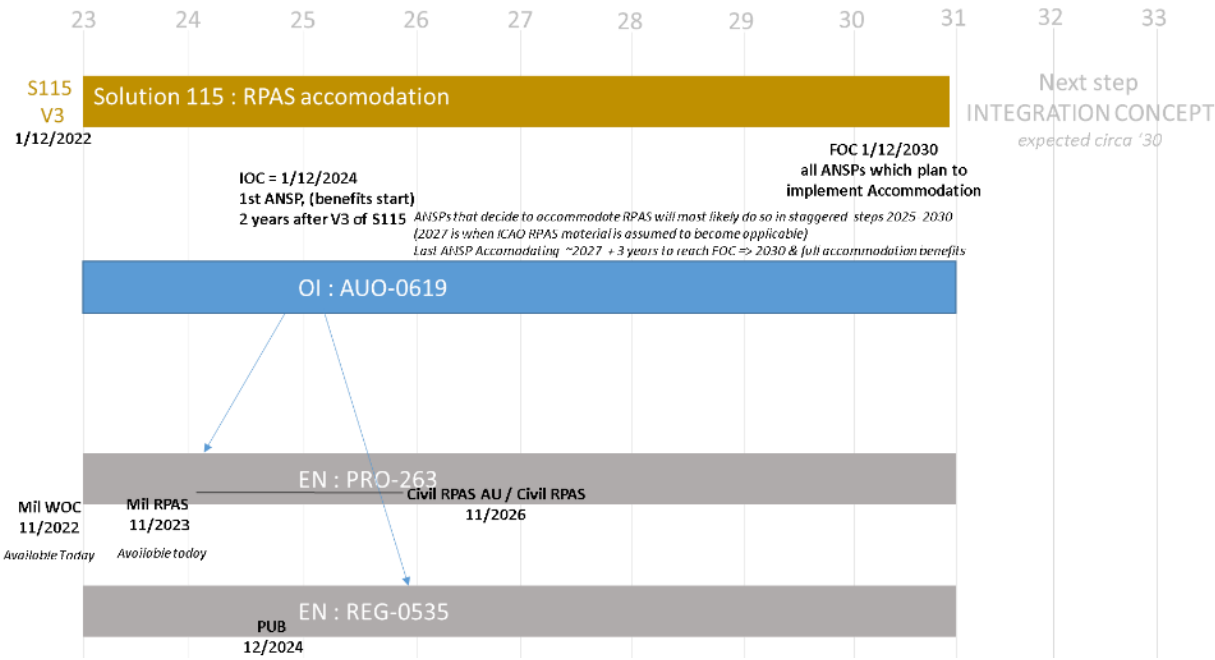

Figure 1: Overall deployment dates and ANSP scenarios

OPERATING ENVIRONMENT:

Solution 115 was initially defined for En-Route Operating Environments classified Low/ Medium complexity (En-Route OE).

However, the solution operational conditions (single RPAS per control sector, low density traffic) provides opportunity for the concept to be used in airspaces classified High & Very-High complexity but only under these operational conditions.

This also corresponds to RPAS user needs in the core European airspace.

A second operational element taken into account is that the accommodated MALE (Mid-Altitude) RPAS transit flight will be between FL100 and FL250 (below jet traffic). There are a number of TMA units that have high ceilings in Europe and the RPAS would be too restricted in only the En-Route ACCs. The RPAS also perform transit through those high ceiling TMAs and the the concept's objective is to freely access airspace. RPAS, with this concept, can be accommodated in the higher complexity airspace under low traffic density conditions in ER & transit TMA (during periods where the total traffic movements are low).

This CBA has summarized the entire set of OEs concerned, for information. The CBA tool is applied only to the numbers of En-Route OEs.

The associated numbers, derived from PRU/ACE data, of the ATS units and associated OE complexity are provided in Table 6: ANSPs / OE spread in scenario – RPAS accommodation assumption.

DEPLOYMENT SCENARIOS:

The S115 deployment scenarios apply to those ANSPs/states most likely and having demand for RPAS accommodation. Two incremental deployment scenarios are addressed in this CBA :

- SCENARIO 1: The first state (France), already well advanced in RPAS accommodation trails on an experimental basis, and will perform the first deployment. It consists of a reference scenario where the ANSP incurs costs for segregation, and a deployment scenario where the ANSP deploys the solution.

- SCENARIO 2: Additional neighbouring states (8 additional ANSPs) that build on the solution and first ANSP's experience, and which also have demand for RPAS accommodation. As above, It consists of a reference scenario where the ANSP incurs costs for segregation, and a deployment scenario where the ANSPs deploy the solution to the extended environment described earlier in this section.

MALE RPAS are already in regular military/state operations. Prior to the solution concept, such operations are under specific bi-lateral arrangements, under restrictions and generally segregated from civil traffic, for example flying predefined reserved corridors to transit to their mission zones.

RPAS user need, in addition to missions and associated OAT flights, is flexible transit across ICAO classes A, B and C controlled airspace as non-segregated general air traffic (GAT). Departure and arrival is not in the solution scope - it remains as currently performed, from dedicated airfields to destination/or mission zones, RPAS remaining segregated during these phases.

Solution 115 has defined an operational concept for such RPAS users to transition from the current mode of segregation (reference scenario) to a flexible and improved airspace access and transit. The solution ensures equity to all airspace users, maintains safety, and does not degrade human performance.

STAKEHOLDERS IMPACT:

REFERENCE SCENARIO

- Corridor creation activity related to specific airspace design for RPAS transit and associated costs to the ANSP.

SOLUTION SCENARIO

- Introduction of the adapted operational procedures - minimum training will be needed for concerned ATCOs associated with the ANSP / OE spread, costed in this CBA.

  Due to the nature of the demand, the solution only introduces limited procedures, compatible with the existing ATM framework and procedures used to manage manned traffic, and with minimum procedural adaptation where needed.

- No significant systems change in the ATM system (minor evolution costs are negligible or already encompassed in regular changes for ANSP, not included in this CBA)
- Existing RPAS are used (no costs).

The following are only qualitative benefits, figures for which cannot yet be estimated, thus not encompassed in this CBA:

- Improved efficiency to all the airspace users (all GAT flights including the RPAS), as segregated airspace is not used - thus increasing the available airspace and route options.
- Improvements in the previously lengthy process of planning, approval and access. With the accommodation concept, RPAS like any other GAT IFR flight, file a GAT IFR flight plan to access airspace and use published routes with some limitations (inter alia: bounded flight levels, RPAS flights enter/exit transit level GAT controlled airspace (classes A to C), one RPAS in a control sector).
- Non-segregated RPAS transit, in the same airspace and within manned traffic (routine access provided to the initial RPAS state demand as GAT with limited restrictions and it paves the way future initial civil RPAS demand),
- Associated ATC management of RPAS like all other GAT trafic by civil air traffic controllers in controlled A-C class airspace during climb, En-route and descent phases of transit flight.

The CBA is assumptions are very basic, only the reference segregated corridor creation and the solution introduction of the adapted operational procedures (there are no systems change, neither in the ATM system nor in the existing RPAS systems).

OSED Appendix A (ref. [12] SESAR Solution 115 Final SPR-INTEROP/OSED for V3 (D3.1.140)) provides the cost / benefits mechanisms: in the solution.

The associated CBA, Cost and Benefits are evaluated in sections 3. 4. & 5. of this document.

2.3 Intended readership

S2020 Projects and Solutions listed below are also intended as readers and for coordination on this document.

PJ13 ERICA – Enable RPAS Insertion in Controlled Airspace

- Solution PJ.13-W2-111 "Collision avoidance for IFR RPAS"
- Solution PJ.13-W2-117 IFR RPAS integration in Airspace Class A to C

PJ.19 W2 CI, Content integration, performance management and business case development

- Solution PJ.19 Content integration, performance management and business case development

PJ.20 W2 AMPLE

- Solution PJ.20 Master Planning

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Other Organizations

The relevant Organizations listed below are also welcome as intended audience for this document.

- ICAO
- EASA
- JARUS
- EUROCAE & RTCA
- EUROCONTROL
- EDA
- OCCAR
- NATO
- External TAC (Technical Advisory Committee) to SESAR PJ13
- IFATCA
- IFALPA

2.4 Structure of the document

This S115 CBA document is organised in the following sections:

- Section 2 provides an introduction to the solution.
- Section 3 describes the objectives and scope of the V3 CBA. It highlights the key points of the solution concept, establishes the CBA Scenarios and summarizes the overall Costs and Benefits expected.
- Sections 4 and 5 detail, respectively, the qualitative benefits and the basic cost elements of the only concerned ANSP stakeholder
- Section 6 provides information on the data and its use in the CBA model
- Section 7 provides the CBA model outputs (results)
- Section 8 provides brief elements on the sensitivity of the data and results
- Section 9 provides recommendations for next steps
- Section 10 lists applicable and reference documents

2.5 Background

In Europe, the European Commission promotes a 'Roadmap for the integration of civil RPAS into the European aviation system', officially launched in June 2013.

In response to this roadmap, the SESAR Joint Undertaking launched in 2013, nine co-funded demonstration projects within the SESAR1 framework and further work has been undertaken in SESAR 2020 Wave 1 projects. The principal predecessor project for RPAS insertion into controlled airspace is SESAR 2020 Wave 2 PJ.10.05 PROSA which mainly addressed RPAS Integration, while Accommodation concept was introduced without a definition of a set of specific requirements and relevant operating methods. There was limited focus at the time on MALE IFR RPAS accommodation in class A-C airspace in the short to mid-term.

In the current (reference) situation, MALE RPAS are already in regular military/state operations. Such operations require lengthy preparation, are under specific bi-lateral arrangements, and particularly under restrictions requiring airspace reservations for segregation from civil traffic, for example flying predefined reserved corridors to transit to their mission zones.

SESAR-W2 PJ13 Solution 115 was launched to resolve the lack defined above and to respond to the increasing existing RPAS user demand (mainly military) to deploy operational non-segregated RPAS accommodation, hence the V3 target. In parallel, operational RPAS flight experiments in non-segregated airspace have also been conducted over the period. Solution 115 has regularly coordinated with the external projects that conducted the trails.

The overall process as defined by SESAR PJ20, illustrated below was applied to establish this CBA.

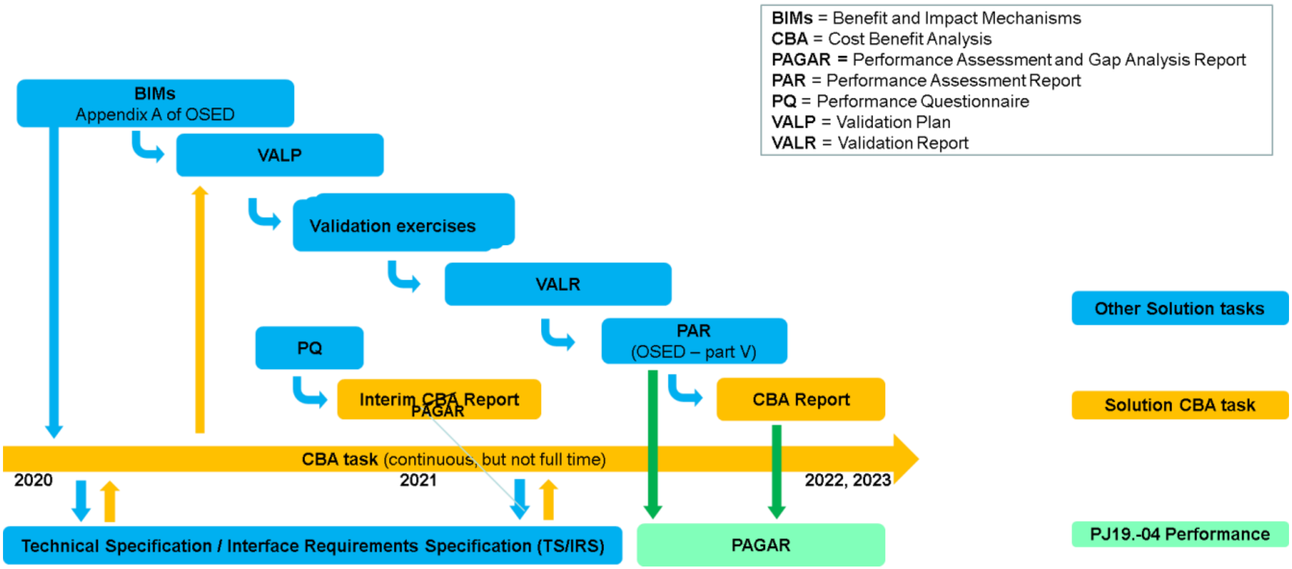

Figure 2: CBA establishment process in the solution

2.6 Glossary of terms

Term	Definition	Source of the definition
Net Present Value	Net Present Value (NPV) is the sum of all discounted cash inflows and outflows during the time horizon period.	*Investopedia*
Command and Control (C2) link	The data link between the remotely piloted aircraft and the Remote pilot (RP) station for the purposes of managing the flight.	*ICAO DOC 10019*
Enabler	New or modified technical system/infrastructure, human factors element, procedure, standard or regulation necessary to make (or enhance) an operational improvement. Note. Enablers are linked to Operational Improvement Steps that they support. The implementation of a set of Enablers allows an Operational Improvement Step to complete. Enablers are the means to implement the Change in the ATM Operational Environment	*SESAR ATM MASTER PLAN 2020*
Operational Improvement (OI)	An OI is a new or modified capability of the ATMS which introduces performance benefits in terms of Capacity, Efficiency (cost, time, fuel), Environment, Safety and Security. An OI is implemented by means of one or more Enablers which upgrade an existing capability (basic building block of the ATMS) or create a new one.	*SESAR ATM MASTER PLAN 2020*
Remote pilot (RP)	The person who manipulates the flight controls of a remotely piloted aircraft during flight time.	*ICAO DOC 10019*
Remotely piloted aircraft (RPA)	An unmanned aircraft which is piloted from a remote pilot station.	*ICAO DOC 10019*
Remotely piloted aircraft system (RPAS)	A set of configurable elements consisting of a remotely piloted aircraft, its associated remote pilot station(s), the required C2 links and any other system elements as may be required, at any point during flight operation	*ICAO DOC 10019*

Remote pilot station (RPS)/ Ground Control Station	The station at which the remote pilot manages the flight of an unmanned aircraft.	*ICAO DOC 10019*
TMA (Terminal Manoeuvring Area)	A terminal control area is a Control Area normally established at the confluence of Air Traffic Service (ATS) Routes in the vicinity of one or more major aerodromes.	*ICAO Annex 2: Rules of the Air*

Table 1: Glossary of terms

2.7 List of Acronyms

Acronym	Definition
ACC	Area Control Centre
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
AU	Airspace User
BIM	Benefit Impact Mechanism
C2 (link)	Command and Control link (between the RPS and the RPA)
C2LL	Command and Control Link Loss
CWP	Controller Working Position
ER	En Route
FOC	Full Operational Capability
GAT	General Air Traffic
IFR	Instrument Flight Rules
IOC	Initial Operational Capability
NPV	Net present value
PAR	Performance Assessment Report
PRR	Performance Review Report
RP	Remote Pilot
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft Systems
RPS	Remote Pilot Station

SESAR	Single European Sky ATM Research Programme
SOD	Start Of Deployment
S3JU	SESAR3 Joint Undertaking (Agency of the European Commission)
TMA	Terminal Manoeuvring Area

Table 2: List of acronyms

3 Objectives and scope of the CBA

3.1 Problem addressed by the solution

This document provides the V3 Cost Benefit Analysis (CBA) for the deployment of SESAR Project PJ.13 W2 ERICA, Solution 115 (PJ.13-W2-115). It focuses on short-medium term accommodation of MALE RPAS (Medium Altitude Long Endurance Remotely Piloted Aircraft Systems) flying under IFR (Instrument Flight Rules), and controlled/managed by Air Traffic Control (ATC) as GAT (General Air Traffic), in non-segregated shared classes A – C airspace amongst all other controlled traffic.

In the current (reference) situation, MALE RPAS are already in regular military/state operations. Such operations require lengthy preparation, are under specific bi-lateral arrangements, and particularly are under restrictions requiring airspace reservations for segregation from civil traffic, for example flying predefined reserved corridors to transit to their mission zones.

RPAS accommodation targets a response to the short to medium term user need. It relies on the existing mechanisms and systems already in place with minor improvements if necessary. The solution has defined specific provisions on flight planning and RPAS management by establishing harmonized **procedural improvements**.

The solution enables improved accessibility of existing/initial Medium Altitude Long Endurance Remotely Piloted Aircraft System (MALE RPAS) as a standard IFR flight to access and fly in controlled class A-C airspace as General Air Traffic (GAT) under Instrument Flight Rules (IFR) with **no segregation and no technical change to the existing ATM systems**. The RPAS are considered acquired, and the ATM systems and procedures already in operation. It takes into account some technical and compliance limitations that existing RPAS still have in the short-medium timeframe, and has defined a solution with suitable scope of operation, associated bounds, constraints and mitigations.

To the stakeholders, the solution delivers:

- To the RPAS operator: improvements to planning, approval and access like any other GAT IFR flight, for the RPAS transit segment : reduced planning lead-time to “file and fly”.
- To the ANSP : reduction, or elimination of reserved corridor creation activity and associated costs,
- To the Airspace users: Equity and improved efficiency to all the airspace users (all GAT flights including the RPAS), as segregated airspace is not used, thus increasing the available airspace and route options,
- To the RPAS operator: Non-segregated RPAS transit with flexibility to choose and replan IFR flight routes: regular routine RPAS flights in the accessible IFR airspace.
- To the ANSP (ATC): Traffic management in controlled A-C class airspace, as performed for IFR GAT flights, by civil air traffic controllers.
- To the European ANSP community: a simple concept which provides an iso-traffic management capability to encourage early adoption by those ANSPs having RPAS demand.

Due to the nature of the demand, the **solution only introduces a limited addition to existing operational procedures, compatible with the existing ATM framework and procedures used to manage manned traffic, and with minimum adaptation where needed**.

The CBA is assumptions are very simple: only on pre-deployment (reference) costs on creation of additional reserved RPAS mid-altitude corridor, and on the deployment (solution) costs on introduction of the adapted operational procedures (there are no systems change, neither in the ATM system nor in the existing RPAS systems). Solution deployment costs, in this V3 CBA are only related to limited additional Air Navigation Service Provider ANSP training.

For information, overall costs before (reference) and when the solution is deployed are :
Before deployment costs(reference):

- ANPSs incur long and resource consuming processed to create additional reserved RPAS mid-altitude corridor. This corridor creation activity is related to specific airspace design for RPAS transit with associated costs to the ANSP.
- ANSPs also incur implementation costs of reserved corridor display on ATCO HMI.
- Additionally all actors have associated airspace reservation processes effort.

Deployment implementation costs

- limited training costs for ANSPs (En-Route centres and those TMA high transit flights)
- Other minor evolution costs are negligible or already encompassed in regular changes for ANSPs.

Benefits are noted, but were difficult to monetize. They are associated, initially, to low numbers of a new type of additional airspace user, RPAS and efficiency gains to the other airspace users.

3.2 SESAR Solution description

SESAR Solution ID	Title
PJ.13-W2-115	IFR RPAS accommodation in Airspace Class A to C
The Solution is contributing to	
Key feature	Advanced Air Traffic Services
Essential Operational Change (EOC)	Multimodal Mobility and integration of all Airspace Users
Capability	Collaborative Trajectory Planning; Coordination and Transfer; Emergency Management; Separation Provision (airspace)
Operating Environment	
Sub-OEs	ER-Low, Medium (and Higher Complexity during low traffic periods[1]) sub-OEs. The Solution focuses on the RPAS transit phase, which concerns the En-Route[2] operating environments (OE). However when considering only transit operations, there are no differences between En-Route and Terminal airspace aircraft management (En-route transit operations are outside terminal manoeuvring, where the climb, cruise and descent phases of flight take place and within which, or part of which, area control service is provided by an ATC unit). Thus, the OEs of interest are En-Route OE and Terminal OEs where RPAS will cross for transit flights (with high ceilings).

[1] The solution would be applicable to airspaces classified as Higher Complexity as long the number of movements is similar or lower than the Medium Complexity OE one, e.g. during low traffic periods

[2] During RPAS accommodation the primary operation is RPAS transit in climb, descent and en-route manoeuvres, the only operating environment associated to the solution was the En-route OE, but also must encompass TMAs with high ceilings with transit flights which, with regard to the intent of SESAR OE definitions, is "extended TMA" and not strictly a TMA sector for the type of RPAS operations in transit. (Terminal manoeuvres – typically approach/departure to aerodromes - are not in the solution scope)

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Table 3: SESAR Solution 115 Summary

SESAR Solution ID	OI Steps ref.	OI Steps definition	OI step coverage	Source reference
SESAR Solution 115	**AUO-0619** RPAS accommodation in class A-C airspace	First step to accommodate IFR RPAS as General Air Traffic (GAT) in European airspace, during their transit phase through non-segregated controlled class A-C airspace. RPAS is managed alongside manned-aircraft traffic in En-Route and partly TMA airspace structure for climb/descent (which corresponds to En-route operating environment) only with accommodation rules and procedures (planning and execution phases, applicable to Remote pilots and ATC) and allowing to manage Command and Control link loss. It applies to the short to medium term, in airspaces of low to Medium complexity. Departure/arrival remain from/to dedicated airfields or dedicated mission areas. No technological changes are envisaged. The solution uses existing ATM technologies.	Full	SESAR Solution 115 Final SPR-INTEROP/OSED for V3 - Part I (D3.1.140, section 3)

Table 4: SESAR Solution 115 Scope and related OI steps

OI Steps ref.	Enabler ref.	Enabler definition	Enabler coverage	Applicable stakeholder	Source reference
	(R)		Full	Air Navigation Service Provider ANSPs (Civil and Military) • Civil ATS En-Route & Approach Service Provider; • Military ATS En-Route & Approach Service Provider RPAS	EATMA &

				Civil Unmanned Aircraft System; Military Unmanned Aircraft System;	SESAR Solution 115 Final SPR-INTEROP/OSED for V3 - Part I (D3.1.140, section 3)
	(R)	RPAS Accommodation in national regulations for IFR GAT flights	Full	Air Navigation Service Provider ANSPs (Civil and Military) • Civil ATS En-Route & Approach Service Provider; • Military ATS En-Route & Approach Service Provider RPAS Civil Unmanned Aircraft System; Military Unmanned Aircraft System;	

Table 5: OI steps and related Enablers

3.3 Objectives of the CBA

3.3.1 REFERENCE SCENARIO

Initial (existing) RPAS are already operated as OAT, in segregated airspace.

Pre deployment (reference):

- ANPSs incur long and resource consuming processed to create additional reserved RPAS mid-altitude corridor. This corridor creation activity is related to specific airspace design for RPAS transit with associated costs to the ANSP.
- ANSPs also incur implementation costs of reserved corridor display on ATCO HMI.
- Additionally all actors have associated airspace reservation processes effort.
- Finally, an important restriction exists to other airspaces users – the corridor reservation and activation/use has impact on their flight paths and thus efficiency.

3.3.2 DEPLOYMENT SCENARIO

WHAT: Solution OI step (AUO-0619) and Enablers (PRO-263, REG-535) are detailed in 3.2 SESAR Solution description

SOLUTION DEPLOYMENT /IMPLEMENTATION:

- ATCO training for the adapted operational procedures - limited training costs for ANSPs (En-Route centres, numbers used in this CBA, and for complete consideration extended to those TMA with high transit flights), similar to training for a new aircraft type with a specificity.

There are no significant systems change, neither in the ATM system. Existing RPAS systems are used as is (no costs). Other ANSP minor evolution costs are negligible or already encompassed in regular changes for ANSPs.

WHERE:

States/ANSP & ATS Units concerned: cf. Deployment spread & scenario below

Airspace: En-Route[1] operating environments (OEs) Low-Medium complexity (and includes units of higher complexity during low-medium traffic density periods), low density traffic conditions.

Data on ANSP unit numbers for the two scenarios and associated OEs was derived from PJ.20 which comes from EUROCONTROL ATM Cost Effectiveness data (ACE).

	ER-L	ER-M	ER-H	ER-VH	TMA-L (>FL100)	TMA-M (>FL100)	TMA-H (>FL100)	TMA-VH (>FL100)
France			**5**		**8**	**11**	**3**	**1**
Belgium				1				1
Italy		2	2		9	9	2	
Maastricht				1				
Netherlands				1		1		
Portugal	1	1			3	2		
Spain	1	3		1	6	4		
Switzerland				2	2	1		2
UK			1	1		3	2	2

Table 6: ANSPs / OE spread in scenario – RPAS accommodation assumption

Traffic : One RPAS per operating sector; Low numbers of RPAS during the accommodation timeframe.

DEPLOYMENT SCENARIO :

Two incremental reference & deployment scenarios, which are likely deployment steps over the timeframe from the V3 end of this solution (s115) to. In summary, these increments correspond to:

SCENARIO 1: The first state (France) that is already well advanced in RPAS accommodation trails on an experimental basis, and will rapidly move to the first initial deployment.

SCENARIO 2: 7 Additional neighbouring states (8 ANSPs) which have demand for RPAS accommodation, build on the solution and first state experience, and follow first initial deployment.

In the CBA each scenario has a reference and a deployment output.

3.3.3 DEPLOYMENT DATES & STAKEHOLDERS

Master Plan : DS23 Forecast Dates (cf. Figure 1: Overall deployment dates and ANSP scenarios).

[1] En-Route OE versus Terminal airspace OE for transit operations : there are no differences in the aircraft management (En-route transit flights are not performing terminal manoeuvring, only final climb, cruise and initial descent phases of flight, Terminal is for TMAs with high ceilings managing transit flights). The aircraft management manoeuvring specificities in Terminal airspace for departures and arrivals is out if scope of the solution.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Start of Deployment Date (SOD) 1-12-2023 (=> 2024 starting at first individual ANSP/state – FR implementation), expanding to additional neighbouring ANSPs/states having demand/interest in following years (2026-2030)

Benefits Start Date (IOC) 1-12-2024 (=>2025) : 1st ANSP (scenario 1 deploy single ANSP) , expanding to additional neighbouring ANSPs/states (scenario 2 deploy Add 8ANSPs) 2027

Full Benefit Date & Full Operational Capability (FOC) 1/12/2024 => 2025 1st ANSP (scenario 1 deploy single ANSP), expanding to additional neighbouring ANSPs/states (scenario 2 deploy Add 8 ANSPs) 2030

WHO:

Stakeholders (who deploys, who benefits)

RPAS airspace user: receives primary benefits – qualitative for this solution (rapid, flexible planning/re-planning, approval and access of a RPAS IFR flight) and non-segregated routine RPAS IFR transit with flexibility to choose and replan flight to all accessible IFR airspace.

ANSPs: are the primary stakeholder concerned by deployment costs/actions described in previous sections of this document.

ANSPs: are the primary stakeholder incurring, thus concerned by reduction of airspace design /publication processes and associated costs (related to reserved corridor creation)

ANSPs: receive secondary benefits : Identical Traffic management as for all IFR by civil air traffic controllers, and the whole ANSP community benefits from a simple concept under an this iso-traffic management capability providing a proven, scalable solution, which is rapid and easily adoptable when they have RPAS demand

All Airspace Users (including RPAS): receive benefit of improved efficiency, as non-segregated airspace is used, available airspace and route options /profile options are increased, and a secondary benefit of equity (no user is prioritised).

3.3.4 DEPLOYMENT PRE-REQUISITES

Pre-requisites, and assumptions of the baseline/what is already available and therefore available for the solution to use:

- Initial (existing) RPAS are have already been acquired by the operators and the accommodation concept only makes use of their existing capabilities (no cost/investment is expected for the RPAS operators).
- Accommodated RPAS no longer require segregated airspace for transit operations per the s115 concept.
- ANSPs deploying the concept will continue using existing ATM systems.
- ANSP’s ATCOs will continue using well known and implemented IFR procedures.

- Accommodated RPAS management induces one specific operational procedure, itself derived from, and similar to the IFR Radio communications procedure loss which requires short limited ATCO training.

3.5 Stakeholders[1] identification and impacts

Stakeholder	Stakeholder type and/or applicable sub-OE	Type of Impact	Involvement in the analysis	Quantitative results available in the current CBA version
NM & ANSP (Flight Planning)	Pre-Flight	No impact : Flight Plan information and filing though current ICAO FPL 2012 standard and associated NM & National level ATM systems and interfaces - The additional information for RPAS accommodation is managed in these systems (Remote Pilot phone number in Field 18 (RMK/)	DSNA, FRQ Validation (VALR)	
ANSP (Planning-Design)	Pre-flight	Airspace structure : Beneficial Impact : reduction/elimination in the design and process of specific RPAS transit airspace reserved structures	Inputs provided by DSNA	
ANSP (Flight Execution)	En-route ANS (this includes ANS centres where TMA ceilings are > ~FL100) / Low,Medium Complexity ACCs & TMAs (High complexity in	identical to any IFR flight, knowledge required by ATCOs of RPAS particularities (like for any new aircraft) : Impact : limited ATCO training (RPAS familiarisation, C2LL procedure) NOTA : ATCO training here is basic briefing/training (classic, comparing to other situations where particular traffic types were introduced, requiring knowledge of behaviour, and complements to phraseology (e.g., introduction of «Super" for A380 in initial contact));	Inputs provided by DSNA, NATS, ON + VALR conclusion	
		ATC can provide a Traffic management/control service with ease in controlled A-C class airspace, as performed for IFR GAT flights by regular GAT/civil air traffic controllers. Impact : Low / limited additional ATCO workload (considered equivalent); Neutral Safety impact. Sector capacity maintained.	DSNA Validation	

[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.

	low traffic conditions)	The simple concept available to the European ANSP community which provides an iso-traffic management capability to encourage early adoption by those ANSPs having RPAS demand		
		ATC system : use of existing vs. specific alerting code for C2LL during accommodation transition + HMI implementation : Impact : minor or none	Inputs provided by DSNA, NATS, ON + VALR	
Airlines (Mainline and Regional), **General Aviation**, *all IFR GAT flights* ***including the RPAS***	cf. above	Equity	DSNA Validation (VALR)	Qualitative
		Improved efficiency to all the airspace users, as segregated airspace is not used, thus increasing the available airspace and route options	DSNA Validation (VALR)	Qualitative
RPAS Operator (initial ops State/Mil.)	cf. above	No impact to planning tools and standardized interfaces (current ICAO FPL 2012) Reduction of planning lead-time and flexibility for replanning/changes to "file and fly => improvements to planning, approval and access to published IFR routes like any other GAT IFR flight.	FRQ Validation (VALR)	N/A (operationally & technically OK on the legacy based ICAO FPL 2012)
		Non-segregated RPAS transit with flexibility to choose and replan IFR flight routes: regular routine RPAS flights in the accessible IFR airspace	External inputs from MIL/RPAS stakeholders	Qualitative – per User input on reference scenario
		RPAS C2LL contingency preparation & pre-programmation : Impact none (already in existing RPAS capability and already preparation/pre-programmation in RPAS operations); Information available to Remote-Pilot to add in initial sector contact information. Higher flexibility for C2LL procedure change and flexible (non-fixed) daily routes.	DSNA Validation (VALR)	Qualitative

Table 7: SESAR Solution 115 CBA Stakeholders and impacts

EUROPEAN PARTNERSHIP

Co-funded by the European Union

3.6 CBA Scenarios and Assumptions

3.6.1 Reference Scenario

The reference for this CBA analysis is the situation of MALE RPAS flights operated before applying the concept of non-segregated RPAS GAT flights defined by the SESAR PJ.13 S115 solution. As already expressed, MALE military/state RPAS already operate within national airspace in several individual EU states.

Such operations are under **specific bi-lateral arrangements, under restrictions, segregated from civil traffic through reserved airspace** to transit to their mission zones.

The costs applied to this reference scenario is the **specific airspace design for RPAS mid-level transit corridors.**

Other reference costs do exist. They were not available to be used in this CBA evaluation, and are related to corridor representation on the CWPs, preparation process per RPAs flight, briefing/training of the concerned OAT/MIL ATS units/controllers and impact on flight path efficiency of other airspace users which can become significant as the number of RPAS operations increase in the future.

3.6.2 Solution Scenario

The key points for the CBA Analysis in the target scenario are:

- **RPAS** are have already been **acquired by the operators (no cost/investment is expected for the RPAS operators)**. The accommodation concept only makes use of their existing capabilities .
- **ANSPs** deploying the concept will **continue using existing ATM systems.** Even if ANSPs have minor modifications depending on one deployment change related to the Controller Working Position alerts when a RPAS C2 link loss occurs, the minor evolution costs are negligible or already encompassed in regular changes for ANSPs – they are only noted here for completeness and are not costed in the CBA analysis.

  Europe wide, ANSPs having RPAS accommodation demand, are assumed to deploy in an incremental deployment scenario.
- ANSP's **ATCOs will continue using well known and implemented IFR procedures**.

  Accommodated RPAS management induces one specific operational procedure, itself derived from, and similar to the IFR Radio communications procedure loss.

As a result The only CBA factor (cost) for deployment/implementation is limited ATCO training costs on RPAS familiarisation and on the specific operational procedure, which is similar to training when particular/new traffic types enter into service.

Data on ANSP unit numbers is provided in section 3.3.2 DEPLOYMENT SCENARIO (Table 6: ANSPs / OE spread in scenario – RPAS accommodation assumption).

Data used in the CBA figures below on associated ATCO spread per OE numbers was derived from the EUROCONTROL Performance Review Unit / ATM Cost Effectiveness data (Source data : ATM Cost-Effectiveness (ACE) 2019 Benchmarking Report; Performance Review Unit, May 2021 - and Annex 5 - Table 0.5: Total staff and ATCOs in OPS data).

Data on the costs was derived from project stakeholder input.

The source data is documented in section 12 (Appendix B – ANSP Stakeholder Inputs on impacts).

3.6.3 Assumptions

SCENARIO 1 REFERENCE:

France experience of implementing costs of Airspace design for specific RPAS segregated corridor structure : ~200 k€ per implementation – two segregated corridor structures were implemented, North and South.

The overall reference cost may be under-costed due to other unavailable reference data (corridor representation on the CWPs, lengthy preparation process per RPAs flight, briefing process of the concerned OAT/MIL ATS units/controllers.

DEPLOYMENT SCENARIO 1 & 2

As the ATS unit individual ATCO numbers are not available in this source, the number of ATCOs that has been used is the total ACC number (associated to the ER-OE costed in this CBA).The cost may be over-costed as it is high estimate training cost per ATCO per day, and as summary data further in the document shows it can be greatly reduced or even be nil.

Country	ANSP	ACC ATCOs		
France	DSNA	1551	**SCN 1**	**1551**
Belgium	Skeyes	76		
Italy	ENAV	811		
Maastricht	MUAC	229		
Netherlands	LVNL	73		
Portugal	NAV Portugal (Cont)	78	**SCN2**	**3298**
Spain	ENAIRE	1045		
UK	NATS (Cont)	850		
Switzerland	Skyguide	136		

Table 8: Investment data : number of ATCOs to be trained per ANSP

ATCO numbers to be trained

Scenario 1: all 5 FR ACCs = 1551 ATCOs

Scenario 2: Total ATCOs in ACCs of additional ANSPs in scenario 2 = 3527 ATCOs

Note: The Scenarios are incremental - France ATCO training costs are not recounted (double-count) in scenario 2 as FR is the first state to deploy (scenario 1) and have already deployed when scenario 2 starts.

- ATCO training : RPAS specificities and Phraseology addition / briefing note on the 2 added elements at initial contact costed at 2 k€ for 1 training day per ATCO, as a base high estimate per ANSP. There is no opportunity cost (loss of operational ATCO periods) as the training day is assumed part of the regular training periods of the ATCO

- ATC systems alerting configuration : minor costs, already encompassed in ANSP regular updates / plans.

4 Benefits

4.1 Performance and Validation Targets

Solution 115, taking into account the low number (one single) of RPAS per control sector, meets the specific validation targets associated to the allocated transversal areas: Safety (ER MAC) and Human Performance –maintaining the existing levels (i.e. no degradation).

4.2 Qualitative Benefits

Solution 115 also highlighted qualitative benefits mechanisms that the RPAS user benefits form improved access to the airspace, and that equity is ensured all airspace users, RPAS included.

In more detail, the solution validated and confirms the following benefits:

- RPAS operator benefit: improvements to planning, approval and access like any other GAT IFR flight, for the RPAS transit segment: reduced planning lead-time to "file and fly".
- RPAS operator benefit: Non-segregated RPAS transit with flexibility to choose and replan IFR flight routes: regular routine RPAS flights in the accessible IFR airspace.

- ANSP (ATC) benefit: Traffic management in controlled A-C class airspace, as performed for IFR GAT flights, by civil air traffic controllers.
- ANSP community benefit: a simple concept, which provides an iso-traffic management capability to encourage early adoption by those ANSPs having RPAS demand.

- Airspace users benefit: Equity and improved flight path efficiency to all the airspace users (all GAT flights including the RPAS). As segregated airspace is not used, there is increase in the available airspace and route options.

5 Cost assessment

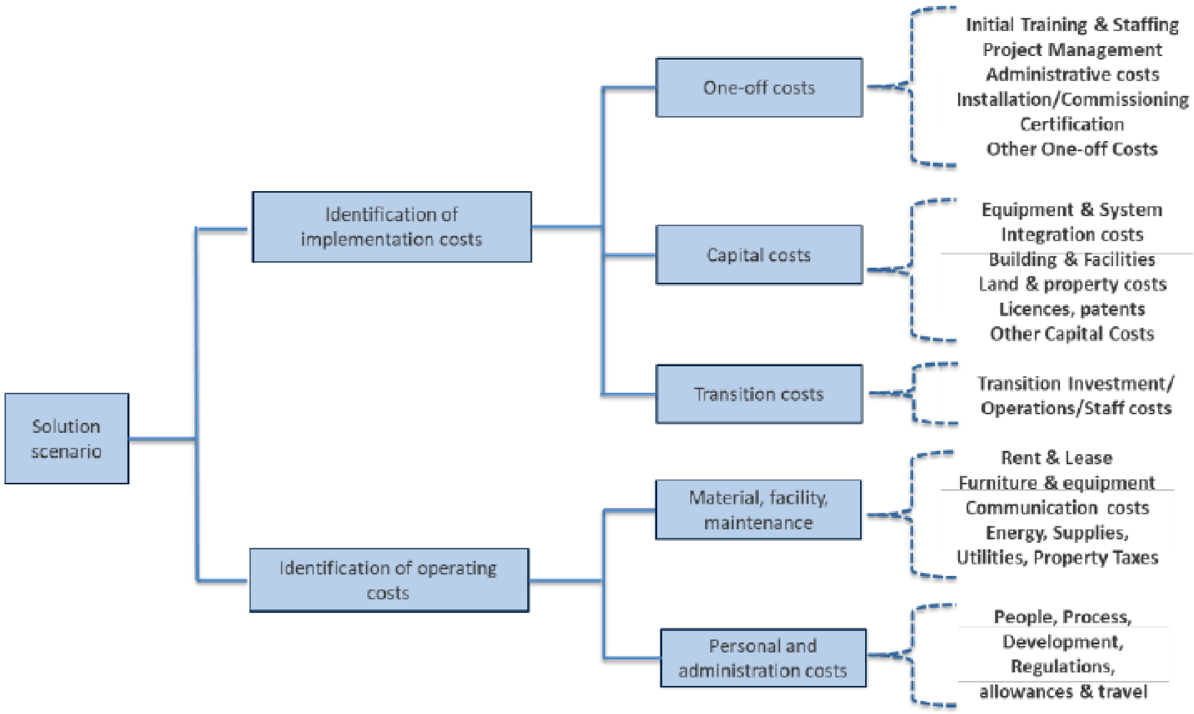

Figure 3: Cost assessment process

The only cost factors used in the CBA analysis are defined and described in Section 3.6.

5.1 ANSPs costs

Solution 115 does not require any ANSP technical enablers.

It does require the cost elements defined and described in section 3.6 CBA Scenarios and Assumptions which are used in the CBA cost model :

• (Reference Scenario) ANSPs airspace design costs for segregated RPAS transit, which is the cost of the “do nothing” scenario.

• (Solution scenario) Limited ANSPs training costs for relevant ATCOs (En-Route centres), mapped to a situation where any new aircraft with a particular characteristic starts service. The training is on RPAS familiarisation and on training of the specific RPAS C2LL characteristic and associated operational procedure.

.

5.1.1 ANSPs cost approach

The context of RPAS accommodation from initial RPAS operators is first and in the short-term an increasing national or limited zone demand.

Hence, this CBA assumes that RPAS accommodation deployment will take place incrementally, on an individual ACC unit basis in a first state, and then expanded to additional neighbouring states, which have demand for RPAS accommodation.

Two incremental reference & deployment scenarios are evaluated in this CBA:

SCENARIO 1 (ref. & deploy): The first ANSP/state reference costs and solution deployment costs.

This scenario is assumed as a one-off reference cost in 2024. The solution deployment start is 2024, and IOC & FOC by 2025.

SCENARIO 2 (ref. & deploy): increment to scenario 1, 8 Additional neighbouring ANSPs/states follow first initial deployment.

This scenario is assumed as a one-off reference cost per ANSP in 2026. The solution IOC is 2027 for these neighbouring ANSPs, FOC is 2030.

5.1.2 ANSPs cost assumptions

SCENARIO 1 & 2 (REFERENCE):

- 200 k€ per ANSP, and per implementation of a specific segregated corridor structure for RPAS

In this CBA, for the fisrt ANSP (FR) the ref. cost of the 2 corridor structures was used (2*200 k€).

For the added ANSPs in scenario 2, the number of reference corridor structures is unknown, therefore only one specific segregated corridor structure cost per ANSP is assumed at the same base cost of200 k€ .

DEPLOYMENT : Each ANSP will incur a minor one-off cost for deployment is limited ATCO training costs on RPAS familiarisation and on the specific operational procedure, which is similar to training when particular/new traffic types enter into service.

SCENARIO 1 DEPLOYMENT:

- First ANSP (FRANCE) ATCOs to be trained : **1551 ATCOs**

SCENARIO 2 DEPLOYMENT:

- Additional neighbouring state/ANSPs ATCOs to be trained : additionally **3298 ATCOs**

5.1.3 Number of investment instances (units)

Per the previous assumptions and scenarii, the ANSPs Units and associated number of ATCOs are in Table 8: Investment data : number of ATCOs to be trained per ANSP.

5.1.4 Cost per unit

Using the data that was available in the project, cost elements and data identified in the preceding sections, the ANSP cost summary per unit that has been used in the CBA tool :

Cost category	En-route VH & H, M, L
Pre-Implementation (Reference)	200 k€ => 0.2 M€ for each transit corridor structure
Implementation costs (solution deployment)	Low estimate : 0 k€ : encompassed in brief/recurrent training High estimate (CBA cost assumption) : 2 k€ (1 day of training) x nb. ATCOs per unit to be trained SCENARIO 1 : 2*1551 = 3102 k€ => 3.1 M€ SCENARIO 2 : 2*3298 = 6596 k€ => 6.6 M€
Operating costs	0 k€ Equivalent to regular operating costs

Table 9: Cost per Unit – ANSP costs

5.2 Network Manager costs

N/A:

For the short-term accommodation period the current flight planning method and interfaces is compatible with the existing Network Manager and ANSP methods and interfaces for ICAO FPL 2012, thus no costs are included.

5.2.1 Network Manager cost approach

N/A

5.2.2 Network Manager cost assumptions

N/A

5.2.3 Network Manager cost figures

N/A

5.3 Airspace User costs

N/A:

For the short-term accommodation period the RPAS are have already been acquired by the operators (state/military RPAS) and the solution is defined for such RPAS to be used at no additional cost in their existing configuration.

There is no quantified impact on RPAS operator benefits, neither to other manned aviation airspace users available.

5.3.1 Airspace User cost approach

N/A

5.3.2 Airspace User cost assumptions

N/A

5.3.3 Number of investment instances (units)

N/A

5.3.4 Cost per unit

N/A

5.4 Military costs

N/A: (cf. 5.3 Airspace User costs)

5.4.1 Military cost approach

N/A

5.4.2 Military cost assumptions

N/A

5.4.3 Number of investment instances (units)

N/A

5.4.4 Cost per unit

N/A

6 CBA Model

The single solution CBA model (Version s7.3.8) has been fed with data from section 5. The data is input into Sol. Info. ANSP / Ground cost cell for each the 4 scenarios : 2 reference and 2 deployment.

S115(CBAtool)-post-delivery3.xlsm

7 CBA Results

The investment costs per stakeholder (ANSPs are the only concerned stakeholders for S115), discounted and undiscounted, for each scenario are extracted below from the single solution CBA tool output.

From the same tool, the cash flow (CAPEX, discounted and undiscounted, and Costs-Benefits) per stakeholder (ANSPs only concerned), for each of the scenarios are extracted below. As only costs have been fed to the CBA tool, the output indicates a negative CAPEX.

Scenario 1ref. (reference single state (FR) investment)

Capex-Opex-Benefits

Sol 115 - 2024-2030 (discounted 8%) (M€) — Discounted

	NPV	Capex	Opex	Benefits
ANSP	-0.343	-0.343	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-0.34	-0.34	0.000	0.000

Capex-Opex-Benefits

Sol 115 - 2024-2030 (undiscounted) (M€) — Undiscounted

	Net Benefits	Capex	Opex	Benefits
ANSP	-0.400	-0.400	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-0.4	-0.4	0.0	0.0

Scenario 1 deploy. (solution deployment single state (FR) investment)

Capex-Opex-Benefits

Sol 115 - 2024-2030 (discounted 8%) (M€) — Discounted

	NPV	Capex	Opex	Benefits
ANSP	-2.658	-2.658	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-2.66	-2.66	0.000	0.000

Capex-Opex-Benefits

Sol 115 - 2024-2030 (undiscounted) (M€) — Undiscounted

	Net Benefits	Capex	Opex	Benefits
ANSP	-3.100	-3.100	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-3.1	-3.1	0.0	0.0

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Scenario 2 ref. (reference 8 additional ANPs investment)

Capex-Opex-Benefits

Sol 115 - 2024-2030 (discounted 8%) (M€) — Discounted

	NPV	Capex	Opex	Benefits
ANSP	-1.270	-1.270	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-1.27	-1.27	0.000	0.000

Capex-Opex-Benefits

Sol 115 - 2024-2030 (undiscounted) (M€) — Undiscounted

	Net Benefits	Capex	Opex	Benefits
ANSP	-1.600	-1.600	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-1.6	-1.6	0.0	0.0

Scenario 2 deploy. (solution deployment 8 additional ANPs investment)

Capex-Opex-Benefits

Sol 115 - 2024-2030 (discounted 8%) (M€) — Discounted

	NPV	Capex	Opex	Benefits
ANSP	-4.338	-4.338	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-4.34	-4.34	0.000	0.000

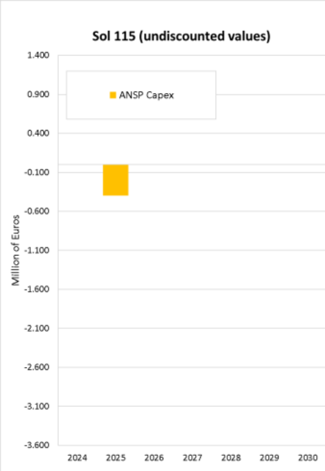
Capex-Opex-Benefits

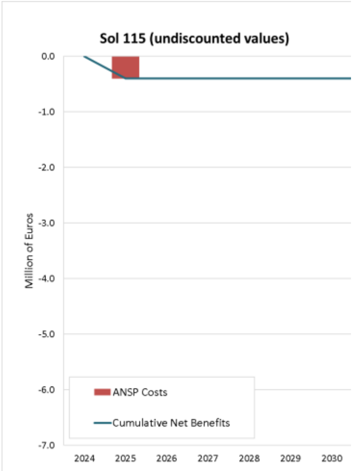
Sol 115 - 2024-2030 (undiscounted) (M€) — Undiscounted

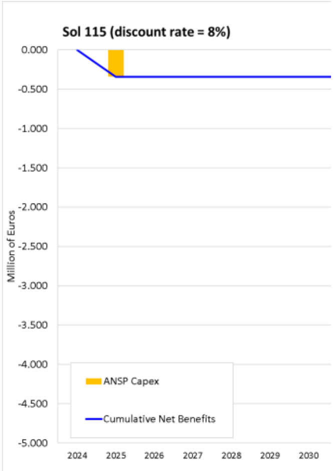
	Net Benefits	Capex	Opex	Benefits
ANSP	-6.600	-6.600	0.000	0.000
Airports	0.000	0.000	0.000	0.000
Network Manager	0.000	0.000	0.000	0.000
Business Aviation	0.000	0.000	0.000	0.000
Scheduled Aviation	0.000	0.000	0.000	0.000
RPAS-Civil	0.000	0.000	0.000	0.000
RPAS Military	0.000	0.000	0.000	0.000
Overall	-6.6	-6.6	0.0	0.0

For these scenarios, the ANSP CAPEX, and the Cost charts are :

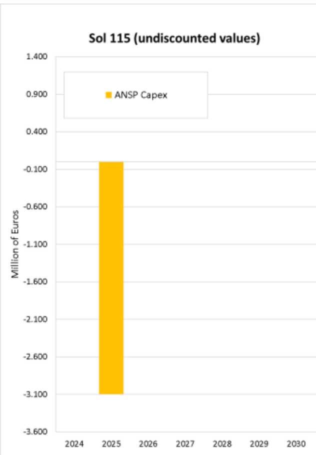
Scenario 1ref. (reference single state (FR) investment)

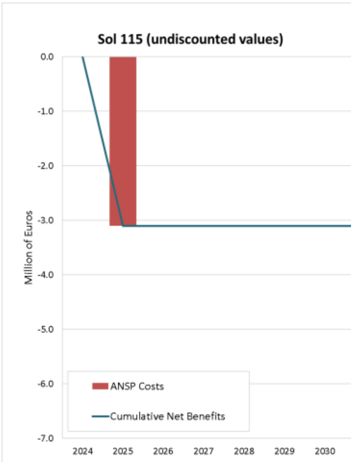


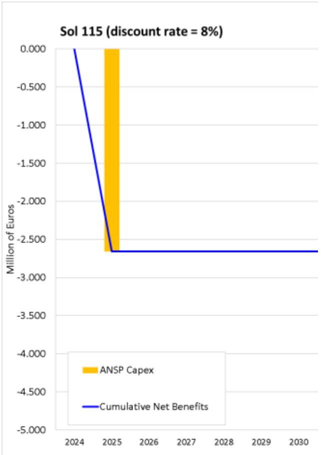




Scenario 1 deploy. (solution deployment single state (FR) investment)







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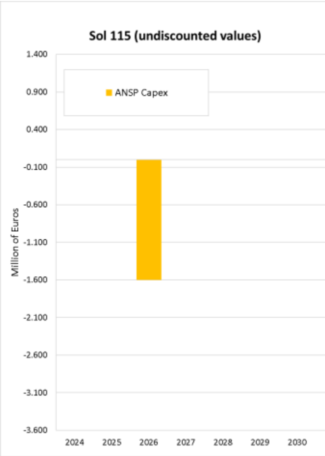
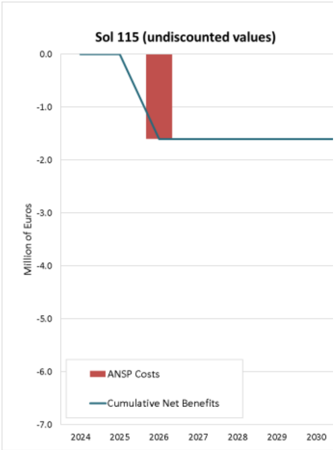
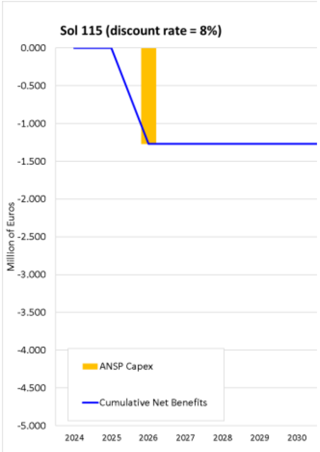
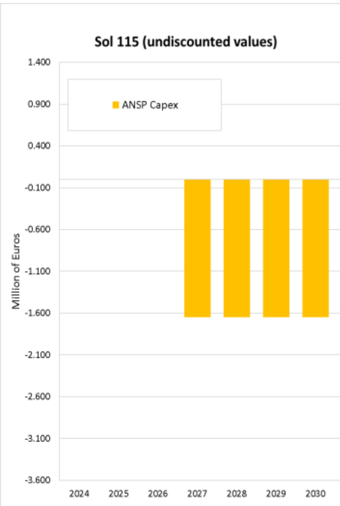
Scenario 2 ref. (reference 8 additional ANPs investment)

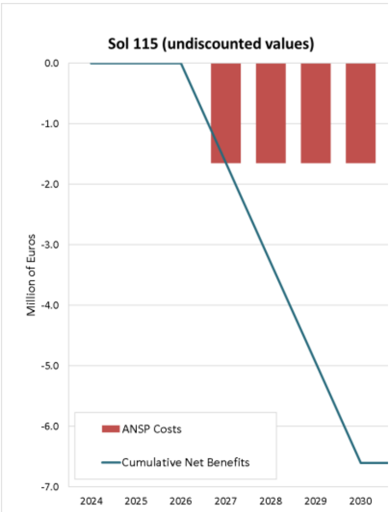


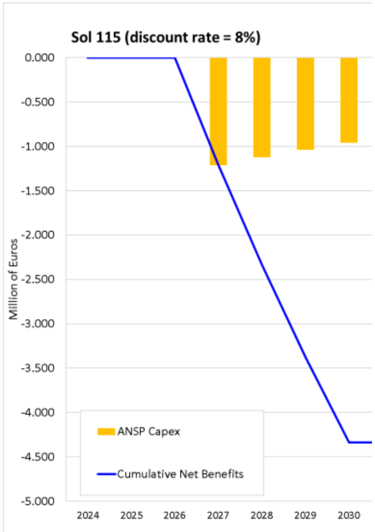




Scenario 2 deploy. (solution deployment 8 additional ANPs investment)







8 CBA Sensitivity and risk analysis

No sensitivity is analysed through the CBA tool.

The principal elements that will affect the CBA results :

- Refined and additional reference costs on :
  - ANSP corridor airspace design
  - ANSP data management and implementation of reserved corridor display on ATCO CWP HMI
  - Briefing/training costs that are also incurred in existing of the concerned OAT/MIL ATS units/controllers
  - Reservation processes effort
- Refined and additional depoyment costs/benefits on :
  - The number of ATCOs to train
  - The quantity (fixed costs &) of training
  - The nb. of hours training hourly rate
  - The exact ATS unit spead concerned by RPAS accommodated flights
  - The improvement to RPAS operations: in planning/re-planning, approval and access of a RPAS IFR flight)process improvements and in flight route accessibility
- Finally, an important restriction exists to other airspaces users – the corridor reservation and activation/use has impact on their flight paths route/profile and thus efficiency and will become more significant as the number of RPAS operations increase in the future.

9 Recommendations and next steps

During the next phase (V4, industrialisation/implementation), ANSPs and RPAS operators planning to deploy will be in a position to refine the data used in this CBA.

10 References and Applicable Documents

10.1 Applicable Documents

[1] SESAR Project Handbook;

[2] Guidelines for Producing Benefit and Impact Mechanisms;

[3] Methods to Assess Costs and Monetise Benefits .

[4] SESAR Cost-Benefit Analysis Model[7]

[5] Cost Benefit Analyses – Standard Input

[6] Cost Benefit Analyses – Method to assess costs

[7] ATM CBA Quality checklist

[8] Methods to Assess Costs and Benefits for CBAs

10.2 Reference Documents

[9] Common assumptions

[10] European ATM Master Plan Portal https://www.atmmasterplan.eu/

[11] Performance Framework

[12] SESAR Solution 115 Final SPR-INTEROP/OSED for V3 (D3.1.140)

[13] SESAR 2020 PJ13 Solution 115 VALR (D3.1.030)

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

11 Appendix A

Mapping between ATM Master Plan Performance Ambition KPAs and SESAR Performance Framework KPAs, Focus Areas and KPIs, source reference *[11]*

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

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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
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
	PA3 - 5-10% reduction in fuel burn			FEFF1	Average fuel burn per flight
Environment	PA8 - 5-10% reduction in CO_2 emissions			(FEFF2)	CO_2 Emissions
Safety	PA9 - Safety improvement by a factor 3-4	Safety	Accidents/incidents with ATM contribution	<SAF1>	Total number of fatal accidents and incidents
Security	PA10 - No increase in ATM related security incidents resulting in traffic disruptions	Security	Self- Protection of the ATM System / Collaborative Support	(SEC1)	Personnel (safety) risk after mitigation
				(SEC2)	Capacity risk after mitigation
				(SEC3)	Economic risk after mitigation
				(SEC4)	Military mission effectiveness risk after mitigation

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

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12 Appendix B – ANSP Stakeholder Inputs on impacts

12.1 Oro navigacija (ON) inputs on C2LL SQUAWK code and on ATCO training

1. Transponder code – C2L management (not about 7400), about system reaction perspective (specific color and alert): Answer from our programmer was, that it is no problem on implementing that, since our system is still on maintenance period, it could be implemented for free, and it would take up to 1 year.

2. Impact on ATCO training in Accommodation phase. Answer: ATCs would need a short training, because they already accustomed to work with RPAS. So, such situations, as radar contact loss of aircraft, FPL processing, loss of communication and other non-ordinary situations would need to be trained during training, which will take (according to our opinion) about 3h for one air traffic controller. Due to the fact, that we have 37 of them, it will cost about 2200 euros.

12.2 EUROCONTOL (MUAC) input on C2LL SQUAWK code

For MUAC, the A7400 display has been agreed with SMART and skeyes (Belgian ANSP) actually. A7400 will be displayed in the future with yellow "R" (similar to existing S/R/H/E indication)

12.3 DFS input on C2LL SQUAWK code

DFS have not integrated any special procedure relating the usage of the SQ 7400. They use it today as any other normal Squawk indication. DFS is waiting for the official government statement regarding the usage. They do not see any difficulties to introduce 7400 (including certain indication) as a special Squawk.

12.4 NATS input on C2LL SQUAWK code

I can confirm that NATS have used the code 7400 successfully during RPAS flight trials and tested it on our ATC systems at our 2 centres. The code is displayed slightly differently at each centre. At one centre 7400 triggers 'UAV Link Lost' to be displayed on the track data block. At both centres the track data block flashes to alert the controller.

This was implemented using existing functionality/adaptation at no cost.

12.5 DSNA inputs (training, reserved corridor airspace design)

Cost of corridor creation for RPAS in French Airspace:

1 Full-Time Equivalent (FTE) for a year

Additional costs, of implementation of reserved corridor display on ATCO HMI, were incurred (value unavailable)

Phraseology change:

Phraseology (2 additional elements to be used for ATCOs anticipated awareness in case of C2 link loss - provided by Remote Pilot over R/T following initial contact information : Diversion Waypoint ident. & Diversion Aerodrome).

This can be provided to ATCOs though a briefing note – cost is negligible.

Additional training to introduce ATCOs to RPAS particularities:

This training could be considered as an informative animated session to fostering questions. It is part of the usual informative sessions, then only the cost of the support has to be taken into account.

The cost would be minor, below or within the cost estimates provided for ATCO training in these appendices.

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12.6 PJ13 – cross solution data for ANSP training (source from PJ13/S117)

The following data is extracted for PJ13 Solution S117 CBA analysis

Feedback from ON

Price of course should be calculated per hour per ATCO. As you rightly mentioned that average ATCO cost per hour is €119. We took Luxembourg institute examples of courses price for ATCOs. We took three example and in everyone case the price was €46.25 per hour. – It is a price of 1hour at training organization for 1 ATCO. As said above we took several examples at Eurocontrol Institute at Luxembourg and in all cases price of training for one ATCO was 46.25. So we assumed, that **cost of 1hour of training would be 165euros**. 119+46.25=165.

ENAV

1. Current One-Off Cost Proposal (ENAV)

Note: As updated for latest ACE benchmarking report for 2020 with 2021-2024 outlook May be split according to size of ANSP…

Cost of ATCOs attending per ANSP:

- The training period 5 ATCO days (including resting days)
- The opportunity cost : €131 per hour
- 38 ANSPs with a total of 9660 ATCOs in operations for 2019. This equates to an average of 254 ATCOs per ANSP.

*# of ATCO days * # of ATCO hours/day * # of ATCOs * ATCO cost/hour = 5*8*254*131 = €1.3M*
Cost of Training Course per ANSP:

- The training fees requested by the training entity: **€1,428 per training day**.
- Each training session should include a maximum of 12 controllers, which, for an average number of 254 ATCOs, will require 21 training sessions per ANSP.

*# of training days/session * # of training sessions * cost/training day = 3*21*1428 = €89.9K*

2. Annual ATCO Update Training

Assumptions:

- Annual -- required to maintain ATCO licencing
- 8 hours a year training per ATCO on Solution related aspects
- 95% of ATCOs retained i.e. previously trained on Solution

Cost of ATCOs attending per ANSP:

- The training period 1 ATCO day
- The opportunity cost : €131 per hour
- 38 ANSPs with a total of 9660*0.95 = 9177 retained ATCOs in operations: an average of 241 ATCOs per ANSP.

Annual Cost:
*# of ATCO days * # of ATCO hours/day * # of ATCOs * ATCO cost/hour = 1*8*241*131 = €253K*
Cost of Training Course per ANSP:

- The training fees requested by the training entity: €1,428 per training day.
- Each training session has a maximum of 12 controllers; average of 241 ATCOs, will require 20 training sessions per ANSP.

Annual Cost:

*# of training days/session * # of training sessions * cost/training day = 1*20*1428 =* €28.6K

Alternative view: No additional recurrent ATCO or training course provision costs

Recurrent Solution update training for ATCOs is absorbed into existing recurrent training with no additional time required. It is noted that recurrent training may be "on-the-job" conducted by in-house trainers.

3. Annual new ATCO Training

Assumptions:

- Proportion of one-off ATCO training costs
- Annual 5% turnover of ATCOs

Cost of ATCOs attending per ANSP:

- The training period 5 ATCO day
- The opportunity cost : €131 per hour
- 38 ANSPs with a total of 9660*0.05 = 483 new ATCO in operations. This equates to an average of 13 ATCOs per ANSP.

Annual Cost:

*# of ATCO days * # of ATCO hours/day * # of ATCOs * ATCO cost/hour = 5*8*13*131 =* €68.1K

Cost of Training Course per ANSP:

- The training fees requested by the training entity: €1,428 per training day.
- Each training session should include a maximum of 12 controllers, which, for an average number of 13 ATCOs, will require 2 training sessions per ANSP.

Annual Cost:

*# of training days/session * # of training sessions * cost/training day = 5*2*1428 =* €14.3K

Alternative view: No on-going additional cost for new ATCO training.

The Solution is absorbed into the existing standard training for new ATCOs with no additional ATCO days required and the training course includes inclusion of any required updates etc.

12.7 ATM Cost-Effectiveness (ACE) 2019 report Benchmarking Report data - ACE Annex 5 Table 0.5 data

PJ.20 provided ANSP data (ACE Benchmarking Report derived) and OEs

En-route & Terminal
Airspace OEs_Octobe

ATM Cost-Effectiveness (ACE) 2019 report Benchmarking Report - Annex 5 Table 0.5 data

ACE2019-Annex5-Tab
le 0.5.xlsx

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